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January 16, 2009

Luly Massaro
Clerk
Public Utilities Commission
89 Jefferson Boulevard
Warwick, RI 02888

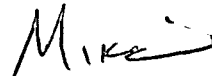
Re: Providence Water Supply Board – Docket No. 4022

Dear Luly:

Enclosed for filing in this matter are an original and nine copies of Providence Water's responses to the 1st set of data requests of the Division of Public Utilities and Carriers.

If you have any questions, please feel free to call.

Very truly yours,



Michael R. McElroy

MRMc:tmg

cc: Pamela Marchand
Boyce Spinelli
Jeanne Bondarevskis
Richard Blodgett
Service List in Docket 4022

**Docket No. 4022 - Providence Water Supply Board Providence Water Supply Board
Request for Approval to use a \$5 million property tax refund
Service List updated 1/9/09**

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PUC Docket No.4022 -- Providence Water's Response to Division of Public Utilities Data Requests, Set 1

REQUEST # 1

"Please provide a copy of any studies, reports or other analyses that address the need for the acquisition of additional watershed protection property in the Scituate Reservoir watershed."

RESPONSE

- R.I.G.L. 46-15.3-5.1 and 46-15.3-7 require Providence Water to prepare a Water Quality Protection Plan and to update it every five years. R.I.G.L. 46-15.3-7(a)(3) specifically requires "identification of measures needed to protect each reservoir . . . from sources of contamination, including acquisition of buffer zones . . ." (emphasis added). All four of Providence Water's Water Quality Protection Plans (both previous plans, the current plan, and the proposed plan) recommend that additional watershed property be acquired in order to protect our drinking water supply. Attached are portions of these four plans which recommend the acquisition of watershed land.
- Several studies have documented the connection between land use and water quality; specifically how water quality degrades as land use becomes more intensive. Land acquired and protected in its natural state is an excellent natural filter and is the best guarantee that a public drinking water supply will sustainably provide the purest water to its customers. Some of these studies are attached hereto.
- Additional studies recommend that Providence Water keep purchasing watershed property in order to protect the State's largest drinking water supply. These studies, in their entirety, along with those referenced above, would total several hundred pages. If the Division so desires, complete copies could be made available. However, at this time it seemed prudent to provide only pertinent sections, which are attached hereto.

Attached are portions of the following documents which address the relationship between land use and water quality, along with the effectiveness of land acquisition as a watershed protection tool:

- "Statistical Analysis of Drinking Water Treatment Plant Costs, Source Water Quality, and Land Cover Characteristics", 2008
- "State Guide Plan Element 125 – Scituate Reservoir Watershed Management Plan", 1990

- “State Guide Plan Element 731 – RI Nonpoint Source Pollution Management Plan”, 1995
 - “The Scituate Reservoir Source Water Assessment”, 2003
 - “Public Drinking Water Supply System Protection – Legislative Findings”, R.I.G.L. 46-15.3-1.1
 - “Public Drinking Water Supply System Protection – Water Supply System Management Plans”, R.I.G.L. 46-15.3-5.1
 - “Public Drinking Water Supply System Protection – Water Quality Protection Component”, R.I.G.L. 46-15.3-7
 - “Protecting the Source”, 2004
 - “Smart Growth For Clean Water”, 2003
 - “An Ounce of Prevention”, 1998
 - Board of Providence Water policy entitled “Providence Water Property Interests”, 2007.
- Providence Water recently hired an engineering firm (Fuss & O’Neill Inc.) to conduct a survey of major water suppliers in southern New England. The following suppliers participated: Boston, Cambridge, Hartford, New Haven, Springfield and Worcester (see Figure 1.1). These drinking water suppliers, including Providence Water, provide water to over four million people in the region. Data pertaining to their watershed protection programs (including land ownership and the percent of their watershed which is protected), were included in the information that was gathered (see Figure 1.2). In summary, Providence Water ranked below average in both categories (watershed land owned and watershed land protected).
 - Providence Water therefore strongly supports the acquisition of more watershed land to protect the purity of its raw water supply.

