DAVID A. PATERSON
GOVERNOR

PETER M. IWANOWICZ
ACTING COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233-1010

NOV 2 3 2010

Honorable Malcolm A. Smith
President Pro Tempore
New York State Senate
909 Legislative Office Building
Albany, New York 12247

Dear Senator Smith:

Enclosed is the report *Potential Reuses of Greywater and Reclaimed Wastewater in New York State* issued pursuant to Chapter 619 of the Laws of 2005.

Chapter 619 required the Department of Environmental Conservation (DEC), in consultation with the Department of Health, to conduct a study of potential uses of greywater and reclaimed wastewater in New York State and develop a strategy for promoting water reclamation projects. This report presents the findings from that study.

The study confirmed that while most of New York has an abundant supply of water, population density and growth in some areas of the state are beginning to exert stress on potable water sources and local water supply infrastructure. Droughts have led to use restrictions in the Hudson Valley, New York City and Rockland County. Other areas of the state, notably Long Island, have limited options to bring in fresh water from beyond their borders. Interest in reuse projects in the state is increasing as population pressures and water needs expand.

The report recognizes that except on Long Island, there is no explicit state control over water withdrawals other than for public water supply. This fact highlights the importance of implementing a comprehensive statewide water management program, as proposed in Governor's Program Bill #51.

This bill (S.8280-A) passed the Senate earlier in this session. Thank you for passing this important legislation. This legislation would result in providing DEC with more comprehensive information on water uses across the state and allow us to better manage New York State's water resources, which will become increasingly important as water availability varies due to stressors such as population density and climate change.

Additionally, this legislation would allow DEC to meet one of its obligations under the Great Lakes-St. Lawrence River Basin Water Resources Compact. Under the Compact, DEC must implement a regulatory program for all water withdrawals in New York's portion of the Great Lakes Basin by December 2013.

Thank you again for passing this important piece of legislation. It will ensure DEC has the authority necessary to effectively manage the state's water resources now and into the future.

Please call me at 402-8540 if you have any questions about the report.

Sincerely,

Peter M. Iwanowicz

Enclosure

DAVID A. PATERSON
GOVERNOR

PETER M. IWANOWICZ
ACTING COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK 12233-1010

NOV 2 3 2010

Honorable Sheldon Silver
Speaker
New York State Assembly
932 Legislative Office Building
Albany, New York 12248

Dear Speaker Silver:

Enclosed is the report *Potential Reuses of Greywater and Reclaimed Wastewater in New York State* issued pursuant to Chapter 619 of the Laws of 2005.

Chapter 619 required the Department of Environmental Conservation (DEC), in consultation with the Department of Health, to conduct a study of potential uses of greywater and reclaimed wastewater in New York State and develop a strategy for promoting water reclamation projects. This report presents the findings from that study.

The study confirmed that while most of New York has an abundant supply of water, population density and growth in some areas of the state are beginning to exert stress on potable water sources and local water supply infrastructure. Droughts have led to use restrictions in the Hudson Valley, New York City and Rockland County. Other areas of the state, notably Long Island, have limited options to bring in fresh water from beyond their borders. Interest in reuse projects in the state is increasing as population pressures and water needs expand.

The report recognizes that except on Long Island, there is no explicit state control over water withdrawals other than for public water supply. This fact highlights the importance of implementing a comprehensive statewide water management program, as proposed in Governor's Program Bill #51, introduced in the Assembly as A.11436-B. The Senate has already passed this bill. We urge the Assembly to pass this bill this year so DEC can begin to implement a program to regulate all significant water withdrawals in the state.

This legislation would result in providing DEC with more comprehensive information on water uses across the state and allow us to better manage New York State's water resources, which will become increasingly important as water availability varies due to stressors such as population density and climate change.

Additionally, this legislation would allow DEC to meet one of its obligations under the Great Lakes-St. Lawrence River Basin Water Resources Compact. Under the Compact, DEC must implement a regulatory program for all water withdrawals in New York's portion of the Great Lakes Basin by December 2013.

Without this new program, New York State will continue to lack the necessary data to fully understand the statewide level of demand for water supply, commercial, industrial and agricultural use, and our ability to meet future demand in a changing climate. Please pass A.11436-B this year to ensure DEC has the authority necessary to effectively manage the state's water resources now and into the future.

Please call me at 402-8540 if you have any questions about the report or the importance of passing A.11436-B this year.

Sincerely,

Peter M. Iwanowicz

Enclosure

David A. Paterson
Governor

Peter M. Iwanowicz
Acting Commissioner

State of New York
Department of Environmental Conservation
Albany, New York 12233-1010

NOV 2 3 2010

Honorable David A. Paterson
Governor of New York State
New York State Executive Chamber
State Capitol
Albany, New York 12224

Dear Governor Paterson:

Enclosed is the report *Potential Reuses of Greywater and Reclaimed Wastewater in New York State* issued pursuant to Chapter 619 of the Laws of 2005.

Chapter 619 enacted a new Title 6 in Environmental Conservation Law Article 15—Water Efficiency and Reuse—the purpose of which was to actively "promote the reuse of reclaimed wastewater for landscape irrigation, and wetland maintenance, as well as suitable industrial, commercial, residential, and agricultural purposes." It required the Department of Environmental Conservation, in consultation with the Department of Health, to conduct a study of potential uses of greywater and reclaimed wastewater in New York State and develop a strategy for promoting water reclamation projects. This report presents the findings from that study.

Please call me at 402-8540 if you have any questions about the report.

Sincerely,

Peter M. Iwanowicz

Enclosure

Potential Reuses of Greywater and Reclaimed Wastewater in New York State

New York State Department of Environmental Conservation

November 2010

About the cover: Within the traditional recycling arrows is a final clarifier of the Albany County Sewer District, soon to be the largest provider of reclaimed water in New York State. At left is a color infrared aerial photo of a municipal golf course at Canton, vivid pink due to being well watered by treated wastewater from the Canton municipal wastewater plant. At right is The Solaire, a green building in Battery Park City in Manhattan, which has an internal 25,000 gallon per day treatment plant that reclaims the building's sewage for toilet flushing, evaporative air conditioning and landscape irrigation. At bottom is an anonymous set of cooling towers. Will these one day be supplied with reclaimed water instead of needing potable water or taking water from the environment?

Executive Summary

Overview

Water is an essential resource that must be carefully managed and actively conserved. To ensure that all means of protecting the state's water supply are pursued, New York has begun to use reclaimed wastewater for non-drinking water purposes, including landscape irrigation, wetland maintenance, and other industrial, residential and agricultural uses. This report, a feasibility study mandated by New York State's 2005 Water Efficiency and Reuse Law, assesses the potential for exploiting the reuse of two water sources:

- Greywater, as defined in the 2005 law, which includes all water from bathtubs, showers, washing machines, dishwashers and sinks, but excludes discharges from toilets, urinals, and all industrial sources.
- Reclaimed wastewater, which is discharged from municipal waste water treatment plants (WWTP).

Currently water reuse projects in New York account for less than one tenth of one percent of the natural water flow in the state. They are regulated on a case-by-case basis by several different state and local entities, depending on the nature of the project, its health and environmental implications, and the jurisdiction of a given project. For example, the New York State Department of Environmental Conservation (DEC) regulates reclaimed wastewater from WWTPs through State Pollutant Discharge Elimination System (SPDES) permits. The New York Department of State (DOS) regulates greywater reuse within buildings through the state's plumbing code, which may, in turn, be enforced by local building inspectors.

Municipal Wastewater Reuse Approaches, Practices, and Assurance Beyond New York

While New York State, due its abundant natural water supplies, has not capitalized on wastewater reclamation projects to the extent that many other states have, the experience of those other states is instructive. Florida and California are at the forefront of wastewater reuse, together recycling more than one billion gallons per day, with plans to double that figure. Other states with well developed reuse programs include New Jersey, Washington, Massachusetts, Arizona, and North Carolina. The different regulatory requirements and types of reuse projects that characterize each state are described in detail.

When assessing whether to embark on a reuse project, the following potential benefits must be weighed:

- Energy Use: Water reuse projects may offer a net energy savings relative to the use of potable water, though this must evaluated on a case-by-case basis.
- Instream Flow: By reducing the need to draw water from natural water bodies and aquifers, water reuse projects can contribute to maintaining necessary natural instream flow and reservoir levels.

- Wetlands: Strategic use of reclaimed wastewater can augment existing wetlands, stabilize their water budgets, or be used to create new wetlands.

- Aquifer Level Maintenance and Groundwater Supply: Land application or underground injection of reclaimed wastewater can recharge aquifers. Such recharge can be applied strategically near coastal areas to help stave off saltwater intrusion into the aquifer.

- Financial: As with energy calculations, the economics of using reclaimed water, rather than potable sources, will vary on a case-by-case basis. The existence of various incentives, subsidies, grants, or loans, to encourage water reuse, may alter the calculation.

Depending on the nature of a reclamation project, secondary treatment and disinfection to prevent risks from pathogens or other contamination may be required. States with well developed reclamation programs have addressed such risks using a variety of regulatory tools, including monitoring, setbacks and plumbing specifications. Because of such risks, reclamation projects often face opposition. Public involvement early in the planning process can help alleviate concerns or lead to project changes, and some proposals may prove acceptable. Both DEC and the New York state Department of Health (DOH), for example, would not recommend that reclaimed wastewater be used as potable water.

New York State Practice and Potential

As of this writing, New York State has nine municipal and green building water reuse projects permitted under the SPDES program, and three golf course water reuse systems. Several other projects are on the horizon. The report includes four case studies, the Riverhead/Suffolk County Indian Island Golf Course, the City of Oneida/Turning Stone Resort, the Solaire residential building in Manhattan, and the Albany South WWTP/Empire Generation Company, LLC Power Plant in Rensselaer. Several future projects are under development or consideration, including a WWTP in Rockland County that may be used to recharge groundwater and ensure sufficient baseflow in the Ramapo River, and another WWTP in the Village of Delhi in Delaware County that may be used to provide irrigation for golf course irrigation.

The small number of current projects in New York reflects the lack of local demand and the relative low cost of potable supplies in most of the state. While ideas for different kinds of reuse projects have been floated, and pairing WWTPs with single large users has been successful – the volume of water reused in New York State is likely to remain low, less than 100 million gallons/day, unless major policy shifts or financial subsidies that favor water reuse are instituted.

Any changes in policy will need to address the current regulatory structure.

- Water withdrawals from public suppliers and in New York's portion of the Great Lakes are the purview of DEC. Public suppliers must submit water conservation plans when seeking new permits. Water users withdrawing from the Great Lakes Basin must register with DEC. Requests to withdraw water are balanced against competing needs. Water

withdrawals in the Susquehanna and Delaware River basins require permits from the independent commissions operating in those basins.

- Waste water discharges are regulated by DEC under the state's SPDES program.

- Health concerns are addressed: by DOH, in its advisory role to DEC under the Water Efficiency and Reuse Law; through the State Plumbing Code (for reuse in green buildings); and by the New York State Department of Agriculture and Markets, which oversees certain consumer safety issues related to food production, including irrigation.

Greywater

Greywater was a lower priority for this feasibility study because of the much smaller volumes of water encompassed by such reuse projects. Greywater can be reused within buildings, via specially designed plumbing systems that ensure recycled water will only be used for non-potable purposes, as in the Solaire project case study described in the case studies. Greywater may also be used for on-site purposes such as watering. Only two examples of such projects exist in New York State, however, because of strictures on greywater discharge in the plumbing code intended to avoid its potential pathogen risks. Although Leadership in Energy and Environmental Design (LEED) guidance for new green buildings encourages such reuse, and other states have more permissive regulations governing greywater reuse, for such reuse to occur more widely in New York State will require that DOS revisit the State Plumbing Code, and DOH be consulted in its role overseeing on-site waste treatment and disposal. Where such authority has been delegated to local entities, these should part of the effort.

Recommendations for Municipal Wastewater Reuse and Green Buildings

New York State currently addresses water reuse proposals under a variety of different authorities. The purpose of the Water Efficiency and Reuse Law, under which this feasibility study was mandated, is to prompt the State to take a more active role in promoting such projects.

To this end, New York State can undertake a number of non-regulatory initiatives, such as publicizing successful projects, creating demonstration opportunities, including using state property, and providing direct financial incentives through state revolving funds, or indirect compliance incentives, through water goal goals for specific water bodies.

From a more formal standpoint, DEC could issue guidance documents that clarify the design and approval process for reclamation projects. Guidance is recommended over regulation, because of the ease with which such documents can evolve to incorporate new lessons and technical advances of this still nascent approach.

DEC should also:

- Train its SPDES staff in the unique qualities of reuse technology
- Maintain an advisory body to keep guidance current and promote cross-agency cooperation

- Join the WateReuse Association
- Establish a registry of all reuse projects, not just those that require SPDES permits
- Abandon the definition of greywater in the Water Efficiency and Reuse Law in favor of the more restrictive and thus protective definition of gray water in the State Plumbing Code (which does not allow reuse of water discharged from kitchen sinks and dishwashers)

DOH should consider developing criteria for recycling greywater in large buildings that is more specific than those currently exist in state or local plumbing codes.

DOS should be engaged in the above initiatives.

Conclusion

New York State is water rich and, as a consequence, reuse projects are sparser here than in drier states. Interest is increasing, however, as population pressure and water needs expand. This report details strategies for New York State to meet this challenge.

Table of Contents

1. Overview
1.1 Purpose of the Reclaimed Wastewater Feasibility Study 1
1.2 The 2005 New York State Law 1
1.3 Wastewater Reuse in New York State's Supply Perspective 1
1.4 Operational and Legal Definitions of Reclaimed Wastewater, Greywater and Related Terms 3
1.5 Current Regulatory Oversight of Reuse 6
1.6 Potential Wastewater Reclamation Projects 7
1.7 Study Scope and Process 7
1.8 Remainder of this Document 8
2. Municipal Wastewater Reuse Approaches, Practices, and Assurance Beyond New York 9
2.1 Survey Approach 9
2.2 National Diversity of Municipal Wastewater Reuses 10
2.3 Reuse Oversight in Seven States 15
2.4 Reasons to Choose Reuse for Sub-Potable Uses 41
2.5 Perceived and Actual Risks 46
3. New York State Practices and Potentials 49
3.1 Information Sources 49
3.2 Existing and In-Progress New York State Reuse 49
3.3 Possible Future Instances 51
3.4 Featured Case Studies of New York State Wastewater Reuse 52
3.5 Potential Extent of Reuse in New York State 65
3.6 New York State Policy Structure 66
4. Greywater 69
4.1 Large Buildings 69
4.2 Small Greywater/Gray-Water Uses 72
4.3 Jurisdiction over Greywater/Gray-Water Reuse 75
5. Recommendations for Municipal Wastewater Reuse and Green Buildings 76
5.1 Promoting Safe Municipal Wastewater Reuse 76
5.2 Controlling Risk via State and Local Oversight of Municipal Wastewater Reuse 77
5.3 Use-Based Criteria 79
5.4 Tracking Reused Water 80
5.5 Wastewater Recycling in Green Buildings 81
5.6 Gray Water versus Greywater 81
6. Conclusion 82
References 83
Acknowledgments 87
Appendices 88
Appendix A: New York State Water Efficiency and Reuse Law 88
Appendix B: 2007 New York State Plumbing Code Provisions about Gray Water 90
Appendix C: Excerpt from the New York City Plumbing Code 92

List of Tables

Table 1: New York's Regulatory Environment for Municipal Wastewater and Greywater Reuse 6
Table 2: Types of Municipal Wastewater Reuses in 2004 EPA Guidelines 10

Table 3: Health and Environmental Considerations for Selected Municipal Wastewater Reuses 11
Table 4: EPA's Summary of State Reuse Regulations and Guidelines (2003) 13
Table 5: Numbers and Volumes of Florida Municipal Reuse Systems 16
Table 6: Florida's Municipal Wastewater Reuse Classes and Requirements 17
Table 7: Florida's Municipal Wastewater Reuse Requirements 19
Table 8: Florida's Reuse Feasibility Study Content Guidelines 20
Table 9: California's Municipal Wastewater Reuse Classes and Requirements 22
Table 10: California's Municipal Wastewater Reuse Classes and Requirements 24
Table 11: California Reuse Engineering Report Contents 24
Table 12: New Jersey's Reclaimed Water Types and Requirements 27
Table 13: New Jersey's Reclaimed Water Types and Requirements 28
Table 14: Washington State's Reclaimed Water Classes and Requirements 30
Table 15: Massachusetts' Interim Reuse Types and Requirements 33
Table 16: Massachusetts' Interim Reuse Types and Requirements 34
Table 17: Arizona's Domestic Wastewater Reuse Classes and Requirements 35
Table 18: North Carolina Details for Different Water Reclamation Systems 38
Table 19: North Carolina Details for Different Water Reclamation Systems 39
Table 20: Official Cases of Municipal and Green Building Water Reuse 49
Table 21: SPDES Permit Limits for Three Operating Golf Course Reuse Systems 51
Table 22: Comparison of Gray Water and Blackwater Recycling Systems, Plumbing Code vs. Solaire 71
Table 23: Arizona Type 1 General Permit Conditions for Gray Water (under 400 gallons/day). 73
Table 24: Findings of Water CASA Arizona Study of Gray Water and Irrigated Soil 74
Table 25: Candidate Contents for New York Municipal Wastewater Reuse Engineering Plans . 77
Table 26: Proposed New York Municipal Wastewater Reuse Categories and Requirements 80

List of Figures

Figure 1: Spatial Patterns of New York State Precipitation 2
Figure 2: Fresh Water Withdrawals in 2000, as Depths (excluding power plant cooling water)... 3
Figure 3: State Reuse Programs as of 2003 (with correction for New York) 15
Figure 4: Energy Use Changes from a Reusing Irrigator 42
Figure 5: Energy Use Changes from a Green Building that Recycles Blackwater 43
Figure 6: Energy Use Changes from an Industrial Reuser of Municipal Wastewater 43
Figure 7: Multiple Barriers for Health Protection 48
Figure 8: Locations of Four Featured New York Wastewater Reuse Cases 53
Figure 9: Riverhead Wastewater Treatment Plant and the Indian Island Golf Course 54
Figure 10: Components of the Planned Riverhead Supplemental Treatment System 55
Figure 11: Oneida City and the Turning Stone Resort 56
Figure 12: Components of the Oneida/Turning Stone Reuse System 58
Figure 13: Basement Wastewater Treatment System in The Solaire 59
Figure 14: Solaire Components and First Year Flows (Zavoda 2005) 60
Figure 15: Schematic of The Solaire's Internal Blackwater Recycling System 61
Figure 16: Albany North WWTP and Rensselaer Power Plant Site 63
Figure 17: Albany/Rensselaer Power Plant Reuse Components 64
Figure 18: 2007 New York State Plumbing Code Gray Water System for Toilet Flushing 70

1. Overview

1.1 Purpose of the Reclaimed Wastewater Feasibility Study

The purpose of this study is to provide information to the New York State Department of Environmental Conservation (DEC) and New York State Department of Health (DOH) about potential uses of reclaimed wastewater and residential greywater as these agenices develop regulations and other standards for reuse. This study was mandate by Chapter 619 of the Laws of 2005, known as the Water Efficiency and Reuse Law. It evaluates current and future reuse in New York State, reuse programs across the nation, and other issues relating to reuse.

1.2 The 2005 New York State Law

New York State's Environmental Conservation Law (ECL) was amended in 2005 to include sections 15-0601, 15-0603, 15-0605, and 15-0607 regarding water efficiency and reuse. (Appendix A contains the full text of the ECL additions, together with a related new section of the Public Health Law.) The Water Efficiency and Reuse Law mandated a feasibility study of municipal wastewater and residential greywater reuse. The law requires DEC to lead the study and to subsequently develop rules, regulations and standards in consultation with DOH. DEC contracted with the New York State Water Resources Institute at Cornell (NYSWRI) to prepare this feasibility study. The law also requires DEC to promote wastewater reuse and to create a registry of reusers.

The Water Efficiency and Reuse Law stated that water is a valuable resource that must be used efficiently and conserved. This law recognized the importance of providing information to the public to point out the "value of potable water, the costs associated with providing potable water, and measures that should be taken to minimize the use of potable water, and to encourage the reuse of water whenever possible."

Reflecting the national trend toward increasing reuse and growth of interest in New York, the New York Water Environment Association (NYWEA) convened a task force on the topic (NYWEA 2003). NYWEA represents interests and viewpoints of wastewater producers, consultants and regulators. This statewide feasibility study provides a context for future, optional, local feasibility studies in places where reuse makes economic and environmental sense.

1.3 Wastewater Reuse in New York State's Supply Perspective

Wastewater reuse is closely associated with water conservation, providing an option that can reduce the volume of water withdrawn from the environment for human uses. Conservation and reuse developed late in New York State because of its abundant supply of clean water. The state receives an average of 40 inches of precipitation per year. Assuming that half of the precipitation evaporates, leaving 20 inches of precipitation to flow in rivers and recharge aquifers, an average of twenty trillion gallons of water per year flows over and through the state's 54,000 square miles. Current reuse projects represent less than 700 million gallons per year–not even a tenth of one percent of the natural flow.

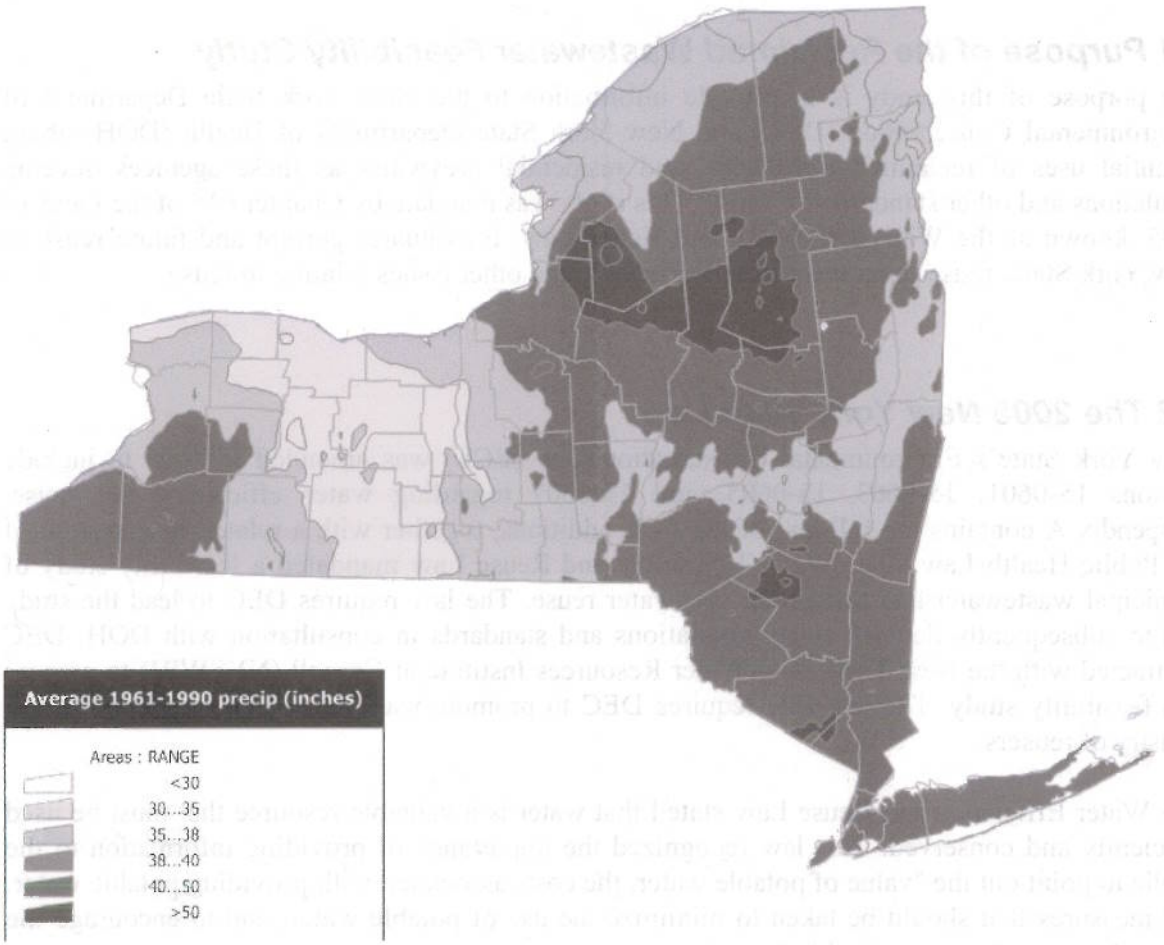

Figure 1: Spatial Patterns of New York State Precipitation

While most of New York has an abundant supply of water, population density and growth in some areas of the state are beginning exert stress on local supply infrastructure and potable water sources. Droughts have led to restrictions in the Hudson Valley, New York City, and Rockland County. Other areas of New York State, notably Long Island, have limited options to bring in fresh water from beyond their borders.

New York State's precipitation, population and water use are spatially uneven. Twenty inches of surplus water (precipitation minus evapotranspiration) over New York City's 320-square miles equals about 100 billion gallons per year. Yet the City discharges about 500 billion gallons per year of wastewater from its municipal wastewater treatment plants (WWTP). It balances its water budget by bringing in 400 billion gallons per year from outside city boundaries, drawing most heavily from Ulster and Delaware counties.

In general, the southeastern part of the state withdraws the largest proportion of fresh water flowing through and near it. Compare Figure 1, a map of precipitation, to Figure 2, a map of estimated water withdrawals (excluding power plant cooling water). The most heavily exploited

water budgets are in the southeastern part of the State, particularly in the ring of suburbs around New York City.

