dcr
Massachusetts

Watershed Protection Plan FY19-FY23

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Massachusetts Department of Conservation and Recreation
Division of Water Supply Protection
Office of Watershed Management

Abstract

The Department of Conservation and Recreation, Division of Water Supply Protection, Office of Watershed Management manages and protects the drinking water supply watersheds that provide water for approximately 2.5 million Massachusetts residents. This Watershed System is comprised of three active water supply watersheds, the Quabbin Reservoir, Ware River, and Wachusett Reservoir, and an emergency supply comprised of the Sudbury and Foss Reservoirs. Watershed Protection Plans were initially developed for the active supply watersheds in 1991, with updates in 1998 and 2003 for the Wachusett Reservoir and 2000 for Quabbin Reservoir and Ware River. The Sudbury and Foss Reservoirs had a plan prepared in 1997. The *2008 Watershed Protection Plan* updated and unified all of these documents. The *2013 Watershed Protection Plan* update maintained the comprehensive, unified approach to this critical document.

The *Watershed Protection Plan FY19-FY23* continues DCR's successful efforts of managing the source of an unfiltered water supply. This plan update provides a structured methodology to assess changes in watershed threats, develops programs to address the threats, and prioritizes staff assignments so they are congruent with current watershed management issues. The plan concludes with a five year implementation strategy that summarizes objectives for the Division of Water Supply Protection to achieve from Fiscal Years 2019 to 2023.

CITATION

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All maps were produced by DCR/DWSP Office of Watershed Management GIS staff Craig Fitzgerald, Phil Lamothe, and Erica Tefft, using DWSP and MassGIS data.

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Department of Conservation and Recreation Watershed Protection Plan FY19-FY23

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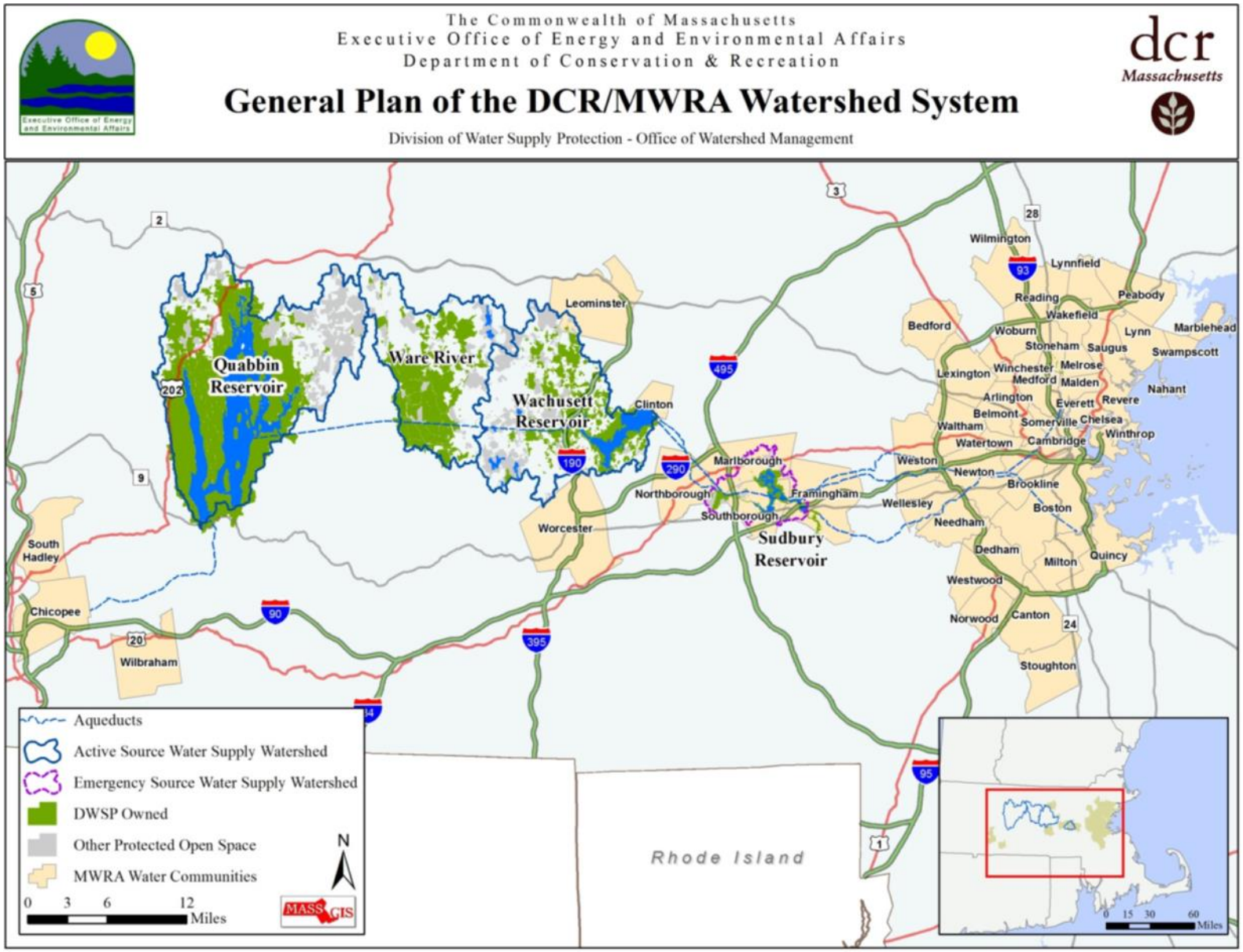
Acronyms

ACOE	US Army Corps of Engineers
ADA	Americans with Disability Act
AIS	Aquatic Invasive Species
ALB	Asian Longhorned Beetle
AST	Aboveground Storage Tank
ATV	All-terrain Vehicle
BLA	Quabbin Reservoir Boat Launch Area
BMP	Best Management Practice
CFI	Continuous Forestry Inventory
cfu	Colony Forming Units
CMR	Code of Massachusetts Regulation
CVA	Chicopee Valley Aqueduct
DAR	MA Dept of Agricultral Resources
DCR	MA Dept of Conservation and Recreation
DFW	MA Dept of Fish and Wildlife
DWSP	DCR's Division of Water Supply Protection
EOEEA	MA Executive Office of Energy and Environmental Affairs
EPA	US Environmental Protection Agency
EPO	MA Environmental Police
EQ	DWSP Environmental Quality Section
EQA	Environmental Quality Assessment
FCPA	MA Forest Cutting Practices Act
FoQ	Friends of Quabbin
FY	Fiscal Year (July-June)
ICS	Incident Command System
LAP	Land Acquisition Panel
LMP	DWSP 2017 Land Management Plan
MassDEP	MA Dept of Environmental ProtectionMassDOT MA Department of Transportation
MassGIS	Commonwealth's Office of Geographic Information
MCP	Mass Contingency Plan
mgd	Million gallons per day
MGL	MA General Law
MS4	Municipal Separate Storm Sewer Systems
MSP	MA State Police
MWRA	Massachusetts Water Resources Authority
NGO	Non-governmental Organization
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
OAG	MA Office of the Attorney General
ORV	Off-road Vehicle
PILOT	Payments in Lieu of Taxes
PPCP	Pharmaceutical and Personal Care Products
Res Ops	Reservoir Operations Group
ROW	Right of Way
STAC	Science and Technical Advisory Committee
SWPPP	Stormwater Pollution Prevention Plan
SWTR	Federal Surface Water Treatment Rule
USDA	US Department of Agriculture
USGS	United States Geological Survey
UST	Underground Storage Tank
WPR	Watershed Preservation Restriction
WQSWAT	Water Quality Sampling and Analysis Team
WsPA	Watershed Protection Act

Figure 1-1: DCR/MWRA Watershed System Map



1. Introduction

The Massachusetts Department of Conservation and Recreation (DCR), Division of Water Supply Protection, Office of Watershed Management (DWSP) manages and protects the drinking water supply watersheds that provide water for approximately 2.5 million Massachusetts residents. DWSP provides the Massachusetts Water Resources Authority (MWRA) source water for treatment and distribution to 51 communities in the Commonwealth (Figure 1-1). The DCR/MWRA water supply system is one of the few unfiltered drinking water supplies in the country (see Section 3-1).

The mission of DWSP is to utilize and conserve water and other natural resources to protect, preserve and enhance the environment of the Commonwealth and to assure the availability of pure water for future generations. This important mission requires a thoughtful and deliberative approach to develop programs that can achieve this very broad goal. Watershed Protection Plans are an important tool used by DWSP to implement programs that enable staff to carry out this mission. The purpose of this report is to update the *2013 Watershed Protection Plan*. It summarizes a year-long assessment process conducted by DWSP staff and updates watershed control programs in order to continue effectively protecting the drinking water supply.

The watershed protection planning process and implementation of plan recommendations has been on-going since DCR's first Watershed Protection Plans were completed in 1991. Since that time, significant accomplishments have been made to greatly increase protection of the water supply, including:

- Acquisition of approximately 24,000 additional acres of land.
- Passage of the Watershed Protection Act's comprehensive land use regulations.
- Implementation of successful bird harassment programs at both Quabbin and Wachusett Reservoirs.
- Construction of sewers (with transport to a treatment plant outside the watershed) in areas no longer suitable for on-site wastewater disposal.
- Implementation of monitoring and control programs for invasive species.
- Redesign of roadway drainage to remove stormwater and eliminate risk from transportation releases.

A summary of accomplishments over the past five years has been organized into an ArcGIS Online Story. A link to this application is available at www.mass.gov/service-details/dcr-watershed-plan-publications.

Priorities for watershed control programs change as water quality threats are contained and new issues emerge. The process used to develop Watershed Protection Plans provides a structured methodology to assess changes in watershed threats, develop programs to address the threats, and review staff assignments to ensure that staff priorities align with current watershed issues. Table 1-1 provides a summary of the more significant changes and proposals made in this update from the previous plan.

Table 1-1: Significant Changes Made in Watershed Protection Plan Update FY19-FY23

Section	Change
2.5	Added information on Drought Management.
3.1	Added details about DWSP history, including filtration waiver.
3.2	Expanded category of potential contaminant from "Aquatic Invasive Species" to "Invasive Species" to include terrestrial species. Subsequent changes made to Table 3-2 to reflect increased scope. Noted that Pathogens includes cyanobacteria.
3.2.4	Included concern on long-term increases in specific conductance in watershed tributaries possibly related to road maintenance activities.
3.2.10	Changed Assessment of Importance for Planning from Low to Medium for Future Growth in the Quabbin Reservoir watershed (and shown in Table 3-4).
3.2.11	Added objective to produce a comprehensive Vulnerability Assessment, which is reflected in the objectives throughout the plan.
3.3.3 and 3.3.4	Included implementation of the 2017 Land Management Plan in this section and all subsequent Land Management and Wildlife Management subsections.
3.3	Propose development of a Terrestrial Invasive Plant Species Plan in in this section and all subsequent Land Management subsections.
3.3.10	Changed program title to "Water Quality and Hydrologic Monitoring" to better reflect duties.
3.3.11	Combined two previous program categories ("Watershed Monitoring and Surveillance" and "Environmental Quality Assessments") into a unified program of "Watershed Monitoring and Assessment" to better reflect duties.
4.5	Implement the *2018 Quabbin Reservoir Watershed Access Management Plan Update*.
4.10, 5.10, and 6.10	Finalize and implement a *Cryptosporidium* and *Giardia* Action Plan with MWRA to establish guidelines for Inter-Agency Notifications and Coordination.
5.5	Update the Ware River Watershed Public Access Management Plan.
6.5	Update the Wachusett Reservoir Watershed Public Access Management Plan.
7.5	Update the Sudbury Reservoir Watershed Public Access Management Plan

The *Watershed Protection Plan Update FY19-FY23* is organized into eight chapters. After this Introduction, Chapter 2 describes the watershed system. Chapter 3 analyzes potential sources of pollution and presents the goals of DWSP's watershed control programs. The manner in which these control programs are implemented in each of the four distinct watersheds is discussed in Chapters 4-7. The Organization and Management of DWSP, including a five year Implementation Plan, are discussed in Chapter 8. This document integrates information from an array of detailed plans, reports, and other publications. Most of the referenced materials are available on the DWSP website, www.mass.gov/dcr/watershed.

2. The Watershed System

The first step in developing a watershed protection program is to delineate the watershed and assess major characteristics of the watershed, including stream hydrology, reservoir characteristics, land use, water quality, soil characteristics, and population trends. This information has been collected and updated by DWSP staff since the preparation of the first watershed protection plans. A brief summary is presented in this section.

2.1 Reservoir System

The source of water for the DCR/MWRA Water Supply System comes from three separate watersheds: Quabbin Reservoir, Ware River, and Wachusett Reservoir. The system also has an emergency water supply source, the Sudbury and Foss Reservoirs. The watershed system, shown in Figure 1-1, is large and well protected. Table 2-1 presents a summary of acreage information for the system.

The system was built over two centuries from east to west, as engineers and planners expanded the system to meet demands of the growing metropolitan Boston area. This chapter and the remainder of the plan describe the system's components from west to east, which chronologically follows from the newest to the oldest portions of the system.

Quabbin

Quabbin Reservoir is located in the valley of the Swift River, a tributary to the Connecticut River, in central Massachusetts. The reservoir was created in 1939 when the Swift River was impounded by the newly constructed Winsor Dam. Quabbin Reservoir has a watershed area of 95,466 acres (excluding the reservoir surface area). At full capacity, when its elevation is 530 feet above sea level, the reservoir covers an area of approximately 24,469 acres. The reservoir has 39 square miles of surface area and is 18 miles long. It has 118 miles of shoreline and holds 412 billion gallons when filled to capacity. The mean depth of the reservoir is 45 feet and the maximum depth is 141 feet. The Quabbin Reservoir is an oligotrophic drinking water reservoir, very clear and rich in oxygen with low nutrient levels so it does not readily support substantial algal or plant growth. It functions as both a terminal supply reservoir for the Chicopee Valley Aqueduct system in central Massachusetts and as a storage reservoir for the Quabbin Aqueduct system serving metropolitan Boston to the east.

Ware

The Ware River watershed encompasses 61,737 acres in the Central Uplands of north central Massachusetts, east of Quabbin Reservoir. The Ware River watershed essentially functions as a tributary to Quabbin Reservoir via the Quabbin Aqueduct and a diversion structure along the Ware River in Barre. There is no permanent reservoir located in the Ware River Watershed.

Wachusett

The Wachusett Reservoir watershed is located in central Massachusetts east of the Ware River. The reservoir, completed in 1906, was created by constructing a dam across the South Branch of the Nashua River. The reservoir surface area is 4,122 acres and the watershed consists of 74,800 acres. The reservoir has 6.5 square miles of surface area and holds 65 billion gallons when filled to capacity. The mean depth of the reservoir is 49 feet and the maximum depth is 128 feet. The normal operation range is between 387 and 392 feet above sea level; the overflow elevation is 395 feet above sea level.

Like Quabbin, Wachusett is an oligotrophic reservoir. Quabbin water is transferred to the Wachusett Reservoir through the Quabbin Aqueduct.

Sudbury

The seven reservoirs that originally comprised the Sudbury Reservoir System were constructed over several decades in the late nineteenth century, with the largest component, the Sudbury Reservoir, completed in 1896. Over the course of the twentieth century, five reservoirs – Hopkinton, Whitehall, Ashland, Brackett, and Stearns – have been removed from the watershed system due to a combination of limited yield, poor water quality, contamination, and superior supplies from the west. The Foss and Sudbury Reservoirs, which are hydrologically separated from these other reservoirs, while removed from the active water supply system in the 1960s, remain as an emergency source supply. The watershed surrounding the Sudbury and Foss is much more developed than any other part of the system. The reservoir is classified as meso-eutrophic, with more nutrients available for plant and algal growth compared to the active reservoirs. The water is suitable for drinking water in emergency situations; the Sudbury Reservoir was most recently put into service very briefly in 2010.

Table 2-1: DCR/DWSP Watershed System Acreage

	Watershed	Land Area (acres)	Reservoir Area (acres)	Total Watershed Area (acres)
Active System	Quabbin Reservoir	95,466	24,469	119,935
	Ware River	61,737	0	61,737
	Wachusett Reservoir	70,678	4,122	74,800
Emergency System	Sudbury Reservoir	13,153	1,215	14,368
	Foss Reservoir #3	3,197	217	3,414

2.2 Land Use, Land Cover, and Land Protection

Land use and land cover within the watersheds varies. Quabbin Reservoir watershed is sparsely populated and has a small percentage of developed land. The watersheds become more populated and developed as one travels from west to east in the system. The relative proportion of protected lands also decreases from west to east. Overall, however, the active system is characterized by large tracts of undeveloped land with low population densities in the developed portions of the watersheds (Figures 2-1 to 2-4).

Land use and land cover data are an important tool for developing watershed protection strategies. Detailed analyses have been conducted for each of the previous watershed protection plans. The *2013 Watershed Protection Plan Update* utilized a 2009 digital dataset of land use from the Commonwealth's Office of Geographic Information (MassGIS) using semi-automated methods and digital ortho-imagery captured in April 2005. The classification scheme, comprising thirty-three land use codes, is based on the coding scheme used for previous Massachusetts land use datasets. It was aggregated into seven major categories by DWSP staff for ease of analysis (Table 2-2). The 2009 changes in land use classification methodology resulted in some large areas previously shown as forest now correctly identified as forested wetland (red maple swamp). Large neighborhoods were no longer considered residential in their entirety but were classified as a mixture of residential, forest, wetland, and open space.

Figure 2-1: Quabbin Reservoir Watershed Land Use and Land Cover

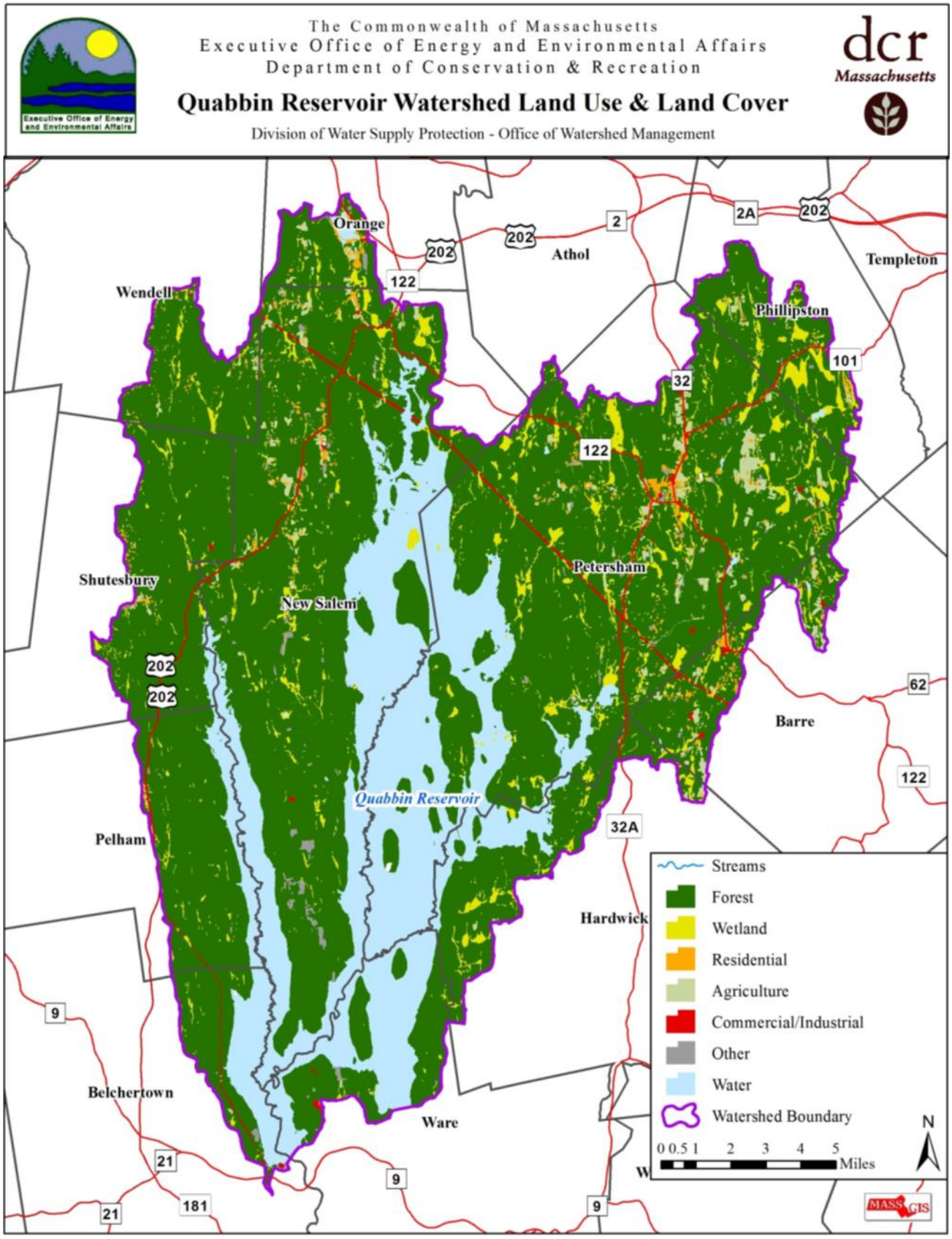


Figure 2-2: Ware River Watershed Land Use and Land Cover

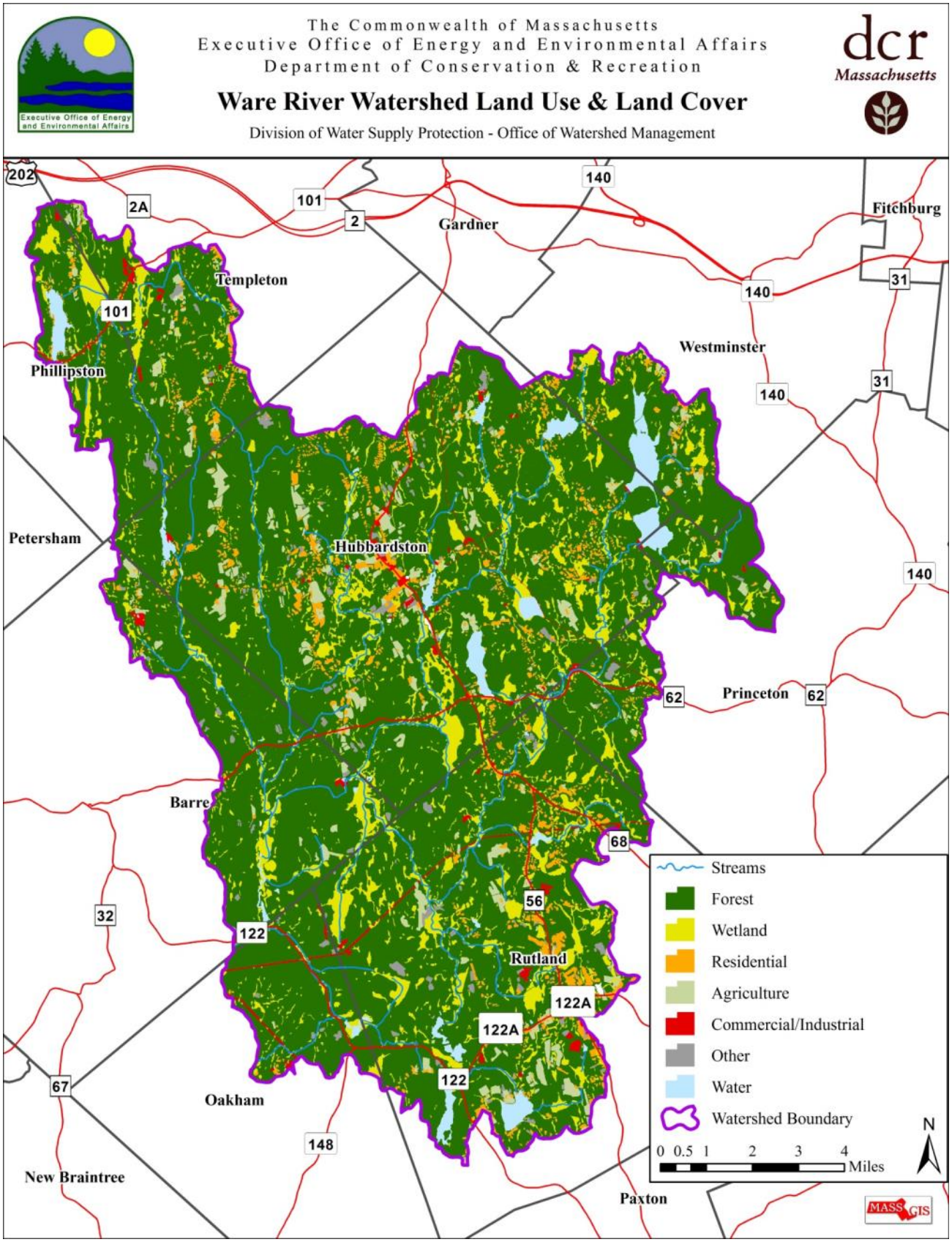


Figure 2-3: Wachusett Reservoir Watershed Land Use and Land Cover

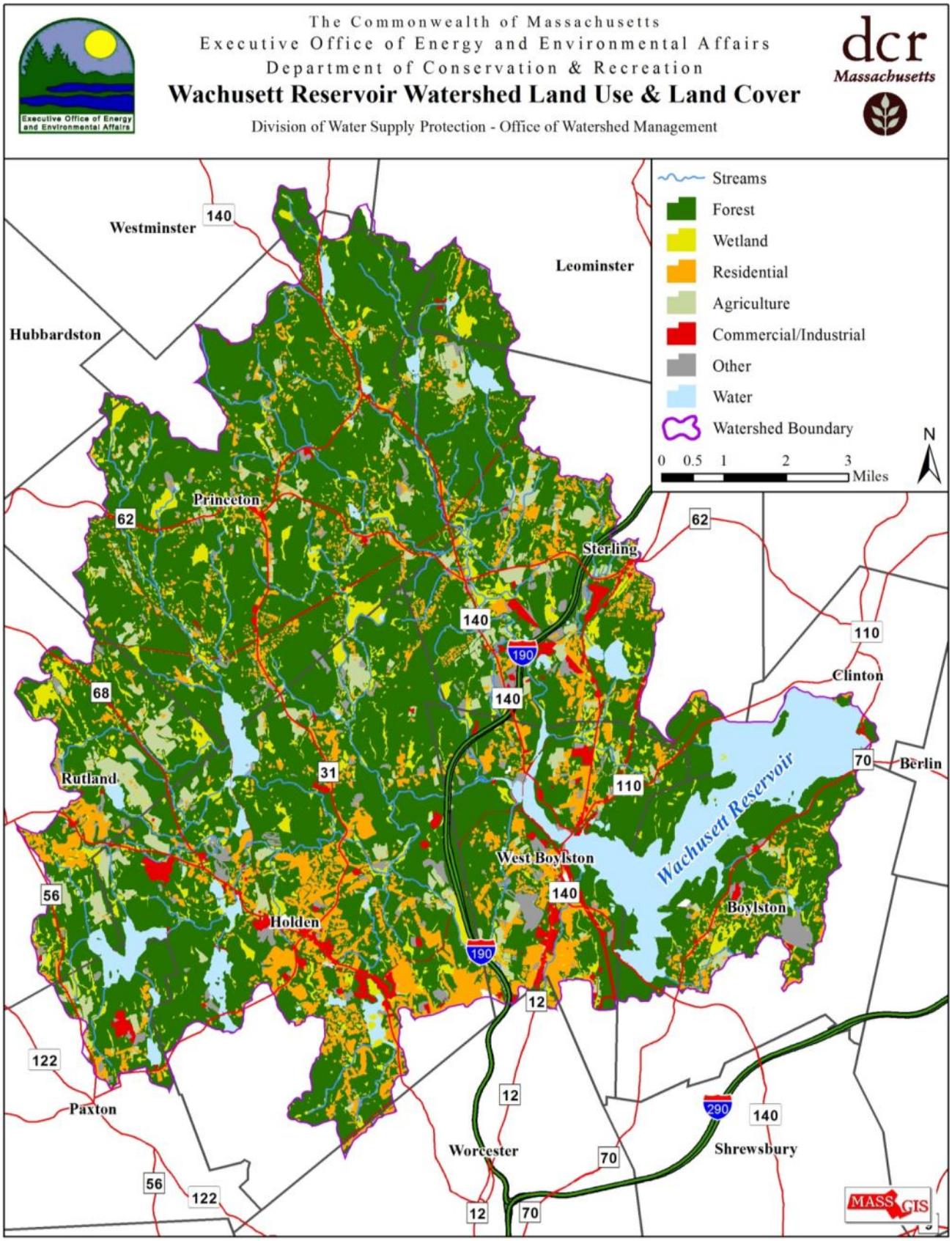
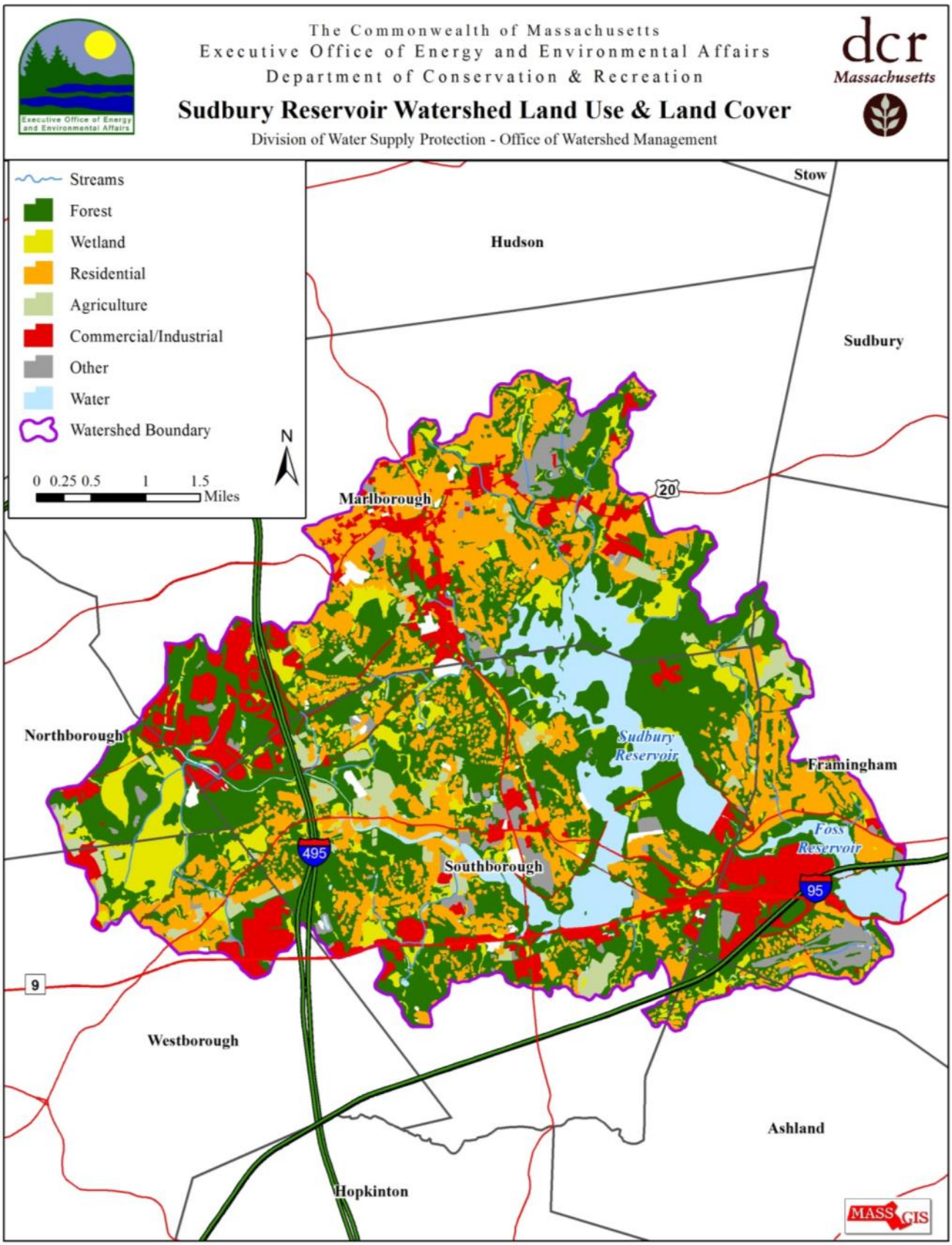


Figure 2-4: Sudbury Reservoir Watershed Land Use and Land Cover



This was a much more accurate representation of actual land use, but made it difficult to compare current land use with earlier data in order to assess land use changes. In 2016, Wachusett staff updated that watershed's land cover data through visual interpretation and field visits. A Land Cover Update Model was then created in ArcGIS Model Builder and run to automatically update the land cover based on a one meter cell size. While this work provided more accurate depiction of land use in the Wachusett Reservoir watershed, there were no significant changes from the figures reported in the 2013 plan.

Table 2-2: Summary of Land Use in the DCR/DWSP Watershed System

		Land Use (%) *(excluding the reservoirs)*						
	Watershed	**Forest**	**Wetland**	**Agriculture**	**Residential**	**Commercial Industrial**	**Open Water**	**Other**
Active System	Quabbin	88.2	5.6	2.2	1.5	0.2	0.4	1.9
	Ware	75.6	11.4	3.2	4.2	0.6	2.6	2.5
	Wachusett	66.7	7.7	4.4	11.9	2.4	2.4	4.6
Emergency System	Sudbury and Foss	40.8	1.3	6.2	30.5	12.2	0.2	8.8

Source: DCR and MassGIS. Quabbin, Ware, and Sudbury 2009; Wachusett 2016; Open Water excludes reservoir area.

The Watershed System is well protected, as shown in Table 2-3. DWSP has an extensive Land Protection Program which has spent $139 million provided by Commonwealth and MWRA funding since 1985 to acquire 26,431 acres in both fee and Watershed Preservation Restriction as described in Chapters 3.2.1 and 3.2.2. This total acreage also includes the beneficiary of many gift sales/donations as well as federally funded Forest Legacy projects. Detailed accomplishments within each watershed are presented in Chapters 4.1-4.2, 5.1-5.2, and 6.1-6.2. Small scale maps displaying DWSP and other protected lands are displayed in the respective watershed's program chapters (Figures 4-1, 5-1, 5-2, 6-1, and 7-1).

Table 2-3: Summary of Protected Lands in the DWSP Watershed System

	Watershed	**DWSP Fee**	**DWSP WPR**	**Other Protected**	**Total Protected**	**Land Area**	**Off-Water-shed**
Active System	Quabbin Reservoir	57,163	4,377	19,455	80,995	95,466	3,180
	Ware River	24,079	1,407	10,295	35,781	61,737	
	Wachusett Reservoir	18,078	2,665	14,910	35,653	70,678	636
	Total	**99,320**	**8,449**	**44,660**	**152,429**	227,881	
Emergency System	Sudbury and Foss Reservoirs	2,381	0	2,146	4,527	16,350	

Source: MassGIS and DWSP. WPR = Watershed Preservation Restriction, similar to a Conservation Restriction. Other Protected lands constitute property identified by MassGIS as Open Space protected in perpetuity less DWSP fee lands and WPRs. Acreage differentials from previous years due to increased accuracy of MassGIS data.

Table 2-3 (continued):

		Ownership as % of Watershed		
	Watershed	**DWSP Controlled**	**Other Protected**	**Total Protected**
Active System	Quabbin Reservoir	64.5%	20.4%	84.8%
	Ware River	41.3%	16.7%	58.0%
	Wachusett Reservoir	29.3%	21.1%	50.4%
	Total	47.3%	19.6%	66.9%
Emergency System	Sudbury and Foss Reservoirs	14.6%	13.1%	27.7%

Quabbin

The Quabbin Reservoir watershed is the least developed in the system. In addition, Quabbin was the beneficiary of the most aggressive land acquisition program at the time of its construction. Approximately 76% of the Quabbin Reservoir Watershed is protected lands with 61% of the Quabbin Reservoir Watershed Land Area directly controlled by DWSP. Other state agencies, non-governmental organizations (NGOs), and watershed communities own the remaining protected lands. Eighty-eight percent of the land in the Quabbin watershed is forested, making it the dominant land use. Wetlands are the second most present land cover (six percent) and residential land uses are ranked third with only two percent. The percent of impervious cover in the watershed as a whole is a remarkable less than one percent.

Ware

In the Ware River watershed, 53% of the land is classified as protected open space. Of this total, DWSP controls 25,486 acres, or 41% of the watershed. DWSP owns approximately 24,079 acres in fee, with an additional 1,407 acres controlled through Watershed Preservation Restrictions. Other government agencies, local governments, and non-government organizations own the remainder of protected open space. The Ware River watershed is still largely undeveloped and forested (75%), with approximately 4% in residential, and less than one percent classified as commercial or industrial. Wetland, cropland and pasture comprise the majority of remaining uses. Ownership patterns have changed in recent years for private lands, with average parcel size declining as larger parcels are subdivided for residential development or through the estate probate process as large landowners die and their land is passed on to multiple descendants. The Ware River watershed is under 3% impervious.

Wachusett

Land use in the Wachusett Reservoir watershed remains dominated by undeveloped forest, open water, and wetlands. Residential development is relatively common, with updated assessment methodology indicating just less than 12% of the watershed currently in residential use. Agricultural is less common, and has diminished to under 5% of the watershed area. Commercial and industrial land uses are very uncommon and tend to be located in distinct areas such as in town centers or along major roadways. In total, 44% of the land is classified as protected open space. This is a much greater percentage of protected land than when the first watershed protection plans were written due to DWSP's aggressive land acquisition program and work with other land protection groups. DWSP now controls just under 20,000 acres in the

Correction to *Watershed Protection Plan Update FY19-FY23*

In the publication *Watershed Protection Plan Update FY19-FY23* (Department of Conservation and Recreation, Division of Water Supply Protection. Boston, MA. 2018), there were errors in Table 2-3. The calculations for "DWSP Fee" and "DWSP WPR" were incorrectly transferred from an excel file. Similarly, the figures for "Other Protected Lands" were transferred from incomplete calculations. Therefore the "Total Protected" numbers as well as the percentages presented for each category were incorrect. The correct figures, however, are stated in the narrative that follows the table. Table 3-2 should read as follows, using data current to 3/1/2022:

Table 2-3: Summary of Protected Lands in the DWSP Watershed System

	Watershed	DWSP Fee	DWSP WPR	Other Protected	Total Protected	Land Area	Off-Watershed Fee	Off-Watershed WPR	Reservoir
Active System	Quabbin Reservoir	54,280	4,647	14,608	75,535	95,364	4,374	26	24,469
	Ware River	23,803	1,364	7,642	32,809	61,671	0	0	N/A
	Wachusett Reservoir	17,698	2,702	12,223	32,623	70,876	712	23	4,122
	Total	95,781	8,713	34,473	138,967	227,911	5,635	49	28,591
Emergency System	**Sudbury and Foss Reservoirs**	**2,367**	**0**	**1,810**	**4,177**	**16,298**	**0**	**0**	**1,432**

Source: DWSP and MassGIS; all figures in acres. Fee – land owned in fee simple by Commonwealth of MA managed by DWSP; WPR – Watershed Preservation Restrictions, similar to Conservation Restrictions, are land restrictions on private property in DWSP's Watershed System; Other Protected – land owned in fee simple by other MA state agencies, municipalities, or non-profit organizations for conservation purposes listed as permanently or limited protected open space by MassGIS; Off-Watershed – land owned in fee or held under a WPR managed by DWSP that is outside the boundary of the respective watershed.

		Ownership as % of Watershed Land Area			
	Watershed	DWSP Controlled	Other Protected	Total Protected	DWSP Controlled Including Reservoirs
Active System	Quabbin Reservoir	61.8%	15.3%	77.1%	69.6%
	Ware River	40.8%	12.4%	53.2%	40.8%
	Wachusett Reservoir	28.8%	17.2%	46.0%	32.6%
	Total	**45.8%**	**15.1%**	**61.0%**	51.9%
Emergency System	Sudbury and Foss Reservoir	14.5%	11.1%	25.6%	21.7%

Data from MassGIS and DCR Records. Land area excludes the reservoir surface.

Wachusett Reservoir watershed, or 28% of the land area. It is estimated that 5.5 % of land in the Wachusett watershed is impervious .

Sudbury

The Sudbury watershed, located just twenty miles from metropolitan Boston, is much more developed than active parts of the system. A major highway crosses Foss Reservoir, and several industrial/commercial developments exist in the watershed. Nevertheless, approximately 40% of the watershed is forested. A quarter of the watershed is protected, with DWSP lands comprising over half of this amount. Approximately 22 % of the Sudbury Reservoir watershed land area is impervious.

Population

Twelve municipalities are wholly or partially located in the Quabbin Reservoir's watershed: Athol, Barre, Belchertown, Hardwick, New Salem, Orange, Pelham, Petersham, Phillipston, Shutesbury, Ware, and Wendell. Portions of Barre and Phillipston are also in the Ware River Watershed. Additional communities located in the Ware River Watershed are Hubbardston, Oakham, Rutland, Princeton, Templeton, and Westminster. Portions of Princeton and Rutland also lie in the Wachusett watershed, along with most or all of Boylston, Holden, Paxton, Sterling, and West Boylston. Framingham, Marlborough, Northborough, Southborough, and Westborough comprise the Sudbury watershed.

Table 2-4 shows the populations according to the 2010 US Census and 2016 estimates provided by the Massachusetts State Data Center. The data illustrates the increase in population as one travels from Quabbin watershed eastward. It also demonstrates that there are several towns in the Wachusett and Ware watersheds, such as Hubbardston, Rutland, and Holden that continue to see growth as a suburban housing option for both Worcester and Boston.

Table 2-4: Watershed Town Populations 2010 and 2016

	Town	2010 Population	2016 Estimated Population	Change	% Change
Quabbin	Athol	11,577	11,619	42	0.4%
	Belchertown	14,649	15,033	384	2.6%
	Hardwick	2,990	3,005	15	0.5%
	New Salem	990	1,002	12	1.2%
	Orange	7,839	7,606	-233	-3.0%
	Pelham	1,321	1,331	10	0.8%
	Petersham	1,234	1,242	8	0.6%
	Phillipston	1,689	1,746	57	3.4%
	Shutesbury	1,771	1,760	-11	-0.6%
	Ware	9,872	9,902	30	0.3%
	Wendell	848	873	25	2.9%
Ware River	Barre	5,398	5,498	100	1.9%
	Hubbardston	4,382	4,645	263	6.0%
	Oakham	1,902	1,934	32	1.7%
	Rutland	7,973	8,579	606	7.6%
	Templeton	8,013	8,157	144	1.8%
	Westminster	7,277	7,633	356	4.9%
Wachusett	Boylston	4,355	4,569	214	4.9%
	Holden	17,355	18,799	1,444	8.3%
	Paxton	4,806	4,878	72	1.5%
	Princeton	3,413	3,462	49	1.4%
	Sterling	7,808	8,055	247	3.2%
	West Boylston	7,669	7,831	162	2.1%
Sudbury	Framingham	68,326	71,594	3,268	4.8%
	Marlborough	38,499	39,697	1,198	3.1%
	Northborough	14,157	14,994	837	5.9%
	Southborough	9,767	10,087	320	3.3%
	Westborough	18,274	18,946	672	3.7%

Source: www.donahue.umassp.edu/business-groups/economic-public-policy-research/massachusetts-state-data-center/data
Note: These figures are for entire municipality. Most towns are not fully within a given watershed. Several towns are split between two watersheds; they are placed in this table based on majority of area in a given watershed and/or administrative practice of DWSP.

2.3 Water Quality

DWSP conducts extensive water quality monitoring of the surface waters in the water supply watersheds. Routine water quality monitoring provides data that are used to assess current water quality conditions. Routine monitoring also allows staff to establish ranges of values for parameters considered normal or typical. Review of the routine data results allows screening for excursions from normal ranges, alerting staff to potential contamination events. Data collected in routine sampling over several years are used to assess watershed trends. Shorter term studies may be conducted to evaluate specific issues. Although it is often difficult to measure and/or link discrete water quality impacts to specific management actions, DWSP's goal is to base all management decisions on potential water quality impacts.

In addition to all the tributary and reservoir sampling, source water quality at the intakes is monitored for compliance with drinking water regulations (310 CMR 22.00). DWSP works closely with MWRA to comply with regulatory requirements for source water. MWRA conducts hundreds of thousands of additional tests on samples collected from the Carroll Water Treatment Plant, the Brutsch Water Treatment Facility, and throughout the system to ensure compliance with standards for the distribution system. MWRA's comprehensive testing is summarized in their Annual Consumer Confidence Report. All MWRA water test results can be found at www.mwra.com/watertesting/watertests.htm. The DCR/MWRA water supply system consistently meets all regulatory standards established by the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP).

2.3.1 Watershed and Reservoir Monitoring

Quabbin /Ware

Since 2005, the water quality monitoring program has included up to 14 sampling stations in the Quabbin Reservoir watershed, up to 10 sampling stations in the Ware River watershed, and three Wachusett Reservoir sampling stations. In 2017, 24 surface water monitoring stations were routinely monitored, including all major tributary inflows to Quabbin Reservoir, some minor tributaries flowing to the Quabbin Reservoir or Ware River, and selected locations within the Quabbin Reservoir. Of the 24 monitoring stations, 11 stations were located within the Quabbin Reservoir watershed, and 10 tributary stations were located in the Ware River watershed to characterize this supplemental source water supply. Each watershed is divided into sanitary districts, and water quality of each watershed is monitored with "core" sites and "Environmental Quality Assessment" (EQA) sites. Core sites are long-term monitoring stations, while EQA sites support ongoing evaluations of threats to water quality by sanitary district. The remaining three sampling stations are located within the reservoir and are monitored monthly during the months of April through December, weather-permitting, with samples collected from several depths at each location.

Each tributary station is sampled biweekly, with sampling runs alternating between the Quabbin Reservoir watershed and the Ware River watershed. Samples are collected by hand early in the work week (typically Tuesday) regardless of weather conditions. Tributary stream temperature, dissolved oxygen, pH, and specific conductance levels are determined in the field using a Eureka multiprobe meter. Samples from core sites are collected biweekly for turbidity, bacteria, and calcium analyses, while samples for nutrient analysis are collected quarterly. UV_{254} absorbance

samples from core sites are analyzed quarterly in the Quabbin watershed and biweekly in the Ware River watershed. Samples from EQA Sites are collected biweekly for alkalinity, turbidity, bacteria, nutrients, calcium, and UV_{254}. Bacteria include total coliform bacteria and *Escherichia coli* (*E. coli*) bacteria, and are analyzed at the MWRA Quabbin laboratory. Nutrients include nitrate, total Kjeldahl nitrogen, and total phosphorus. Calcium monitoring was begun in 2010 in response to the potential threat of zebra mussels in the reservoir. Calcium is a key indicator for the viability of this invasive species; levels remain well below the threshold for zebra mussel colonization.

Wachusett

An extensive monitoring system remains in place for tributary sampling in the Wachusett watershed. Sampling plans are evaluated and modified annually. Environmental Quality (EQ) staff collected routine water quality samples from 23 stations on 19 tributaries in 2013 and from 19 stations on 18 tributaries in 2014-2017. There are four reservoir nutrient and phytoplankton sampling stations.

After five years of an expanded sampling program that collected data from a large number of stations to be able to address issues identified in previous water quality summaries and EQA reports, sampling has gradually been reduced to include only direct tributaries to the reservoir and those stations deemed historically significant or potentially threatened. Additional stations are sampled as needed to support special studies or potential enforcement actions. Each tributary station is visited weekly, as long as there is adequate flow. Temperature and specific conductance are measured in the field, and samples collected for bacteria and turbidity. Bacteria samples are driven to the MWRA Southborough Laboratory and turbidity is measured at the DWSP Wachusett lab. Nutrient samples are collected monthly from ten tributary stations.

Stormwater sampling was done during the early part of this period from four sites to characterize 24 storms. Standardized sampling methodologies were developed with collection of nutrients, total organic carbon, and total suspended solids during both the rising limb and falling limb of the storm's hydrograph. The program went on hiatus while a sampling needs assessment was undertaken. Stormwater sampling at three locations has been resumed in 2018 during events that produce two or more inches of rainfall.

Sudbury

There is currently no regular water sampling in the Sudbury watershed. Nutrient data from numerous previous monitoring efforts of Sudbury Reservoir (going back as far as 2002) consistently show elevated levels of nutrients as one would expect for this urbanized water body. In addition to loading of phosphorus, nitrogen, and bacteria from the developed watershed, the data indicate that there are two additional major factors influencing water quality in this system: 1) the development of hypolimnetic anoxia that recurs each summer (leading to "internal" loading of nutrients); and 2) the periodic transfer of colder and higher quality water from Wachusett through the open channel into Sudbury. DWSP has documented that a transfer from Wachusett in September can destabilize the thermal stratification structure in Sudbury and hasten the occurrence of turnover thereby interrupting the influence of hypolimnetic anoxia.

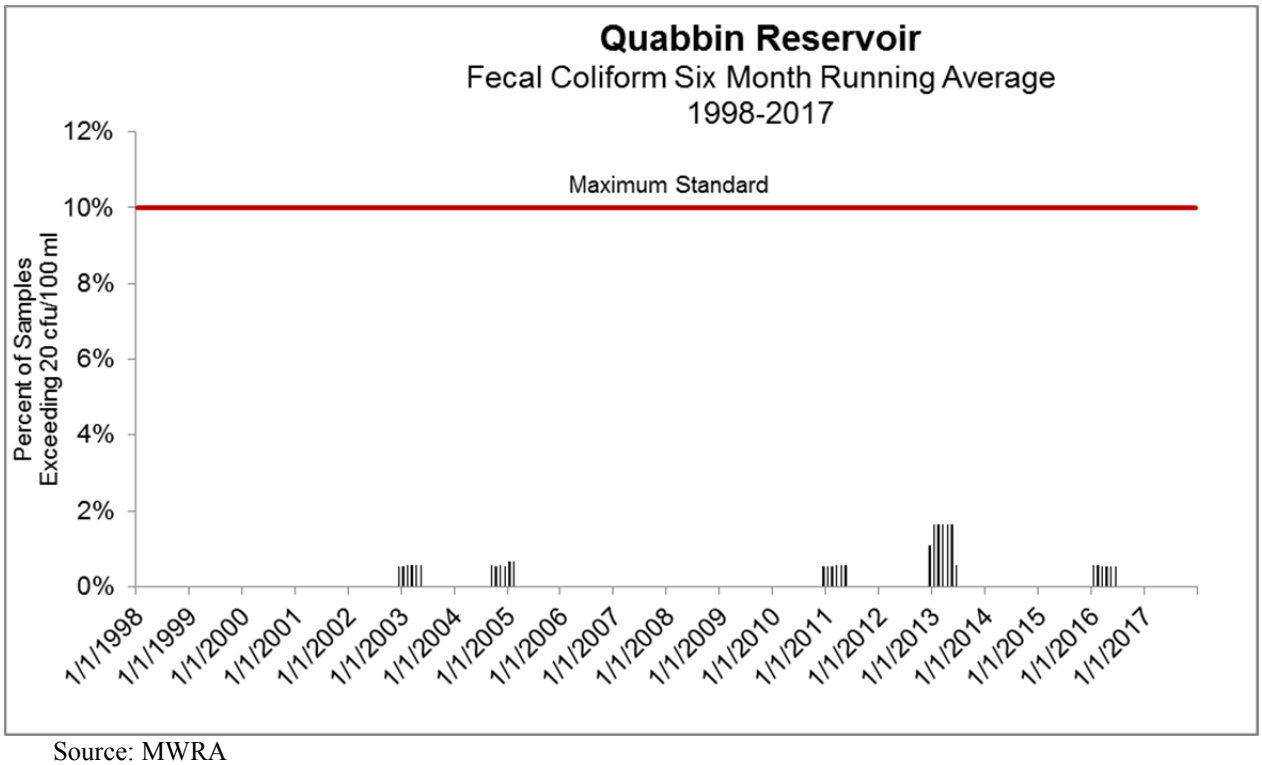
2.3.2 Monitoring for Compliance with Federal and State Drinking Water Standards

The Federal Surface Water Treatment Rule (SWTR) requires that fecal coliform concentrations of raw water just prior to disinfection for an unfiltered surface water supply be no greater than 20 colonies per 100 ml in ninety percent of the samples in any six month period. Fecal coliform testing at the Wachusett Cosgrove Intake and the Winsor Intake began in 1991. The Winsor Intake transmits water to the Winsor Power Station, the Swift River and the McLaughlin Fish Hatchery; water leaving the Winsor Power Station goes into Chicopee Valley Aqueduct (CVA).

The initial testing in 1991 showed that Wachusett exceeded this standard at certain times of the year. Quabbin was able to meet the standard but also showed seasonal increases in fecal coliform concentrations. Staff investigations revealed that the source of the bacteria was seasonal bird populations. The development and implementation of bird harassment activities resulted in a dramatic drop in both roosting gull populations and fecal coliform concentrations.