Figure 1.1

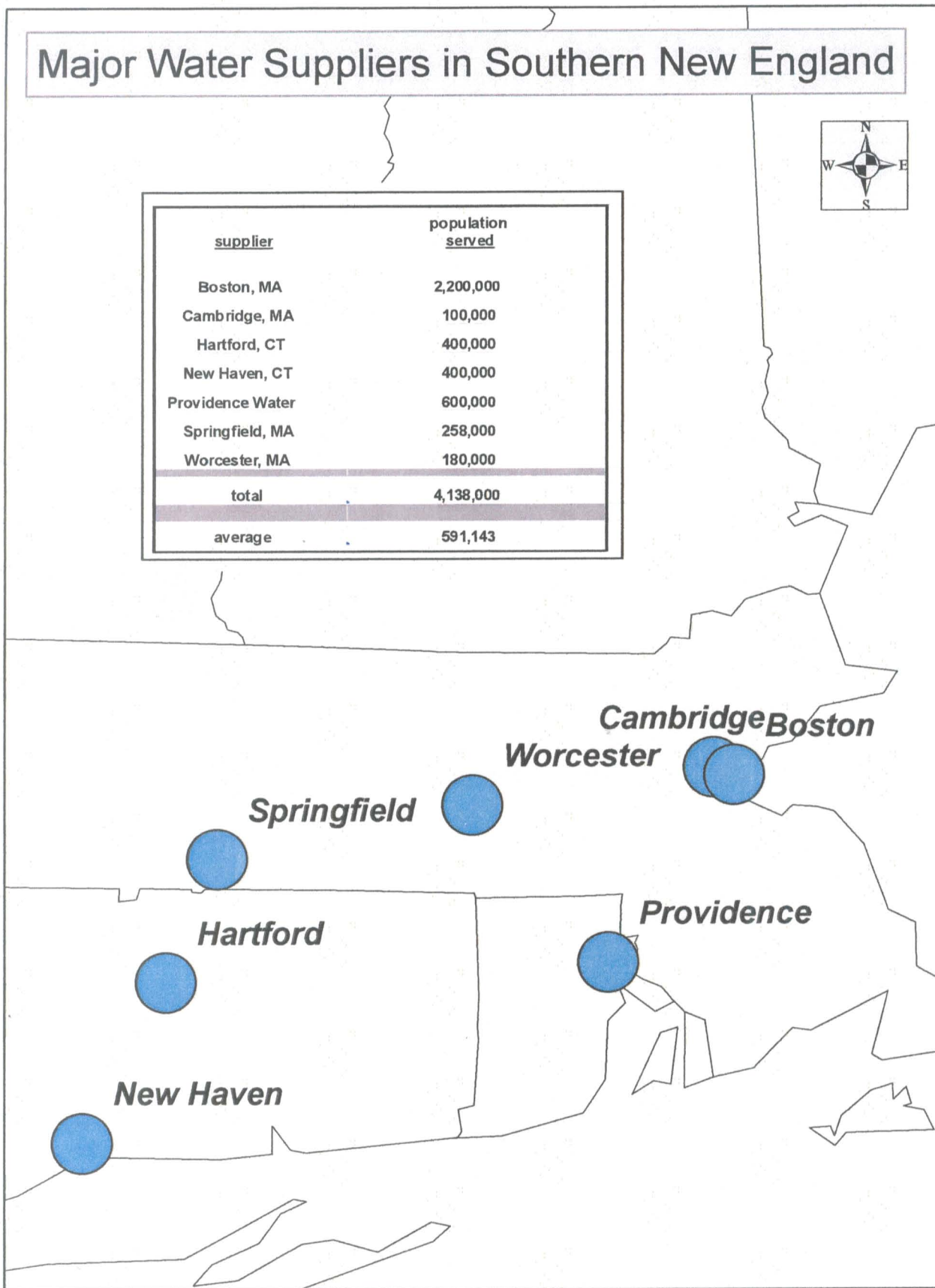


Figure 1.2

PUC Data Request – Set # 1

December 26, 2008

Comparison of Major Water Suppliers in Southern N.E.

<u>supplier</u>	<u>percent watershed owned by utility</u>	<u>percent watershed protected</u>	<u>population served</u>
Springfield	46	74	258,000
Boston	43	85	2,200,000
Hartford	35	47	400,000
New Haven	30	31	400,000
Providence Water	28	32	600,000
Worcester	25	47	180,000
Cambridge	5	27	100,000
average	30	49	591,143

<u>supplier</u>	<u>percent watershed owned by utility</u>	<u>percent watershed protected</u>	<u>population served</u>
Boston	43	85	2,200,000
Springfield	46	74	258,000
Hartford	35	47	400,000
Worcester	25	47	180,000
Providence Water	28	32	600,000
New Haven	30	31	400,000
Cambridge	5	27	100,000
average	30	49	591,143

Footnotes

Figures based on:

"Northeastern Water Suppliers Questionnaire" (January 2005)

RIGIS data (2006)

Providence Water GIS data (2007)

**PROVIDENCE WATER
SUPPLY BOARD**

**WATER QUALITY
PROTECTION PLAN**

Developed in accordance with the
Public Drinking
Water Protection Program
Title 46, Chapter 15.3 of the
General Laws of Rhode Island
as amended

MAR. 8, 1989

PREPARED BY:
CATAUDELLA ASSOCIATES INC.
222 Richmond Street/ Suite 310
Providence, Rhode Island 02903

EXISTING WATERSHED PROTECTION PROGRAM

I. CURRENT POLICIES AND PROCEDURES

Early efforts at watershed protection were initiated with a reforestation program in 1926 soon after construction of the Scituate Reservoir dam was completed. Extensive tree planting was accomplished between 1935 and 1943 when approximately 5,000,000 trees were produced in a nursery operated by the Department. Limited forest culture work began in 1946 and continued until 1951 when the first professional forester was employed. Intensive forest management of forest holdings proceeded from 1951 to the mid 1970's. The 1960's saw the platting of sizable acreages of non-PWSB watershed land as the urban sprawl reached into watershed communities. With this development emerged the direction of PWSB efforts to address the potential impacts of unchecked development. The watershed management staff has increased progressively in scope to what now exists.

1. The PWSB Watershed Division program can be described generally as follows:

a. Forest Management (maintain a healthy and productive forest to protect the source-of-supply:

- Headed by a professionally trained forester who is guided by a forest management plan.
- Continuous forest resource inventory.
- Forest protection against insect and disease damage.
- Property boundaries.
- Silvicultural treatments and harvesting operations.
- Security and enforcement.

b. Watershed Land Management:

- Surveillance of the total watershed area to identify existing and potential contamination threats to the reservoir system and subsequent investigations with the State DEM and DOH.
- Determination of ecological and hydrological implications of land use decisions and trends.
- Review environmental legislation.
- Represent the agency along with other staff members and present testimony at various local and state hearings.
- Coordination of land use/purchase agreements.
- Implementation of contingency plans for spills and dumping of hazardous materials.