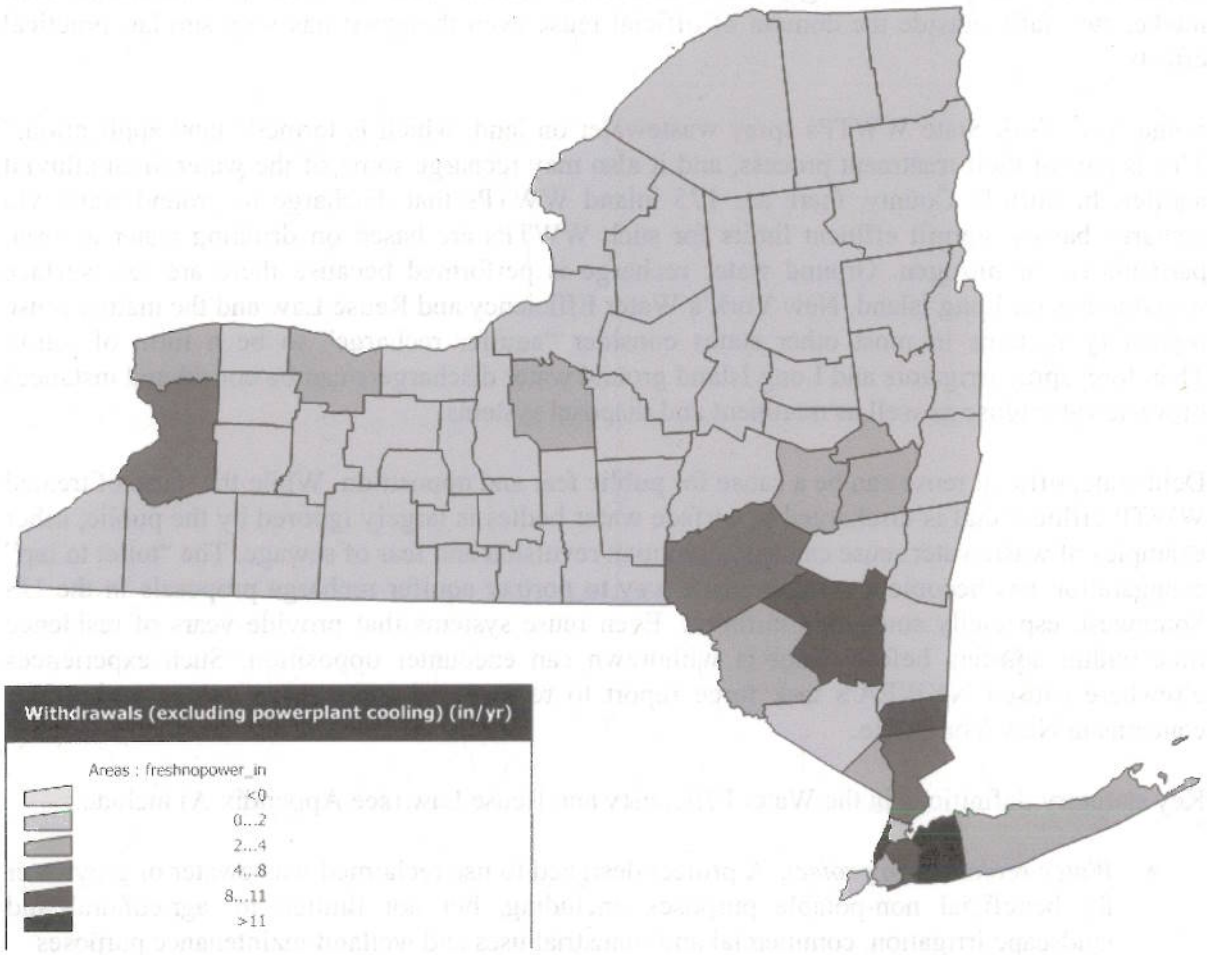

Figure 2: Fresh Water Withdrawals in 2000, as Depths (excluding powerplant cooling water) (Data source: USGS)

The tighter water balance in this region provides more impetus for water conservation and reuse than in most other parts of New York State.

1.4 Operational and Legal Definitions of Reclaimed Wastewater, Greywater and Related Terms

Wastewater reuse occurs when someone uses the treated effluent of a municipal sewage treatment plant or greywater from a bathtub for a beneficial purpose before it goes back into the environment. "Before it goes back into the environment" is the key phrase for understanding New York's official definition – to count as reuse, the *pipe* goes directly from the treatment facility to the next user.

There are many instances of WWTP discharges to streams upstream from water supply intakes worldwide. Dilution, river chemistry and environmental microbes will all improve water quality between sewage discharges and water intakes given enough time. An upstream to downstream sequence of intake, use, discharge, second intake, second use, second wastewater discharge, third intake, etc., falls outside the domain of official reuse even though it has very similar, practical effects.

Some New York State WWTPs spray wastewater on land, which is termed "land application." This is part of their treatment process, and it also may recharge some of the water to an alluvial aquifer. In Suffolk County, there are 175 inland WWTPs that discharge to ground water via recharge basins. Permit effluent limits for such WWTPs are based on drinking water criteria, particularly for nitrogen. Ground water recharge is performed because there are few surface water bodies on Long Island. New York's Water Efficiency and Reuse Law and the mature reuse regulatory systems in most other states consider "aquifer recharge" to be a form of reuse. Therefore, spray irrigators and Long Island ground water dischargers can be considered instances of wastewater reuse as well as treatment and disposal systems.

Deliberate, official reuse can be a cause for public fear and opposition. While the reuse of treated WWTP effluent that is discharged to surface water bodies is largely ignored by the public, other examples of wastewater reuse can trigger human revulsion and fear of sewage. The "toilet to tap" exaggeration has become a commonplace way to portray aquifer recharge proposals in the US Southwest, especially southern California. Even reuse systems that provide years of residence time within aquifers before water is withdrawn can encounter opposition. Such experiences elsewhere caused NYWEA's task force report to recommend extra attention to local public concerns in New York State.

Key statutory definitions in the Water Efficiency and Reuse Law (see Appendix A) include:

- *Water reclamation project:* A project designed to use reclaimed wastewater or greywater for beneficial non-potable purposes, including, but not limited to, agricultural and landscape irrigation, commercial and industrial uses and wetland maintenance purposes
- *Greywater:* Untreated wastewater from bathtubs, showers, washing machines, dishwashers and sinks, but shall not include discharges from toilets or urinals or industrial discharges
- *Reclaimed wastewater:* Water discharged from a treatment works using at least effective secondary treatment as defined in ECL, Title 6, 17-0509[1]

This report focuses primarily on *reclaimed wastewater*, because that represents a much larger volume of water in New York State than *greywater*.

---

1 *17-0509. Minimum treatment required. 1. As used in this section, the term "effective secondary treatment" shall mean the removal of substantially all floating and settleable solids and the removal of at least eighty-five percent of suspended solids and at least eighty-five percent of five day biochemical oxygen demand, or such other standard as may be adopted pursuant to the Act. 2. The minimum degree of treatment required for the discharge of sanitary sewage into the surface waters of the state shall be effective secondary treatment, provided, however, that additional treatment may be required consistent with the standards established for specific waters by the department pursuant to section 17-0301 or with standards, criteria, limitations, rules or regulations promulgated or applied pursuant to title 8 hereof.*

One clarification of *reclaimed wastewater* is important. This report always interprets the term to mean reclaimed *municipal* wastewater. There are many different kinds of wastewater treatment plants in New York State. Treatment plants at chemical refineries, manufacturing plants, livestock farms and other non-municipal facilities produce a variety of effluent qualities and do not lend themselves to standardization of reclamation treatment technology. Municipal wastewater after standard secondary treatment is much more homogeneous and thus a strong candidate for standardized reuse regulations. Limiting discussion to municipal wastewater reflects reuse oversight practices in other states. It is certainly possible to reuse certain non-municipal wastewaters. For example, food process wastewater has routinely been applied to the land for over 30 years in New York. However, state oversight of industrial wastes will remain case-by-case for the time being.

A second clarification regarding the term greywater is also important. Under New York State's 2007 plumbing code (see Appendix B), *gray water* (note two words) means "waste water discharged from lavatories, bathtubs, showers, clothes washers and laundry sinks." New York City's plumbing code (Appendix C) incorporates the state's *gray water* definition and adds the closely related term *black water,* which it defines as "waste water discharged from water closets, urinals and any other fixtures discharging animal or vegetable matter in suspension or solution." Together *gray water* and *black water* encompass all of the indoor wastewater in most residences. In industry practice, when all of a building's wastewater is combined, it is considered *black water.*

The Water Efficiency and Reuse Law uses the term residential *greywater* (one word), and counts water from kitchen sinks and dishwashers, which are excluded from the plumbing code's *gray water* definition because they often yield water with "animal or vegetable matter in suspension or solution." Wastewater from these sources may contain pathogens, as was found in Arizona's sampling.

While the difference in New York State's definitions of *greywater* and *gray water* may seem minor, there is an important practical distinction – plumbing. A building that segregates this class of wastewater must route extra collection pipes to specific rooms. Two entirely separate collection pipe networks are needed, one for the gray water and one for everything else (black water). A building designed around the state or city plumbing codes would not send a *gray water* branch pipe into the kitchen, while a building designed around the reuse law could opt to send a *greywater* branch pipe to the kitchen.

See Chapter 4 for details about *gray water*, *black water* and *greywater*, and Chapter 3's case study of Manhattan's Solaire building for a very creative reuse of that building's unseparated *black water.*

1.5 Current Regulatory Oversight of Reuse

Four types of regulatory arenas are most relevant to municipal wastewater and greywater reuse: wastewater treatment, plumbing codes, public and worker exposure s, and agriculture. Wastewater, plumbing code and health hazard protection are each divided across state and local agencies in New York, and involve seven types of regulatory entities (Table 1).

Table 1: New York's Regulatory Environment for Municipal Wastewater and Greywater Reuse

Category of Regulation	State	Local
Municipal wastewater treatment and discharge	DEC - particularly SPDES permits and water allocation to municipal water supplies	County and New York City Health Departments (environmental health) (where these exist)
Health protection	Department of Health	County and New York City Health Departments (environmental health)
Plumbing code (gray water and blackwater)	Department of State	Municipal building inspectors, New York City Building Department
Agricultural crop protection	Department of Agriculture and Markets	(none)

DEC currently regulates the use of reclaimed wastewater from municipal WWTPs through State Pollutant Discharge Elimination System (SPDES) permits on a case-by-case basis. The permittee provides the treated wastewater in accord with their permit's reclamation treatment requirements. The SPDES permittee then has oversight for how the reuser operates with regard to the terms in its SPDES permit. The state does not oversee the reusing entity directly, unless they are the same entity as the SPDES permittee.

SPDES permit provisions for reuse have been developed on a permit-by-permit basis. The state does not publish advance guidance to permittees who are contemplating this option. DEC and DOH (acting as a scientific and technical advisor) review each proposed case individually using criteria developed for that case.

An industry may receive reclaimed wastewater from a municipal WWTP. The first case of these cases, for a power generation plant, is imminent. DEC has not yet regulated reuse of an industrial facility's own wastewater on its property.

The state regulates in-building gray water reuse through the plumbing code, published by the New York State Department of State (DOS). To date, all known cases of gray water reuse are in New York City, which has replaced the state plumbing code's provisions related to reuse. New York City oversees both the design and operation of these reuse systems.

One consideration for reusing water to produce crops is that the definition of food in Agriculture and Markets law treats crops for livestock feed identically to crops for human consumption."

1.6 Potential Wastewater Reclamation Projects

This study evaluates a multitude of potential users of reclaimed wastewater, discussed in more detail in Chapter 2:

- Golf courses in water-short areas, or those that have a "green" philosophy, commonly use reclaimed wastewater for irrigation. This is the subject of textbooks, conferences, and even in-service training in New York for course managers. Besides water, wastewater provides an extra source of plant nutrients, allowing reduced fertilization.
- Agriculture can use treated wastewater for irrigation, particularly for ornamental crops where there is less concern over pathogens and other wastewater constituents than for food crops.
- Power generators can use treated wastewater for cooling.
- Evaporative air conditioning system operators in cities and industries can use treated wastewater to replace water that evaporates.
- Green building owners who choose to follow LEED ("Leadership in Energy and Environmental Design;" see USGBC 2007a) water recycling guidance are both producers and reusers of wastewater. Some segregate gray water and blackwater, while others collect everything in one set of pipes and provide blackwater treatment.
- Wastewater treatment plants themselves can use their treated effluent for washing, dust control, on-site irrigation, and other purposes in accordance with wastewater treatment plant design standards.
- Local water managers can use treated wastewater to recharge aquifers for purposes such as reducing coastal salt water intrusion or augmenting base streamflow.

1.7 Study Scope and Process

DEC formed a work group to guide development of this feasibility study, consisting of representatives from DEC, DOH, NYWEA, the New York State Energy Research and Development Authority (NYSERDA), NYS WRI, and the Department of Agriculture and Markets.

DEC and NYSERDA contracted with NYSWRI for staff assistance. The project focused study resources on reclaimed municipal wastewater, limiting most consideration of greywater to larger "green" buildings, due to New York City's encouragement.

The primary sources of information were:

- a canvass of nine DEC Regional offices water programs;
- visits and telephone contacts with existing and prospective reusers and key local regulators;
- extensive literature from other states already having formal reuse oversight and promotional programs;
- extensive literature from the water reuse industry; and

- work group member experience.

Because there is a presumption in the Water Efficiency and Reuse Law that reuse should be increased (if done safely), local advocates representing existing New York State reuse systems were asked to assist in preparing the case studies featured in Chapter 3.

The work group met several times between mid-2006 and early 2008 to review progress, guide next steps and evaluate draft materials.

1.8 Remainder of this Document

Chapter 2 summarizes and evaluates extensive experience with treated wastewater reuse elsewhere in the United States, providing a menu of experience from which New York State can draw.

Chapter 3 reviews New York State's precedents and reuse potentials for municipal and one instance of green building blackwater reuse.

Chapter 4 provides a preliminary reconnaissance of greywater and blackwater in New York State.

Chapter 5 provides recommendations about regulatory, promotional, and registration programs for reclaimed wastewater and green building greywater and black water.

2. Municipal Wastewater Reuse Approaches, Practices, and Assurance Beyond New York

2.1 Survey Approach

U.S. EPA National Survey

Neither the United States Environmental Protection Agency (EPA) nor other federal agencies are directly involved in regulation. Individual states must integrate their reuse programs with WWTP SPDES or National Pollutant Discharge Elimination System (NPDES) permitting.

The EPA provides technical resources on the topic. Consultants to EPA prepared a 2004 compilation of standards and practices for municipal wastewater reuse. The compilation provides overviews of types of reuse, water quality considerations, treatment technologies, state policies, finance, and most other facets of reuse (EPA 2004).

The 2004 EPA survey provided general background for this feasibility study, including most of the content in section 2.2.

Current Regulatory Programs in Selected Other States

Individual states have regulations and guidance that address their programs for wastewater reuse. California and Florida have the most experience, together recycling more than 1 billion gallons per day (bgd) and each striving to exceed 1 bgd within a few years. Florida already has the capacity to reclaim 1.3 bgd of wastewater, providing plenty of room to grow from its current reuse volume of 0.7 bgd.

These two states, plus North Carolina, New Jersey, Massachusetts, Arizona and Washington State provide a diverse array of effluent reuse programs for New York to consider. Section 2.3 reviews each of these seven states based on information current as of late 2007, about four years later than the cutoff date in the EPA's compilation.

WateReuse Association

The WateReuse Association brings together local water and wastewater agencies, regulators, consultants and others from across the nation to exchange information, advocate, and improve the state of practice. It originated in states where reuse first took hold, especially the far Southwest. The Association has held annual conferences for decades. Proceedings for 2002-2007 conferences were used in preparing this report and evaluating trends in reuse practice and technology.

2.2 National Diversity of Municipal Wastewater Reuses

Types of Reuses and Associated Regulatory Criteria

Treatment technologies exist today that can convert raw wastewater into water suitable for any type of use, including potable uses. Depending on the type of planned reuse, wastewater effluent may receive additional treatment ranging from disinfection to microfiltration or even reverse osmosis. Table 2 draws from the EPA's national summary (EPA 2004) to classify different kinds of reuses.

Table 2: Types of Municipal Wastewater Reuses in 2004 EPA Guidelines

Category	Typical uses
Urban reuse	Irrigation of parks, playing fields, schoolyards, residential landscapes, commercial and industrial landscapes, golf courses Washdown of vehicles, windows, streets Mixing of liquid pesticides and fertilizers Commercial laundry Fire fighting Dust control Decorative water features, such as fountains Toilet and urinal flushing
Industrial	Cooling water, including once-through and recirculating (evaporative) Boiler make-up water Industrial process water
Agricultural	Irrigation of food crops, ornamental crops, fodder, pastures
Environmental and recreational	Water level and flow augmentation in wetlands Water level and flow augmentation in impoundments Streamflow augmentation (intentional)
Groundwater recharge	Aquifer storage and recovery Stream baseflow augmentation Salt water intrusion prevention Land subsidence prevention Replacement of liquid supply to hot springs and geysers
Augmentation of potable supplies	Indirect potable: streamflow augmentation and aquifer recharge Direct potable: introduction into surface reservoirs and distribution systems without much environmental residence time

Many wastewater treatment plants discharge treated wastewater into streams or ground water recharge basins. Some facilities use wetlands as part of their treatment system. Others use treated effluent for irrigation. All of these are wastewater reuses in one way or another, but the wastewater reuse law focuses specifically on treated wastewater plant effluent provided directly

to another user. The treated wastewater is considered a resource, not a waste. This is analogous to solid waste management, in which some of the former waste stream provides revenue via reuse or recycling.

Supplemental treatment must be keyed to the type of use and the starting quality of the secondary treated wastewater. Typically the source of reclaimed wastewater is effluent that meets current SPDES permit requirements ranging from undisinfected secondary effluent to disinfected tertiary treated effluent. Supplemental treatment is applied to meet minimum requirements within the options allowed in state oversight. Uses which may involve involuntary exposure of the public — being sprayed by landscape irrigation, eating a food crop whose edible portion has been irrigated recently, breathing an aerosol from a cooling tower, or drinking from a well whose flow is augmented by nearby reclaimed water injection — require vigilance. When the public may be exposed, states mandate the highest quality, distance setbacks, high treatment reliability with automatic shutoffs, and advanced operator training. Further, some types of reuse require water of a particular quality for a process reason, such as water that will not encourage the growth of microorganisms in a cooling tower.

Table 3 arrays some of the use types from Table 2 against the safety and performance considerations used in deciding what kinds of treatment and reliability are needed.

Table 3: Health and Environmental Considerations for Selected Municipal Wastewater Reuses

Use type	**Health considerations**	**Other quality considerations**	**Other considerations**
Publicly accessible landscape irrigation	Pathogens via inhalation or skin contact from spray drift; worker exposure during irrigation and service	Salt buildup in soil; fertilizer versus nutrients in irrigation water	Ground water nitrate, trace chemicals, pathogens; runoff if over-irrigated
Food crop spray irrigation: edible parts	Pathogens or toxics on surface of edible part; worker exposure during irrigation and service	Solids clogging spray apparatus; salt buildup in soil	Ground water nitrate, trace chemicals, pathogens; runoff if over-irrigated
Food crop flood or drip irrigation: no direct contact	Worker exposure during irrigation and service	Solids clogging spray apparatus; salt buildup in soil	Ground water nitrate, trace chemicals, pathogens; runoff if over-irrigated
Ornamentals irrigation (not publicly accessible)	Worker exposure during irrigation and service	Solids clogging spray apparatus; salt buildup in soil	Ground water nitrate, trace chemicals, pathogens; runoff if over-irrigated

Use type	Health considerations	Other quality considerations	Other considerations
Cooling and air conditioning makeup	Worker exposure during service; public exposure via aerosols	Corrosion; biofouling due to nutrient-rich water	
Toilet and urinal flushing	Worker exposure during service		Potential for cross-connection by user with access to plumbing
Aquifer recharge	Water consumer exposure via downgradient potable wells		Geochemical and microbial interactions between aquifer material and treated wastewater
Streamflow and wetland augmentation	Water consumer exposure via downstream potable intakes	Nutrient stimulation of aquatic plants and algae	

States generally define a hierarchy of uses that require higher and lesser water quality. For each water quality class, or each group of uses compatible with that class, states specify treatment types, performance criteria and monitoring technologies. For residential or golf course irrigation, for example, a state will typically prescribe a high level of supplemental treatment. This might include coagulation, filtration, and disinfection by ultraviolet light (UV) or chlorine. Filtration serves two purposes. First, it improves disinfection effectiveness. Second, it removes solids that could clog irrigation apparatus.

Next, the supplemental treatment system's performance may be monitored via continuous sensors of turbidity and disinfection, such as light level, or chlorine residual concentration. Backup power may be required. The state may also require automated shutoff if sensors indicate that criteria are not being met. The treated water would then have to receive additional treatment or be sent to a different reuse customer with lower quality requirements.

On the other hand, water sent to an industry for power cogeneration cooling, for example, may be nearly unregulated by a state. The supplying WWTP might provide undisinfected secondary effluent and leave the industry responsible for any treatment needed to meet their equipment and worker or public exposure requirements.

Many states regulate water reusers through the WWTP, the reclaimed wastewater supplier. Such states mandate an agreement between the WWTP and the user that permits the WWTP to enforce state requirements that the user must adhere to, for example in cross-connection prevention, signage and setbacks.

EPA's Survey of All States

A majority of states have regulations or published guidelines for state oversight of domestic water reuse. Table 4, adapted from EPA 2004, provides a snapshot of 2003 state program status. Figure 3 maps the formality of state programs.

Section 2.3 goes into more detail about selected states of particular interest as examples for New York State. The EPA report contains details about many more states' requirements than the ones selected here, although it is a few years out of date (EPA 2004).

Table 4: EPA's Summary of State Reuse Regulations and Guidelines (2003)

State	Regulations	Guidelines	No Regulations or Guidelines (1)	Unrestricted Urban Reuse	Restricted Urban Reuse	Agricultural Reuse Food Crops	Agricultural Reuse Non-Food Crops	Unrestricted Recreational Reuse	Restricted Recreational Reuse	Environmental Reuse	Industrial Reuse	Groundwater Recharge	Indirect Potable
Alabama		*			*		*						
Alaska	*						*						
Arizona	*			*	*	*	*		*				
Arkansas		*		*	*	*	*						
California (2)	*			*	*	*	*	*	*		*	*	*
Colorado	*			*	*	*	*	*	*				
Connecticut			*										
Delaware	*			*	*		*						
Florida	*			*	*	*	*			*	*	*	*
Georgia		*		*	*		*						
Hawaii		*		*	*	*	*		*		*	*	*
Idaho	*			*	*	*	*						
Illinois	*				*		*						
Indiana	*			*	*	*	*						
Iowa	*				*		*						
Kansas		*		*	*	*	*						
Kentucky			*										
Louisiana			*										
Maine			*										
Maryland		*			*		*						
Massachusetts		*		*	*		*					*	*
Michigan	*					*	*						
Minnesota			*										
Mississippi			*										
Missouri	*				*		*						
Montana	*			*	*	*	*						
Nebraska	*				*		*						
Nevada	*			*	*	*	*	*	*				
New Hampshire			*										
New Jersey		*		*	*	*	*				*		
New Mexico		*		*	*	*	*						

State	Regulations	Guidelines	No Regulations or Guidelines (1)	Unrestricted Urban Reuse	Restricted Urban Reuse	Agricultural Reuse Food Crops	Agricultural Reuse Non-Food Crops	Unrestricted Recreational Reuse	Restricted Recreational Reuse	Environmental Reuse	Industrial Reuse	Groundwater Recharge	Indirect Potable
New York		*					*						
North Carolina	*			*	*						*		
North Dakota		*		*	*		*						
Ohio		*		*	*		*						
Oklahoma	*				*		*						
Oregon	*			*	*		*	*	*		*		
Pennsylvania		*					*						
Rhode Island			*										
South Carolina	*			*	*		*						
South Dakota		*		*	*		*			*			
Tennessee	*			*	*		*						
Texas	*			*	*	*	*	*	*		*		
Utah	*			*	*	*	*	*	*		*		
Vermont	*						*						
Virginia			*										
Washington		*		*	*	*	*	*	*	*	*	*	*
West Virginia	*					*	*						
Wisconsin	*						*						
Wyoming	*			*	*	*	*						

(1) Specific regulations on reuse not adopted; however, reclamation may be approved on a case-by-case basis.

(2) Has regulations for landscape irrigation excluding residential irrigation; guidelines cover all other uses.

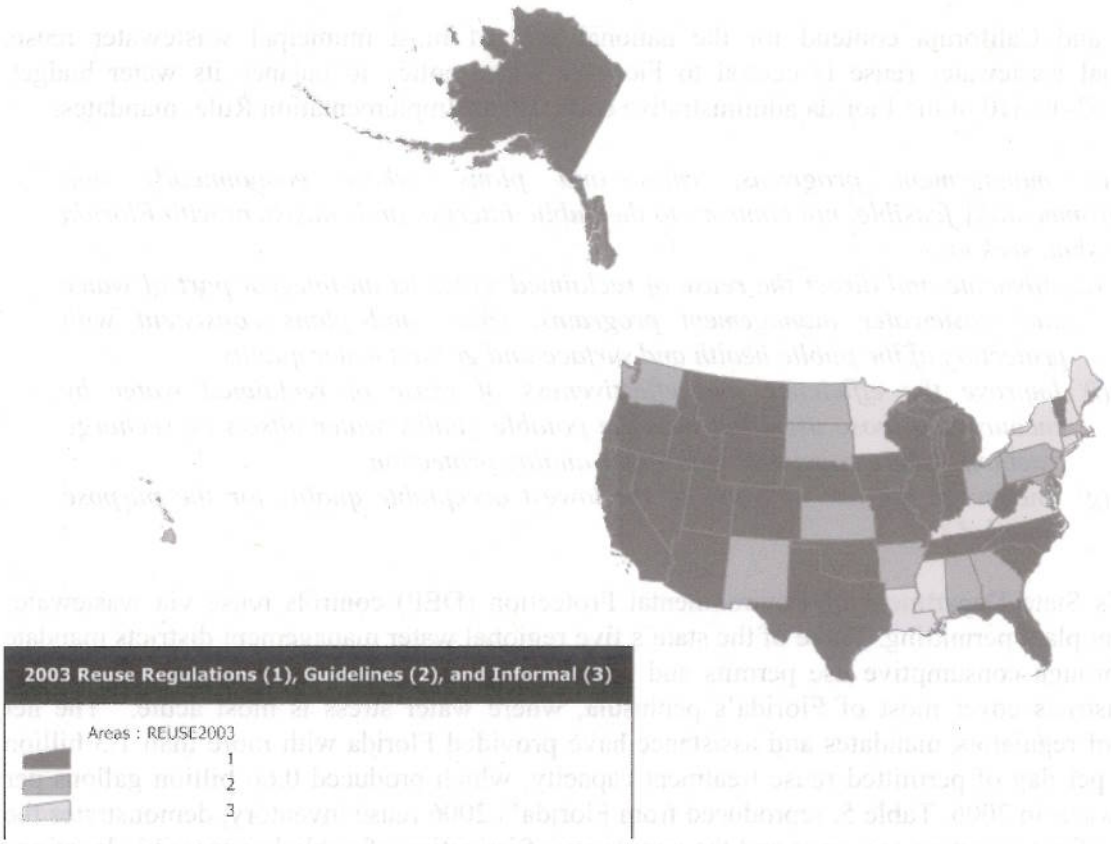

Figure 3: State Reuse Programs as of 2003 (with correction for New York)

2.3 Reuse Oversight in Seven States

The following sections focus on seven states which have especially interesting or relevant programs for New York's consideration. All of these states require the following features of reuse systems:

- Color-coded and/or marked pipes to carry reclaimed water, distinct from potable water pipes
- No cross-connections, possibly with the exception of ones that involve air gaps between potable and reclaimed water piping
- Non-standard hose attachments to exposed reclaimed water piping to prevent connection to hoses used for potable water
- Spray drift control
- Signs around sites irrigated with reclaimed water to notify employees and the public
- Fences or landscaping around storage ponds for reclaimed water to exclude people and animals

Focus: Florida

Florida and California contend for the national title of most municipal wastewater reuse. Municipal wastewater reuse is central to Florida's water policy to balance its water budget. Section 62-40.310 of the Florida administrative code, Water Implementation Rule, mandates:

> *Water management programs, rules and plans, where economically and environmentally feasible, not contrary to the public interest, and consistent with Florida law, shall seek to:*
>
> *(e) Advocate and direct the reuse of reclaimed water as an integral part of water and wastewater management programs, rules, and plans consistent with protection of the public health and surface and ground water quality.*
>
> *(f) Improve the efficiency and effectiveness of reuse of reclaimed water by encouraging those uses that increase potable quality water offsets or recharge fractions, where consistent with water quality protection.*
>
> *(g) Encourage the use of water of the lowest acceptable quality for the purpose intended.*

Florida's State Department of Environmental Protection (DEP) controls reuse via wastewater treatment plant permitting. Three of the state's five regional water management districts mandate reuse through consumptive use permits and provide financial assistance (Florida 2007d). The three districts cover most of Florida's peninsula, where water stress is most acute. The net effects of regulatory mandates and assistance have provided Florida with more than 1.3 billion gallons per day of permitted reuse treatment capacity, which produced 0.66 billion gallons per day of water in 2006. Table 5, reproduced from Florida's 2006 reuse inventory, demonstrates the breadth of reuse system coverage and the popularity of irrigation of publicly accessible locations (Florida 2007).