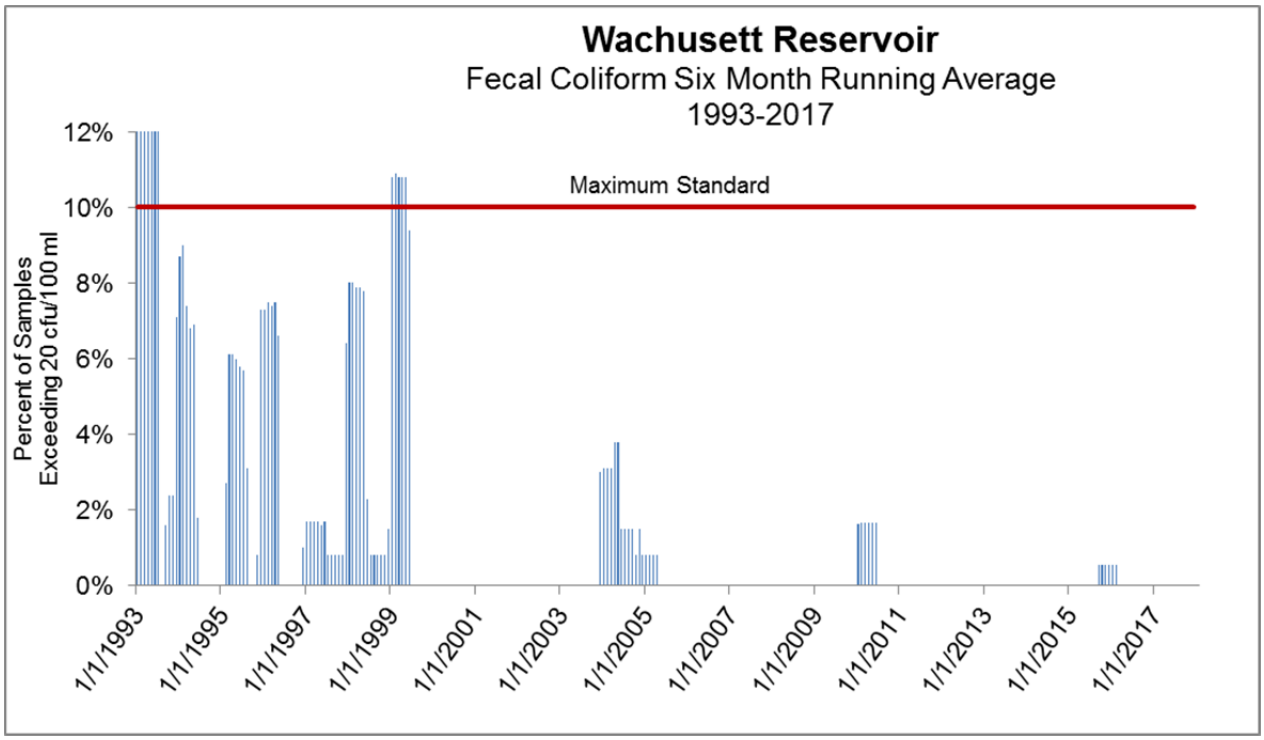
The standard has not been exceeded in the past twenty years for Quabbin Reservoir (Figure 2-5) and the last time for Wachusett Reservoir was in the spring of 1999 (Figure 2-6). A sample above 20 cfu/100 ml is an unusual occurrence that is usually due to extreme weather conditions which may also prevent active gull harassment by DWSP crews.

Figure 2-5: Quabbin Reservoir Fecal Coliform Bacteria Concentration Six Month Averages, 1998-2017



Source: MWRA

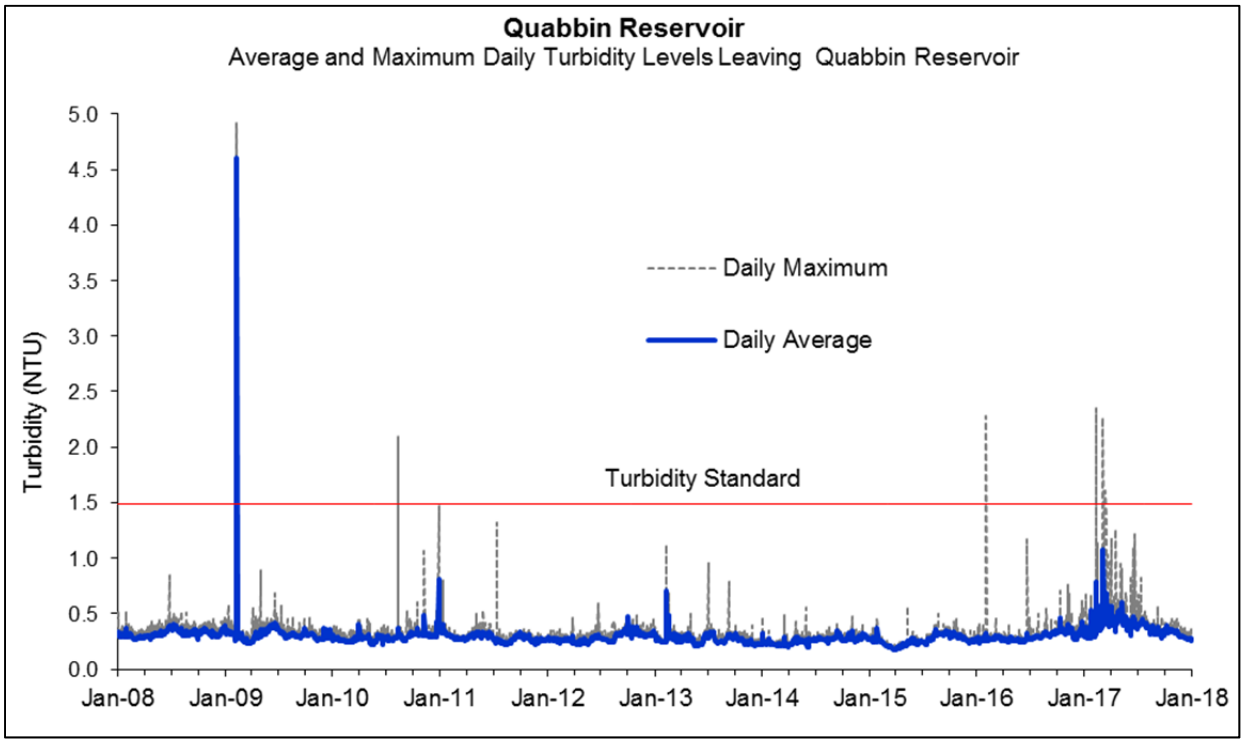
Figure 2-6: Wachusett Reservoir Fecal Coliform Bacteria Concentration Six Month Averages, 1993-2017



Source: MWRA

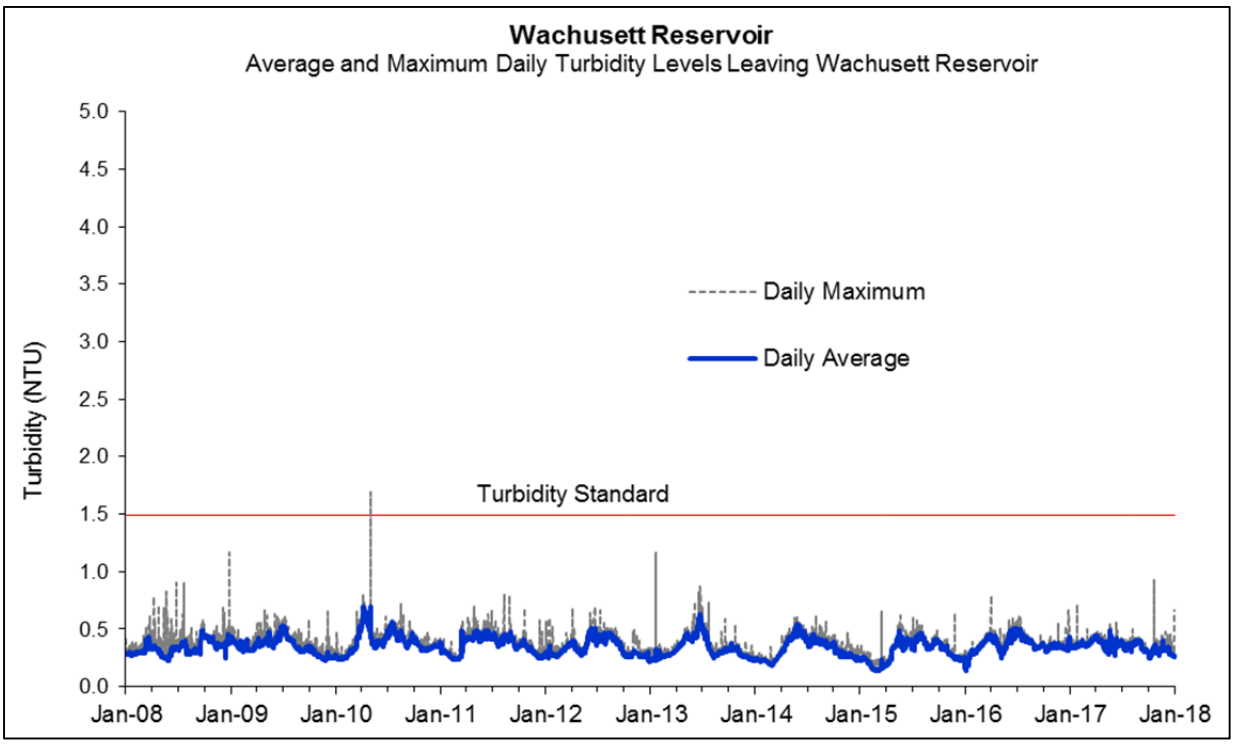
There are two standards for turbidity: all water must be below five NTU (Nephelometric Turbidity Units), and water only can be above one NTU if it does not interfere with effective disinfection. Figure 2-7 depicts daily maximum and average turbidity levels for 2008-2017 at Quabbin Reservoir, where turbidity levels averaged well below one NTU. Turbidity levels of one or above are reported to MassDEP immediately, while monitoring and operational adjustments are continued to ensure treatment effectiveness. Large turbidity spikes are infrequent and short-term; they can be attributed to severe weather events or operational impacts. None of the turbidity spikes interfered with disinfection and no violations of drinking water standards occurred. Wachusett reservoir turbidity, measured at the Carroll Treatment Plant, generally is around 0.5 NTU. Turbidity values for 2008 through 2017 are shown in Figure 2-8.

Figure 2-7: Quabbin Reservoir Source Water Turbidity 2008-2018



Source: MWRA

Figure 2-8: Wachusett Reservoir Source Water Turbidity 2008-2017



Source: MWRA

2.4 Hydrology

Quabbin

Quabbin Reservoir was created by damming portions of the Swift River (Figure 2-9). There are three discharge locations from the reservoir: the release through the Winsor Intake to the Swift River, the discharge through the Chicopee Valley Aqueduct (CVA) to provide water to three western MA communities, and the discharge through the Quabbin Aqueduct to Wachusett Reservoir and, ultimately, the communities in metropolitan Boston and Metrowest areas. Quabbin reservoir is fed by streams in its watershed as well as transfers from the Ware River. The Quabbin spillway discharges to the Swift River.

Ware

Waters from the Ware River can be diverted to the system (Figure 2-10). Water is collected at Ware River Intake and transported to Quabbin Reservoir via the Quabbin Aqueduct. Although water could also be diverted from Ware River to Wachusett Reservoir, it is DWSP and MWRA operating policy to divert only to Quabbin.

Wachusett

More than fifty percent of annual inflow into Wachusett Reservoir is from the Quabbin Reservoir; an additional thirty percent is provided by the Stillwater and Quinapoxet Rivers (Figure 2-11). Quabbin transfers, Quinapoxet River and Stillwater River all enter the reservoir through the Thomas Basin and pass through a constriction under the Route 12 Bridge. Water in the Wachusett Reservoir is assumed to have an approximate six month residence time, although during stratified conditions cold water transfers from the Quabbin Reservoir can pass through the reservoir in as little as three weeks. This phenomenon is called the Quabbin interflow and has been extensively studied by DWSP and MWRA staff. The Wachusett spillway discharges to the Nashua River.

Sudbury

The major hydrologic inputs to the Sudbury and Foss reservoirs are the natural watershed drainage and the flow from the Wachusett Aqueduct and Open Channel (Figure 2-12). Water flows from the Sudbury to the Foss. Overflow from the Foss will enter into the Stearns Reservoir and eventually flow into the Sudbury River.

DWSP and MWRA cooperate with U.S. Geological Survey to maintain continuous, real time recording gages at a total of ten sites. Data from the sites are used to monitor hydrologic inputs and mandated releases. A summary of information about the gages is presented in Table 2-5. Continuous, real-time data for each station are available at the USGS web site, http://waterdata.usgs.gov/ma/nwis/current/?type=MWRA&group_key=basin_cd.

Table 2-5: USGS Stream Gages

Station #	Location	Utilization	Parameters
01170500	Connecticut River at Montague City	Required for decisions on releases from Quabbin to the Swift River	Stage-Discharge
01174500	East Branch Swift River near Hardwick	Streamflow monitoring	Stage-only
01174565	West Branch Swift River near Shutesbury	Streamflow monitoring	Stage-Discharge
01175500	Swift River at West Ware	Monitors Quabbin Reservoir release to Swift River and downstream conditions	Stage-Discharge
01173000	Ware River at Intake Works near Barre	Required for decisions on Ware River Transfer	Stage-Discharge, Temperature
01095220	Stillwater River at Sterling MA	Streamflow monitoring	Index-Velocity, Temperature, Conductivity, Precipitation
01095375	Quinapoxet River near Holden, MA	Streamflow monitoring	Stage-Discharge, Temperature, Conductivity, Precipitation
01095434	Gates Brook near West Boylston	Streamflow monitoring	Stage-Discharge, Temperature, Conductivity
01095503	Nashua River at Water Street at Clinton	Monitors Wachusett Reservoir release to Nashua River and downstream conditions	Stage-Discharge, Temperature
01098530	Sudbury River at Saxonville, MA	Monitors Sudbury Reservoir release to Sudbury River	Stage-Discharge

Figure 2-9: Quabbin Reservoir Watershed Hydrography

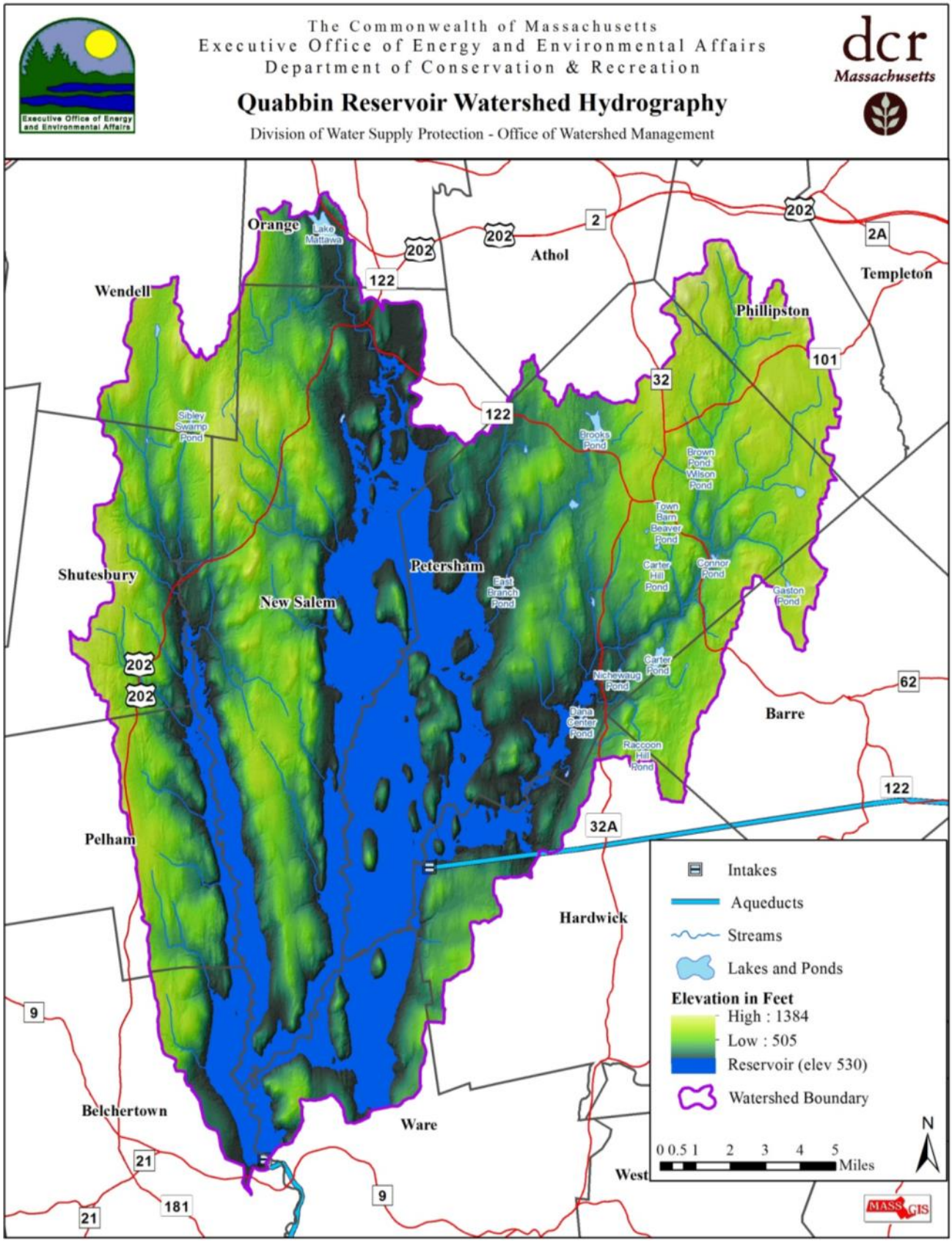


Figure 2-10: Ware River Watershed Hydrography

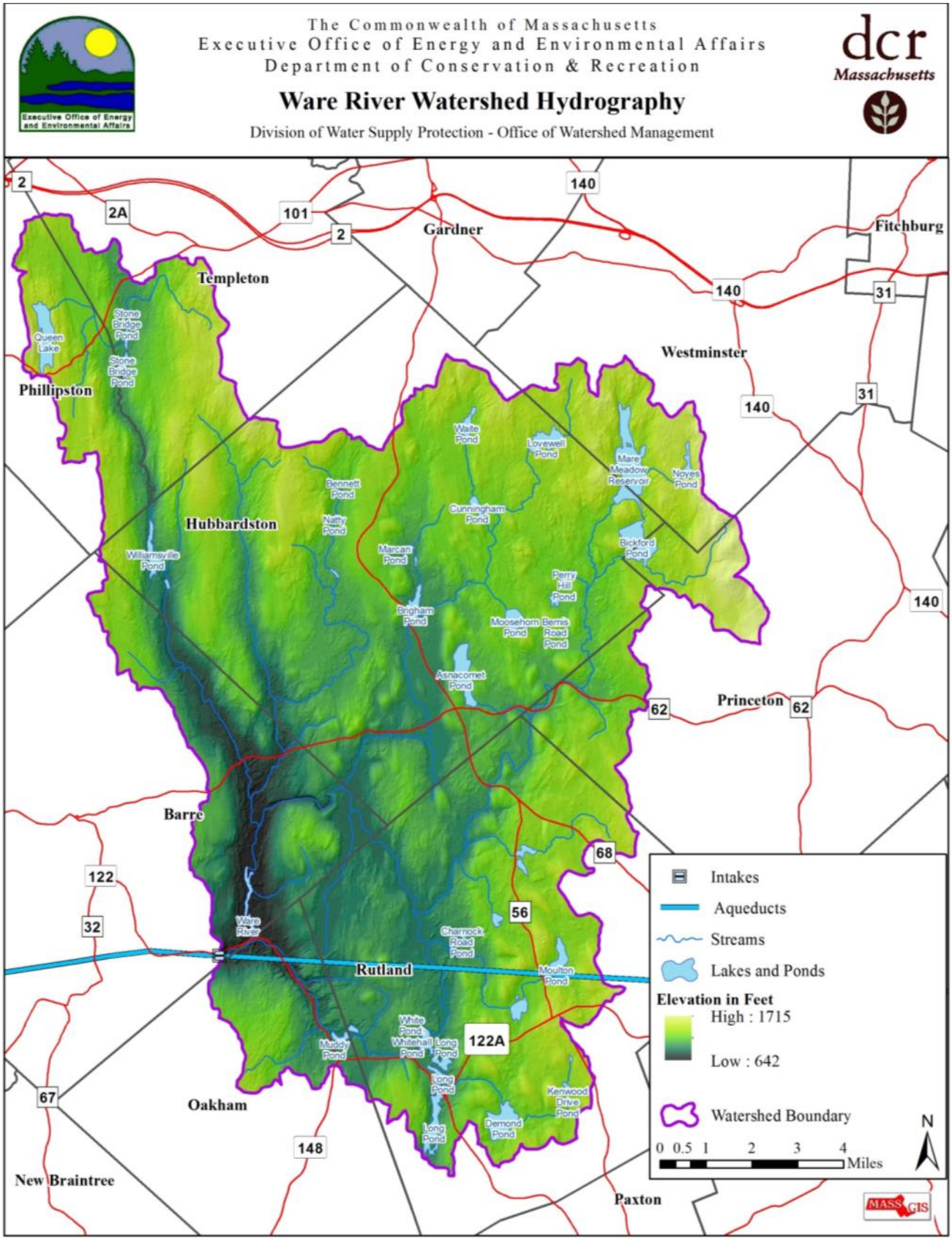


Figure 2-11: Wachusett Reservoir Watershed Hydrography

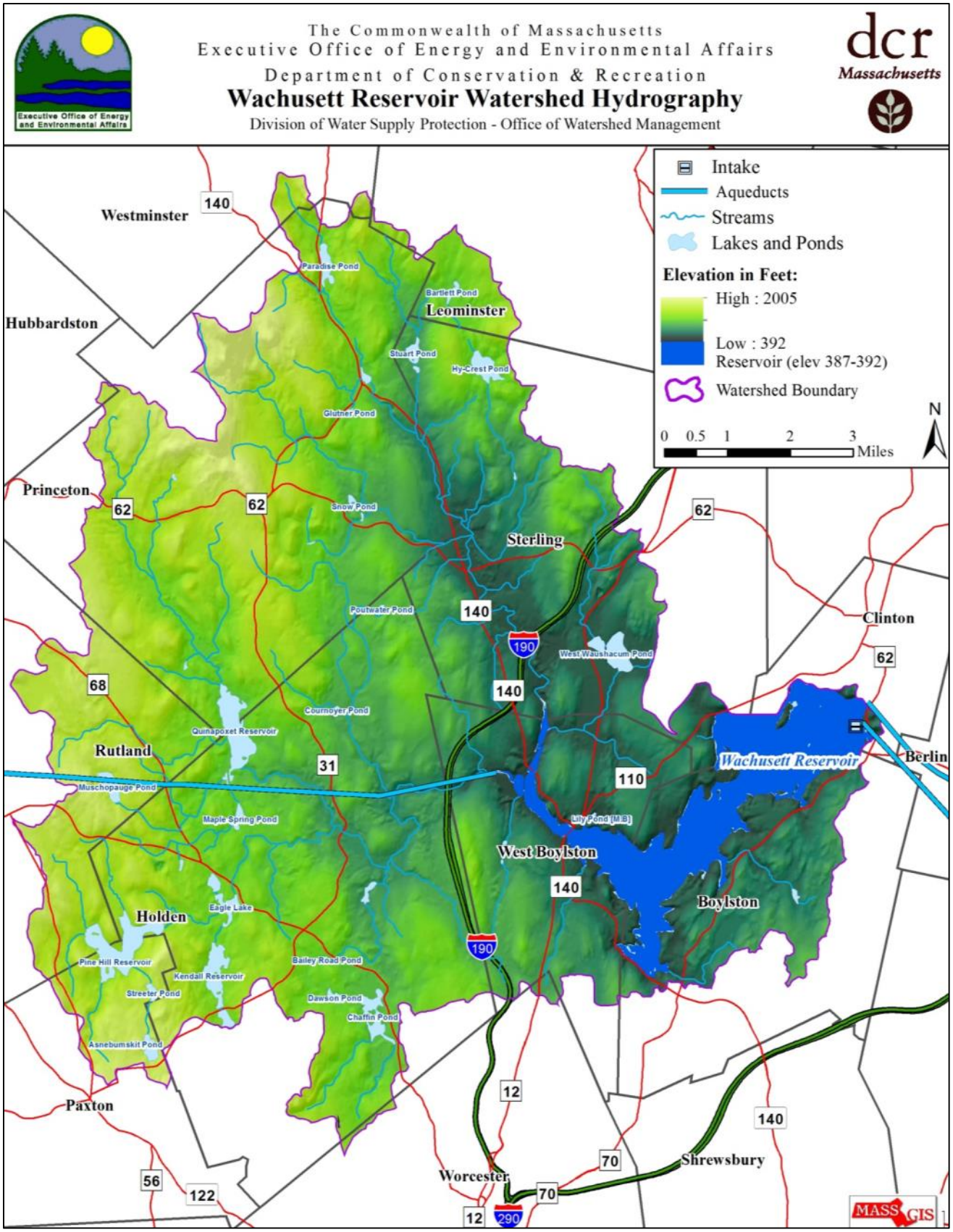
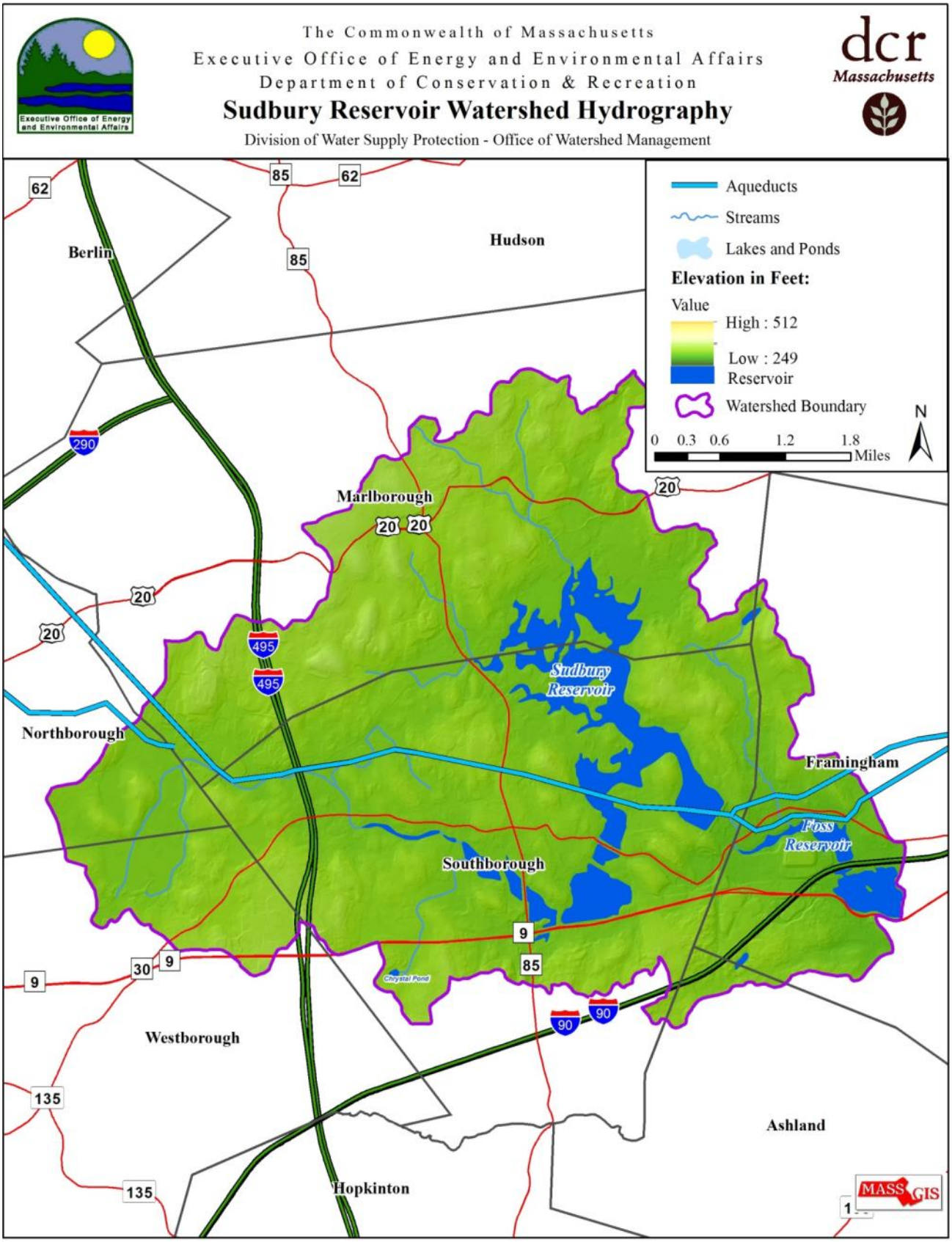


Figure 2-12: Sudbury Reservoir Watershed Hydrography



2.5 System Operation and Safe Yield

DWSP partners with the MWRA to deliver water to a total of 2.5 million people and 5,500 industrial users in 51 communities. There are two distribution systems supplied by the DWSP system. The Chicopee Valley Aqueduct is fed by the Quabbin Reservoir and supplies three communities in western Massachusetts. Quabbin water is also transferred east, through the Quabbin Aqueduct to Wachusett Reservoir, where it enters the Cosgrove Intake to travel to communities in the east. MWRA is completing a new pump station in 2018 to provide redundancy for water transport to the treatment plant via the Wachusett Aqueduct. MWRA provides ozonation for primary disinfection, chloramination for residual disinfection, corrosion control, and fluoridation at the John J. Carroll Water Treatment Plant in Marlborough prior to delivery to municipalities in the greater Boston and Metrowest regions. The long-term average yields from each source are summarized in Table 2-6.

Table 2-6: Long-Term Average Yields from Supply Sources

	Source	Watershed Land Area (sq. mi.)	Watershed Yield (mgd)
Active System	Ware River	97	47
	Quabbin Reservoir	149	195
	Wachusett Reservoir	111	127
	Total	401	369
Emergency System	Sudbury Reservoir	21	N/A
	Foss Reservoir	5	N/A

Source: DWSP and MWRA

Due to the large storage volumes, 300 million gallons per day (mgd) can safely be supplied constantly by this system (referred to as the "safe yield"), even with release requirements and operational constraints. Withdrawals for water supply peaked in 1980 at 340 mgd, but have come down substantially due to MWRA's demand management programs. From 2013 to 2017, the average system withdrawal was 202.72 mgd, with a high of 208.01 mgd in 2016 and a low of 195.40 in 2017. Monthly water use data is available on the MWRA's website at www.mwra.state.ma.us/04water/html/wsupdate.htm .

DWSP and MWRA staff coordinate to make systems operations decisions. Operating policies for the water supply system cover several topics, including watershed yield, public safety, and the generation of hydropower. The objective is to optimize delivery of high quality drinking water while ensuring adequate volume in storage to respond to fluctuations in precipitation and demand, meeting downstream minimum flow release requirements, and preventing violations of minimum pool reservoir stage limitations.

Two interagency groups have been established to facilitate this work: the Reservoir Operations Group (Res Ops) and the Water Quality Sampling and Analysis Team (WQSAT). Examples of the issues dealt with by these groups include establishing a normal range of reservoir elevations for Wachusett Reservoir, decision-making for initiating Quabbin transfers, developing reservoir treatment thresholds for taste and odor organisms, coordinating security and emergency-response capabilities, developing watershed water quality sampling programs, managing flood control, and planning for major infrastructure improvements. Reservoir operations coordination also includes the Army Corps of Engineers (ACOE), MA Fish & Wildlife (DFW), and MassDEP.

Emergency System

The Sudbury and Foss Reservoirs remain the only emergency drinking water source reservoirs for over 2 million residents of Eastern Massachusetts. There are three conditions under which these reservoirs would be used as an emergency source for the greater Boston and Metrowest area:

1. Wachusett Reservoir is declared non-potable.
2. The inability to convey water from the Wachusett Reservoir to the MWRA system.
3. Extended, extreme drought.

The combined resources of Sudbury and Foss Reservoirs could provide an estimated long-term safe yield of 18.0 mgd and could provide a rate of 200 mgd for a maximum of 30 days before virtual depletion of these sources. Water quality will be an issue should any of the emergency scenarios occur. In the event of a serious drought, low water levels in Sudbury would be anticipated to result in higher temperatures, greater algae blooms, and taste and odor problems.

The potential for the Sudbury system to be utilized has decreased since the completion of the Hultman Aqueduct overhaul and completion of the valve chambers that connect the aqueduct to the newer MetroWest Tunnel. MWRA now has the ability to divert water from the tunnel to the Aqueduct should circumstances warrant. Wachusett Reservoir water flows to the Carroll Water Treatment Plant primarily via the Cosgrove Tunnel. The likelihood of aqueduct failure and vulnerability from Wachusett Reservoir contamination have been reduced because the upgraded Wachusett Aqueduct and new Aqueduct pump station can also deliver water for treatment and distribution.

Drought Management

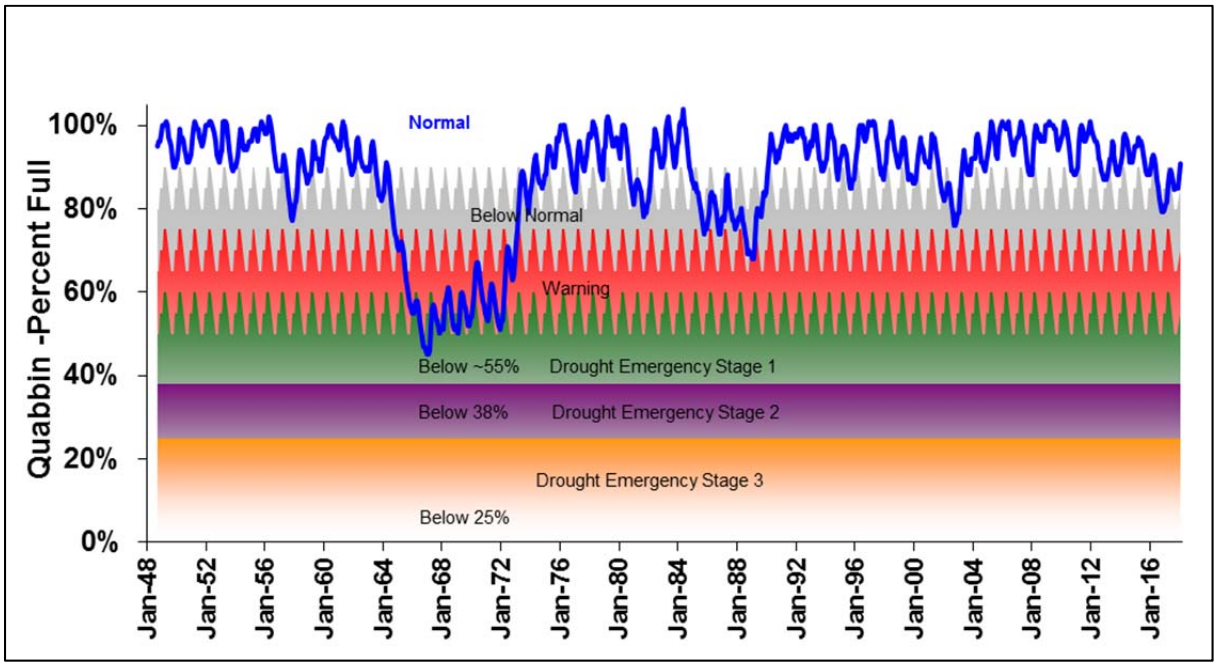
The amount of water a system can supply can be enhanced if a drought management plan is used to curtail demand during extended dry conditions. MWRA has a MassDEP-approved Drought Management Plan that was developed in 1989. The objective of the plan is to conserve water through implementing demand reduction measures. Due to the size of Quabbin and Wachusett Reservoirs, their volume drops slowly during a drought and then refills slowly after a drought. The Drought Management Plan is designed to ramp up slowly and would be expected to remain in effect after other systems have recovered. MWRA is a member of the state Drought Management Task Force, which is supported by staff from the Office of Water Resources within the Division of Water Supply Protection.

Drought response actions are triggered by seasonal levels of Quabbin Reservoir – the saw tooth pattern in Figure 2-13 shows Quabbin Reservoir levels in relation to the Drought Management Plan Operating Ranges.

Table 2-7 describes the stages of the Drought Management Plan, giving triggering levels, reduction targets and the broad actions that need to be taken to achieve those targets. Given the expected gradual response of the DCR/MWRA system to drought, it is anticipated that response actions would be fine-tuned as the system moved toward Drought Warning. At current low demand levels, the DCR/MWRA System would be able to withstand the drought of record without triggering restrictions.

Internal MWRA modeling has shown that the Drought Management Plan may increase Safe Yield (the amount of water that can reliably be supplied on a continuous basis during a critical drought) by 8 to 10 mgd. If ever necessary, DWSP will work closely with MWRA in implementing the Drought Management Plan.

Figure 2-13: Historic Quabbin Reservoir Levels and Drought Management Plan Stages



Source: MWRA

Table 2-7: Drought Management Plan Stages

Stage	Trigger Range (Quabbin % Full)	Average Trigger Range	Target Water Use Reduction	Response Measures
Normal Operation	80-100	90	0	
Below Normal	65-90	78	Previous year's system use	Advise Drought Management Task Force, local officials and media. Distribute materials. Repair leaks. Rehabilitate meters.
Drought Warning	50-75	63	5%	Identify drought coordinator. Restrict outdoor and municipal use. Request voluntary cuts from large and visible users (car washes, restaurants, etc.). Activate Water Bank. Enforcement: fines.
Drought Emergency				
Stage 1	38-60	49	10%	Ban non-essential outdoor, municipal water use. Request more larger user cutbacks. Distribute new materials. Continue coordination of local actions. Consider rate structure changes.
Stage 2	25-38	32	15%	Increase meter reading frequency. Establish mandatory rationing and enforcement. Distribute informational materials and feedback on savings. Modify rate structures. Moratorium on new connections.
Stage 3	Below 25	Below 25	30%	Revise rationing for 30% reduction. Continue distribution of materials and organization of local response. Implement emergency sources or interconnections.

Source: MWRA

3. Watershed Protection Program

DWSP and MWRA use a multi-barrier approach to protect the water supply system. The multi-barrier approach is defined as an integrated system of procedures, processes, and tools that collectively prevent or reduce the contamination of drinking water from source to tap in order to reduce risks to public health. The multi-barrier approach relies on integrated programs that prevent contamination of drinking water at all points in the system, from source to tap. Source protection is guided by the DWSP watershed protection program. Water treatment is provided at the John J. Carroll Water Treatment Plant at Walnut Hill in Marlborough and the William A. Brutsch Water Treatment Facility in Ware. Distribution pipeline maintenance and improvement program ensures that high-quality is maintained to the tap.

As an unfiltered water supply, the DCR/MWRA system must comply with federal drinking water regulations. The Surface Water Treatment Rule (SWTR, June 1989) essentially requires filtration of all surface water supplies, but allows filtration waivers if specific criteria are met. One of the criteria required for unfiltered public water systems is an effective watershed control program that can preserve high quality source water through control of pollutants in the watershed.

DWSP and its predecessor agencies have historically understood the importance of watershed protection. Watershed protection programs were initially described and managed through a variety of programs and documents, including Sanitary Surveys and Land Management Plans. Development of comprehensive Watershed Protection Plans began in 1990 in response to requirements of the SWTR. The history of these plans is described Section 3.1; the organization of the plan has evolved over time, but the general approach remains similar and is described in this chapter.

The *Watershed Protection Plan Update FY19-FY23* provides a systematic approach to evaluate potential water quality threats and to develop and implement programs that eliminate or minimize these threats. Priorities for watershed control programs change as water quality threats are contained and new issues emerge. The process used to develop Watershed Protection Plans provides a structured methodology to assess changes in watershed threats, develop programs to address the threats, and review staff assignments to ensure that staff priorities align with current watershed issues. This *DWSP Watershed Protection Plan Update FY19-FY23* outlines major goals and programs for Fiscal Year 2019 through 2023 (July 1, 2018 through June 30, 2023).

3.1 History

The Boston area drinking water supply, like the city itself, has a long history. Cisterns were originally used in the 17th century. The need for water, which came from increasingly further distances, grew with Boston's population. The 18th century tapping of Jamaica Pond, using log pipes with three to four inch internal diameters over a distance of about five miles, was one of the first instances in the country of a community reaching out to another town for drinking water. During the 19th century, drinking water came mostly from Lake Cochituate in Natick; some communities were also served by the Mystic Lakes. Officials determined that these sources of

supply would prove inadequate, so in 1878 a system of seven reservoirs was constructed to supplement the Cochituate system by holding back the Sudbury River.

The dawn of the 20th century saw limited yield, urbanization of the watersheds, and unsatisfactory water quality, which led to a 1895 study by the state health board that recommended the development of a reservoir along the South Branch of the Nashua River. The Wachusett Reservoir was the world's largest man-made reservoir when it was completed in 1908, however in a just a few decades it too was insufficient for the growing needs of eastern Massachusetts. Ultimately, the Quabbin Reservoir was created in the 1930s, using the Winsor dam to impound the Swift River and flood an area formerly occupied by the four Western Massachusetts towns of Dana, Enfield, Prescott, and Greenwich. At the same time, the Ware River was also identified as a drinking water source; diversions of water from the river are conveyed into the Quabbin Reservoir through the Quabbin tunnel from October through June when flows in the river are sufficient and water is needed.

The development of the DCR/MWRA watershed system has been shaped by feats of engineering and multiple laws. The quantity of water available from these three watersheds, combined with water conservation measures implemented over the past twenty years, is a sufficient quantity for the foreseeable future (see Section 2). The following sub-sections provide a description of the most recent legal requirements and planning efforts that have had a role in the management of this renowned drinking water supply.

3.1.1 Creation of the MWRA

The DCR/MWRA water system was established by Chapter 372 of the Acts of 1984. The Act reassigned, as of June 30, 1985, various responsibilities of the former Metropolitan District Commission (MDC) Water Division to the MWRA and the MDC Division of Watershed Management (now the DCR/DWSP; see Section 3.1.8). A Memorandum of Understanding (MOU) was developed between the two agencies on April 9, 1986 that documented the responsibilities between the agencies concerning "the division of personnel, property, and responsibilities for maintenance, operations, policy making and long range planning pursuant to Chapter 372 of the Acts of 1984." The MOU was updated in April 2004 after DCR's creation (see Section 8.2).

3.1.2 SDWAA and SWTR

The DCR/MWRA system is regulated as a Public Water Supply by the U.S. Environmental Protection Agency (EPA). EPA has delegated enforcement of the drinking water regulations to the Massachusetts Department of Environmental Protection. The 1986 Amendments to the 1974 Safe Drinking Water Act (SDWAA) and the 1989 Surface Water Treatment Rule (SWTR) established major changes in drinking water regulations.

The impact of these changes to this system was evaluated in a MWRA project, summarized in the report *Safe Drinking Water Act Impact Study prepared for Massachusetts Water Resources Authority by CH2M Hill and Peer Consultants, March 8, 1989*. This study assessed existing conditions in the [DCR]/MWRA system, identified areas of noncompliance, and recommended

actions necessary to come into compliance with the SDWAA. With respect to the watershed, the 1989 study found that:

> The [DCR] and MWRA currently do not have a watershed control program that meets the site-specific conditions of the SWTR. To be in compliance with the site-specific conditions, and, thus, avoid filtration, the following conditions would have to be met.
>
> A. There must be a disinfection system that meets the criteria for Giardia cyst inactivation and residual maintenance.
>   a. A program must be developed in which the activities in the watershed are monitored and controlled by complete ownership of the land and/or by written agreements with landowners.
> B. A program must be implemented in which all activities that could affect source water quality are identified and controlled.
> C. Onsite sanitary surveys must be performed annually on the watersheds.
> D. It must be shown that the system in its current configuration has not had an identified waterborne disease outbreak, as determined by State and local health officials.
> E. The distribution system must meet the long-term MCL of the Total Coliform Rule.
> F. The water system must be in continuous compliance with the requirements for trihalomethanes.

Staff began work on developing a watershed program to address these needs.

3.1.3 MassDEP Guidance for Development of a Watershed Protection Plan

In 1989, MassDEP issued guidance for development of watershed protection programs in the publication DEP DWS Policy 89-09 DEP Guidance on the Preparation of a Watershed Resource Protection Plan (WRPP). This policy described the minimum components for a Watershed Resource Protection Plan (WRPP):

> It is DEP/DWS policy to accept for review a report describing a Watershed Resource Protection Plan which includes at a minimum, the information described below:
>
> A. Watershed Description
> B. Identification of Watershed Characteristics and Activities Detrimental to Water Quality
> C. Control of Detrimental Activities
> D. Monitoring
> E. Agreements and Land Ownership
> F. Management and Operations.

3.1.4 The 1991 Watershed Protection Plans

[DCR] and MWRA worked to develop Watershed Protection Plans in accordance with the MassDEP guidance and to be used to guide the watershed protection program. Two separate plans were developed: *Watershed Protection Plan Quabbin Reservoir and Ware River Watersheds 1991* and the *Watershed Protection Plan Wachusett Reservoir Watershed 1991*. A separate plan was required for the Quabbin/Ware system because it provides water for communities served by the Chicopee Valley Aqueduct (CVA). The Quabbin Plan was submitted to MassDEP for review; MassDEP approved the plan and granted a waiver from the filtration requirements of the SDWA for the CVA in 1991.

The Wachusett Reservoir plan was not submitted when completed due to concerns about meeting the source water quality requirements for filtration waiver. [DCR] and MWRA did recognize the importance of watershed protection in all systems, filtered and unfiltered, and committed to implementing a strong watershed protection program at Wachusett although the plan was not formally submitted to the regulatory agencies. Significant resources were added in order to carry out recommendations contained in the Wachusett and Quabbin plans.

3.1.5 Wachusett Reservoir Filtration Waver

In 1993, MWRA requested a more flexible approach to SDWA compliance for Wachusett Reservoir, believing that filtration might not be necessary to meet the requirements of the Surface Water Treatment Rule. This decision was made, in part, due to the successful implementation of many programs developed in the 1991 Plan, as these controls produced dramatic improvements in source water quality. On June 11, 1993, [DCR] and MWRA entered into an administrative consent order with MassDEP which set forth a compliance schedule for meeting the requirements of the SWTR for Wachusett Reservoir. The consent order permitted a dual track approach: [DCR] and MWRA would pursue aggressive watershed protection in order to obtain a filtration waiver; at the same time, MWRA would continue to do design work for filtration should the watershed protection measures fail to secure a Filtration Avoidance Determination. The Wachusett Watershed Protection Plan was submitted to MassDEP in 1993 with an updated implementation plan, and formally approved by MassDEP in 1994.

In October, 1998, [DCR] and MWRA requested a redetermination from MassDEP to grant the system a waiver from filtration requirements. Since passage of the SWTR, the two agencies had accomplished major improvements in the watershed protection program as well as in water treatment and in the distribution system. Watershed Protection accomplishments included an aggressive land acquisition program to increase the holdings of protected lands, passage and implementation of the Watershed Protection Act which established land use controls in sensitive watershed areas, successful wildlife management program which improved source water quality, and commitment to sewer areas of the Wachusett Reservoir watershed that were not suitable for on-site wastewater disposal. This work was completed following the 1991 Watershed Protection Plans. In November, 1998, MassDEP granted MDC/MWRA a waiver from the requirements of filtration. A subsequent federal court ruling confirmed this decision to provide a filtration waiver (http://caselaw.findlaw.com/us-1st-circuit/1004480.html).

3.1.6 Watershed Protection Plan Updates 1998-2000

An updated watershed protection plan for Wachusett Reservoir watershed, *Watershed Protection Plan Update for Metropolitan Boston Water System Wachusett Reservoir*, was developed as part of the filtration waiver process.

MassDEP had developed a *Program to Measure Success of Watershed Protection Efforts Conducted by Public Surface Water Supplies to Obtain, and Maintain, a Waiver from Filtration Requirements* ("Measures of Success," 1996). The Measures of Success identified programmatic milestones organized into ten categories:

1. Watershed Control
2. Public Access/Recreation
3. Wildlife Management
4. Infrastructure Improvements
5. In-lake Problems
6. Sampling
7. System Operation/Maintenance
8. Staffing
9. Emergency Planning/Response
10. Education/Multi-town coordination.

The 1998 Wachusett plan include a section that demonstrated compliance with all of MassDEP's programmatic milestones. The Updated Wachusett Watershed Protection Plan was submitted to MassDEP in December 1998, and approved by MassDEP in February, 1999.

The Quabbin/Ware River 1991 plan was developed with an eight year implementation schedule. Therefore, the Quabbin/Ware plan was updated in 2000. Similar to the 1998 Wachusett plan, the Quabbin/Ware plan included a section that demonstrated compliance with all of MassDEP's "Measures of Success" programmatic milestones. The Quabbin/Ware plan update was submitted to MassDEP in December 2000 and was approved by MassDEP in 2001.

3.1.7 SWAP

The Federal Safe Drinking Water Act Amendments requires every state to examine existing and potential threats to the quality of all its public water supply sources and to develop a Source Water Assessment Program (SWAP). In 2002, MassDEP conducted a SWAP process for all public ground and surface water sources in Massachusetts, including one for the MWRA Quabbin Reservoir, Ware River, and Wachusett Reservoir. The SWAP noted that the [DCR]/MWRA system met MassDEP's annual review of "Measures of Success" for implementation of Watershed Protection Plans and disinfection treatment processes. The SWAP further noted that [DCR] implemented MassDEP-approved Watershed Protection Plans to protect source waters since 1991. The [DCR] and MWRA plans were more representative of the true nature of the watersheds than the SWAP, which was developed by a uniform, statewide process based on information available for every source in the state.

3.1.8 DCR and Subsequent Watershed Protection Plan Updates

In July of 2003, the MDC was combined with the Massachusetts Department of Environmental Management. A new agency, the Department of Conservation and Recreation was created. The responsibilities of the MDC/DWM were transferred to the DCR Division of Water Supply Protection.

In December, 2003, a second update to the Wachusett Reservoir Watershed Protection Plan was completed. The *2003 Watershed Protection Plan Update for the Wachusett Reservoir Watershed* was submitted to MassDEP and approved by MassDEP in 2004. The 2003 plan included an updated "Measures of Success." The 2003 plan also addressed the issues raised in the SWAP.

The 2008 Watershed Protection Plan Update consolidated the Wachusett and Quabbin plans into one document, and integrated an update to the 1997 Sudbury Watershed Protection Plan as well.

The 2013 DWSP Watershed Protection Plan update, like all previous Watershed Protection Plans, was approved by MassDEP's Drinking Water Program and follows their guidance for developing an unfiltered water supply system's watershed protection plan.

Implementation of the Watershed Protection Program is reviewed annually by MassDEP, as part of their annual inspection of the entire DCR/MWRA system. Two inspections are conducted, one for the Quabbin Reservoir and Ware River watersheds, and the other on the Wachusett Reservoir watershed. MassDEP has granted continued approval to DWSP and MWRA for both these watershed protection programs.

3.1.9 Emergency System – Sudbury

Sudbury Reservoir is classified an Emergency Water Supply Source by the MassDEP. There is no current plan to re-activate the reservoir as a permanent active source.

There is no regulatory guidance regarding watershed protection for Emergency Water Supply Sources. Federal and State Drinking Water Regulations pertaining to Emergency Water Supply Sources mainly deal with issues that arise when there is need to bring an emergency source on line (e.g., issuance of boil water orders).

The Sudbury system is a valuable resource and DWSP conducts several management programs in the watershed. The level of protection, however, provided through DWSP programs are less stringent than for the active water supply watersheds. Though not required by federal and state drinking water regulations, a Watershed Protection Plan was prepared for the Sudbury Reservoir and Foss Reservoir in June 1997 and has been part of the Watershed Protection Plan since 2008.

3.2 Pollution Sources and Assessment

DWSP staff identify activities or conditions that could potentially degrade water quality and develop strategies to control these threats on a daily basis. The process undertaken in developing the *2018 DWSP Watershed Protection Plan Update* provides a long-term and systematic approach to evaluating threats and developing comprehensive, integrated programs to deal with the threats. The original threat assessment for watershed protection plan development was conducted in 1991, following guidelines developed by MassDEP. Assessments were repeated in 1998, 2003, 2008, and 2013 for Wachusett Reservoir and 2000, 2008, and 2013 for Quabbin Reservoir and Ware River. The process was reviewed and updated with each plan to better assess potential sources of contamination in the watersheds.