- Routine sampling of brooks, streams, reservoirs and periodic update of same.
- c. Security and Enforcement:
- Enforcement of departmental rules and regulations regarding access to PWSB land holdings.
 - Fire suppression.
 - HAZMAT responses.
 - General watershed surveillance in conjunction with the Land Management Specialist.
- d. Maintenance:
- Maintenance of all grounds in and about the water treatment plant and related facilities.
 - Maintenance of Gainer Dam and tributary reservoir dams.
 - Maintenance of forest access roads, and fencing.
2. Current Laws and Land-use Regulations Utilized in Protection of Water Resources.
- a. Federal Laws and Regulations such as the Safe Drinking Water Act, Clean Water Act, and the Clean Air Act.
- b. Existing State Laws such as 46-14 and 11-44 which are used in protection efforts on both PWSB properties and related watersheds.
- c. Regulations adopted in accordance with State Law as enforced by Departments of Health and Environmental Management, and State/Local police agencies.
- d. Local Ordinances in zoning, planning, and related land and water resource protection enforced by watershed towns and city.
3. Land Acquisition.
4. Involvement with State Task Forces related to water resource protection issues:
- Revision to ISDS Regulations.
 - Revision to Sediment and Erosion Control Regulations.
 - Development of Stormwater Management Regulations.
 - State Forest Resource Plan.
 - RIEMA Task Force on Hazmat Spill Response.
 - Legislative Task Force on Routing of Hazardous Materials through the Scituate Reservoir Watershed.

III. PRIORITY OF PLANS AND PROTECTIVE MEASURES

1. Ongoing: (14)
 - a. Continue to implement and address recommendations of EPA Sanitary Survey (January 1988).
 - b. Maintain forest and property management efforts.
 - c. Maintain watershed surveillance and land-use protection programs.
 - d. Continue aggressive participation on inter-agency task forces at state level designed to address water resource protection.
 - e. Continue participation in state and local hearings and meetings of zoning boards and plan commissions on protection issues.
 - f. Persist in efforts to discourage highway development on the watershed but encourage drainage improvements.
 - g. Continue to press RIDOT for containment of deicing salt storage - i.e. Clayville site.
 - h. Continue watershed stream sampling program and review on an annual basis.
 - i. Maintain participation in programs which support the conservation and management of forest and/or open space resources on the watershed such as Tree Farm Program; Farm Forest and Open Space Act; Soil Conservation Service Districts.
 - j. Continue to identify and monitor specific and potential sources of contamination and take corrective action as available under existing laws and regulations.
 - k. Continue to urge state and local highway agencies to employ conservation deicing measures.
 - l. Cooperate with state and watershed towns in overall watershed protection efforts.
 - m. Continue development of hazardous materials spills response program at the state and local level.
 - n. Work with state and local agencies to enforce existing laws and regulations.

2. **Proposed for Immediate Implementation:** (5)
- a. **Implement Land Acquisition Program utilizing the Strategic Lands Inventory.**
 - b. Finalize purchase of pcARC/INFO Geographic Information System with goal for in-house use by Fall 1989.
 - c. Harden water treatment facilities and watershed areas through such security measures as extension of fencing, updating of security systems and increased staffing.
 - d. Encourage adoption of revisions to ISDS Regulations, Sediment and Erosion Control Ordinances, Stormwater Management Ordinances, Waste-water Management Districts, Non-point Source Pollution Control Regulations and Zoning Enabling Legislation.
 - e. Make available environmentally oriented legal staff to pursue environmental protection issues.
3. **Implementation Within Five (5) Years:** (8)

- a. A program of diagnostic study to monitor the nutrient, metal, and bacteriological status of the Scituate Reservoir and its tributaries. Agencies: PWSB and/or contractual agent.
- b. A hydrodynamic reservoir water quality model should be developed for the Scituate Reservoir and its tributaries. Agencies: PWSB and/or contractual agent.
- c. Implement monitoring of atmospheric pollutants and their potential impact on water quality. Agencies: PWSB and/or contractual agent.
- d. Research abandonment of certain town and state roads.
- e. Aggressively encourage adoption of revised ISDS regulations (as developed by ISDS Study Committee), Stormwater Management Regulations, and Sediment and Erosion Control Regulations.
- f. Implement a groundwater monitoring program in relation to impacts from former and current landfills and junkyards; highways; and highly developed commercial districts. Agencies: PWSB, RIDEM, RIDOT, towns, SWMC and/or contractual agent.

WATER QUALITY PROTECTION PLAN

December 1995

Prepared for:

Providence Water
552 Academy Avenue
Providence, Rhode Island

Prepared by:

Roy F. Weston, Inc.
187 Ballardvale Street
Wilmington, Massachusetts

RFW # 05607-003-001

SECTION 4

WATER QUALITY PROTECTION PLAN - UPDATED

4.1 INTRODUCTION

This Section defines the boundaries of the watershed and mapping resources, identifies potential sources of contamination and reviews past, present and recommended activities to protect water quality. A survey of the watershed and interviews with staff of Providence Water were conducted to evaluate past and present activities to protect water quality and to develop recommendations for future programs. Local, State and Federal regulations pertaining to water quality protection were reviewed. Town Assessor's records were reviewed to identify protected lands. Subsection 4.4.2 identifies activities and programs which are recommended for implementation in the next five years.