Table 5: Numbers and Volumes of Florida Municipal Reuse Systems

Reuse Type	Number of Systems (1)	Reuse Capacity (mgd)	Reuse Flow (mgd)	Area (acres)
Public Access Areas & Landscape Irrigation				
Golf Course Irrigation	194	273.07	123.63	58,899
Residential Irrigation	108	288.52	158.37	127,352
Other Public Access Areas	105	150.15	70.92	29,987
Subtotal	407	711.74	352.91	216,238
Agricultural Irrigation				
Edible Crops	18	58.81	12.57	14,067
Other Crops	109	139.00	70.01	24,468
Subtotal	127	197.81	82.58	38,535
Ground Water Recharge & Indirect Potable Reuse				
Rapid Infiltration Basins	162	172.01	82.52	6,565
Absorption Fields	20	9.16	2.76	537
Surface Water Augmentation	0	0	0	NA
Injection	1	10.00	7.35	NA
Subtotal	183	191.17	92.63	7,102

		Reuse Capacity	Reuse Flow	Area
Industrial				
At Treatment Plant	94	101.20	54.23	255
At Other Facilities	25	62.00	36.17	1,440
Subtotal	119	163.20	90.40	1,695
Toilet Flushing	6	0.58	0.42	NA
Fire Protection	1	0	0.1	NA
Wetlands	17	93.96	41.10	4,554
2006 Totals	441	1,368.25	662.73	268,153
2005 Totals	438	1,325.07	659.68	232,341

Notes: (1) The numbers of facilities are not additive because a single facility may engage in more than one reuse type.
(2) Discrepancies in column totals are due to internal rounding.

Tables 6 and 7 summarize Florida's categories of reuse and associated quality and treatment requirements. In all cases, the treatment begins with secondary treatment (oxidation to remove biochemical oxygen demand and suspended solids). (Florida 2007b)

Table 6: Florida's Municipal Wastewater Reuse Classes and Requirements

Class	Uses Allowed (1)	Filtration/ Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
Slow rate land application; restricted public access	Pastures, fodder, fiber, seed, trees	TSS ≤10 mg/L if subsurface (to prevent clogging)	Basic disinfection; fecal coliform ≤ 200/100 mL monthly arithmetic mean, no more than 10% above 400, no sample above 800; Chlorine, if used: 0.5 mg/L for 15 minutes	Take into account nitrogen in irrigation water when determining fertilizer.
Slow rate land application; public access, residential irrigation, edible crops	Residential lawns, golf courses, cemeteries, parks, landscape areas, highway medians; fire protection (3), aesthetics (fountains) (4), irrigation of edible crops (2), toilet flushing (3), dust control on construction sites, commercial laundries, others	TSS ≤ 5 mg/L; filtration; at least standby chemical coagulation equipment	High-level disinfection; TSS removal beyond secondary, to 5.0 mg/L; fecal coliform 75% of samples below detection limits, no single sample above 25/100 mL; if chlorine used, residual 1.0 mg/L 15 minutes, CT requirements based on influent	At least 0.1 mgd (sum across all users from a WWTP), except for toilet flushing and fire protection
Rapid rate land application (if system recollects under 50% of applied water) (5)	This is effectively shallow ground water recharge.	TSS ≤ 10 mg/L to prevent clogging, possible waiver	Basic disinfection as above	Nitrate-N ≤ 12 mg/L; many more requirements in certain hydrogeologic conditions such as Karst, including meeting drinking water standards in applied water

Class	Uses Allowed (1)	Filtration/ Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
Ground water recharge (including to coupled surface waters) and indirect potable	Barriers to landward or upward migration of salt water; planned augmentation of surface water used for potable supply	If needed to meet high-level disinfection criteria	High-level disinfection as above	At least 0.1 mgd; if discharge to Class I waters: TOC 3.0 mg/L monthly average, 5.0 mg/L any sample; no mixing zones; all parameters in drinking water standards; pilot test of treatment required; public involvement in planning required
Industrial uses (6)	Cooling, process, washwater at industries	None required explicitly	Basic disinfection and also part of secondary treatment may be delegated to the industry, but it is regulated as if it were part of the domestic WWTP.	Water may not come into contact with food or beverage product; other site-specific treatment may be needed (not regulated); minimum size required if open cooling tower.
Use within WWTPs	Irrigation, process, washdown, toilet flushing, fire protection Not considered a reuse unless water has had secondary treatment at least.	None required	If irrigating, provide basic disinfection as above.	Effluent from reuses must be fed back into plant treatment stream.

1. Plus those requiring less strict quality protection
2. Allowed application method of water depends on crop type. No restrictions on citrus or tobacco, or crop that is peeled, skinned, cooked or thermally processed. Other edible crops must have indirect application method that does not allow contact with edible portion of crop.
3. Toilet flushing and fire protection allowed in commercial and industrial settings. They are allowed in apartments and motels if residents do not have access to plumbing for repairs and modifications.
4. Recommend that aesthetic users apply additional treatment.
5. Requirements vary based on setting. Those shown are minimum requirements.
6. This is for industrial use of treated domestic wastewater. Industrial water use and wastewater are regulated separately.

Table 7: Florida's Municipal Wastewater Reuse Requirements

Class	Setbacks	Reliability	Storage and blending	Monitoring
Slow rate land application; restricted public access	25, 50, or 100 ft. from buildings or property line; 500 ft. potable well; 200 or 500 ft. from optional storage pond to potable well; 15-day rest before grazing of milk cattle; shorter if subsurface application	Shut off delivery if TSS or pathogen requirement not met.	Not required (except if for flow equalization) if alternate discharge is approved	TSS (if subsurface), pathogens after disinfection; ground-water monitoring required, parameters case-by-case, include well near optional storage pond
Slow rate land application; public access, residential irrigation, edible crops	75 ft. from water supply wells; system storage 75 or 200 ft. from public well; Control aerosol drift near outdoor public eating, drinking or bathing facilities.	Class I unless there is a permitted alternate treatment or discharge system; No discharge to system storage or to user unless turbidity and chlorine residual requirements are met; May send reject water to a different reuser if quality meets their criteria, or may discharge to environment if that is permitted.	Unlined system storage (treated water) for flow equalization; Lined reject storage for one day's flow; storages may be multipurpose (such as a golf course pond); May be blended with other water that also meets same criteria, such as potable, stormwater, ground water, etc. backflow prevention required	Continuous online turbidity monitoring; Continuous chlorine residual if using chlorine
Rapid rate land application	500 ft. from potable wells, class I and class II surface waters (shorter if high-level disinfection); 25, 50 or 100 ft. from buildings and property lines	Provision for emergency discharge.	None	
Ground water recharge and indirect potable	500 ft. to potable intake; 1,000 ft. from injection well to potable well		No system storage needed; reject storage for three days' flow	
Industrial uses	Cooling towers 300 ft. from property line (no setback if high-level disinfection); industrial site irrigation subject to setbacks under slow rate restricted or slow rate public above, depending on disinfection level		None required. If present at the domestic WWTP, must meet requirements for 0.414 (not regulated if at industry)	*Cryptosporidium* and *giardia* monitoring required for open cooling towers
Industrial use: within WWTPs	None specific	None specific	None specific	None specific

Florida regulates reuse as part of the WWTP's state-issued permit. Reclaimed water users do not require permits. A WWTP enters agreements with users, in some cases as local ordinances, which give the WWTP authority to enforce state requirements for users. The state holds the WWTP accountable for both the quality of its reclaimed water and the behavior of users of the reclaimed water. In special cases, reclaimed water intermediaries can receive state permits.

These are allowed when an intermediary receives wastewater from more than one WWTP. Such an intermediary can also be under one of its source WWTP's permits.

Consumptive-use permits issued by water management districts are the state's key means for mandating wastewater reuse. A consumptive use is any use of water which reduces the supply from which it is withdrawn or diverted. In certain critical areas (water resources caution areas), reuse feasibility studies are required, and reuse is effectively mandatory for certain types of uses if reclaimed water is available to them. Besides the districts, which are state entities, local government can declare mandatory reclaimed water zones.

Table 8 enumerates the mandated contents of Florida's local reuse feasibility studies (Florida 1991).

Table 8: Florida's Reuse Feasibility Study Content Guidelines

Section	Description
Chapter 1 - Introduction	Purpose; legal context
Chapter 2 - Existing Conditions	Geographic area to be covered presently and in future for wastewater management and reuse facilities
General Conditions	General area characteristics
Wastewater Management	Existing wastewater management
Water Supply	Existing water supply
Reuse Facilities	Existing reuse systems
Chapter 3 - Future Conditions	Basic constraints on planning for wastewater management and reuse in the area; projections for 20 years, consistent with local comprehensive plans; itemized as in Chapter 2
General Conditions	
Wastewater Management	
Water Supply	
Reuse Facilities	
Chapter 4 - Description of Alternatives Considered	Alternatives evaluated (including no action). Includes maps of service areas and major reclaimed water distribution lines and reclamation facilities;. major users of reclaimed water; areas for residential irrigation
Chapter 5 - Evaluation of Alternatives	Evaluation of all alternatives considered (including no action). Most content in sections below
Present Value Analysis	Costs and revenues, with and without the value of the water saved
Evaluation of Rates and Fees	Impact on rates and fees of each alternative considered
Technical Feasibility	Technical feasibility of each alternative, with methods to overcome problems and constraints
Environmental Assessment	Impacts on physical, biological, and socioeconomic environments within the study area. Construction phase and project implementation; benefits associated with reuse
Chapter 6 - Summary and Conclusions	Pros and cons of each alternative considered. Summary tables of present value analysis (with and without consideration of the value of water saved) and results of the evaluation of rates and fees

Incentives to match the water management district's regulatory controls include financial assistance programs. Districts make grants to support reclamation treatment and reclaimed water reuse. A second source of state financing is the State Revolving Fund (SRF) for wastewater, a state-only source that is related to the federally funded revolving loan fund but that uses no federal funds and is not considered cost sharing for the federal funds. The SRF rating system in Florida offers priority points to reuse systems of any kind. Reuse systems that are mandated to

help solve a water quality problem receive points under a water quality criterion, and other reuse systems receive points under a reuse-specific criterion.

WWTPs producing at least 0.1 mgd of reclaimed water report annually to the Florida DEP. Their reports include total facility flow, reuse flow, and itemized data about irrigation of edible crops. Data in these reports can be estimates and are primarily for preparation of the mandated annual statewide report.

St. Petersburg is notable among the larger reusers in Florida. Because of potable water shortages, St. Petersburg developed a reclamation system in the late 1970s. The system provides a sub-potable distribution system paralleling about one-sixth of the city's potable water supply service area. Sub-potable water reaches individual residences and is restricted by ordinance to landscape irrigation. A lower price per gallon provides an incentive to the customer to irrigate with sub-potable water instead of potable water (Parsons 2007).

In the Tampa Bay area, water has become scarce and expensive enough that a new 25 mgd desalination plant came online in late 2007. More than half of that region's wastewater is already reused. Hillsborough County has a target of reusing 100% of its wastewater (Parsons 2007). Florida remains at the forefront of water reuse out of necessity because of its burgeoning population and limited freshwater resources.

Focus: California

California competes with Florida for the largest reuse water volume. Unlike well-watered Florida, California packs millions of people into desert areas and makes many long-distance water supply transfers which require a great deal of energy to move, thus giving a higher innate price to basic potable water supply and a stronger financial incentive for reuse within the water supply service area. As of 2003, Californians reused about a half-million-acre feet of water per year (450 mgd).

State policy provides an impetus for reuse. California Water Code (CWC) Division 7, Chapter 7, or Water Recycling Law states:

> *"It is hereby declared that the people of the state have a primary interest in the development of facilities to recycle water containing waste to supplement existing surface and underground water supplies and to assist in meeting the future water requirements of the state.*
>
> and
>
> *The Legislature hereby finds and declares that the use of potable domestic water for nonpotable uses, including, but not limited to, cemeteries, golf courses, parks, highway, landscaped areas, and industrial and irrigation uses, is a waste or an unreasonable use of the water within the meaning of Section 2 of Article X of the California Constitution if recycled water is available which meets all of the following conditions, as determined by the state board.*

It is State policy to promote the use of recycled water to the maximum extent in order to supplement existing surface and ground water supplies to help meet water needs (CWC sections 13510-13512). One of the primary conditions on the use of recycled water is protection of public health."

California organizes its reuse categories by supplemental treatment level. All levels include basic secondary treatment—oxidation and suspended solids reduction. Tables 9 and 10 summarize requirements for each treatment class. (California 2001) California is unique among the seven featured states in this report because it exempts some irrigation from disinfection. (Each state makes its own tradeoff among economic considerations and health risk considerations, and the weights may vary over time within a state.)

Table 9: California's Municipal Wastewater Reuse Classes and Requirements

Treatment Class	**Uses Allowed (1)**	**Filtration/Turbidity**	**Disinfection/ Pathogens**	**Other Treatment/ Parameters**
Disinfected tertiary	Irrigation: food crops, including edible root crops in which recycled water contacts edible portion; parks and playgrounds; school yards; residential landscaping; unrestricted access golf courses Non-restricted recreational impoundments Cooling tower, evaporative condenser, spraying, or anything that creates a mist Flushing toilets and urinals Priming drain traps. Industrial process water that may come into contact with workers Structural fire fighting Decorative fountains. Commercial laundries;. artificial snowmaking Commercial car washes	Two options before disinfection: (1) Coagulation then undisturbed soil or bedded filter media, with ≤ 2 NTU turbidity 24 hour average, ≤ 5 NTU 95% of the time, and ≤ 10 NTU all of the time; or (2) micro-, ultra-, or nano-filtration, or reverse osmosis, yielding ≤ 0.2 NTU 95% of time, and always ≤ 0.5 NTU. Coagulation may be able to be omitted. May use "nonconventional tertiary" treatment if impoundment is sampled for *giardia*, *cryptosporidium*, and enteric viruses	7-day median total coliforms ≤ 2.2/100 mL, no more than one of seven samples over 23/100 mL, no sample over 240/100 mL; Chlorine contact time, or virus inactivation 99.999%	Cooling use requires drift eliminator plus biocide to minimize growth of *Legionella* and other micro-organisms.
Disinfected secondary-2.2 or better	Irrigation of food crops in which there is no contact of water with edible portion and edible portion is aboveground Restricted recreational impoundments and fish hatcheries	Not explicitly required	Same as for disinfected tertiary	

Treatment Class	Uses Allowed (1)	Filtration/Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
Disinfected secondary-23 or better	Irrigation: cemeteries, freeway landscaping, restricted-access golf courses, ornamental nursery stock and sod farms with no public access restrictions; pasture for milk animals; nonedible vegetation with controlled access by children Landscape impoundments without decorative fountains Cooling or air conditioning producing mist; industrial boiler feed; nonstructural fire fighting; dust control on roads and streets; cleaning roads, sidewalks and outdoor work areas; industrial process water that will not come into contact with workers	Not explicitly required	Same as for disinfected tertiary, except 23/100 mL; 7-day median, no sample above 240/100 mL	
Undisinfected secondary or better	Irrigation: orchards and vineyards if no contact of water with edible parts; non-food bearing trees including Christmas trees up to 14 days before public access or harvest; fodder and fiber crops; pasture for non-milk animals; seed crops not for humans; food crops that undergo pathogen-destroying processing; ornamental nursery stock up to 14 days before harvest or retail sale or public access Flushing sanitary sewers	None	None	Organic matter stabilized, nonputrescible, contains dissolved oxygen
Case-by-case	Ground water recharge			Evaluation by state DPH

1. In general, any use requiring a lesser degree of treatment of water may also use a higher quality water (i.e., water complying with any row above in the table).

Table 10: California's Municipal Wastewater Reuse Classes and Requirements

Treatment Class	Setbacks	Reliability	Storage and Blending	Monitoring
Disinfected tertiary	No irrigation within 50 feet from potable well; no impoundment within 100 feet of potable well	Alarm plus standby power supply; alarm and automatic short-term influent retention; OR automatic long-term storage or disposal	If storage provided for rejected water, 24 hours capacity. All equipment except a pump-back (to above supplemental treatment) should have independent or standby power source. No automatic switch backs after incidents	Continuous turbidity, including recorder, after filtration. Quarterly reporting to regional board
			Can divert reject water to an alternate reuser if criteria for them are met by water unsuitable for primary user	
			Long-term storage if provided should be for at least 20 days.	
Disinfected secondary-2.2 or better	No irrigation within 100 feet from potable well; no spray irrigation within 100 feet of residence or place of public exposure similar to park, playground or school yard	As above	As above	At least daily sampling for total coliform.
Disinfected secondary-23 or better	No irrigation within 100 feet from potable well; no spray irrigation within 100 feet of residence or place of public exposure similar to park, playground, or school yard.	As above.	As above.	At least daily sampling for total coliform
Undisinfected secondary or better	No irrigation or impoundment within 150 feet from potable well	As above	As above	At least daily sampling for total coliform

California controls reuse through permits (orders) issued by nine regional water quality control boards, under standards in regulations from the Department of Public Health (DPH; formerly Department of Health Services (DHS)). (California 2001) A 1996 memorandum of agreement among DHS, the regional boards, and the state Water Control Board organizes interagency responsibilities. Table 11 describes the content of the engineering reports required from applicants for permits (California 2001a).

Table 11: California Reuse Engineering Report Contents

Chapter or Section	Contents
Recycled Water Project	Description of project
General	Who will design, treat, distribute, construct, operate and maintain; legal arrangements; coordination arrangements if multiple entities?
Rules and Regulations	Requirements imposed by distributor or user; how codified; compliance program for public health and cross-connections; enforceability; entity with authority and pertinent personnel
Producer - Distributor - User	Identities and roles of each entity (producer, distributor, user)

Chapter or Section	Contents
Raw Wastewater	Chemical quality; source of wastewater, proportion and types of industrial waste, and industrial waste source control programs
Treatment Processes	Schematic of treatment train; treatment processes; filtration design criteria; expected turbidities of filter influent effluent; chemicals to be used, how mixed; chemical storage and handling; O&M manuals
Plant Reliability Features	Plant reliability features proposed to comply with sections 60333 - 60355 of CA Water Recycling Criteria; under what conditions feature actuates; where alarms will be received, how location is staffed, and who notified; hours plant will be staffed
Supplemental Water Supply	Purpose, support, quality, quantity available, backflow prevention, cross-connection control
Monitoring and Reporting	Frequency and location of sampling; method and frequency of calibration of continuous analysis and recording equipment
Contingency Plan	What conditions require immediate diversion; diversion procedures; diversion area capacity, holding time and return capabilities; plans to activate supplemental supplies; how to dispose or treat any inadequately treated effluent; fail safe features under power failure; how to notify recycled water user(s), regional board, health and other agencies
Transmission and Distribution Systems	Maps of transmission facilities and distribution systems; ownership and location of potable water lines, recycled water lines and sewer lines within recycled water service area and use area(s)
Use Areas	Land uses; type of reuse; who is responsible for distribution and use; other governmental regulators; use area containment measures; map of use areas; areas of public access; surrounding land uses; location and details of nearby wells; signage; degree of access by employees and public; cross-connection control procedures
Irrigation	Piping networks in use area (recycled, potable, sewage and others); what will be irrigated; method of irrigation; domestic water supply facilities nearby; containment measures; measures to minimize ponding; direction of drainage and a description of area where drainage will flow; how to maintain setback distances; protection measures for water fountains and outdoor eating areas; public warning signs; irrigation schedule; how to minimize public contact
Impoundments	Type of use or activity; degree of public access; conditions and frequency of expected overflow, direction of drainage; description of the area where drainage will flow
Cooling	System type; biocides; drift eliminator; potential for public and worker exposure; exposure mitigation
Groundwater Recharge	Potential impacts on aquifers (case-by-case consultation with state)
Dual Plumbed Use Areas	Specific California rules about such areas which emphasize prevention of cross-connections, particularly by tenants
Other Industrial Uses	Case-by-case
Use Area Design	Describe how cross-connections and escape of reclaimed water will be prevented.
Use Area Inspections and Monitoring	Define program; identify most likely problems; identify responsible personnel.
Employee Training	Describe training, who provides it, frequency, reference manuals.

The regional board reviews the report in consultation with DPH and issues requirements as an order granting the permit to the WWTP. Included in the permit is a requirement that the permittee establish and enforce rules or regulations for reclaimed water users, governing the design and construction of reclaimed water use facilities and the use of reclaimed water in accordance with the uniform statewide reclamation criteria. Thus California, like Florida, regulates users through the recycled water provider.

California has multiple cases in which a single reclaimed water producer distributes reclaimed water to multiple customers via a sub-potable distribution system. This is restricted to commercial, industrial and multi-unit residential customers, the latter excluding buildings in which units are individually owned.

The state provides loans and grants for general wastewater treatment as well as specific funds for wastewater reuse. Since 1978, California has provided $130 million in grants and $500 million in loans related to water recycling. (These figures do not count recipients' cost-sharing.) This assistance has enabled 340,000-acre-feet/year (300 mgd) to be delivered (California 2007).

Focus: New Jersey

New Jersey is a particularly interesting case for New York State due to its proximity and similar climate, geography, and legal and regulatory structures. The New Jersey Department of Environmental Protection (NJ DEP) administers a reuse program within its SPDES wastewater permitting system. The program, originated in 1999, is called Reclaimed Water for Beneficial Reuse (RWBR). Approximately 75 wastewater treatment plants have received approval for beneficial reuse of their treated effluent.

Recent New Jersey state water policy includes the statements:

> *Reclaimed wastewater, which was once considered a waste for disposal, is now a resource desired by commercial entities, municipalities, county parks, and various recreation departments, and residential developments. N.J.A.C. 7:14A-2.1 established a responsibility for [NJ DEP] to encourage and promote RWBR and water conservation.*
>
> *Objective: To help preserve the highest quality water and reduce the export of freshwater out of basins in support of meeting water supply needs and natural resource protection (NJ DEP 2007).*

New Jersey imposes fairly strict supplemental treatment requirements on all WWTPs that provide reclaimed water, while maintaining the possibility of justifying lesser treatment if a case is made. (NJ DEP 2005; NJ DEP 2007) The basic requirements include:

- Removing nitrogen to 10 mg/L;
- Filtering with a membrane or granular medium;
- Adding polymers or coagulants;
- Disinfecting using chlorine or UV; and
- Metering the flow to each reuser.

Tables 12 and 13 provide New Jersey's specific guidelines for different types of reuse.

Table 12: New Jersey's Reclaimed Water Types and Requirements

Reclaimed Water Type	Typical Uses	Filtration/Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
I. Public access	Spray irrigation of golf courses, baseball/soccer/ football fields and parks; irrigation of landscaped areas; highway median strip irrigation Decorative outdoor fountains	TSS 5.0 mg/L before disinfection - continuous turbidity monitoring; must correlate turbidity with TSS before operation and then update annually ≤2 NTU turbidity if UV is used	Chlorination if used: residual 1.0 mg/L for at least 15 min. UV if used:100 mJ/cm^2; NWRI 2003 Other disinfection such as ozone may be accepted. Fecal coliform ≤ 2.2/100 mL weekly median of daily values, ≤ 14/100 mL any one sample	Minimum 0.1 mgd capacity of whole WWTP Toxics and metals: Per EPA metals and toxics in *EPA Guidelines for Water Reuse* Loading rate ≤ 2 inches/week
II: Restricted access and non-edible crops	Spray irrigation of sod farms and pasturelands or similar areas where public access to the application area is restricted	None explicit; may be needed to meet pathogen criteria	Fecal coliform ≤ 200/100 mL monthly geometric mean; ≤ 400/100 mL weekly geometric mean UV if used: 75 mJ/cm^2.	TN ≤ 10 mg/L. Toxics and metals: Per EPA metals and toxics in *EPA Guidelines for Water Reuse* Loading rate ≤ 2 inches/week 15-day non-use period before dairy cattle can graze (no restrictions other cattle)
III: Ag edible crop systems	Spray irrigation only if crop is peeled, skinned, cooked, or thermally processed before consumption; otherwise, must use ridge/furrow irrigation or another method that precludes direct contact	Same as Type I	Same as Type I	
IV: Industrial, maintenance, construction		Case-by-case	Fecal Coliform: ≤200/100 mL monthly geometric mean; ≤ 400/100 mL,weekly geometric mean	Uniqueness precludes specific standards; case-by-case review. Note that non-contact cooling water "may require very little if any changes to the level of treatment."
Other types	Case-by-case	Case-by-case	Case-by-case	Case-by-case

Table 13: New Jersey's Reclaimed Water Types and Requirements

Class	Setbacks	Reliability	Storage and Blending	Monitoring
I: Public access	75 ft. to potable wells and a few protected surface waters; aerosol control within 100 ft. of public eating, drinking and bathing facilities; 100 ft. from indoor aesthetic features and public eating or drinking if in the same room or same building space; no off-site spray or drift; may require extra setbacks from adjacent, privately owned, occupied dwellings		Unlined pond for water that meets criteria; lined or sealed pond for reject water; no outlets to surface water allowed	Continuous turbidity, continuous chlorine residual or UV intensity
II: Restricted access	100 or 500 ft. from potable wells; 400 ft. from residences, dwellings, occupied structures; 100 ft. from property lines		As above	
III: Ag edible crop systems	Same as Type I		As above	Include inventory of edible crop irrigation with annual report to NJ DEP.
IV: Industrial, maintenance, construction	Case-by-case	Case-by-case	Case-by-case	Case-by-case
Other	Case-by-case	Case-by-case	Case-by-case	Case-by-case

NJ DEP regulates reuse systems via the SPDES permit of the wastewater producer. The producer submits a RBWR plan, which includes intended uses and locations, treatment processes, and an operation protocol that specifies monitoring and control systems, and rules for when water does not meet quality requirements. The SPDES permit will include requirements for formal agreements between the wastewater permittee and the individual reusers or local ordinances governing reuse.