The basic assessment approach consists of three steps:

1. Compile a list of potential land uses that could degrade water quality. Identify pollutants or contaminants of concern that are associated with each activity. This pollutant list is not intended as a comprehensive inventory of water quality threats from activities or uses; rather it is developed as a tool to assist in conducting the evaluation.
2. Conduct a watershed-wide review to update the status of the activities identified as potential cause of concern in Step 1.
3. Conduct a screening level review to evaluate the threats. This is a qualitative evaluation that incorporates relevant water quality data collected since the last assessment and staff input of field observations made during the same period. Assign a ranking of Low, Medium or High.

It is very important to note that this is a tool used by DWSP and other watershed managers as part of a comprehensive planning process to develop control programs and prioritize efforts. It is a difficult process where staff strive to be vigilant for potential threats but not unnecessarily alarm users or regulators about conditions in the watershed.

DWSP staff, as in past Watershed Protection Plan iterations, have made the evaluation under a hypothetical scenario where the existing DWSP control programs do not exist. Because DWSP has an extensive watershed protection program in place, the rankings should not be interpreted as the actual risk to the DWSP system.

The source categories developed for use in this assessment are summarized in Table 3-1. As with the pollutant categories, this list was developed as a screening tool and is not intended as a definitive catalog. It was developed with the intention of encompassing all potential pollution sources in order to develop a comprehensive protection program.

Table 3-1: Potential Contaminant Source Categories

Source	Concern
Wildlife	Threat to water quality from wildlife populations. *Examples: the direct threat of pollution from bird and aquatic mammal waste; indirect threats to water quality such as over browsing by herbivores and impacts from beaver activity.*
Public Access/ Recreation	Threat to water quality from public access on publicly owned properties. *Examples: erosion from human activities; waste from humans or animals; trash disposal and dumping.*
Timber Harvesting/ Forestry	Threat to water quality from timber harvesting activities. *Examples: harvesting within wetlands and riparian zones; road and landing construction and use; stream crossings; mechanical preparation for tree planting; spills from power equipment.*
Wastewater	Threat to water quality from wastewater treated in on-site systems or transported via sewers to (off-watershed) wastewater treatment plants. *Examples: leachate from failing or improperly sited on-site septic systems; release of untreated sewage from a sewer or pump station; gull feeding at treatment plants and then roosting on reservoirs.*
Roadways, Railways and Rights-of-Way	Threat to water quality from roads and railways. *Examples: pollutants transported by stormwater runoff; releases of fuel or transported products caused by accidents; maintenance practices such as herbicide treatment of ROWs; potential contaminant impacts from de-icing or fire suppressant material.*
Agriculture	Threat to water quality from growing and harvesting crops and keeping livestock. *Examples: horse stables; waterfowl feeding at agricultural sites and then roosting on reservoirs; spreading of fertilizer, compost and wood ash.*
Construction	Threat to water quality from construction activities on a site. *Examples: earth moving with inadequate erosion and sediment controls; releases from construction equipment; introduction of invasive species through use of inappropriate erosion controls.*
Commercial, Industrial, and Governmental Sites	Threat to water quality from activities on sites in commercial, industrial, or governmental use. *Examples: runoff due to increased impervious surfaces; release of materials stored and used on site; kennels; construction of solar farms.*
Residential Sites	Threat to water quality from practices associated with land in residential use. *Examples: nutrient and pesticides from lawn care products; pet waste; pharmaceuticals and personal care products (PPCPs) from on-site wastewater disposal systems; use of non-native species in landscaping or aquaria.*
Future Growth	Threat to water quality from development of land that is currently undeveloped. *Examples: potential contaminants related to property development, which could be residential, agricultural, commercial, or industrial.*
Climate Change	Threat to water quality from impacts of climate change. *Examples: higher water temperatures; changes in the timing, intensity, and duration of precipitation, leading to flooding and erosion; need for infrastructure resiliency (roads, culverts, etc.); permitting for infrastructure repair.*
Security Threats	Threat to water quality from malicious attempts to contaminate water.

DWSP created five categories of pollutants that are most likely to be associated with these potential threats and share common properties for the purpose of this screening. These categories are based on conventional definitions which have been adapted to meet DWSP's efforts to assess potential sources and develop protection programs. The five water quality pollutants categories are: Pathogens, Nutrients, Turbidity, Anthropogenic Compounds, and Invasive Species. This discussion has been developed as a tool to help conduct the threat assessment.

Pathogens

Pathogens are biological agents that can cause illness or disease. Indicator organisms, such as fecal coliform and total fecal coliform, are commonly examined, as specific pathogens are difficult and expensive to test for in water. Such tests "indicate" possibility of presence of pathogenic compounds. Pathogens include cyanobacteria, photosynthetic bacteria that share similar characteristics of algae and can multiply quickly in response to conditions that are favorable for their growth. Harmful algal blooms composed of cyanobacteria have the potential to produce toxins that can be harmful to the environment, animals, and public health. Prevention of pathogen contamination is a high priority for water suppliers. Extensive watershed and reservoir testing using indicator organisms is conducted by DWSP and MWRA (Table 3-2).

Table 3-2: Bacteria Testing Summary

Sample Location	Agency	Test	Standard
Intake to Carroll Treatment Plant and Chicopee Valley Aqueduct	MWRA	Fecal Coliform	Federal Surface Water Treatment Rule (SWTR): Fecal coliform concentrations at a reservoir intake of an unfiltered system shall not exceed 20 colonies per 100 ml in 90 percent of the samples in any six month period.
Reservoir	DCR	Fecal Coliform	Massachusetts Water Quality Standards (314 CMR 4.00): Water supply intakes in unfiltered public water supplies requires either fecal coliform shall not exceed 20 fecal coliform organisms per 100 ml in all samples taken in any six month period, or total coliform shall not exceed 100 organisms per 100 ml in 90% of the samples taken in any six month period. If both fecal coliform and total coliform are measured, then only the fecal coliform criterion must be met.
Stream	DCR	*E. Coli*	Massachusetts Water Quality Standards (314 CMR 4.05c): The geometric mean of all *E. coli* samples taken within the most recent six months shall not exceed 126 colonies per 100 ml, typically based on a minimum of five samples, and no single sample shall exceed 235 colonies per 100 ml.

Nutrients

In discussions of water quality, DWSP uses the term nutrients as a category of chemical compounds that promote aquatic plant growth, primarily certain forms of phosphorus and nitrogen. Elevated levels of nutrients and the subsequent increase in aquatic plant growth can be deleterious to aquatic life and can impact drinking water quality. DWSP uses Total Phosphorus, Ammonia-nitrogen and Nitrate-nitrogen to evaluate the nutrient levels in the watershed streams and reservoirs. DWSP collects nutrient samples from the reservoir and its tributaries.

Turbidity

Turbidity is a measure of the clarity of water. Material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. Turbidity samples are collected from watershed streams as part of routine sampling and in special studies to evaluate specific issues, such as monitoring the effectiveness of erosion controls at a construction site. Samples collected for turbidity are analyzed by DWSP staff using a turbidity meter.

Anthropogenic Compounds

There are many non-natural chemicals that pose potential threat to the drinking water supply. These compounds are often defined relative to the environmental laws that regulate the compounds. These materials are grouped in a category called Anthropogenic Compounds for the purpose of this assessment. The category includes hazardous materials, pesticides, and Pharmaceuticals and Personal Care Products (PPCPs) as pollutants. These pollutants can find their way into the water supply from human activities via accidents or by deliberate discharges, directly or indirectly, to ground and surface waters. DWSP does not routinely monitor for any anthropogenic compounds in the reservoirs; MWRA has not found any of these items in the regular analyses they perform on the finished water.

Invasive Species

The US Department of Agriculture defines invasive species as a species that is: 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). For water quality and distribution considerations, DWSP is primarily concerned with Aquatic Invasive Species (AIS). DWSP monitors extensively for AIS; MWRA has funded extensive AIS control efforts in the watershed system since 2002 in addition to reservoir-wide surveys to detect new invasives. Terrestrial invasives may not categorically threaten the short-term protection of a drinking water supply, but they can monopolize species composition, interfere with native tree regeneration, and simplify the structural complexity of the watershed cover. Their impact can conflict with watershed objectives for a diverse, resistant, and resilient forest cover.

The potential sources of water quality contaminants most likely to be associated with the activities identified are presented in Table 3-3.

DWSP staff conducted a review of each watershed to assess the potential threat from the pollution sources described above. The assessment process provided important information that was used to update the watershed control programs. The following is a brief summary of the detailed description developed for each watershed along with the ranking of the potential threat to water quality in each watershed. This assessment is summarized in Table 3-4 at the end of this Section.

Table 3-3: Potential Sources of Water Quality Contaminants

	Contaminant				
Source	**Pathogens**	**Nutrients**	**Turbidity**	**Anthropogenic Compounds**	**Invasive Species**
Wildlife	●	●	●		●
Public Access/Recreation-	●	●	●	●	●
Timber Harvesting			●	●	●
Roadways/Railways/ROWs			●	●	●
Agriculture	●	●	●	●	●
Construction			●	●	●
Commercial, Industrial, and Governmental Sites	●		●	●	●
Residential Sites	●	●		●	●
Wastewater	●	●		●	
Future Growth	●	●	●	●	●
Climate Change	●	●	●		●
Security Threats	●			●	

3.2.1 Wildlife

Wildlife populations can directly threaten water quality through bacterial contamination from bird and mammal feces and unstable beaver dams and indirectly through herbivore over-browsing that impacts forest regeneration. Pollutants most likely to be created or spread by wildlife are pathogens, nutrients, turbidity, and invasive species. Burrowing mammals are a threat to infrastructure and also are considered in the threat assessment.

Quabbin

The types of wildlife most closely monitored at Quabbin are: 1) ring-billed gulls, herring gulls, great black-back gulls, Canada geese, and other waterfowl; 2) beaver and muskrat; and 3) white-tailed deer and moose. The threat from wildlife within the Quabbin Reservoir watershed is assessed through a wide range of monitoring activities and protection procedures to document their presence, type, and activity. General and systematic monitoring is conducted on a daily basis in the water quality monitoring program, on a weekly basis in the CVA Shoreline Weekly Survey (looking for nuisance animals), on a biweekly basis in the watershed monitoring program, and a monthly basis in the reservoir monitoring program. Targeted monitoring and protection activities are conducted through the Gull Harassment Program, the Canada Goose Population Control Program, Pathogen Control Zone Program, and the White-tailed Deer Management Program.

FY19-FY23 Watershed Program System-wide Assessment of Importance for Planning: High.

Ware

Data on the wildlife resources and their impacts in the Ware River Watershed come from surveys (e.g., monitoring of moose sign, aquatic invasive surveys of ponds and rivers), staff reports (e.g., about beaver-plugged road culverts), observations made during Environmental Quality Assessments, and via water quality sampling results. Additional data comes from the New

England Research Institute for Moose and Forest Dynamics at UMASS Amherst and from the Division of Fisheries & Wildlife.

When water sampling data has elevated bacteria counts, staff conduct field investigations to determine the source. The elevated results are frequently attributed to beavers and their habitat; mitigation is performed as necessary.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

Wachusett

Wachusett, similar to Quabbin, provides a daytime loafing area and nighttime roosting site for a large number of gulls, geese, ducks, and cormorants. Numbers generally begin to increase in late summer and early fall and reach a maximum of up to several thousand gulls during the winter months when other water bodies freeze. Nesting populations of resident geese utilize the reservoir shoreline and islands. Pathogens and nutrients from avian feces are a significant threat to water quality.

Beaver can cause localized damage to roads, culverts, and trees, and catastrophic beaver dam failure can lead to downstream flooding and elevated concentrations of nutrients, bacteria, and sediment. Burrowing by beaver, muskrat, and other mammals has the potential to damage dikes or dams.

Watershed management dictates that an actively growing, diverse, multi-age forest should be managed for regulating stream flow, maintaining water quality and preventing erosion. Expanding deer populations pose a threat to the forest within areas of the Wachusett Reservoir watershed. Recently, the Division foresters began to see significant impact on forest regeneration in the un-hunted Division lands close to reservoir. Deer densities above a certain threshold have an impact on tree regeneration and growth.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: High.

Sudbury

As a mostly urban/suburban watershed, the wildlife issues present in the Sudbury system are not as varied as those in the Quabbin Reservoir, Ware River, or Wachusett Reservoir watersheds. As an emergency water supply, there is less need to manage for water quality impacts from wildlife on the reservoir.

The most serious threat to water quality that is actively managed by DWSP is the resident Canada goose population on the Sudbury Reservoir. Data collected by DWSP Natural Resources staff indicates that the Sudbury and Foss Reservoirs are used by roosting gulls on a regular, but intermittent basis. Control of burrowing animals is important in the Sudbury system. DWSP-owned lands around the Sudbury Reservoir are not hunted and as a result have a significantly high deer density. This deer density coupled with non-native/invasive species makes the regeneration of trees a challenge at the reservation.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.2 Public Access/Recreation

Public access is the human presence and activities on DWSP owned lands and waters. The potential threat to water quality from public access and recreation comes both from allowed (e.g., hiking) and prohibited (e.g., swimming, dumping) activities. Pollutants most likely to be introduced to water resources due to public access and recreation are pathogens, nutrients, turbidity, and invasive species.

Quabbin

Recreation, both passive and active, by the general public is the most common public access activity on Quabbin lands and waters. Presently the most popular land based activities at Quabbin include driving for sight-seeing, walking and bicycling (on designated routes), and bird watching. Water-based activities are boat fishing through one of the three Boat Launch Areas and shore fishing from several locations around the reservoir. Unauthorized activities on both DWSP lands and waters are considered a potential threat to water quality.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Ware

Public access and recreational activities are allowed on designated portions of DWSP's Ware River watershed lands, but are most popular in the areas closest to Route 122. Information on public access and recreation comes largely from staff observations, public interactions, and Watershed Rangers. Recreation is an activity of particular concern in the Ware River watershed due to: an increase in uncontrolled and/or unauthorized vehicular access or use; the expansion of snowmobiling, mountain biking, and horseback riding; and the extension of a rail trail.

Substantial staff time is now spent dealing with recreational issues, including impact control, working with user groups, and resolving user conflicts. Unrestricted public access can result in dumping and vandalism problems on the watershed. Access to the more remote portions of the watershed is obtained when gates are open for legitimate DWSP activities. Partying, vandalism, and dumping has been an issue in recent years. Off-road vehicle (ORV) usage is occurring illegally in the watershed, resulting in soil erosion, direct water pollution from vehicles driving through streams, littering, and passage into areas not readily accessible to the public. All these impacts are potentially problematic.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

The *Wachusett Reservoir Watershed 2011 Public Access Plan Update* describes the current status of recreational activities on DWSP lands in the Wachusett watershed. The most popular activities on DWSP lands include walking and fishing from shore. Many other activities, including trapping, boating, biking, and horseback riding are not allowed, or allowed in limited areas.

Enforcement of DWSP public access regulations and assessment of impacts from public access on DWSP land is done primarily by the Watershed Rangers. Watershed Rangers interact with the public to prevent or reduce inappropriate recreational uses.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Sudbury

The Sudbury land holdings are a popular area for the surrounding watershed communities, which are much more highly populated than any other part of the system. Wachusett/Sudbury Ranger staff regularly patrol to enforce DWSP public access requirements. Illegal swimming chronically occurs at certain spots around the two reservoirs, in particular the train trestle crossing the Foss Reservoir. Boating violations mostly occur from the launching of small craft at nearby roadways or adjacent private lands. Shoreline fishing is currently allowed along most of the Sudbury Reservoir shoreline, with a fishing season that runs from the first Saturday in April until November 30 each year, provided no ice is present.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.3 Timber Harvesting

The maintenance and diversification of forest cover is an excellent strategy for supporting watershed protection efforts. Timber harvesting in Massachusetts is a highly regulated activity controlled by the MA Forest Cutting Practices Act (FCPA; MGL Chapter 132, §§ 40-46 and 304 CMR 11.00). DWSP lands have several additional layers of water quality protection that are outlined in the comprehensive *2017 Land Management Plan*. Active silviculture can have deleterious impacts on water quality when it involves harvesting in wetlands and riparian zones, road and landing construction and use, stream crossings, mechanical preparation for the planting of trees, and spills from power equipment. The pollutants most likely introduced to the watershed through timber harvesting are organic and mineral sediments, which can effect turbidity, and anthropogenic compounds. However, due to the extensive regulation and oversight of timber harvesting on both DWSP and private lands, this activity is rated as a low potential risk to water quality in all four watersheds.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

3.2.4 Highways/Railways/ROW

The threats to water quality from roads, railways, and Rights-of-Way (ROWs) include pollutants transported by stormwater runoff, releases of fuel or transported products caused by accidents, and maintenance practices such as herbicide treatment of ROWs or sand and salt application for ice and snow treatment. The construction of new roadways or improvements to existing ones can lead to problems with erosion and sedimentation unless adequate management practices are utilized. The pollutants of concern related to Highways/Railways/ROW are turbidity, anthropogenic compounds, and invasive species.

Long term increases in specific conductance in watershed tributaries and in the reservoirs suggest that salt applied during winter storms remains present in groundwater and surface water throughout the year. Best management practices may slow the movement of road salt runoff but do not prevent salt from eventually reaching the reservoir. DWSP will examine all potential causes of the specific conductance increase and will propose specific remedial action if it is needed.

Quabbin

In the Quabbin Reservoir watershed there are many locations where roads and streams intersect, and it is likely that a piped drainage outfall or paved chute empties directly into a tributary. Maintenance of these roads is the responsibility of Massachusetts Department of Transportation Highway Division (MassDOT), local communities, or DWSP; DWSP maintains over 200 miles of roads on its property. There are no functioning railways located in the Quabbin Reservoir Watershed. Annual reviews of ROW maintenance plans are conducted for the three electrical utilities in the Quabbin Reservoir Watershed.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Ware

The issues of concern related to roadways, railways, and other ROWs in the Ware River mainly relate to fuel or other hazardous material spills and the application of pesticides to control vegetation growth along those corridors. Despite the fact that the Ware River watershed is situated in a relatively rural part of Massachusetts, there are still a number of transportation and transmission corridors that pass through the watershed. These include six numbered state highways, many town roads, one active railway, and several electrical transmission lines. GIS data indicates that there are approximately 272 miles of roadways in the watershed, seven miles of active railroad lines, 12 miles of above-ground utility transmission lines and another 12 miles of underground cable line. These land uses represent linear access points into the heart of the watershed, many of which cross or run adjacent to streams, rivers, wetlands and other water bodies, that may also involve activities that are potentially harmful to water quality (e.g., vegetation control operations).

DWSP lands in the Ware River watershed have historically been much more open to vehicle access than its counterpart in either the Quabbin Reservoir or Wachusett Reservoir watersheds. This poses a particular challenge in regards to controlling illegal dumping, vandalism, and other access-related issues. Many of the town roads in the Ware River Watershed are dirt with country drainage, often draining directly to resource areas. Stormwater impacts along existing public ways, especially those adjacent to steep slopes, can be exacerbated under current statewide subdivision control laws which allow "Approval Not Required" house lots (MGL c. 41, §§81L and P), as there are no requirements for improved drainage with this common form of development.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

There are nearly 500 miles of primary and secondary roadways, including Interstate 190, and almost thirty miles of railroad tracks in the Wachusett watershed. The transportation of hazardous materials has a high potential risk to water quality due to the proximity of a number of roadways and railroads to the reservoir. While the construction of Best Management Practices (BMPs) and reconfiguration of drainage pathways has removed almost all direct discharges to the reservoir and consequently reduced the risk from an accidental release, the risk remains high due to train traffic. Local fire departments have been provided training and access to emergency response materials by DWSP to help prevent any hazardous materials spilled from reaching the reservoir.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: High.

Sudbury

There are over 265 miles of roads throughout the Sudbury and Foss basin. Two of Massachusetts's major thoroughfares bisect the watershed: the Massachusetts Turnpike, running east/west, and Interstate 495, running north/south. There are also four heavily traveled state numbered routes that pre-date the modern highways: Rte. 9, Rte. 20, and Rte. 30 running east/west, and Rte. 85, running north/south. Approximately 9 miles of rail line operated by CSX runs in an east/west direction across the watershed. The rail line and the Turnpike both travel across the southerly section of the Foss Reservoir. Rte. 9 runs along the southern border of the two reservoirs, and Rte. 85 crosses the Sudbury Reservoir at its western arm near its connection with the Open Channel.

DWSP depends on the local public works departments, MassDOT, and CSX to safely operate their respective road or rail line. The most significant risk from this myriad of transportation corridors is an accidental spill of hazardous materials. DWSP utilizes an Emergency Spill Management Plan and protocol developed in association with MWRA and local responders. These procedures were utilized successfully in 2004 to contain a spill of diesel fuel from a school bus parking yard that drained directly to Foss Reservoir.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: High.

3.2.5 Agriculture

Threats to water quality from agriculture are related both to the keeping of livestock and to the cultivation and harvest of crops. This category also includes hobby farms, backyard horses, and kennels. Pollutants of concern from agriculture are pathogens, nutrients, turbidity, and anthropogenic compounds. The percentage of land in agricultural use is very low in all watersheds, and most of the agricultural operations are small. DCR and MassDEP regulations (see Section 3.2.11) provide setbacks and buffers that further protect water resources.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

3.2.6 Construction

Threats from construction activities include earth moving with inadequate erosion and sediment controls, releases from construction equipment, and invasive species growth in disturbed areas. The pollutants of concern are turbidity, anthropogenic compounds, and invasive species. Construction is a threat to water quality from activities such as land clearing and earth moving for the creation of new driveways, access routes, drainage basins, septic systems, and building lots. These activities can be the source of nutrients and sedimentation. In addition, unprotected work sites during construction activities, coupled with inadequate erosion and sedimentation controls, can also yield turbidity and nutrients into nearby water bodies.

Quabbin

Over seventy percent of the watershed is protected open space, where new construction is not allowed. Areas where construction is possible have significant protection from zoning. Construction activity is principally residential.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

Ware

A few towns in the Ware River watershed have experienced rapid growth over several years, at times overwhelming the ability of local boards to monitor and control construction activity. Parts of the Ware River watershed are in what is known as the "Sprawl Frontier" of Boston and Worcester, an exurban area likely to continue growing.

A significant portion of the new construction in the watershed is occurring on hillsides that are less stable and thus more prone to erosion and sedimentation during the construction phase. In some cases the hillsides developed or slated for development lie directly above water resource areas with little or no intervening level uplands to mitigate the effects of construction-induced runoff.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

Construction is still active in the watershed. Identification of construction activities is accomplished through regular communication with local boards and commissions, review of Watershed Protection Act applications, Massachusetts Environmental Policy Act filings, and sites regulated through EPA Municipal Separate Storm Sewer Systems (MS4) and Construction General Permits.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Sudbury

The Sudbury watershed is in a very active area for construction and redevelopment of currently developed sites. In addition, DWSP land holdings are small and development has occurred in close proximity to the reservoirs.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.7 Commercial/Industrial/Governmental Sites

Threats to water quality from activities on commercial, industrial, or governmental sites include increased runoff from large amounts of impervious surfaces commonly associated with these uses, and the potential release of materials stored and used on-site. Discharges to the ground via shallow injection wells or infiltration devices can lead to groundwater contamination and long-term water quality problems. Pollutants of concern most likely to be generated from commercial, industrial, and governmental sites are anthropogenic compounds.

Quabbin

Facilities evaluated in this category at Quabbin include automotive repair shops, a junk yard, community Department of Public Works garages, DWSP facilities, a saw mill, and gravel pits. There are a very limited number of these sites, and they are generally well regulated by MassDEP and local officials.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

Ware

Most commercial and industrial establishments in the Ware River watershed are small retail establishments, primarily located in the towns of Hubbardston and Rutland. There are a variety of governmental offices and other facilities in the watershed, including schools, town halls, libraries, fire stations, DWSP facilities, and town garages. In addition, there is a MassDOT maintenance facility located on the shore of Long Pond in Rutland that could be of concern if a spill should occur onsite. Numerous gravel pits are scattered throughout the watershed, evidence of the glacial history of the area.

There are no active solid waste facilities in the Ware River watershed at the present time. There is one active landfill just off the watershed downstream of the Shaft 8 Intake. Recent EQA assessments identified an old, overgrown landfill in Templeton that was not properly closed.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

There are many businesses and industries within the Wachusett Reservoir watershed, mostly concentrated in a few areas of Holden and West Boylston, especially along Routes 12 and 122A. Governmental sites such as state and municipal office complexes, schools, highway department facilities, DWSP facilities, and public safety buildings are scattered throughout watershed communities.

Staff made a concerted effort to add information on any location that uses, stores, or generates hazardous materials, closed landfills, and on all spills and releases of hazardous materials. Information including hazardous waste generator status was added to more than 200 files.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Sudbury
There are several nodes of commercial and industrial activities in the Sudbury and Foss Reservoirs watershed, mostly clustered around the major transportation arteries of the Mass Turnpike, I-495, and Rt. 9. While many of these sites are in the western edge of the watershed, the Framingham Technology Park is situated adjacent to Foss Reservoir. Commercial activity also spreads along the length of Rt. 9 as it borders the two reservoirs, and there is a strip of commercial sites along Rt. 85 to the northwest of Sudbury Reservoir.

According to a 2010 study completed by the MetroWest Regional Collaborative and the Metropolitan Area Planning Council, it is noted that the Route 9 corridor along Southborough, Framingham, Natick and Wellesley has the potential to expand commercial space by 88 percent under current zoning by-laws. In addition, traffic would also be expected to grow by 40 percent with this development. While towns are pushing to increase this economic development, "smart growth" design would decrease commercial space, according to the Collaborative.

There are three closed or inactive solid waste facilities in the Sudbury basin. Spills or releases of hazardous materials of certain concentrations are reportable to MassDEP under the Mass Contingency Plan (MCP). DWSP monitors submitted reports of cleanup efforts and relays concerns to MassDEP as conditions warrant for these sites.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.8 Residential Sites

The threats to water quality from practices associated with residential use include nutrients and pesticides from lawn care products, unmanaged pet waste, disposal of pharmaceuticals, personal care products and household hazardous materials, and use of non-native species in landscaping or aquaria. The major pollutants of concern for residential sites are pathogens, nutrients, anthropogenic compounds and invasive species.

Quabbin
Residential use is quite limited in the Quabbin watershed at less than two percent of total land use. Although there can be some impact from residential sites, they are considered a low potential threat to water quality at Quabbin.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

Ware
There are no indications of significant issues related to residential sites in the Ware River watershed except for occasional septic system failures or other localized problems. Some residential sites have had releases of oil from heating oil storage tanks. Encroachments, however, are a concern as homeowners sometimes "extend" their property onto adjacent state land. Encroachment onto DWSP lands is a long-standing issue with impacts throughout the watershed. Encroachment can range from mild – cutting of foot paths or trails – to severe – storing of excavators, digging, vehicles abandoned on DWSP property. Another concern related to residential development is the conversion of summer cottages to year-round residences; there

is the potential for water quality impacts, at least localized, since this often occurs along lake shores.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

Population in the Wachusett watershed has increased by about ten percent in the past fifteen years, with a majority of the growth taking place in Rutland and Holden, two communities with sewered portions of town. An increase in population means increased residential use and a subsequent increase in potential problems. Household pets, especially dogs, have been identified as a possible major source of pathogens in the Wachusett Reservoir watershed. Lawn care and large household gardens are a potential source of nutrients, pesticides, and herbicides, and in extreme cases can result in erosion and sedimentation problems. Control of insect or rodent pests in and around residential development can lead to contamination of groundwater and surface water. Household use of hazardous materials leads to an increased risk of accidents or inappropriate disposal.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Sudbury

Almost one third of the Sudbury watershed is in residential development, with over 140,000 residents in the five towns encompassing this watershed. Stormwater runoff from residential sites poses a risk to the water supply. Dumping into storm drains, pet waste, improper disposal and storage of hazardous materials, automobile fluid leaks, fertilizer and pesticide use makes its way into the reservoir via storm drains and tributaries during rain events.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.9 Wastewater

Human wastewater may be treated with on-site systems or connected to a sewer for treatment at a municipal wastewater treatment plant. Properly functioning on-site treatment systems should not cause contamination of either groundwater or surface waters. Recent studies have indicated that some chemical compounds, including Pharmaceuticals and Personal Care Products (PPCPs), may not be removed in septic systems. Municipal sewerage systems in the watershed system transport sewage out of the watershed. Municipal sewers can cause water quality problems from events such as breaks in sewer lines and sewer pump failures. The primary pollutant of concern in this category is pathogens. In addition, human wastewater can contain nutrients and anthropogenic compounds.

Quabbin

There are no sewered areas in the Quabbin Reservoir watershed. All homes and facilities are served by on-site wastewater disposal. Wastewater is considered a low potential threat to water quality given the overall low population density in the watershed and the current state-wide and watershed specific regulations in place for installation, repair, and conversion of septic systems.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

Ware

Most towns in the Ware River watershed rely on on-site septic systems. Current Title 5 regulations, technological advances in septic system design and installation, and increasing oversight by local boards of health have improved over the past several years. As failed systems are identified, they are repaired or replaced with better-functioning systems. On small lots where space limitations prevent conventional systems (e.g., around lakes or ponds), failed systems or cesspools are commonly replaced by tight tanks, an improvement over pre-existing conditions.

Sewer lines exist in only two relatively small parts of the Ware River watershed – in and around the center of Rutland and in a small portion of Templeton. In both cases, the wastewater collected in these systems is transported off-watershed.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

A majority of homes, businesses, and industries in the Wachusett watershed utilize on-site wastewater disposal. On-site systems are monitored by DWSP staff to ensure that wastewater disposal issues do not become a water quality problem by investigating any reports of failing septic systems. Routine water quality monitoring of tributaries is used to detect any dramatic increases in fecal coliform concentrations that may be linked to problems with septic systems.

Major investments in constructing and maintaining sewers in key locations of the watershed have been made by DWSP, MWRA, predecessor agencies, and local municipalities, including the original 1930s era Rutland-Holden trunk line, the 1980s Rutland-Holden relief line, and the more recent $83 million expansion in West Boylston and Holden. Many homes in the Wachusett watershed are now connected to these municipal sewer systems, which treat and discharge effluent off-watershed. All properties with available sewer connections in West Boylston were required to connect by July 2007, and most have done so, with more than seventy percent of the town now connected to the municipal sewer system. Individual homes and businesses in Holden are not required to connect to the sewer, but more than fifty-five percent in Holden are now connected.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Sudbury

The majority of the Sudbury watershed is sewered. The town of Framingham is serviced by the MWRA sewer system. The city of Marlborough and the town of Westborough have their own municipally operated sewer service, while the town of Northborough is partially sewered using Marlborough's facilities. Portions of Westborough and Northborough still utilize septic systems. The Town of Southborough relies solely on septic systems, with no plans to add sewers. The 2009 Town of Southborough Open Space Plan notes: "A vote to install sewers has always been rejected because of concerns over the increase in development density that sewers historically bring." None of the municipal wastewater treatment plant discharges are within the Sudbury watershed.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.10 Future Growth

Changes in land use without careful planning can have long-term impacts on hydrology and water quality, as unregulated growth and development can introduce a variety of pollutants into tributaries and the reservoir. Potential contaminants are closely related to zoning and include pathogens, nutrients, turbidity, anthropogenic compounds, and invasive species.

Quabbin

Land ownership analyses and Watershed Protection Act maps are the primary tools used to assess future growth in the Quabbin watershed. Watershed town zoning maps and master plans can also help assess potential growth impact on individual towns. At the state level, Executive Office of Energy and Environmental Affairs (EOEEA) conducted a build-out analysis for all towns. Permanent land protection has increased in the watershed over the past decade, however growth is also increasing all around the perimeter of the watershed. Staff are observing growth as remote parcels are liquidated and developed according to local zoning bylaws, which often specify a density of a new dwelling on every one or two acres. Ongoing and potential future growth has increased as development continues to push west. Despite the presence of Quabbin Reservoir, DWSP and other protected lands, and the general rural nature of the watershed, there will continually be pressure for future growth in the watershed as land prices remain relatively low compared to the developed portions of the state.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Ware

Future growth in the Ware River watershed can be affected by a variety of factors, including statewide and local decisions related to zoning and land use practices, economic conditions, and open space protection programs. EOEEA build out data suggests that almost 23,000 acres in the Ware River watershed are potentially available for future growth. While much of this land is located in the upper reaches of the watershed, significant acreages of developable land is also available in relatively close proximity to the major tributaries. Portions of the watershed with easy access to Rt. 2 in Templeton and Phillipston are likely to experience significant growth in the future. The eastern portions of the watershed are within what has been described as the "Sprawl Frontier" of Boston and Worcester. Growth in Rutland (25.5%) over the last census period was more than twice as rapid as any other watershed community and four times the rate overall in Worcester County; the town continued to grow an additional 7.6% since 2010. Exurban growth will likely continue apace, especially in those areas with significant amounts of developable privately-owned lands, barring significant economic disruption or increases in gasoline prices.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Wachusett

Population in the Wachusett watershed continues to increase, placing additional pressure on undeveloped lands. Total population of the six primary watershed communities increased 8% between 2000 and 2010, and has continued to grow an additional 5% over the past six years. Not all communities are experiencing an equal amount of pressure since the 2010 census, with small

increases in Princeton and Paxton, moderate increase in Sterling and Boylston, and the most significant gains in Holden (see Table 2-4).

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

Sudbury

The Sudbury watershed is part of the MetroWest region, a focal point for growth in the greater Boston region. Its location and transportation infrastructure provide access to employment, services, and other amenities. There is little land available, however, for new development, so future growth will be more likely to result in redevelopment of properties already in residential, commercial, or industrial use.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

3.2.11 Climate Change

Threats to water quality in the water supply watersheds from climate change include both short-term and long-term effects, including potentially higher water temperatures and changes in the timing, intensity, and duration of precipitation, with lengthy dry periods and infrequent but very heavy episodes of rainfall. Higher water temperatures reduce dissolved oxygen levels in water and can have an adverse effect on aquatic life. Increased frequency and intensity of rainfall may cause erosion and sedimentation problems, with changes in stormwater runoff carrying a variety of pollutants into streams and wetlands. Changing patterns and quantities of precipitation can lead to drought, less dilution of pollutants, and impacts to aquatic organisms. Variations in temperature and precipitation also can lead to changes in plant and animal populations and thus the forest composition, with new invasive species arriving or problematic resident species becoming more dominant. Pollutants of concern related to climate changes are pathogens, nutrients, turbidity, and invasive species.

Warming temperatures might also impact migratory behavior of wildlife, with greater numbers of waterfowl remaining in the area for an extended period of time. Higher temperatures could delay or prevent reservoir ice cover, allowing direct access by gulls, geese, and ducks throughout the winter and increasing the possibility of contamination by nutrients and pathogens.

Increased temperatures are predicted to change some or most of winter precipitation from snow to ice or rain. Even if annual precipitation amounts in the watershed remained the same, a decrease in snowfall would impact the timing and amounts of water storage in the reservoir and will be considered for future planning. DWSP will continue to monitor and evaluate scientific literature as global climate models evolve.

DWSP is already witnessing impacts from changing storm intensity with flooding and increased erosion, as well as periods of drought conditions. Climate change will lead to continued alterations in storm frequency and intensity. These impacts are likely to affect forest roads, including the need to up-size culverts. In order to address the effects of climate change, DWSP will initiate a comprehensive vulnerability assessment that will outline actions to track changes

to the environment, identify infrastructure maintenance issues, and develop possible actions to address the impending consequences from this global plight.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Medium.

3.2.12 Security Threats

The probability of intentional contamination of a drinking water supply is relatively low, but the issue is taken seriously by all water utilities. Watershed Security Programs provide surveillance of the watershed and protect the water supply system from intentional malicious actions. DWSP, working with MWRA, have made many improvements to strengthen security measures that protect the watershed system.

FY19-FY23 Watershed Protection Program Assessment of Importance for Planning: Low.

3.2.13 System-wide Assessment of Potential Threats

A summary of the relative potential water quality threats from land uses and activities, to be used for watershed protection program planning is presented in Table 3-4.

A reminder that these evaluations are made under a hypothetical scenario where the existing DWSP control programs do not exist. Because DWSP has an extensive watershed protection program in place, the rankings should not be interpreted as the actual risk to the DWSP system.

Table 3-4: DWSP Watershed System-wide Assessment of Potential Contaminant Sources for Watershed Protection Program Planning FY19-FY23

	Active			Emergency
Source	**Quabbin**	**Ware**	**Wachusett**	**Sudbury**
Wildlife	H	L	H	M
Public Access/ Recreation	M	M	M	M
Timber Harvesting	L	L	L	L
Highways/ Railways/ROW	M	M	H	H
Agriculture	L	L	L	L
Construction	L	M	M	M
Commercial/ Industrial/ Government Sites	L	M	M	M
Residential Sites	L	M	M	M
Wastewater	L	M	M	M
Future Growth	M	M	M	L
Climate Change	M	M	M	M
Security Threats	L	L	L	L

3.3 Watershed Protection Control Programs

The DCR DWSP Watershed Protection Program provides a drinking water source of exceptionally high quality. DWSP is committed to the goal of maintaining and enhancing this level of quality for future generations. In order to achieve this goal, DWSP has organized its efforts into programs that control water quality threats identified in ongoing assessments. This concept is used to manage staff, set priorities, and establish budgets. The programs are elastic, with the ability to shift in response to organizational changes as well as emerging issues as they are identified by DWSP.

DWSP protection efforts are organized into fifteen programs in this iteration of the *Watershed Protection Plan Update*. In comparison, the *2013 Watershed Protection Plan Update* organized the protection program in sixteen programs. This plan includes all the protection program components from previous plans, reorganized to better reflect current internal organizational structure.

The overall goal of the control programs is to develop proactive strategies to prevent water quality problems wherever possible and to respond to detected problems quickly to limit their potential impact. The fifteen programs and their goals are shown in Table 3-5.

The Sudbury system is an emergency supply, and so the protection program conducted by DWSP is less aggressive than the program in the active supply watersheds. As shown in Table 3-5, a subset of the fifteen control programs is utilized in the Sudbury to provide an appropriate level of watershed protection.

Implementation of the DWSP Watershed Protection Plan is an iterative and ongoing process. It builds on an extensive body of work conducted by DWSP staff. Table 3-6 summarizes the relation between DWSP's Control Programs and the potential pollutant sources for which they are most effective. The purpose of this table is to illustrate that DWSP has developed multiple, overlapping control programs to protect from potential contamination threats and provide effective water supply protection.

The following sections provide a brief description of each program as it relates to the entire watershed system. Chapters 4, 5, 6 and 7 describes how these control programs are developed and implemented for Quabbin Watershed, Ware River Watershed, Wachusett Watershed, and Sudbury Watershed, respectively.

Table 3-5: DWSP Watershed Protection Control Programs

DWSP Programs	Goal	Quabbin, Ware, Wachusett	Sudbury
Land Acquisition	Purchase critical lands by fee and Watershed Preservation Restriction (WPR) using money allocated for land acquisition in MWRA's capital budget as well as other funding sources and gifts.	✓	
Watershed Preservation Restriction Monitoring	Maintain control of watershed lands through stewardship of Watershed Preservation Restrictions.	✓	
Land Management	Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.	✓	✓
Wildlife Management	Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.	✓	✓
Public Access Management	Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.	✓	✓
Watershed Security	Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to protect the watershed system from potential threats.	✓	✓
Infrastructure Maintenance	Maintain the integrity of all High Hazard class dams under joint DWSP/MWRA control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.	✓	✓
Watershed Protection Act	Enhance protection of the water supply through implementation of the Watershed Protection Act, which regulates land use in critical areas of the watersheds.	✓	
Education and Outreach	Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.	✓	✓
Water Quality and Hydrologic Monitoring	Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.	✓	✓

DWSP Programs	Goal	Quabbin, Ware, Wachusett	Sudbury
Watershed Monitoring and Assessment	Use Environmental Quality Assessments, site inspections, local board meetings, and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.	✓	✓
Aquatic Invasive Species Management	Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, and decontamination measures at potential entry points. Implement active management when appropriate.	✓	✓
Wastewater Management	Monitor on-site wastewater disposal systems and operation of Rutland-Holden sewer to ensure proper treatment of wastewater.	✓	
Stormwater Management	Reduce water quality problems caused by uncontrolled stormwater.	✓	
Emergency Response	Maintain and improve short- and long-term emergency response capabilities to protect the water supply.	✓	✓

Table 3-6: Potential Contaminant Sources and Watershed Control Programs

	DWSP Watershed Protection Program														
Potential Contaminant Sources	**Land Acquisition**	**Watershed Preservation Restriction Monitoring**	**Land Management**	**Wildlife Management**	**Public Access Management**	**Watershed Security**	**Infrastructure**	**Watershed Protection Act**	**Education and Outreach**	**Water Quality/Hydrologic Monitoring**	**Watershed Monitoring and Assessment**	**Aquatic Invasive Species**	**Wastewater Management**	**Stormwater Management**	**Emergency Response**
Wildlife			✓	✓			✓			✓	✓	✓			
Public Access/ Recreation			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Timber Harvesting			✓					✓	✓	✓	✓	✓	✓	✓	✓
Wastewater	✓	✓						✓		✓	✓		✓		✓
Roadways, Railways and Rights-of-Way					✓			✓		✓	✓	✓	✓		✓
Agriculture	✓	✓						✓	✓	✓	✓		✓	✓	
Construction	✓	✓						✓		✓	✓		✓	✓	
Commercial, Industrial, and Governmental Sites	✓	✓						✓	✓	✓	✓	✓	✓	✓	
Residential Sites	✓	✓						✓		✓	✓	✓	✓	✓	
Future Growth	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓	
Climate Change	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Security Threats	✓				✓	✓	✓			✓	✓				✓

3.3.1 Land Acquisition

Land procurement protects watershed land from development and allows DWSP to restore and/or maintain a stable vegetative cover. The purchase or control of new properties provides permanent protection and helps reduce the threat from additional urbanization. The Land Acquisition Program uses money allocated in the MWRA's capital budget for the purchase of critical lands by fee or Watershed Preservation Restriction (see 3.2.2) to protect watershed land from development and to restore and maintain stable vegetative cover. DWSP also utilizes other funding sources whenever possible, such as the federal Forest Legacy program, and encourages land owners to take advantage of tax benefit programs that allow them to make gift or bargain sales to the state. Acquisition of Watershed Preservation Restrictions rather than fee interest is preferred due to lower costs to the program.

The Land Acquisition Panel (LAP) was formed by DWSP to help determine the most appropriate and efficacious way to prioritize land procurement options. The LAP, which includes DCR and MWRA staff, developed a land acquisition model for the Wachusett watershed that incorporated various geographic, hydrologic, and regulatory parameters to develop weighted criteria to identify critical parcels. The model has guided LAP's land acquisition prioritization process for the past fifteen years. DWSP will review the model during this planning period to determine how it may need to be modified so it can be best utilized in the coming years. DWSP will also examine land prioritization for Quabbin and Ware watersheds.

Since 1985, $139 million of ratepayer money has been spent on the acquisition of over 26,000 acres in both fee and WPR. This figure includes 2,350 acres purchased with $2.3 million in federal funds.

3.3.2 Watershed Preservation Restriction Monitoring

A Watershed Preservation Restriction (WPR) is a legal agreement between DWSP and a private landowner where the landowner sells or donates the development rights of their property to DWSP while keeping ownership of the land. The WPR remains in effect in perpetuity and carries forward even if the landowner sells the property.

In recent years there has been a strong preference for acquisition of WPRs rather than acquiring land in fee. Lands protected through WPRs are less costly than outright acquisitions and do not involve annual payments in lieu of taxes (PILOT) to watershed towns, as the private landowner continues to pay local real estate taxes. Because WPRs are still privately owned, DWSP has ongoing stewardship obligations to make sure that the landowner is abiding by a list of restrictions, including prohibitions on construction, dumping, mining, and certain agricultural practices. Important objectives of the Watershed Preservation Restriction Monitoring Program are documentation of baseline conditions on all WPR properties, routine monitoring to check compliance with restrictions, resolution of any violations, and maintenance of good working relationships with landowners.

DWSP's first WPRs were purchased during the 1990s, and several WPRs have been purchased each year. The proportion of WPRs to fee purchases has increased due to greater emphasis on

trying to acquire a WPR on a piece of land before pursuing a fee option. There are 145 WPRs covering 8,449 acres.

DWSP continues to acquire new WPRs. As the number of WPRs increases, accomplishing basic stewardship goals with existing resources becomes more difficult and could lead to an increased risk for violations. Staff resources may need to be reexamined to meet the goal of one site visit every two years. The assistance of Foresters, Watershed Rangers, Engineers, and Environmental Quality staff who are already in the field will be considered as an option to help complete these tasks. Use of an existing statewide database could prove to be beneficial to tracking WPR information; additional staff resources are necessary to help with uploading and managing this DWSP data.

3.3.3 Land Management

The Land Management program incorporates principles from the current scientific knowledge of watershed and natural resource management to develop and implement policies, goals, and methods for managing DWSP lands. The primary goal of the program is to continue to create and maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Forest cover provides the best protection for drinking water quality. Maintaining a vigorously growing multi-aged, multi-species forest will provide the best resistance to and resilience following a variety of known and unknown threats. Designated non-forested lands are managed in a manner to minimize potential water quality impacts.

The Land Management program takes guidance from the comprehensive *2017 Land Management Plan* (LMP), which replaces earlier watershed-specific plans and addresses how DWSP cares for Forested Lands, Non-Forested Lands, Wildlife, and Cultural Resources. Specific details of land management activities can be found in the *2017 Land Management Plan* and are not reproduced in this document.

Timber Harvesting

Timber harvesting on DWSP lands is carefully planned and monitored. Timber harvests are supervised by the watershed forester and abide by the current Massachusetts Forest Cutting Practices Act regulations and additional DWSP guidelines, restrictions, Best Management Practices, and Conservation Management Practices outlined in the *2017 Land Management Plan*.

Water Quality Monitoring for Timber Harvesting

There was a temporary moratorium placed on new timber sales in 2010 and the existing Science and Technical Advisory Committee (STAC) conducted a review of the scientific principles that guide existing Land Management Plan objectives. The STAC was also asked to analyze proposed changes to DWSP implementation of the plan on issues such as opening sizes and retention standards. A finding of the STAC report was the need for both short-term and long-term water quality monitoring of forest cutting practices, which has been implemented in the active water supply watersheds.

Forest Health Monitoring
DWSP staff monitor a variety of other parameters to assess the health of the forest, whether or not the areas have been recently harvested. Staff routinely spot signs of potential problems related to insects and/or diseases including gypsy moths, red pine scale, hemlock woolly adelgid, and Asian Longhorned Beetle. Staff regularly interact and share information with DCR Forest Health officials and other researchers.

Climate Change Monitoring
There is a long history of data collection on DWSP watersheds that includes measurements of physical, chemical, and biological parameters as part of the water quality and forest health monitoring programs. Much of this data could be utilized in detecting and documenting the indicators of climate change.

Many of the forest adaptation actions suggested by climate change experts are already regularly implemented by DWSP. For example, simply maintaining and promoting a diverse mix of coniferous and deciduous tree species may minimize changes in water yield as precipitation patterns and hydrology respond to increasing surface air temperatures. Table 3-7 gives an overview of forest adaption strategies currently being implemented by DWSP; Table 3-8 provides examples of activities under consideration for future implementation.

Table 3-7. DWSP Current Climate Change Forest Adaption Strategies

Strategy	Examples of Activities Currently Being Implemented
Sustain fundamental ecological functions	Maintain riparian areas.
	Maintain hydrology (protect wetlands, streams).
	Maintain soil quality and nutrient cycling using harvesting BMPs, timing, and Coarse Woody Debris.
Reduce the impact of existing biological stressors	Manage herbivores to protect regeneration.
	Prevent and control invasive plants.
	Make forests more resistant to pests (remove infestations; diversify plantations; thin to enhance vigor).
Protect forests from severe fire and wind disturbance	Alter forest structure to reduce severity or extent of wind and ice damage.
	Maintain road network for fire access.
Maintain or create refugia	Prioritize and protect existing populations on unique sites.
	Protect sensitive or at-risk species or communities.
Maintain and enhance species and structural diversity	Promote diverse age classes.
	Maintain and restore diversity of native trees.
	Establish reserves.
Increase ecosystem redundancy across the landscape	Manage habitats over a range of sites and conditions.
	Establish multiple reserve locations.
Promote landscape connectivity	Protect land through ownership and WPRs to reduce the effects of fragmentation.
	Develop partnerships to promote mutual conservation goals and create protected habitat corridors.
Facilitate community adjustments through species transitions	Allow and/or encourage range expansion of southern native species.

Table 3-8. DWSP Potential Climate Change Forest Adaption Strategies

Strategy	Examples Of Activities Under Consideration Based on Additional Research and Stakeholder Input
Enhance genetic diversity	Favor existing genotypes that are better adapted to anticipated future habitats.
	Use seeds, germplasm, and other genetic material from across a geographic range.
Facilitate community adjustments through species transitions	Manage for species and genotypes with wide moisture and temperature tolerances.
	Establish or encourage new mixes of native species.
Plan for and respond to disturbance	Expect more frequent storms, and plan response options, e.g., salvage, replanting vs. natural regeneration, invasives control.

Terrestrial Invasive Species

Damaging insects and disease-causing organisms are a normal part of the forest ecosystem, but the presence of non-native organisms without natural predators and parasites can be a serious threat to forest health. Terrestrial invasive species were discussed in DWSP's *Terrestrial Invasive Plant Strategy* (2011), but the document did not include specific plans nor did it include species other than plants, such as insects. DWSP's approach to preventing forest infestations, as well as managing the effects and outcomes if present, varies by species and is described in detail in the LMP. A Terrestrial Invasives Plant Species Plan will be developed and implemented over the next five years.

Terrestrial invasive plants may not categorically threaten the short-term protection of a drinking water supply watershed, but their presence can monopolize tree species composition, simplify structural complexity, and damage existing resources. This conflicts with watershed objectives for a diverse and resilient forest cover to protect water quality. Some invasive plant problems on DWSP properties are the result of former land uses, or of deliberate plantings of species that addressed specific concerns but later exhibited invasive behavior. Other invasive species populations have spread onto DWSP lands from landscaping or construction work, such as roadsides or backyards.

As described in the LMP, a number of invasive plant species are now established on DWSP properties. Controlling these species is important in order to maintain favorable conditions for tree regeneration and native plant diversity.

DWSP plans to use integrated vegetation management (i.e., mechanical, chemical, biological, and cultural control methods) for the control of terrestrial invasive plants and will monitor and evaluate the results of these efforts for their effectiveness and cost. In some situations, use of herbicides may be the preferred control and a detailed, site-specific document will be written that will include the justification for herbicides, application protocol, and precautionary measures to ensure resources are protected. These site-specific documents will be prepared as needed and will be presented, as appropriate, to advisory committees and the public for review and comment.

3.3.4 Wildlife Management

The primary focus of the Wildlife Management program on the watersheds is to protect the water supply from potential adverse impacts caused directly or indirectly by wildlife while also protecting wildlife diversity and habitats. Mitigating the negative impacts of roosting birds, aquatic wildlife, and burrowing animals on the water supply is a critical component of management. In addition, broad scale, active wildlife management, especially to manage the deer populations at Quabbin, is conducted as part of this plan for the protection of the drinking water supply.

While management to protect water supply is a major component of wildlife management, DWSP property is also inhabited by a number of state and federally listed, threatened or endangered species. Watershed activities avoid adversely impacting these species or their habitats, primarily through inventory and survey work to locate rare species and habitats, proper coordination with MassWildlife's Natural Heritage and Endangered Species Program, and proper precautions using management guidelines and Conservation Management Practices (CMPs) to support rare species and certain habitats. DWSP recognizes the regional importance of maintaining some of its lands as open grassland, shrubland, or other non-forest land. A variety of plant and animal species are dependent on non-forested land.

3.3.5 Public Access Management

Human activity on or near water supply source waters can introduce disease-causing agents to the water supply and cause increases in nutrients, turbidity, and invasive species. Federal and state drinking water regulations require that public access on drinking water supply lands must be managed to minimize the risk of waterborne disease and to control other impacts such as erosion and sedimentation. The reservoirs and associated lands are valuable environmental resources of the Commonwealth that are open space attractions to watershed residents and the general public alike. Public access has historically been allowed on portions of DWSP's water supply lands, and DWSP believes that controlled public access can continue to be allowed without creating significant risk to the watershed system.

The Public Access Management program guides and controls public access and use of DWSP lands in order to protect water quality, safety, and security. A Public Access Management Plan is in place for each watershed. Public access includes the ability to enter and use land for recreational activities, legal restrictions or prohibitions related to access or specific land or water-based recreational activities, sign placement, mapping, user education, and inter-governmental coordination and public safety. Public access is controlled by regulations (313 CMR 11.09) and public access policies.