4.2 DETERMINATION OF THE BOUNDARIES OF THE WATERSHED - WATERSHED AREA MAPPING

The boundaries of the Scituate Reservoir watershed, as indicated in Appendix A of the original plan, have not changed. The boundaries of the watershed represent the area in which natural and human activity may impact the water quality of the Scituate Reservoir. The information available as well as Providence Water's ability to generate maps and complete statistical analysis through the ARC/INFO system has changed. Providence Water obtained the watershed boundary maps including thirty-three (33) sub-watersheds. Each of these sub-watersheds has been plotted with the inclusion of various parameters such as:

- Land currently owned by Providence Water;
- Lakes, rivers, streams and wetlands;
- Potential sources of contamination (pollution points), including commercial and industrial businesses, large septic systems (schools, etc), troubled septic systems, former landfills, superfund sites, salt storage areas;
- Tax map lot boundaries (property lines);
- Roads;
- Zoning districts;
- Town boundaries;
- 100 year flood plain boundaries;
- Water supply wells - community and non-community and protective areas;

of surface water to groundwater. These areas are vulnerable to contamination during operation and if not properly closed after use.

4.3.15 Junk/Salvage Yards

Junk/salvage yards pose a threat to water quality from fluids which may leak from vehicles as well as solvents which may be used in dismantling the vehicles. Facilities should be subject to performance standards designed to prevent pollution of ground and surface waters.

4.3.16 Logging

Logging operations may threaten water quality through erosion and sedimentation from construction and use of roads and removal of vegetation. Proper logging techniques and erosion and sedimentation practices must be implemented to protect water quality.

Potential contamination sources are areas on which Providence Water must focus attention when protecting water quality. Identification of the locations of these potential contamination sources is included on Figure 5.

4.4 MEASURES NEEDED TO PROTECT THE WATER QUALITY

4.4.1 Original Actions

The 1989 watershed protection program for Providence Water consists primarily of the following activities:

- *Land use control,*
- *Watershed surveillance,*
- *Modifications to road salting procedures,*
- *Forest management,*
- *Land acquisition,*
- *Security and enforcement, and*
- *Reservoir use restrictions*

The approved WQPP plan (included in Appendix A) identified the ongoing and planned efforts of Providence Water to protect the water quality. Progress on the Water Quality Protection Plan identifies the efforts of Providence Water since the approval of the original plan. All of the ongoing activities continue to be implemented. In fact, watershed security patrols, community liaison, and education efforts have intensified.

4.4.2 Recommended Enhancements to Providence Water's Watershed Protection Program

Tasks which will enhance the program include enhancement of on-going tasks and implementation of new initiatives. These activities are described in the following sections.

Similar package could be developed for community leaders and existing residents if time and funds allow.

10. **Raw Water Monitoring Program** - The raw water monitoring program should be expanded to include reservoir and stream sampling of pathogens such as *Giardia* and *Cryptosporidium* which may soon be more tightly regulated. Total organic carbon (TOC) should also be studied more closely, given the recent promulgation of the Disinfection-Disinfectant Byproducts (D-DBP) rule. See Appendix G for additional information regarding the raw water quality monitoring program. Providence Water should consult with the USGS or URI to comprehensively review the raw water monitoring program. The number and location of sampling points, frequency of sampling and the constituents analyzed should all be reviewed.

Providence Water has begun sampling to monitor for zebra mussels. Zebra mussels are small black and white striped mollusks which have caused millions of dollars in damage to industrial plants and water treatment facilities in the Great Lakes region. The mussels can severely impact water quality in addition to physically clogging culverts and water intakes. To date, no zebra mussels or veligers (mussel larvae) have been identified in the State of Rhode Island. The best method of defense against zebra mussels is to prevent their introduction into the waterway. Due to the limited access to water bodies of the Scituate Reservoir complex, the risk of introduction is reduced. Providence Water should educate those persons with access to the reservoirs (fishermen and boaters), particularly those using boats on the Ponaganset Reservoir. Some utilities in New York State have required boat inspections prior to launching to prevent the transmission of zebra mussels into their water supplies.

11. **Uncontrolled Releases** - An emergency HAZMAT response plan is in place for spills within the watershed. This program should be enhanced by the documentation of all tributaries and drainage areas near roadways to quickly identify the flow route of any spills. Providence Water is presently working to install boom connection pins near hazardous road areas to expedite response. Access to drainage swales and basins along roadways should be cleared and maintained to expedite access to spill areas. Road signs cautioning drivers of the watershed should be replaced as they are vandalized and/or stolen. Providence Water should also review and have input into local HAZMAT response plans.
12. **Land Acquisition** - Since 1990, Providence Water acquired 28 parcels totalling 1,439 acres. Providence Water has amended its policy towards land acquisition, but will continue to acquire property that is of strategic importance to raw water quality protection. The new policy is outline in Appendix D. Figure 5 indicates the status of land ownership and acquisition in the watershed as of December 31, 1995. Cooperative efforts have also been developed with the USDA Forest Legacy Program, Trust for Public Land, DEM, local land trusts and other agencies to coordinate the acquisition and protection of lands in the watershed with limited available funds.