Permittees must continuously monitor flow to each reuse location, as well as turbidity. Summaries of these routine data become part of their periodic discharge monitoring reports (DMRs) already submitted to NJDEP. A reuse-specific annual report to NJDEP must include a summary of average and maximum monthly average flow to each location, plus edible crop irrigation data if there is any such reuse.

New Jersey provides an incentive to reusers; there is no regulatory fee for the SPDES permit modification if it is for a RWBR application.

NJ DEP also controls water allocation to users, issuing water supply allocation permits to users of more than 100,000-gallons/day, excluding agriculture and horticulture (NJDEP 2005b).

Reuse could become a mandatory consideration in the future under this authority or NJ DEP's wastewater authority:

> *The NJPDES permitting programs may be requiring the assessment of RWBR feasibility at all wastewater treatment and disposal facilities in the State with a design flow of 0.1 MGD or greater. The Water Allocation permitting program may be requiring similar reuse feasibility studies for all applicants proposing to use water for non-potable and consumptive uses. Reuse of reclaimed water from domestic wastewater treatment facilities could be required, unless such reuse is not economically, environmentally, or technically feasible as indicated by a Department approved study that conforms to the requirements of this guideline. (NJ DEP 2005)*

New Jersey's guidance about reuse feasibility studies draws heavily, with acknowledgment, from Florida's guidance. (See Table 8 in the Florida section above.)

Focus: Washington State

Washington began to stimulate domestic wastewater reuse in the 1990s, both by regulatory changes and by funded demonstration projects. Its state water policy now declares that:

> *Many communities in this state are approaching or have reached the limits of their available water supplies. Water reclamation and reuse can become an attractive option for conserving and extending available water resources. Water reuse may also present an opportunity for pollution abatement when it replaces effluent discharge to sensitive surface waters.*
>
> *The use of reclaimed water to replace potable water in nonpotable applications conserves potable water and stretches the potable water supply. A water reuse facility is a very reliable source of water and using reclaimed water instead of potable water can avoid costs. Furthermore, using reclaimed water can help preserve water rights for potable water sources to accommodate growth.*
>
> *A reuse program can reduce or totally eliminate the effluent discharge to surface bodies of water, thus reducing pollutant loading in the environment. Protection of salmon runs or shellfish beds is also a benefit. Wastewater reuse is viewed as a very environmentally progressive approach to dealing with a community's waste stream.*
>
> *Reclaimed water can be viewed as a commodity and sold. Utilizing reclaimed water for a beneficial purpose instead of wasting it can help a community recapture some of its financial investment in wastewater treatment.*

A 1992 law mandated Washington's Department of Ecology (DOE) to develop standards for reuse in conjunction with its Health Department.

Washington's reuse criteria are contained in the sewage works design standards, chapter E1 Water Reclamation and Reuse (Washington 2006). All treatment chains start with secondary treatment: biochemical oxygen demand and total suspended concentrations of 30 mg/l. Table 14 provides specific details for different classes of uses.

Table 14: Washington State's Reclaimed Water Classes and Requirements

Reclaimed Water Class	**Uses Allowed (1)**	**Filtration/ Turbidity**	**Disinfection/ Pathogens**	**Other Treatment/ Parameters**
A	Ground water recharge; injection wells; spray irrigation of food crops; surface irrigation of root crops; landscape irrigation of open access areas (include golf courses, parks, playgrounds, school yards, residential); spray street washing; non-restricted recreational impoundments; decorative fountains; street washing involving spray; fire hydrants or sprinklers in buildings; toilet and urinal flushing; industrial cooling if any mist or aerosol; industrial cooling: forced air evaporation or spraying; industrial process with exposure of workers; fisheries, or potential human contact recreational or educational use	Turbidity ≤ 2 NTU average of monthly samples, no single reading above 5 NTU	Total coliform ≤ 2.2/100 mL 7-day median, no single sample over 23/100 mL	Nitrogen removal to drinking water quality standard, if groundwater recharge. All drinking water criteria plus reverse osmosis treatment required for underground injection
B	Surface irrigation of food crops where there is no reclaimed water contact with edible portion of crop; restricted recreational impoundments; fish hatchery basins; washing of corporation yards, lots, and sidewalks; non-contact recreational or educational use, with unrestricted access	No coagulation or filtration required; filtration recommended if UV disinfection	Same as class A	

Reclaimed Water Class	Uses Allowed (1)	Filtration/ Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
C	Irrigation of sod, ornamentals for commercial use, and pasture to which milking cows and goats have access; landscape irrigation in restricted access areas (cemeteries, freeways); landscape impoundments; street sweeping and brush dampening; dust control on unpaved roads and other surfaces; dampening of soil for compaction at construction sites; water jetting for compaction around reclaimed water pipelines, sewage, storm drainage, conduits for gas and electricity; firefighting via dumping from aircraft; ship ballast; washing aggregate and making concrete; industrial or boiler feed; industrial cooling without mist or aerosols; industrial process without exposure of workers; non-contact recreational or educational use with restricted access	Same as class B	23/100 mL 7 day median, no single sample over 240/100 mL	
D	Irrigation of trees, fodder, fiber and seed crops; spray or surface irrigation of food crops which undergo physical or chemical processing sufficient to destroy all pathogenic agents; surface irrigation of orchards and vineyards; flushing of sanitary sewers; discharge to wetlands	Same as class B	240/100 mL 7-day median	
Streamflow augmentation		Same as class A, except if indirect potable (see below)	Same as class A, except if indirect potable (see below)	Site-specific NPDES and surface water quality standards apply
Indirect potable reuse	Discharge of treated wastewater into a reservoir or stream, with intention to augment flow	Case-by-case	Case-by-case	Case-by-case Requires participation of water supply utility

An incentive to produce reclaimed water in Washington is that the water rights clearly belong to the wastewater producer. Water rights can be very valuable in the water-scarce West, where under the appropriations doctrine, the earliest user can pre-empt latecomers. In the eastern

United States, which uses the riparian doctrine, all landowners adjacent to a water body share in water rights regardless of whether or when they exercise them.

The rights allocation is part of the reclaimed water permit issued by Washington to the reclaimed water treatment facility. The state oversees users through the treatment facility's permit, requiring that all users be itemized and that there be a binding Service and Use Area Agreement between the water provider and each water reuser. Such an agreement may be via a local ordinance. The agreement must provide the wastewater supplier with authority to cut off the supply to a user who violates state standards.

Washington sought experience in reuse by funding and overseeing demonstration projects starting in 1997; a publication of results is available (Washington 2000a). There is also a demonstration irrigation project for the State Capitol campus. In 2007, a reclaimed water grants program began providing $5 million for projects in the Puget Sound area. These are aimed at water quality improvement and will include 3-6 projects that receive up to 75% in state funds for implementation. Feasibility assessments for those projects costing up to $250,000 are 100% funded by the state.

Washington provides extra points for reuse systems in scoring for their SRF program for wastewater infrastructure.

Washington mandates consideration of wastewater reuse in several ways. First, in wastewater plans:

> *The evaluation of any plans submitted under RCW 90.48.110 must include consideration of opportunities for the use of reclaimed water as defined in RCW 90.46.010. Wastewater plans submitted under RCW 90.48.110 must include a statement describing how applicable reclamation and reuse elements will be coordinated as required under RCW 90.46.120(2).*

Wastewater reuse must also be considered in local water supply plans. State agencies are required to use reclaimed water where feasible (as explicitly defined).

Reclaimed water monitoring and reporting requirements are integrated with WWTP influent and effluent monitoring. Monthly reporting is via NPDES DMRs, and facilities submit an annual summary separately.

Focus: Massachusetts

The Massachusetts Department of Environmental Protection (DEP) oversees wastewater reuse. DEP developed interim guidance for wastewater reuse in 2000 and began updating it in 2004. The guidance focuses on groundwater; unlike all of the other states summarized here, Massachusetts does not have delegation from EPA for wastewater discharge permitting and supervision. Wastewater reuse falls under Massachusetts state law for ground water discharge permitting, which does not require a permit under the Federal Clean Water Act. Most phraseology in the guidance refers to disposal rather than a beneficial reuse for water quantity or quality management purposes (Massachusetts 2007; Massachusetts 2000).

Massachusetts is included here as an example of a state very early in a program, one which has similar climate and terrain to New York. Its experience is particularly relevant to Long Island, as Cape Cod shares the same concerns about vulnerable ground water.

Tables 15 and 16 provide Massachusetts' categories and criteria for reusers.

Table 15: Massachusetts' Interim Reuse Types and Requirements

Use Type	Filtration/Turbidity	Disinfection/Pathogens	Other Treatment/ Parameters
Urban reuse: golf course spray and drip irrigation	Filtration required Turbidity ≤ 2 NTU all times. TSS ≤ 5 mg/L	Chlorine or UV disinfection Fecal coliform 7-day median not detected, no more than 14/100 mL any sample	Total N < 10 mg/L Must meet SDWA drinking water standards 8-week pilot project required for treatment technology Golf course fertilization must be reduced to account for nutrients in irrigation water.
Urban reuse: nurseries	As above	As above	Requires regular irrigation schedule
Aquifer recharge (Applies to Zone II of community water systems, plus interim wellhead protection areas. (Zone II is well-capture zone based on 180-day drought at permitted pumping rate)	Turbidity ≤ 2 NTU or ≤ 5 NTU TSS 5 or 10 mg/L No specific filtration mandate, but may be necessary to meet turbidity and TSS criteria More rigorous criteria above apply to certain situations	Fecal coliform 7-day median none detectable, max 14/100 mL or 200/100 mL, more rigorous maximum applies in certain situations	Must meet drinking water MCLs in WWTP effluent; pretreatment program required for non-human wastes into the WWTP TN < 10 mg/L Nitrate loading model if >20% of well yield, if well is over 5 mg/L NO_3 or ≥ 100,000 gpd
Toilet flushing (only for commercial establishments; assumes that the eventual discharge is to groundwater)	As for urban reuses. Turbidity ≤ 5 NTU TSS 10 mg/L	As for urban reuses Fecal coliforms ≤ 100/100 mL	Approval by local board of health required TN < 10 mg/L Class I Groundwater Permit standards

Table 16: Massachusetts' Interim Reuse Types and Requirements

Use Type	Setbacks	Reliability	Storage	Monitoring
Urban reuse	100 ft. from buildings, private wells, certain surface water bodies, surface water intakes; green barrier can be used to cut setback to 50 ft. No spray irrigation during operating hours	Two independent and separate power sources, unit redundancy, additional storage, spare parts inventory to minimize time offline	Short- and long-term holding options required; off-season discharge permission required. Storage ponds: lined, aerated, sized to promote turnover, no runoff from fertilized areas, stormwater structures to minimize nutrient transfer into ponds, landscaped to exclude children	Continuous turbidity; daily fecal coliform, disinfection UV intensity or chlorine residual, MS-2 phage quarterly, heterotrophic plate count quarterly Use pilot test as basis for requirements beyond the above. Pilot monitoring of parameters including; viruses, crypto, giardia, coliphage, enterococci, coliforms. Monitoring wells. Long-term monitoring of buildup of contaminants in upper soil horizons: pathogens, metals, chlorides Lysimeters required if reclaimed water over 10 mg N/L
Urban reuse: nurseries	As above	As above		
Aquifer recharge	As above	As above		Groundwater monitoring plan: upgradient, performance of land uses at wastewater discharge area, overall impact, early warning system before sensitive receptors
Toilet flushing	None	As above, plus two days' storage required for influent when treatment system is not functioning Advanced level WWTP operator. O&M Manual section		Continuous turbidity Fecal coliform 1/week, daily UV or Cl residual, weekly TSS

Massachusetts oversees wastewater reuse via its groundwater discharge permit system, issued to both the reuser and the wastewater producer. (Reusers require a permit because of their own discharge, not because of the reuse; presumably this does not apply to toilet flushing reusers if their effluent is to a city sewer.) A contract based on a sample in the interim guidelines is required if the producer and reuser are different legal entities. The WWTP owner is responsible for actions of the reuser. Permits apply for facilities above 10,000 gallons/day.

In Massachusetts, EPA Region 1 issues NPDES permits to surface dischargers. This includes discharge into an unlined pond used to store treated water for reuse. DEP issues a water quality certification permit in parallel with EPA's NPDES permit. The NPDES permit reflects provision of treated wastewater to a reuser; it incorporates requirements of interim guidelines, including a requirement that the permittee enforce the reuse terms.

Massachusetts requires monitoring of water out of the WWTP supplemental treatment system, ground water from monitoring wells or suction lysimeters, and proximal surface waters.

Focus: Arizona

Arizona's Department of Environmental Quality (DEQ) administers the state's domestic wastewater reuse program. Table 17 summarizes requirements for six classes (Arizona 2006). Classes A+ and B+ are minor variants on classes A and B, adding nitrogen treatment and quality criteria.

Table 17: Arizona's Domestic Wastewater Reuse Classes and Requirements

Treatment Class	Uses Allowed	Filtration/Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
Class A+	All uses. Not specifically required for any use	Chemical feed facilities to add coagulants or polymers; may remain idle if turbidity criterion is achieved without chemical addition 24-hour average turbidity ≤ 2.0 NTUs, never over 5.0 NTU Alternative treatment methods or alternative turbidity criteria may be used, or reclaimed water may be blended with other water, provided the owner demonstrates through pilot plant testing, existing water quality data or other means that disinfection and nitrogen criteria are met.	No detectable fecal coliform organisms in four of the last seven daily samples. No single sample ≥ 23/100 mL If alternative treatment processes or alternative turbidity criteria are used, or reclaimed water is blended with other water to produce Class A+ reclaimed water, there must be no detectable enteric virus in four of the last seven monthly reclaimed water samples taken.	Nitrogen removal treatment. 5-sample geometric mean concentration of total nitrogen < 10 mg/L

Treatment Class	Uses Allowed	Filtration/Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
Class A	Irrigation of food crops; recreational impoundments; residential landscape irrigation; schoolground landscape irrigation; open-access landscape irrigation; toilet and urinal flushing; fire protection systems; spray irrigation of an orchard or vineyard; commercial closed-loop air conditioning systems; vehicle and equipment washing (does not include self-service vehicle washes); snowmaking	Same as Class A +	Same as Class A+	Nitrogen removal not required
Class B+	Same as Class B	None specified	Fecal coliforms in four of the last seven daily samples < 200/100 mL No single sample ≥ 800/100 mL	Nitrogen removal treatment. 5-sample geometric mean concentration of total nitrogen < 10 mg/L
Class B	Surface irrigation of an orchard or vineyard; golf course irrigation; restricted access landscape irrigation; landscape impoundment; dust control; soil compaction and similar construction activities; pasture for milking animals; livestock watering (dairy animals); concrete and cement mixing; materials washing and sieving; street cleaning	Same as Class B+	Same as Class B+	Nitrogen removal not required
Class C	Pasture for non-dairy animals; livestock watering (non-dairy animals); irrigation of sod farms; irrigation of fiber, seed, forage and similar crops; silviculture	None explicit	Fecal coliform organisms in four of the last seven daily samples < 1000/100 mL. No single sample ≥ 4000/100 mL	Secondary treatment in a series of wastewater stabilization ponds, including aeration, with or without disinfection. The total retention time of Class C reclaimed water in wastewater stabilization ponds is at least 20 days.
Industrial reuse	Food production or processing other than that covered by an above class.			Case-by-case

There are no specific setback, monitoring, storage or reliability requirements prescribed in regulations. Presumably, these are prescribed via guidelines or developed case-by-case.

Arizona DEQ issues reuse permits to both reclaimed water producers and reclaimed water end users. Agents are allowed to hold permits as intermediaries rather than having every end user receive a state permit directly. The state offers general and individual permits. Individual permits have fees of at least $1,000. General permits apply to smaller users automatically. Contracts between producers and users are referred to in permits.

The state mandates that producers and users maintain records and provide them on demand to the state.

Arizona offers extra points for reuse in the Conservation Index part of ranking criteria for their SRF loan priority list. Arizona has a mature greywater regulation program which is described in Chapter 4.

Focus: North Carolina

North Carolina's experience with wastewater reuse dates back decades, starting with agricultural irrigation and expanding into municipal wastewater reuse in areas accessible to the public by the late 1990s (Hilger 2003). The North Carolina Division of Water Quality, part of the Department of Environment and Natural Resources, oversees reclaimed water treatment and use as part of their wastewater not discharged to surface water regulations, which were last updated in late 2006 and early 2007. As in Florida, North Carolina's reuse regulations are closely related to other land applications of wastewater that are primarily intended to dispose of the water rather than to enable an additional use.

Tables 18 and 19 summarize North Carolina's requirements for three different classes of reuse systems (North Carolina 2006). A conjunctive reclamation system is one whose WWTP has other allowed options for effluent disposal at all times. A non-conjunctive system must dispose of all of its water to a reclaimed water user and thus must provide for extra storage and have additional reliability features to reduce the need for re-treatment.

Every use of reclaimed water except industrial uses that do not expose the public requires the same quality of water. Conjunctive and non-conjunctive systems differ in their monitoring and reliability requirements.

Table 18: North Carolina's Details for Different Water Reclamation Systems

Reuser Type	Uses Allowed	Filtration/ Turbidity	Disinfection/ Pathogens	Other Treatment/ Parameters
Conjunctive systems (including a conventional wastewater discharge)	Land application to publicly accessible areas: residential lawns, golf courses, cemeteries, parks, school grounds, industrial or commercial site grounds, landscape areas, highway medians, roadways and other similar areas Industrial process water or cooling water, aesthetic purposes such as decorative ponds or fountains, fire fighting or extinguishing, dust control, soil compaction for construction purposes, street sweeping (not street washing), and individual vehicle washing for personal purposes Urinal and toilet flushing or fire protection in sprinkler systems located in commercial or industrial facilities if demonstrated that public health and theenvironment will be protected Not allowed for irrigation of direct food chain crops, swimming pools, hot tubs, spas or similar uses, or direct reuse as a raw potable water supply	Monthly average TSS of $\leq$ 5 mg/l and daily maximum $\leq$ 10 mg/l Maximum turbidity of 10 NTUs	Monthly geometric mean fecal coliform level $\leq$ 14/100 mL, daily maximum $\leq$ 25/100 mL	Monthly average $BOD_5 \leq 10$ mg/l and daily maximum $BOD_5 \leq 15$ mg/L Monthly average $NH_3 \leq 4$ mg/L and a daily maximum $NH_3 \leq 6$ mg/L Reclaimed water produced by industrial facilities shall not be required to meet TSS, turbidity, fecal coliform, BOD_5, and NH_3 criteria if the reclaimed water is used in the industry's process and the area of use has no public access. Irrigation rate limits
Non-conjunctive systems	As above	As above	As above	As above
Closed loop systems (nondomestic wastewater)	The following are permitted by regulation. Other uses require an application. Return of wastewater contained and under roof within an industrial or commercial process where there is no anticipated release of wastewater Recycling of rinse water at concrete mixing facilities for concrete mix removal from equipment Recycling of wash and rinse water at vehicle wash facilities Reuse or return of wastewater within the treatment works of a permitted wastewater treatment system	None specific	None specific	Spill control plans, with containment No earthen basins Storage capacity to contain runoff No public access

Table 19: North Carolina's Details for Different Water Reclamation Systems

Use Type	Setbacks	Reliability	Storage	Monitoring
Conjunctive systems (including a conventional wastewater discharge)	Irrigation and utilization areas: 25 ft. from surface waters, including streams (intermittent and perennial), perennial waterbodies, and wetlands not classified SA; 100 ft. from surface waters, including streams (intermittent and perennial), perennial waterbodies, and wetlands classified SA; 100 ft. from any well, except monitoring wells; no setback between the application area and property lines	No discharge to storage, distribution or irrigation system if either the turbidity exceeds 10 NTU or if the permitted fecal coliform levels cannot be met. Automatic standby power source or other means to prevent improperly treated wastewater from entering the storage, distribution or irrigation Certified operator on call 24-hours/day.	No storage facilities required if other permitted means of disposal are available if the reclaimed water cannot be completely used.	Continuous on-line monitoring and recording for turbidity or particle count and flow prior to storage, distribution or irrigation
Non-conjunctive systems	As above	Dual facilities for all essential treatment units Effluent from the treatment facility discharged to a detention pond if either the turbidity exceeds 10 NTU or if the permitted fecal coliform levels cannot be met. Ability to return the effluent in the detention pond back to the head of the treatment facility Automatic standby power supply Certified operator on call 24-hours/day No by-pass or overflow lines Multiple pumps if pumps are used Water-tight seal on all treatment/storage units or minimum of two feet protection from 100-year flood	Aerated flow equalization facilities with capacity based on either a representative diurnal hydrograph or at least 25 percent of the daily system design flow Five-day side-stream detention pond with liner	Continuous on-line monitoring and recording for turbidity or particle count and flow prior to storage, distribution, or irrigation

Use Type	Setbacks	Reliability	Storage	Monitoring
Closed-loop systems	(Apply to Treatment/storage units) 100 ft. to residence or place of public assembly under separate ownership or not to be maintained as part of the project site; 100 ft. to private or public water supply source; 50 ft. to surface waters, including streams (intermittent and perennial), perennial waterbodies and wetlands; 100 ft. to any well, except division-approved groundwater monitoring well; 50 ft. to property lines	Ability to stop production of effluent, return the effluent back to the treatment facility, store the effluent, or discharge the effluent to another permitted wastewater treatment facility when recycling cannot be conducted Essential treatment units in duplicate where proper operation of the treatment unit is essential to the operation of the closed-loop recycle system and the operation cannot safely or efficiently be immediately stopped or altered to operate without the closed-loop recycle system Automatic standby power source	None required	None required

North Carolina issues permits for water reclamation systems and reclaimed water distribution systems independently from a WWTP's state NPDES permit. Since January 2007, the state has been able to delegate some of its permit issuance and oversight to local governments and authorities who distribute reclaimed water.

Water reclamation and reuse systems are eligible for extra points (in a category that also covers water conservation) in a priority setting for use of North Carolina's SRF program.

2.4 Reasons to Choose Reuse for Sub-Potable Uses

When reuse is an option, it should be compared to other options using economic, energy, health risk and environmental criteria. Candidate municipal wastewater reusers may have three choices to obtain sub-potable water: (1) withdraw water from a nearby stream, lake or aquifer; (2) use potable water from a municipal or private water supplier or (3) use treated wastewater. It may even be possible to use stormwater or rainwater. Environmental water and treated wastewater may need supplemental treatment if a water reclamation system is not already in operation. Any source may require laying a pipeline to connect to the point of use, and pumping may be necessary.

Each option has benefits and costs from the perspective of the candidate reuser, water and sewer utilities, and water managers. This section examines several aspects of the reuse choice from each of these perspectives, based primarily on experiences in other states, with an emphasis on those aspects most relevant to the Northeast and New York.

Energy Use

Note that this section is about energy use *to treat and transfer water, when comparing reuse versus environmental water versus potable water. Energy* generation *facilities can also use reclaimed water for cooling.*

Literature about energy use in reuse systems is scarce. Advocates may assume that wastewater reuse saves energy, but that is not necessarily the case.

Energy requirements to provide potable water and treat wastewater are substantial. NYSERDA's consultant to a project inventorying energy use in municipal water supply and wastewater reported energy use of about 500 kWh/mg (kilowatt hours per million gallons) for water pumping, treatment and distribution, and 1,500 kWh/mg for wastewater collection and treatment. These figures compare to 1,500 kWh for water supply and 1,200 kWh for wastewater nationally (Yonkin 2007). Nationally, energy constitutes a majority of water supply operating costs and 25-40% of wastewater treatment costs. Pumping is a notable part of this cost. Pumping energy is correlated with the volume, distance, and elevation change in water supply withdrawal, transmission, distribution and wastewater collection.

When reuse is substituted for municipal potable water, energy use falls in certain ways and increases in others. The following schematics show how the most likely kinds of reuse in New York State affect energy use. (Actual energy use and costs would be site specific, depending on relative elevations, distances, and volumes among water supplier, wastewater treatment and reuser.) In these illustrations, plus (+) and minus (–) signs in the diagrams indicate differences in energy use compared to the baseline without reuse.

This report provides these illustrations to show that future feasibility studies of local reuse must incorporate energy demand into their analyses, so as not to limit their evaluation to the viewpoint of the reclamation system and reuser in isolation from their municipal context.

Consider a golf course that wishes to use reclaimed municipal wastewater instead of municipal potable water for irrigation. Figure 4 features three irrigators, one using potable water, one making its own withdrawal from the same source the potable water utility draws from, and one using reclaimed wastewater. Because the reuser does not draw on potable water, less water has to be treated and conveyed to the course. This is indicated by the (-) annotations on the left half of the diagram. Reuse adds new energy requirements to reclaim the wastewater and to convey the reclaimed water from the reclamation facility to the course. Depending on the relative energy uses of these treatment and pumping processes in a given area, there could be an increase or decrease in total energy use. Notable determinants of actual energy cost are distances and relative elevations of the supply source, reuser and wastewater treatment plant. Additional determinants include quality requirements of the reuser versus the degree of treatment needed for potable water and secondary wastewater.

Figure 4 includes a (-) annotation for the "water environment" fate of the discharged wastewater. This represents a reduced effluent amount to the environment and possibly reduced energy use if there is any pumping involved for the WWTP's outfall.

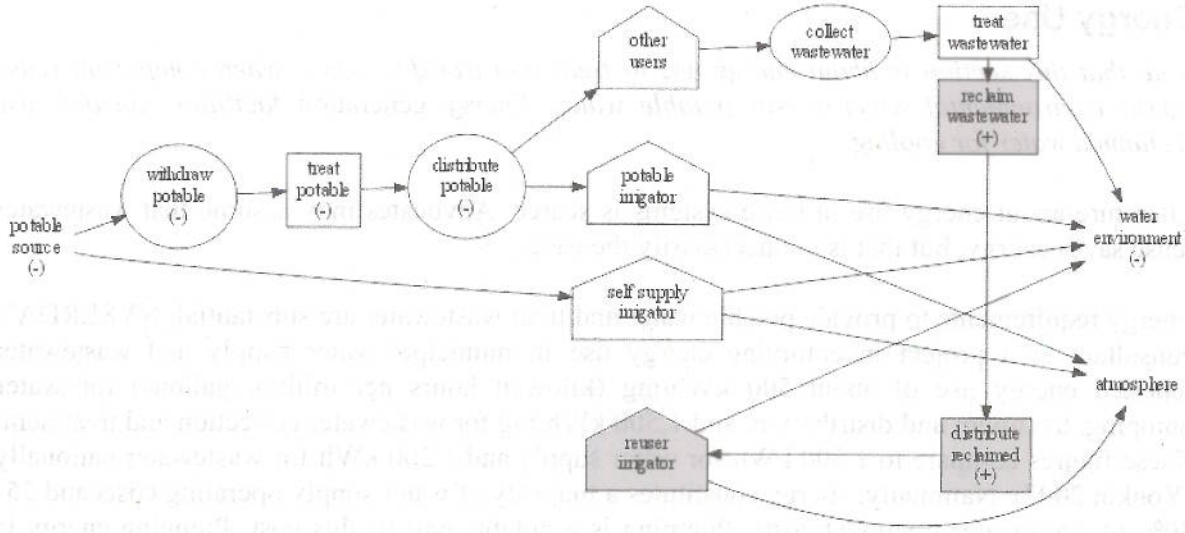

Figure 4: Energy Use Changes from a Reusing Irrigator

For a second case, consider a green apartment building that recycles part of its blackwater for toilet flushing and other uses, compared to a conventional apartment building (call it a "brown building"). Figure 5 portrays energy savings in both municipal water supply and wastewater, unlike the irrigation example, due to reduced municipal sewage flow as well as reduced potable water flow. Blackwater treatment can require quite a bit more energy because, in essence, a whole secondary waste treatment chain has to be provided, as well as the supplemental treatment for reclamation. A green building can also choose to recycle greywater. That does not reduce water demand and exiting wastewater as much as blackwater recycling does, but it may use much less extra energy onsite.