Watershed Ranger staff has the primary responsibility for monitoring and enforcing appropriate public access, with the police as the official enforcement entity if needed. Watershed Rangers spend most of their time utilizing visitor contacts to explain watershed protection efforts and public access controls. Enforcement through education and outreach is a priority. Watershed Rangers were given additional support for rules enforcement in September 2015 with the ability to issue non-criminal citations and also parking tickets in May 2016. Watershed Rangers now issue non-criminal citations under 313 CMR 11.09 (Watershed Protection); 302 CMR 18.00

(Aquatic Nuisance Control Plan); 313 CMR 5.00 (Parking and Penalties); and MGL 92A ½ §8 (Watershed Management Enforcement).

Signs, kiosks, and other printed information provide guidance on allowed activities and locations where specific recreational uses can be enjoyed.

3.3.6 Watershed Security

Watershed Security is a vital function in an unfiltered public water supply system. The terrorist attacks of September 11, 2001 forced all public water suppliers to re-focus their attention on the security of the water supply. DWSP and MWRA consider security of the water system to be of the highest importance. Security of the water system is comprehensive – source to tap – but is also flexible enough to adjust to a range of potential threat conditions. The probability of intentional contamination of a drinking water supply is relatively low, but it is possible to contaminate a portion of a drinking water system and cause adverse public health consequences or decrease public confidence in the water supply. DWSP's policies are periodically reviewed in order to achieve the goal of providing a safe and secure water supply system.

The primary responsibility of the Watershed Rangers is to protect drinking water resources by conducting regularly-scheduled patrols and surveillance of DWSP-owned lands and waters. Patrols are focused on both popular recreational access locations and security areas around the watershed system. Patrols are conducted by motor vehicle, boat, bicycle, snowmobile, foot, and all-terrain vehicles. Watershed Rangers provide security for DWSP facilities and other designated buildings and regularly monitor potential trouble spots on the watersheds. Special use and group permits may be checked by Watershed Rangers to ensure that permittees are in compliance with their permit. Watershed Rangers keep daily logs of their patrolling activities. In addition, Watershed Rangers are trained as emergency first responders, maintain radio communication with local and state police, have undertaken ice rescue training, and have Incident Command System certifications.

Physical barriers are used where needed throughout the watershed to prevent unauthorized access to sensitive areas. Locked metal gates and wooden barways are located throughout the watershed to limit vehicular access. In addition, concrete barriers, metal security fencing, and boulders/felled trees are used to limit access to certain areas. These structures are regularly installed, monitored, and replaced when necessary.

Rapid advancements in technology have contributed to improved communication within DWSP and from outside of DWSP. DWSP staff regularly receive inquiries via email, often accompanied with photos, from the visiting public regarding questions or concerns. This mode of communication can be responded to quickly, greatly enhancing watershed security. DWSP will explore additional technology opportunities to enhance security through improved communication. In addition, DWSP and MWRA will continue to explore options to monitor areas remotely to further improve watershed system security.

A Vulnerability Assessment was required by the federal *Public Health Security and Bioterrorism Preparedness and Response Act of 2002* – Title IV, Section 401, which amended the Safe

Drinking Water Act. In this amendment, each community water system serving a population of greater than 3,300 persons is required to conduct an assessment of the vulnerability of its system to a terrorist attack or other intentional acts intended to substantially disrupt the ability of the system to provide a safe and reliable supply of drinking water. DWSP and MWRA are implementing the recommendations of this assessment; due to the sensitive nature of this matter, however, specific details will not be included in this report.

3.3.7 Infrastructure Maintenance

The Infrastructure Maintenance program provides resources to preserve the integrity of dams, provide upkeep and improvements to facilities, and construct and repair the roads, culverts and bridges which are under DWSP control. These activities are conducted by professional engineering staff, contractors overseen by engineering staff, and skilled mechanics, equipment operators, tradesmen, and laborers.

Buildings owned by DWSP must comply with the Americans with Disabilities Act (ADA) Accessibility for Buildings Guidelines and will also incorporate recommendations for energy efficiency and clean energy. DWSP strives to make infrastructure decisions that conserve energy and reduce greenhouse gases without compromising public safety and can be accomplished within budgetary restrictions. DWSP maintained fire roads and improvement projects on DWSP property are monitored by EQ staff and follow or exceed all applicable state, federal and municipal regulations during the work phase.

3.3.8 Watershed Protection Act

The Watershed Protection Act (WsPA, also known as the "Cohen Bill") is a 1992 state law (Chapter 36 of the Acts of 1992; MGL Chapter 92A½ §§1, 5) implemented by DWSP that restricts certain land uses in the Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds. There are two types of WsPA protective buffers: the "Primary Protection Zone" – the area within 400 feet of the reservoirs and 200 feet of tributaries and surface waters – where alteration is prohibited; the "Secondary Protection Zone" – the area between 200 and 400 feet of tributaries and surface waters, on land within flood plains, over some aquifers, and within bordering vegetated wetlands – where certain activities are not allowed, including storage, disposal or use of toxic, hazardous, and certain other materials, alteration of bordering vegetated wetlands, and dense development. Landowners proposing certain construction or other land use activities within established buffer zones along the regulated tributaries or surface waters of the watershed must comply with such restrictions and may apply to DWSP for either a determination of non-jurisdiction, exemption, or compliance, or for a variance that allows them to proceed with their plans (possibly with certain restrictions).

Over twelve percent of the three active source watersheds receive some level of protection through the WsPA. The WsPA regulations, 313 CMR 11.01-11.08, however do not prevent all development, as there are a number of exemptions and grandfathering provisions that reduce the breadth of the law. In these instances, the regulations are still able to promote improved site designs, helping to control potentially harmful water quality impacts, particularly within 200 feet of tributaries and surface waters.

Much of the easily developable land in the watershed system, particularly in the Wachusett Reservoir and Ware River watersheds, has been utilized and there is pressure to develop marginal land with increased risks from both short-term site development impacts and long-term land use alteration. One potential difficulty in administering the WsPA is that neither the Act itself, nor the corresponding regulations, require landowners to contact DWSP prior to conducting regulated activities on their land. As a result, DWSP depends upon having good relationships with town boards, building inspectors, realtors, consulting engineers, surveyors, and septic system designers, and others to inform landowners about the law and their obligations. WsPA regulations promote both water quality and community land use protection that is accepted by landowners, realtors, developers, and town officials. Development is monitored by DWSP staff through attendance of meetings of municipal boards and committees and review of legal advertisements and other information in local newspapers. Landowners impacted by the WsPA are notified of requirements and staff works closely with them to develop projects that comply with WsPA regulations.

The WsPA legislation mandates that "a program of technical assistance" be provided to those watershed communities affected by the Act's regulations (Chapter 36 of the Acts of 1992, Section 15). Environmental Planning and Environmental Quality staff support initiatives that enhance local land use protection capabilities. Staff, upon municipal request, may assist local boards in their review of particular development proposals, development of bylaws and regulations, and provide clarifications of the various statutes which govern land use planning and regulation.

3.3.9 Education and Outreach

The Education and Outreach program provides public education for students, local residents, and visitors on the importance of watershed protection. Educational programs are an effective way to protect watershed resources over the long term by instilling a better understanding and appreciation of stewardship of natural resources. Many water suppliers incorporate interpretive services into their watershed protection programs to enhance their measure of water quality and resource protection. Interpretive services are delivered through school programs, programs on DWSP properties (primarily at the Quabbin Visitor Center in Belchertown and the Stillwater Farm Interpretive Site in Sterling), and through Watershed Ranger interactions that inform the public about watershed protection and drinking water issues. Additional details of each program are provided in subsequent watershed-specific chapters. An educated user population is one of the best ways to protect water quality in a drinking water supply watershed.

3.3.10 Water Quality and Hydrologic Monitoring

The Water Quality and Hydrologic Monitoring program conducts routine tributary and reservoir sampling to identify short term water quality problems and maintain the historical record for long term trend analysis, with annual adjustments to the sampling plan to adapt to changing conditions. It is a comprehensive program used to screen for potential pollutants, to measure the effectiveness of watershed management programs, to better understand the responses of the

reservoirs to a variety of physical, chemical, and biological inputs, and to assess the ecological health of the reservoirs and the watershed system.

Environmental Quality staff develops and implements water quality monitoring programs. Hydrologic data are collected to support water quality work and reservoir operations. Stormwater sampling is conducted to assess potential stormwater contaminant inputs. In some cases, water quality impacts may not be apparent due to limitations in methodology or due to extended time periods for impacts to become discernible. DWSP continually reviews its sampling programs to meet changing priorities and public health concerns, as well as to incorporate newly developed analytical methods and updated regulatory requirements. DWSP plans to develop more integrated assessments of water quality across the entire system and develop and use mathematical models when possible to assist water quality elements of watershed management issues.

Water quality data provide information on a variety of physical, chemical, and biological parameters. Water quantity (flow) data are necessary to develop and compare watershed loadings and have become increasingly important as the use of predictive modeling becomes more common. Data are used to identify potential water quality problems, better understand reservoir responses to physical, chemical, and biological inputs, assess ecological health of the reservoir and watershed, measure effectiveness of watershed management programs, and ensure protection of the water supply sources.

All monitoring programs are developed and executed in coordination with MWRA. To further this cooperation, DWSP and MWRA staff holds quarterly or as needed Water Quality Sampling and Analysis Team (WQSAT) meetings; MassDEP also annually inspects DWSP. DWSP monitoring is presently used entirely for watershed protection planning and implementation purposes. For example, coliform data is used to track both pollution sources in tributaries as well as gull locations on the reservoirs; other parameters, such as specific conductance, are currently being analyzed for potential pollutants, such as road salt. All system monitoring for compliance with federal drinking water regulations is done by MWRA and not discussed in this report.

There is a long history of data collection by DWSP on its watersheds, which makes DWSP uniquely positioned to detect and document indicators of climate change. These include physical, chemical, and biological parameter measurements made as part of the water quality monitoring program as well as forest health data.

3.3.11 Watershed Monitoring and Assessment

DWSP utilizes site inspections, Environmental Quality Assessments, local board meetings, and information from Watershed Rangers to identify possible violations of state and federal regulations and potential water quality threats. Threats may be identified by unusual water quality sampling results, field observations by DWSP staff, review of public records, or notification from watershed residents. Suspected threats are investigated, identified, and then corrective actions are pursued utilizing the legal support of all applicable environmental laws. DWSP works with the appropriate local, state, and federal government agencies to enforce these laws.

Environmental Quality Assessments (EQAs) provide a systematic method to locate and control all sources of pollution in each active watershed. EQAs are comprehensive inventories and evaluations of threats to water quality, including DWSP facilities. These reports are conducted by EQ staff on a recurring basis within distinct geographic areas called sanitary districts that are based on watershed hydrology. The EQAs incorporate field inspections, water quality data analysis, and records review, including compliance with environmental regulations for wastewater, stormwater, agriculture, and hazardous materials and waste. The assessment and mitigation components of this program receive equal consideration during the EQA process. EQAs develop recommendations for actions to improve watershed protection and water quality that are incorporated into the annual Work Plans.

Federal, state, and local environmental regulations provide a significant level of protection for the watershed. Regulations may prohibit activities or establish limits or controls on activities. Regulations may also establish protection zones which complement those established in the Watershed Protection regulations (313 CMR 11.00). Notably section 22.20B of Massachusetts Drinking Water regulations (310 CMR 22.00) establishes protections zones for drinking water reservoir and their tributaries; Zones A, B, and C are applicable to all MWRA source water supplies. Spills or releases of hazardous materials of certain concentrations are reportable to MassDEP under the Mass Contingency Plan (MCP). DWSP monitors submitted reports of cleanup efforts for large sites and relays concerns to MassDEP as conditions warrant for sites within the watershed. DWSP works with the appropriate local, state, and federal government agencies to enforce these laws.

Climate change for the Northeast is projected to result in shorter, more intense and more frequent rain events and severe storms which can potentially contribute more contaminants to surface waters. Research and data will be reviewed as it is released for guidance on potential impacts from stormwater pollution, erosion, and emergency preparedness. DWSP will complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on the water supply.

3.3.12 Aquatic Invasive Species Management

Potential impacts from the spread of Aquatic Invasive Species (AIS) vary according to the characteristics of the invading organism. Many AIS cause local extinctions of native species through competition or predation. This loss of biodiversity causes changes in the trophic structure of the community because of disruptions of food web connections, productivity, energy flow, and nutrient cycling. Invasive aquatic macrophytes aggressively displace native plants and grow so densely that littoral zone habitats become choked with vegetation. Water quality is impaired by excessive macrophyte growth because macrophytes function as nutrient pumps, extracting nutrients from the sediment with their roots and releasing them to the surrounding water.

Managing the watershed system to prevent the introduction of AIS requires a comprehensive strategy that integrates public education and outreach, exclusion and decontamination measures at boat ramps and other potential entry points, and an expanded monitoring program. Public

education focuses particularly on recreational anglers and boaters, but also includes those involved in the sale of bait, aquarium fish, water gardens, and exotic pets. Routine monitoring also expands beyond the reservoir and the tributaries to include lakes and ponds in the watershed system.

3.3.13 Wastewater Management

Improper disposal of wastewater is a serious threat to the water supply due to the potential for contamination by pathogens and nutrients, and any release of untreated wastewater must be considered of highest priority for action by DWSP staff. Staff monitors installation of onsite wastewater disposal systems and works with state and local regulators to ensure compliance with all applicable regulations to make sure wastewater is handled safely throughout the watershed.

DWSP staff helps manage the MWRA-operated and maintained Rutland-Holden Trunk and Trunk Relief sewers, which are connected through the City of Worcester to the Upper Blackstone Water Pollution Abatement District Facility in Millbury, MA. The treated effluent is discharged outside the watershed system into the Blackstone River.

3.3.14 Stormwater Management

Stormwater carries pollutants from many different sources to watershed tributaries and reservoirs. It is currently considered the most significant threat to water quality in the Wachusett Reservoir watershed. The DWSP Stormwater Management program develops and implements strategies to reduce pollutant loads from stormwater, such as quantifying stormwater inputs and assisting private individuals, businesses, and local municipalities in their efforts to reduce pollutant loading. DWSP has worked closely with the MassDOT to design and construct stormwater BMPs in key locations on state highways around Wachusett Reservoir.

3.3.15 Emergency Response

Despite the best efforts to implement control over public access, maintenance, land management and other activities on watershed property, emergency situations – especially those involving spills of hazardous materials – could result in immediate threats to public drinking water supplies. Therefore, emergency response is a crucial part of watershed protection programs, especially where water supply reservoirs or watersheds are readily accessible to potential contamination sources, such as transportation corridors passing closely to the reservoir or tributaries.

DWSP maintains and improves emergency response capabilities to assist local emergency responders should a release occur. A prompt response that recognizes the importance of the tributaries and reservoirs can help minimize any impact to the water supply. DWSP staff, along with MWRA and consultants, provide expertise regarding the hydrologic characteristics of the reservoir and its tributaries, on-water spill control, and specialized equipment for reservoir response. Components of this program include Incident Command training, first responder training, the purchase equipment, including MWRA-supplied boom and response trailers, staging

of materials at key locations around the reservoirs, mathematical modeling of potential spill scenarios, and development of Standard Operating Procedures for emergency situations.

DWSP has developed and will implement a multi-year *Emergency Training and Exercise Plan*. This plan provides the framework for enhancing the preparedness capabilities identified by the previously conducted *Threat and Hazard Identification Risk Assessment*. This plan also includes the improvement components identified from previous emergency response exercises.

4. Quabbin Reservoir Watershed Control Programs

4.1 Land Acquisition

Goal: Purchase critical lands by fee and Watershed Preservation Restriction (WPR) using money allocated for land acquisition in MWRA's capital budget as well as other funding sources and gifts.

Land protection priorities in the Quabbin Reservoir watershed are primarily driven by water quality considerations, such as proximity to tributaries and intakes. The watershed has been divided into three land acquisition priority sectors: primary is the West Branch of the Swift River and Hop Brook, secondary is the Middle Branch of the Swift River along with Fever Brook, and tertiary is the East Branch of the Swift River. Other considerations include boundary consolidation, management or access enhancement such as in-holdings, and mitigation of water quality degradation threats.

Accomplishments

Approximately $1.6 million was spent on land acquisition in the Quabbin Reservoir watershed from FY14 to FY18, procuring over 2,284 acres. The acreages and percentages of DWSP-protected land in the watershed over time are summarized in Table 4-1. As indicated, the percentage of DWSP-protected land in the watershed has increased from 54.3% in 1985 to 64.5% at the end of 2017. Some acquisitions were acquired in cooperation with other organizations, such as the "Quabbin to Wachusett" Forest Legacy project, which purchased 1,531 acres with $2.3 million in federal funds. Improved accuracy of the MassGIS data also accounts for a portion of the acreage increase from 2013 to 2018.

Table 4-1: DWSP Protected Land with the Quabbin Reservoir Watershed 1985-2018

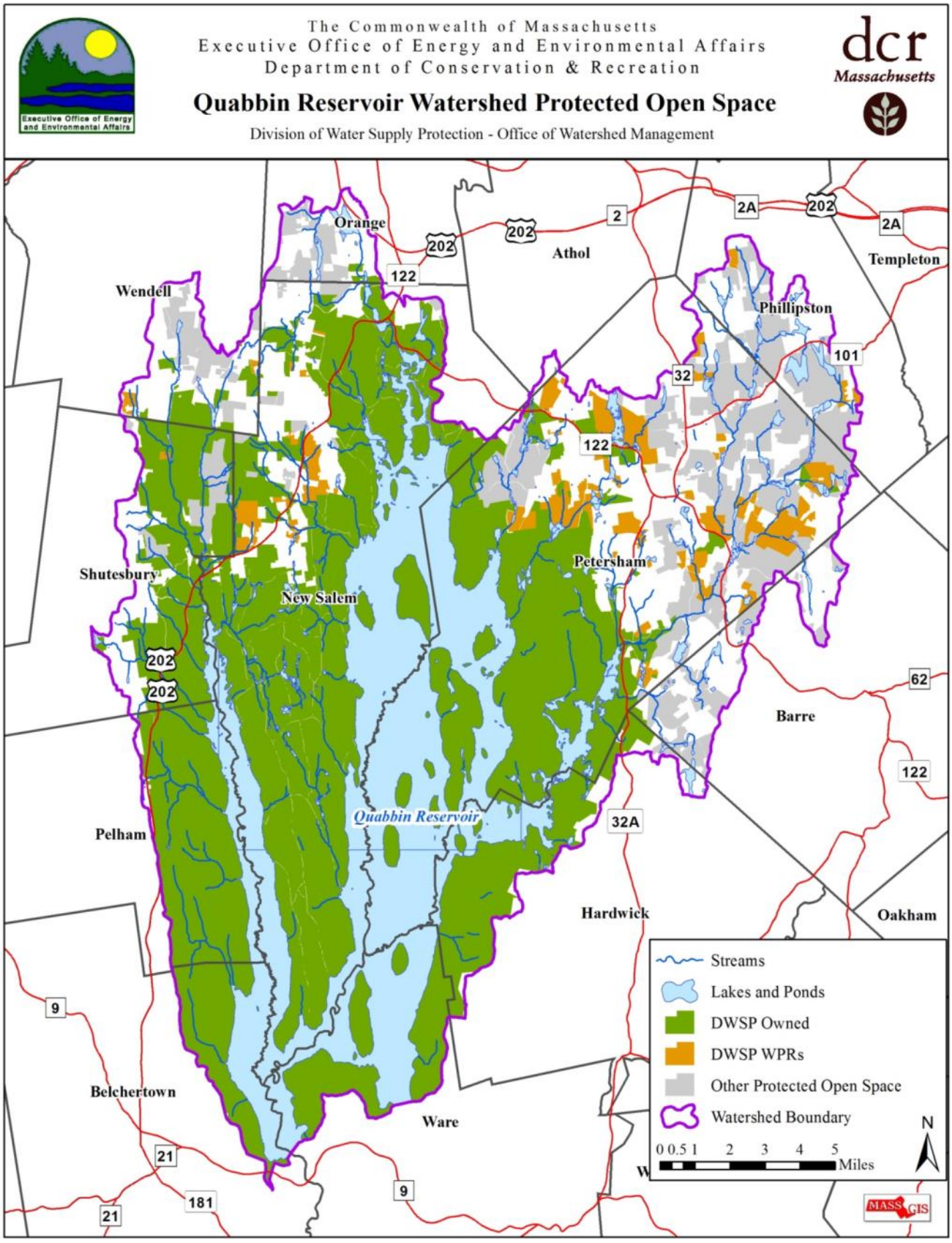
1985		2008		2013		2018	
Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
51,792	54.3%	54,050	56.6%	55,355	58.0%	61,540	64.5%

Source: MassGIS, 2018. Acreage includes WPRs. Acreage differentials from previous years due to increased accuracy of MassGIS data.

Five Year Objectives

- Identify opportunities for land procurement and forward information to the Land Acquisition Panel.
- Using Land Acquisition models and other criteria, purchase lands in fee or, whenever possible, through a Watershed Preservation Restriction (WPR).
- Review existing Land Acquisition models and modify as necessary.
- Collaborate with Land Trusts and other land protection groups to acquire lands through gifts and other means.

Figure 4-1: Quabbin Reservoir Watershed Protected Open Space



4.2 Watershed Preservation Restriction Monitoring

Goal: Maintain control of watershed lands through stewardship of Watershed Preservation Restrictions.

Accomplishments

There are currently 66 WPRs in the Quabbin Reservoir watershed, covering 4,377 acres (Figure 4-1). WPR acquisitions require initial baseline documentation and annual monitoring reports. Baseline documentation reports are completed prior to WPR acquisition. These reports are occasionally performed by contractors when staff availability does not allow for them to be completed by DWSP. High-priority WPR properties are monitored on an annual basis. Other WPRs are generally monitored every two years; sometimes this task can take three years due to limited staff time.

Five Year Objectives

- Complete baseline documentation reports prior to WPR acquisition.
- Monitor each WPR every two years; monitor high-priority ones annually.
- Maintain good working relationships with landowners and resolve WPR violations.
- Enhance field inspections by integrating use of ArcGIS online.
- Collaborate with other divisions of DCR, EOEEA, and other statewide conservation programs.

4.3 Land Management

Goal: Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.

The comprehensive *2017 Land Management Plan* was finalized in January, 2018; it addresses land protection, forest management, wildlife management, and protection of cultural resources. Specific details of land management activities can be found in the *2017 Land Management Plan* and are not reproduced here.

Monitoring the effects of implemented timber harvesting practices on natural and cultural resources has occurred regularly over the past six decades of land management at Quabbin Reservoir watershed. This monitoring has included establishment of permanent Continuous Forest Inventory (CFI) plots, on which various measurements are collected every ten years on individual trees labeled within a designated plot, the most recent in 2010. Results from this long-term dataset continue to show that Quabbin Reservoir watershed lands are growing more wood volume than is being harvested or lost to mortality.

Assessing the regenerative capacity of the forest following disturbance has been a regular part of Quabbin forestry activities since controlled deer hunting was initiated. Regeneration monitoring during the last five years has been modified on occasion and now is focused on counts of only the tallest two stems per six-foot radius plot, which may provide better information regarding future forest species composition.

The Quabbin Reservoir watershed is part of a large monitoring program funded by the National Science Foundation; the National Ecological Observatory Network (NEON) is a continental-scale research platform for discovering and understanding the impacts of climate change, land-use change, and invasive species on ecology. The NEON network is comprised of sites centered in 20 eco-climatic domains representing distinct regions of vegetation, landforms, climate, and ecosystem performance. Both Northeast core sites for this program are located within the Quabbin Reservoir watershed. The aquatic core site is located on DWSP land along Hop Brook in New Salem, and the core terrestrial site is located in Harvard Forest in Petersham.

Accomplishments

Forest monitoring included the collection of regeneration data in 2013, 2014, and 2015. Analysis of the data shows that tree regeneration develops following forest management operations at Quabbin in quantities sufficient to assure the continuation of forest cover. Hardwood tree diversity, however, is still lower than desirable due to a number of factors, likely including the slow recovery from many decades of intense herbivore pressure.

Foresters collected defoliation data in 2017 within some Quabbin oak stands as part of a collaborative effort with UMass to develop remote sensing assessments of gypsy moth damage and mortality. DWSP staff have continued to collect baseline data as part of a long-term paired-watershed forestry and water quality monitoring research effort at both Quabbin and Wachusett watersheds; the treatment phase of these studies is expected to commence in 2019.

DWSP staff issued 28 Permits to Harvest Forest Products on 1,115 acres and supervised 26 timber harvest operations since 2013. New forestry lots are proposed and reviewed annually and made available for public comment, prior to timber marking and sale. DWSP also initiated a monitoring protocol for stream crossings to assess BMP utilization and effectiveness at preventing or minimizing water quality impacts at applicable stream crossing locations during and after harvest activities.

Significant efforts have been made to resolve abutting land use encroachments on Quabbin lands. Efforts have included the completion of approximately 75 miles of boundary marking and sending letters to encroaching abutting property owners.

Five Year Objectives

- Implement the 2017 Land Management Plan.
- Research and monitor, including long-term water quality sampling, to verify the effectiveness of existing statewide and DWSP-specific forestry Best Management Practices (BMPs) in protecting the water supply.
- Continue forestry operations and follow all documented management techniques including oversight and water quality monitoring of active timber harvesting.
- Develop and implement a Terrestrial Invasive Plant Species Plan.
- Assess forest health in Quabbin Reservoir and Ware River watersheds by monitoring regeneration and other indicators of forest health, especially in areas of timber harvest operations.
- Assess and monitor status of encroachments onto DWSP property in Quabbin and Ware River watersheds, and take follow-up actions to resolve encroachments.

- Coordinate monitoring and analysis efforts with National Ecological Observatory Network (NEON) regarding climate change.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on land management in the water supply.

4.4 Wildlife Management

Goal: Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.

The Quabbin watershed supports an impressive variety and abundance of wildlife, and a number of species are monitored by DWSP personnel or other agencies. DWSP is required by state and federal law to protect rare, uncommon, threatened, or endangered species. In general, DWSP works to protect important wildlife and their habitats while minimizing or eliminating adverse wildlife impacts on other watershed resources. In certain circumstances, where applicable, active management to enhance wildlife habitat may occur.

Bird Harassment Program

The Bird Harassment Program operates year-round, but the active harassment phase usually takes place between mid-October and mid-April, with a break in the winter when and if the west arm of the reservoir freezes over. During the active harassment phase, a three-mile "Bird Free Zone" is patrolled daily, weather permitting, by boat crews utilizing pyrotechnics and herding techniques to move the gulls and other waterfowl outside of the sensitive water supply protection area (Figure 4-2). When weather or ice conditions on the reservoir prevent the launching of boats, harassment is conducted from shore.

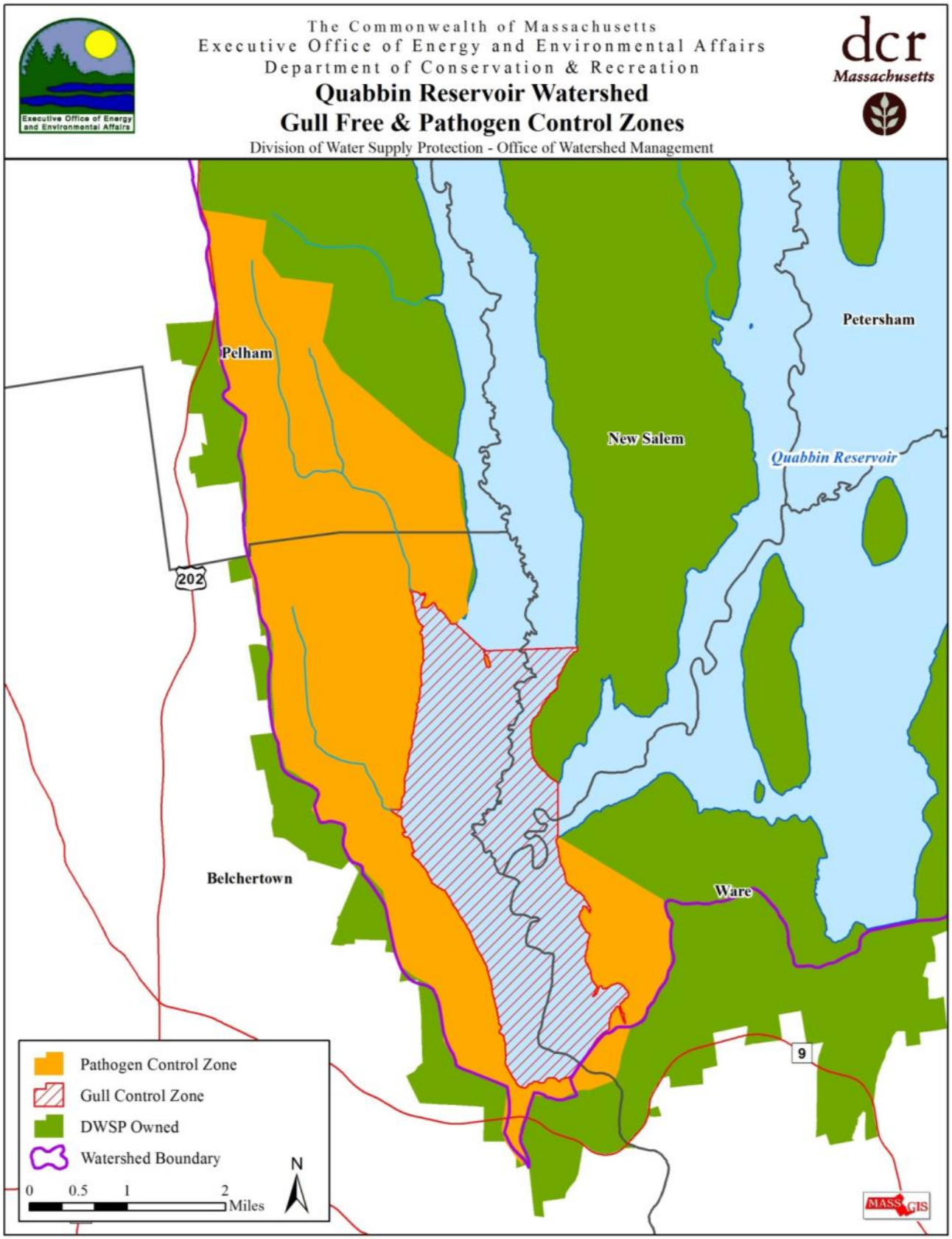
Results from daily bacteriological testing of water entering the Winsor Dam Intake indicate fecal coliform levels have consistently remained well below the SWTR source water quality standard since the inception of the control program. Harassment efforts, coupled with food source reduction efforts, have been an important component in maintaining Quabbin Reservoir's filtration waiver by reducing fecal coliform levels caused by birds. The primary goal of the Bird Harassment Program over the next five years is to ensure continued compliance with source water fecal coliform criteria through a safe and effective program.

Accomplishments

The Quabbin Bird Harassment Program was successful in helping maintain full compliance with fecal coliform standards. DWSP staff produced weekly summary reports on the program during the active phase, and annual reports were completed after the active phase. Harassment safety protocols were improved for program staff.

Work was also performed to limit potential food sources for gulls in the vicinity of the watershed. Landfills, waste water treatment plants, and parking lots are monitored on an ongoing basis. If gull problem areas were observed, DWSP staff followed up with facility managers or parking lot owners to control food sources at these locations.

Figure 4-2: Quabbin Reservoir Watershed Gull Free and Pathogen Control Zones



Canada Goose Population Control

Canada geese can expel *Giardia* cysts into the environment and be carriers of *Cryptosporidium spp*. The Canada Goose Population Control Program includes locating active nesting areas in selected areas of the Quabbin Reservoir's shoreline, particularly on islands. After nests are discovered, the eggs are marked and treated to prevent hatching. In addition, efforts are made to prevent geese with goslings from accessing the lawn of the Administration building, Boat Launch Area (BLA) 1, and the auxiliary spillway. Efforts will continue to focus on eliminating breeding and excluding birds. Barrier fencing will be monitored, and active harassment will be implemented to discourage geese access onto lawns.

Accomplishments

DWSP staff performed goose harassment as needed around Winsor Basin. Staff installed and maintained goose fencing in critical locations. Reservoir islands and nearby ponds were surveyed and eggs were treated to prevent hatching. New harassment techniques were implemented, including the installation of coyote goose-repellent decoys.

Pathogen Control Zone Program

The Pathogen Control Zone program is designed to control the occurrence of *Giardia spp*. and *Cryptosporidium spp*. in the Quabbin Reservoir by preventing populations of aquatic mammals, specifically beaver and muskrat, near intake structures. The program is conducted in a delineated zone (Figure 4-2) where regular monitoring for selected aquatic mammals occurs. When these species are identified in this area, efforts are made to remove the populations with priority on populations closest to the intake. In addition, fecal samples from most removed animals are tested for the presence of *Giardia* and *Cryptosporidium*.

Accomplishments

Staff conducted regular surveys of the pathogen control zone and removed beavers attempting to build dams and lodges within this zone. Most aquatic mammals removed from pathogen control zone were analyzed (as well as fecal samples from gulls and geese when possible) for the presence of *Giardia and Cryptosporidium*.

White-tailed Deer Impact Management Program

DWSP has operated the White-tailed Deer Impact Management Program since 1991. The main goal of the program is to maintain deer population densities at levels that allow for the regeneration and growth of trees. Quabbin deer populations have decreased substantially and regeneration data indicate that regeneration goals have been met.

Accomplishments

DWSP staff made preparations for and conducted the annual Quabbin Controlled Deer hunt for the past five years on Quabbin Reservation lands, with approximately 1,000 hunters participating each year. Over the five year period, almost 400 deer were harvested. DWSP publishes an Annual Report.

Problem Animal Response

This program addresses various wildlife problems that arise throughout the watershed and are not covered by other programs, such as burrowing animals (woodchucks, moles, and voles) causing damage to the integrity of earthen dams, dikes, and other watershed structures or beaver

problems outside the Pathogen Control zone. Lethal methods are used to remove these problem animals under the direction of the DWSP Wildlife Biologist.

Accomplishments

Staff responded to a variable number of beaver-related flooding issues in several locations on DWSP lands in the Quabbin Reservoir watershed each year. Routine surveys were conducted of Winsor Dam and Goodnough Dike; when necessary, burrows were treated at each location.

Rare and Declining Species Habitat Maintenance

DWSP recognizes the regional importance of maintaining some of its lands as open grassland, shrubland, or other non-forest land. A variety of plant and animal species are dependent on non-forested land.

Accomplishments

Open lands have been maintained through mowing by DWSP staff using tractor-mounted deck mowers and a skid steer with a drum grinder attachment to mow larger woody growth.

The *2017 Land Management Plan* includes the designation of several Focus Areas in which DWSP seeks to develop and maintain acreage of young forest habitat and oak-pine barrens habitat. Implementation of this approach has already begun.

Up to twelve floating nest platforms/rafts have been placed in selected locations annually to provide safe breeding locations for State-listed Common loons. These rafts are unaffected by changing Reservoir levels.

Five Year Objectives

- Continue year-round bird observations and harassment efforts on the reservoir.
- Control the resident Canada goose population on the Quabbin Reservoir.
- Reduce the amount of food available to gulls in Central Massachusetts by controlling public feeding and identifying and controlling alternative food sources.
- Monitor, assess, and control aquatic and burrowing mammals that threaten water quality or infrastructure.
- Monitor moose populations and their impact on forest dynamics through browsing surveys, annual moose sign surveys, and exclosure studies.
- Administer the White-tailed Deer Management Program in the Quabbin watershed, including the application, permit, biological data collection, and orientation components of the program.
- Develop a deer management program for Quabbin Park.
- Test mammal and bird fecal samples for the presence of *Giardia* and *Cryptosporidium*.
- Manage habitat for rare and declining species; monitor populations of select species.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wildlife in the water supply.
- Monitor and assess impact of newly created young forest and barrens habitat on targeted rare and declining species populations.

4.5 Public Access Management

Goal: Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.

The 2018 *Public Access Management Plan Update: Quabbin Reservoir Watershed System* describes DWSP's Public Access Management Program in detail; please refer to the plan, available at www.mass.gov/service-details/dcr-watershed-plan-publications for current policies and associated maps. Stakeholders have been involved in public access policy review and modification since the first Public Access Plan was developed for Quabbin in 1988. The general public (local residents, land abutters, visitors, and environmental organizations) have been generally supportive of DWSP's policies to protect the public water supply while allowing controlled access. Public access management has become a high priority in DWSP's watershed protection efforts, especially following the events of September 11, 2001.

The interest in legal recreational public access is changing, as measured by the number of people visiting and frequency in which they visit DWSP lands and waters. This trend of increased intensity of use is best quantified by Watershed Ranger encounters and the number and size of Interpretive Services visitor programs. This increased intensity, for the most part, has been concentrated within Quabbin Park; approximately half of Quabbin Park is outside of the Reservoir's watershed. Informal public access to DWSP lands and waters is increasing as residential development continues in the watershed. Use of the BLAs (see below) has fluctuated over time; there are currently fewer people fishing than historical numbers.

Visitor Education regarding access rules is formally conducted by Interpretative Services and informally by the Watershed Rangers and BLA staff. The Quabbin Visitors Center, located in Quabbin Park, remains busiest on weekends and some holidays.

Access Rules and Regulations – Monitoring and Compliance
While monitoring public access activities on DWSP lands and waters, Watershed Rangers use a variety of enforcement methods, starting with education and then progressing to include written warnings, non-criminal citations, and/or evictions when other methods fail or in the case of severe violations.

The Watershed Rangers also work with other law enforcement agencies, such as the Massachusetts State Police (MSP) and Environmental Police Officers (EPO), to enforce access rules and regulations. The rangers are in regular contact with these agencies; they communicate with them and other enforcement agencies when situations occur that require law enforcement personnel. In addition, the EPO provide rules enforcement for complementary state-wide environmental regulations. Watershed Rangers are in radio contact with both the EPO and MSP, share weekly activity reports with the MSP, and regularly meet with both groups. These relationships are critical to the enforcement of DWSP regulations.

Access Permit Issuance, Monitoring, and Enforcement
Access permits are issued by DWSP to individuals or groups requesting unique access to watershed property in the Quabbin Reservoir watershed. There are three main categories of

access permits issued by DWSP: research, timber harvesting operations, and visitor/educational needs, which are administered by Administration, Forestry, and Interpretive Services, respectively. All three types of permits are monitored by the Watershed Ranger staff and MSP. Enforcement of permit conditions is conducted by the section issuing the permit in coordination with the findings of the Watershed Ranger staff or MSP/EPO if necessary. These permits allow monitoring, tracking, and evaluation of public access activities on DWSP's lands and waters..

Scientific Research Proposal Review and Permitting
DWSP has supported a wide variety of scientific research on the watershed by providing access to its properties, directed management activities, and/or limited direct funding. Research proposal submission requires an application that is reviewed by the Regional Director with guidance from DWSP senior staff. Research proposals are reviewed against specific criteria related to supporting or improving watershed protection activities. If granted, researchers receive conditional permits that expire annually. Researchers are required to notify the Watershed Rangers prior to accessing research areas. Research findings, databases, and publications are annually shared with DWSP. This program is tracked in a database to provide security and to help avoid user conflicts with other research, forestry activities, and other land use activities managed by DWSP. Changes were made in 2018 to improve DWSP's control of this process.

Public Access Information
DWSP recognizes the role of public education in the protection of public drinking water supplies and associated resources. DWSP staff disseminates information about access policies and recreation on Quabbin Reservoir watershed lands and waters. Educational programs are operated at the Quabbin Visitors Center, where staff, exhibits, and materials help visitors interpret the DWSP/MWRA water system, the history of the reservoirs, and the natural and cultural features of the watershed. By raising the public's awareness and appreciation for these precious resources, DWSP is helping to fulfill its mandate to "protect, conserve and enhance the resources of the Commonwealth and to assure the availability of pure water for future generations."

Signage
The first informational signs were created and installed around the Quabbin Reservoir watershed in the 1940s to help control access to certain lands and waters. Today, DWSP staff use various types of equipment to make, repair, or re-word signs in-house. DWSP staff can quickly produce professional signs to communicate a message, such as describing a specific activity, demarcating land ownership, emphasizing rules, and providing directions. Signage types range from single-use, historical signs to special event signage. Updated, accurate, and legible signage is an invaluable, yet ever-changing, watershed protection tool.

Boat Launch Areas (BLAs)
DWSP operates three BLAs which provide limited access to the Quabbin Reservoir in a manner that protects water quality and controls impacts of motorized boats. Motor boat fishing at Quabbin Reservoir is a legacy of political decisions made during the 1950s that were implemented against the recommendations of Quabbin Reservoir's managers. The main responsibilities of BLA staff are to prevent human contact with the water, monitor equipment use near and on the water, and prevent the introduction of aquatic invasive species. The BLA facilities operate off-the-grid using solar power for communication and wood heat. Public

education and rules enforcement is performed by staff at the BLAs, Watershed Rangers, EPO, and MSP. Private motor boats used for fishing are inspected for invasive species and tagged by DWSP staff with a seal prior to being put in the water. Public restrooms are provided at the launch areas and, for day-long boat users, at mapped locations on shore in more remote areas. Boat motor size is limited by the Watershed Protection regulations (313 CMR 11.00); times and locations of access are also limited by DWSP policies.

Quabbin Park and Quabbin Park Cemetery
DWSP is preparing internal policy and operations and maintenance plans for Quabbin Park and Quabbin Park Cemetery. The focus of these plans will be on protocols for routine and special maintenance work. Specific guidance will be provided on vegetation management as well as culvert and guardrail maintenance.

Special Event Oversight
DWSP watershed lands, specifically the Quabbin Park, are popular sites that are frequently requested for many private and public events. A limited number of large events hosted by outside organizations are held annually at DWSP facilities, such as the Walk of Champions at Goodnough Dike. DWSP staff work to control access, protect vulnerable areas, prevent conflicts, and protect public safety in order to balance the desire for these events with the goal of drinking water supply protection. These events generally require access permits issued by the Interpretative Services staff, which are subsequently monitored by the Watershed Rangers.

Field Education
Watershed Rangers are DWSP's "good will ambassadors," not only showing a positive presence but also speaking on behalf of DWSP about watershed stewardship and drinking water supply protection to visitors. Through their positive interaction with visitors, the Watershed Rangers protect these open spaces and encourage all people to do the same by obeying all watershed rules and regulations.

Accomplishments
The *Quabbin Reservoir Watershed System Public Access Management Plan* update was completed at the end of FY18. DWSP staff implemented and improved the Quabbin Boat Seal Program at the three BLAs. Staff also successfully operated the Boat and Shore Fishing Program for 185 days per year. Maps, regulations and other assistance were provided to police and the public to enhance emergency response in the watershed. New boundary signage and expanded information kiosks were installed throughout the watershed. The DCR website is increasingly utilized to share and obtain public access information. From July 2013 through December 2017, Watershed Rangers logged over 82,000 visitor contacts, 1,200 violations, and 35 written citations within the Quabbin Reservoir watershed. More than 1,500 short-term access permits were issued and monitored during this period.

Five Year Objectives
- Implement the *Quabbin Reservoir Watershed System Public Access Management Plan*.
- Maintain working relationships with MSP, EPO, and local police.
- Monitor DWSP lands and water to ensure compliance with rules and regulations designed to protect the water supply and protect the public.
- Implement existing protocol for maintaining gates and other structural controls.

- Expand use of electronic media to disseminate information.
- Prepare and implement Quabbin Park and Quabbin Park Cemetery Policy and Operations and Maintenance Plans.
- Operate the shoreline and boat fishing program in designated portions of Quabbin Reservoir in a manner that minimizes threats to water quality and accommodates visitors with accessibility needs. Implement the Quabbin Boat Seal program.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on public access in the water supply.

4.6 Watershed Security

Goal: Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to protect the watershed system from potential threats.

Security of the water supply system must be thorough and comprehensive, but flexible enough to adjust to a range of potential threat conditions. The terrorist attacks of September 11, 2001 forced public water suppliers to focus their attention on the security of the water supply. DWSP's policies and procedures are regularly reviewed in order to achieve the goal of providing a safe and secure water supply system.

Accomplishments

DWSP staff provided logistical support for a major MWRA security upgrade project at the Quabbin Reservoir. This project, known as the Power and Security Improvement project, installed and/or upgraded the power and communication lines from the hydropower station at the base of Winsor Dam to Quabbin Tower as well as to Shaft 12. The project also included the installation of additional security cameras, illuminators, and alarms to critical facilities.

Watershed Rangers conducted daily patrols of gates/barways, dam, dike, CVA, and Shaft 8. Maintenance and repairs to the gates/barways were performed as needed. Watershed Rangers also deploy up to six motion-activated cameras throughout the watershed to better monitor remote locations.

There is an informal network of recreational users of the watershed that use email, digital photos, and cell phones that supports DWSP by reporting violations of regulations or suspicious activities in real time. The Quabbin Boat Seal Program, initiated to prevent aquatic invasive species, has also added a level of security by insuring all private boats brought onto Quabbin are identified by owner registration and are sealed or inspected since its last use on the reservoir. DWSP updated the forms at the BLAs to obtain more detailed information about people who rent boats for fishing on the reservoir.

Five Year Objectives

- Coordinate with MWRA in order to maintain comprehensive system-wide approach on all security issues.
- Continue Watershed Ranger patrols on all DWSP properties, with particular focus on highly vulnerability sites.

- Work with local, state and federal responders and ensure they receive current agency emergency contact information on a regular basis.
- Remain up to date with any guidance materials available from EPA, American Water Works Association, and Department of Homeland Security.
- Improve physical access control structures, as necessary, and implement a maintenance program.

4.7 Infrastructure Maintenance

Goal: Maintain the integrity of all high hazard dams under DWSP control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.

Program components include: reservoir operations, dams and dike maintenance, facilities management, BLAs, Quabbin Park, Quabbin Park Cemetery, internal DWSP roads and culvert maintenance, bridge inspections, surveying and drafting, construction planning and supervision, fleet procurement and maintenance, and snow removal. Opportunities to improve energy efficiency and sustainability are sought and implemented where possible.

Dams and Dike
The Quabbin Reservoir is impounded by two large, earthen structures: Winsor Dam and Goodnough Dike. The two major, high hazard dams and their ancillary structures are inspected and maintained jointly by MWRA and DWSP. DWSP works with MWRA to optimize the delivery of high quality water for drinking water supply while ensuring adequate volume in storage to respond to fluctuations in precipitation and demand, meet downstream minimum flow release requirements, and prevent violation of minimum pool reservoir stage limitations. In addition, hydroelectricity is generated by the downward flow of water from the Quabbin Reservoir to the Wachusett Reservoir.

DWSP also owns and maintains a number of smaller dams located throughout the watershed system. DWSP maintains and manages a total of 15 small dams located throughout the Quabbin Reservoir and Ware River watersheds. These dams are regularly maintained, inspected, and monitored by DWSP staff in accordance with Massachusetts Dam Safety Regulations.

Facilities Management
DWSP Quabbin/Ware Region manages and maintains 26 separate facilities ranging in size from small photovoltaic power sheds to the 40,000-square-foot Administrative building. Ancillary structures and utilities associated with these facilities include water supply systems, septic systems, IT equipment, fueling islands, and heating systems that include the 60 horsepower, wood-fired boiler system that heats the Administrative building. Civil Engineering staff provide primary oversight of these operations, while maintenance staff provide support with skilled tradesman, mechanics, and laborers. Ongoing maintenance and repairs to these facilities provides compliance with public health, safety, and environmental standards, while opportunities are realized to improve energy efficiency, universal access, and the long term sustainability of each facility.

Internal DWSP Roadways/Culverts/Bridges
DWSP manages and maintains a network of more than 300 miles of roads in the Quabbin/Ware Region. The majority of these roads are unpaved and susceptible to road washouts. The stream crossings of many of these roads are spanned with simple culvert pipe or box structures. However, a smaller number of bridge crossings exist that service woods roads, timber harvesting traffic, and recreational trails throughout the watersheds. The amount of staff time and resources devoted to repair and upkeep of the roads within the Region is not insignificant. An assessment of road needs and priorities, as well as a plan for maintenance, will guide how much time and resources are allocated for this work in the future.

In addition, DWSP is responsible for the primary care and control of five major bridge spans, including the Spillway Bridge Crossing at Winsor Dam and Horseshoe Dam bridge crossing at BLA 3. Bridge decks at the three other major crossings were removed due to safety concerns.

Gravel Pits
DWSP owns approximately 20 acres of gravel pits. Gravel resources are primarily used for repair and upkeep of roads within the Region. Certain watershed towns, such as Petersham and New Salem, also own and/or operate gravel pits. In some cases, there are also privately owned gravel pits in the watershed.

Construction Planning and Supervision
DWSP staff provides a wide array of construction support services ranging from project planning, contract writing, survey, design, permitting, and construction oversight. In-house projects have included boat ramp replacements, septic systems design and installation, and design and construction of stormwater treatment BMPs. In addition to serving as design and construction engineer on a number of in-house projects, Civil Engineering staff also work closely with private contractors on the development of facility improvement plans and on oversight of construction.

Snow Removal
Snow removal work is performed to meet the following goals: 1) provide 24/7 access to the Administration Building/MWRA lab, MSP, and stockroom facility; 2) clear work areas for employee access prior to and during business hours; 3) make Quabbin Park and Cemetery accessible to the public within a reasonable amount of time after a storm has ended; 4) plow roads throughout the watershed based on priority access and ongoing activities.

<u>Accomplishments</u>
Major accomplishments included the development of a Capital Plan for longer-term facility planning. Planning and design work for a new vehicle maintenance building is underway, and this building will be the first project under the Capital Plan. In addition, DWSP staff performed the design, permitting, and construction of several projects, including a new septic system to serve both the existing Stockroom building and the proposed vehicle maintenance building; a culvert on the Gate 8 road; and a culvert and drainage improvements on Blue Meadow Road. Staff also installed a low water boat ramp at BLA 1. Engineering staff oversaw major work performed by subcontractors, including a study of repair/replacement options of the BLA 3 bridge, an updated asbestos survey and operation and maintenance plan of the Administrative building, and the re-paving of the roads in Quabbin Park.

In addition to the support provided for the Power and Security Upgrade project described in Section 4.6, staff provided logistical support for a number of other large infrastructure projects. Examples of these projects include the Hatchery Pipeline project, which conveys about six million gallons per day for both hydropower generation and fish hatchery use, and the Winsor Dam Intake Screen Replacement project.

Significant effort was invested in Quabbin Dam and Dike monitoring and maintenance, including monthly inspections and reporting.

Five Year Objectives

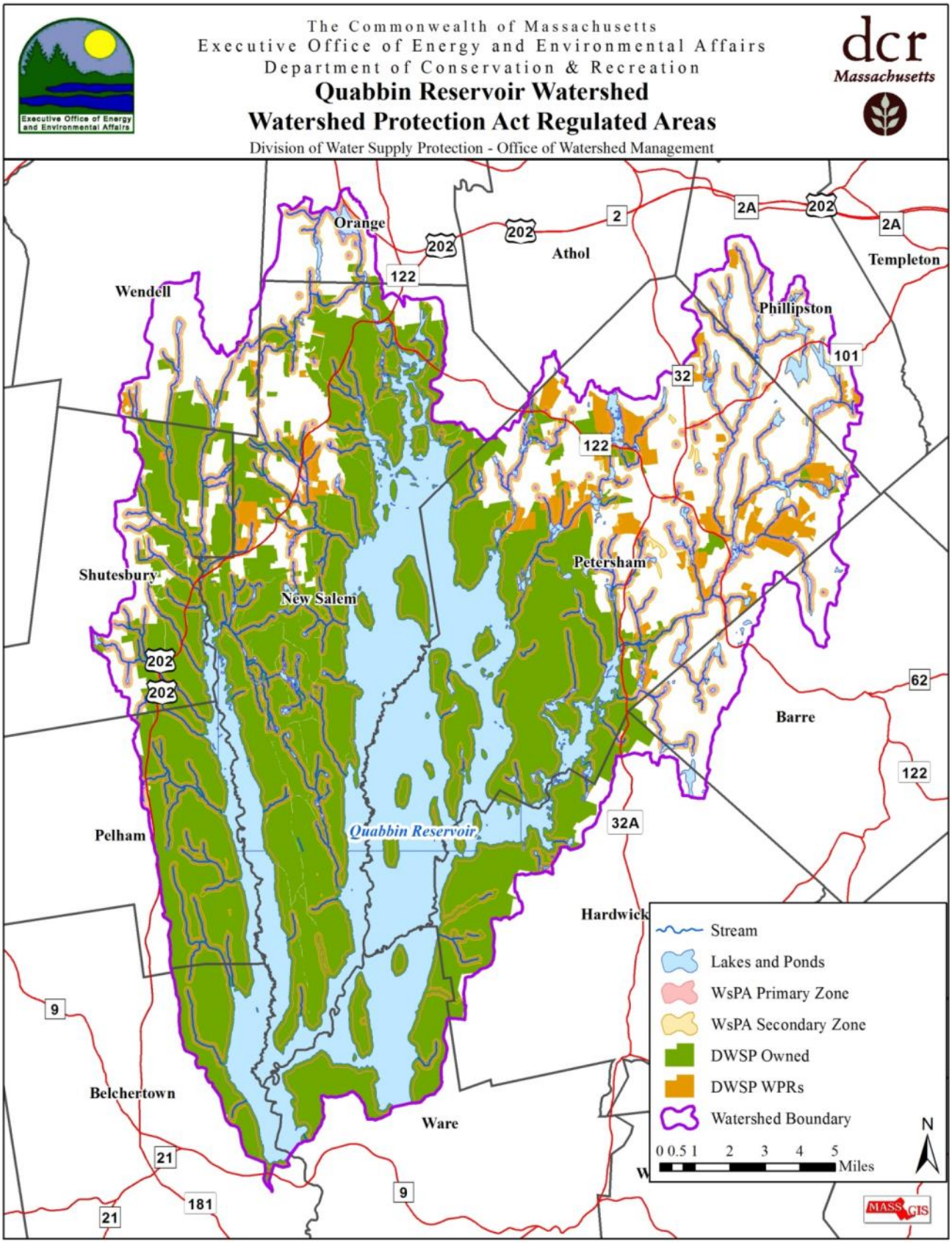
- Maintain and rehabilitate DWSP facilities and roads, including evaluation of Quabbin Administration Building drinking water system and New Salem Forestry office. Investigate road alignment and stream crossing improvements when possible for purposes of emergency response and land management needs. Develop a road classification system for priority maintenance.
- Evaluate need for reservoir maintenance in vicinity of hangar ramp and Winsor intake.
- Work with MWRA on renovation of Quabbin Administration Building.
- Complete construction of maintenance building on Blue Meadow Road.
- Assess infrastructure needs and explore alternative mechanisms for funding to make needed repairs to small dams and bridges.
- Maintain DWSP fuel storage facilities in proper working order and in compliance with all applicable codes and regulations. Investigate feasibility of upgrading or converting underground storage tanks to above ground structures.
- Reduce energy use through energy efficiency practices.
- Evaluate gravel resources in Quabbin watershed. Follow gravel management procedures as outlined in the Land Management Plan and develop a plan for future DWSP gravel needs.
- Evaluate the feasibility of removing or repairing unsafe small dams.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on infrastructure in the water supply.