**WATER QUALITY PROTECTION PLAN
FOR
PROVIDENCE WATER SUPPLY BOARD**

VOLUME V

PREPARED FOR:

*PROVIDENCE WATER SUPPLY BOARD
552 ACADEMY AVENUE
PROVIDENCE, RI*

PREPARED BY:

*FUSS & O'NEILL, INC.
THE FOUNDRY CORPORATE CENTER
275 PROMENADE STREET, SUITE 350
PROVIDENCE, RI*

**SUBMITTED AUGUST 31, 2001
REVISED JULY 2002**

EXECUTIVE SUMMARY

Overview

Providence Water has established and continues to develop and implement watershed management and source protection measures to ensure the future quality and availability of its raw water sources within the Scituate Reservoir watershed. Documentation of these efforts and other measures to ensure the effectiveness and efficiency of its water distribution system was required by the Rhode Island State Legislature in 1987 with the passage of the Rhode Island Water Quality Protection Act (46-15.3). This legislation required water suppliers to develop water quality protection plans to ensure the continued protection of their water supplies and to establish means to fund the implementation of the plan elements.

The Rhode Island Water Quality Protection Act established a 1.125 cents per 100 gallons surcharge on water sold to certain retail and wholesale customers to provide funds to water suppliers in preparing and implementing measures to protect water quality. Amendments to the Act in 1989 increased the surcharge to 2.59 cents per 100 gallons to provide funds for the operation of the Rhode Island Department of Environmental Management's Division of Water Supply. The amount available to Providence Water for implementation of its Water Quality Protection Plan remains at 1.125 cents per 100 gallons.

Providence Water prepared its first approved Water Quality Protection Plan in June of 1989. An update was prepared in December 1995 by Roy F. Weston, Inc and was subsequently approved. Recommendations included in the 1995 update were implemented by December 2000.

The goal of this plan update is to ensure the protection of adequate supplies of water for treatment and distribution to all Providence Water customers. This plan is intended to be modified in the future in response to changes in land uses and applicable federal, state and local regulations. Providence Water continues to take steps to address, and remove where possible, conditions which may impact source water quality and to foster relationships with the watershed communities and other public and private entities to educate the public on the need for source water protection and to encourage land uses and best management practices to protect watershed surface and ground water resources.

This plan update is consistent with the Water Quality Protection Act of 1987, as amended, the Rhode Island Comprehensive Planning and Land Use Act of 1988 and the Comprehensive Plans of watershed municipalities.

Watershed management and source protection has been practiced by Providence Water since its inception. Providence Water originally had the vision to purchase much of the land surrounding its six water supply reservoirs and land adjacent to critical streams and ponds. Access to reservoirs for recreational purposes has also been prohibited. Much of the land owned by Providence Water has been fenced and posted to restrict access.

Providence Water must continue to take steps to protect this valuable drinking water resource as development continues and certain potentially detrimental land uses continue to operate within the watershed.

Land uses on parcels directly adjacent to the reservoirs and along rivers and streams feeding the reservoirs can be potentially hazardous to the quality of the source water. Therefore, it is necessary that such parcels be identified and a method of protecting the source water becomes part of the plan.

The Watershed Land Acquisition Plan is an ongoing program that requires periodic review and re-appraisal to ensure protection of water resources in the face of changing regulations and land-use. The acquisition program is also impacted by diminishing revenues and it is important that water quality funds be expended in the most effective manner possible.

The development of this plan has shed light on the various challenges of watershed protection. The watershed includes five towns, numerous land uses, and involves groups of individuals with varied interests and desires for the land. Some core issues include:

- Support from all communities is an integral part of water quality protection. Local, state and federal regulations affect activities within the watershed and the success of protection measures.
- Numerous groups of individuals have a variety of competing interests which must be satisfied while maintaining the protection of water quality. Economic growth and other interests in the area must be balanced with watershed protection.
- To help protect the water supply, Providence Water must rely on the regulatory and enforcement process of local, state and federal agencies. Providence Water will encourage the development of cooperative ventures between these agencies who have direct interests and work on common problems in order to coordinate work and reduce costs.
- Coordination of watershed protection activities are difficult due to the number of state agencies, local boards, commissions and groups involved in addition to Providence Water.

- Assessed risks from, and alternative actions for, above ground and underground fuel storage tanks within the watershed;
- Performed a watershed chemical inventory of commercial and industrial facilities within the watershed;
- Assessed and assisted in expanded access to household hazardous water collection programs within the watershed;
- Investigated and established voluntary individual sewage disposal system inspection program, wastewater management districts, and groundwater impacts;
- Established a commercial and industrial facility environmental audit program;
- Established a program to perform an annual aerial sanitary survey of watershed;
- Investigated and established a stormwater best management practice program with the Rhode Island Department of Transportation and local departments of public works;
- Assisted the implementation of agricultural and silvicultural best management practices;
- Participated in review of proposed development projects within the watershed;
- Continued participation in the Scituate Watershed Zoning Project to work with community in developing land use controls that adequately protect source waters

Summary of Findings

Providence Water is responsible for the protection of the Scituate Reservoir, its tributary reservoirs, and all streams and groundwater basins contributing to the Scituate Reservoir. Protection is necessary to ensure that National Primary Drinking Water Standards can be met and public health and safety protected.

In water supply and source water technology, it is desirable to start with the highest quality raw water possible. Prevention of pollution is preferred over correcting contamination sources and will result in a higher quality end product for the customer at a lower cost. Treatment of polluted water may become expensive and inefficient and not guarantee the removal of various pollutants.

attribute the success of their watershed management plans to public education and community support. Providence Water presently has a comprehensive program with local elementary schools. This has been continued and expanded to middle schools and local community groups. Discussions with NRICD have begun to expand the program into the high schools. Owners of community wells and septic systems have been targeted as potential candidates for an education program. Targeted watershed educational packages could be developed for community leaders and existing residents if time and funds allow.