Again, the recycling system reduces wastewater volume discharge to the environment.

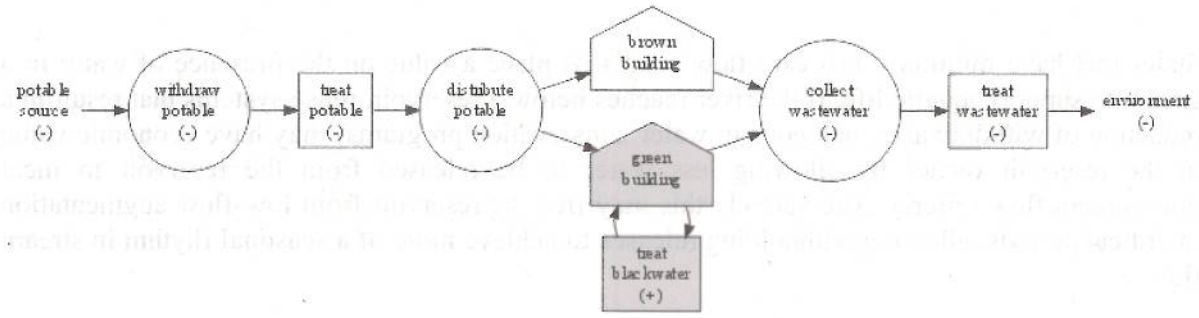

Figure 5: Energy Use Changes from a Green Building that Recycles Blackwater

A more complex case includes a sub-potable reuser that discharges sewage to the municipal wastewater collection systems. Figure 6 illustrates that there are still energy savings at the potable withdrawal, treatment, and distribution side of the chain, but that there is still the same amount of municipal wastewater to treat. (Less water is discharged from the municipal WWTP to the environment.)

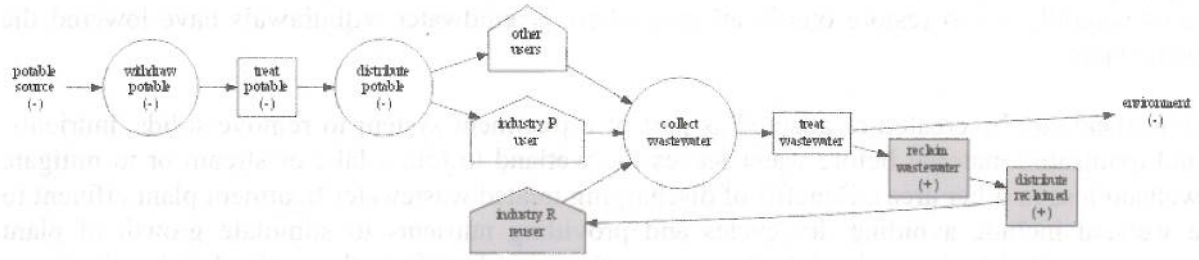

Figure 6: Energy Use Changes from an Industrial Reuser of Municipal Wastewater

Finally, it must be noted that New York State has one unusual feature that limits energy savings. New York City's potable water system is already enormously energy efficient. The city obtains most of its water supply from high-elevation watersheds via gravity and does not provide filtration treatment, thus it has a very low average energy cost to deliver potable water to customers. Compare this to a water system in Nassau County which might pump from a deep well, treat the water to remove nitrate or synthetic organics and then pump for distribution due to flat terrain. While reuse instances in a city with a protected high-elevation water supply still save energy in wastewater collection and treatment, the extra energy used to treat blackwater or gray water inside the building may exceed the total municipal energy savings.

Instream Flow

To the extent that water supply or wastewater flows in pipes instead of aquifers or streams, wastewater reuse will increase instream flow or aquifer storage. Consider the case of 100,000-gallons per day from a reservoir linked to a community via a transmission pipe. If the user could replace some of this demand with wastewater reuse within the community (e.g., recycled wastewater for irrigational demands), then the portion of that 100,000 gpd that is no longer taken from the reservoir could be released through the dam for flow augmentation purposes. This type of reuse would also reduce the interbasin transfer of water when wastewater is piped for treatment and discharged into another basin.

States that have minimum instream flow standards place a value on the presence of water in a stream to support aquatic life. If the river reaches below a reservoir, reuse systems that result in a reduction of withdrawals (analogous to water conservation programs) may have economic value to the reservoir owner by allowing less water to be released from the reservoir to meet downstream flow criteria. Alternatively this may free the reservoir from low-flow augmentation in critical periods, allowing withholding releases to achieve more of a seasonal rhythm in stream flow.

Wetlands

According to DEC, New York State has lost almost half of its historic wetlands to filling and draining. Because wetlands perform valuable functions for aquatic ecosystems and humans, state and federal rules have attempted to halt this loss. State wastewater reuse programs often consider wastewater as an opportunity to maintain and stimulate wetlands. Treated sewage can augment water levels in a wetland. A wastewater source tends to be a more even supply than seasonal rhythms of the water cycle; thus it is possible to create a perennial wetland where one would not exist naturally, or to restore one in an area where groundwater withdrawals have lowered the water table.

A wetland can be created or adapted as part of a treatment system to remove solids, nutrients, and oxidizable material before water leaves the wetland to join a lake or stream or to mitigate wetland loss in other areas. Benefits of discharging treated wastewater treatment plant effluent to a wetland include avoiding dry cycles and providing nutrients to stimulate growth of plant species essential to the wetland. In these cases, there is a benefit to the wetland and to the larger ecosystem or society if one considers a wetland's perennial wet condition or lush vegetation to be more desirable ecologically than a more intermittently wet condition or dry land with less diverse and less lush vegetation.

Aquifer Level Maintenance and Groundwater Supply

Aquifer levels can be maintained by spreading wastewater on land and allowing it to infiltrate the soil, using recharge basins, or injecting it under pressure into wells. In areas where there are potable wells downgradient from recharge and injection sites, wastewater would be required to meet the highest level of treatment plus extra monitoring to meet drinking water standards in the recharging water.

A special case of aquifer level maintenance is the creation of barriers to lateral or upward salt water movement. Extra recharge with highly treated wastewater is done near coastlines, allowing an enclosed ground water basin to develop inland and providing a barrier to salt water intrusion into the aquifer.

In some areas, an aquifer can be a temporary storage location for extra reclaimed water, to be drawn down only during dry or peak demand periods. This is termed aquifer storage and recovery (ASR). ASR has an advantage over surface water storage as there are no evaporative losses. Florida permits and encourages ASR, with the constraint that the recovered water must be treated again after withdrawal if it does not meet criteria for the later use.

In New York State, underground injection is regulated by the EPA rather than the state, which could add a level of policy complexity to reuse schemes that would inject water.

It is also possible that climate change will impact the availability of groundwater as a drinking water source. Groundwater wells are used as a source of drinking water by 15-20% of the state's population. The International Climate Change Partnership's (ICCP) predictions suggest that New York State will have heavier rain events with longer dry periods between. This may stress wells during dry periods and could result in less overall recharge of groundwater wells, leading to groundwater supply shortages.

Financial

The capital and operating costs of supplemental treatment for filtration and disinfection are small relative to the entire cost of operating a wastewater treatment plant. For more elaborate treatment to meet drinking water criteria in effluent destined for aquifer recharge, capital and operating costs escalate and become more of a factor. As with energy costs, comparative costs among potable water, environmental water, and reclaimed wastewater are highly situation-dependent.

Several states subsidize wastewater reuse to offset the costs of mandates, to accelerate adoption, or to gain experience. Subsidies may come in the form of extra points in scoring applications for loans from the SRFs, hardship grants from the SRFs, earmarked funding for planning and construction grants, or demonstration grants targeted at reuse in certain areas.

Localities with very mature programs, such as St. Petersburg, Florida and Marin County, California, have dual water supply distribution systems, one for potable water and the other for reclaimed wastewater. The relative retail prices of these water supplies reflect the different costs of providing two sources and policies to subsidize the sub-potable source. Some California utilities provide "designer" reclaimed water for sub-potable customers, with up to triple reverse osmosis treatment and an array of different prices.

New York City's fledgling reuse program (which is further discussed in Chapter 3) discounts unit costs in water and sewer bills by 25% if a building has an approved wastewater recycling system that cuts its water use by at least 25%, thus subsidizing the reuser at the expense of other system users. This is an operating cost subsidy, in contrast to grant and loan programs which target capital costs.

New York State provides tax incentives for green buildings. The Leadership in Energy and Environmental Design (LEED) Green Building Rating System, developed by the U.S. Green Building Council, provides a suite of standards for environmentally sustainable construction and is used by New York. One section of the national LEED system for rating the environmental footprint of new and retrofit buildings covers in-building wastewater treatment. The use of greywater for subsurface irrigation and other non-potable uses, as well as the collection of rainwater, is encouraged in LEED buildings.

Other Advantages and Disadvantages of Reuse

Reusing wastewater is part of a broader green building philosophy, which may become part of the overall marketing of a building to tenants or part-owners.

Operating supplemental treatment systems for reclaimed water for sensitive purposes such as aquifer recharge or residential irrigation may require adding personnel, higher degrees of training, and more on-call or on-site staff. An upset at a small secondary treatment plant discharging to a large water body may not be an emergency, but an upset that affects a key reuser, and possibly poses health risks, requires established contingency plans.

When a wastewater treatment operation becomes a sub-potable water supplier, management and governance need to adapt to the new roles. The water customer now has a voice in the facility, particularly if they take a large portion of the effluent. WWTP personnel may need to inspect the water user's premises and possibly enforce state requirements *against* the user.

In New York State, and in other areas, reuse can be an option that helps meet receiving water quality goals. A WWTP may not be required to count pollutant loads in the reclaimed water it provides to others. This can require coordination between the regulatory agency, the wastewater treatment plant and the reuser. For example, nitrogen applied in irrigation water to a golf course along a river might end up in the river anyway, as if it were discharged directly, unless the course's fertilization regimen is adjusted to account for the nitrogen in the irrigation water.

In some places, regulatory constraints may effectively force the use of reclaimed wastewater regardless of cost and other criteria, as long as it is available. Critical areas in Florida have such constraints about landscape irrigation.

2.5 Perceived and Actual Risks

In the hundreds of pieces of literature reviewed for this feasibility study, there was no evidence that anyone had been made sick from reused wastewater. The record is remarkable, indicating that the combination of technology, standards, careful operation by both treatment and user personnel, contingency planning, and regulatory supervision is working well to protect public health.

State programs for wastewater reuse oversight are largely risk-averse. Common risks that seem to be universally recognized and controlled through standards, technology, setbacks and operating rules include:

Pathogens in treated wastewater in general. Essentially all reused wastewater to which people can be exposed requires an extra chain of treatment after secondary treatment — filtration, then disinfection. Some industrial reuses, such as cooling water that does not form atmospheric mists, do not normally need health-related treatment. Florida goes beyond indicator bacteria by mandating regular monitoring for protozoans, including *cryptosporidium* and *giardia*. Some states require virus monitoring of pilot reclamation treatment systems.

Exposure concerns about workers, business customers, general public. In some states, even golf courses are differentiated by their degree of public access. Private courses do not need as high a degree of treatment as those open to public. Every state requires warning signs aimed at the general public and workers who are near reclaimed water uses. All states examined require setbacks between outdoor water use areas and buildings and property lines.

Food safety in use of wastewater for irrigating crops for human consumption. Standards must be developed that consider whether the edible part of an irrigated crop is above ground or below ground; how long the reuser must avoid irrigating this type of crop before harvest; whether there are livestock health concerns; and whether milk cows are considered separately from other livestock. Other states have developed various methods to address these concerns.

Prevention of cross-connections in dual distribution systems. Other states have developed standards such as separately colored pipes, warning labels, inspections, and bans on dual plumbing where individuals can make pipe changes. Continuous monitoring of turbidity and disinfection with a mandatory shutoff of flow from the WWTP if monitoring goes out of range is common.

Nitrate is usually controlled when wastewater is recharged to ground water.

When all of these types of considerations are reflected in a reclamation/reuse system design, they place multiple barriers between public and worker exposure and pollutants from raw wastewater sources. Figure 7 indicates five separate barriers used in a municipal reclamation system. Industrial pretreatment prevents toxics from entering the municipal wastewater collection system. The WWTP's own treatment reduces some toxics levels. Reclamation treatment emphasizing disinfection deals with pathogens. A continuous turbidity monitor helps to ensure that the outflow from the reclamation treatment meets specifications and automatically precludes higher turbidity water from leaving the reclamation site. Finally, protective measures within the use area provide the last barrier.

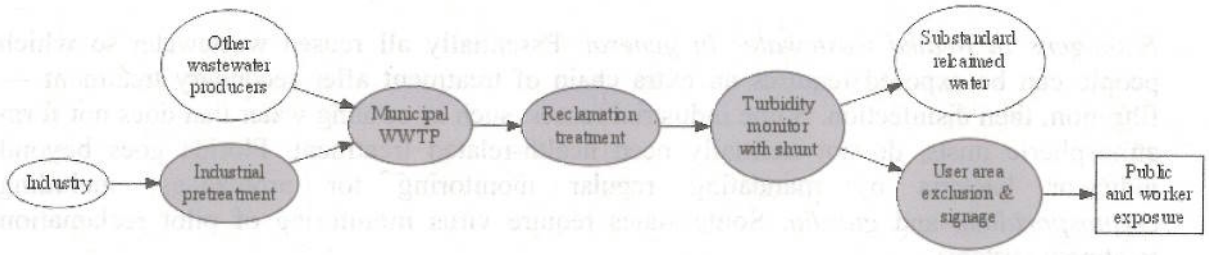

Figure 7: Multiple Barriers for Health Protection

Despite regulatory sensitivity and a good record, there is organized opposition to wastewater reuse in some areas, particularly to indirect potable reuse. There is a psychological dimension, rooted in people's fears of human waste (Dingfelder 2004). Raw sewage and sometimes treated sewage can be repellent. The public may not be aware that today's major wastewater treatment systems are highly efficient, with automatic monitors and controls, and they are designed to be conservatively protective of human health.

Media in the Southwest enjoy using "toilet to tap" imagery when describing proposals for aquifer recharge, even though several years pass before recharged, reclaimed water would reach water supply wells. An expensive aquifer injection facility in Los Angeles was mothballed after one day of operation due to public fear following the end of a political campaign against it. Fear and ignorance about treated wastewater discharges upgradient or upstream from water supply intakes contrasts with marketing of wastewater reuse as a benefit in LEED green buildings.

States where opposition has been significant recommend or mandate several tactics to counter negative public perception of effluent reuse. Public involvement early in the planning process is essential. If indeed there are risks from certain reuses that a community is unwilling to accept, then those reuses may not be viable. The community may learn how to put aside exaggerations by advocates and opponents to help their elected officials be objective about the downsides and upsides of reuse.

Another issue in water safety is emerging contaminants, such as drug residues, consumer products and hormones (Esposito 2005). It is unclear how well these chemicals are removed by secondary wastewater treatment and whether the levels discharged impact human or aquatic health. However, trace levels of personal care products in reclaimed municipal wastewater are not expected to be an impediment to most reuses, and the expected concentrations of these substances in highly treated water will not be high enough to cause concern regarding dermal contact, inhalation or plant uptake. DEC and DOH would not recommend using reclaimed wastewater as potable water.

3. New York State Practices and Potential

This chapter draws together existing, likely, and possible instances of treated domestic wastewater reuse in New York State, The projects covered are wide-ranging, including some that were not considered to involve reuse at the time they were established. However, they fall within the topical domain of New York's water reuse law.

3.1 Information Sources

Primary information sources for this chapter included:

- A poll of DEC regional water staff;
- DEC SPDES permit records in Albany;
- NYWEA's reuse task force report (NYWEA 2003); and
- Visits and telephone conversations with DEC regional staff, local regulators, WWTP managers, engineers, and other interested persons in New York City, Suffolk County, Nassau County, Rockland County, Orange County, Battery Park City, City of Oneida and Albany County.

3.2 Existing and In-Progress New York State Reuse

Table 20 inventories known instances of water reuse under the SPDES system and New York City green buildings with internal recycling.

Section 3.4 below describes the Riverhead, Albany/Rensselaer, Oneida/Verona, and Battery Park City instances in greater detail. Additional, mature examples of reuse include the Lake Placid and Canton systems. These both reduce nutrient loads to watersheds impacted by nutrients by diverting part of their effluent to nearby golf courses. Table 21 includes SPDES permit limits for all three reuse instances involving golf courses.

Table 20: Official Cases of Municipal and Green Building Water Reuse

Location	WWTP	Reuser	Start	Motivation	Status
Riverhead	Riverhead WWTP	Indian Island Golf Course	2011 (projected)	Nitrogen reduction in Peconic Bay	Construction
Albany/ Rensselaer	Albany South WWTP	Empire Generating Company, LLC power plant	2010	FERC mandate	Design

Location	WWTP	Reuser	Start	Motivation	Status
Oneida/ Verona	Oneida WWTP	Turning Stone Resort (golf, power plant, air conditioning)	2003 (Permit modified 1998)	Water shortage, green philosophy of reuser	Operating
Lake Placid	Village of Lake Placid WWTP	Lake Placid Club golf course	1999	Phosphorus reduction in Lake Champlain	Operating
Canton	Village of Canton WWTP	Partridge Run golf course	1996	Golf course irrigation need	Operating
Battery Park City	The Solaire and five other buildings	Buildings themselves	2004	Green philosophy, water rate incentive	Operating
57th St. Manhattan	The Helena	Building itself	2005	Green philosophy; water rate incentive	Operating
43-50 Main St. Flushing, NY	Queens Botanical Garden Visitor & Administration Building	Building itself	2007	Green philosophy; water rate incentive*	Operating
1 Rockefeller Park New York, NY	Riverhouse	Building itself	2007	Green philosophy; water rate incentive*	Operating

Green building notes from http://www.greenhomenyc.org/
*The rate incentive in New York City may have motivated the construction.

Table 21: SPDES Permit Limits for Three Operating Golf Course Reuse Systems

Plant (SPDES#)	Outfall	Start Date	Limits
Oneida (NY0026956)	004	2003	20 mg/L nitrate-N daily max Flow: monitor only Total general coliform: 5000/100 mL maximum, 2400/100 mL daily avg. Fecal coliform: 400/100 mL 7-day geometric mean, 200/100 mL 30-day geometric mean; Total residual chlorine 0.5 - 2.0 mg/L daily
Lake Placid (NY0022187)	002	1999	Total Phosphorus: monitor only Flow: monitor only Nitrate-N: 20 mg/L daily maximum Chlorine: max 2.0 mg/L Fecal coliforms: 400/100 mL 7-day geometric mean, 200/100 mL 30-day geometric mean Total coliforms: 5000/100 mL 7-day geometric mean, 2400/100 mL 30-day geometric mean Both influent and effluent required for flow, phosphorus and nitrogen.
Canton (NY0236586)	002	1996	(monitor wells are outfalls 003, 004, & 005) 003,004,005 (monitor only): specific conductance, pH, water level, nitrate-N, fecal coliform, chloride 002: residual chlorine maximum 0.1 mg/L 002: fecal coliforms 400/100 mL 7-day geometric mean, 200/100 mL 30 day geometric mean 002: total coliforms, monitor only 002: flow, monitor only 002: nitrate-N, maximum 20 mg/L

Additional monitoring requirements apply to the golf course effluents, including timing of irrigation, allowed location of irrigation, signage, and control of cross-connections with potable water.

There are six green buildings in Battery Park City that employ internal wastewater reuse. The Solaire was the pioneer and provided design and operating experience. The Helena on 57th St. in Manhattan was an earlier example outside of Battery Park City. New York City DEP staff believes that this type of reuse could be more significant than the reuse of treated municipal wastewater in terms of water conservation.

3.3 Possible Future Instances

A new wastewater treatment plant is being constructed in Rockland County that will discharge tertiary treated wastewater to the Ramapo River above a wellfield and provide a source of aquifer recharge. Rockland County has limited freshwater sources and major demands due to

population growth and does not have the ability to import water except from the Hudson River, which is saline at that point. Furthermore, agreements with New Jersey require that there be sufficient base flows in the Ramapo River where it enters New Jersey. The proposed reuse project will recharge ground water in an alluvial valley using treated wastewater to increase base streamflow, thus helping to meet the New Jersey agreement. The alluvial aquifer would be used for flow equalization storage. Discussions with Rockland County Health Department staff indicated that reuse opportunities were not common in the county due to large, regional sewerage systems that bring wastewater to low areas in the county for treatment. Reclaimed water would require that it be pumped back uphill, increasing energy use.

Another option being considered in other states is sewer mining, which removes raw wastewater from interceptor sanitary sewers long before it reaches its originally intended WWTP. A small WWTP near a reuser provides the equivalent of secondary treatment plus reclamation treatment specific to the reuser.

The Village of Delhi in Delaware County considered using part of their effluent to irrigate a golf course across the Delaware River belonging to SUNY-Delhi, in the hope that this would reduce phosphorus loading from the WWTP to the West Branch of the Delaware River. Under a phosphorus cap imposed by New York City, the reuse system would enable a small expansion of the WWTP so it could serve more customers. A second benefit would be to eliminate irrigation withdrawal from a small tributary of the river. However, the impetus to proceed was reduced when the Cannonsville Reservoir's phosphorus levels improved markedly due to upgrades at all municipal WWTPs in the basin and to successful non-point source management initiatives (references: personal communications with Delaware Engineering, consultant to Delhi, and with Delaware County Planning Department staff).

A county-operated WWTP serves the area of the SUNY Stony Brook campus on Long Island. Nitrogen load limits to Long Island Sound require a substantial reduction in nitrogen in the effluent of this WWTP discharge. The Suffolk County Sewer District applied in August 2008 to recharge the local aquifer with 300,000 gpd of municipal wastewater to help them meet the total nitrogen limit in their SPDES permit (reference: personal communication with Suffolk County Dept of Public Works).

Eastern Westchester County is another area where nitrogen loadings from WWTPs must be reduced to comply with limits under the interstate Long Island Sound program.

During a tour of the Solaire green building (see section 3.4), a New York City representative cited the City's goal to reduce the its water demand by roughly 50 mgd via reuse systems that emphasize internal recycling within buildings. This compares to hundreds of millions of gallons saved under the city's initiative to reduce water demand by subsidizing water conservation measures and changing most customers to metered billing. Reuse of stormwater and treated wastewater within green buildings could have a significant impact on the volume and frequency of discharges from the city's 450 combined sewer overflow (CSO) points.

3.4 Featured Case Studies of New York State Wastewater Reuse

This section presents four detailed cases of wastewater reuse within New York State. Two are already operating, and two are committed and under construction. They illustrate the potential

range of reuses possible in New York, even in the absence of a formal program. Each impetus was local, in two cases from an entity seeking water, and in two cases from intense advocates at the facilities. The cases include contact information for management at the treatment facilities; these leaders are advocates for reuse and collaborated in preparing this material.

Figure 8 shows the locations of the four facilities.

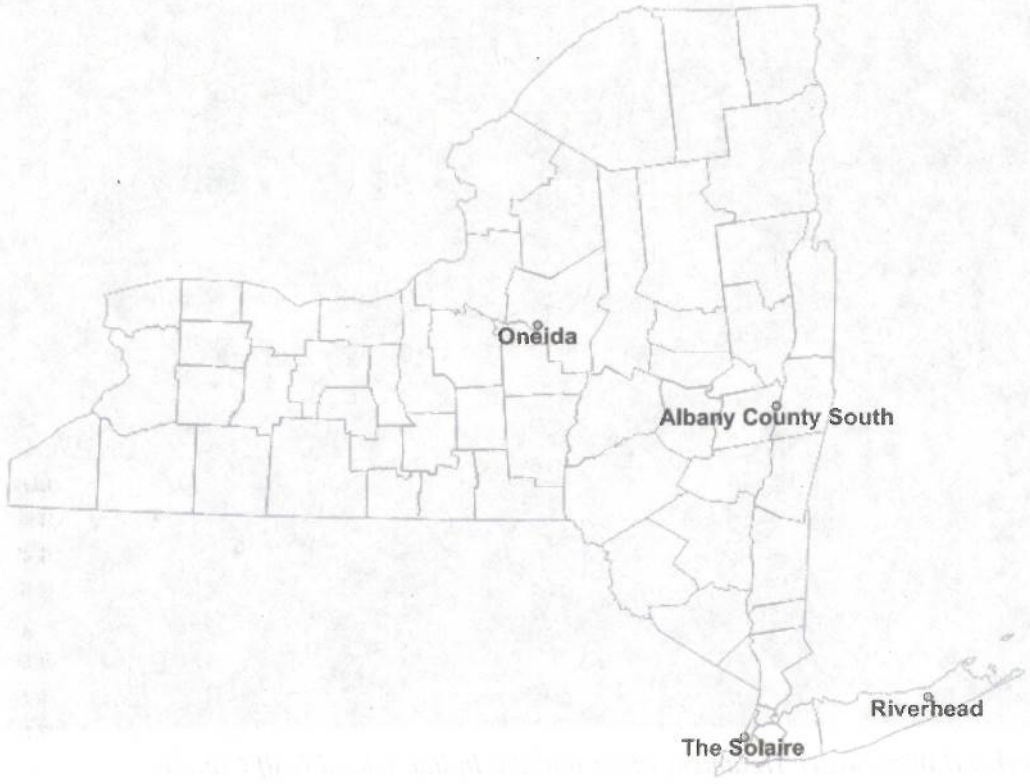

Figure 8: Locations of Four Featured New York Wastewater Reuse Cases

Case: Riverhead's Wastewater Treatment Plant and Suffolk County Indian Island Golf Course

Figure 9: Riverhead Wastewater Treatment Plant and the Indian Island Golf Course

Description: The Riverhead WWTP plans to transmit approximately 300,000 gpd of its 0.8 mgd effluent to its neighbor, Suffolk County's Indian Island public golf course during the golf season, instead of to the Peconic Bay. The treatment plant and golf course conducted a successful pilot study of supplemental treatment, irrigation and golf course grass response. The course's groundskeepers maintained the pilot's "19th hole" to gain early experience. Due to concerns about lack of a formal agreement with the golf course and the fear of additional total nitrogen load reduction in the future, the Town of Riverhead has evaluated performing the golf course irrigation project along with an upgrade to the WWTP so that it can meet the 40 lbs/day total nitrogen limit year-round. The town submitted a detailed engineering report, describing the evaluation of nitrogen treatment with membrane filtration and the golf course irrigation project, in early 2010 for DEC review. The report proposes to increase the design flow of the WWTP to 1.5 mgd.