4.8 Watershed Protection Act

Goal: Enhance protection of the water supply through implementation of the Watershed Protection Act, which regulates land use in critical areas of the watershed.

The Watershed Protection regulations, 313 CMR 11.00, applies to the following towns in the Quabbin Reservoir watershed: Athol, Barre, Belchertown, Hardwick, New Salem, Orange, Pelham, Petersham, Phillipston, Shutesbury, Ware, and Wendell (Figure 4-3).

Figure 4-3: Quabbin Reservoir Watershed Watershed Protection Act Regulated Areas



Accomplishments

The WsPA has been effectively implemented, maintaining both inter- and intra-agency coordination for the past five years. DWSP staff handled 53 WsPA cases during the past five years in the Quabbin Reservoir watershed. Judicial rulings by the Division of Administrative Law Appeals, the MA Superior Court, and the MA Supreme Judicial Court have supported DWSP's rulings and enforcement of the WsPA.

Quabbin staff has worked with several watershed towns on planning, zoning, and subdivision projects involving assistance in master planning, drafting of zoning bylaws, and updating subdivision regulations. A series of environmental protection measures have been added to local subdivision regulations as well as a model open space design methodology for zoning bylaws. Zoning, wetland, and soil testing manuals have been distributed to each watershed community's planning and zoning boards, building inspectors, conservation commissions, and boards of health for their use in field investigations and regulatory review.

Five Year Objectives

- Implement the Watershed Protection Act and regulations.
- Maintain good relations with building inspectors and other town permitting staff and boards to enhance the notification of potentially affected parties of WsPA requirements.
- Provide professional support on land use planning or other associated topics related to DWSP mission to watershed communities.
- Review WsPA applications for stormwater applicability, including NPDES construction general permit, MA Stormwater Performance Standards, and/or town stormwater bylaws. Coordinate with other DWSP staff to ensure that WsPA projects comply with other environmental regulations.

4.9 Education and Outreach

Goal: Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.

The Education and Outreach program is primarily based at the Quabbin Visitor Center, and includes education programs, teacher workshops, and general information about DWSP resources. Four full-time Interpretative Services staff members are available to assist with visitor information and services. In addition, an automated telephone system provides 24-hour access to current information on fishing, hunting, programs, rules and regulations, and public access. Current information and updates are also available on the DCR website.

Visitor Center

The Quabbin Visitor Center is located on the first floor of the DWSP Quabbin Administration Building in Belchertown and is generally open seven days a week from 9 a.m. to 4:30 p.m. The Center is closed on Thanksgiving, Christmas, New Year's Day, and the weekend between Christmas and New Year's Day. The Center features exhibits, brochures, books, and videos about Quabbin management and history. Maps, books, trail guides and related materials are available for purchase from the Friends of Quabbin (FoQ) at the Visitor Center. Vital records for

the disincorporated towns of Dana, Enfield, Greenwich, and Prescott are available in digital format for genealogical research.

Visitor Education
Groups visiting Quabbin Reservoir can stop at the Visitor Center for an introduction to Quabbin by DWSP staff, including a history of the Quabbin area, a summary of reservoir construction, an overview of the DWSP/MWRA water system, DWSP watershed management activities, and information about the wildlife and other natural resources found at Quabbin. More extensive programs on Quabbin history and natural resources are also available. The Visitor Center also offers an ongoing series of guest speakers on a variety of topics ranging from wildlife and local history to art and photography. Group size is limited and program reservations must be made well in advance of the anticipated date. A variety of self-guided educational opportunities exist for groups visiting Quabbin, including eagle watching at Enfield Lookout and 22 miles of hiking trails with a descriptive trail guide (available for purchase at the Visitor Center). Interpretive staff is available to consult with teachers planning Quabbin Reservoir or water-related programs in their school, or for those interested in a group visit to the reservoir. Interpretive staff also maintains up-to-date information kiosks at selected sites in the Quabbin Reservoir watershed.

School Programs/Community Based Education
Educational programs are offered for school groups at the Quabbin Visitor Center on a variety of topics, from Quabbin history to the bald eagle restoration program as well as many topics related to watershed protection. Group size is limited to 60, and programs are offered on a first come, first serve basis. Classroom programs and field trips are also offered to schools and groups in the watershed area and to communities which receive water from Quabbin. Topics include water quality, water awareness, watersheds, natural history, and Quabbin area history. The Quabbin Interpretive staff offers teacher workshops on Water Quality Testing, Watersheds, Project WET, Project WILD, Project Learning Tree, Quabbin History, and other topics. Interpretive staff also have a long history of involvement in the Massachusetts Envirothon.

Visitor Permitting
Interpretive Services staff currently works as the liaison for review of and issuance of group and special permits. Staff provides educational programs to groups interested in visiting parts of the watershed within the constraints of the rules and regulations.

Records Research and Management
Upon dissolution of the Swift River Valley towns for construction of the Quabbin Reservoir, the Quabbin Superintendent became Town Clerk for Dana, Greenwich, Prescott, and Enfield. Each Superintendent (now Regional Director) has held this office and has been responsible for maintaining and managing the Vital Records of previous inhabitants of the valley towns. Copies of these records are stored at the Quabbin Administration Building and are available to the public for research purposes. Similarly, the original survey "Taking Sheets," photographs, and records of each property purchased by the Commonwealth prior to the actual reservoir construction are archived in the Quabbin Engineering Office. Interpretive Services staff frequently draw upon in-house collections of artifacts, as well as the extensive records of reservoir construction and the early management of the watershed lands, for educational outreach purposes.

Collaboration with Quabbin Park Cemetery
Information about the cemetery, its history, the layout of lots, and the process of accessing Vital Records and burials at the Quabbin Park Cemetery is disseminated through the Visitor Center in person, by phone, or by electronic and written correspondences. In addition, an informational sign for visitors is posted at near the entrance of the cemetery.

Outreach and Public Relations
Future efforts of Interpretive Services staff will focus on visitor outreach and education related to the role of the Quabbin Reservoir as a public drinking water supply resource. Activities related to public involvement, either on-site or off-site, for many of the plan reviews, updates, and development are typically coordinated through the Interpretive Services program. *Downstream*, a newsletter, is produced in-house with input from various DWSP staff (www.mass.gov/service-details/downstream).

Accomplishments
Over the past five years, IS staff has implemented the Interpretive Services Plan for Quabbin Reservoir. The Visitor Center staff operates, on average, 360 days/year with approximately 123,000 visitors for this period. Staff conducted over 400 public education programs. In addition, staff coordinated with the FoQ, Swift River Historical Society, Envirothon, and Wachusett Greenways. Staff has developed extensive paper and electronic educational resources such as handouts, posters, displays. Ten issues of *Downstream* were published, and DWSP's website is maintained with current information.

Five Year Objectives
- Maintain and/or initiate information sites, such as kiosks, and programs in watersheds. Expand interpretive signage opportunities to enhance public understanding of the water supply system.
- Operate Quabbin Visitor Center.
- Implement and amend, as needed, the Quabbin Interpretive Services Plan.
- Conduct and monitor established program of public education. Expand educational outreach efforts on aquatic invasive species and climate change.
- Participate in environmental programs with other environmental groups, including environmental education teacher training and Mass Envirothon.
- Develop interactive electronic interpretation for visitors.
- Produce and distribute *Downstream* newsletters to watershed residents.
- Utilize the DWSP website to provide information and resources for the public.

4.10 Water Quality and Hydrologic Monitoring

Goal: Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.

Water quality data provide information on a variety of physical, chemical, and biological parameters. Hydrological data are necessary to develop and compare watershed loadings. These data are used to identify water quality problems, better understand reservoir responses to

physical, chemical, and biological inputs, assess the ecological health of the reservoir and watershed, measure the effectiveness of watershed management programs, and ensure protection of the water supply sources.

Water Quality Monitoring

Chicopee Valley Aqueduct (CVA) Monitoring – daily

DWSP conducts daily site and data monitoring and weekly inspections by foot, vehicle, or boat to identify potential man-made or natural contamination. Follow-up assessments are conducted as needed. Staff regularly monitor wildlife activity in the area surrounding the Winsor Intake which provides water to the CVA. Daily and monthly sampling and analysis from the intake is conducted by MWRA laboratory staff. These samples are analyzed to measure fecal coliform, *Giardia* or *Cryptosporidium*, and total coliform; levels found to exceed certain thresholds trigger DWSP staff notification for additional investigation.

Reservoir Monitoring

DWSP staff collect water quality samples at three established sample sites on Quabbin Reservoir, except during periods of adverse weather and ice conditions in the winter (Figure 4-4). Water quality parameters measured include plankton, bacteria, ammonia, nitrate, total Kjeldahl nitrogen (TKN), total phosphorous, silica, ultraviolet absorbance at wavelength 254 nm (UV_{254}), and calcium. Monitoring frequencies for these parameters ranges from bimonthly to quarterly. In addition, field measurements of temperature, dissolved oxygen, pH, conductivity, chlorophyll-a, and phycocyanin are measured at each site prior to sample collection.

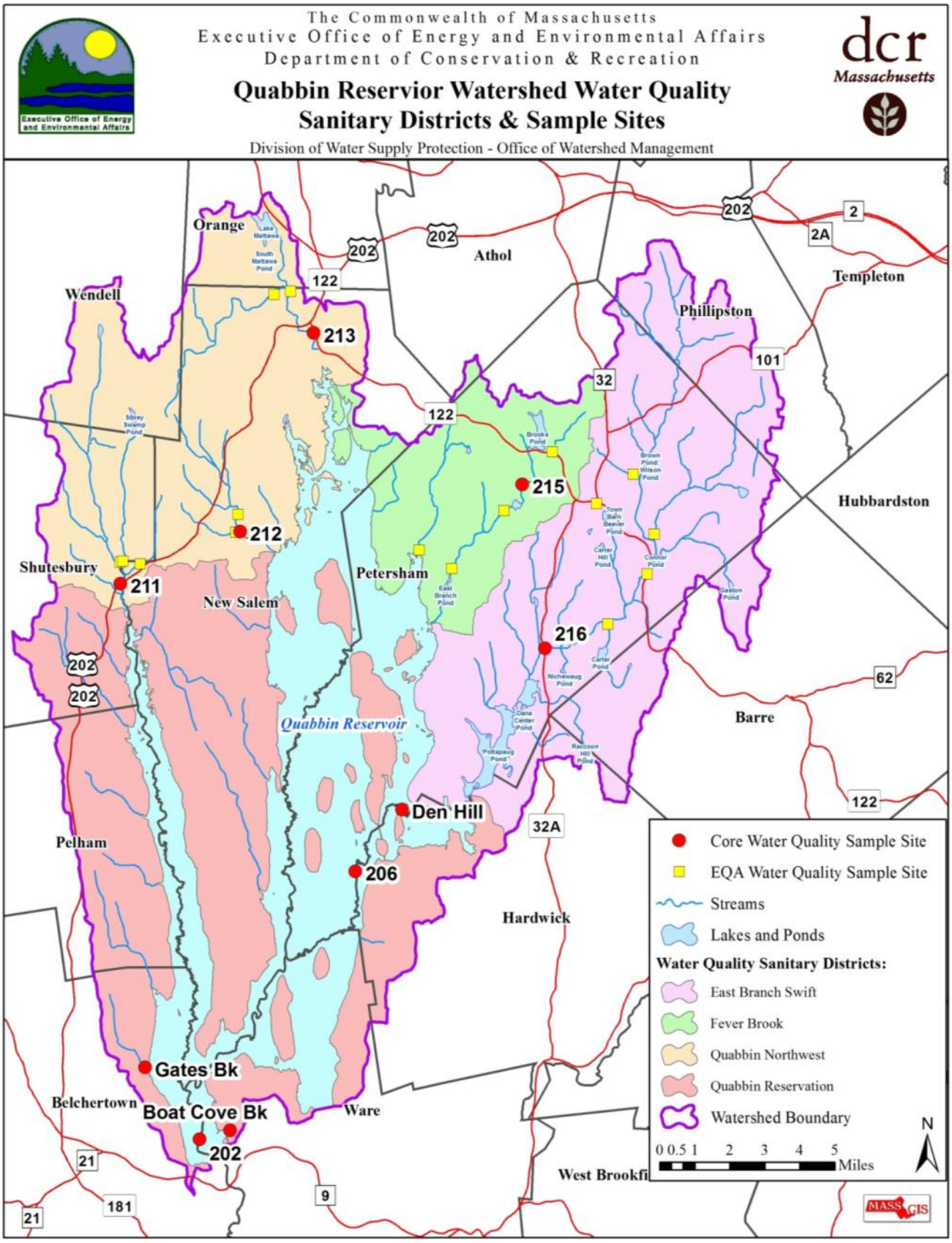
Tributary Monitoring

Surface water in the Quabbin Reservoir watershed is routinely monitored, including major tributary inflows to the reservoir. Sampling locations include seven core sites as well as a number of sites which rotate among several subwatersheds on an annual basis. Tributary samples are collected biweekly regardless of weather conditions. Samples are analyzed for bacteria (total coliform and fecal coliform) and physicochemical parameters (turbidity, alkalinity, nitrate, TKN, ammonia, total phosphorous, UV_{254}, and calcium). In addition, field parameters, including temperature, dissolved oxygen, specific conductance, are measured in the surface water when each sample is collected.

Forestry Water Quality Monitoring – Short- and Long-term

Water quality samples are regularly collected for short-term monitoring at active timber harvest lots and at long-term monitoring sites to assess potential water quality impacts of harvests. Sampling for short-term monitoring is performed during dry and wet weather, and samples are collected upstream and downstream of the harvest lot and some stream crossings. Forestry BMPs are regularly monitored, and additional sampling is conducted if appropriate. Sampling is initiated prior to any disturbance in order to establish baseline conditions, and continues until after the timber harvest has been completed. In the long-term monitoring program, samples are collected during storms to characterize nutrient and sediment loads during these events.

Figure 4-4: Quabbin Reservoir Watershed Water Quality Sanitary Districts and Sample Sites



Hydrological Monitoring

Meteorological Monitoring

DWSP performs meteorological monitoring in collaboration with MWRA to better measure and understand hydrological resources in the watershed. Daily precipitation has been measured at the Belchertown monitoring station since 1930. These data are used for a number of applications, including regulatory reporting, assessment of pollutant loads, and informing water transfer protocols between Quabbin and Wachusett Reservoirs.

USGS Stream Gages

DWSP and MWRA cooperate with U.S. Geological Survey (USGS), Water Resources Division, to maintain continuous, real-time stream gauges at two sites in the Quabbin Reservoir watershed: on the East Branch Swift River in Hardwick and the West Branch Swift River in Shutesbury (Table 2-5). Real time data are available from these stations at the USGS website at https://waterdata.usgs.gov/ma/nwis/rt.

Accomplishments

An extensive water quality monitoring system is in place for tributary and reservoir sampling in the Quabbin Reservoir Watershed. DWSP staff routinely collects tributary and reservoir water quality samples and measures field parameters of surface water bodies using a multimeter. Bacteriological and chemical analyses are performed by MWRA at the Quabbin or Deer Island laboratories. DWSP interact regularly with the MWRA lab to assure efficient operations. DWSP prepares annual water quality reports to document findings.

DWSP maintains relatively large sets of data set from historical water quality and hydrologic monitoring work. The data, while extensive, can be difficult to synthesize in ways that allow for long-term analysis and interpretation. An effort to improve the management of water quality and hydrologic data is underway with a new data management system. Staff at the Quabbin Reservoir collaborated with personnel from Wachusett Reservoir and UMass Amherst Environmental Engineering to develop better ways to manage the large volume of water quality and hydrologic data. UMass engineers developed an application to provide an easier way to review and interpret data from multiple sources. Efforts to organize and improve the data management system are ongoing.

Coordination and communication occurs within DWSP and outside agencies to monitor for potential water quality threats. DWSP staff have successfully advocated for continued funding of USGS sites at two main tributaries of the Swift River and an additional site on the Middle Branch of the Swift River.

In addition, a forestry operations water quality monitoring program was implemented to minimize possible threats to water quality generated by timber harvest operations. Sites are inspected and samples are collected before, during, and after each timber harvest. Water quality and quantity at long-term forestry sites were also monitored, including during storm events to assess nutrient and sediment loads during these events.

Five Year Objectives

- Conduct routine tributary and reservoir sampling program to collect, interpret, and manage meteorological and reservoir data. Identify potential water quality problems and maintain the historical record for long-term trend analysis, with annual adjustments to the sampling plan to adapt to changing conditions.
- Transition to new data management system, and use the system to asses for potential gaps in the sampling program as well as the potential use of the historical record to support analyses of long-term trends and effects of climate change.
- Assure that water entering the Winsor Intake meets MassDEP standards for microbial and physicochemical parameters.
- Conduct short- and long-term water quality monitoring program of timber harvest sites to assess for potential impacts to water quality.
- Develop and implement streamflow monitoring at selected watershed sites. Evaluate permitting requirements, equipment needs, and staff hours for implementation and maintenance. Coordinate implementation with sampling plans and new database.
- Work with researchers to investigate climate change questions related to algae blooms and invasive species in the Quabbin Reservoir.
- Investigate and implement wind monitoring near the Winsor Basin to help determine wind impacts to changes in water quality parameters, such as turbidity and fecal coliform levels.
- Utilize long-term water quality data to investigate increases in turbidity at Winsor Intake.
- Finalize and implement a *Cryptosporidium* and *Giardia* Action Plan with MWRA to establish guidelines for inter-agency notifications and coordination.
- Work with MWRA to install continuous water quality monitoring buoy at Quabbin Reservoir.
- Use water quality and hydrologic data to assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

4.11 Watershed Monitoring and Assessment

Goal: Use Environmental Quality Assessments, site inspections, local board meetings, and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.

The Quabbin Reservoir watershed has historically been divided into four main Sanitary Districts for assessment purposes: 1) Quabbin Northwest Sanitary District; 2) Fever Brook Sanitary District; 3) East Branch Swift River Sanitary District; and 4) Quabbin Reservation Sanitary District. Each Sanitary District is further divided into sub-districts (Figure 4-4 and Table 4-2). The water quality monitoring program, described in Section 4.10, includes monitoring of each sanitary district in order to provide water quality data to support the EQAs. EQAs will be completed according to the schedule in Table 4-3.

Accomplishments

DWSP staff has worked with the US EPA, MassDEP, and local boards and commissions to address situations where pollution has entered watershed tributaries. Results have included both

environmental remediation and fines. Hundreds of sites have been inspected for a variety of possible water quality threats and corrective actions taken when necessary.

EQAs of each sanitary district of the Quabbin Reservoir watershed were completed within the five-year Watershed Protection Plan schedule (Table 4-3). The EQAs relied on database research, records reviews, field assessments, and water quality data to provide a focuses assessment of each district. Mitigation recommendations were reviewed and addressed following the completion of each EQA.

Table 4-2: Sanitary District and Sub-district Attributes

Sanitary District/ Sanitary Sub-district	Drainage Area (sq. miles)	% DWSP Land Ownership	USGS Stream (miles)
Quabbin Northwest Sanitary District			
West Swift River Sanitary Sub-district	14.1	47.6%	24.5
Middle Swift River Sanitary Sub-district	12.25	37.7%	25.3
Hop Brook Sanitary Sub-district	9.67	48%	19.8
Fever Brook Sanitary District			
West Fever Brook Sanitary Sub-district	8.17	59.07%	6.1
East Fever Brook Sanitary Sub-district	8.71	37.9%	8.0
East Branch Swift River Sanitary District			
East Swift River Upper Sanitary Sub-district	10.42	<1%	18.7
East Swift River Lower Sanitary Sub-district	12.97	17.6%	21.1
Pottapaug Pond Sanitary Sub-district	11.65	77.12%	7.1
East Petersham Sanitary Sub-district	11.13	0%	13.1
Quabbin Reservation Sanitary District			
Winsor Dam Sanitary Sub-district	10.50	99%	12.3
Shaft 12 (includes islands) Sanitary Sub-district	20.79	98.6%	26.9
West Arm (Quabbin Reservoir) Sanitary Sub-district	19.67	90%	45.5

Source: EQ, 1998

Table 4-3: Quabbin Reservoir Watershed Environmental Quality Assessment Schedule

Sanitary District	Years Completed	Next EQA
Quabbin Northwest Sanitary District	2000, 2006, 2007, 2013, 2017	2022
Fever Brook Sanitary District	2003, 2008, 2014	2018
East Branch Swift River Sanitary District	2003, 2008, 2012, 2016	2021
Quabbin Reservation Sanitary District	2003, 2005, 2007, 2011, 2015	2020

Source: EQ, 2018

Five Year Objectives

- Conduct Environmental Quality Assessments (EQAs) as scheduled. Incorporate recommendations from EQAs into annual Work Plans. Present findings and proposed mitigation measures annually to DWSP staff.
- Use fieldwork, local contacts, and EQAs to find violations of environmental regulations.
- Coordinate with other agencies, such as MassDEP and Attorney General, to enforce all environmental regulations.

- Monitor status of agricultural operations, above ground storage tanks, hazardous waste generators, spills, and hazardous materials use through field inspections and records reviews.
- Monitor activities in utility Rights-of-Ways (e.g., powerlines, highways).
- Monitor climate change research, data, and recommendations.
- Use watershed monitoring information to help assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

4.12 Aquatic Invasive Species Management

Goal: Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, and decontamination measures at potential entry points. Implement active management when appropriate.

The Quabbin Reservoir has remained largely free of Aquatic Invasive Species (AIS). Potential modes of AIS introduction to the reservoir include wildlife (such as birds or mammals), wind distribution of seeds from nearby water bodies, fishing equipment, or boats (if not monitored). Over 30,000 anglers visit Quabbin each year, bringing a relatively large potential for introduction of AIS to the reservoir if not carefully controlled. The 2009 discovery of zebra mussels in Massachusetts led to the development and adoption of the Quabbin Boat Seal Program, the hiring of an Aquatic Biologist, and the prioritization of AIS controls as a major program.

AIS management activities in the Quabbin Reservoir watershed include: reservoir monitoring; surveys of watershed ponds and rivers; and the identification, collection, and analysis of plants and zooplankton. Some water bodies are surveyed annually, and others are surveyed on a rotating annual schedule by subwatershed. Macrophyte surveys are conducted during the growing season and have been performed periodically since 1998 and on a regular basis since 2006.

Aquatic Invasive Species - biweekly, monthly, and seasonally

Non-native aquatic invasive species within the reservoir are monitored and managed through several focused efforts. This effort characterizes macrophyte flora using visual observation and mapping techniques in areas with the greatest potential for introduction of AIS. In addition, AIS surveys of the reservoir have been performed by consulting firms on an annual basis since 2013, under a contract with MWRA. These surveys provide the most comprehensive data currently available on aquatic macrophytes in the Quabbin Reservoir.

DWSP conducts routine monitoring for invasive macrophytes throughout the watershed near tributary sample sites and other locations including ponds with public boat ramps. Priority is given to water bodies with ramps suitable for launching trailered boats. Monitoring of aquatic invasive macrophytes and invertebrates has been conducted since 2006.

The Quabbin Boat Seal program was established in 2009 due to the potential for aquatic invasive species to be introduced by private boats through the Boat Launch Areas. The program runs throughout the year and includes boat quarantines, boat washing (at a privately-run car wash), inspections, and sealing. Private boats are inspected and must be sealed before launching on the

reservoir; a comprehensive database tracks sealed boats. A kayak/canoe rental program operates at two BLAs to keep private boats out of these water bodies.

Accomplishments

AIS monitoring and sampling was performed in accordance with the AIS Management Plan. Specifically, a reservoir-wide assessment for AIS was conducted annually, and assessments of watershed lakes and ponds were conducted regularly.

Assessments of water bodies in the watershed indicated the presence of several invasive species of plants. DWSP has conducts extensive public education and outreach, including signage, brochures, and presentations, to educate the public about AIS.

The Quabbin Boat Seal Program was implemented over the past five years. There are currently 2,210 unique boats in the Quabbin Boat Decontamination/Boat Seal database. To date, a total of 2,301 decontaminations have been conducted. Approximately 3,300 boat seals have been processed on average at the BLAs since 2014.

Five Year Objectives

- Implement and update the 2010 *Aquatic Invasive Species Management Plan*.
- Operate the Quabbin Boat Seal Program, and evaluate ways to streamline program.
- Survey, monitor, and prevent the spread of aquatic invasive macrophytes in the Quabbin Reservoir and throughout water bodies in the Quabbin and Ware River watersheds.
- Conduct pre-diversion surveys of AIS at Shaft 8 to help prevent spread of AIS. Monitor condition of fragment barriers, replacing or adjusting as needed.
- Inspect equipment and gear to be used in or on Quabbin Reservoir. Notify other agencies and/or consultants of decontamination requirements.
- Control populations of AIS, when possible and necessary, in Quabbin Reservoir and surrounding water bodies.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on aquatic invasive species in the water supply.

4.13 Wastewater Management

Goal: Monitor on-site wastewater disposal systems to ensure proper treatment of waste.

On-site septic systems and, to a lesser extent, "tight tanks" are the methods of wastewater treatment or collection/disposal within the Quabbin Reservoir watershed; there are no wastewater treatment plants within the watershed. Septic systems throughout Massachusetts are regulated by Title 5 regulations. Massachusetts' Title 5 regulations, last modified in 1995, are now fully implemented by local Boards of Health across the watershed. Board of Health records vary considerably within Quabbin watershed towns, making it difficult for DWSP to easily monitor activities related to system installations, repairs, and replacements on private lands in the watershed that are outside of the areas regulated by the WsPA.

DWSP's Watershed Protection regulations provide an additional level of protection to review new system siting within regulated areas, as well as an avenue to review repairs/conversions.

System conversions from septic to tight tanks are common for lake houses on very small lots where a conventional system cannot be sited (e.g., Lake Mattawa). Installations of new septic systems, septic repairs, and septic conversions occur regularly within the watershed. DWSP facilities in the watershed are all serviced by septic systems, which are maintained by DWSP staff.

Accomplishments

A majority of DWSP systems were upgraded beginning in 1998 as part of the Clean State Initiative. To date, 14 DWSP-Quabbin septic systems have been replaced; two systems have been abandoned/closed (Quabbin Park Cemetery and Antennae site); and one system has been converted from a septic system to tight tank (BLA 3).

Five Year Objectives

- Review water quality data and other pertinent information to identify potential problem sites.
- Monitor and enforce the provisions of Title 5, working with local Boards of Health and MassDEP.
- Provide technical assistance, upon request, to towns regarding onsite wastewater management issues.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wastewater in the water supply.

4.14 Stormwater Management

Goal: Reduce water quality problems caused by uncontrolled stormwater.

Stormwater management within the Quabbin Reservoir watershed is primarily focused on road drainage systems. The total impervious surface within the watershed is less than one percent. Historically, a hydraulically efficient storm drain system is one that collects and conveys stormwater from the road surface and surrounding area to the nearest receiving watercourse as efficiently and as quickly as possible, which is typically not the best approach for water quality protection. Road redevelopment projects occurring within the watershed present an opportunity to correct or make improvements to better safeguard receiving watercourses against the effects of stormwater pollution. These projects include work immediately adjacent to Quabbin Reservoir as well as road systems in the wider watershed.

Other discharges of concern are flows to tributaries from the State roadways that surround the reservoir, primarily Routes 202, 122, 32A, and 9. Staff strives to work cooperatively with MassDOT and local officials on highway and local road reconstruction projects to more effectively influence stormwater management design aspects and redevelopment improvements. DWSP efforts begin with the review of project designs and continue through the construction phases of the project to completion.

A significant portion of the watershed roads are rural roads incorporating "country drainage" systems (i.e., no piped collection and conveyance of stormwater), and unpaved roads are common. DWSP is the largest owner of gravel roads within the watershed, with more than 250

miles under its direct care and control. DWSP's gravel roads provide access for water quality monitoring, water supply protection purposes, wildlife management, fire protection, forest management, and controlled visitor access. To ensure a reliable road system the system is maintained using best management practices to limit road washouts, ensure road safety, and to satisfy environmental standards.

Accomplishments

DWSP advised local boards on stormwater regulations and monitored the NPDES database for stormwater management projects. In addition, MassDOT projects were also reviewed for stormwater improvements, such as the Harvard Pond culvert on Route 122 in Petersham.

In addition DWSP posted interpretive signage at the Quabbin Reservoir rain garden and maintained the garden.

Five Year Objectives

- Provide input into state and local road reconstruction projects to influence storm water management design aspects of projects.
- Integrate, maintain, and monitor structural storm water Best Management Practices (BMPs) needed and/or constructed on DWSP property.
- Inspect all construction sites greater than one acre to ensure compliance with Stormwater Pollution Prevention Plans (SWPPPs).
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on stormwater impacts in the water supply.

4.15 Emergency Response

Goal: Maintain and improve short- and long-term emergency response capabilities to protect the water supply.

The Emergency Response program has been put in place for the Quabbin Reservoir watershed in an attempt to minimize the risk of accidental or intentional contamination of the water supply. This program, focused on spill response, has several components, including planning, staff training, and equipment acquisition and maintenance; it will continue to expand as it incorporates additional vulnerability assessments.

Planning

DWSP maintains and periodically updates an Emergency Response Handbook, which provides guidance related to spills of hazardous materials. It includes contact information for DWSP and MWRA staff, as well as local emergency management agencies, contact procedures, information on the DWSP radio system, and roles/responsibilities for staff and local emergency personnel. It also includes information on Incident Command procedures, maps, and other pertinent information that might be needed during emergency situations.

Emergency procedures have also been developed for loggers working on the watershed, including emergency contact cards that instruct loggers who to call in the event of a spill or other emergency situation.

Training
Annual training, in conjunction with MWRA, is provided to DWSP staff and local emergency officials on containment boom deployment and terrestrial spill response. The Watershed Rangers are key participants in these trainings and also receive additional emergency response training.

Equipment
Emergency response equipment is stored and maintained in several locations in the watershed. There are three spill response trailers: one holds boom supplies, another contains terrestrial spill response equipment and supplies, and the third stores supplies mainly pertaining to on-water spill situations. These trailers are sited in appropriate locations for quick access in the event of an emergency situation. A boom deployment shed is stocked and maintained on the bank of the West Branch Swift River (due to the proximity of Route 202). Additional boom supplies are stored in particularly sensitive locations around the reservoir where rapid deployment may be necessary. Spill response supplies are also positioned near active timber harvesting operations or ROW construction work when the site is located close to the reservoir, certain tributaries, or sensitive areas. Spill response equipment is periodically checked, tested, and maintained; new or replacement equipment is added on a regular basis.

Accomplishments
The three spill response trailers were rehabilitated, replacing deteriorating supplies and acquiring additional supplies to expand inventories. Watershed Rangers perform monthly inventory inspections of the trailers. In addition, MassDEP maintains a regional response trailer at the Quabbin Administration building.
Annual emergency trainings were held to train DWSP staff on how to respond to an emergency. These trainings included mock drills with both tabletop and field exercises. Many staff also completed Incident Command System (ICS) 100 training, with certain staff pursuing higher levels of ICS training as appropriate.

Emergency Action Plans were updated for Winsor Dam and Goodnough Dike. Spill response plans were prepared for every timber harvest to ensure prompt responses to spills on the watershed.

Five Year Objectives
- Provide emergency response support services; maintain response supplies and up-to-date contact lists.
- Provide Incident Command System (ICS) training to appropriate staff.
- Coordinate with MWRA and local emergency officials to provide ICS, emergency response training, and annual tabletop or field exercises.
- Construct additional structural controls to reduce likelihood of spills reaching the Quabbin Reservoir.
- Evaluate, monitor, and oversee spills that threaten water quality or DWSP property and work with appropriate federal, state, and local agencies to contain and remediate.

- Finalize and update, as needed, the Emergency Response Manual for the Quabbin and Ware River watersheds.
- Produce spill response plans and spill notification cards for timber harvesting operations, and continue to offer spill response training for timber harvesters working on the Quabbin and Ware River watersheds.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on emergency response in the water supply.

5. Ware River Watershed Control Programs

5.1 Land Acquisition

Goal: Purchase critical lands by fee and Watershed Preservation Restriction (WPR) using money allocated for land acquisition in MWRA's capital budget as well as other funding sources and gifts.

DWSP currently controls 25,486 acres in the Ware River Watershed, or 41% of the land area. That acreage includes virtually all of the most critical property that is closest to the Shaft 8 intake building on the Ware River. DWSP has concentrated efforts toward acquiring land in the Wachusett Reservoir watershed due to the relatively low percentage of that watershed that is under DWSP ownership. DWSP, however, has been able to add significant holdings within the Ware River Watershed over the last five years through a partnership with several local non-profits, protecting 745 acres of land using $1.2 million in funds from the federal Forest Legacy Program.

Accomplishments

DWSP has acquired 232 acres in fee and 614 acres in WPRs in the Ware River Watershed since the beginning of FY2014 (Figure 5-1). Most of this property was purchased through the federal Forest Legacy Program's "Q2W" Project. Other smaller properties were gifted to DWSP.

Table 5-1: DWSP Protected Land within the Ware River Watershed, 1985-2018

1985		2008		2013		2018	
Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
19,300	31.3%	24,137	39.1%	24,232	39.3%	25,486	41.3%

Source: MassGIS. Acres includes WPRs. Acreage differentials from previous years due to increased accuracy of MassGIS data.

Five Year Objectives

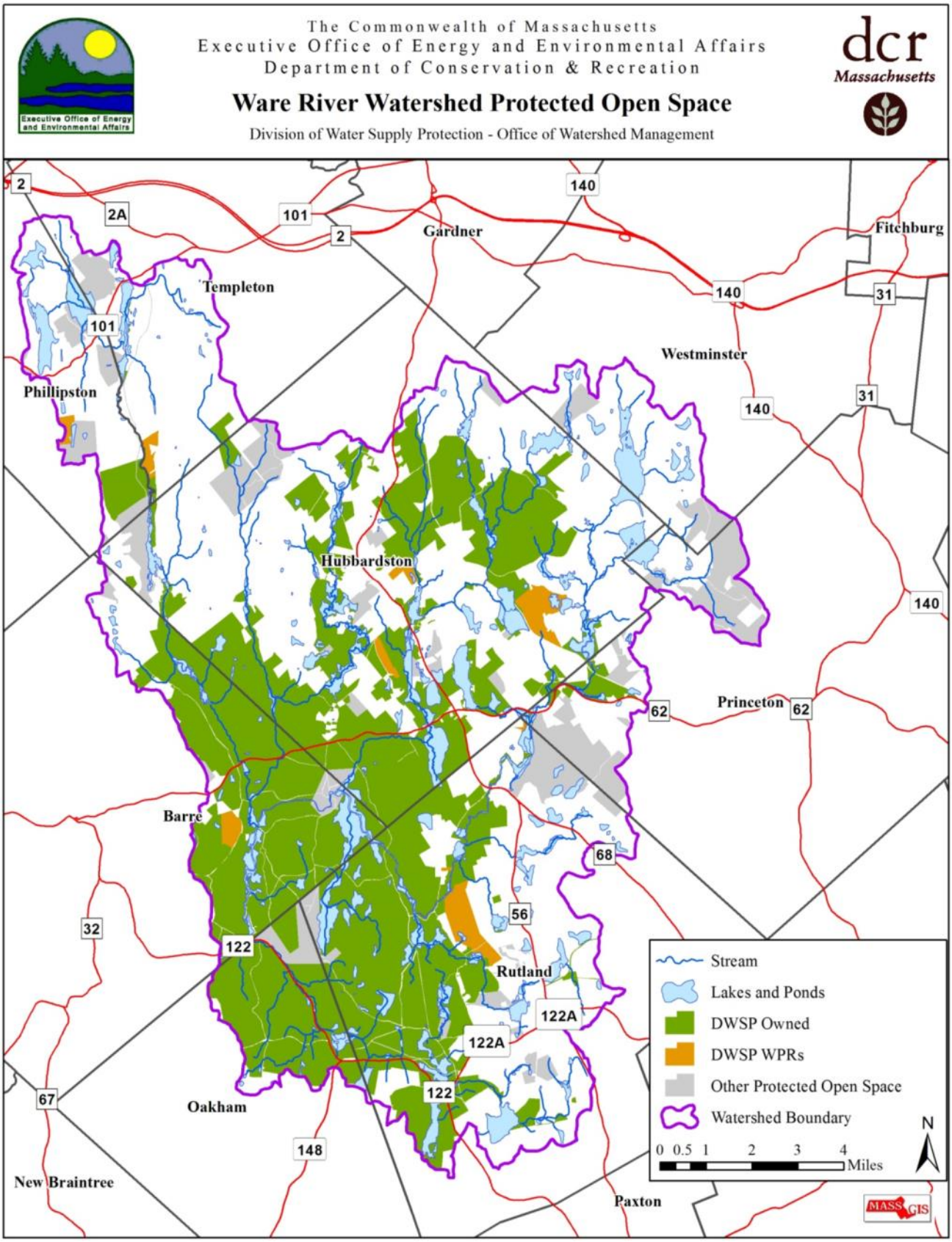
- Identify opportunities for land procurement and forward information to Land Acquisition Panel.
- Using various criteria, purchase land in fee or, whenever possible, through a Watershed Preservation Restrictions (WPR).
- Review existing Land Acquisition models and modify as necessary.
- Collaborate with Land Trusts and other land protection groups to acquire lands through gifts and other means.

5.2 Watershed Preservation Restriction Monitoring

Goal: Maintain control of watershed lands through stewardship of Watershed Preservation Restrictions.

There are currently 18 Watershed Preservation Restriction properties, covering 1,407 acres in the Ware River watershed.

Figure 5-1: Ware River Watershed Protected Open Space



Accomplishments
Since 2013, DWSP purchased or had donated six watershed preservation restrictions on 613 acres within the Ware River Watershed. Funds from the Forest Legacy Program, worth $977,500, were used to purchase watershed preservation restrictions on five of these properties, totaling 604 acres. DWSP staff worked with landowners to ensure compliance on all watershed preservation restrictions within the watershed.

Five Year Objectives

- Complete baseline documentation report prior to each WPR acquisition.
- Monitor each WPR every two years; monitor high-priority ones annually.
- Maintain good working relationships with landowners and resolve WPR violations.
- Maintain records and distribute information as necessary. Enhance field inspections by integrating use of ArcGIS online.
- Collaborate with other divisions of DCR, EOEEA, and other statewide conservation programs.

5.3 Land Management

Goal: Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.

The comprehensive *2017 Land Management Plan* guides DWSP forest management activities on DWSP lands in the Ware River watershed during the next planning period, with the continued goal of establishing a diverse and resilient watershed protection forest.

Long-term land monitoring activities include deer and moose pellet surveys, regeneration surveys, and CFI plots. Terrestrial invasive species are monitored as part of CFI plots. A study of invasive buckthorn on a completed timber harvest was undertaken and will continue over the next five years.

Accomplishments
The comprehensive *2017 Land Management Plan* was written, reviewed, and finalized.

Forest management operations were restarted in 2014 after a review of DWSP timber harvesting policies. Sixteen harvest lots on 335 acres spread throughout the watershed were bid out to private contractors from FY14 to FY18. Thirteen of those lots, covering 293 acres, have been completed.

Regeneration and deer and moose pellet surveys were used to assess forest health.
Multiple habitat restoration projects were begun, including the Barre Heath, Oak Hill Wildlife Management Area, and the Riis Hill field site.

Hay and brush fields were maintained and reclaimed throughout DWSP lands in the watershed.

Over 14 miles of DWSP property lines were marked.

Five Year Objectives

- Implement the 2017 Land Management Plan.
- Research and monitor, including long-term water quality sampling, to verify the effectiveness of existing statewide and DWSP-specific forestry Best Management Practices (BMPs) in protecting the water supply.
- Continue forestry operations and follow all documented management techniques including oversight and water quality monitoring of active timber harvesting.
- Develop and implement a Terrestrial Invasive Plant Species Plan.
- Assess forest health in Ware River watersheds by monitoring regeneration and other indicators of forest health, especially in areas of timber harvesting operations.
- Assess and monitor status of encroachments onto DWSP property in Quabbin and Ware River watersheds, and take follow-up actions to resolve encroachments.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on land management in the water supply.

5.4 Wildlife Management

Goal: Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.

Wildlife management in the Ware River watershed primarily consists of research, dealing with problem animals, and collaborating with hunters. Research is conducted by DWSP staff and other agencies on gulls, deer, moose, and bats. Problem animals, typically beaver that block road culverts, are dealt with on a case-by-case basis. Accommodations for hunters (of whitetail deer and game birds) are made by controlling gate access during applicable seasons. Additionally, seasonal trout stocking occurs on the Ware River. Water quality threats from wildlife is considered a low risk in the watershed, so less emphasis is placed on monitoring and managing wildlife that can impact water quality.

When water sampling data has elevated bacteria counts, EQ staff conduct field investigations to determine the source. The elevated results have frequently been attributed to beavers and their habitat; mitigation is performed as necessary.

Accomplishments

Beaver flooding problems were evaluated and appropriate control measures implemented as needed. Annual deer and moose sign surveys were conducted. The initial results from a moose exclosure study conducted by researchers partly on DWSP land have been published. The study is ongoing. Vernal pools were identified, located, assessed for obligate species, and verified.

Five Year Objectives

- Monitor, assess, and control aquatic and burrowing mammals that threaten water quality or infrastructure.
- Monitor deer and moose populations and their impact on forest dynamics through browsing surveys, pellet surveys, and exclosure studies.

- Test mammal and bird fecal samples for the presence of Giardia and Cryptosporidium.
- Manage habitat for rare species; monitor populations of select species.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wildlife in the water supply.

5.5 Public Access Management

Goal: Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.

The Ware River Watershed offers relatively open access to the public and provides outdoor recreational opportunities to multiple user groups. Public access and recreation on the watershed is presently governed by the 2010 *Ware River Watershed Public Access Management Plan Update.*

The 2010 plan outlines a number of policies, guidelines, and restrictions for recreational activities and other public access on the watershed reservation. It strives for a balance between appropriate recreational activities and the need to protect water quality and the natural, cultural, and historical values of the watershed lands. DWSP will begin to update the 2010 Public Access Plan in 2018. Please refer to the plan, available at www.mass.gov/service-details/dcr-watershed-plan-publications for current policies and associated maps.

DWSP has made a concerted effort in the last five years to educate the public about what types of recreation are allowed in the watershed and where those activities are allowed. Information regarding rules and regulations on public access is available online, through the Quabbin Visitor's Center, and is displayed on kiosks and signs throughout the watershed. Watershed Rangers and other DWSP staff use visitor contacts to educate users about the watershed and the rules and restrictions that govern recreation.

Public access on DWSP's Ware River watershed land suffers in part from public confusion over who manages the property. Many recreationalists assume that property in the watershed is owned and managed by either Rutland State Park or the US Army Corps of Engineers because most access to the watershed is through the park or Barre Falls Dam. In many instances, members of the public have been frustrated to discover that the recreational activities that they have been enjoying in the watershed for years were never authorized or were more limited than they had realized. This has led to some contention at Ware River Advisory Committee meetings, in conventional and social media, and in staff interactions with the public.

Unauthorized trail building on DWSP property, particularly within ecologically sensitive areas, has been an ongoing issue in the watershed. DWSP has recently mapped and closed dozens of these unauthorized trails throughout the watershed. Watershed Ranger patrols have increased to provide more of a presence on the watershed. Bicycles, ATVs, and snowmobiles are now available to the rangers to allow patrols of more remote areas of the watershed.

The Ware River Watershed Public Access Management Plan is due to be updated during this planning period. That process will be an opportunity to update and develop policies to allow public access that will allow DWSP to meet its mandate to protect and enhance the watershed resources.

Accomplishments

Informational kiosks and websites were updated annually with new and current public information. New signs were developed and posted throughout the watershed. Almost 50 miles of unauthorized trails on DWSP property were mapped by staff and volunteers. Over 39 unauthorized trailheads were blocked or closed by Student Conservation Association crews supervised by DWSP staff. Ware River Watershed Advisory Committee meetings were regularly attended by DWSP staff to address issues and inform the committee and the public about DWSP activities.

Five Year Objectives

- Evaluate, update, and implement the Ware River Watershed Public Access Management Plan.
- Develop improved, uniform signage and maps; improve online mapping of recreational opportunities.
- Maintain working relationships with State, Environmental, and local police.
- Monitor DWSP lands and water to ensure compliance with rules and regulations designed to protect the water supply and protect the public.
- Implement existing protocol for maintaining gates and other structural controls.
- Expand use of electronic media to collect and disseminate information.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on public access in the water supply.

5.6 Watershed Security

Goal: Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to protect the watershed system from potential threats.

The components of the Water Supply System that are considered most vulnerable in the Ware River watershed are under the control of MWRA, who provide the majority of the security to those facilities. Watershed Rangers are assigned to Ware River watershed patrols on a regular basis. The ACOE also has a Ranger Section that provides additional security to the land they control within the watershed.

Security checks of the Oakham field office are made during all Watershed Ranger patrols, along with checks of MWRA and ACOE facilities made under agreements with those agencies. Watershed Security is also enhanced by a cooperative relationship with MSP, EPO, local police and MWRA.

Physical barriers, such as locked gates and barways, serve to protect certain areas of the watershed. Vandalism of these barriers occurs infrequently. Surveillance of problem areas, such

as illegal dumping sites and illegal trails, was enhanced with the use of portable game cameras. Opportunities exist to utilize new technologies (e.g., smart tags, dedicated email for reporting suspicious activities) as part of the security program.

Accomplishments

Watershed Rangers increased patrols and security checks, including gates, barways, and facilities in the Ware River watershed. Watershed Rangers participated in collaborative patrols with the Massachusetts EPO, and coordinated with state and local police as necessary. Watershed Rangers reported 4,722 visitor contacts in the Ware River Watershed, which resulted in 131 documented violations and 13 written citations.

Many security improvements have been made by both MWRA and DWSP over the past years. Due to security concerns, these improvements will not be listed here.

Five Year Objectives

- Coordinate with MWRA in order to maintain comprehensive system-wide approach on all security issues.
- Continue Watershed Ranger patrols on all DWSP properties, with particular focus on highly vulnerability sites.
- Work with local, state and federal responders and ensure they receive current agency emergency contact information on a regular basis.
- Remain up to date with any guidance materials available from EPA, American Water Works Association, and Department of Homeland Security.
- Improve physical access control structures, as necessary, and implement a maintenance program.

5.7 Infrastructure Maintenance

Goal: Maintain the integrity of all high hazard dams under DWSP control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.

This program involves maintenance and/or inspection of DWSP-owned buildings, dams, roads, culverts, and bridges on DWSP property in the watershed. DWSP engineers must complete periodic Phase 1 Dam Safety Inspections on Demond Pond in Rutland, Asnacomet Pond in Hubbardston, and Brigham Pond in Hubbardston in order to comply with state law. There are also 13 smaller dams on DWSP property within the watershed. In addition, DWSP owns the trail, bridges, and tunnels associated with the MassCentral rail trail, although the non-profit organization Wachusett Greenways is partly responsible for maintenance of these structures.

Boat access at Long Pond boat ramp and Asnacomet (Comet) Pond boat ramp, although formally under control by the Office of Boating and Fishing, is seasonally managed by DWSP staff. DWSP plows the parking lot at Comet Pond boat ramp in the winter, and installs jersey barriers over the winter to prevent vehicles from driving onto the pond's ice.

DWSP road maintenance is on-going throughout the year to protect water quality and insure DWSP staff access. Over 300 miles of gravel roads and rights of way are monitored, maintained and repaired through the year in the Ware River watershed. DWSP ensures that staff are properly trained, equipment is regularly inspected and serviced, and appropriate materials are used in this program.

Accomplishments

DWSP completed Phase 1 Dam Safety Inspections and Reports on Demond Pond Dam, Asnacomet Pond Dam and Brigham Pond Dam. Dam restoration and design plans have been completed but have not been implemented due to funding constraints. Some minor repairs have been done.

The Oakham Field Office was re-sided with vinyl siding in 2016 and a new oil tank was installed in 2017.

Gravel pits on DWSP property within the Ware River watershed were inventoried and assessed.

Several portable bridges were purchased to replace bridges on DWSP roads that were condemned twenty years ago and never replaced. When the bridges are installed, they will restore DCR vehicle access to thousands of acres of DWSP property for management, security, and emergency response purposes.

Five Year Objectives

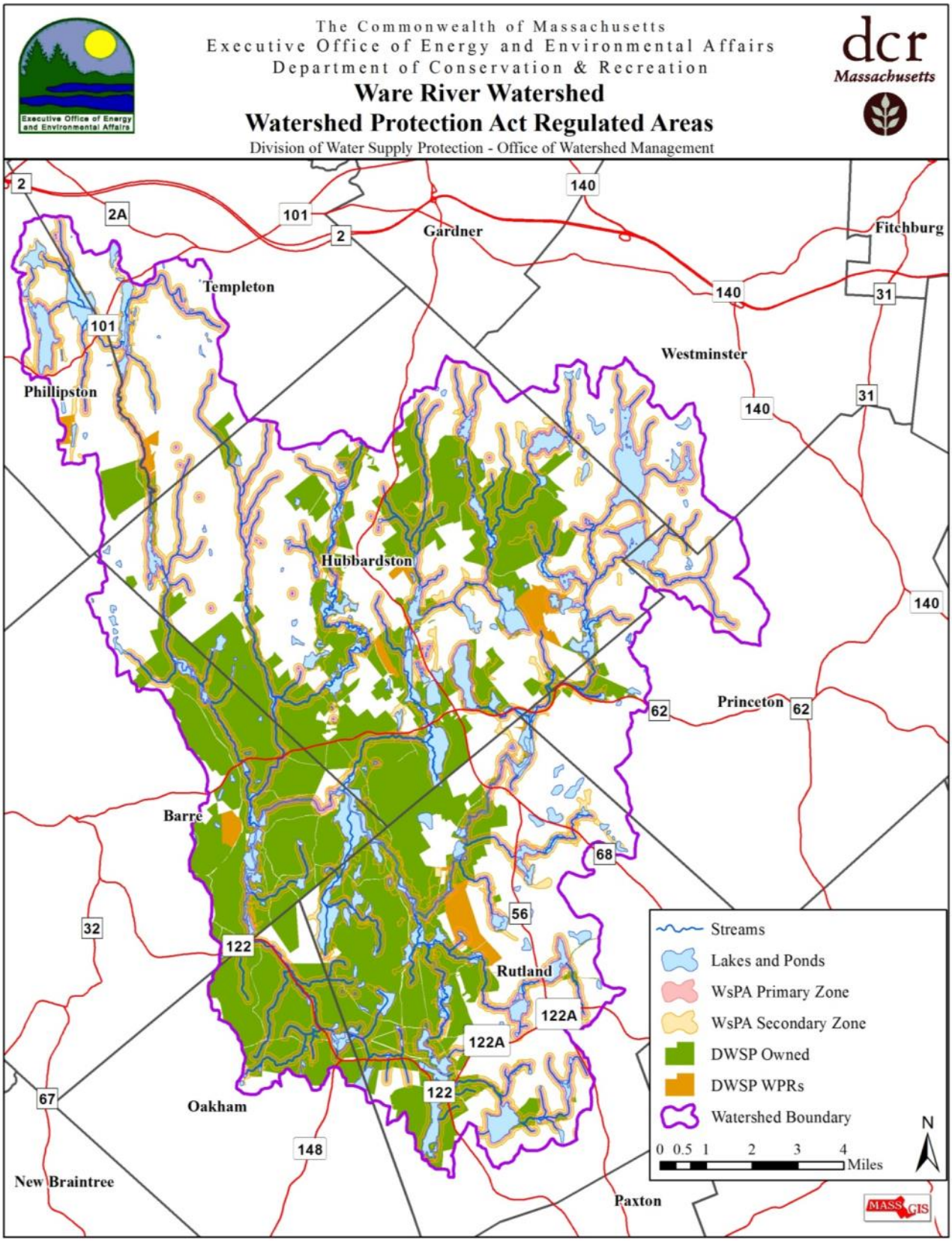
- Maintain and rehabilitate DWSP facilities and roads. Investigate road alignment and stream crossing improvements when possible for purposes of emergency response and land management needs.
- Develop Ware River Watershed Road Plan.
- Install temporary bridges over existing stream crossings and control access.
- Assess infrastructure needs and explore alternative mechanisms for funding to make needed repairs to small dams and bridges.
- Reduce energy use through energy efficiency practices.
- Evaluate gravel resources in Ware River Watershed. Follow gravel management procedures as outlined in the Land Management Plan and develop a plan for future DWSP gravel needs.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on infrastructure in the water supply.