10. **Raw Water Monitoring Program** - The raw water monitoring program as described in Section 8.0 of this WQPP should be periodically reviewed and adjusted to respond to changes in watershed conditions.
11. **Uncontrolled Releases** - An emergency HAZMAT response plan is in place for spills within the watershed. This plan should be periodically reviewed and updated to remain current with watershed conditions. Recently installed boom pins should be periodically inspected to confirm their presence and access to the pins periodically cleared. Road signs cautioning drivers of the watershed should be replaced as they are vandalized and/or stolen. Providence Water should also periodically review and have input on local HAZMAT response plans.
12. **Land Acquisition** - Providence Water should continue to acquire property that is of strategic importance to raw water quality protection. Cooperative efforts have also been developed with the USDA Forest Legacy Program, Trust for Public Land, DEM, local land trusts and other agencies to coordinate the acquisition and protection of lands in the watershed with limited available funds.
13. **Mitigation of Birds in the Watershed** - In the past, bird populations have been identified as a contributor of coliform to reservoir waters in other systems. However, this potential source has been controlled as a result of past efforts. If birds begin to be problematic again, Providence Water should reinstitute bird control efforts such as harassment and maintenance of signage at public access areas to discourage feeding as required.
14. **Watershed Survey** - Providence Water should periodically conduct a watershed wide property survey. This survey should be accomplished with a questionnaire to be mailed to all residents of the watershed consistent with the successful survey completed as part of the December 2000 Implementation Report. The survey should inquire about septic system practices, septic system construction and age, household chemical disposal, presence of underground storage tanks, number of people occupying a dwelling, number of pets, type of development (residential/commercial), abundance of wildlife in the area and other pertinent information. Door-to-door surveys could be performed in targeted areas (e.g., high-density residential areas near water resources) to increase response levels a gain a greater understanding of conditions in areas that could significantly impact water quality.

Information gained from future surveys should be entered in a database and would assist Providence Water to develop other programs such as public education and focus on other water quality protection efforts. Some parameters, such as pet

Water Quality Protection Plan
Update 2008

Providence Water
Providence, Rhode Island

November 2008



FUSS & O'NEILL
Disciplines to Deliver

Fuss & O'Neill
317 Iron Horse Way
Suite 204
Providence, RI 02908



An additional review of water quality was conducted and summarized in *ISDS and Wetland Loss Impact Evaluation*, December 2006. This study focused on the potential water quality impacts from both development of individual sewage disposal systems (ISDSs), now called Onsite Wastewater Treatment Systems (OWTS), and loss of existing wetlands. Specifically, phosphorus and nitrogen pollutant loadings were calculated for OWTS systems added to the watershed and also for loss of wetlands. The analysis and modeling identified the potential for phosphorus to break through the binding capacity of underlying soils in the watershed, ultimately increasing levels for eutrophication within several years. The likelihood of this actually happen increases as the OWTSs in the watershed continue to age and the watershed's soils reach their capacities to buffer phosphorus. Nitrogen loading from OWTSs may also be a concern for water quality, as nitrogen are soluble and will not bind on soils to the extent that phosphorus does. Control of nitrogen at the OWTS, rather than control within the reservoir, would mean less treatment is required and less potential for decreased water quality or environmental impacts.

Wetland loss has not been significant in the watershed and will likely decline due to more stringent regulatory oversight and enforcement. Based on historic data identified in the *ISDS and Wetland Loss Impact Evaluation* report, the rate of wetlands loss in the watershed does not appear to present a significant risk to water quality.

7.0 OWNERSHIP OF PROTECTED LANDS

7.1 Protected Lands

Records of tax-exempt properties from tax assessor offices in the towns of Scituate, Foster, Gloucester, Johnston and Cranston were reviewed as part of the 2001 WQPP update to identify properties within the watershed that are protected from future development. Each of these properties is listed by town in Appendix B with the owner's name and the respective plat and lot numbers. This listing of protected properties is grouped in the following tables:

- Properties owned by municipalities or the state of Rhode Island
- Properties owned by PW
- Properties under the Farm, Forest and Open Space Act, and
- Properties owned by preservation organizations.

It should be noted that properties identified under the Farm, Forest and Open Space Act are only updated through 2001. It is recommended that PW consider updating this information through contact with the Watershed Towns.

Preservation organizations were contacted to confirm ownership, or potential future ownership, of lands within the watershed. Properties owned by PW were obtained by PW and confirmed by examining the tax-exempt property lists of the watershed municipalities. Tax-exempt properties that were not included in this listing include cemeteries, churches



and local emergency response facilities as these uses are not necessarily protective of the water supply or could potentially change use in the future.

7.2 Land Acquisition

PW has ongoing efforts to acquire critical parcels of land and buffer zones within the watershed to ensure critical watershed resources are protected now and in the future protection. Most lands owned by PW are within a critical half-mile zone from the main reservoir. To date, PW owns approximately 28 percent of the watershed. Table 7.1 below lists recent land acquisitions by PW. A map depicting current land owned by PW is provided in Appendix A identifies land currently owned by PW.