Motivation: The WWTP management and the town wanted to be environmentally responsible. Wastewater reuse is considered responsible in both the wastewater and golf industries. The town also anticipated requirements to reduce the nitrogen load from the WWTP to Peconic Bay during the summer season due to a proposed total maximum daily load (TMDL) for dissolved oxygen in

Peconic Bay, which has been approved by EPA. Removing nitrogen from Peconic Bay is necessary to increase dissolved oxygen levels. The WWTP management also envisions this case as inspiring others and perhaps sparing other local cases involving golf courses the effort of a pilot study.

Treatment Technology: The WWTP currently provides secondary treatment plus nitrogen removal via a sequencing batch reactor that cycles between aerobic and anaerobic conditions. The town proposes to add membrane filtration to the facility for further nitrogen treatment. A portion of secondary, denitrified effluent will be routed to a cloth filtration unit, then to UV disinfection, stored to equalize flow, and finally, pumped to the golf course.

Flow Volume: Planned 300,000 gpd during the growing season

System Diagram:

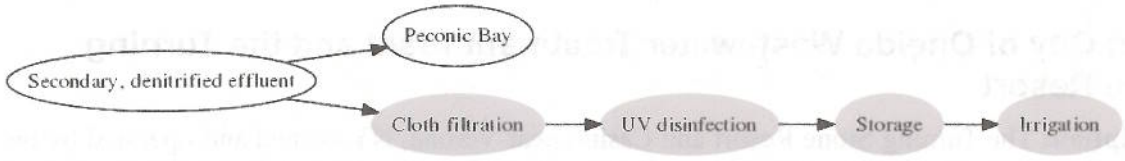

Figure 10: Components of the Planned Riverhead Supplemental Treatment System

Capital and operating expense recovery: A $2 million Clean Air, Clean Water Bond Act grant was awarded to Riverhead to help with construction costs for the golf course irrigation project. Operating costs for filtration and disinfection will be paid by Suffolk County as part of the operating budget of the golf course.

Regulation and Monitoring: DEC and Suffolk County Department of Health Services oversaw the system design and pilot test. DEC has authority over the treatment plant and the final effluent discharge to Peconic Bay. Suffolk County Department of Health Services oversees the discharge to ground water from the irrigation system. (This applies because of the use of treated sewage; there is no county or state regulation of irrigation *per se*.) Suffolk County also has authority for protection of public health at the golf course. This represented a pioneering activity for Suffolk County Health regulators; it is hoped that future instances in the county will benefit from their experience and this precedent. DEC will amend the SPDES permit to define the pipe to the golf course as an additional outfall. Monitoring requirements and effluent limits (flow, chlorine levels and pathogens) will apply at the entry to the pipe. Additional monitoring requirements in relation to groundwater will be developed by Suffolk County, DEC, the town and the golf course. Reporting to the state would be via the WWTP's DMRs under the SPDES system.

Relationship between wastewater producer and reuse: The state will require an intergovernmental agreement between Suffolk County Department of Parks and the Town of Riverhead.

How it is portrayed to public: The town involved stakeholders and environmental advocates early in planning. Golf course users should be accustomed to the use of treated wastewater for irrigation because it is a very common practice in other states and is the most common reuse in New York.

Contact and Co-author of this section: Michael Reichel, Sewer District Superintendent, Town of Riverhead, NY; http://www.riverheadli.com/sewer.html; e-mail: reichel@riverheadli.com; phone: 631-727-3069

References: H2M 2004, H2M 2006a, H2M 2006b; personal communication with Suffolk County Department of Health Services

Case: City of Oneida Wastewater Treatment Plant and the Turning Stone Resort

Description: The Turning Stone Resort and Casino near Verona, NY, owned and operated by the Oneida Nation, is the largest volume wastewater reuser "in" New York State. (New York State does not have sovereignty over Oneida Nation territory; thus the land is actually "surrounded by" New York.) The City of Oneida's WWTP sends the majority of its effluent, after supplemental treatment, to the Turning Stone property via a four-mile force main. The resort receives the water into a holding pond, from which it draws water for landscape irrigation (golf courses Shenendoah, Kaluhyat and Sandstone Hollow), air conditioning makeup water and co-generation cooling. The reuse system began operating in 2003.

Figure 11: Oneida City and the Turning Stone Resort

Aerial photo insets show the Oneida City WWTP (upper left) and Turning Stone resort (lower right). A four-mile force main that follows the right of way of the former New York Central railway for most of its distance joins the two locations. At the resort complex just south of the Thruway exit, three golf courses surround the prominent casino buildings and parking area; one large course is evident from its many sand traps visible at the upper right of the aerial photo. (Aerials from New York State GIS repository; base map from U.S. Geological Survey.)

Motivation: The Turning Stone resort found a source of water that was much more economical than bringing potable water from distant sources and had much less local environmental impact than withdrawing local water from wells or streams. The original reuse, golf course irrigation, is part of the environmentally oriented philosophy of the course design and operation. The city reduced its discharge volume and nutrient loadings to the original receiving stream, with benefit to Oneida Lake's nutrient balance.

Treatment Technology: The city's secondary effluent, all of which formerly went to Oneida Creek and then to Oneida Lake, is now divided into two parts. The majority, for use by Turning Stone, undergoes filtration with an AquaDisk cloth filter and disinfection using liquid chlorine. The remainder is discharged to Oneida Creek. At the Turning Stone facility, water not used for irrigation is dechlorinated before use.

Process monitoring and assurance: The WWTP monitors turbidity continuously, and an alarm warns about values above a target level. The WWTP remains permitted to discharge all of its wastewater to Oneida Creek when the quality of the water destined for Turning Stone does not meet criteria or the volume is not needed.

Diagram:

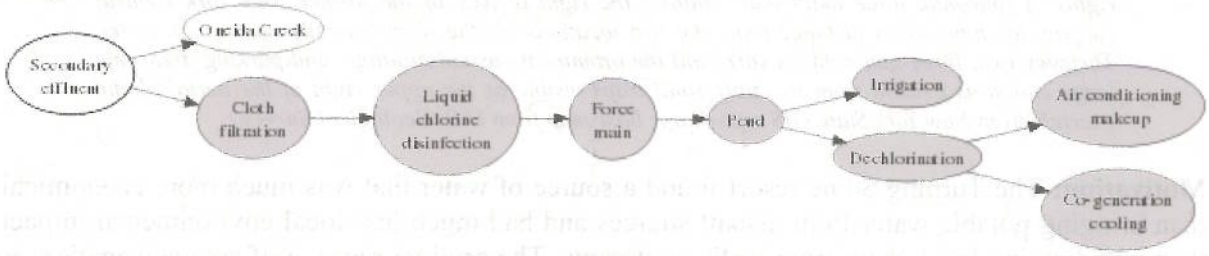

Figure 12: Components of the Oneida/Turning Stone Reuse System

Flow volume: In fall 2007 during the golf season, the WWTP was sending 1.1 mgd to Turning Stone—more than half of the WWTP's total flow. This is the maximum pumping capacity at present. The agreement between Oneida Nation and the city allows for up to 1.5 mgd. Winter flows are typically 500-700,000 gallons/day.

Capital and operating expenses recovery: All capital and operating expenses for the filtration, disinfection, force main and pumping, plus a share of the WWTP's administrative costs, are paid by the Oneida Nation.

How it is regulated and monitored: The City's SPDES permit specifies treatment technology, chlorine residual at the entry to the force main (based on a target residual after about four hours of travel time to Turning Stone), and monitoring of pathogens, chlorine and total nitrogen. This is outfall 004 of the WWTP. Reporting of flow and quality are via the city's SPDES DMRs.

Relationship between wastewater producer and reuser: Intergovernmental agreement between the City of Oneida and the Oneida Nation.

Co-author and contact information: Dan Ramer, City of Oneida; 109 N. Main St., PO Box 550, Oneida, NY 13421; email: drramer@oneidacity.com; phone 315-363-4860; http://www.ci.oneida.ny.us/Departments/sewer/sewer.htm

References: TurningStone 2007, OneidaNation 2007

Case: The Solaire, a Green Residential Building in lower Manhattan

Description: The Solaire is a pioneering green residential building in Battery Park City in lower Manhattan. The 293-apartment, 27-story building has an internal wastewater recycling system that collects building wastewater (excluding only air conditioning blowdown), treats the wastewater in the basement, and feeds the reclaimed water to three uses: (1) toilet flushing, (2) air conditioning makeup water and (3) irrigation of a small park. Four additional existing buildings in the complex also have similar internal water recycling systems, and one new building is currently under construction. Laundry is a reuse in one of the buildings which starts operation in 2010. Because of recycling and low-flow plumbing fixtures, the Solaire uses 48% less potable water and discharges 63% less sewage per apartment than comparable New York

City buildings. The Solaire operates as both a profitable commercial enterprise and an environmental showcase that hosts tours for visitors from all over the world.

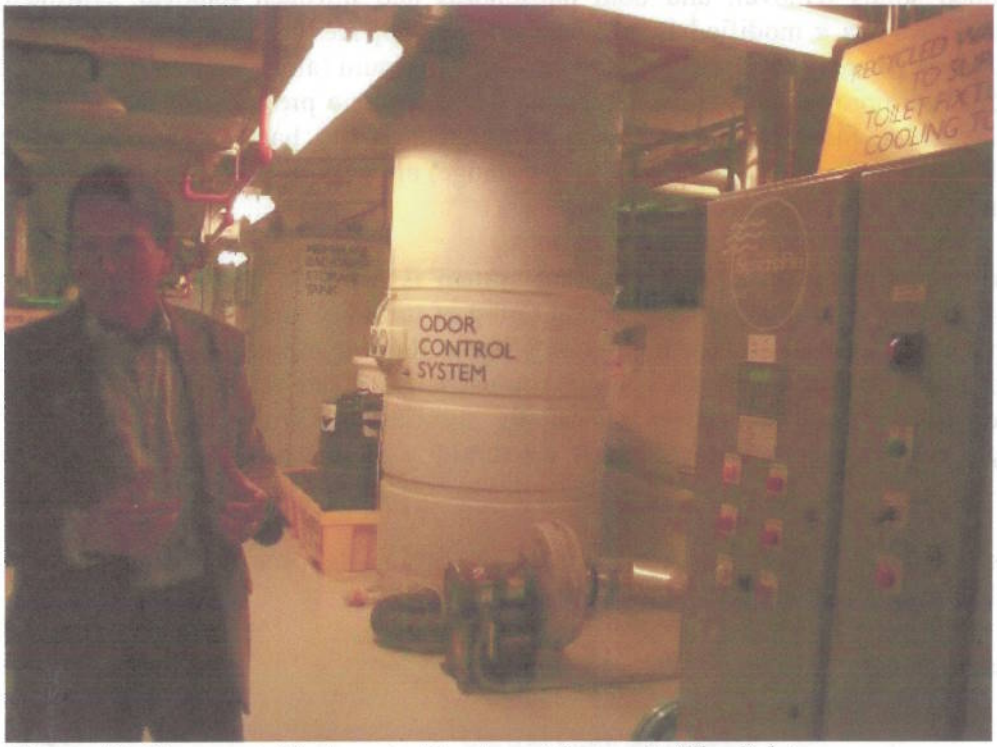

Figure 13: Basement Wastewater Treatment System in The Solaire (photo courtesy of Ed Clerico, Alliance Environmental LLC)

It has proven more economical to collect the entirety of the building's wastewater instead of segregating wastewater into greywater and blackwater streams. Recycling only greywater would have entailed using two sets of wastewater collection pipes.

The building has various protective features related to its unusual water system. When necessary, the system can switch completely to using New York City water supply water in place of its reclaimed water. Stored reclaimed water recirculates through the UV disinfection system to prevent pathogen regrowth.

Motivation: The Battery Park City Authority requires that all buildings in their domain be green, and that each successive one be greener than its predecessor. Water reuse was a starting component of this basic philosophy, and marketing to prospective residents features this philosophy. With Solaire's 48% lower water supply use, it already has a major operating cost saving. On top of that, New York City's 25% discount for water reuse cuts their bill to below 40% of what a similar-sized peer building would pay. Even though at the outset, the cost to produce the reuse water was more expensive than using public water and wastewater services, significant cost increases in the public system together with the incentive discount have improved the economics of water reuse significantly.

Treatment Technology: A membrane bioreactor with anoxic and aerobic zones provides oxidation, suspended solids removal, and both phosphorus and nitrogen removal. Nitrogen removal is accomplished via a modified Lutzig-Ettinger process, feeding nitrified wastewater back to the anoxic zone where denitrification can occur. An aluminum (aluminum hydrochlorate) compound is added to improve phosphorus removal. UV and ozone provide disinfection, the latter also reducing color. Storage following disinfection recirculates back to disinfection to prevent microbial regrowth during storage. Solids (i.e., sludge) are periodically discharged to the sewer system, which New York City prefers at times.

Process monitoring and assurance: The recycling system is operated and monitored by a computer controller which provides continuous monitoring of turbidity and UV radiation levels as overall performance measures to assure high-quality water. Remote monitoring and control is provided via connection to the operator's off-site computer. Recycled water can be shunted entirely to the city sewer and the city water supply substituted for the recycled source. Switching to city services occurs automatically if the turbidity or UV levels vary beyond set points.

How much water is involved: Treatment capacity is 25,000 gallons/day; see the system diagram below for internal flow details in the first year of operation (2004).

System diagrams:

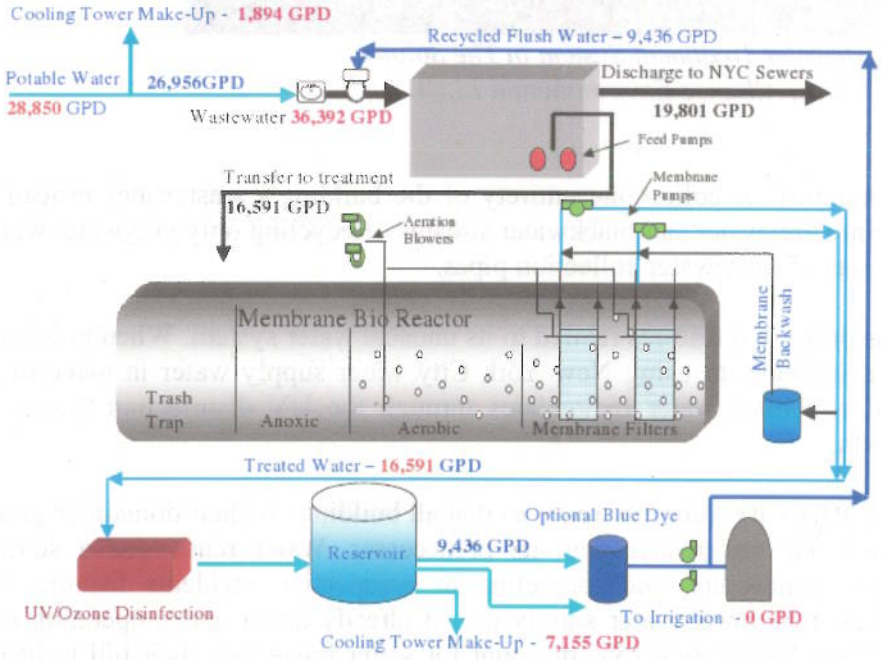

Figure 14: Solaire Components and First Year Flows (Zavoda 2005)

Not shown on diagram: (1) Reverse osmosis treatment of water destined for irrigation to reduce dissolved solids. (2) Reservoir recirculates continuously through disinfection subsystem. (3) Air-conditioning cooling tower effluent high in dissolved solids is discharged to NYC sanitary sewer. Initially this was fed back into the bioreactor, but that concentrated dissolved solids too much for the treated water to be suitable for the cooling tower.

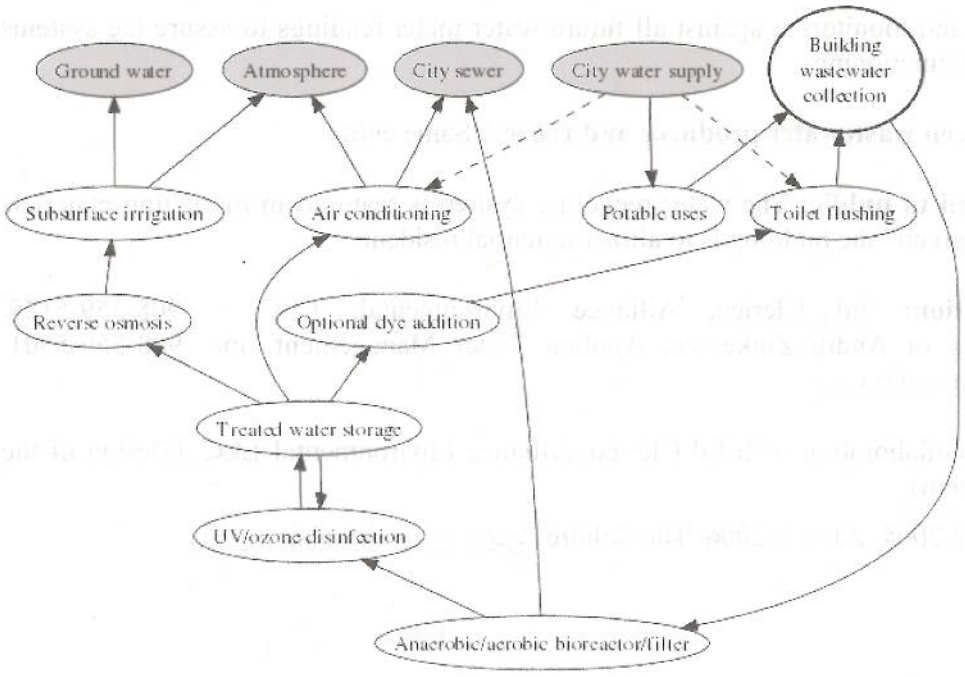

Figure 15: Schematic of The Solaire's Internal Blackwater Recycling System

(Dashed lines indicate backup paths not normally used.)

How capital and operating expenses are recovered: Part of the operating expenses of the building are recovered from the building residents as rent. Buildings that are condominiums will derive revenue through owner association fees.

How it is regulated: The Solaire and other green buildings with internal water recycling are largely outside the state environmental regulatory system. The Solaire is regulated as a non-potable water supplier by the New York City Buildings Department, though it is first regulated by the New York City Department of Health and Mental Hygiene (NYCDOHMH). The SPDES system affects the Solaire only on one minor point—its small subsurface irrigation system using treated wastewater could conceivably release a small amount of water to a street or sidewalk. This water could enter the Hudson River and would be considered an environmental discharge. Subsequent buildings in Battery Park City did not require a SPDES permit. The facility negotiated the treatment system structure and operations with NYCDOHMH and the New York City Department of Environmental Protection (NYCDEP). NYCDOHMH acted as the lead agency setting the water quality requirements. Prior to final approval to place the water reuse system on line, the system had to be started and operated for several months with intensive monitoring to demonstrate complete compliance. During this commissioning period, treated water was put back into the drains and discharged to the city sewer. The facility is currently monitored via routine monthly samples that are analyzed by an independent certified laboratory. The building remains a water and sewer customer of NYCDEP. To earn the 25% rate incentive, the building must comply with NYCDEP's Comprehensive Water Reuse Incentive Program criteria and achieve a minimum of 25% water savings compared to a peer building. A professional engineer must file a report demonstrating the water savings to NYCDEP where it is reviewed and approved for the incentive program. NYCDEP subsequently benchmarks the

building water use and monitors it against all future water meter readings to assure the systems remain in place and functioning.

Relationship between wastewater producer and reuser: Same entity

How it is portrayed to public: The water recycling system is featured in marketing materials that describe how "green" the building is to attract potential residents.

Contact information: Ed Clerico, Alliance Environmental, LLC – 908-359-5129, eclerico@clerico.biz or Andre Zinkevich, Applied Water Management, Inc. 908-359-5501, andre.zinkevich@amwater.com

Credit: written in collaboration with Ed Clerico, Alliance Environmental LLC. (Design of the water recycling system)

References: Zavoda 2005, Zavoda 2006. The Solaire: http://www.thesolaire.com/

Case: Albany South Wastewater Treatment Plant and Empire Generation Company, LLC Power Plant in Rensselaer

Figure 16: Albany South WWTP (center left) and Rensselaer Power Plant Site (lower right corner)

Description: The Empire Generating Company, LLC broke ground on November 7, 2007 for construction of a new natural-gas fired, 635MW power generation plant in Rensselaer, NY, across the Hudson River from Albany. The facility is built on a brownfield site. Based on engineering analyses conducted for previous owner Besicorp, under state Public Service Commission regulations, the plant will obtain cooling water from the effluent of the Albany South WWTP in the Port of Albany, directly across the river. An 0.5-mile pipeline under the bed of the Hudson will transfer treated effluent from the WWTP to the power plant. Operation is expected to begin in late 2010.

Motivation: State Public Service Commission rules ("Title X") for power plant siting required consideration of treated wastewater as a source of cooling water for new power plants. The consultant to Besicorp evaluated use of Hudson River water, potable water from the City of Rensselaer, Empire State Plaza stormwater, and Albany South WWTP water. Potable water was not available in sufficient quantities, and Empire State Plaza stormwater is intermittent and would require a long pipeline whose construction would be disruptive. Albany South secondary effluent is reliable and of adequate quality. The consultant recommended the river as a backup source.

While Besicorp originally approached the Albany County Sewer District about the venture, the district became an advocate. The sale of effluent to the power plant creates a new revenue stream to support the WWTP, and reuse of the effluent instead of river water, as well as reduction in WWTP discharges to the river creates a local environmental benefit.

Treatment Technology: The Albany South WWTP uses activated sludge for its secondary treatment. The power plant will provide supplemental treatment on their site, which will include filtration and chlorine disinfection of the treated WWTP effluent.

Process Monitoring and Assurance: The design has been approved. There are agreements regarding coordination between the Albany South WWTP and the power plant, for example, to notify the power plant operator quickly when there is any notable change in flow or quality in water that the WWTP provides.

Flow volume: The power plant will draw up to 7.6 mgd, compared to the Albany South WWTP's average flow of 21 mgd and minimum flow of around 13 mgd.

System diagram: (generalized)

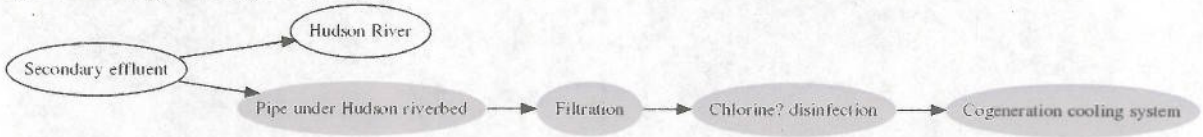

Figure 17: Albany/Rensselaer Power Plant Reuse Components

How capital and operating expenses are recovered: The power plant will pay the sewer district based on the volume of treated wastewater received, with an annual minimum. The power plant is responsible for capital costs of transmission (pumping, under-river pipeline) and supplemental treatment facilities.

How it is regulated: The privately owned power plant is regulated by New York State's Public Service Commission. The power plant's SPDES permit will contain no provisions related to wastewater reuse. Albany County Sewer District's SPDES permit for their South WWTP will identify an outfall discharging to the power plant.

Relationship between wastewater producer and reuser: Lease agreement effective starting in 2004 between Albany County Sewer District and power plant owner.

Co-Author and contact info: Richard Lyons, Executive Director, Albany County Sewer District; email: rlyons@albanycounty.com; phone: 518-447-1617

References: Albany 2006, Besicorp 2001, FirstLight 2007

3.5 Potential Extent of Reuse in New York State

The scattered, modest nature of existing and proposed reuses suggests that there is not that much demand in New York State. Conventional economics have not favored reuse over self-supply or potable supply in most of the state. As indicated in Chapter 1, downstate New York is the most probable location for continued growth in reuse.

One consultation downstate provided a suggestion from outside the traditional, engineering-dominated approach to reuse. Consider the settlement patterns in newly developing areas that integrate reuse. Instead of regional, large-scale sewer systems, sub-potable water users such as ornamental horticulturists could be located near decentralized WWTPs. Highly efficient small-scale treatment is becoming more economically feasible and reliable due to technological progress.

Another idea, known as sewer mining, is to tap into the interceptor sewers of a WWTP and provide small-scale wastewater treatment for specific reusers nearby. This type of technology can be retrofitted to a developed area with large-scale sewers and avoids the common problem of a WWTP being too distant from the reuser.

One Suffolk County official speculated that decentralized reuse could reduce peak demands for irrigation water in residential subdivisions. Many such subdivisions use automatic watering programmed to obey local rules about water conservation, i.e., not to irrigate during the peak sunlight period. With many subdivisions coming online for irrigation, the Suffolk County Water Authority is experiencing considerable peak energy and water demand. Alternatively, these same subdivisions could install advanced wastewater treatment plants that discharge to groundwater basins. With some additional treatment at WWTPs, reclaimed water could satisfy many peak irrigation demands that impinge on the potable supply system.

In discussions about agriculture, it was noted early that extensive agricultural land and large WWTPs are not located near one another in New York State. Wastewater reuse for most agricultural purposes would thus require long-distance piping and pumping of sub-potable water. However, there is another type of agriculture that does flourish within or close to urban areas — intensive ornamental cultivation. Imagine an urban WWTP whose neighbor is a greenhouse in which high-value plants can benefit from the cheap water, which may offer some fertilization as well.

Work group discussions have suggested that winter snowmaking could be another potential reuser. Ski resorts tend to be in headwaters areas with small streams and thin or bedrock aquifers. A ski resort with lodging will have the added benefit of using its own fairly clean wastewater for a small reclamation system. In some other states that permit this, it is believed that snowmaking should have a high level of treatment because people's skin can be exposed to pathogens in snow.

The Canton, Riverhead and Lake Placid cases were spurred by nutrient constraints on wastewater discharges. There are now extensive areas subject to nutrient loading constraints to address surface water quality impairments. The Susquehanna River basin is the most extensive and has 40% reduction goals for both nitrogen and phosphorus. New York City's watersheds have phosphorus concerns. Long Island Sound (Long Island 1994), Peconic Bay (Peconic 2001, Peconic 2008) and Lake Champlain (Lake Champlain 2003, Lake Champlain 2008) all have nutrient caps under which wastewater reuse via land application could contribute to a WWTP's loading reduction. It is noted that land discharges are not 100% efficient in attenuating wastewater nutrients in soils, particularly in the case of nitrogen. Thus, for a land application to result in credit toward meeting a TMDL, it must be shown that the recharged water does not result in additional nutrients being discharged, via submarine ground water discharge, to the surface water being protected.