5.8 Watershed Protection Act

Goal: Enhance protection of the water supply through implementation of the Watershed Protection Act, which regulates land use in critical areas of the watersheds.

The WsPA regulations, 313 CMR 11.01-11.08, applies to these towns in the Ware River watershed: Barre, Hubbardston, Oakham, Phillipston, Princeton, Rutland, Templeton, and Westminster (Figure 5-2).

Figure 5-2: Ware River Watershed Watershed Protection Act Regulated Areas



Accomplishments
Staff effectively implemented the WsPA by monitoring water quality and enforcement orders, conducting fieldwork and research on subdivisions and ANR lots in Rutland and Hubbardston, and attending town planning board meetings. Staff worked on 83 WsPA cases in the Ware River watershed between FY 2014 and FY 2018.

Five Year Objectives
- Implement the Watershed Protection Act and regulations.
- Maintain good relations with building inspectors and other town permitting staff and boards to enhance the notification of potentially affected parties of WsPA requirements.
- Provide professional support on land use planning or other associated topics related to DWSP mission to watershed communities.
- Review WsPA applications for stormwater applicability, including NPDES construction general permit, MA Stormwater Performance Standards, and/or town stormwater bylaws. Coordinate with other DWSP staff to ensure that WsPA projects comply with other environmental regulations.

5.9 Education and Outreach

Goal: Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.

The Interpretive Services program provides public education for students, local residents and visitors on the importance of watershed protection. Services are mainly provided by Interpretive Services staff based at the Quabbin Administration Building. Ware River field staff located in the Oakham field office handle inquiries occasionally and as time allows.

The program is administered in three ways:

1. The Quabbin Visitors Center provides information and responds to inquiries about the Ware River watershed. The Quabbin Visitors Center also handles public relations and group access permitting and maintains a library of Ware related records.
2. Visitor education is primarily through informational kiosks, as there are no interpretive services staff assigned to Ware River.
3. Community education to the watershed and user communities for school groups and the general public is provided through the Quabbin Visitors Center and Watershed Rangers.

Accomplishments
Informational kiosks in the watershed were updated annually. DWSP staff at the Oakham field office and Quabbin Visitor Center answered questions and provided information when requested. Work began on the Ware River Interpretive Plan.

Five Year Objectives

- Maintain and/or initiate information sites, such as kiosks. Expand interpretive signage opportunities to enhance public understanding of the water supply system.
- Develop interactive electronic interpretation for visitors.
- Complete the Interpretive Services Plan for the Ware River watershed.
- Promote outreach to user groups in the Ware River watershed.
- Produce and distribute *Downstream* newsletters to watershed residents.
- Utilize the DWSP website to provide additional information and resources for the public.

5.10 Water Quality and Hydrologic Monitoring

Goal: Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.

The Water Quality Sampling Program is designed to characterize and monitor water quality in the different subbasins of the Ware River watershed, usually in conjunction with EQAs (see Section 5.11). Sampling results are summarized in an annual water quality report and are incorporated into EQA reports. Water quality parameters are added to the sample analyses as needed, such as calcium for zebra mussel evaluation. Additional water sampling is performed in response to elevated bacteria at sample sites or during enforcement activities.

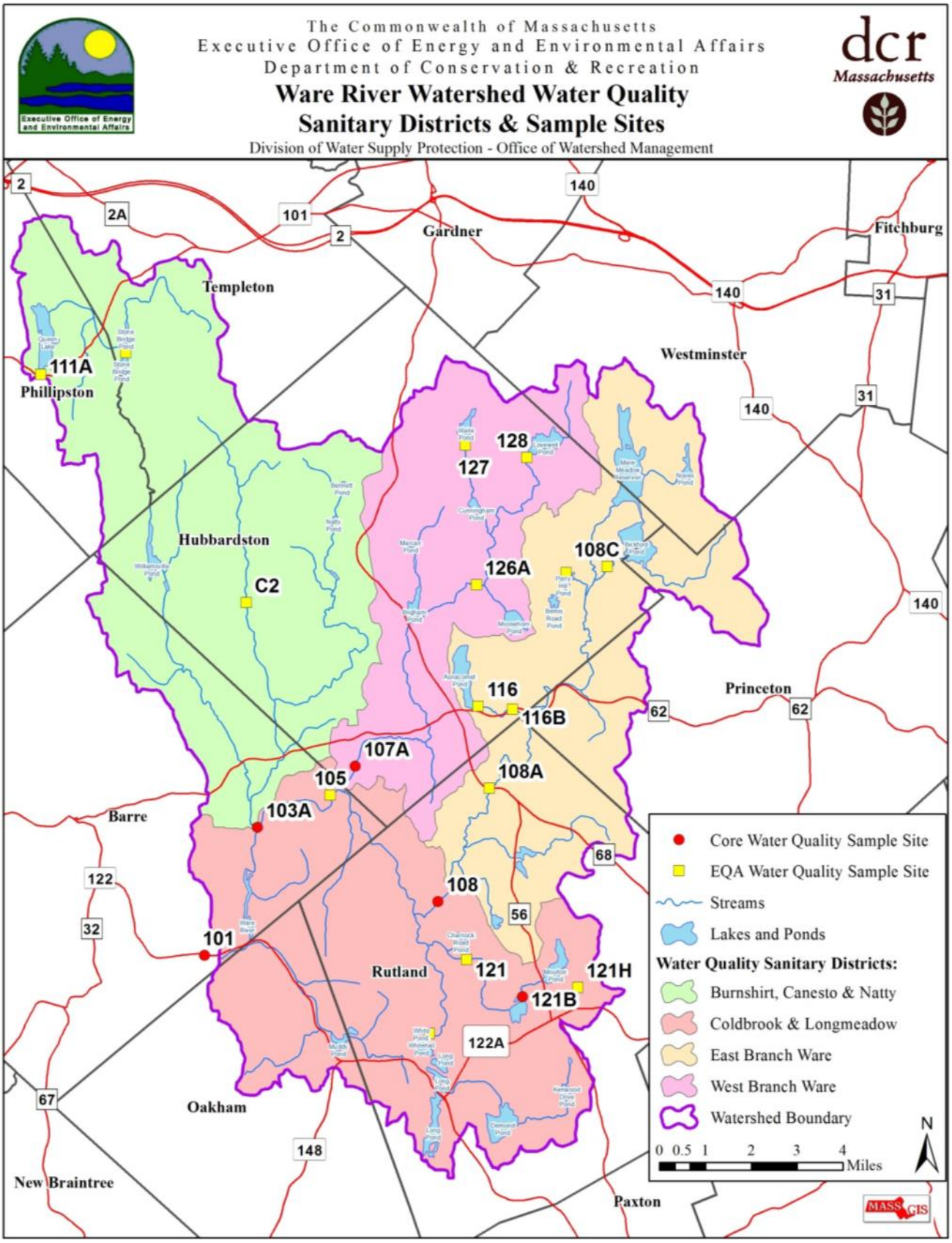
Tributary Monitoring
Surface water monitoring sites are monitored biweekly in the Ware River watershed. The number and locations of sample sites varies annually, depending on assessment and monitoring needs (Figure 5-3). Some sites are sampled every year and provide long-term data. Tributary samples are analyzed for some or all of the following parameters: bacteria (total coliform and fecal coliform), turbidity, calcium, nutrients, alkalinity, UV, pH, temperature, dissolved oxygen, and specific conductance. These data are analyzed and reported annually and summarized every ten years.

Shaft 8 - Quabbin Aqueduct Intake
Samples are collected from Shaft 8 as part of routine tributary monitoring. This is a long-term, historical monitoring site.

Forestry
Forestry sampling within the Ware River watershed consists of baseline samples prior to timber harvesting and then periodic samples during work and after project completion.

Water Quantity
The ACOE at Barre Falls Dam maintains stream gages below the dam and at Barre Plains. The USGS maintains a stream gage (number 01172500) on the Ware River downstream of Shaft 8. In addition, MWRA has gages in the Shaft 8 intake building. DWSP is planning on installing additional gages to monitor and assess water quantity in the watershed.

Figure 5-3: Ware River Watershed Water Quality Sanitary Districts and Sample Sites



Accomplishments

Routine tributary sampling and analysis, as well as macrophyte surveys on ponds and lakes, were completed throughout the watershed. Targeted investigations were performed at tributary sampling sites with high bacteria counts.

Various activities were conducted related to Ware River diversions, including surveys of the intake area prior to diversions.

Water quality monitoring was conducted on one forestry operation stream crossing within the watershed.

Five Year Objectives

- Conduct routine tributary and reservoir sampling program to collect, interpret, and manage meteorological and reservoir data. Identify potential water quality problems and maintain the historical record for long-term trend analysis, with annual adjustments to the sampling plan to adapt to changing conditions.
- Transition to new data management system, and use the system to asses for potential gaps in the sampling program as well as the potential use of the historical record to support analyses of long-term trends and effects of climate change.
- Conduct short- and long-term water quality monitoring program of timber harvest sites to assess for potential impacts to water quality.
- Develop and implement streamflow monitoring at selected watershed sites. Evaluate permitting requirements, equipment needs, and staff hours for implementation and maintenance. Coordinate implementation with sampling plans and new database.
- Conduct targeted sampling at sites with potential for water quality impacts in the Ware River Watershed.
- Use water quality and hydrologic data to assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

5.11 Watershed Monitoring and Assessment

Goal: Use Environmental Quality Assessments, site inspections, local board meetings, and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.

Four districts and 16 subdistricts have been delineated for the Ware River watershed (Figure 5-3). In general, one district assessment is completed each year within the five-year Watershed Protection Plan cycle (Table 5-2).

Table 5-2: Ware River Watershed Environmental Quality Assessment Schedule

Sanitary District	Completed Plans	Future Schedule
East Branch Ware River	1994, 2012, 2016	2021
Coldbrook & Longmeadow	1992, 1994, 2009, 2013, 2017	2022
Burnshirt, Canesto, & Natty Pond	1992, 2010, 2014	2018
West Branch Ware River	2000, 2008, 2011, 2015	2020

Accomplishments

EQAs were streamlined to focus on findings and mitigation, and stormwater treatment and gravel pits were incorporated. EQAs were completed annually for each district, and the results were reported to MassDEP.

Restoration of Molton Pond, which was impacted by runoff from the Bear Hill subdivision in Rutland, was completed in 2014. The Bryce Lemon subdivision in Rutland underwent a number of permitting meetings and a variance process. Construction began in 2017 and is ongoing. The site is constantly monitored for compliance with the WsPA Variance decision and for potential erosion.

Conservation commission meetings were regularly attended in Rutland and Hubbardston, and inspections were conducted on potential problem sites. Staff collaborated with other local officials on issues as they arose.

Several potential water quality/quantity problems were investigated, including high bacteria levels at numerous sites. Staff also routinely monitored both the UST and the 21e databases from MassDEP for new sites and conducted file reviews on existing sites. Potential violations of other regulations – Wetlands Protection Act, Solid Waste regulations and local town bylaws – were referred to the appropriate enforcement agencies.

Five Year Objectives

- Conduct Environmental Quality Assessments (EQAs) as scheduled. Incorporate recommendations from EQAs into annual Work Plans. Present findings and proposed mitigation measures annually to DWSP staff.
- Use fieldwork, local contacts, and EQAs to find violations of environmental regulations.
- Coordinate with other agencies, such as MassDEP and Attorney General, to enforce all environmental regulations.
- Monitor status of agricultural operations, above ground storage tanks, hazardous waste generators, spills, and hazardous materials use through field inspections and records reviews.
- Monitor activities in utility Rights-of-Way (e.g., powerlines, highways).
- Monitor climate change research, data, and recommendations.
- Use watershed monitoring information to help assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

5.12 Aquatic Invasive Species Management

Goal: Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, and decontamination measures at potential entry points. Implement active management when appropriate.

AIS program activities within the Ware River watershed include surveys of ponds and rivers, and the identification, collection, and analysis of plants and zooplankton. Some water bodies are surveyed annually, while others are done in conjunction with EQAs.

Macrophyte surveys are done during the growing season and have been completed on a regular basis since 2010.

Monitoring is conducted at Shaft 8 to assess the potential for AIS in diversion water. Zooplankton are collected and analyzed monthly from Shaft 8. A *Didymo* sampler at Shaft 8 is deployed (unless there is ice cover) and is also checked monthly. In addition, MWRA conducts invasive species surveys.

DWSP runs a self-certification program for boaters at Long Pond and Comet Pond. The Long Pond boat permit program serves as an educational and control program. Staff also conduct outreach and education through signage, newsletter articles, and talking with users at boat ramps in the watershed.

Accomplishments

Staff monitored and collected samples from numerous water bodies in the watershed. Staff collected samples at Shaft 8 for AIS prior to diversions and during the annual Ware River drawdown, and conducted monthly net sampling and artificial substrate monitoring.

Five Year Objectives

- Implement and update, as needed, the 2010 Aquatic Invasive Species Management Plan.
- Survey, monitor, and prevent the spread of aquatic invasive macrophytes in waterbodies in the Ware River watersheds.
- Conduct pre-diversion surveys of AIS at Shaft 8 to help prevent spread of AIS. Monitor condition of fragment barriers, replacing or adjusting as needed.
- Control populations of AIS, when possible and necessary, in Ware River and surrounding water bodies.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on aquatic invasive species in the water supply.

5.13 Wastewater Management

Goal: Monitor on-site wastewater disposal systems and operation of Rutland-Holden sewer to ensure proper treatment of waste.

The majority of the Ware River watershed is served by on-site wastewater disposal systems. Staff monitors to ensure compliance with all applicable regulations, particularly in regulated areas. There are portions of Rutland within the Ware River watershed that are serviced by the Rutland/Holden trunk and relief line sewer system.

Accomplishments

Staff continues to communicate directly with each community's Board of Health on septic system issues. Staff reviewed water quality data and followed up on potential issues.

Five Year Objectives

- Review water quality data and other pertinent information to identify potential problem sites.
- Monitor and enforce the provisions of Title 5, working with local Boards of Health and MassDEP.
- Provide technical assistance, upon request, to towns regarding onsite wastewater management issues.
- Identify larger on-site systems with inspection requirements under MassDEP regulations in the Ware River Watershed.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wastewater in the water supply.

5.14 Stormwater Management

Goal: Reduce water quality problems caused by uncontrolled stormwater.

Stormwater management within the Ware River watershed is primarily treatment systems at newer subdivisions and road drainage. A significant portion of roads in the Ware River watershed have country drainage. Dirt roads, both DWSP and town owned, are common in the watershed. Stormwater management of paved roads with culverts is handled cooperatively with other agencies, primarily MassDOT. Staff monitor and provide input on road projects, particularly those that involve stormwater discharge.

Accomplishments

EQ staff reviewed MassDOT projects and provided input for stormwater improvements on Rt. 122 in Oakham, Rt. 68 in Hubbardston, and Intervale Rd. in Rutland. A direct discharge from Rt. 68 to the West Branch of the Ware River will be eliminated and replaced with a detention basin. The reconstruction of the Intervale Rd. Bridge in Rutland was monitored closely for potential erosion into the East Branch of the Ware River.

Five Year Objectives

- Provide input into state and local road reconstruction projects to influence storm water management design aspects of projects.
- Integrate, maintain, and monitor structural storm water Best Management Practices (BMPs) needed and/or constructed on DWSP property.
- Inspect all construction sites greater than one acre to ensure compliance with Stormwater Pollution Prevention Plans (SWPPPs).
- Examine DWSP stormwater management as part of Ware River Watershed Road Plan.
- Initiate plan to inventory, monitor, and assess performance of stormwater BMPs on privately-owned property.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on stormwater impacts in the water supply.

5.15 Emergency Response

Goal: Maintain and improve short term and long term emergency response capabilities to protect the water supply.

Responsibility for emergency response in the Ware River watershed is divided among several work units: Administrative and Technical Support staff are responsible for developing response plans and training; the Assistant Regional Director serves as the Incident Commander during actual emergency situations; the Watershed Rangers are often the first responders in emergency situations and thus have additional training and response equipment; and staff from all other work units obtain spill response training.

Accomplishments

Staff completed yearly spill response trainings in coordination with MWRA. All Watershed Rangers have had Incident Command System (ICS) training. Staff located and removed illegal dump sites on DWSP property. Spill response plans were developed for all active timber harvest operations and shared with timber harvest contractors.

Five Year Objectives

- Provide emergency response support services; maintain response supplies and up-to-date contact lists.
- Provide Incident Command System (ICS) training to appropriate staff.
- Coordinate with MWRA and local emergency officials to provide ICS, emergency response training, and annual tabletop field exercises.
- Evaluate, monitor, and oversee spills that threaten water quality or DWSP property and work with appropriate federal, state, and local agencies to contain and remediate.
- Finalize and update, as needed, the Emergency Response Manuals for the Quabbin and Ware River Watersheds.
- Produce spill response plans and spill notification cards for timber harvesting operations, and continue to offer spill response training for timber harvesters working on the Quabbin and Ware River watersheds.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on emergency response in the water supply.

6. Wachusett Reservoir Watershed Control Programs

6.1 Land Acquisition

Goal: Purchase critical lands by fee and Watershed Preservation Restriction (WPR) using money allocated for land acquisition in MWRA's capital budget as well as other funding sources and gifts.

DWSP formed the Land Acquisition Panel (LAP) to determine the most appropriate and efficient way to prioritize land procurement options in the Wachusett Reservoir watershed. The LAP developed a land acquisition model that incorporated various geographic, hydrologic, and regulatory parameters to develop weighted criteria to identify critical parcels. The resulting Wachusett Land Acquisition Model Map has guided LAP's land acquisition prioritization process for the past twenty-five years.

Accomplishments

More than $115 million has been spent since 1985 on watershed land acquisition in the Wachusett Reservoir watershed. The MWRA's 1993 Consent Order with the MassDEP required DWSP to acquire or control 25% of the Wachusett Reservoir watershed in order to avoid filtration. The DWSP achieved that goal through a combination of aggressive land acquisition and a "care and control agreement" with State Parks and the DFW that incorporated their lands located in the watershed. Approximately $4.2 million was spent to acquire 502 acres on 28 parcels in the Wachusett Reservoir watershed from FY13 through FY17 (Table 6-1). In addition to nearly 21,000 acres (almost 30%) now under control of DWSP, there are approximately 12,500 acres (17.7%) of other protected open space in the Wachusett watershed (Figure 6-1).

Table 6-1: DWSP Purchases within the Wachusett Watershed, FY14-FY18

Year	# of Properties	# of Acres	Cost*
FY14	4	28.3	$382,500
FY15	7	196.7	$1,419,000
FY16	7	127.5	$964,000
FY17	5	111.1	$624,000
FY18	6	195.8	$1,560,000

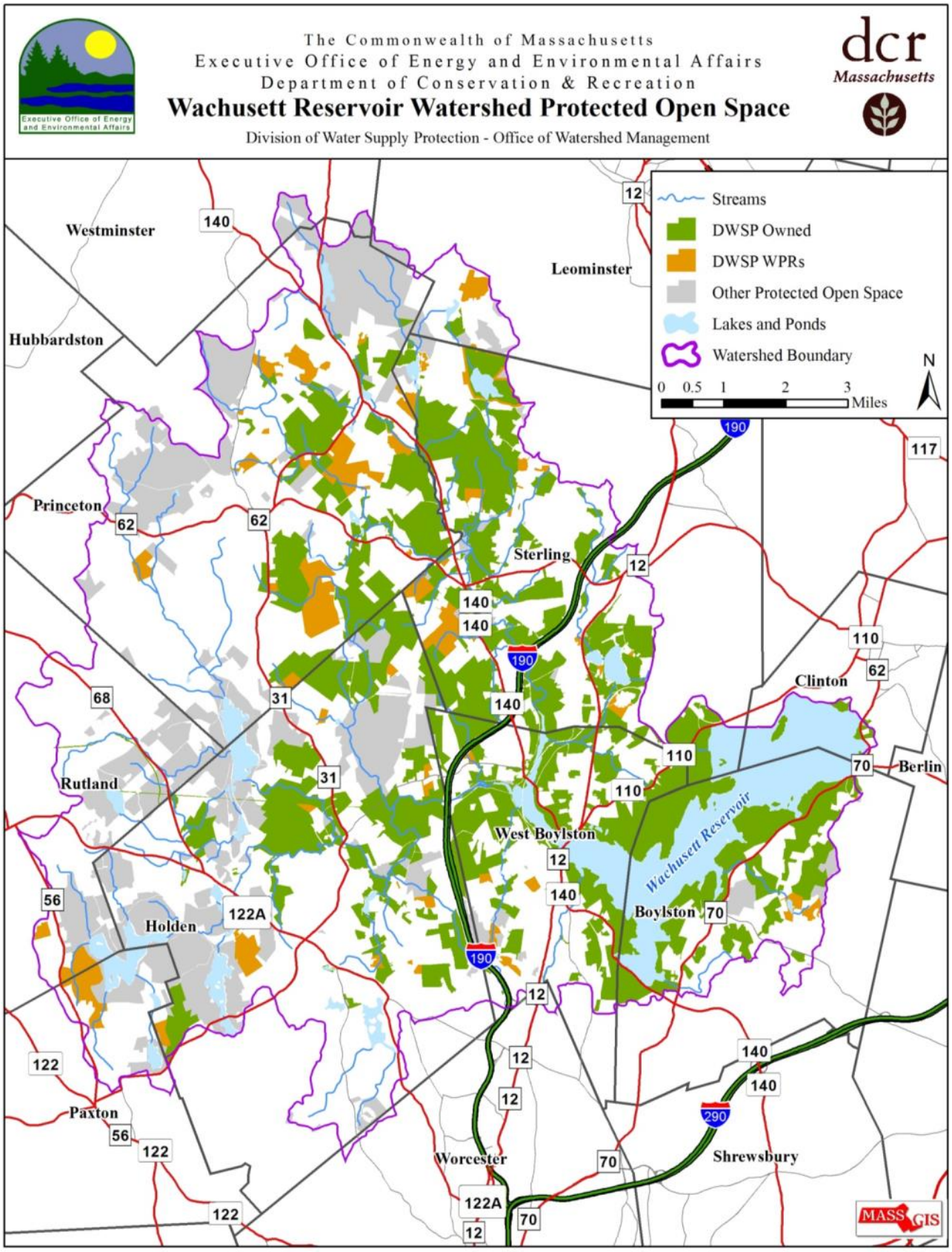
Source: DWSP.
* Cost represents funding by MWRA. Does not include $345,000 in federal funds or gifts.

Table 6-2: DWSP Controlled Land within the Wachusett Watershed, 1985-2018

1985		2008		2013		2018	
Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
5,608	7.9%	18,888	26.8%	20,084	28.4%	20,743	29.3%

Source: MassGIS. Acreage differentials from previous years due to increased accuracy of MassGIS data.

Figure 6-1: Wachusett Reservoir Watershed Protected Open Space



All recommendations from the *2013 Watershed Protection Plan Update* have been addressed. Highly rated properties were purchased by fee or protected through WPRs, with an attempt to focus on the latter. Staff also made a concerted effort to acquire land through gifts or through cooperative efforts with land trusts. Commercial and residential development continues in the Wachusett Reservoir watershed although at a slower pace than in the past. All future efforts to acquire land will be focused on highly rated remaining undeveloped areas.

Land Acquisition Panel meetings were held as needed to review potential acquisitions. Most parcels (19) acquired in the past five years were fee purchases but nine new properties have Watershed Preservation Restrictions and four were outright gifts. The acquisition of the Chapman Company property, the only industrial site on the shoreline of the reservoir, was significant. Due diligence and negotiations continue on additional properties in the watershed.

Five Year Objectives

Numerous smaller holdings within the watershed will continue to be offered as changes in ownership and market conditions motivate people to sell undeveloped tracts. The MWRA has agreed to continue to financially support land acquisition efforts.

- Identify opportunities for land procurement and forward information to the Land Acquisition Panel.
- Using Land Acquisition models and other criteria, purchase lands by fee or, whenever possible, through a Watershed Preservation Restriction (WPR).
- Review existing Land Acquisition models and modify as necessary.
- Collaborate with Land Trusts and other land protection groups to acquire lands through gifts and other means.

6.2 Watershed Preservation Restriction Monitoring

Goal: Maintain control of watershed lands through stewardship of Watershed Preservation Restrictions.

Accomplishments

The proportion of lands protected by WPRs to parcels protected by fee purchases has increased during each five year segment since 1993 (Table 6-3). As of the end of FY17, there were 64 WPRs within the Wachusett Reservoir watershed covering 2,618 acres.

The *2008 Watershed Protection Plan* set a goal of modernizing the WPR program. A new WPR Coordinator was hired in 2009, and by 2013 the program had met many of its core stewardship obligations. During the 2013-2018 plan period the goals remained much the same:

- Complete baseline documentation reports prior to all WPR acquisitions.
- Monitor each WPR every two years; monitor high-priority ones annually.
- Maintain good working relationships with landowners and resolve WPR violations..
- Maintain good records and distribute them to other staff as necessary.
- Investigate ways to increase DWSP's stewardship capabilities.

Table 6-3: New Lands Under Control of DWSP in the Wachusett Watershed (in acres)

Years	Total Newly Protected Acres	Total New WPRs	% New WPRs	Total % WPRs
2013-2017	428	190	44.4%	18.2%
2008-2012	635	369	58.1%	17.4%
2003-2007	671	352	52.5%	15.5%
1998-2002	5,196	1,411	27.2%	13.5%
1993-1997	5,521	297	5.4%	4.0%
1985-1992	1,903	0	0.0%	0.0%

Source: DWSP.

The number of WPRs has increased while staffing has remained nearly constant. WPR baseline reports were completed for most new WPRs and nearly all of the high priority WPRs were monitored annually, but remaining WPRs were inspected once every three years or even less frequently (Table 6-4).

Table 6-4: WPRs within the Wachusett Watershed, FY2013-2017

Year	# of Properties Inspected	Total WPRs
FY13	11	55
FY14	33	57
FY15	12	58
FY16	23	60
FY17	13	64

Source: DWSP.

The WPR Coordinator meets regularly with other staff and shares up-to-date information. A shapefile of WPRs exists but is not currently linked to any type of additional database. All paper data have been scanned into digital form and information on site visits is maintained in Excel spreadsheets and Word documents.

Good working relationships with landowners were maintained. Two newsletters have been written, published, and distributed to landowners each year. Meetings were held with successor landowners. Boundaries were posted on selected WPRs.

Five Year Objectives

- Complete baseline documentation reports prior to WPR acquisition.
- Monitor each WPR every two years; monitor high-priority ones annually.
- Develop strategy to meet WPR monitoring goal.
- Maintain good working relationships with landowners and resolve WPR violations.
- Maintain records and distribute information as necessary. Enhance field inspections by integrating use of ArcGIS online.
- Collaborate with other divisions of DCR, EOEEA, and other statewide conservation programs.

6.3 Land Management

Goal: Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.

The Land Management Program takes guidance from the comprehensive *2017 Land Management Plan* (LMP) which addresses how DWSP cares for Forested Lands, Non-Forested Lands, Wildlife, and Cultural Resources. Specific details of land management activities can be found in the Land Management Plan and are not reproduced here. Monitoring of short-term impacts of silviculture in the Wachusett Reservoir watershed is described below; the long-term monitoring program for Wachusett Reservoir is described in detail in Section 6.10.

Accomplishments

The LMP for all watersheds was completed in 2017. Proposed timber sales were reviewed internally for consistency with the new LMP.

DWSP Foresters compiled a plan of all proposed timber harvesting activities each December that could occur during the upcoming fiscal year. Each January, the Foresters carefully mapped and described or marked the boundaries of each planned operation so that they would be easily distinguishable on the ground.

After mapping the areas where timber harvesting were proposed, the Foresters digitized site maps and completed forms describing the proposed operation in detail, including proximal wetlands and previously identified critical cultural and wildlife sites. Summaries of the planned harvests were submitted for review to the Regional Director, the DCR Archaeologist, DWSP's Wildlife Biologist, and the Director of Natural Resources. Information on proposed and existing projects are posted on DWSP's website.

Table 6-5: Timber Sales within the Wachusett Watershed, FY2013-2017

Year	# of Timber Sales	# of Acres
FY13	6	284
FY14	4	208
FY15	7	324
FY16	9	457
FY17	8	454

Source:

DWSP's Wildlife Biologist reviewed the planned timber harvesting operations each spring and, where necessary, conducted site visits. Environmental Quality staff also visited each site to determine if water quality sampling was necessary, and if so, developed and implemented a regular water quality monitoring program. Monitoring of short term impacts of silviculture consists of monthly turbidity sampling above and below stream crossings when flow is present during both dry and wet weather at all proposed and active timber harvesting sites.

Hundreds of visits were made to 18 different locations during the past five years to collect water quality samples, establish baseline turbidity, and monitor water quality during active timber harvesting and during the installation and removal of stream crossings. This monitoring did not show any short-term adverse impacts on water quality.

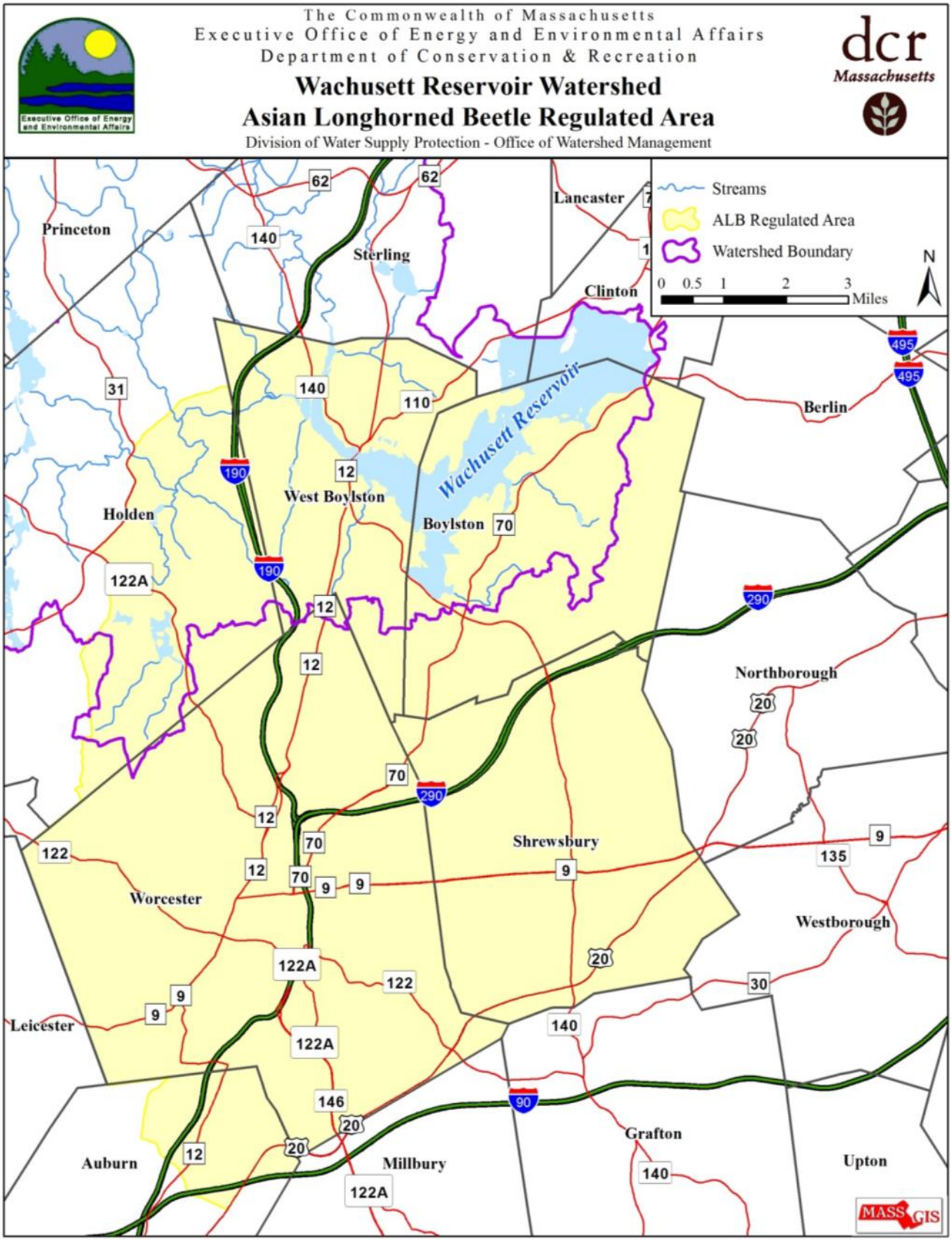
Damaging insects and disease causing organisms are a normal part of the forest ecosystem, but the presence of non-native organisms without natural predators and parasites can be a serious threat. DWSP's approach to prevention of infestation as well as managing the effects and outcomes if present varies by species and is described in detail in the LMP.

The detection of Asian long-horned beetle (ALB) in Worcester in 2008 has resulted in a lengthy and expensive control effort. ALB is one of the most destructive invasive insects in the United States, infesting a wide variety of hardwoods found in the watershed forests. The Massachusetts Cooperative Asian Long-horned Beetle Eradication Project is a coordinated effort by federal, state, and local agencies with the goal of preventing the spread of ALB to other areas of New England. The ALB Eradication Project established quarantine areas and protocols for surveying and eliminating host trees. Asian long-horned beetle host tree removal operations have been conducted on 132 acres at nine locations on DWSP properties in the Wachusett watershed during the past five years. More than 40% of all DWSP forested land within the watershed remains under quarantine (Figure 6-2).

Terrestrial invasive plants may not categorically threaten the short-term protection of a drinking water supply, but can monopolize species composition, simplify structural complexity, and damage existing resources which conflicts with watershed objectives for a diverse and resilient forest cover. Some invasive plant problems on DWSP properties are the result of deliberate plantings of species that addressed other concerns but later exhibited invasive behavior. Other invasive species populations are escapees from landscaping and have spread from roadsides and backyards into DWSP lands.

A number of invasive plant species are currently established on DWSP properties. Control of these species is important to allow for the establishment of tree regeneration and maintenance of native plant diversity. Invasive plant species currently found in the Wachusett Reservoir include Norway maple, Oriental bittersweet, Buckthorn, Honeysuckle, Autumn Olive, and Multiflora rose. An inventory of terrestrial invasives and mapping protocols were developed, but a comprehensive survey of invasive plant species and the extent of their spread have not yet been completed. A population of bittersweet and Autumn Olive was controlled in West Boylston during the past five years.

Figure 6-2: Wachusett Reservoir Watershed ALB Regulated Area



Criteria have been developed to decide which DWSP-owned property will be maintained as hay fields through the agricultural permitting system. DWSP personnel created a management plan for every field that has been chosen for continued agricultural use, which includes a map of all required buffers, specifications for allowable fertilizers and soil testing, and restrictions on timing or number of cuts allowed and the type and frequency of reseeding. In order to maximize wildlife value, some leased fields may be subject to additional restrictions when deemed necessary in order to conserve grassland nesting birds and other wildlife.

Reservoir shoreline areas provide breeding habitat and food resources for wildlife species including some that could impact water quality. To address these concerns, shoreline management decisions sometime recommend conversion of grassy shoreline to woody vegetation. The North and South Dikes must be maintained free of woody vegetation in order to preserve the structural integrity of these earthen dikes and are mowed several times annually to maintain a good grass condition. The downstream slopes of both dikes were completely cleared to meet new regulations.

A study of reservoir bluff erosion was completed during the past five years. Reference markers were placed on a number of bluffs to determine the rate of erosion. A 2014 report examined the issue of falling trees and bluff erosion along sections of the shoreline and concluded that downed trees and eroded soils reaching the reservoir would add undesirable nutrients, promote algal growth, and increase shallow substrate and the possibility of invasive aquatic plants. The report recommended that all tree species on the bluffs other than arborvitae be cut and that any trees that fall into the reservoir will be removed.

Erosion of high bluffs such as Sawyer Bluffs and Scar Hill Bluffs in Boylston are caused primarily by wind action. Efforts were made to try to stabilize the face of these bluffs with plantings, hydroseeding, and erosion-control fabric with mixed success.

The entire perimeter of DWSP land in the Wachusett Reservoir watershed, excluding the reservoir, is nearly 359 miles. Some properties are bounded by roads, railroad frontage, and shorelines; there are sections of boundary that cross swamps and marshes that are considered too difficult to maintain. Approximately 256 miles of boundary line require full maintenance. Seventy-six miles of property boundary line were inspected and maintained during the past five years. It is DWSP's goal to utilize a 10-year interval to service the entire area that requires full maintenance.

Although DWSP properties are clearly marked, private landowners sometimes encroach on these properties for their own use. DWSP staff have located and investigated 51 encroachments during the past five years. After an initial field investigation, a letter was sent to each property owner; in most cases the encroachment was easily rectified. In instances where the landowner was reluctant to comply, assistance was requested from DCR General Counsel's Office as well as state or local police.

The LMP also addresses wildlife management, the management and protection of biodiversity, and maintenance of forest and other roads under DWSP control, but these issues are discussed separately in Sections 6.4 (Wildlife Management) and 6.7 (Infrastructure and Facility Maintenance).

Five Year Objectives

- Implement the 2017 Land Management Plan.
- Research and monitor, including long-term water quality sampling, to verify the effectiveness of existing statewide and DWSP-specific forestry Best Management Practices (BMPs) in protecting the water supply.
- Continue forestry operations in the Wachusett watershed and follow all documented management techniques including oversight and water quality monitoring of all active timber harvesting operations.
- Develop and implement a Terrestrial Invasive Plant Species Plan.
- Assess forest health in Wachusett and Sudbury watersheds by monitoring regeneration and other indicators of forest health, especially in areas of timber harvesting operations.
- Support cooperative efforts to monitor and control Asian long-horned beetle
- Identify all encroachment activities and work with Watershed Rangers to resolve all conflicts in Wachusett and Sudbury watersheds.
- Manage hayfields and other open areas.
- Maintain efforts to prevent bluff erosion.
- Monitor for gypsy moth activity and tree conditions, especially if drought conditions reoccur.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on land management in the water supply.

6.4 Wildlife Management

Goal: Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.

The Wachusett watershed supports an abundance of wildlife, and a number of species are monitored by DWSP personnel or other agencies. The DWSP is required by state and a federal law to protect rare, uncommon, threatened, or endangered species, and consequently works to protect important wildlife and their habitats while minimizing or eliminating adverse wildlife impacts on watershed resources. In certain circumstances, where applicable, active management to enhance wildlife habitat may occur.

The Wildlife Management Program takes guidance from the LMP. This plan includes an explanation of bird harassment activities, describes aquatic mammal control, and discusses problems caused by burrowing mammals. Specific details of wildlife management actions can be found in the LMP and are only summarized for this Watershed Protection Plan Update.

Several decades ago, water quality sampling determined that roosting gulls in the vicinity of the reservoir intake structure were responsible for elevated bacteria concentrations. The bird harassment program began in the early 1990s to negate the impact of these birds on water quality. The program is a year-round effort, although active harassment activities usually occur from September until April except when the reservoir is completely ice covered. During partial ice conditions, when boat use is unsafe, DWSP can use an airboat to harass birds. Although some birds are present at the reservoir all day, most leave the roost shortly after sunrise, spend the day feeding elsewhere, and return to the reservoir to spend the night. As a result, harassment

efforts are focused during the late afternoon to early evening. Daily harassment activities on the Wachusett Reservoir are supervised and carried out from shore primarily by Environmental Quality personnel. Watershed Rangers and maintenance personnel conduct harassment from boats when necessary. Staff from the Natural Resource section participates in the program through monitoring, passive harassment techniques, and program development. Active harassment is done using pyrotechnics, boats, and rarely live ammunition.

Program activities have been conducted annually since 1993. The goal of the program is to scare birds away from the north end of the reservoir as shown on Figure 6-3. Documentation of bird numbers and movement is important, and weekly counts of roosting birds are done just before dark. Daytime observation and harassment is done by a single observer from shore unless gull numbers at the north end of the reservoir exceed 50 and shore harassment is ineffective. A boat is utilized when that occurs. Evening observation and harassment is done by one or two staff on shore and often two people in a boat. When bird numbers are excessive, or birds are difficult to move, a second boat is added. Observation and harassment activities usually occur five to seven days per week, with weekly reports of observations and activities produced and distributed, although frequency and effort are modified based on weather conditions and bird numbers.

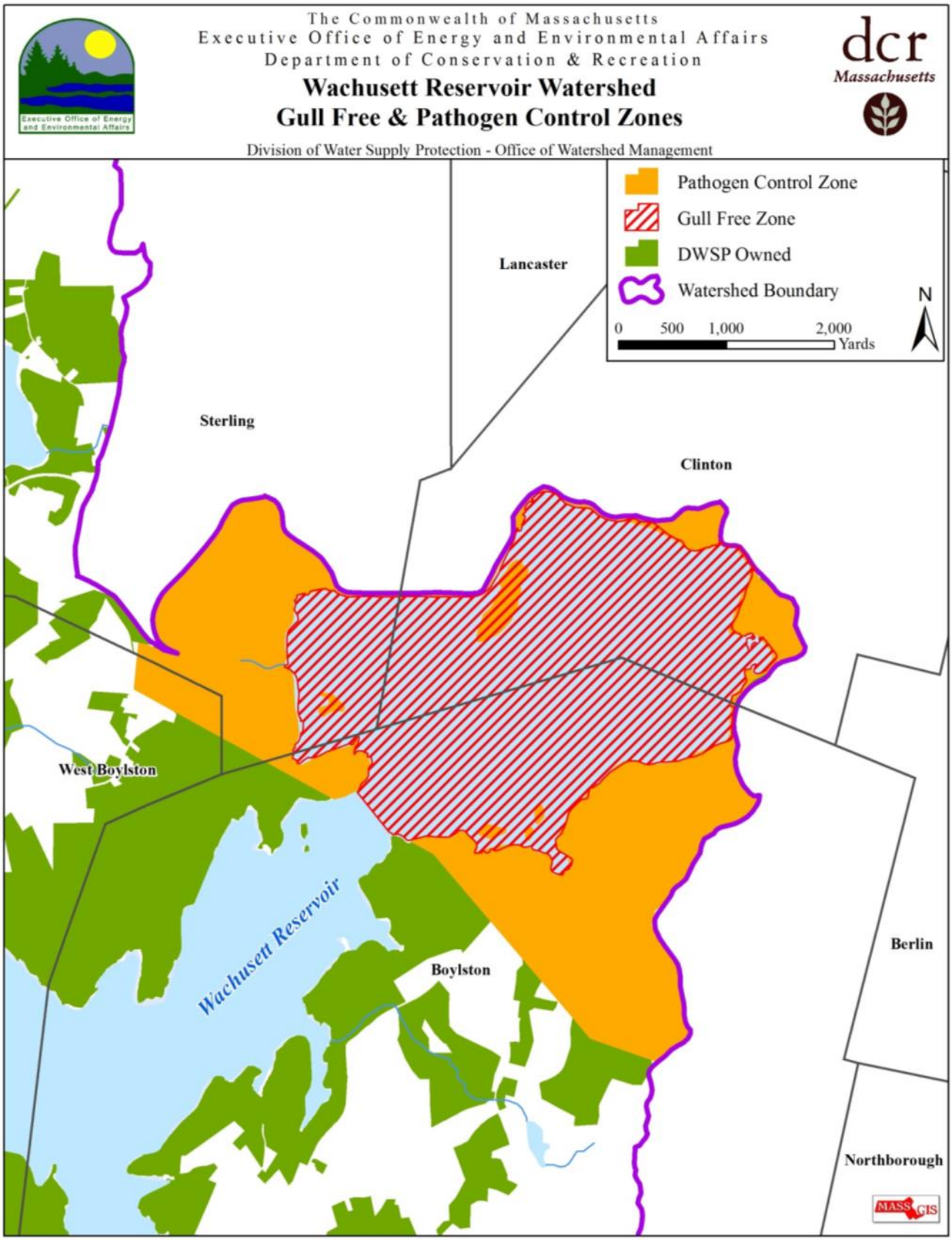
A majority of the birds present year-round at the Wachusett Reservoir are gulls, but there are also hundreds of resident and migratory geese and ducks as well. Harassment efforts directed at gulls are generally effective against these other birds. In addition, there is a seasonal population of cormorants present during the summer and fall that perch on containment booms and on the MWRA monitoring buoys in the reservoir. Although these birds are few in number relative to the other species, they usually do not respond to harassment efforts.

In addition to active harassment, several passive techniques have been used, such as placing netting to exclude birds from critical areas, erecting structures that support “scary-eye” balloons, using remote activated sound deterrent stations, and manipulating habitat to discourage bird use. The DWSP has worked with other state agencies to reduce gull numbers at solid waste landfills. To aid efforts to disperse and move gulls from the reservoir, long-term control has focused on reducing food resources. A multi-year research project continues in an effort to identify and control alternative food sources, provide information on breeding sites and seasonal movement, and maintain control of locations, such as landfills and wastewater treatment plants, where work has been done to remove sources of food.

A program to reduce the year-round resident goose population focuses on locating all active nests and treating eggs to prevent hatching. The grassy shoreline along the reservoir and its islands provides breeding habitat and food resources, and habitat modification is a necessary component of any control effort.

DWSP monitors and controls populations of beaver and muskrat in the Pathogen Control Zone near the intake to prevent occurrence of *Giardia* spp. and *Cryptosporidium* spp. in the Wachusett Reservoir (Figure 6-3). While most of the reservoir’s shoreline provides marginal to poor beaver habitat, there are areas with sufficient resources to support beaver. Any populations at the north end of the reservoir are removed and fecal samples from all removed animals are tested for the presence of *Giardia* and *Cryptosporidium* Individuals in other areas are removed as needed.

Figure 6-3: Wachusett Reservoir Gull Free Zone and Pathogen Control Zone



Aquatic and terrestrial mammals can cause damage to infrastructure, including earthen dams, dikes, access roads, and other watershed structures. Lethal methods are used to remove these problem animals under the direction of the DWSP Wildlife Biologist when non-lethal methods would not be effective and as long as lethal methods will not threaten public safety, domestic animals, or other wildlife.

DWSP works to avoid adversely impacting rare wildlife species or their habitats. It may be feasible to manage habitat in certain areas for the benefit of wildlife species that are rare or of special concern on a regional or statewide basis, but DWSP recognizes that protection of the water supply must always take top priority.

Accomplishments

The Bird Harassment Program was successfully implemented during the past five years, with periodic daytime monitoring of the reservoir usually starting in mid-August and evening observations and harassment implemented in mid-September. Boats, pyrotechnics, and lasers were used effectively to move birds away from the intake and maintain bacteria concentrations below the regulatory threshold. The program was conducted continuously through March in most years but was halted due to ice cover in January 2015.

Documentation of all activities and results of these actions are included in weekly reports that are distributed regularly to appropriate individuals. The source water standard for fecal coliform was met throughout the year.

A full reservoir harassment program was attempted for three weeks during the fall of 2016 to determine if it was possible to remove all birds from the reservoir for a period of time. Five boats and five shore personnel were utilized for the first two weeks; two boats and three shore personnel were used during the final week. Although very resource and time intensive, the pilot program was very successful in preventing birds from roosting overnight on the reservoir, although birds returned to the reservoir once the program was discontinued in 2017.

Area landfills near the Wachusett Reservoir have been identified as a food source for gulls that roost on the reservoir. There has been a coordinated effort of active harassment between the landfill, DWSP, and USDA that resulted in a substantial reduction in gull use. Natural Resources staff continued efforts to reduce overall gull population by monitoring other regional feeding areas and installing exclusion wires when problems were identified, including area wastewater treatment plants and a nearby pig farm.

There has been a strong effort to reduce the local goose population through an intense population reduction program. Canada goose nests on the reservoir have been located and the eggs in each nest treated to prevent hatching. The goal of this program is the gradual long-term reduction in the resident adult goose population, and the number of goslings and resident adult geese has declined substantially since the effort was initiated.

Surveys for beaver and muskrat populations are done regularly. A group of beaver causing water quality problems on Muddy Brook was removed and their dams deconstructed with cooperation from railroad personnel. Beaver and muskrat identified in the exclusion zone of the reservoir near the intake were removed and tested for the presence of *Giardia* and *Cryptosporidium*. A random

sampling of ring-billed and herring gulls were also captured and tested for these pathogens. Data collected to date indicate a very low level of infection.

Routine surveys of all dams and dikes were completed to look for damage caused by burrowing mammals. Approximately fifteen burrows were treated and filled annually.

Documentation of deer population densities and impacts of grazing on DWSP forests have led to the proposal to develop an expanded deer hunting program on lands adjacent to the reservoir.

Long term wildlife monitoring at forestry sites continued during the past five years as well as ongoing studies on common loons and cooperative research with DFW on eagles and lake trout.

Five Year Objectives

- Continue year-round bird observations and harassment efforts on the reservoir.
- Control the resident Canada goose population on the Wachusett and Sudbury Reservoirs.
- Reduce the amount of food available to gulls in Central Massachusetts by controlling public feeding and identifying and controlling alternative food sources.
- Monitor, assess, and control aquatic and burrowing mammals that threaten water quality or infrastructure.
- Monitor moose populations in the Wachusett watershed and deer populations in the Wachusett and Sudbury watersheds and their impact on forest dynamics through browsing surveys, annual moose and deer sign surveys, and exclosure studies.
- Implement an expanded white-tailed deer hunting program in the Wachusett watershed.
- Test mammal and bird fecal samples for the presence of *Giardia* and *Cryptosporidium*
- Manage habitat for rare species; monitor populations of select species.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wildlife in the water supply.

6.5 Public Access Management

Goal: Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.

The use of watershed lands for recreation can conflict with the primary mission of water supply protection and requires careful control of these activities to limit the risk of negative impacts. Specific practices and procedures that address recreational issues and help identify unauthorized activities, reduce future instances of encroachment or trespass, and propose solutions for problems are addressed in the *Wachusett Reservoir Watershed 2011 Public Access Plan Update*. Please refer to the plan, available at www.mass.gov/service-details/dcr-watershed-plan-publications for current policies and associated maps; some of the information included in that plan is summarized below. Additional information on public access can be found within the 2017 Land Management Plan.

Public access is controlled by regulations (313 CMR 11.09) and public access plans and policies. Watershed Ranger staff have the primary responsibility for monitoring and enforcing appropriate public access and now have the ability to issue citations, although the police serve as additional

enforcement entity if needed. Rangers spend most of their time utilizing visitor contacts to explain watershed protection efforts and public access controls. Enforcement through education and outreach is a priority and has been highly successful. Signs, kiosks, and printed materials provide guidance on allowed activities and places where specific recreational uses are allowed.

Public access on non-DWSP property has the potential to impact tributary water quality and eventually the reservoir. Staff now assesses permitted uses in state forests and parks, Division of Fisheries and Wildlife properties, Massachusetts Audubon Sanctuaries, private land trusts, and other protected open space to determine if there are any significant threats to water quality.

Accomplishments

Implementation of the comprehensive *Wachusett Public Access Plan Update 2011*, which provides detailed descriptions of a wide range of public access issues and includes a number of tasks proposed to improve water supply protection efforts, has continued.

The Watershed Ranger staff patrols the Wachusett watershed seven days a week, providing education about rules and encouraging good stewardship habits. The Watershed Rangers continued to coordinate with the MSP and the Massachusetts EPO. Authorization to issue non-criminal citations was granted in FY16 and nearly 200 written warnings and citations have been issued since then.