**TABLE 7.1
LAND ACQUISITIONS BY PROVIDENCE WATER SINCE 1990**

Name	Plate	Lot	Town	Year Acquired
Ash	20	60	Scituate	1990
C. Allen	17	147	Scituate	1990
Brightman	48	49/1	Scituate	2002
Fiske	42	4	Scituate	1990
Foglia	49/1	251	Scituate	1999
Folcarelli	47	3	Scituate	1990
Gorham/Fenner	41	41	Scituate	1990
Harvey	47	15	Scituate	2000
Hull	51	41, 67 & 68	Scituate	1998
James Battey	42	5	Scituate	1991
Joslin Estate	51	*	Scituate	1991
Langlais	37	14	Scituate	1990
Mansolillo	37	15	Scituate	2007
Merchant	14	35	Scituate	1991
Paquette	11	6	Scituate/Cranston	1989
Peck	51	47	Scituate	1990
R. Smith/Allen/Swallow	17	37	Scituate	1990
Relahan	11	16	Scituate	2004
Ronci	47	14	Scituate	1996
Saute	46	18	Scituate	1998
Scituate L & P	49/1	82	Scituate	2000
Suibielski	52	29	Scituate	1990
Tasca	38	11	Scituate/Johnston	2001
Weidele	52	30	Scituate	1990



Name	Plate	Lot	Town	Year Acquired
Wilbur Land	49/1	83	Scituate	2000
Wilbur Land	49/1	81	Scituate	2000
Church	15	52	Foster	1997
Church	15	50	Foster	2000
DiColo	12	47 #	Foster	2007
D&M Concepts **	18	32A	Foster	1991
DEPCO	6	*****	Foster	1994
Emmons	12	41A	Foster	1990
Katlan	21	31	Foster	1991
Keebler	6	49	Foster	1997
Lucy Corp.	15	49	Foster	1991
Saccoccio	12	42	Foster	1990
Thompson	12	42A	Foster	1990
Allen, Tom	9	24&29	Foster	2006
Campanini	57	5, 6, 7, & 58	Johnston	1990
Green Acres	57	17	Johnston	1991
Guarino	59	20	Johnston	1990
Ronci	57	18	Johnston	2002
Verde	57	34	Johnston	1991
Verde	59	22,36,96,276	Johnston	2005
Spencer****	18	162	Glocester	1992

In addition to protecting watershed resources, PW manages protected lands in order to regenerate forest cover with native, sustainable tree species that may provide some economic value.

PW has recently noticed an increase in the deer population on the Watershed's protected lands. Further, both non-native and native invasive species are competing with existing vegetation throughout the Watershed. Insect nuisances have been recently associated with the killing of hardwoods throughout the Watershed. Invasive species and other nuisances ultimately compromise PW's efforts to regenerate forest cover with native, sustainable tree species that may provide some economic value.

7.3 Recommendations



7.3.1 General Land Acquisition Recommendations

PW may wish to consider the following recommendations addressing land acquisition and protected lands:

1. PW should continue to acquire property that is of strategic importance to raw water quality protection. Cooperative efforts have also been developed with the USDA Forest Legacy Program, Trust for Public Land, DEM, local land trusts and other agencies to coordinate the acquisition and protection of lands in the watershed with limited available funds.
2. The Strategic Lands Inventory and ranking approach should be periodically reviewed and adjusted such that it continues to meet PW's needs.
3. Watershed land recently purchased by PW and deemed necessary to limit access should be fenced and posted in accordance with PW's policy. This policy maximizes the protection of property through discouraging trespassing.
4. PW should obtain certification of existing forest management operations and implement recommendations resulting from the audit. This certification is essentially a series of audits on the operator's harvesting practices, record keeping, and a variety of additional forest management related activities. Currently, the Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) provide third-party certification. PW should consider utilizing one of these three organizations to achieve a third-party certification on PW owned lands.
5. PW may wish to consider partnering with organizations that manage the deer populations, invasive species, and other nuisances to control water quality impacts and promote regenerative forest cover.
6. PW may also wish to develop and implement invasive plant control strategies for both PW land holdings and privately-owned watershed land.
7. PW may also wish to develop and implement deer management strategies for both PW land holdings and privately-owned watershed land.
8. Recently acquired land should be inventoried to determine the presence of rare and endangered species and/or species of special concern as well as cultural/historic resources. This could include both a review of RIDEM and RIGIS databases as well as filed inspections. This data should be incorporated into the watershed databases.
9. Explore the advantages and disadvantages of relocating the existing firing range on PW property. Construction of a new facility and remediation of

Statistical Analysis of Drinking Water Treatment Plant Costs, Source Water Quality, and Land Cover Characteristics

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Abstract

Revisiting an earlier study conducted by The Trust for Public Land in 2004, this research brings new data and methodologies to offer insight on the impact of the decline of forest cover and the increase of agriculture or urban land cover in a drinking water source drainage area on the water quality for that drinking water source and the drinking water treatment costs. The statistical analyses showed that there were significant relationships among percent land cover, source water quality, and drinking water treatment costs. The data exhibited high variability indicating possibly unaccounted constraining factors – such as the differences in water treatment plant practices/processes and hydrological, geological, and regional differences, which remain as future considerations.