New York State is likely to continue to have projects that pair one WWTP with one larger reuser. There is little potential for parallel distribution systems that would serve manifold users, if only because of the enormous cost of laying new pipes in old city streets. Perhaps new subdivisions in areas with limited water supplies will begin to consider laying parallel sub-potable piping in their streets.

If New York State wishes to foster more water reuse, examples are needed in selected locales and categories to break the ice. Golf courses are already well covered and supported through interstate professional networks. Experienced engineering consultants bring much out-of-state expertise to the design of efficient and effective treatment systems. Less familiar reuses in New York, such as irrigation of ornamentals, snowmaking, and TMDL relief in general require active promotion and support from the state.

Currently approved cases, including the Albany County/ Empire Generating Company, LLC, will bring New York's seasonal peak reuse to around 10 mgd by 2010. Absent major policy shifts in financial subsidies or mandates, even with a standardized regulatory approach and some modest promotion, it is unlikely that the reuse volume will grow beyond 100 mgd in the foreseeable future.

3.6 New York State Policy Structure

Water Quantity Management: Conservation, In-stream Flow and Water Allocation

DEC regulates water withdrawn by public water suppliers. Public suppliers must provide water conservation plans when seeking a new permit or a permit change (DEC 1989). The state controls the volume withdrawn to balance competing withdrawal and non-withdrawal interests and protect aquatic ecosystems. Except on Long Island, there is no explicit state control over other types of water withdrawals; there are indirect controls related to impact on water bodies, and impacts of a withdrawal on other water users are subject to civil court actions. However, within the Susquehanna and Delaware River basins, the inter-basin commissions, i.e., Susquehanna River Basin Commission (SRBC) and Delaware River Basin Commission (DRBC), also regulate water withdrawals and consumptive uses. Both SRBC and DRBC permit

all withdrawals greater than 100,000 gpd, and SRBC also permits consumptive uses in excess of 20,000 gpd.

In New York State's portion of the Great Lakes Basin, all water users withdrawing 100,000 gallons or more per day must register with DEC. The Great Lakes - St. Lawrence River Compact has recently been ratified by Congress and was signed by the president in 2008. Each Great Lakes state is required to develop a regulatory program covering all withdrawals greater than 100,000 gpd. The New England states have similar policies.

Wastewater Discharges

The state's SPDES system regulates all aspects of wastewater discharge, volume and quality. All outdoor reuses to date have been controlled by the wastewater producer's SPDES permit, including monitoring and reporting requirements. Permittees' monitoring data are provided to the EPA for for its Integrated Compliance Information System (ICIS) database, where the public can retrieve them. A SPDES permit can mandate that there be an agreement between the WWTP and the reusing entity, for example, to allow the WWTP or the state to inspect the reuse site and enforce pass-through permit conditions intended to protect the public or workers at the reuse site.

Effluent limitations based on receiving water sensitivity, such as nutrient load allocations, can force very expensive treatment. The basin TMDL and related programs discussed in section 3.5 above apply such allocations to many facilities within the same basin. Wastewater reuse for land application is especially applicable to nutrients, as long as the area of reuse considers the nutrient addition as part of the nutrient balance of the application area. This may require harvesting plants, adjusting fertilizer use and performing extra monitoring. At least part of a WWTP's allocated nutrient load reduction could be satisfied via direct reuse.

Health Protection

Reuse is first and foremost a water quantity management tool and DOH's mandate for public health protection may imply that it discourages wastewater reuse. An argument could be made that, for safety's sake, using the highest quality of water possible for any purpose is prudent in order to protect human health. The EPA's guidance document (EPA 2004) cites its policy favoring "best water" but also cites an international recommendation for "only as good water as necessary." The latter philosophy seems to apply in places of water scarcity (notably Florida) or poor water quality when there is little choice but to reserve adequate quality water for potable use. In New York State, general water abundance does not force a departure from "best water" policies. However, providing excess treatment, above what is "as good as necessary," can be quite costly in both dollars and energy use.

The New York State Department of Agriculture and Markets has a dual role in relation to water reuse in to food production. It is both an advocate for access to cheap irrigation water, especially for ornamentals, and a force for caution with regard to the application of wastewater to human and livestock food crops. (Note that the term "food" includes feed for livestock consumption in New York State; therefore, reuse rules about edible crop production must consider livestock similarly to humans.)

The Water Efficiency and Reuse Law places DOH in an advisory role to DEC for treatment and water quality criteria as they apply to reused water. DOH has already cooperated with DEC by providing guidance in reuse cases under SPDES permits that predated the Water Efficiency and Reuse Law, and has been consulted through the Suffolk County Department of Health Services in the pending Riverhead golf course instance.

Notably, DOH has not been as involved is in water reuse criteria within green buildings. All known cases of such reuse are in New York City, and standards for such have been generated by NYCDOHMH. In green buildings outside of New York City, the state plumbing code applies (see Chapter 4), and it does not currently contain provisions for health entity oversight or criteria. Instead, the plumbing code mandates technology within a relatively narrow range and is somewhat conservative in that it only allows certain types of segregated wastewater to be reused for the sole purpose of toilet and urinal flushing.

Categories of New York State Reusers

Drawing from the experience of New York and other states, existing and foreseeable New York reuse possibilities fall into the following categories:

- Landscape/ornamental irrigation (especially golf courses)
- Cooling water, including evaporative air conditioning (large residential and industrial)
- In-building recycling, including toilet flushing
- Aquifer recharge for water level or base streamflow augmentation
- Other

Another important aspect is that one reuse instance can cover all of the categories. Imagine a large green building in Nassau County that:

- Treats all of its own wastewater (as blackwater) like the Solaire;
- Flushes its toilets, provides air conditioning makeup water, and irrigates its grounds using treated water; and
- Discharges the remainder of its highly treated wastewater into a recharge basin rather than to a distant coastal wastewater treatment plant.

This is not only conceivable, but probably economically viable, based on the Solaire's experience. However, it is far beyond what the current plumbing code allows.

4. Greywater

As explained in Chapter 1, there are legal differences between *greywater* as defined in the Water Efficiency and Reuse Law, and *gray water* as defined in the State Plumbing Code. This chapter discusses both types.

Greywater was a low-priority subject of this feasibility study due to the much smaller amounts of water potentially involved compared to municipal wastewater reuse. This chapter provides basic information about greywater regulation in New York State, how wastewater reuse in newer green buildings compares to existing state regulations, and how certain western states use management standards to allow small-scale rural greywater reuse without state permits. The latter is presented as a theoretical future direction for New York after higher priorities are addressed.

4.1 Large Buildings

New York State's promotional materials about green building tax credits include the sentence: Gray water from sinks and showers or clothes washers can be recycled for irrigation in some areas (DEC 2007a). LEED and other green building standards encourage reducing water use via conservation plumbing fixtures and in-building reuse. New York's 2007 Plumbing Code specifically facilitates one kind of reuse in green buildings, via a gray water provision based on the 2003 model International Plumbing Code (see Appendix B). New York City's plumbing code considers blackwater recycling (see Appendix C).

The 2007 state plumbing code specifies one particular way of treating and using greywater (called gray water in the code), outlined in Figure 18. The treated water may only be used for flushing toilets in the same building. Any other use appears to require a variance.

The Solaire building in Battery Park City, described in detail in Chapter 3, predated the 2007 plumbing code and is based on a design negotiated with New York City regulators. Table 22 compares the Solaire system (which is representative of other recent residential buildings in Battery Park City) against the system represented by the plumbing code.

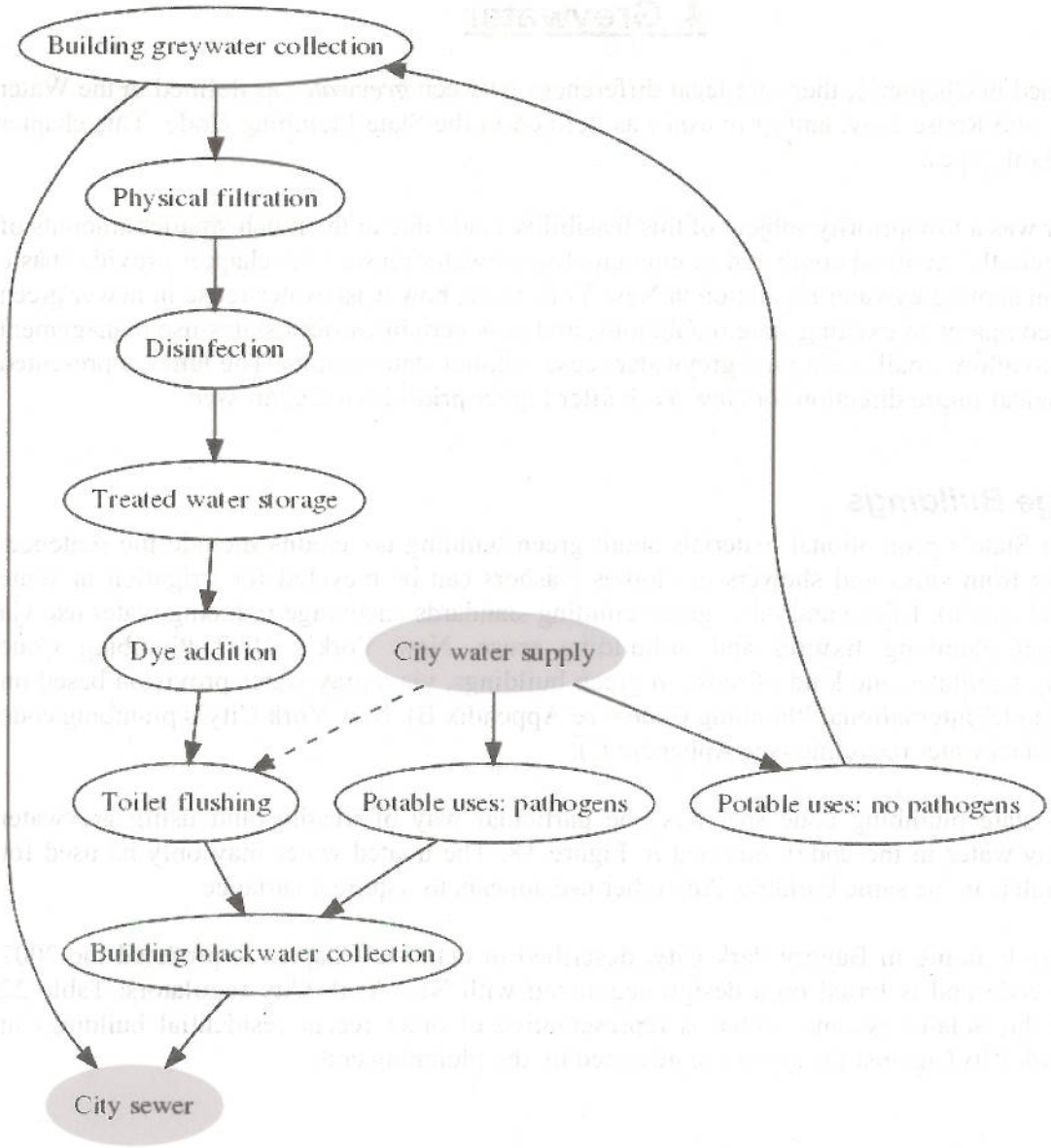

Figure 18: 2007 State Plumbing Code Gray Water System for Toilet Flushing

Table 22: Comparison of Gray Water and Blackwater Recycling Systems, Plumbing Code vs. Solaire

Aspect	State Plumbing Code	Solaire
Type of wastewater collected	Greywater: Waste water discharged from lavatories, bathtubs, showers, clothes washers and laundry sinks	All building wastewater except air conditioning blowdown
Building wastewater collection systems	Greywater collection separate from blackwater collection	One wastewater collection system
Biological and chemical treatment	None	Anaerobic and aerobic, equivalent of secondary plus denitrification plus phosphorus removal
Filtration	Approved filter such as a media, sand or diatomaceous earth filter	Membrane
Disinfection	An approved method that employs one or more disinfectants such as chlorine, iodine or ozone	Ultraviolet and ozone (ozone also removes color)
Storage	Tank holding for no more than 72 hours. Once through	Tank recirculating through disinfection unit continuously
End uses	Toilet and urinal flushing	Toilet flushing Air conditioning makeup. Outdoor irrigation
Fate of end-use water	Standard external waste treatment, i.e., city WWTP	Back into biological/chemical treatment system, except for air conditioning blowdown that discharges to city sewer

A notable difference is that toilet flushing water travels twice through the plumbing code building and possibly many times through the Solaire's system. This leads to substantial lower water use and sewage volumes in the Solaire. The plumbing code building brings in potable water, uses some of it through gray water fixtures, treats it, returns it to flush toilets, and then discharges it from the building as untreated black water. The Solaire's system takes wastewater from all fixtures—including toilets—treats it and sends some back to flush toilets again. That constitutes a "loop" between the toilets and treatment system. The loop is open — new, potable water enters the building for interior uses other than toilet flushing, and some wastewater is taken out. However, the loop permits greater water savings because the water involved, more than 7,000 gpd, can be seen as continuously reused and needs only to be "topped up" to account for minor leakage and evaporation within the building.

Participants in work group discussions speculated that the loop may add some additional risks because it concentrates solutes that are not removed well by the wastewater treatment system. This could include "emerging" contaminants of the types discussed in Chapter 2. Because the

Solaire and its cohorts are unusual, and because the concern about emerging contaminants is relatively recent, there is little experience to go by. (A twice-through plumbing code system would not concentrate these contaminants above levels found in the incoming potable water.)

The lack of oxidation and nutrient removal in a greywater treatment system, particularly if there is no recirculating disinfection, presents a risk of biological growth within the reservoir, building pipes, and toilet tanks(Ludwig 2004). This is much less of a concern at Solaire than in a plumbing code building due to the use of biological aerobic treatment, nutrient removal, membrane filter, and storage recirculation through disinfection.

Discussions with Solaire wastewater system designers indicated that a greywater system was considered versus a blackwater system. Economics drove the choice of a blackwater system; the cost of a second set of wastewater collection piping, and lower water-use savings, outweighed the higher treatment cost for blackwater.

LEED guidance for new green buildings encourages greywater reuse, rainwater capture and use, water-saving plumbing fixtures and municipal wastewater reuse. All of these measures contribute to a basic performance measure—reduction in potable water use (USGBC 2005). The state plumbing code is compatible with LEED guidance, though by limiting greywater reuse to toilet flushing it limits potential water savings.

Discussions with NYSERDA staff involved in green building evolution in New York indicate that while there is much activity on the LEED front in various parts of the state, it will probably be rare to see green buildings with internal wastewater recycling outside of New York City. The city's 25% rate incentive for internal recycling is unique on the State, and the price of water is so low in most places that recycling would be uneconomical. Basic water conservation, such as low-flow plumbing fixtures, remains the first choice for reducing water demand in major retrofits.

4.2 Small Greywater/Gray Water Uses

DOH staff consulted for this study noted that in New York, the plumbing code and state health code provisions always require on-site wastewater treatment systems. Untreated wastewater may not be released into the environment or reused.

This is in contrast to permissive gray water controls in Arizona and New Mexico. Arizona is promoted as a model by gray water advocates (Ludwig 2004), giving guidance *without state oversight* to gray water users of under 400 gpd. Table 23 quotes Arizona's guidance for persons operating under a Type 1 general permit for gray water. Arizona's definition of gray water is equivalent to New York State's definition — omitting toilets, dishwashers and kitchen sinks. There are no statewide filing or reporting requirements under this general permit.

Table 23: Arizona's Type 1 General Permit Conditions for Gray Water (under 400 gpd)

- *First and foremost, avoid human contact with gray water.*
- *Gray water may be used for household gardening, composting, and lawn and landscape irrigation, but it should not run off property.*
- *Do not surface irrigate any plants that produce food, except for citrus and nut trees.*
- *Use only flood or drip irrigation to water lawns and landscaping. Spraying gray water is prohibited.*
- *When determining the location for your gray water irrigation, remember that it cannot be in a wash or drainage way.*
- *Gray water may only be used in locations where groundwater is at least five feet below the surface.*
- *Label pipes carrying gray water under pressure if confusion between gray water and drinking water pipes is possible.*
- *Cover, seal and secure storage tanks to restrict access by small rodents and to control disease-carrying insects.*
- *Hazardous chemicals, such as antifreeze, mothballs and solvents, cannot be in gray water. Do not include wash water from greasy or oily rags in your gray water.*
- *Gray water from washing diapers or other infectious garments must be discharged to a residential sewer or other wastewater facility, or it can be disinfected prior to its use.*
- *Surface accumulation of gray water must be kept to a minimum.*
- *Should a backup occur, gray water must be disposed into your normal wastewater drain system. To avoid such a backup, consider using a filtration system to reduce plugging and extend the system's lifetime.*
- *If you have a septic or other on-site wastewater disposal system, your gray water use does not change that system's design requirements.*

Such delegation of authority and responsibility to individuals using gray water can cause public health concerns. Some states go as far as to ban use of dishwashing basin water in a garden, citing health risks. Indeed, there are indicator microorganisms present in untreated gray water.

Arizona carried out one study of the pathogen exposure potential to small-scale gray water users, using a mail survey in the Tucson area followed by sampling of gray water and soil for pathogens for one year at 11 different types of properties. (WaterCASA 2004) The sampled households included several with kitchen sinks connected to greywater systems, which may have been permitted under earlier Arizona rules than the ones cited in Table 24. Water sampling (Table 25) revealed fecal coliform and *e. coli* bacteria counts across the board at levels far above treated wastewater or potable water—4,000-5,000 fecal coliforms per 100 mL, 10-60 *e. coli* per 100 mL. Contamination occured despite the exclusion of toilet wastewater. Households including kitchen sinks in the greywater stream showed increased levels of indicator bacteria. The presence of children in the household did not make a significant difference. *Giardia*, *cryptosporidium*and viruses were absent, a fact attributed to the health status of the 11 families.

Table 24:Findings of WaterCASA Arizona Study of Gray Water and Irrigated Soil

	Organisms	Including kitchen sink	Excluding kitchen sink
Water (MPN/100 mL)	Fecal coliforms	88,400	822
Water (MPN/100 mL)	*E. coli*	94.8	8.33
Graywater irrigated soil (MPN/100g)	Fecal coliforms	1,560	26.9
Background soil (MPN/100g)	Fecal coliforms	2.61	8.25

These results indicate that plumbing code definitions of reusable gray water that exclude kitchen sinks are prudent. Arizona's exclusion of dishwasher effluent from gray water is a protective measure beyond New York State's coverage, albeit in a largely unregulated environment for the smallest reusers.

New York's actual and potential gray-water reuse outside of green buildings is likely to be small in volume. There is one existing case at the Bronx Zoo, in which water from bathroom sinks feeds landscape irrigation as part of the zoo's larger water conservation program.

DEC referred two inquiries about future outdoor gray water reuse to NYSWRI project staff. The first was an environmental education summer camp on Long Island. To reduce potable water use, a shower building's specialized wastewater (in a building that did not contain any toilets) could be used for landscape irrigation. The manager is particularly interested in irrigating a soccer field and sustaining water flow in a small wetland. The camp's environmental theme could benefit from the direct example of reuse.

The second case involved reducing potable water use for washing and landscape purposes at a proposed large residential development in the Hudson Valley. In a new development, dual plumbing and a secondary collection system for gray water from some subset of household fixtures was deemed more economically feasible than retrofitting.

Neither of these cases seems to be permitted by the plumbing code, because they take water outside of the producing building and use it for purposes other than toilet flushing. They may be able to be handled as experimental installations if they include some sort of treatment and perhaps spot monitoring for pathogens. In New York's current handling of these, local health and building code authorities are the primary decision makers. In both cases, the counties involved have their own health departments with experienced environmental health units. There may thus be a chance that both proposals will receive support.

4.3 Jurisdiction over Greywater/Gray-Water Reuse

The Water Efficiency and Reuse Law mandated DEC to lead this feasibility study, with technical guidance from DOH. The ultimate goal is for DEC to develop regulations, incorporating DOH guidance. This mandate tracks how municipal wastewater is currently regulated, with DEC's SPDES system predominating.

DEC, however, is not currently involved in the regulatory process for individual household sewage handling or internal wastewater handling in green buildings. DEC only became involved in the Solaire project due to its proposal to reuse treated wastewater for outdoor irrigation. DEC determined that there was no SPDES permit required for irrigation at Battery Park City.

Presently, jurisdiction over in-building and small household wastewater design resides with DOS (for the building and plumbing codes) and DOH (for on-site waste treatment and disposal standards). Generally, oversight is delegated to local agencies, such as county health departments and municipal code enforcement officers.

This raises the question of where to situate new regulations related specifically to greywater in large buildings. As in-building sewage treatment systems become more sophisticated — such as the Solaire's, which cost $1M and provides effluent of higher quality than that found in most of New York State's outdoor WWTPs — they become closely akin to the facilities regulated through the SPDES system. In New York City, NYCDOHMH (with assistance from City wastewater and water supply personnel) is capable of overseeing the design, construction, testing, and operation of such a system. Recently, the New York City Buildings Department has taken over this responsibility. Suffolk County Department of Health Services also has the appropriate staff and experience to oversee reuse. In the case of a green building in a small city like Oneonta, however, where there is no county health department, it is worth considering a new DEC role that can be delegated to a county or local health department in relation to larger building greywater treatment systems.

Any follow-up activity regarding rural greywater should involve DOS, and should perhaps should lead to regulations in the Public Health Code, as opposed to adding to DEC's span of involvement. DEC's non-point source management program provides an interagency framework for on-site waste disposal; it involves DOS and DOH representatives, and it has been used for DOH-led activities such as source water assessment. Perhaps DEC could provide this venue for follow up by DOH and DOS.

5. Recommendations for Municipal Wastewater Reuse and Green Buildings

5.1 Promoting Safe Municipal Wastewater Reuse

Current New York State policy neither encourages nor discourages municipal wastewater reuse; each project is evaluated on a case-by-case basis. However, the Water Efficiency and Reuse Law required DEC to develop a strategy for promoting water reclamation projects and to take an active role in them. One of the requirements of this study was to develop a strategy for promoting water reclamation projects.

New York is effectively at a demonstration stage in the life cycle of a reuse program. To date, a handful of cases exist, with no reported health problems. The next stage in a purely promotional mode would be to publicize the successful cases so that municipalities that may be willing to consider reuse could see that it has been successful in neighboring communities. This report takes one step toward that by featuring geographically diverse case studies whose local leaders are willing to host visits and answer questions. Professional networking (NYWEA, golf course managers) has already made many in New York's wastewater industry very aware of options.

Incentives are another step in promoting wastewater reuse projects. At present, there are no loan or grant sources in New York that give extra priority to wastewater reuse. New York could give extra points to wastewater reuse systems in the state revolving fund loans as do most of the states reviewed in Chapter 3. NYSERDA's assistance program could fund pilot wastewater or residential greywater reuse projects to study possible energy savings.

Total maximum daily loads (TMDL) that severely restrict nutrient discharges, such as those in Long Island Sound, Peconic Bay, New York City watersheds, the Lake Champlain basin, and the Chesapeake Bay Program (Susquehanna basin) provide further incentives. If wastewater reuse were introduced into those programs as an option, offering some load reduction credit accruing to the WWTPs, there would be increased interest in considering reuse options.

Beyond these obvious things, which could be accomplished with minor legislative and regulatory effort, Washington State's examples hint at later steps that require funding. For instance, Washington will use its state capitol grounds as a reclaimed water irrigation demonstration site. A future green building for a New York State agency could include an internal wastewater recycling system, including interpretive signage like the Solaire's basement WWTP. Washington also appropriated state funds for two rounds of demonstration projects, documenting the completed round and gaining experience for regulation and promotion. New York's grassroots examples are all interesting and useful locally but, aside from the Solaire, which shows off its systems to many international visitors, they are not intended as demonstration projects. The state could start more deliberate demonstrations, and reinforce the existing ones via grants to perform and publish extra monitoring to develop training materials and to make provisions for routine visitors.

While it would be uneconomic to mandate feasibility studies in SPDES permit renewals, it may be valuable to require evaluation of wastewater reuse for the 230 major WWTPs when they propose to upgrade their facilities.

Under DEC's water supply permit program, guidance should be prepared to assist in evaluating wastewater reuse for all water suppliers exceeding 100,000 gpd, so that potable water is not always used for irrigation and other non-potable uses. There need not be a mandate, simply increased encouragement to consider reuse along with other potable water saving options.

5.2 Controlling Risk via State and Local Oversight of Municipal Wastewater Reuse

Oversight and Review System

The state should continue to oversee municipal wastewater reuse under the SPDES system and oversee reusers through the WWTP, rather than directly. This requires that there be a formal agreement between the WWTP and each of its reusers.

One way to promote reuse is to make the ground rules easier to follow. Table 25 shows a candidate design for engineering reports in support of local water reclamation projects. This is derived from California's mandated reports. There are several assumptions made about future regulations, notably that they will contain reliability criteria.