Table 6-6: Visitor Contacts within the Wachusett Watershed, FY2013-2017

Year	# of Visitor Contacts	# of Violations
FY13	**20,287**	**1,068**
FY14	**21,106**	**890**
FY15	**17,564**	**1,201**
FY16	**17,671**	**882**
FY17	**16,337**	**788**

Source: DWSP Wachusett Watershed Rangers

Watershed Rangers conducted an investigation that involved illegal cutting and the clearing of trees on DWSP property to create unauthorized trails. Rangers set up surveillance cameras to gather information and were able to photograph the perpetrator. The individual was eventually arrested and banned from all DCR property for one year.

There are a number of recreational activities that are restricted or completely prohibited on DWSP property in the Wachusett watershed but remain popular nevertheless. Watershed Rangers have been able to reduce the number of swimmers and waders, but continue to encounter illegal use of ATVs on DWSP property.

Several brochure boxes have been placed at key kiosk locations around the watershed to distribute information on water quality and public access issues. They have become an integral part of the DWSP Education and Outreach program (see Section 6.9) and are monitored and filled by Watershed Ranger staff. Brochures were also distributed at a range of events including the West Boylston Fall Festival, Nashua Riverfest, New England Public Works Expo, Clinton Old Home Day, Holden Public Safety Day, Springdale Mill Day, Massachusetts Municipal Association Annual Conference, Johnny Appleseed Festival, Wachusett Dam Opening (Spring

and Fall each year), Tower Hill Botanic Garden, Mass Envirothon, Princeton Arts Festival, and at the Main Entrance of John Augustus Hall.

DWSP continues to implement a fishing line recycling program and asks fisherman to discard old and unusable fishing line in specially made canisters located at several heavily used fishing areas. In addition to protecting wildlife, this line is kept out of landfills by recycling into other products.

Aquatic Invasive Species (AIS) can pose a serious threat to water supplies (see Section 6.12). While DWSP prevents AIS entering the reservoir on boats and trailers by limiting use to official business and requiring those vessels to be thoroughly free of AIS, there is still a threat of introduction from anglers fishing from shore. DWSP continues to educate anglers on AIS using Watershed Ranger contacts, notices at local bait and tackle shops, advisories posted on DWSP bulletin boards and kiosks, and through contacts with all watershed sportsmen's clubs.

Dogs are prohibited on DWSP land, but there are thousands of dogs licensed within the five watershed towns; there is continual pressure to utilize DWSP land for dog walking. Significant outreach has been conducted by staff to educate watershed residents and watershed visitors on the dangers of pet waste. Public education and outreach conducted to date has included distribution of nearly 18,000 brochures on pet waste, information bulletin boards and kiosks, letters mailed to neighborhoods where dog waste is the suspected cause of higher bacteria levels in tributaries, and production of an award-winning animated public service announcement.

A number of popular and well-attended educational/interpretive programs were offered each year and provided the opportunity to distribute information to tens of thousands of residents and visitors.

Five Year Objectives

- Implement Watershed Access Management Plans for Wachusett Reservoir and Sudbury Reservoir watersheds.
- Evaluate and modify, if necessary, specific access plan policies within a *Wachusett Reservoir Watershed 2020 Public Access Plan Update.* Provide periodic review of policies with updates, as needed.
- Reconstruct and improve, where appropriate, universal access sites.
- Maintain working relationships with State, Environmental, and local police.
- Monitor DWSP lands and water to ensure compliance with rules and regulations designed to protect the water supply and protect the public.
- Maintain gates and other structural controls using existing protocol.
- Continue to develop improved, uniform signage and maps.
- Expand use of electronic media to disseminate information.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on public access in the water supply.

6.6 Watershed Security

Goal: Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to protect the watershed system from potential threats.

Watershed Security programs provides surveillance of the watershed for potential threats to the water supply system. The events of September 11, 2001 heightened concerns regarding security and the need to protect public works from possible terrorist action. Many security improvements have been made by both MWRA and DWSP over the past years. Due to security concerns, these improvements will not be listed here.

Accomplishments

Watershed Rangers provide a visible presence and monitor for and respond to all suspicious activities. They attended a Behavior Observation and Suspicious Activity Recognition course conducted by the MSP and regularly coordinate with the MSP and MEP. Night operations are conducted during peak visitor periods. Security has been enhanced at key locations throughout the watershed and at DWSP facilities. Communication and coordination with MWRA has been enhanced and there is ongoing communication and coordination with local Emergency Responders.

Two new snowmobiles, two new ATVs, and an off road Utility Task Vehicle (UTV) were obtained during the past five years to assist with patrols, search and rescue, fire support, and medical support when needed.

The University of Massachusetts Amherst has developed modeling capability to determine the likelihood of a contaminant reaching the intake structure. This was tested during a simulated release in 2015. The short term fate and transport of the contaminant in the reservoir was simulated using the 2D hydrodynamic and water quality model CE-QUAL-W2. Both average travel time of the contaminant and peak relative concentrations were successfully modeled within hours of the 'release'.

Direct access to the reservoir is a clear threat to water quality. Over 6,100 feet of steel guardrail was installed along the South Dike, portions of the North Dike, and on Thomas Street adjacent to the Quinapoxet Basin to replace inadequate wire fencing and prevent vehicular access.

Five Year Objectives

- Coordinate with MWRA in order to maintain comprehensive system-wide approach on all security issues.
- Continue Watershed Ranger patrols on all DWSP properties, with particular focus on highly vulnerability sites.
- Work with local, state and federal responders and ensure they receive current agency emergency contact information on a regular basis.
- Remain up to date with any guidance materials available from EPA, American Water Works Association, and Department of Homeland Security.
- Improve physical access control structures, as necessary, and implement a maintenance program.

6.7 Infrastructure Maintenance

Goal: Maintain the integrity of all high hazard dams under DWSP control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.

The 2017 *Land Management Plan* includes a discussion of construction and maintenance of forest roads under DWSP control. Specific details and supporting documentation are not reproduced in this Watershed Protection Plan Update.

Accomplishments

DWSP inspects and maintains a number of large and small dams, miles of improved and unimproved roads, and facilities ranging from administrative offices to maintenance garages and storage sheds throughout the watershed. A Phase II inspection of Unionville Pond Dam was completed in 2017.

Monthly inspections of the Wachusett Dam and dikes continued during the past five years, and DWSP worked with MWRA to remove trees from both the north and south dike to preserve the structural integrity of these earthen dikes. A geotechnical evaluation of River Road in Clinton was completed. Civil Engineering and Environmental Quality staff evaluated a small dam in Princeton for possible removal, but it was determined to be not economically feasible nor an imminent threat.

DWSP forest roads were inspected regularly and a number of areas needing maintenance were addressed. Civil Engineering and Environmental Quality staff worked together to develop an inspection and review protocol, and combined efforts to ensure proper design and environmental review.

Work continued on major projects related to infrastructure and facilities, including construction of a new carpenter shop, paving the Lower Road and fountain area at the Wachusett Dam, completion of a new handicap ramp and associated landscaping at John Augustus Hall, installation of security fencing at the West Boylston labor yard, installation of new security cameras at all facilities, upgrades at the Maintenance Garage, and removal of the underground storage tanks at the Wilson Street Yard. Demolition of several acquired buildings on the Chapman Company and Kristoff Pig Farm properties was completed.

Five Year Objectives

- Monitor and maintain large dams, spillways, and dikes, and periodically update Emergency Action Plan in conjunction with MWRA.
- Conduct annual inspection of roads and develop annual plan for repairs.
- Assess infrastructure and oversee repairs, maintenance, and renovation projects at DWSP facilities, including construction of Clinton Crew Headquarters, a garage addition, and evaluation of the Ranger Station.
- Maintain existing BMPs to manage stormwater and assess need for additional control measures.
- Reduce energy use through simple energy efficiency practices.
- Maintain fire roads for water supply operations as necessary in Sudbury Watershed.

- Size replacement culverts and other infrastructure to address likely changes in flow due to ongoing climate change.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on infrastructure in the water supply.

6.8 Watershed Protection Act

Goal: Enhance protection of the water supply through implementation of the Watershed Protection Act, which regulates land use in critical areas of the watershed.

WsPA regulations (313 CMR 11.01-11.08) apply to regulated areas in Boylston, Clinton, Holden, Leominster, Paxton, Princeton, Rutland, Sterling, West Boylston, and Worcester (Figure 6-4). DWSP uses its WsPA regulatory authority to guide development in a manner that protects water quality.

Accomplishments

Development in the watershed was monitored by DWSP staff who attended meetings of municipal boards and committees, monitored meeting agendas and minutes, and reviewed legal advertisements in local newspapers. Landowners impacted by the WsPA are notified of requirements and staff continues to work closely with them to develop projects that comply with WsPA regulations.

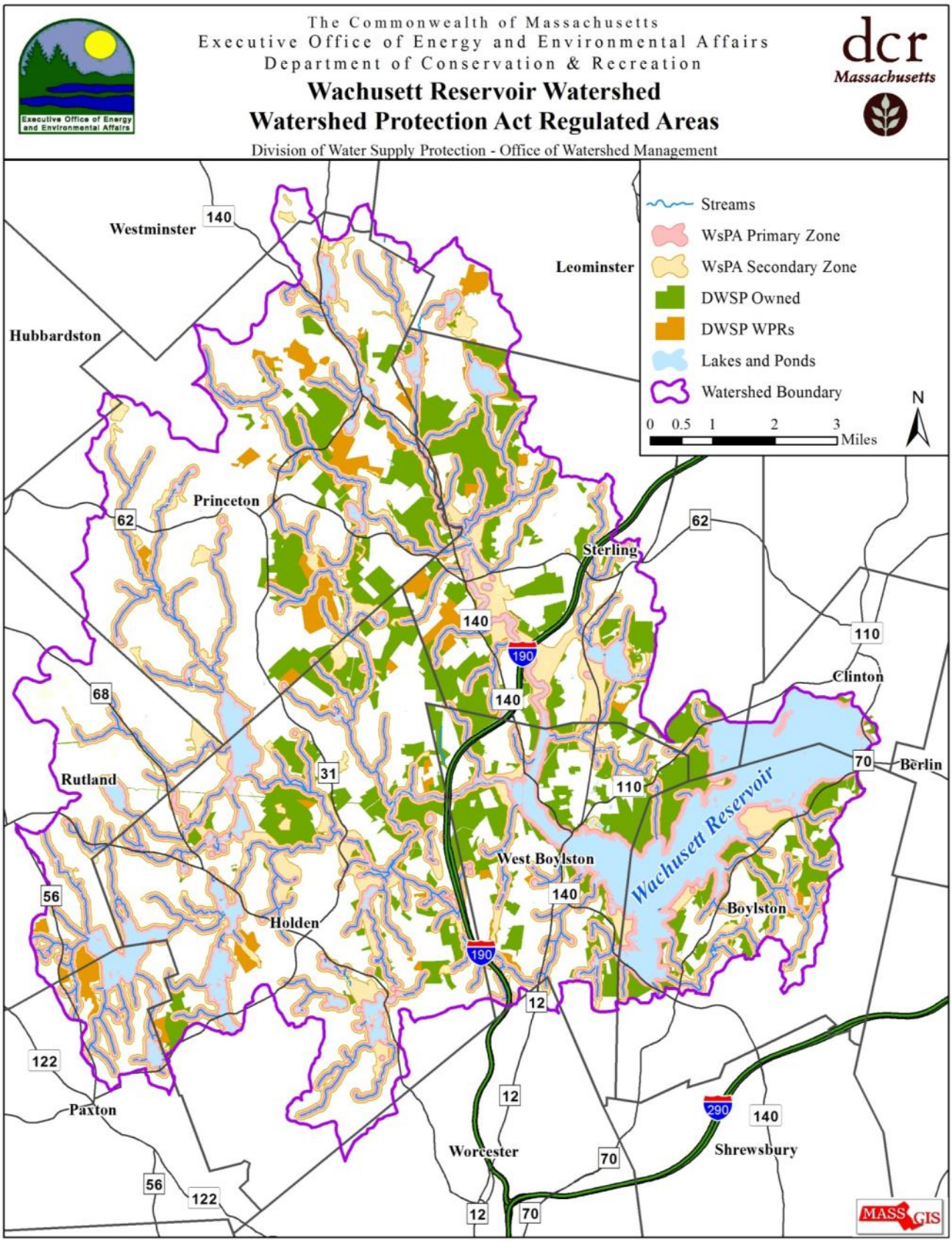
There were a total of 267 applications filed under the WsPA during the past five years, including 71 Request for Advisory Rulings, 180 Applications for Watershed Determination of Applicability, and 16 Application for Variances filings (Table 6-7). There were also 31 proposals that were denied because the desired activity was prohibited within the area identified in the proposal. In addition, there were several Applications for Variances that were filed but never completed. These incomplete Applications were reviewed and letters sent to the owner or applicant informing them of the information needed to complete the filing but the requested information was never submitted.

Table 6-7: Wachusett Reservoir Watershed – Watershed Protection Act Decisions

Year	Advisory Opinions	Determinations	Variances	Denials
FY13	15	30	2	6
FY14	11	28	4	3
FY15	13	37	2	4
FY16	15	40	5	8
FY17	17	45	3	10

Source: DWSP Wachusett Environmental Planning

Figure 6-4: Wachusett Reservoir Watershed Watershed Protection Act Regulated Areas



Wachusett staff continued to meet with applicants and their representatives, hold Variance hearings, and issue decisions within time frames as required by the regulations. Staff inspected active projects to ensure compliance with conditions and visited sites where work had been completed to check for problems. Building permits and property transfers for watershed communities were reviewed monthly to identify additional properties affected by the WsPA, and owners were notified of regulatory jurisdiction. More than 500 letters have been sent to property owners in the past five years.

The Commonwealth's Office of Geographic Information updated digital parcel and landowner information for watershed towns through a statewide initiative. This new information was added to existing datalayers and used to improve search functionality of the DWSP EQ database. All WsPA files now can be mapped and tallied geographically by subbasin, weekly reports summarizing all database activity are generated automatically, and both plans and documents can be added electronically to database files.

All WsPA filings have recently been reviewed with additional information added to files in the Wachusett EQ database. The database now indicates if each file is new, ongoing, complete, withdrawn, never built, or has been denied relative to Section 11.04. If a project had not previously been completed and it was not possible to determine if the file could be closed, a letter was sent to the owner requesting information. Most people responded to the request.

Staff from across DWSP who implement the WsPA meet regularly as part of the Watershed Protection Act Working Group (WsPAWG) to discuss confusing or controversial issues and to resolve problems related to implementation of the regulations. Staff visit the Town Halls in watershed communities at least twice per year. Brochures and applications are delivered for distribution and inquiries are made to determine if additional WsPA maps are needed. Maps are usually available in five offices – Town Clerk, Board of Health, Conservation Commission, Planning Board, and Building Inspector. Visiting each community also gives DWSP staff the ability to answer questions and to find out if there has been any staff turnover.

There has been both inter- and intra-agency coordination on regulations that often intersect with the WsPA, including the Wetland Protection Act, Title 5 (septic systems) , and both state and federal stormwater programs. Staff also utilize the Massachusetts Environmental Policy Act to identify, review, and comment on projects in the watershed.

Education and outreach are important for landowners and town officials in order to promote common areas of concern about the effects of development on water quality and ways to mitigate these impacts. DWSP provided technical assistance to watershed communities by working cooperatively, upon request by local boards, on projects of mutual concern including development of local regulations. Staff supported local implementation of state environmental regulations through training, project review, and professional services, such as GIS mapping, environmental engineering, and planning.

Five Year Objectives

- Implement Watershed Protection Act and regulations.
- Review building permits and sales and notify property owners of their need to file.
- Inspect previous filings for compliance with decisions and conditions.

- Provide professional support on land use planning or other associated topics related to DWSP mission to watershed communities.
- Maintain good relations with building inspectors and other town permitting staff and boards to enhance the notification of potentially affected parties of WsPA requirements.
- Review WsPA applications for stormwater applicability, including NPDES construction general permit, MA Stormwater Performance Standards, and/or town stormwater bylaws. Coordinate with other DWSP staff to ensure that WsPA projects comply with other environmental regulations.

6.9 Education and Outreach

Goal: Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.

The Education and Outreach Program provides educational opportunities for users, watershed residents, and visitors to learn about the importance of watershed protection, environmental stewardship, and the impact of climate change on water quantity and quality. Educational programs are an effective way to protect watershed resources over the long term by instilling a better understanding and appreciation of natural resources. Water suppliers incorporate interpretive services into watershed protection programs to enhance resource protection.

Education and outreach are delivered through school programs, interpretive programs on DWSP properties, watershed community programs, assistance to local boards and commissions, and through Watershed Ranger interactions that inform the public about watershed protection and drinking water issues.

Accomplishments

The DWSP Wachusett Reservoir has an established program of public education with local schools and provides outreach to the watershed community through public programs on DWSP properties, Watershed Ranger contacts, and the *Downstream* newsletter. Wachusett Reservoir staff maintained watershed interpretive sites, including kiosks. Interpretive staff reviewed, revised and distributed informational brochures. Staff developed and updated materials for the DWSP website on public assess issues, stormwater management, and water quality, including aquatic invasive species control.

The Wachusett Reservoir Interpretive Plan has formalized the public education programs offered throughout the watershed, but remains a flexible document without specific time-sensitive tasks. The plan is reviewed and updated regularly. Site-specific programs and an updated brochure were developed for DWSP's Stillwater Farm interpretive site in Sterling. An Aquatic Invasive Species brochure was designed, printed, and distributed.

Rangers conducted more than 160 separate programs with nearly 7,000 attendees during the past five years. They also were present at annual openings of the Clinton Dam walkway and were able to interact with the more than 13,000 people who attended.

Teacher workshops were held, and education specialists continued to provide school programs for students in the 4th grade. Environmental Quality section staff supported the Mass Envirothon by attending Steering Committee meetings, presenting 35 workshops on water quality, bioassessment, groundwater, and stormwater pollution for 1,650 students and coaches, updating the water curriculum, and administering the water test at the Envirothon competition.

Environmental Quality staff continued to attend meetings of local boards and commissions and provide assistance to the volunteer boards. GIS support was provided to the towns and environmental groups.

Information kiosks and the bulletin board at the John Augustus Hall field headquarters in West Boylston were updated regularly, and an informational brochure about new state phosphorus regulations was prepared and distributed. Brochures that explained rules and regulations related to the WsPA and one that addresses household pollution prevention were mailed to all new property owners in the watershed. Brochures were also enclosed in letters sent to all businesses along Route 12 in West Boylston, to watershed Conservation Commissions, to watershed Fire Departments, to watershed towns Recreation Departments and Public Works Departments, to the Wachusett Area Chamber of Commerce, and to all DCR agricultural lease holders. More than 8,000 brochures have been distributed over the past five years.

Other specific accomplishments over the past five years include:

- Creation of an animated Public Service Announcement on dog waste, which has been posted on the DCR and Water Environment Federation websites and the WEF STORM TV YouTube project.
- Installation of new stormwater interpretive signage at the Route 62 infiltration basin.
- Development of stormwater interpretive signage for the Route 12 Causeway Direct Discharge project.
- Construction of a photoboard with water quality message for outreach events.
- Preparation of a stormwater outreach tote for use by watershed Public Works Departments.
- Partnership with the Nashua River Watershed Association on a “Save Fish, Don’t Flush” pharmaceutical project funded through MET Grant.
- Partnership with CEI, Inc. on a hobby farm outreach document project funded through 319 Grant program.
- Mailing of letters to residents where dog waste was a noticeable problem.
- Participation in the Leominster High School Career Day, speaking about careers in water quality assessment and watershed management.
- Support of a West Boylston Girl Scout Troop project about impacts of dog waste on surface waters.
- Presentation of seven training session on stormwater pollution prevention for DCR labor staff and supervisors and Leominster and Boylston Departments of Public Works employees.

Five Year Objectives

- Review, implement, and amend as needed, the Wachusett Interpretive Services Plan.
- Conduct, record, and evaluate established public education programs with a focus on water supply, water quality, Aquatic Invasive Species, and climate change.
- Conduct programs at Stillwater Farm Interpretive Site.
- Conduct environmental education teacher training and support Mass Envirothon.
- Participate in environmental programs with other environmental groups.
- Research and implement electronic media for interpretation.
- Support stormwater education efforts in Wachusett Reservoir watershed towns that must meet federal Small Municipal Separate Storm Sewer Systems (MS4) requirements.
- Provide programs that reduce threats from public access (e.g., Earth Day cleanups, fishing line collections, etc.).
- Educate the public of the importance of Sudbury and Foss Reservoirs as a reserve drinking water supply and natural resource through informal education as staff availability allows.
- Maintain and/or initiate information sites, such as kiosks, and programs in watersheds. Expand interpretive signage opportunities to enhance public understanding of the water supply system.
- Produce and distribute *Downstream* newsletters to watershed residents.
- Utilize the DWSP website to provide information and resources for the public.

6.10 Water Quality and Hydrologic Monitoring

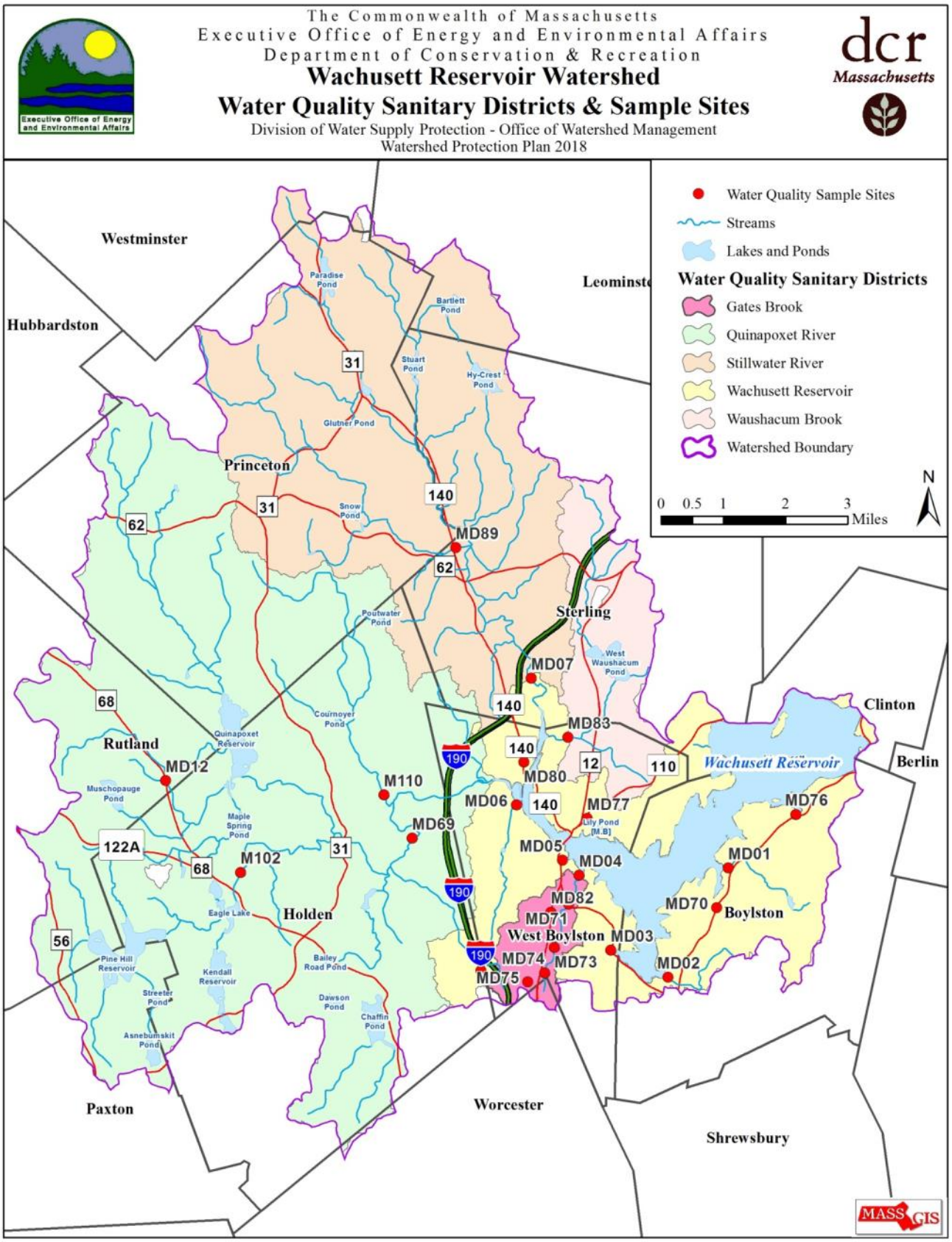
Goal: Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.

An extensive monitoring system is in place for tributary and reservoir sampling in the Wachusett Reservoir watershed. Environmental Quality staff collects water quality samples and provides analysis for physical and biological parameters. All bacteriological and chemical analyses are performed by MWRA at their Southborough and Deer Island Laboratories.

Accomplishments

Environmental Quality staff collected routine water quality samples from 23 stations (19 tributaries) in 2013 and from 19 stations (18 tributaries) in 2014-2017 (Figure 6-5).

Figure 6-5: Wachusett Reservoir Watershed Water Quality Sanitary Districts and Sample Sites



Nutrients and total suspended solids were collected monthly from ten of these stations. All new tributary data are automatically uploaded into a Water Quality database developed by Environmental Quality section staff; all historic data were added to the database after a thorough review for accuracy. More than 137,000 data points have been uploaded. This database has a multi-user front end and a linked shared back end, and is linked to separate databases created to store hydrological data and all aquatic biology data.

The development of the database has greatly increased analytical options and water quality data security. User forms allow for data viewing, filtering, export, statistical analysis, basic graphing, and automated analysis and reports. Data were used to assess ongoing water quality conditions across the watershed and to help address problems identified in Environmental Quality Assessments.

Stream depth was measured regularly at the ten nutrient stations and flow calculated from stage-discharge relationships developed using Aquarius time-series software. Weekly depth observations were recently supplemented with data collected every 15 minutes by HOBO flow monitoring sensors. Data are downloaded monthly and daily maximum, minimum, and average flows are calculated. The USGS provides continuous real time monitoring of flow and other parameters from Gates Brook and the Stillwater and Quinapoxet Rivers; these data are also automatically uploaded to the database. The reporting accuracy of the gauges has improved significantly during the past five years due to better oversight by DWSP staff and more USGS maintenance.

Groundwater, snow pack, and precipitation were monitored regularly. More than 75 individual discharge measurements have been made to verify stage-discharge relationships. Annual Water Quality Reports were completed each year and posted on the DCR website.

DWSP has maintained an interagency service agreement with the University of Massachusetts, Amherst, Department of Civil/Environment Engineering throughout the implementation period of the current Watershed Protection Plan. Studies conducted under this agreement have facilitated a better understanding of reservoir and watershed processes. UMass has also been available as a resource to advise DWSP staff on issues that arise.

UMass maintains a two dimensional water quality model of Wachusett Reservoir (CEQUAL-W2). An annual model is prepared each year, and a catalogue of models that begins in 1998 spans a variety of hydrologic inputs (wet years, dry years, different transfer regimes). Development of the model has identified problems with hydrologic data collection which have since been corrected, provided better understanding of reservoir processes and allowing for a more accurate assessment of the impact of watershed inputs to the reservoir.

Three dimensional modeling of hydrodynamics and water quality for Wachusett Reservoir was also undertaken. The motivation for the work was recognition that lateral variability is likely to be significant in some portions of the reservoir and may be need to be considered when assessing issues in the vicinity of the Cosgrove Intake. The 3-D modeling results suggest that the 2-D approach is suitable for modeling spills. Three dimensional modeling was completed in 2014.

A detailed evaluation of historical water quality data for assessment of constituent loadings to the Wachusett Reservoir from tributary inputs was conducted by UMass graduate students. Statistical methods were applied to the event based and the routine water quality monitoring data to refine constituent load estimation and assess temporal trends. This work was done in close collaboration with DWSP staff, and used to evaluate routine and stormwater tributary sampling programs. Water quality and flow data for tributaries and direct stormwater runoff was used to quantify contaminant loads to the Wachusett Reservoir.

Potential climate change impacts have been analyzed using extreme event water quality data from other water supply systems and predictions of possible extreme events. These projects were then used as input to Wachusett Reservoir, and reservoir impact assessed using CEQUAL-W2.

DWSP staff has also continued to work with the Civil and Environmental Engineering department at Worcester Polytechnic Institute. WPI requires seniors to conduct a Major Qualifying Project. Two projects were completed during the past five years that evaluated removal efficiencies in three stormwater basins in the watershed.

Stormwater sampling was done during the early part of this period from four sites to characterize 24 storms. Standardized sampling methodologies were developed with collection of nutrients, total organic carbon, and total suspended solids during both the rising limb and falling limb. The program is currently on hiatus until future data needs can be determined.

A daily time-step watershed hydrology and solute loading model for the Wachusett Reservoir watershed was developed in-house using MapShed and Flux32. Nutrient and sediment loading from 2008 forward was estimated. The Flux model is run each year as new flow data becomes available.

Macroinvertebrate samples are periodically collected from selected tributaries to supplement routine water quality sampling. Biotic communities integrate the effects of short-term environmental stresses and reflect impacts of intermittent or low level pollution events often missed by routine sampling programs. A biomonitoring program compares biotic communities at different stream sites and then uses a variety of numerical measurements (metrics) to calculate the degree of site impairment. DWSP uses aquatic macroinvertebrates to determine the degree of site impairment because they are easy and inexpensive to sample, relatively easy to identify, abundant in most streams, and indicative of localized conditions as a result of their sessile nature. Samples were collected from fourteen locations during the past five years and are currently being identified and assessed.

Plankton monitoring at multiple depths was done weekly, or more frequently, in the Wachusett Reservoir. A new microscope with digital imaging capability was purchased in 2013 which allows plankton size and identifications to be documented and included in annual reports. Temperature, specific conductance, dissolved oxygen concentration, percent oxygen saturation, chlorophyll a, and hydrogen ion activity (pH) profiles were recorded weekly, and nutrient samples were collected in May, July, October, and December at three depths from three locations. Bacterial transect samples were collected from 23 surface stations on the reservoir monthly or more frequently throughout the year.

Cyanobacteria are photosynthetic bacteria that share similar characteristics of algae and can multiply quickly in response to conditions that are favorable for their growth. Harmful algal blooms composed of cyanobacteria have the potential to produce toxins that can be harmful to the environment, animals, and public health. Although concentrations of cyanobacteria have not approached levels of concern in the Wachusett Reservoir, biologists pay close attention to their presence and are prepared to respond if populations increase. Staff will supplement routine areal standard measurements with cyanobacteria cell counts to comply with national data trends. Specific notification requirements and response actions are being developed by the MWRA.

EQ staff and Watershed Rangers revived an angler creel survey in 2017 following the successful online publication of a summary of the 2011 and 2012 surveys. Comparison of the results to three earlier creel surveys conducted since 1979 show that the species most frequently caught by anglers have changed, and that this may reflect changes in the fish community composition over this time period. Fish are an important component of the reservoir ecosystem, and knowledge of fish population dynamics in the reservoir is important to understanding the Wachusett Reservoir food web and its impacts upon drinking water quality.

The creel survey report led to the initiation of a lake trout tagging program in 2014. DWSP staff collaborated with DFW biologists to capture spawning lake trout during the fall of 2014, 2015, 2016, and 2017 with hundreds of lake trout tagged, measured, weighed, and released back into the reservoir.

A long-term monitoring study to assess the potential impact of forestry on water quality was initiated, with routine monthly sampling and quarterly storm sampling. The long term forestry monitoring project will gather data from a control subbasin and an active subbasin for a ten year period before, during, and following completion of timber harvesting operations. Four years of data have now been collected. The study includes monthly dry weather discrete grab sampling and quarterly storm event monitoring using automatic samplers. Parameters monitored are flow, pH, temperature, dissolved oxygen, turbidity, total suspended solids, total organic carbon, ammonia, nitrate, nitrite, and total phosphorus. A preliminary report with data analysis that addresses sampling protocol, flow, develops a statistical relationship between the two subbasins, examines seasonal differences, and documents any water quality trends summarizing results to date is planned on being completed by June 2018.

Five Year Objectives

Environmental Quality staff will continue routine tributary and reservoir sampling to identify potential water quality problems and to maintain the historical record for long term trend analysis, with annual adjustments to the sampling plan to adapt to changing conditions. Routine bacteria samples have been collected on a weekly or every other week basis without regard to weather conditions in order to obtain an assessment of annual water quality at each location. This protocol with slight annual variations has been in place for thirty years, although only a subset of locations was sampled during the entire period of record. The DWSP now will shift to a ‘goal-specific’ sampling that continues collection of routine bacteria samples (on an every other week basis) from direct tributaries and other locations of significance, and will supplement routine sampling with follow-up samples (within 48-72 hours) when concentrations are higher than a predetermined level. Additional samples may also be collected when specific flow conditions are present that have been under-sampled in the past.

Nutrients and total suspended solids have been collected monthly from ten stations with available flow data. Staff will continue to collect monthly samples during dry weather but in addition will try to sample once per month during wet weather or periods of high flow as well. Samples will also be collected during extreme precipitation events (>3" of rain) when possible. Sample parameters will remain the same with the addition of chloride in 2018 and beyond.

Routine phytoplankton samples have been collected from the reservoir by DWSP Aquatic Biologists twice per week (May – September) or weekly (October – April, barring ice) to obtain a snapshot of the phytoplankton community and provide information about growth patterns. This protocol, with slight annual variations, has been in place for nearly thirty years. Advancements in the accuracy and frequency of probes used to measure water quality parameters now provide the opportunity to make the program more efficient. Fluorescence values can serve as a surrogate for algal density and now allow for targeted sampling, and regular fluorescence profiles from buoys stationed in the reservoir can provide warning of increases in algal density that triggers sampling.

DWSP will shift to a baseline of weekly sampling during May – September and every other week during October – April. Sampling would take place at the beginning of the week and would be accompanied by manual reservoir profiles. Sampling early in the week would allow for additional samples to be collected later in the week as appropriate in the event that taxa of concern are documented and/or increase in density. Increases in chlorophyll a, phycocyanin, or dissolved oxygen may also trigger more frequent sampling. Additionally, conditions that have been documented in the past to be favorable to algae proliferation would trigger increased monitoring (i.e., warm dry conditions and *Anabaena* surface grabs).

DWSP anticipates that these changes will allow more staff time for data analysis to advance the understanding of phytoplankton dynamics in the reservoir and to document long term water quality trends in the tributaries.

Unmanaged stormwater is a threat to water quality and there is an increased need for the collection of additional hydrologic data and storm event samples to accurately quantify stormwater loading and to detect variations in water quality and quantity due to climate change. This will be a priority over the next five years.

Water quality in the Wachusett Reservoir watershed is impacted by water quality in other watersheds within the MWRA water supply system and has an impact on water quality within the distribution system. A consistent and comprehensive sampling and analysis plan will be developed to provide a unified approach to water quality and water quantity sampling efforts throughout the system. A continuation of cooperative efforts with area colleges and universities will provide additional low or no-cost help with monitoring, assessment, and modeling efforts.

- Conduct routine and non-routine reservoir and tributary sampling, compile data, and interpret in annual report. Make necessary monitoring changes to identify causal factors for significant trends.
- Monitor hydrologic budget (stream flow, precipitation data, snow pack) and continue to make necessary improvements. Work with USGS to supplement in-house monitoring.
- Expand stormwater sampling program to quantify stormwater loading.

- Manage new contract with UMass and review project scope annually. Improve water quality models and develop new research topics.
- Develop database backed tools and applications to facilitate data management, review and analysis, writing reports, and modeling efforts.
- Publish a pair of thirty-year Water Quality Summary reports that include assessment of possible correlation of a range of factors with tributary and reservoir water quality. Include an assessment of possible impacts of climate change on water quality and hydrology.
- Implement long-term paired subbasins assessment of the impacts of forestry on water quality and quantity in the Wachusett watershed.
- Increase understanding of reservoir dynamics by collecting profiles in South Basin, Andrews Harbor, etc. in late summer or early fall when the interflow is well established. Investigate interaction between plankton and interflow water quality with Roger Williams University.
- Investigate potential water quality problems in Sudbury watershed tributaries if staff time allows.
- Develop Wachusett/Sudbury notification protocol for cyanobacteria blooms.
- Finalize and implement a *Cryptosporidium* and *Giardia* Action Plan with MWRA to establish guidelines for Inter-Agency Notifications and Coordination.
- Use water quality and hydrologic data to assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

6.11 Watershed Monitoring and Assessment

Goal: Use Environmental Quality Assessments, site inspections, local board meetings, and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.

The Wachusett Reservoir watershed focuses on five Sanitary Districts which have been recently reconfigured (Figure 6-5). An important component of each EQA is a thorough review for compliance with environmental regulations, including those addressing wastewater, stormwater, agriculture, and hazardous materials and waste. Both wastewater and stormwater are significant threats in the Wachusett watershed and are addressed separately in Sections 6.13 and 6.14.

Accomplishments

DWSP has worked with the EPA, MassDEP, and local boards and commissions to correct situations where pollutants have impacted tributaries. Results have included both environmental remediation and fines. Hundreds of sites have been inspected for a variety of possible water quality threats and corrective actions taken when necessary.

Coordination of monitoring and enforcement efforts was greatly enhanced by the development and utilization of the EQ database. All activities are documented in site specific/owner specific files and clear timelines established for future monitoring and enforcement activities. A companion database guide was developed and is regularly updated. The database has new functionality that enables rapid searches by subbasin, town, street, landowner, issue, file status, etc. and includes the ability to add electronic plans and documents. Nearly 800 new files have

been created in the past five years (Table 6-8). Staff activity can be easily tracked due to the development of an automated weekly report.

Table 6-8: Wachusett Reservoir Watershed – Newly Created Files

Year	# of EQ Files Created
FY13	55
FY14	63
FY15	62
FY16	330
FY17	267

Source: DWSP Wachusett EQ

DWSP staff continued to proactively investigate issues that could impact water quality in the watershed. The number of new files created annually increased dramatically in FY16 and FY17 as staff made a concerted effort to add information on all sites with agricultural activities, any location that uses, stores, or generates hazardous materials, and on all spills and releases of hazardous materials. Much of this information had been stored previously in separate spreadsheets.

Efforts to monitor and improve agricultural sites included 124 site inspections, numerous letters mailed to farm owners on good housekeeping, best management practices, and new phosphorus regulations, individual guidance to four new or expanded agricultural operations, and a cooperative effort with a consultant on a hobby farm outreach project. Information on hazardous materials including hazardous waste generator status was added to more than 200 files.

Staff began to scan and georeference all plans with useful information on stormwater infrastructure and water resources. An ongoing effort to accurately identify and represent all wetland resources was continued.

Environmental Quality staff remains on schedule for the Environmental Quality Assessment (EQA) process. All districts were assessed over the past five years except for the recently created Waushacum Brook District, which is currently being investigated. Reports completed during the past five years and the schedule for future reports are shown in Table 6-9. A new enhanced hydrography datalayer was created in 2015 using LIDAR technology that eliminated some subbasins and redefined others, and the watershed sanitary districts were adjusted. Recommendations from all EQAs were incorporated into annual work plans.

Data gathering has continued and all information on agriculture, hazardous material use and storage, USTs, ASTs, and accidental releases are now part of the comprehensive EQ database described in Section 6.11 previously in this section. Field inspections and review of third-party databases have been used by staff to obtain all necessary information. Besides data gathering, staff have provided educational materials and provided technical assistance to help reduce agricultural impacts to water quality.

Table 6-9: Wachusett Reservoir Watershed Environmental Quality Assessment Schedule

Sanitary District	Completed Plans	Future Schedule
Thomas Basin	2013	Discontinued
Quinapoxet	2014	2020
Stillwater	2015	2019
Worcester	2016	Discontinued
Reservoir	2017	2021
Gates Brook	2017	2022
Waushacum Brook	New District	2018

There are no longer any active landfills in the watershed, but closed landfills remain a potential threat to water quality due to the possibility of contaminated leachate. Staff reviews periodic reports on closed landfills in the watershed and take necessary action when problems are noted.

Five Year Objectives

Interpretation and enforcement of environmental regulations can be complicated, with multiple projects on a single site, overlapping local, state, and federal regulations, project changes over time, or other issues that present irregularities. Staff must continue to coordinate and communicate with each other, take actions in a timely manner, communicate clearly and consistently with landowners, provide consistent interpretation of regulations, an accurate log of issues, correspondence, conversations, expectations, and potential consequences, and establish and follow reasonable timelines for resolution of issues. Continued use of the database will help facilitate this process.

Comprehensive assessments that compile detailed information on land use, water quality, and subbasin level threats will continue on an annual basis. Subbasin-based information allows staff to develop specific recommendations at both the subbasin and district level. Detailed plans targeted at specific problems within individual subbasins help produce tangible goals and progress is more easily quantified. Recommendations developed for each EQA will be included as specific tasks in the next year's work plan so that progress might be easily tracked.

- Use field inspections and review of state and federal databases to identify sources of pollution and develop mitigation measures for one Environmental Quality Assessment (EQA) per year. Develop and implement EQA recommendations and include recommendations as specific tasks in annual workplans. Present findings and proposed mitigation measures annually to DWSP staff.
- Use fieldwork, local contacts, and EQAs to find potential violations of environmental regulations.
- Coordinate with other agencies, such as MassDEP and Attorney General, to enforce all environmental regulations.
- Update wetland resources using plans, field observations, and other available data. Add centerlines to streams and wetlands and correct any inaccurate wetland boundaries.
- Improve tracking of local road projects and local updates to stormwater infrastructure. Add new information to appropriate GIS datalayer.

- Add information on agricultural operations, hazardous waste generators, spills, USTs, and hazardous materials use to the electronic database through field inspections and record review.
- Assess status of municipal facilities and practices, including DPW yards, closed landfills and road maintenance practices. Work with towns and MassDEP to resolve any water quality issues.
- Monitor climate change research, data, and recommendations.
- Use watershed monitoring information to help assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

6.12 Aquatic Invasive Species Management

Goal: Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, and decontamination measures at potential entry points. Implement active management when appropriate.

The Aquatic Invasive Species (AIS) management program attempts to prevent the introduction of AIS through monitoring, exclusion, decontamination measures at potential entry points, and public education. Public education focuses particularly on recreational anglers and boaters, but also includes those involved in the sale of bait, aquarium fish, water gardens, and exotic pets.

The 2010 *Aquatic Invasive Species Assessment and Management Plan* explained the threat and current status of AIS in the Wachusett Reservoir watershed and described the management program implemented to control existing infestations and prevent new introductions. AIS currently known to occur in the DCR/MWRA reservoir system consist of five species of macrophytes, one species of snail, and one species of crayfish. Two species of invasive macrophytes – Eurasian Water-milfoil and fanwort – have been actively managed in the upper reaches of Wachusett Reservoir since 2002.

Accomplishments

DWSP staff routinely inspects the reservoir, associated basins, and other waterbodies in the watershed for invasive macrophytes. Priority is given to waterbodies with ramps suitable for launching trailered boats or with other related risk factors. These efforts are supplemented by MWRA through periodic macrophyte surveys performed by independent contractors.

Eurasian Water-milfoil and fanwort are present in the Stillwater, Oakdale, and Thomas Basins and occasionally in coves of the main body of the reservoir. Monitoring and control of these aquatic invasive macrophytes has been underway since 2002. The main components of this program are deployment of floating fragment barriers, deployment and maintenance of benthic barriers, annual hand-harvesting efforts, and routine scouting throughout the reservoir system to insure early detection of pioneering infestations. DWSP and MWRA added a Diver Assisted Suction Harvesting (DASH) component in 2012 to enhance hand harvesting efforts in the densest areas of plant growth.

A large scale DASH project was initiated in the Stillwater Basin during 2013 to address extremely dense growth of AIS that, despite all efforts at containment, was spreading to downstream basins and the reservoir proper. The ongoing hand harvesting and DASH work in

Oakdale Basin, Thomas Basin, and coves in the main basin is continually adjusted to improve control, efficiency, and tracking, and during the 2017 field season was modified to an all-DASH approach. This was due to the presence of missed plants discovered by the quality assurance divers and the documentation of hotspots in new locations. Removal efforts within the Stillwater Basin have been very successful, however, with most plants in that area removed. Stillwater Basin efforts were recently shifted to maintenance-level control.

New aquatic invasive species were found in the Wachusett Reservoir during the past five years. Mudmat (*Glossostigma cleistanthum*) was documented in 2014. Although surveys reveal that this diminutive aquatic plant is well established within the littoral zone of the reservoir, at the present time it is not believed to have a significant negative impact on water quality. Asian waterwort (*Elatine ambigua*) was collected in 2014 and conclusively identified through DNA analysis in 2015. Also a small plant that grows along the bottom, this plant has only been documented in a handful of locations in North America. At present it has only been found growing in small isolated patches in the reservoir and it will be monitored for spread. Eurasian milfoil and fanwort were documented growing within the Quinapoxet Basin of the reservoir for the first time in 2016, and the DASH contract was amended to address removing the newly discovered plants.

The discovery of Eurasian milfoil and brittle naiad (*Najas minor*) in the Lily Ponds (which are just outside the watershed boundary) in 2015 resulted in funding and ongoing treatment to address those infestations in close proximity to the reservoir. Early control results are excellent. Brazilian waterweed (*Egeria densa*) and water chestnut (*Trapa natans*) were discovered in Clamshell Pond at the northern edge of the reservoir in 2016, resulting in DCR Aquatic Biologists hand harvesting the water chestnut plants and pursuing a partnership with the town of Clinton to control the Brazilian waterweed.

The entire reservoir shoreline was scouted for AIS by DCR Aquatic Biologists in 2016, and an aquatic plant biovolume map was produced for the entire 37.5 miles of reservoir shoreline for the first time. This work and follow-up snorkel surveys discovered single Eurasian milfoil plants growing in 3 new locations in the reservoir. ciBiobase acoustic mapping of the Stillwater Basin has allowed biologists to "look below" the water and document the progress of divers removing invasive plant biovolume and the re-growth of native plant stands.

Educational efforts are an important component of the efforts to prevent the spread of aquatic invasive species. A new pamphlet was developed and distributed and Watershed Rangers were given specialized training. A new AIS decontamination certification form was developed by staff to formalize the inspection and decontamination procedures before any craft is launched into Wachusett Reservoir. This has become of increasing importance given the number of contractor vessels now accessing the reservoir.

An update to the 2010 "Aquatic Invasive Species Assessment and Management Plan" was completed in spring of 2016. This document, *Wachusett Reservoir Aquatic Invasive Species Summary; Historical Update and Ongoing Actions*, summarizes the history and threat of AIS in and around Wachusett Reservoir and addresses future actions.

Five Year Objectives

Staff will continue routine tributary and reservoir sampling to identify short term and long term threats from aquatic invasive species. Education and outreach are important tools to help inform the public and change behaviors to help reduce the risk of introduction and spread. Efforts will continue to locate and remove aquatic invasive macrophytes in the reservoir and throughout the watershed, including expanding routine monitoring beyond the reservoir and the tributaries to include lakes and ponds in the watershed.

- Inspect reservoirs, lakes, ponds and tributaries for presence of AIS. Make recommendations for management actions if/when new infestations are found.
- Perform aquatic vegetation survey work prior to Thomas, Oakdale, and cove vegetation management. Provide report to MWRA and contractors to guide plant removal efforts. Monitor, advise, and assist contractors with any necessary removal operations.
- Conduct aquatic vegetation surveys prior to and after aquatic treatments planned for the Lily Ponds and South Meadow Pond complex.
- Use appropriate methods to prevent the spread of pioneering stands of Phragmites along the Wachusett Reservoir shoreline.
- Enforce the decontamination procedures for all watercraft entering the reservoir by inspecting each vessel and collecting completed decontamination certification forms.
- Continue established program of public education on AIS. Educate fishermen on the harmful effects of AIS and encourage proper fishing equipment cleaning. Assess feasibility of adding educational signage at popular fishing areas and town owned fields adjacent to the reservoir.
- Develop and implement study to determine if water quality is the primary vector for AIS distribution in the reservoir coves and basins.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on aquatic invasive species in the water supply.

6.13 Wastewater Management

Goal: Monitor on-site wastewater disposal systems and operation of Rutland-Holden sewer to ensure proper treatment of waste.

Improper disposal of wastewater is a serious threat to the water supply due to the potential for contamination by pathogens and nutrients, and any release of untreated wastewater must be considered of highest priority for action by DWSP staff. Staff work with state and local regulators to ensure compliance with all applicable regulations and will continue to work to obtain cooperative agreements with the user communities.

Accomplishments

Problems in many areas of the Wachusett Reservoir watershed have been reduced with completion of sewers in West Boylston and Holden. Connections to the sewer have improved tributary water quality and reduced the threat from wastewater. DWSP staff have improved mapping of water resources and shared information with MassDEP and local Boards of Health. Staff continues to provide technical support as requested and reviewed more than 200 septic system plans.

DWSP and MWRA continue to cooperatively manage the Rutland-Holden Trunk sewer, although there have been legal challenges due to a lack of agreements with the Town of Holden. The MWRA performed a trunk line and relief line subsurface TV inspection each year. A sewer repair in Holden (cross-country section) was completed, and three connection permits, two utility crossing permits, and a driveway crossing permit were issued. There were no sanitary sewer overflows during the past five years.

The Town of Holden has provided information on the 28 sewer pump stations operated by the Holden Water and Sewer Division, including a list of operation and maintenance checks performed daily, weekly, and annually. All wet wells are vacuumed and cleaned twice per year and valves are disassembled and cleaned annually. Operation and maintenance manuals are located at each pump station.

Staff has been able to track connections to the municipal sewers and regularly enter the data in a spreadsheet and a GIS datalayer. An update to the GIS sewer line datalayer is underway and the final product will accurately depict all sewered areas.

A new septic system database was recently created to compile a complete inventory of onsite septic systems with information on year of installation, date of last repair, and system status. Data gathering will be a lengthy process but is currently underway.

Staff continued to work with Boards of Health in watershed communities to provide technical assistance when requested on septic system repairs and new installations. Information gathered during system reviews is added to the new septic system database.

Five Year Objectives

- Monitor and enforce provisions of Title 5, using water quality data and working with Boards of Health and MassDEP. Provide technical assistance, upon request.
- Track new connections to sewer lines and maintain database and GIS datalayer.
- Compile data on all onsite septic systems and enter into database.
- Manage, with MWRA, the Rutland-Holden trunk sewer and Rutland-Holden Relief trunk sewer.
- Pursue updated sewer agreements with Worcester and DCR sewer communities.
- Design a study, once all known sewer and septic connections are mapped, to determine if populated areas that experienced significant conversion from septic to sewer have seen statistically significant reduction in nutrient loading.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wastewater in the water supply.

6.14 Stormwater Management

Goal: Reduce water quality problems caused by uncontrolled stormwater.

Stormwater is currently considered the most significant threat to water quality in the Wachusett Reservoir watershed. Water quality sampling suggests that significant portions of annual pollutant loads to the reservoir are contributed during storm events. Contaminant concentrations can rise rapidly during first flush and tributary flow increases rapidly as well. DWSP works with the appropriate agencies and watershed communities to increase compliance with stormwater regulations, including Federal NPDES stormwater requirements and Massachusetts Stormwater Standards. DWSP designs and constructs stormwater BMPs on its properties to help control stormwater and supports the direct discharge elimination program.

Accomplishments

DWSP completed a study in 2008 that created a comprehensive inventory of locations where stormwater runoff discharged directly to the reservoir. During the implementation period for the current Watershed Protection Plan, 50 direct stormwater discharges to the reservoir were redirected off watershed or provided with treatment and capacity to temporarily store accidental releases. DWSP has conducted engineering studies for this work at a cost of approximately $600,000. MassDOT has funded all the construction at a total cost of approximately $8.5 million. In addition, West Boylston Water Department conducted $730,000 in improvements to water lines in the project areas.

Construction of drainage improvements at the northern end of the reservoir was completed in the fall of 2012. Two engineering design contracts were advertised and awarded for additional work to remove stormwater drainage from the southern portion of the reservoir and provide containment in case of a material release. Contracts were awarded to redesign drainage on both sides of the Route 12 Bridge crossing and to redesign the drainage at the Beaman Street Bridge and along Route 140 at South Bay in West Boylston. Construction of the stormwater improvements for the Route 12 Bridge began in April 2016 and was completed by April 2017. Construction of the remaining two projects began in 2017 with completion anticipated in 2018. DWSP staff will assume maintenance responsibility.

Elimination of all direct discharges to the reservoir is estimated to potentially remove up to 97 pounds of total phosphorus, 527 pounds of total nitrogen, and 142,000 pounds of total suspended solids each year.

DWSP continues to improve a GIS datalayer of all stormwater drainage structures to help understand potential pollutant flow pathways. All stormwater outfalls in the watershed have been located and staff are now attempting to identify connectivity and to develop stormsewersheds.