I. Project Summary

This study considers the impacts of declining forest cover on drinking water treatment costs. Even though research exists on land cover's impact on water quality, little is known on the associated impact on drinking water treatment costs. The Trust for Public Land (TPL) began studying this subject in 2004. The preliminary study suggested that costs of treatment for utilities using surface water supplies varied depending on forest cover in the source area. Specifically, the less forest in a source water drainage area, the higher the water treatment costs. Therefore, it is of interest to examine whether the percent of forest cover¹ in a source water watershed is negatively related to drinking water treatment costs, i.e., as forest cover decreases, drinking water treatment costs increase. The analyses were conducted in two phases: 1) first analysis investigates

¹ The forest land use class does not distinguish between protected forests or actively managed forests. Literature suggests that undisturbed forests generally create very little erosion while certain forestry-related activities such as road construction, movement of logs, and site preparation can have an impact on erosion (Binkley and Brown 1993; Brown and Binkley 1994; Dissmeyer 2000). Best management practices can, however, mitigate much of the disturbance of forestry practices. The forested Quabbin watershed that serves as Boston's water supply, for example, is actively managed. Its forestry practices have been certified sustainable by the Rainforest Alliance SmartWood and forestry management occurs parallel to drinking water management (Barten, Kyker-Snowman et al. 1998).

whether water quality decreases as percent forest cover decreases; and 2) second analysis investigates whether treatment costs increase as water quality decreases.

This round of research and analysis included extensive data collection, advanced data processing, and statistical analyses of additional variables to examine how source water quality, drinking water treatment cost, and land cover characteristics are related to one another. In addition to evaluating the percent forest cover of the entire source water watershed, this study considered urban land cover, agricultural land cover, and non-forest vegetation cover. The relationship of a 100-ft and 300-ft buffer of the waterbodies in the source water watershed was tested separately. The study also included testing of three different variables to represent water quality, one of them is an index that takes into account multiple parameters, such as TOC, alkalinity, and turbidity.

Overall, this study found that there were significant relationships among source water quality, percent land cover, and drinking water treatment cost. Increased percent agriculture and urban cover were significantly related to decreased water quality, while decreased forest land cover was significantly related to decreased water quality. Further, low water quality was related to higher treatment cost. High percent land cover by non-forest vegetation was significantly related to low treatment cost, while high percent land cover by urban area was related to high treatment cost.

Section II provides a review of relevant literature, Section III present the study methodology, and Section IV describes statistical findings. Finally, Section V presents concluding remarks including observations and recommendations for future study.

II. Literature Review and Background on Study Subjects and Assumptions

Numerous reports make a narrative case linking forests to drinking water quality or treatment costs. However, these reports rarely include data-supported research and statistical studies. Notable narrative references include: *Land Use Effects on Streamflow and Water Quality in the Northeastern United States* (de la Cretaz and Barten, 2007), which provides an exhaustive review of the literature regarding the link from forests to water quality and the effects from converting forests to agriculture or development; *Liquid Assets: the Critical Need to Safeguard Freshwater Ecosystems* (Postel, 2005), a World Watch paper relating the history of human influence on water sources, which includes case studies of watershed-based actions that reduced treatment costs and policy recommendations; *Running Pure: The Importance of Protected Areas to Drinking Water* (Dudley and Stolton, 2003), a World Wildlife Fund/World Bank report, which finds that 33% of the world's 100 largest cities obtain their drinking water primarily from forested watersheds; and *Drinking Water from Forests and Grasslands: a Synthesis of the Scientific Literature* (Dissmeyer, 2000), a Forest Service literature synthesis.

The closest research objective and methodology to this study is a series of economic studies relating turbidity levels to drinking water treatment costs (explored in detail in Section II(E)). But first, there is research focused on interconnected themes that offer useful background information for this study: the relationship between forest land and

related to higher treatment cost, indicating that it costs more to treat lower quality water. Also, the treatment cost was significantly related to urban land cover. Higher percent land cover by urban area is related to higher treatment cost.

Surprisingly, non-forest landcover had a negative relationship with the Water Quality Index, i.e., increased non-forest land cover was associated with decreased water quality. This is illogical given that non-forest land cover has a negative relationship with chemical treatment cost and the Water Quality Index has a negative relationship with the chemical treatment cost. It warrants further examination of the development of the data to identify the cause for this inconsistent result.

In summary, land cover within a drinking water source area can be an indicator of water quality at a drinking water intake. Specifically, high agriculture and urban land cover are related to high turbidity. Conversely, high forest cover is related to low turbidity, low TOC, and high Water Quality Index. Further, poor water quality at a drinking water intake can be an indicator of high treatment costs. In this study, turbidity alone was not found to significantly relate to chemical treatment cost. However, after factoring in TOC and alkalinity to develop a Water Quality Index for each plant, there was a significant relationship between low water quality and high treatment costs.

V. Concluding Remarks

Even with the help of many generous drinking water treatment plant supervisors, lab technicians, and other plant operators, it was not easy to gather enough data for this study to account for the real world variability needed to offer insights as to the nature of drinking water treatment in the United States. There are numerous possible reasons for the high variability shown in the data, which may provide further consideration and guidance to those who wish to endeavor further study in this field.

First, reporting and accounting procedures varied between water plants. For example, the same plant fix may be perceived in one facility as a capital cost because it is an improvement to infrastructure, and in another plant, the labor and part replacement is logged into the operating budget. This made it difficult to isolate annual operating costs from capital costs. As a result, only chemical treatment costs were analyzed.

Second, there was rich diversity in the sequences of treatment and types of chemicals used by the plants in this study. For example, while the majority of plants included a chlorine/chloramines step and a coagulation step, there were several different types and a range of dosages applied for each. It is likely that the combinations and permutations had a confounding effect on this analysis.

Third, raw water sampling methods differed. Some plants used systematic or fixed frequency samples, but others used event-based or random samples. Even though both are valid, comparing results from different sampling strategies likely increased variability and decreased correlations.