Table 25: Candidate Contents for New York State Municipal Wastewater Reuse Engineering Plans

Chapter or Section	Contents
Reclaimed Water Project	Description of project.
Producer - Distributor - User	Identities and roles of each entity (producer, distributor, user). Who will design, treat, distribute, operate, and maintain? What legal arrangements are there among the different parties?
Additional Regulatory Jurisdiction	What agencies, how involved? Include adjacent state if downgradient or downstream.
Raw Wastewater	Chemical quality, source of the wastewater, proportion and types of industrial waste, and [industrial waste] source control programs
Treatment Processes	Schematic of treatment train; treatment processes; filtration design criteria; expected turbidities of filter influent effluent; chemicals to be used, how mixed; chemical storage and handling; O&M manuals. Pilot test design and results (if required)
Plant Reliability Features	Plant reliability features proposed to comply with criteria in [future] DEC reuse regulations; under what conditions feature actuates; where alarms will be received, how location is staffed, and who notified; hours plant will be staffed
Alternate Water Supply to the Use Location	Purpose, support, quality, quantity available, backflow prevention, cross-connection control
Monitoring and Reporting	Frequency and location of sampling; method and frequency of calibration of continuous analysis and recording equipment

Chapter or Section	Contents
Contingency Plan	What conditions require immediate diversion; diversion procedures; diversion area capacity, holding time and return capabilities; plans to activate supplemental supplies to user area; how to dispose or re-treat any inadequately treated effluent; fail-safe features under power failure; how to notify recycled water user(s), regional board, health and other agencies
Transmission and Distribution Systems	Maps of transmission facilities and distribution system; ownership and location of potable water lines, recycled water lines and sewer lines within recycled water service area and use area(s)
Use Areas	Land uses; type of reuse; who is responsible for distribution and use; other governmental regulators; use area containment measures; map of use areas, areas of public access, surrounding land uses, location and details of nearby wells; signage; degree of access by employees and public; cross-connection control procedures
Irrigation (if used)	Piping networks in use area (recycled, potable, sewage and others); what will be irrigated; method of irrigation; domestic water supply facilities nearby; containment measures; measures to minimize ponding; direction of drainage and description of area where drainage will flow; how to enforce setback distances in [future] DEC regulations; protection measures for water fountains and outdoor eating areas; public warning signs; irrigation schedule; how to minimize public contact
Storage ponds (if used)	Type of use or activity; degree of public access; conditions and frequency of expected overflow; direction of drainage and description of area where drainage will flow
Cooling Specifics (if applicable)	System type; biocides; drift eliminator; potential for public and worker exposure, exposure mitigation
Groundwater Recharge (if applicable)	Potential impacts on aquifers (case-by-case consultation with state)
Other Industrial Uses (if applicable)	Case-by-case
Use Area Design	Describe how cross-connections and escape of reclaimed water will be prevented.
Use Area Inspections and Monitoring	Define program; identify most likely problems; identify responsible personnel.
Employee Training	Describe training, who provides it, frequency, reference manuals.
Financial Analysis	Comparison of financial and energy cost of reuse versus alternatives of using potable water and environmental water for the same use. Net energy savings at municipal water supply and wastewater systems from this reuse. Arrangements for cost recovery
Original Receiving Water Effects	Effect of reduced flow and pollutant loadings on the original receiving water. Effects on receiving water if temporary or seasonal discharges are required while user does not need reclaimed water or if reclaimed water is substandard
Consultations and Approvals	Evidence of participation of owners of property neighboring the use area. Evidence of approval by other relevant regulators

Regulations and Guidance Document

Because of New York State's limited experience overseeing reuse, it is premature to develop detailed DEC regulations. Instead, DEC should adopt framework regulations and rely on an evolving guidance document to provide technical criteria to applicants. This is a bridge between the current case-by-case system, which operates without advance guidance to applicants, and actual regulations. A DEC guidance document, updated periodically, could share criteria and preferences across agencies and applicants without becoming rigid at this early stage of experience.

The guidance document should be similar to New Jersey's RWBR guidance and the submitted report similar to how New Jersey reexpressed Florida's reuse feasibility study contents. As in New Jersey's case, alternatives to the provisions of the guidance document should be allowed if the applicant provides sufficient justification.

After five years, DEC should consider moving some of the guidance content into regulations.

When regulations are developed, they should include definitions of three use classes (see below), mandate technology types and parametric criteria across the board and per class, and require that an engineering report be submitted for review. Any future regulations should refer to the DEC guidance document for updated information.

5.3 Use-Based Criteria

This section is a general outline drawn from other states, without providing specific technology or parametric criteria. It is recommended that there be three categories of reuses, with the third being a catchall to allow experimentation. All uses would require at least secondary treatment, without disinfection. Only facilities with a total size (not only the reclamation system size) of at least 100,000 gpd would be allowed to produce water for uses where public exposure was likely, so that adequate staffing and financial backing were available. Table 26 shows the three categories of wastewater reuse proposed.

Table 26: Proposed New York State Municipal Wastewater Reuse Categories and Requirements

Category	Typical reuses	Minimum physical configuration	Quality parameters	Monitoring
Public exposure possible	Golf course and other landscape irrigation; cooling or air conditioning makeup that produces mist; impoundments; nurseries; snowmaking	Filtration and disinfection; contingency storage for reject water unless there is a permitted discharge	Turbidity, TSS, fecal coliform	Continuous turbidity and disinfectant intensity or residual; automatic supply shutoff if not meeting criteria
Industrial use without public exposure (including via mist)	Air conditioning makeup; contained cooling systems that do not release mist; process water; washing of vehicles and equipment	Case-by-case, not regulated tightly; in user contract terms	Case-by-case, not regulated tightly; in user contract terms	Case-by-case, primarily for assurance to user; in user contract terms
Other uses	Indirect potable, any other ground water recharge	Case-by-case	Case-by-case	Case-by-case

Ongoing Program Development and Evaluation

DEC should train its SPDES regional and Central Office permitting staff in wastewater reuse technology and criteria, possibly through NYWEA or other professional organizations.

DEC should maintain an interagency advisory body that meets periodically to assist in updating the guidance, coordinate across agencies, and advise about promotion. This does not necessarily need to be restricted to state agencies. Membership from local reuse interests should be encouraged.

DEC should join the WateReuse Association and allow staff to participate in their conferences and meetings to keep up to date with changes in other states.

DEC should promote municipal wastewater reuse as a viable option for WWTPs and potential reuse clients.

5.4 Tracking Reused Water

The Water Efficiency and Reuse Law required that DEC establish a registry of reuses from the reuser perspective.

DEC currently registers wastewater reuse by defining an outfall within the SPDES permit of the WWTP with the outfall named to indicate the reuse, such as "golf course irrigation." Reuse in green buildings does not require a SPDES permit so it is not registered. In a one-producer to one-reuser system as now exists in New York State, the producer inventory is also a municipal reclaimed water user inventory, and it includes annual data.

To satisfy the registry requirement, DEC would have to mandate reporting at least once from

green building reusers and any others who do not need SPDES permits through the SPDES permit of the WWTP. A single reporting at startup would be sufficient. Because the registry will likely be used to keep track of actual water reuse, DEC would have to mandate annual reporting from green buildings recycling water internally to have data comparable to what it receives from WWTP outfalls carrying reclaimed water. Following Florida's example, an estimate without metering would suffice.

Long Island has 51 municipal WWTPs. Of those, 26 plants discharge to groundwater, and they are all located in Suffolk County. Discharge monitoring reports are submitted as required by their SPDES permit, but there is no specific reuser; thus, even though these might conceivably fall under a definition of reclaimed water producers, they fall outside the registry mandate.

5.5 Wastewater Recycling in Green Buildings

DOH should consider developing statewide large-building greywater criteria analogous to those for municipal wastewater in section 5.2. Such criteria would supersede those in the 2007 Plumbing Code by specifying allowed treatment technologies, and prescribing performance criteria and monitoring.

DOH could examine the experience of blackwater treatment and multiple end uses in the Battery Park City green buildings, using NYCDOHMH sources, and consider developing statewide large building blackwater reuse criteria, again drawing from the New York City example. The Solaire system is considerably more complex and expensive than a greywater system, but it arguably delivers better water at a lower cost than a greywater system would when the cost of providing potable water to a building and treating its wastewater externally are considered. The main reason for providing state criteria would be to encourage appropriate adaptations of this approach outside New York City.

New York State should consider whether or not DEC or DOH should play a role in design and operational oversight for greywater and blackwater reuse systems in buildings above a certain size threshold. Such a role could be delegated to a county or New York City where local government has the capability and interest, or operated in tandem with SPDES oversight in the remainder of the state.

DOS should join any ongoing advisory structure for water reuse that DEC leads.

5.6 Gray Water versus Greywater

If DEC's future regulations do consider on-site reuse of greywater, they should abandon the definition of greywater in the 2005 Reuse Law and instead base it on the "gray water" definitions in the New York State Plumbing Code and the New York City Plumbing Code. This is the more protective of the two options, removing ambiguity.

6. Conclusion

Many states have implemented wastewater reuse programs and promulgated regulations and standards for reuse. Those states have separated the types of reuse into categories with applicable standards and criteria for each category.

States where water conservation is important are more likely to have standards for multiple categories of reuse. In comparison to those states, New York State is water rich, and requests for DEC approval of wastewater reuse projects are thus relatively few. Existing reuses mainly consist of golf course irrigation projects where the golf course is near the WWTP, keeping transmission costs and energy use low.

However, interest in wastewater reuse projects in New York State will increase in the future due to more stringent regulation of phosphorus and nitrogen discharges from WWTPs. In addition, densely populated areas of the state are expected to evaluate options to conserve potable water and use treated wastewater for irrigation, industrial cooling, or groundwater recharge when constructing new housing developments.

Residential greywater reuse is currently expanding in New York City due to tax and water rate incentives for new construction overseen by the New York City Department of Buildings. There are no residential greywater reuse projects in New York State outside of New York City, probably because no other city has an incentive program for greywater reuse. Due to local building and plumbing codes, oversight of residential greywater reuse should be regulated at the municipal level.

DEC recommends the development of a guidance document to provide technical criteria to interested parties rather than development of regulations and criteria for wastewater reuse. An official reuse registry should also be made available on the DEC website.

References

[Albany 2006] Albany County Sewer District. *Annual Report of the Board of Commissioners*. Technical report, Albany County (NY) Sewer District, Albany NY, 2006.

[Arizona 2003] Arizona Department of Environmental Quality. *Using Gray Water at Home*. Technical Report C01-06, March 2003.

[Arizona 2006] Arizona Department of Environmental Quality. *Permits: Reclaimed Water Classes of Reclaimed Water*, July 2006.

[Besicorp 2001] LLC Besicorp-Empire Development Company. Empire State Newsprint Project Rensselaer, New York: Article x/*Draft Environmental Impact Statement*. Article x case 00-f-2057. NYSDEC project 4-3814-00052. Technical report, Kingston, NY, December 2001.

[California 2001] California Department of Health Services. *California Health Laws Related to Recycled Water (The Purple Book)*. Technical report, California Department of Health Services, June 2001.

[California 2001a] California Department of Health Services. *Guidelines for the Preparation of an Engineering Report for the Production, Distribution and Use of Recycled Water*, March 2001.

[California 2007] California Environmental Protection Agency, State Water Resources Control Board. *Strategic Plan, January 2007-December 2008, Water Recycling Funding Program*. Technical report, California Environmental Protection Agency, State Water Resources Control Board, January 2007.

[Dingfelder 2004] Sadie F. Dingfelder. "From Toilet to Tap: Psychologists Lend Their Expertise to Overcoming the Public's Aversion to Reclaimed Water." *Monitor on Psychology*, September 2004.

[Esposito 2005] Kathleen M. Esposito, Patrick J. Phillips, Beverly M. Stinson, Ryujiro Tsuchihashi, and James Anderson. "The Implication of Emerging Contaminants in the Future of Water Reuse." In *Water Reuse and Desalination: Mile-High Opportunities. 2005 Symposium Proceedings (CD-ROM)*. WateReuse Association, 2005.

[FirstLight 2007] FirstLight Power Resources. *Power Generation: Empire Generating Co, LLC Project - FirstLight Power Resources*. WWW, 2007.

[Florida 1991] Florida Department of Environmental Regulation with Florida Department of Public Service and five water management districts. *Guidelines for Preparation of Reuse Feasibility Studies for Applicants Having Responsibility for Wastewater Management.* Technical report, Florida Department of Environmental Regulation, November 1991.

[Florida 2006] Florida Department of Environmental Protection. *2005 Reuse Inventory*. Technical report, June 2006.

[Florida 2007] Florida Department of Environmental Protection. *2006 Reuse Inventory*. Technical report, Florida Department of Environmental Protection, August 2007.

[Florida 2007b] Florida, State of Florida administrative code, chapter 62-610: *Reuse of Reclaimed Water and Land Application*, 2007.

[Florida 2007d] Florida Department of Environmental Protection. *Florida's Reuse Program, 2007.*

[H2M 2004] H2M and Inc. Scientific Methods. Wastewater reuse pilot study phase 1 - on-site implementation. Technical Report RDSD 03-04, H2M Group, Melville, NY, 2004.

[H2M 2006a] H2M and Inc. Scientific Methods. Town of Riverhead/Riverhead Sewer District, *Supplemental Report, Wastewater Reuse for Golf Course Irrigation*. Technical Report RDSD 06-06, H2M Group, Melville, NY, August 2006.

[H2M 2006b] H2M and Inc. Scientific Methods. Town of Riverhead/Riverhead Sewer District, *Supplemental Report Addendum No. 1, Wastewater Reuse for Golf Course Irrigation*. Technical Report RDSD 06-06, H2M Group, Melville, NY, October 2006.

[Hilger 2003] Helene A. Hilger and Mark D. Sobsey. *An Assessment of the North Carolina Water Reuse Regulations: Their Application to a New Reclamation Facility and Their Key Features Compared to National Water Reuse Regulation Trends*. Technical Report UNC-WRRI-2003-346, Water Resources Research Institute of the University of North Carolina, Raleigh, NC, October 2003.

[LakeChamplain 2003] Lake Champlain Steering Committee. *Opportunities for Action: An Evolving Plan for the Future of the Lake Champlain Basin*. Technical report, states of Vermont and New York, April 2003. 2003.

[LakeChamplain 2008] Lake Champlain Basin Program. *Lake Champlain Basin Program*. WWW, 2008.

[LongIsland 1994] Long Island Sound Study Program. *Comprehensive Conservation and Management Plan for Long Island Sound*. Technical report, USEPA and others, March 1994.

[LongIsland 2008] Long Island Sound Study.

[Ludwig 2004] Art Ludwig. *Create an Oasis with Greywater: Choosing, Building, and Using Greywater*. Oasis Design, Santa Barbara, CA, 4th edition, 2004.

[Massachusetts 2000] Massachusetts Department of Environmental Protection. *Interim Guidelines on Reclaimed Water (revised)*. Policy BRP/DWM/PeP-P00-3, Massachusetts Department of Environmental Protection, Boston, MA, January 2000.

[Massachusetts 2007] Massachusetts Department of Environmental Protection. *Wastewater Reuse - Frequently Asked Questions*. WWW, November 2007.

[NJ DEP 2005] New Jersey Department of Environmental Protection. *NJDEP Technical Manual: Reclaimed Water for Beneficial Reuse*. Technical manual, New Jersey Department of Environmental Protection, Trenton, NJ, January 2005.

[NJ DEP 2005b] New Jersey Department of Environmental Protection. N.J.A.C. 7:19.

New Jersey Water Supply Allocation Rules, September 2005.

[NJ DEP 2007] New Jersey Department of Environmental Protection. *Reclaimed Water for Beneficial Reuse* (RWBR). WWW, March 2007.

[North Carolina 2006] North Carolina Division of Water Quality. North Carolina administrative code (NCAC): Title 15a - Environment and Natural Resources: Chapter 2-Environmental Management: Subchapter 2t - Waste Not Discharged To Surface Waters. State administrative code, September 1 2006.

[NWRI 2003] National Water Research Institute (US). *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse, second edition*. Technical Report NWRI-2003-06, National Water Research Institute and American Water Works Association Research Foundation, Fountain Valley, CA, June 2003.

[NYSDEC 1989] New York State Department of Environmental Conservation, Division of Water. *Water Conservation Manual for Development of a Water Conservation Plan*. Technical report, January 1989.

[NYWEA 2003] NYWEA Water Reuse Task Force. *Position Paper on Water Reuse*. Technical report, New York Water Environment Association, Syracuse, NY, April 2003.

[Oneida Nation 2007] Oneida Indian Nation. *Environmental Media Association Lends Support to Turning Stone Resort Championship, PGA's First Green Golf Tournament*. (on-line press release.), September 2007.

[Parsons 2007] Victoria Parsons. Water: "When it Comes to Tampa Bay's Water Supplies, Is the Glass Half Full or Half Empty?" *Bay Soundings*, 7(1), Winter 2007.

[Peconic 2001] Peconic Estuary Program. *Peconic Estuary Comprehensive Conservation and Management Plan*. PDF, 2001.

[Peconic 2008] Peconic Estuary Program. Peconic Estuary Program homepage. WWW, February 2008.

[Tamblin 2003] Michael E. Tamblin, Ronald C. Delo, and Robert Butterworth. "Western Ramapo Wastewater Reuse Project." In *Water Reuse: A Resource Without Borders, 2003 Symposium Proceedings (CD-ROM)*. WateReuse Association, 2003.

[TurningStone 2007] Turning Stone Resort and Casino. *Golf at the Turning Stone Resort*, 2007.

[USEPA 2004] U.S. Environmental Protection Agency and U.S. Agency for International Development. *Guidelines for Water Reuse*. Technical Report EPA/625/R-04/108, U.S. Environmental Protection Agency, Washington, DC, September 2004.

[USGBC 2007a] U.S. Green Building Council. USGBC: *LEED Rating Systems*. WWW, 2007.

[Washington 2000a] Washington State Department of Ecology. *Water Reclamation and Reuse - The Demonstration Projects*. Technical Report 00-10-062, Washington State Department of Ecology, December 2000.

[Washington 2006] Washington State Department of Ecology. *Criteria for Sewage Works*

Design, Chapter e1: Water Reclamation and Reuse. Technical Report 98-37 WQ, Washington Department of Ecology, Olympia, WA, October 2006.

[WaterCASA 2004] Water Conservation Alliance of Southern Arizona. *Residential Graywater Reuse Study*. WWW, 2004.

[Yonkin 2007] Matthew C. Yonkin. "Energy Smart Focus Program for New York's Water and Wastewater Sectors." In *Hudson Valley Water Works Conference*. Malcom Pirnie (consultant to NYSERDA), August 16 2007.

[Zavoda 2005] Michael Zavoda. "The Solaire, A High-Rise Residential Reuse Case Study." In *Water Reuse and Desalination: Mile-High Opportunities. 2005 Symposium Proceedings (CD-ROM)*. WateReuse Association, 2005.

[Zavoda 2006] Michael Zavoda. "NYC High-Rise Reuse Proves Decentralized System Works." *Water & Wastewater International*, February 2006.

Acknowledgments

Cheryle Webber (DEC Water Division) led the feasibility study process under assignment from Bureau Director Dick Draper (DEC Water Division).

Steven Pacenka did legwork, phonework, and report writing while a staff member at the NYS WRI, later continuing with the work group as a volunteer.

Eunice Cho, Cornell undergrad research assistant, acquired and summarized material about reuse programs in other states.

New York local case study co-authors included Ed Clerico (Alliance Environmental, LLC for The Solaire in New York City), Mike Reichel (Town of Riverhead), Rich Lyons (Albany County Sewer District), and Dan Ramer (City of Oneida). Thanks for hosting visits and phone calls, and for enthusiasm!

Wastewater reuse work group members included Cheryle Webber (chair), Kathleen O'Connor (NYSERDA), Gregg Recer (DOH), Lloyd Wilson (DOH), Bob Adamski (NYWEA and Gannett Fleming), Mike Holt (DEC), Pat Palmer (DOH), and Ron Rausch (NYS Ag & Markets). Guy Apicella (NYWEA water reuse task force chair) participated in some work group meetings via telephone.

Key interviewees besides work group members and featured case-study co-authors included:

- Warren Liebold and Amy Ma (New York City Department of Environmental Protection)
- Vito Minei (Suffolk County Department of Health Services)
- Ben Wright (Suffolk County Department of Public Works)
- George Proios (board member of Suffolk County Water Authority and Suffolk County Soil and Water Conservation District)
- Ron Kaplewicz and Mike Latham (NYS Department of Agriculture and Markets, Soil and Water Conservation Committee)
- Bill Spitz (DEC Region 1, Stony Brook)
- Tom Maher (Nassau County executive's office)
- Simon Gruber (Orange County Water Authority consultant)
- Russell Urban-Mead (Chazen Companies)
- Dan Miller (Rockland County Health Department)
- Solaire building tour led by Ed Clerico, also including Michael Zagoda (Applied Water Management)

DEC regional staff around the state provided information about current cases.

Keith Eggleston of Cornell University's Northeast Regional Climate Center provided historical weather data.

Appendices

Appendix A: New York State Water Efficiency and Reuse Law

Environmental Conservation Law, TITLE 6

WATER EFFICIENCY AND REUSE

Section 15-0601. Definitions as used in this title.

15-0603. Reclaimed wastewater feasibility study.

15-0605. Standards for reuse and disposal of reclaimed wastewater.

15-0607. Utilization of reclaimed wastewater registry.

§ 15-0601. Definitions as used in this title.

1. "Water reclamation project" means a project designed to utilize reclaimed wastewater or greywater for beneficial non-potable uses including, but not limited to, agricultural and landscape irrigation, commercial and industrial uses, and wetland maintenance purposes.

2. "Greywater" means untreated wastewater from bathtubs, showers, washing machines, dishwashers and sinks, but shall not include discharges from toilets or urinals or industrial discharges.

3. "Reclaimed wastewater" means water discharged from a treatment works utilizing at least effective secondary treatment as defined in section 17-0509 of this chapter.

§ 15-0603. Reclaimed wastewater feasibility study.

1. The department, in consultation with the department of health, shall conduct a study of potential uses of greywater and reclaimed wastewater in New York State, and develop a strategy for promoting water reclamation projects.

2. Such study shall be completed within eighteen months of the effective date of this section and a report of the findings from the study shall be presented to the governor, the speaker of the assembly and the temporary president of the senate within ninety days of the completion of the study.

§ 15-0605. Standards for reuse and disposal of reclaimed wastewater. The commissioner, in consultation with the Department of Health, shall establish rules, regulations and standards for the reuse and disposal of reclaimed wastewater and/or greywater. The Department of Health shall advise the department on water quality and pathogens monitoring requirements.

1. Such rules, regulations and standards shall specify:

a. the permitted uses of reclaimed wastewater and greywater with required levels of water quality and treatment for each permitted use; permitted uses shall include, but not be limited to:

industrial cooling; commercial and industrial landscaping; park and golf course irrigation; groundwater recharge; surface water supply augmentation; wetland creation and augmentation, and non-food agricultural crop and lawn irrigation.

b. operational requirements including, but not limited to, treatment facility reliability; storage requirements, if necessary; system labeling and color-coding requirements; and pipe location and placement.

2. Such rules, regulations and standards shall be promulgated within thirty months of the effective date of this section.

§ 15-0607. Utilization of reclaimed wastewater registry.

All persons utilizing reclaimed wastewater or greywater shall register such project with the department. The department shall maintain such registry.

Public Health Law

§ 1109. Standards for water reuse.

1. The commissioner shall advise the Department of Environmental Conservation on the establishment of rules, regulations and standards for the reuse and disposal of reclaimed wastewater and/or greywater. Such advice shall include, but not be limited to, advice on water quality and pathogens monitoring requirements for each permitted use of reclaimed wastewater and greywater.

2. For the purposes of this section, the terms "greywater" and "reclaimed wastewater" shall have the same meaning as set forth in section 15-0601 of the Environmental Conservation Law.

Appendix B: 2007 New York State Plumbing Code Provisions about Gray Water

GRAY WATER RECYCLING SYSTEMS

C101
GRAY WATER RECYCLING SYSTEMS

C101.1 General. Gray water recycling systems shall receive the waste discharge only of bathtubs, showers, lavatories, clothes washers and laundry sinks. Recycled gray water shall be utilized only for flushing water closets and urinals that are located in the same building as the gray water recycling system. Such systems shall comply with Sections C101.2 through C101.12.

C101.2 Definition. The following term shall have the meaning shown herein.

GRAY WATER. Waste water discharged from lavatories, bathtubs, showers, clothes washers and laundry sinks.

C101.3 Installation. All drain, waste and vent piping associated with gray water recycling systems shall be installed in full compliance with this code.

C101.4 Reservoir. Gray water shall be collected in an approved reservoir constructed of durable, nonabsorbent and corrosion-resistant materials. The reservoir shall be a closed and gas-tight vessel. Access openings shall be provided to allow inspection and cleaning of the reservoir interior. The holding capacity of the reservoir shall be a minimum of twice the volume of water required to meet the daily flushing requirements of the fixtures supplied with gray water, but not less than 50 gallons (189 L). The reservoir shall be sized to limit the retention time of gray water to 72 hours maximum.

C101.5 Filtration. Gray water entering the reservoir shall pass through an approved filter such as a media, sand or diatomaceous earth filter.

C101.6 Disinfection. Gray water shall be disinfected by an approved method that employs one or more disinfectants such as chlorine, iodine or ozone.

C101.7 Makeup water. Potable water shall be supplied as a source of makeup water for the gray water system. The potable water supply shall be protected against backflow in accordance with Section 608. There shall be a full-open valve on the makeup water supply line to the reservoir.

C101.8 Overflow. The collection reservoir shall be equipped with an overflow pipe of the same diameter as the influent pipe for the gray water. The overflow shall be directly connected to the sanitary drainage system.

Appendix C: Excerpt from the New York City Plumbing Code

APPENDIX C

WATER CONSERVATION SYSTEMS

Note: Section 301.3 of this code requires all plumbing fixtures that receive water or waste to discharge to the sanitary drainage system of the structure. In order to allow for the utilization of a water recycling system, section 301.3 should be revised to read as follows:

301.3 Connections to drainage system. All plumbing fixtures, drains, appurtenances and appliances used to receive or discharge liquid wastes or sewage shall be directly connected to the drainage system of the building or premises, in accordance with the requirements of this code. This section shall not be construed to prevent indirect waste systems provided for in Chapter 8.

Exception: Lavatories shall not be required to discharge to the sanitary drainage system where such fixtures discharge to an approved water recycling system.

PC C101

WATER RECYCLING SYSTEMS

C101.1 General. Water recycling systems shall receive storm water captured from roofs and balconies, condensate reclamation systems, gray water discharge only of lavatories from public restrooms in commercial office buildings, and the treated effluent from an approved black water treatment system as regulated by Department of Health and Mental Hygiene. Recycled water shall be utilized only for flushing water closets and urinals, cooling tower makeup and irrigation systems that are located in the same lot as the water recycling system. Recycled water shall be considered non-potable. Such systems shall comply with sections C101.2 through C101.12.

C101.2 Definitions. The following terms shall have the meanings shown herein.

BLACK WATER. Waste water discharged from water closets, urinals and any other fixtures discharging animal or vegetable matter in suspension or solution.

GRAY WATER. Waste water discharged from lavatories, bathtubs, showers, clothes washers and laundry sinks.

C101.3 Installation. All drain, waste and vent piping associated with gray or black water recycling systems shall be installed in full compliance with this code.

C101.4 Reservoir. Water captured for recycling purposes shall be collected in an approved reservoir constructed of durable, nonabsorbent and corrosion-resistant materials. The reservoir shall be a closed and gas-tight vessel. Access openings shall be provided to allow inspection and cleaning of the reservoir interior. The holding capacity of the reservoir shall be a minimum of twice the volume of water required to meet the daily flushing requirements of the fixtures supplied with recycled water, but not less than 50 gallons (189 L).

C101.5 Filtration. All water entering the reservoir shall pass through an approved filter such as a media, sand or diatomaceous earth filter. Filter may be installed in a sidestream arrangement sized to filter the entire volume of the tank at a rate equal to four times the recycled water in a one-hour period.

C101.9 Drain. A drain shall be located at the lowest point of the collection reservoir and shall be directly connected to the sanitary drainage system. The drain shall be the same diameter as the overflow pipe required by Section C101.8 and shall be provided with a full-open valve.

C101.10 Vent required. The reservoir shall be provided with a vent sized in accordance with Chapter 9 based on the size of the reservoir influent pipe.

C101.11 Coloring. The gray water shall be dyed blue or green with a food grade vegetable dye before such water is supplied to the fixtures.

C101.12 Identification. All gray water distribution piping and reservoirs shall be identified as containing nonpotable water. Piping identification shall be in accordance with Section 608.8.