Staff conducted an inventory and inspection of all structural BMPs in the watershed. More than 700 individual BMPs on 152 sites were inspected and about one third required maintenance. Responsible parties were notified and almost all were cooperative and performed the required maintenance. The most common maintenance issues were accumulated sediment, vegetation,

and debris. Many property owners did not know they were responsible for BMP maintenance and in some cases they were not even aware that the structures existed on their property.

All active construction sites with Construction General Permits (disturbances of more than one acre) were inspected regularly in both wet and dry weather. All DCR stormwater treatment BMPs were inspected and maintained as needed.

A comprehensive cooperative effort to assist towns comply with federal Municipal Separate Storm Sewer Systems (MS4) compliance efforts continued with a focus on education and outreach. Informational brochures about household stormwater pollution prevention, stormwater BMP maintenance, MS4 for fire departments, business-specific stormwater management, and construction site supervision have been provided to each watershed community for public distribution to help meet the public education and outreach requirements. Training on Best Management Practices was provided to DWSP labor crews and DPW employees in Boylston and Leominster. Staff also shared information on construction inspections and provided water quality data to assist communities meet compliance standards. DWSP continues to work with regional collaborative efforts to provide additional assistance with stormwater management efforts.

Five Year Objectives

As a result of the drainage improvements and elimination of direct discharges, DWSP is now responsible for maintenance of nine stormwater basins and eight stormwater treatment units (SWTUs). Maintenance to ensure that the stormwater treatment system operates efficiently is extremely important. It is also important that the basins, especially those near the Old Stone Church, are maintained in an attractive manner, due to the high visibility and public use. Staff will need training to maintain the basins, and contracted services (a vacuum truck) will be necessary to maintain the SWTUs. The frequency of maintenance will need to be determined. The forebays to the basins are lined to provide storage for spills, so they will generally have standing water and may require attention as well.

A divided highway (Interstate 190) passes through the Wachusett watershed and crosses both major tributaries. Stormwater runoff from the highway is managed in a series of basins that line the road and also provide storage in case of a spill of hazardous materials. MassDOT is responsible for regular maintenance of the basins but does not currently have sufficient funding to accomplish this task. DWSP will work with MassDOT and attempt to develop a cooperative arrangement that will allow for improved access and more frequent maintenance.

The control and treatment of stormwater has great potential to protect and improve water quality in tributaries and the reservoir. DWSP will continue to commit significant staff and financial resources to stormwater management efforts. Cooperative efforts with federal, state, and local authorities are an effective way to accomplish shared goals, including the six minimum control measures (CM) that operators of regulated small MS4s must incorporate into stormwater management programs.

- Locate, assess, and require maintenance of public and private stormwater BMPs and BMPs on DWSP property.
- Work with MassDOT and local DPWs to improve infrastructure to control stormwater and with conservations commissions, MassDEP, and EPA for compliance with state and federal stormwater requirements.
- Work with town officials to implement program of public education and outreach related to stormwater and the MS4 permit where applicable.
- Update map of stormwater conveyance structures and define stormwater subbasins.
- Inspect all construction sites greater than one acre to ensure compliance with Stormwater Pollution Prevention Plans (SWPPPs).
- Review, summarize, and assist in the development of bylaws to manage construction site runoff and post- construction runoff if requested, and assist communities with mapping and impervious surfaces analysis.
- Provide regional training on stormwater issues for town employees, DWSP staff, and others.
- Design and conduct water quality monitoring studies to evaluate effectiveness of and optimize performance of direct discharge project structural BMPs.
- Design a prioritization model using stormwater network and storm sewer delineations that takes into account land cover, proximity to tributaries, and other criteria to categorize watershed areas for relative stormwater treatment needs.
- Coordinate with Planning Boards to ensure that all construction projects that have a stormwater management component are reviewed and that any new or changed stormwater infrastructure is added to DWSP GIS datalayers.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on stormwater impacts in the water supply.

6.15 Emergency Response

Goal: Maintain and improve short- and long-term emergency response capabilities to protect the water supply.

Release of chemicals and other hazardous materials within the watershed is a serious potential threat to water quality. DWSP maintains and improves emergency response capabilities to assist local emergency responders and protect the water supply should a release occur.

Accomplishments

DWSP and the MWRA have deployed Emergency Response trailers in key areas throughout the watershed. Annual training has been conducted for DWSP staff and area responders in spill response, boom deployment, and Incident Command System. Nearly all staff has taken ICS 700 and ICS 100 classes, and several have taken ICS 200, ICS 300, and Oil Pollution Act of 1990 Qualified Individual Training.

DWSP continues to monitor any spills in the watershed and work with federal, state, and local officials to ensure successful remediation. DWSP staff has participated in meetings and exercises as part of the South Wachusett Regional Emergency Planning Committee. DWSP also completed a Comprehensive Emergency Management Plan that details actions and procedures

for incidents that occur on DWSP property or that have the potential to impact the water supply. An unannounced mock hazardous materials release drill was conducted in the woods near Justice Brook in 2017.

Anchor points around the reservoir have been upgraded and are available for boom attachment. Sheds were constructed at Gate 1 and the boat cove in Clinton to store new emergency response equipment.

ICS training has been provided to key staff including all new personnel. MWRA has prepared a vulnerability assessment per EPA requirements. DWSP and MWRA regularly hold a variety of drills to acquaint the workforce with how to react to an ongoing emergency. The fall 2015 simulated release was a large-scale exercise involving several hundred individuals in several federal, state, and local agencies.

DWSP and MWRA established a working group to look at potential impacts of a large hazardous material release from a train crossing the reservoir. A tabletop exercise was conducted in 2014 and a full-scale training exercise was held in October 2015 to simulate a railroad based oil spill in the Wachusett Reservoir. DCR staff worked in conjunction with MWRA, MassDEP, and other local, state, and federal emergency responders to practice boom deployment, communication, and other coordination issues. A Combined DWSP & MWRA Inter-Agency Emergency Spill Response / Prevention Plan for the Wachusett and Sudbury Watersheds (2017) was produced and replaced the 2008 plan.

Mathematical modeling of the reservoir, in conjunction with UMass Amherst Department of Civil and Environmental Engineering, has been conducted to evaluate spill scenarios. This information was used during the full-scale training exercise and provided a rapid assessment of possible concentrations and likely intake arrival time of contaminants.

Fire suppressant foams have been identified as the possible cause of contamination of drinking water wells on Cape Cod. DWSP staff has had conversations with local fire chiefs about how much of each type of foam was kept locally. A brochure on fire suppressant foams was developed and has been distributed to all watershed fire departments.

Five Year Objectives

- Provide emergency response support services; maintain response supplies and up-to-date contact lists.
- Provide Incident Command System training to appropriate staff.
- Coordinate with MWRA and local officials to provide emergency response training and annual tabletop or field exercises.
- Construct additional structural controls to reduce likelihood of spills reaching the reservoir.
- Monitor sites of releases or spills that occur near a resource area and follow submitted reports until remediation efforts have been completed under Mass Contingency Plan.
- Implement Multi-year Training and Exercise Plan.
- Ensure that DWSP and town emergency responders are aware of emergency protocols put in place by DWSP and are provided emergency contact phone numbers on a regular basis and when changes occur.

- Provide emergency response training for new DWSP employees and refresher training for veteran staff.
- Conduct emergency response training events with the local first responders.
- Update, as needed Comprehensive Emergency Management Plan for Wachusett and Sudbury Reservoirs.
- Produce spill response plans and spill notification cards for timber harvesting operations.
- Prepare a summary report of information related to containment structures associated with direct discharge abatement projects for use in case of an accidental spill.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on emergency response in the water supply.

7. Sudbury Reservoir Watershed Control Programs

7.1 Land Acquisition

The Sudbury and Foss Reservoirs are an emergency source supply for the MWRA. DWSP and the MWRA focus the limited resources available for land procurement in the active water supply watersheds of Quabbin Reservoir, Ware River, and Wachusett Reservoir, so there is no land acquisition occurring in the Sudbury Reservoir watershed. DWSP manages the area acquired during the development of this water supply in the late 19th century (Table 7-1 and Figure 7-1).

Table 7-1: DWSP Protected Lands in the Sudbury and Foss Reservoirs Watershed

DWSP Fee (acres)	DWSP WPR (acres)	Other Protected (acres)	Total Protected (acres)	Land Area (acres)	Protected as % of Land Area
2,381	0	2,146	4,527	16,350	27.7%

7.2 Watershed Preservation Restriction Monitoring

There are no Watershed Preservation Restrictions in the Sudbury Reservoir watershed.

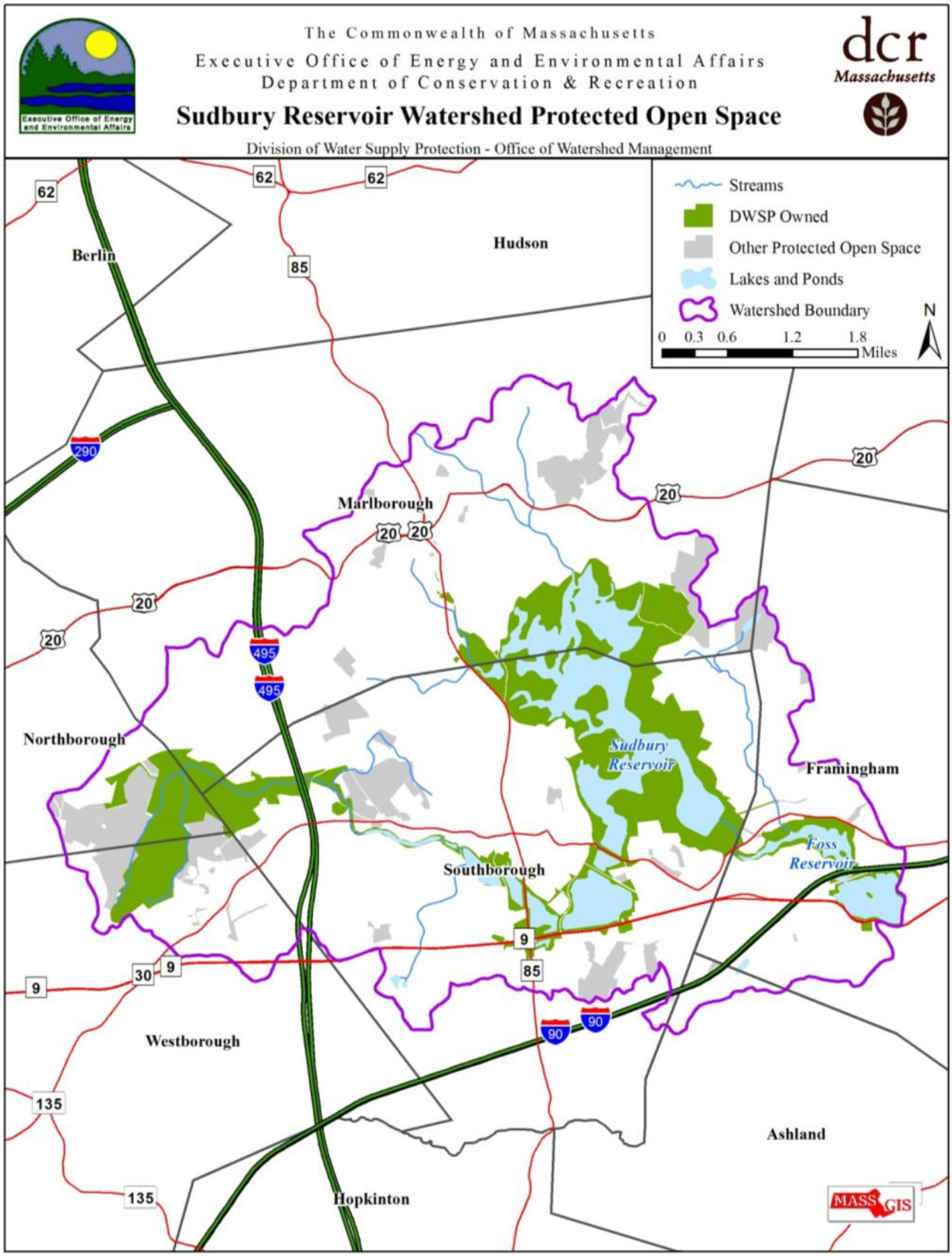
7.3 Land Management

Goal: Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.

The comprehensive *2017 Land Management Plan* lays out an approach towards land management in all of DCR's watersheds. Continued implementation of the *2017 Land Management Plan* provides the best possible protection to the reservoirs.

Land acquisition is one of the most successful approaches for protecting water quality. However, given the Sudbury and Foss Reservoirs' emergency status, DWSP has no plans to add to the existing 2,381 acres in DWSP ownership (Figure 7-1). These current holdings remain a critical buffer to the impacts of future growth in the watershed. Encroachment by abutters onto the Commonwealth's properties has been an ongoing problem in the Sudbury watershed. This is due in part to limited ownership, unclear boundaries, and a lack of monitoring and enforcement. Some of these encroachments have been minor (e.g., mowing onto commonwealth property), while others have been quite significant (e.g., re-grading, landscaping, or placing structures directly adjacent to the reservoirs). Work over the past few years has been completed to identify and rectify these encroachments.

Figure 7-1: Sudbury Reservoir Watershed Protected Open Space



There is relatively little timber harvesting activity in the Sudbury watershed, especially compared to the amount performed in the Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds. In the past, an average of one operation occurred annually on DWSP property, with a targeted coverage of approximately 40 acres. More recently however, there is increasing evidence that the white- tailed deer population has grown to the point where it is having negative effects on the forest, particularly the ability of the forest to regenerate. Timber harvesting operations that seek to establish tree regeneration will not be proposed in the future until the deer population is reduced. Timber harvesting operations that seek to release existing tree regeneration will only be proposed if the regeneration is tall enough to prevent being browsed and can be adequately protected during the harvest to avoid resprouting.

Other than in a few isolated areas, there has not been any extensive tree damage due to gypsy moths. Trees will be monitored for gypsy moth infestations for the next couple of years as drought conditions could allow for a recurrence in this region.

DWSP Foresters receive all Forest Cutting Plans for activity on private property in the Watershed System; the limited private timber harvesting in the Sudbury and Foss Reservoirs watershed means few are ever submitted for DWSP review.

Terrestrial Invasive Species have been noted around the Sudbury Reservoir watershed; the most problematic issues include nine separate locations of garlic mustard as well as instances of bittersweet. Management objectives from the *Terrestrial Invasive Plants: Problem Statement and Management Strategy for Properties under the Care and Control of the DCR Division of Water Supply Protection* have been implemented.

The Sudbury South Basin, hydrologically separate from the North Basin's Sudbury and Foss Reservoirs, consists of several reservoirs that were once part of the drinking water supply system, but were removed in the 1930s due to water quality and quantity issues. Ashland, Hopkinton, and Whitehall Reservoirs were transferred to State Parks in 1947, however Stearns and Brackett Reservoirs (Framingham Reservoirs No. 1 and No. 2) remained under the care and control of DCR's predecessor agency. The South Basin consists of approximately 30,058 acres, of which DWSP has care and control of 1,078 acres, or about 4% of the area. In the 1970s the sediment in the Stearns and Brackett was found to be contaminated with mercury from the Nyanza textile plant Superfund site. The area has been studied and found to not be a health hazard. DWSP has worked with the EPA, MassDEP, towns, and other interested parties on ways to best manage this last vestige of the former drinking water supply, and is currently in the process of transferring this property to DCR State Parks.

<u>Accomplishments</u>
A deer pellet survey was conducted to determine density of white tailed deer on Sudbury Reservoir DWSP lands. An inventory and assessment of terrestrial invasive species has been completed.

Five Year Objectives

- Implement the 2017 Land Management Plan.
- Assess forest health in the Sudbury Reservoir watershed by monitoring regeneration and other indicators of forest health, especially in areas of timber harvesting operations.
- Identify all encroachment activities and work with Watershed Rangers to resolve all conflicts in the Sudbury watershed.
- Continue forestry operations that are feasible in the presence of a high deer population and follow all documented management techniques including oversight of active timber harvesting in Sudbury Watershed.
- Monitor for gypsy moth activity and tree conditions, especially if drought conditions arise.
- Develop and implement a Terrestrial Invasive Plant Species Plan.
- Transfer DWSP lands at Reservoir No. 1 and 2 to State Parks.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on land management in the water supply.

7.4 Wildlife Management

Goal: Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.

As an emergency backup supply, there is no active bird harassment program or Pathogen Control Zone as described at Quabbin and Wachusett Reservoirs.

The *2017* comprehensive *Land Management Plan* includes discussions on wildlife management in the watershed. The resident Canada goose population is the primary target of DWSP's wildlife management activities in the Sudbury. A population reduction program was initiated in 2007, and it has helped limit the growth of the resident population.

Data collected by DWSP Natural Resources Staff indicate that the reservoirs within the Sudbury System are used by roosting gulls on a regular, but intermittent, basis. In the event that this system had to go online as an emergency supply, particularly during the fall or winter months, it may be necessary to assess the extent of the roosting and/or initiate a harassment program if conditions warranted.

A pellet survey was conducted on Sudbury Watershed lands in 2016 which estimated white-tailed deer densities to be approximately 40 deer/square mile. By comparison, The Massachusetts Division of Fisheries and Wildlife has a statewide deer management goal of 6-18 deer per square mile of forest. Deer densities maintained at or below this level prevents major impacts to the forest. As mentioned in the previous Land Management section, the deer population has been impacting forest regeneration and will continue to be monitored.

The West Suburban Conservation Council (WSCC) is a regional consortium of local land trusts, conservation commissions, agencies, individual landowners, and students working together on land conservation and stewardship. The WSCC is based in Metrowest Boston, including the 36 towns within the Sudbury, Assabet and Concord River watersheds and their neighboring towns.

The WSCC is concerned about the detrimental impacts on habitat by deer over-browsing and the spread of Lyme disease, and considers deer management as one of their priorities. They have hosted public forums and several towns have been moving forward with instituting regulated hunting on selected conservation lands in this watershed. If management to control the deer population is required in the future, WSCC might prove to be an invaluable resource and partner. Deer density surveys will be completed again to monitor for any changes if hunting is allowed on surrounding non-DWSP lands.

Accomplishments

All reservoir islands, some shoreline sites, and the area around the MWRA facilities were surveyed each spring to locate nesting Canada geese; eggs in nests were oiled to prevent hatching. Shoreline surveys were completed each summer to document goslings and assess the success of oiling.

Five Year Objectives

- Control the resident Canada goose population on the Sudbury Reservoir.
- Reduce the amount of food available to gulls in Central Massachusetts by controlling public feeding and identifying and controlling alternative food sources.
- Monitor, assess, and control aquatic and burrowing mammals that threaten water quality or infrastructure.
- Monitor deer populations and their impact on forest dynamics through browsing surveys, annual deer sign surveys, and/or exclosure studies in Sudbury watershed.
- Test mammal and bird fecal samples for presence of Giardia and Cryptosporidium.
- Manage habitat for rare species; monitor populations of select species.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wildlife in the water supply.

7.5 Public Access Management

Goal: Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.

DWSP policies regarding public access in the Sudbury system are detailed in the *2010 Sudbury Reservoir Watershed System Public Access Plan*, which will be reviewed and updated during this protection plan cycle. Please refer to the plan, available at www.mass.gov/service-details/dcr-watershed-plan-publications for current policies and associated maps. A key component to the plan is the designation of resource management districts and corresponding public access rules. Many activities are not allowed in the Sudbury and Foss Reservoir watersheds due to the limited resources available to protect both the public and DWSP property. There are ongoing enforcement issues surrounding illegal uses, such as chronic swimming at the railroad trestle crossing the Foss Reservoir. More enforcement is occurring, but the issue remains a challenging one. Watershed Rangers have been given the authority to issue monetary citations for violations of regulations, and will continue to utilize this approach as needed.

Problem access areas are noted through ranger patrols. Gates, barriers and signs are repaired and placed as conditions warrant.

Aquatic Invasive Species pose a threat when using fishing gear that has been submerged in an infested lake, pond, or stream area. Therefore, while fishing is allowed from the shoreline at many areas around the Sudbury Reservoir, it is important that users be vigilant about cleaning any fishing equipment. DWSP encourages that any visible mud, plants, fish or animals be removed before transporting equipment and any fishing equipment that comes into contact with the water be thoroughly cleaned and dried before using at the Sudbury Reservoir or any of its tributaries.

Bacterial contamination and nutrient contribution from dog waste continues to be a threat to water quality due to the amount of residential neighborhoods abutting the tributaries and reservoir as well as illegal dog walking on DWSP lands.

The Sudbury Reservoir watershed includes many open space and recreation fields not owned by DWSP. Callahan State Park allows for a variety of public recreation, including dog walking. Lands are also owned by the Sudbury Valley Trustees, Boy Scouts of America, municipal departments and private schools, offering vast areas of open space for use.

Numerous sports fields are located along tributaries to the reservoir, where chemical use, in addition to human activity, poses a risk to the water supply. These fields offer wide open spaces for Canada geese and are often an area for dog walkers, providing a pathway for bacteria and pathogens to get into the water supply.

The 9/11 Memorial Field and associated parking area is located in close proximity to the Sudbury Reservoir in Southborough. It is a 15 acre site that is leased by the Town of Southborough from DWSP and has been in existence since 2002. A 15-year lease was signed in 2017, and replacement of the artificial turf and drainage improvements began in February 2018. Potential impacts to water quality exist at this location, but an opportunity for outreach and education also is present.

Impacts such as an increase in litter, biking and illegal dog walking could become a potential problem in this watershed due to the creation of trails and more extensive use of existing trails. A portion of the Bay Circuit Trail, a 184-mile permanent recreation trail and corridor that travels through 34 communities, is located within the watershed. Maps and information made available to the public for the Bay Circuit Trail list the area as a drinking water supply and instruct users to follow posted rules and regulations. Portions of the trail that were previously on streets without sidewalks have been re-routed through the woods adjacent to the Fayville Dam and the Southborough Trails Committee is looking for a crossing point over the Sudbury Reservoir in the eastern part of the town near Route 30. The two currently existing options include the path on Route 30 or along the rail lines, neither which are feasible for safety purposes. Organizers will continue to investigate alternatives for this section of the trail. The Sudbury Reservoir Trail is also located adjacent to the southwest portion of the reservoir. The Boroughs Community Trail Loop, a more than 30 mile path that will connect to Southborough, Westborough and Northborough when completed will utilize the existing Sudbury Reservoir and Bay Circuit

Trails. From an initial grant, it was discovered that creating this loop would be a feasible project. Creation of the trail and connections are ongoing at this time through a combination of municipal funds and grants. In 2017, the City of Marlborough received a $40,000 grant through the DCR Recreation Trails Grant program to develop its section.

DWSP continues to get reports of illegal boating on the reservoir throughout the summer. The EPO Officer assigned to this area has made an effort to curb this activity.

Accomplishments

Watershed Rangers have routinely patrolled and educated visitors within the watershed and have worked with local and state law enforcement to curb activities such as trespassing, illegal hunting and trapping as outlined in the *2010 Sudbury Public Access Plan*. Watershed Rangers have conducted weekly night operations starting Memorial Day weekend and continuing through Labor Day weekend; a ranger will stay on late and patrol on Friday, Saturday and occasional Sunday nights. Through this effort over the past few summers they have curbed the illegal partying and night time access on DCR property.

Joint operations with CSX Railroad Police were held to stop illegal activity at the Foss Reservoir railroad trestle. Boat patrols were conducted on the Sudbury Reservoir during the 2017 summer season. Multiple rope swings and platforms along the reservoir were discovered and subsequently removed by DCR labor crews. Through boat use, the Watershed Rangers also discovered a few party spots along the shoreline and islands. They also found and removed a number of boats (small jon boats, kayaks and canoes) in the woods along the shorelines.

Five Year Objectives

- Implement Watershed Access Management Plans for the Sudbury Reservoir watershed.
- Update the Sudbury Public Access Management Plan. Provide periodic review of policies with updates, as needed.
- Maintain working relationships with State, Environmental, and local police.
- Monitor DWSP lands and water to ensure compliance with rules and regulations designed to protect the water supply and protect the public.
- Maintain gates and other structural controls using existing protocol.
- Expand use of electronic media to disseminate information.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on public access in the water supply.

7.6 Watershed Security

Goal: Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to provide surveillance of the watersheds to protect the watershed system from potential threats.

Many security improvements have been made by both MWRA and DWSP over the past years. Due to security concerns, these improvements will not be listed here.

The largest security concern in the Sudbury watershed is the amount of roadway and the railroad lines that abut or cross the reservoir. There are also many technological, chemical and biomedical companies in the watershed. The *Combined DCR & MWRA Inter-Agency Emergency Spill Response/Prevention Plan for the Wachusett and Sudbury Watersheds* was written in 2017, providing guidance for releases of hazardous materials. An Emergency Action Plan, containing the details of procedures to follow in several scenarios associated with a breach at the Sudbury Dam, will be revised to include additional information and locations and is in the process of being updated.

Watershed Rangers regularly patrol the area. Local, State, and EPO are also responsible for monitoring the watershed.

Accomplishments

Regular maintenance and installation of access gates is ongoing. DWSP has completed an update to the DCR & MWRA Inter-Agency Emergency Spill Response / Prevention Plan for the Wachusett and Sudbury Watersheds that details actions and procedures for incidents that occur on DWSP property or that have the potential to impact the water supply.

Five Year Objectives

- Coordinate with MWRA in order to maintain comprehensive system-wide approach on all security issues.
- Continue Watershed Ranger patrols on all DWSP properties, with particular focus on highly vulnerability sites.
- Work with local, state and federal responders and ensure they receive current agency emergency contact information on a regular basis.
- Remain up to date with any guidance materials available from EPA, American Water Works Association, and Department of Homeland Security.
- Improve physical access control structures, as necessary, and implement a maintenance program.

7.7 Infrastructure Maintenance

Goal: Maintain the integrity of all high hazard dams under DWSP control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.

The main infrastructure elements in the Sudbury and Foss Reservoirs watersheds are the reservoirs' respective dams, spillways, gatehouses, and associated dikes. There are also emergency pipelines that connect Foss Reservoir Gatehouse to Stearns Reservoir Gatehouse and the Sudbury Aqueduct. DWSP also maintains responsibility for dam infrastructure maintenance on Stearns (Framingham No. 1) and Brackett (Framingham No. 2) Reservoirs, even though these two reservoirs are no longer an emergency source supply for the water supply system. DWSP and MWRA work cooperatively to ensure that the biannual dam safety inspections required under 302 CMR 10.00 are completed and results reported to the DCR Office of Dam Safety.

DWSP's Civil Engineers perform routine monthly inspections, while MWRA provides capital maintenance and improvements in response to any deficiencies discovered by inspections.

Accomplishments

Phase II Reports for Framingham Reservoir No. 1 and 2 were prepared in 2013, Emergency Action Plans for Framingham Reservoirs No. 1 and 2 were also developed and MWRA has had the inundation maps updated. The toe drain at Framingham Reservoir No. 2 was replaced in 2017 and a new road to access Reservoir No. 2 was constructed. Evaluations were conducted on several internal roads, a gate inventory was completed, and regular inspections were conducted on system dams, spillways and dikes.

Work has been completed by MWRA on the Foss Reservoir dam to bring it into compliance with dam safety regulations.

Five Year Objectives

- Monitor and maintain large dams, spillways, and dikes, and periodically update Emergency Action Plan in conjunction with MWRA.
- Conduct annual inspection of roads and develop annual plan for repairs.
- Maintain fire roads for water supply operations as necessary in Sudbury Watershed.
- Pursue improvements to Reservoirs No 1 and 2, as identified in the Phase II Reports.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on infrastructure in the water supply.

7.8 Watershed Protection Act

The Watershed Protection Act's regulations do not encompass the Sudbury Reservoir watershed.

7.9 Education and Outreach

Goal: Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.

Watershed Rangers, besides patrolling DWSP property, are also able to educate visitors on DWSP rules and regulations, the DCR/MWRA water supply system, and DWSP efforts to manage the watershed. The publications and education material developed and distributed by DWSP's Interpretive Service staff at the Quabbin Visitor's Center, Stillwater Farm, and Wachusett Environmental Quality staff can be shared with the Sudbury Reservoir watershed communities.

The suburban communities that comprise the Sudbury watershed, unlike many of the rural towns that are within the Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds, are municipalities with professional staff. DWSP relies on this knowledge base to support local environmental regulatory implementation. DWSP maintains communication, as needed, with key boards and municipal offices in offering technical assistance and community outreach.

Grant funding for trail work awarded to the cities and towns surrounding the Sudbury Reservoir to develop the Boroughs Community Trail Loop can provide an opportunity for placing educational and interpretive signage on watershed protection and water quality topics in areas that have not been previously accessible.

Education and outreach on stormwater pollution prevention, as a non-traditional Best Management Practice, can be an invaluable tool to improve the quality of stormwater entering into the Sudbury and Foss Reservoirs, as almost one third of the watershed is in residential development. DWSP has the ability to perform outreach and education to watershed residents in the form of brochures and presentations, and will consider this approach in an effort to minimize this source of pollution. DWSP staff has developed a series of brochures on various stormwater topics which will be shared with town departments, boards and commissions as needed for use in the Sudbury Reservoir watershed.

Assistance and programming within watershed school classrooms will continue as staff and resources allow.

Accomplishments

Routine "in the field" education has been ongoing by the Watershed Rangers and several formal interpretive programs were presented, including a "Sudbury Saunter"- a hike along the shores of the Sudbury Reservoir to explore old roads, stone walls, cellar holes and former home sites. A "cache in- trash out" geocaching event was held annually. This event continues to draw a large crowd that gathers and removes a vast amount of trash.

Brochures on the dangers of pet waste were provided to the town of Southborough Board of Health for use in problem neighborhoods where dog waste bags were being disposed in the storm drain system, and a Sudbury Reservoir fact sheet has been developed.

Environmental quality staff participated with a year-long project at Fay School in Southborough about water quality in the Sudbury Reservoir by teaching about sources of pollution in the Fay School's drainage area.

Five Year Objectives

- Conduct, record, and evaluate public education programs with a focus on water supply, water quality, Aquatic Invasive Species, and climate change.
- Conduct environmental education teacher training and support Mass Envirothon.
- Participate in environmental programs with other environmental groups.
- Research and implement electronic media to enhance interpretation programs.
- Provide programs that reduce threats from public access (e.g., Earth Day cleanups, fishing line collections, etc.)
- Educate the public of the importance of Sudbury and Foss Reservoirs as a reserve drinking water supply and natural resource through informal education as staff availability allows.
- Maintain and/or initiate information sites, such as kiosks, and programs in watersheds. Expand interpretive signage opportunities to enhance public understanding of the water supply system.
- Utilize the DWSP website to provide information and resources for the public.

7.10 Water Quality and Hydrologic Monitoring

Goal: Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.

The Sudbury and Foss Reservoirs, as emergency source water supplies, are not subject to the same level of thorough examination as the Quabbin and Wachusett Reservoirs, the active drinking water sources in the DCR/MWRA water supply system. MWRA has a program of water quality monitoring for all of its reserve water supplies, both source (Sudbury and Foss) and distribution (Chestnut Hill, Fells, Norumbega, Spot Pond, and Weston) reservoirs.

Having a baseline for water quality in Sudbury Reservoir tributaries, routine sampling is no longer conducted and will focus on augmenting water quality investigations as needed.

Samples were collected upstream and downstream of the Marlborough filter beds to confirm that no contaminants were affecting the water supply from a historical sedimentation basin. More extensive sampling would be required in the future if any dredging or sediment disturbance were to occur in the basin itself.

Cyanobacteria (blue-green algae) are microscopic bacteria found in freshwater lakes, streams, oceans, damp soil, and even on moistened rocks. Due to reasons including climate change, cyanobacteria can grow to excess, causing cyanobacteria blooms, which occur when there is enough sun, the water is warm, stagnant or slow moving, and if there are enough nutrients such as phosphorus and nitrogen present in the waterbody. The blooms are more common during late summer or early fall. Nutrient pollution is exacerbating the problem, increasing the number of cyanobacteria blooms that occur.

Accomplishments

Data collected from the tributary sampling has resulted in a baseline for water quality parameters. Samples were collected on two occasions in response to potential impacts from adjacent projects.

Five Year Objectives

- Investigate potential water quality problems, including water sampling, in Sudbury watershed as needed and as staff time allows.
- Develop Wachusett/Sudbury notification protocol for cyanobacteria blooms.
- Use water quality and hydrologic data to assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

7.11 Watershed Monitoring and Assessment

Goal: Use Environmental Quality Assessments, site inspections, local board meetings and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.

Since Environmental Quality Assessments are not conducted in Sudbury watershed, assessments of the Sudbury watershed can be obtained from maintaining communication with local, state, and federal regulatory and planning authorities, as well as DWSP's review, as needed, of MEPA filings. DWSP will support enforcement of all local, state, and federal environmental regulations regarding wastewater management, stormwater management, agriculture, and hazardous materials and waste. Visual outdoor inspections of industrial and commercial sites will be conducted when staffing and time allows, and any issues that could impact water quality will be followed up through DWSP and/or local boards or commissions. Watershed Rangers, through regular patrols, inform DWSP Environmental Quality staff of situations that they feel requires investigation. DWSP will continue to follow through with reports made by Ranger staff.

There are two active railroads within this watershed. The diesel freight line, through the center of Southborough, is used occasionally, and the MBTA Framingham/Worcester line which bisects the watershed operates both day and night. This line is shared with CSX (freight), Amtrak and MBTA commuter trains. Releases and derailments could pose a serious threat to the water supply. Transflo CSX remains located in Westborough along the Southborough border. Hazardous materials are stored here to be transported by rail or truck to their Northeast destinations. Although this site is located off-watershed, it will be prudent to continue to monitor the transport of these materials and any projected expansion or changes to the site.

There are several modes of commercial and industrial activities in the Sudbury and Foss Reservoirs watershed, mostly clustered around the major transportation arteries of the Mass Turnpike, I-495, and Rt. 9. While many of these sites are in the western edge of the watershed, the Framingham Technology Park is situated adjacent to Foss Reservoir and the 9/90 Corporate Center is located on the Southern end of the Sudbury Reservoir. At this time, 160,000 square feet of commercial space is on the market within the Corporate Center and a total of three commercial buildings will be vacant by summer of 2018. Commercial activity also spreads along the length of Rt. 9 as it borders the two reservoirs, and there is a strip of commercial sites along Rt. 85 to the northwest of Sudbury Reservoir.

From a Route 9 Executive Summary prepared by MassDOT in 2013, it has been recommended that Route 9 be widened to three lanes in each direction between Computer Drive in Westborough and Deerfoot Path in Southborough. This would be completed by extending into the median, but also requiring use of the former Verizon site which is predominantly wetlands. Any future progress of this project will be monitored for changes to wetland resources. A plan (Interstate 495 Corridor Improvement Program) to provide upgrades to the traffic pattern at the Route 495/I90 interchange has been submitted to the State and a Draft Environmental Impact Report is being prepared as Cedar Swamp, an ACEC, surrounds the proposed work. Although this work directly affects the Sudbury South Basin (which is no longer part of the drinking water supply system), any changes to this plan that might affect the Sudbury North Basin – and thus

the Sudbury and Foss Reservoirs – will be monitored throughout the MEPA review process, including storm drainage which could affect the watershed boundary line.

In addition to the Route 495/I90 interchange project, MA DOT, in conjunction with the Massachusetts Port Authority, is requesting additional funding from the federal Infrastructure for Rebuilding America grant program to incorporate upgrades to the Route 495/Route 9 interchange. If this grant is acquired, any changes to road drainage and potential stormwater best management structures will be investigated, as this interchange is the current North Basin watershed boundary. DWSP relies on the buffering of its land to mitigate against the most serious impacts of commercial and industrial activity. DWSP also depends on local implementation and MassDEP oversight of state regulations to provide protection to the reserve water supply.

Solid waste facilities do not pose a threat to the Sudbury Reservoir. According to MassGIS and MassDEP, there are three closed or inactive solid waste facilities in the Sudbury basin. One is in Framingham, situated between Rt. 9 and the MA Turnpike. The other two are in Southborough: one is a capped and unlined municipal solid waste site that is now a town soccer field on Parkerville Road, and the other is Mt. Vickery Road dump adjacent to the southern edge of Sudbury Reservoir. Annual testing by the town is completed on the Parkerville Road site. DWSP will review any available MassDEP data or reports related to the landfills under the state's Solid Waste Regulations.

There is minimal water impact from crop and pasture lands to water quality in the Sudbury and Foss Reservoirs due to the limited amount of agricultural areas within the watershed. Only about 6% of the land use in the North Basin is agriculture. Chestnut Hill Farm, subject to Conservation Restrictions held by the Town of Southborough and under the care and control of the Trustees, is one of the largest sites. It is 131 acres and is located North of Route 30 and South of the Hultman Aqueduct. An additional 14 acres north of the aqueduct is subject to a Conservation Restriction by the Sudbury Valley Trustees. In 2015, the Trustees started farming the site again and initiated a community supported agriculture (CSA) program. They added cattle to the site – an initial six with a plan to bring in an additional six to ten by the end of 2017 – and are now farming 11 acres of vegetables.

Accomplishments

Inspections were conducted on an as needed basis and included water quality sampling on two occasions in response to potential impacts from adjacent property work. Monitoring efforts were performed in the watershed over the past five years utilizing the MassDEP website, press releases, enforcement actions and news articles. Sites monitored included a Wetlands Protection Act violation and formal enforcement action through MassDEP for improper snow storage that resulted in sedimentation of wetland resources at the Staples site in Framingham. There was also a violation that occurred due to an applicant failing to conduct work in accordance with a Final Order of Conditions which resulted in turbid conditions in a tributary to Foss Reservoir in Southborough. Actions were monitored and communication with Conservation Agents occurred until wetlands restoration and other requirements had been fulfilled. A groundwater discharge violation was noted for a wastewater treatment modification without a permit in Southborough and staff worked with Mass DOT to relocate a dead animal deposition site that was found along

the MassPike on the shore of Foss Reservoir. Plans for one subdivision on the Sudbury Reservoir watershed were reviewed by staff; findings of a deed restriction on the property that did not allow construction of any buildings resulted in the project not moving forward.

A pickup truck was removed from the bottom of Sudbury Reservoir after it was observed in low water levels during dam repairs. Three cars were similarly removed from Foss Reservoir.

Five Year Objectives

- Coordinate with other agencies, such as MassDEP, to enforce environmental regulations as necessary.
- Monitor climate change research, data and recommendations.
- Use watershed monitoring information to help assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.

7.12 Aquatic Invasive Species Management

Goal: Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, decontamination measures at potential entry points. Implement active management when appropriate.

Sudbury Reservoir is host to several aquatic invasive plants. Many of these species are established in the reservoir at high densities and/or have large distributions, rendering management efforts futile. Some species, however, have been identified early enough in their invasion that management has been initiated. MWRA has contracted with several firms which conduct annual monitoring of the vegetation in Sudbury Reservoir (in addition to other emergency water supplies) as well as perform direct management of pioneer infestations when deemed appropriate.

Fanwort was discovered in June 2017 for the first time in the Sudbury Reservoir by an MWRA contractor that conducts reservoir macrophyte surveys. There were two patches of plants in the northern portion of the main basin in the vicinity of Parmenter Road in Marlborough. Due to the small size of the patches and since this was the first fanwort growth that had been identified, MWRA mobilized a Diver Assisted Suction Harvest (DASH) crew to remove the plants in hopes that this growth was new and a rapid response would prevent their spread further into the reservoir.

The Town of Southborough, as a result of a previous Open Space and Recreation Plan recommendation, has offered public workshops on identifying, monitoring and controlling invasive species. In 2016, the Southborough Stewardship Committee voted to join the SuAsCo Cooperative Invasive Species Management Area (CISMA) which is a partnership of organizations whose goal is to manage and control invasive species in the SuAsCo watershed. DWSP is encouraged by the work of CISMA and the management of invasive species in the watershed will benefit from sharing information with this organization.

Accomplishments

Water chestnut was first discovered by DWSP biologists in 2006 in the northern portions of the reservoir. This species reproduces via seed, making control possible if plants are removed on a yearly basis before producing seeds. Following a period of mechanical harvesting, water chestnut management has been conducted via hand-pulling. As a result, the total biomass of this species has been reduced by 98% according to recent MWRA contractor reports. Annual removal of these plants will continue for the foreseeable future.

Foss Reservoir water level was lowered by ten feet in 2015 and 2016 in an effort to kill and stop the spread of invasive species, mainly Eurasian milfoil.

Fanwort was first discovered in the Sudbury Reservoir by MWRA contractors conducting vegetation monitoring in 2017. Due to the small size and isolation of the infestation, MWRA employed a contractor to conduct diver assisted suction harvesting of fanwort. This method allows divers to harvest plants including root systems with the assistance of a suction hose.

DWSP and MWRA implemented an Aquatic Invasive Species Decontamination Protocol in 2015 that includes Sudbury Reservoir. All MWRA, DWSP and contractor boats (and associated equipment) are required to be decontaminated in accordance with the protocol and inspected before being launched. Even though privately owned canoes and small boats are prohibited on the Sudbury and Foss Reservoirs, their illegal use nevertheless poses an ongoing AIS threat to the reserve water supply.

Five Year Objectives

- Inspect reservoirs for presence of AIS. Make recommendations for management actions if/when new infestations are found.
- Enforce the decontamination procedures for all watercraft entering the reservoir by inspecting each vessel and collecting completed decontamination certification forms.
- Continue established program of public education on AIS. Educate fishermen on the harmful effects of AIS and encourage proper fishing equipment cleaning. Assess feasibility of adding educational signage at popular fishing areas and town owned fields adjacent to the reservoir.
- Protect infrastructure from harmful effects of Water Chestnut and other invasive species in the Sudbury watershed.
- Assess the feasibility of continued fanwort removal in the Sudbury Reservoir.
- Communicate with SuAsCo Cooperative Invasive Species Management Area and keep informed of their activities and outreach.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on aquatic invasive species in the water supply.

7.13 Wastewater Management

There is no specific Wastewater Management program in the Sudbury Reservoir watershed. Wastewater issues are covered under the Watershed Monitoring and Surveillance program.

Threats to the reservoir persist from the Town of Southborough's reliance on septic systems. As the Southborough Board of Health is proactive in protecting the environment, they have been adding addenda to the state Title 5 Code since the early 2000s, including additional design criteria. In 2014, the Board of Health approved a change to the Title 5 regulations to include mandatory septic pumping (including septic tank and pump chamber tank if any exist) at the time of a system inspection for property transfers. The inspector must completely document various conditions of the septic tank both before pumping and after pumping. The Board of Health gave approval to repair three large systems that had failed as was discussed in the previous protection plan. In 2015, St. Mark's School was fined by the MassDEP for maintenance problems that resulted in partially treated effluent bypassing the sand filter units and being discharged onto the ground. The school and MassDEP agreed on a repair schedule. Replacement or repair of large failing septic systems or alternative systems will be monitored as staff is made aware of them through media outlets, local Boards of Health, or MassDEP enforcement actions. Residents of Southborough have voted to build a new public safety complex on a portion of St. Mark's golf course, which will bring a fairly large subsurface sewage disposal unit in close proximity to the Sudbury Reservoir.

7.14 Stormwater Management

Goal: Reduce water quality problems caused by uncontrolled stormwater.

Education and outreach on stormwater pollution prevention, as a non-traditional Best Management Practice, is an important component of a successful stormwater management program. DWSP staff has developed a series of brochures on various stormwater topics which will be shared with town departments, boards and commissions as needed for use in the Sudbury Reservoir watershed.

Potential development of large residential areas will pose a threat to the water supply if stormwater is not managed correctly and until all of the available land is built out. At this time, the Residences at Park Central in Southborough have been proposed. This development would consist of 180 apartments and 150 townhouses on a parcel which contains over five acres of wetlands and five potential vernal pools. Currently there are several different issues with the plan. Another project being proposed is for 114 age-restricted condominiums on the Marlborough Airport site. This proposal will require a zoning overlay district and a special permit before it could be started. Housing which property managers say is needed to attract industry and commercial ventures to the 9/90 Corporate Center on Crossing Boulevard is being proposed near the corporate center. Zoning variances are currently being requested to construct six four-story buildings with underground parking on 31 acres. A new public safety complex has been approved by voters of Southborough to be built on a portion of St. Mark's golf course, off of Cordaville Road and in close proximity to the reservoir.

Stormwater pollution problems will be addressed as needed.

Accomplishments

Regular mowing has been conducted on DWSP property and buffer areas around pertinent resources have been left in place to mitigate the impacts from stormwater runoff.

Five Year Objectives

- Work with MassDOT and local DPWs to improve infrastructure to control stormwater and with conservations commissions, MassDEP, and EPA for compliance with state and federal stormwater requirements.
- Work with town officials to implement program of public education and outreach related to stormwater and the MS4 permit where applicable.
- Raise awareness of stormwater as a pollutant in the Sudbury watershed, including techniques for reducing runoff and improving the quality of stormwater runoff, as an effort to create a behavior change among watershed residents that will protect natural resources. Provide stormwater programs, resources and/or support as resources allow to town departments, boards and commissions in the Sudbury watershed
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on stormwater impacts in the water supply.

7.15 Emergency Response

Goal: Maintain and improve short- and long-term emergency response capabilities to protect the water supply.

The level of threat from an accident depends on the type and volume of the product released, the location of the incident, and weather conditions. While not the same high priority as the Quabbin and Wachusett Reservoirs, DWSP and MWRA must still be prepared for accidents near the Sudbury and Foss Reservoirs. Updated protocols for the Sudbury watershed are integrated into the 2017 *Combined DCR & MWRA Inter-Agency Emergency Spill Response/Prevention Plan for the Wachusett and Sudbury Watersheds*. In addition to a hazardous materials spill, damage, interruption or contamination of the public water supply could result from a major natural disaster such as flooding or tornadoes. A critical component to any Emergency Response is communication, cooperation, and coordination with the local first responders as well as MassDEP.

Accomplishments

DWSP staff has been regularly trained in reservoir boom deployment and terrestrial spill response. DWSP has updated the emergency response protocol using inter-agency protocols in the 2017 *Combined DCR & MWRA Inter-Agency Emergency Spill Response/Prevention Plan for the Wachusett and Sudbury Watersheds*. The plan details actions and procedures for incidents that occur on DWSP property or that have the potential to impact the water supply or surrounding property. DWSP conducted a Dam Safety Tabletop exercise at Framingham State University with multiple agencies, including Department of Conservation and Recreation, Department of Environmental Protection, Framingham Fire Department, Framingham Police Department, Framingham Department of Public Works, Framingham State University, Massachusetts Water Resources Authority, and MSP.

A Threat and Hazard Identification Risk Assessment (THIRA) was conducted to determine the most likely threats or hazards that would most occur or would have a significant impact on the water supply, facilities, and operations of the Wachusett and Sudbury watersheds.

Five Year Objectives

- Provide emergency response support services; maintain response supplies and up-to-date contact lists.
- Provide Incident Command System training to appropriate staff.
- Coordinate with MWRA and local officials to provide emergency response training and annual tabletop or field exercises.
- Monitor sites of releases or spills that occur near a resource area and follow submitted reports until remediation efforts have been completed under Mass Contingency Plan.
- Implement multi-year Training and Exercise Plan.
- Ensure that DWSP and town emergency responders are aware of emergency protocols put in place by DWSP and are provided emergency contact phone numbers on a regular basis and when changes occur.
- Provide emergency response training for new DWSP employees and refresher training for veteran staff.
- Conduct emergency response training events with the local first responders.
- Update, as needed Comprehensive Emergency Management Plan for Wachusett and Sudbury Reservoirs.
- Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on emergency response in the water supply.

8. Implementation

8.1 Organization and Management

DCR's Division of Water Supply Protection, Office of Watershed Management (DWSP) implements the watershed management program developed and described in this report. The organizational structure of the Office of Watershed Management is shown in Table 8-1.

Table 8-1: DCR/DWSP Office of Watershed Management Organization

Section		
Division	**Wachusett/Sudbury**	**Quabbin/Ware**
Management Division Director Budget Director Natural Resources Director	Management Regional Director Assistant Regional Director	Management Regional Director Assistant Regional Director
Budget and Administrative Support	Administrative and Technical Support	Administrative and Technical Support
Program Coordination and Technical Support – GIS	GIS	GIS
Natural Resources	Forestry	Forestry
Program Coordination and Technical Support – Environmental Planning	Environmental Planning	Environmental Planning
	Environmental Quality	Environmental Quality
	Civil Engineering	Civil Engineering
	Watershed Rangers	Watershed Rangers
	Interpretive Services	Interpretive Services
	Watershed Maintenance	Watershed Maintenance

8.2 MWRA Memorandum of Understanding and the Water Supply Protection Trust

A Memorandum of Understanding (MOU) was signed in 2004 between the DCR and the MWRA that coordinates the implementation of the respective agencies responsibilities in regard to the "protection, construction, operation, maintenance and improvement of water supply resources, facilities, and infrastructure within the [Metropolitan Boston water supply] watershed and waterworks system" (see www.mass.gov/files/documents/2017/10/11/memorandum.pdf). Section 7.0 of this MOU details the development of an annual Work Plan for the Office of Watershed Management.

The legislature further enhanced the ability of the Office of Watershed Management to maintain the drinking water supply by establishing a Water Supply Protection Trust, created by Chapter 149 of the Acts of 2004, §27, and written into the general laws at MGL c. 10, §75. The trust provides a more efficient mechanism for MWRA's funding of the Office of Watershed Management. The Trust has also allowed the Office of Watershed Management to more efficiently manage its budget.

The Water Supply Protection Trust has a five person board of trustees responsible for approving the Office of Watershed Management's annual work plan and budget each spring for the following fiscal year beginning in July. The members of the board of trustees are:

1. The Secretary of the Executive Office of Energy and Environmental Affairs
2. The Executive Director of the MWRA
3. A representative jointly selected by the North Worcester County Quabbin Anglers Association, Inc. and the Quabbin Fishermen's Association, Inc.
4. A representative from the Swift River Valley Historical Society
5. The Chairman of the MWRA Advisory Board.

The Water Supply Protection Trust works diligently to ensure that the Office of Watershed Management has sufficient funding to staff and implement the *Watershed Protection Plan Update FY19-FY23*.

8.3 Work Plan and Annual Budget

DWSP prepares an Annual Work Plan that meets all of the requirements set forth by the MOU and achieves the watershed protection goals and objectives developed in this report. The Annual Work Plans include a detailed description of tasks for the two operational sections – Quabbin/Ware and Wachusett/Sudbury. The Work Plan's tasks are developed and organized by the programs described in this report.

The Quabbin/Ware and the Wachusett/Sudbury Five Year Program Objectives are presented, respectively, in Table 8-2 and Table 8-3. These tables will be the basis for developing Annual Work Plans for Fiscal Years 2019 through 2023. Annual Work Plans and the associated budget process ensure that DWSP achieves the five-year objectives and overall system-wide goals of the watershed protection program. All objectives unless noted otherwise are ongoing throughout this five year period.

Progress reports are submitted to MWRA to keep the agency informed on DWSP's progress towards achieving annual goals set out in the budget. Implementation also requires ongoing evaluation of the effectiveness of the programs and modification to adapt to changing conditions or concerns

The creation of the Water Supply Protection Trust and the reporting parameters established by the MOU has created an efficient and transparent mechanism for MWRA's funding of DWSP activities. The funding of major capital expenditures, Payments in Lieu of Taxes, and land acquisition are also the responsibility of MWRA.

8.3.1 Quabbin/Ware Operational Section Five Year Implementation Plan

Table 8-2: Quabbin/Ware Operational Section Five Year Implementation Table

Key to Abbreviations
Quabbin/Ware Staff: A=Administration; CE=Civil Engineers; EP=Environmental Planning; EQ=Environmental Quality; F=Forestry; GIS=Geographic Information Services ; IS=Interpretive Services; RD=Regional Director, Assistant Regional Director; WM=Watershed Maintenance; WR=Watershed Rangers
Boston/Division Staff: AF=Administration and Finance; D=Division Director; GIS =Geographic Information Services; NR= Natural Resources; P=Planning

#	Objective	Lead	Additional Staff
A. Land Acquisition *Goal: Purchase critical lands by fee and Watershed Preservation Restriction (WPR) using money allocated for land acquisition in MWRA's capital budget as well as other funding sources and gifts.*			
1.	Identify opportunities for land procurement and forward information to the Land Acquisition Panel.	NR	GIS
2.	Using Land Acquisition models and other criteria, purchase lands in fee or, whenever possible, through a Watershed Preservation Restriction (WPR).	NR	GIS, P, A
3.	Review existing Land Acquisition models and modify as necessary.	NR	D, RD, EQ, F, GIS, P
4.	Collaborate with Land Trusts and other land protection groups to acquire lands through gifts and other means.	NR	
B. Watershed Preservation Restriction Monitoring *Goal: Maintain control of watershed lands through stewardship of Watershed Preservation Restrictions.*			
1.	Complete baseline documentation reports prior to WPR acquisition.	NR	GIS
2.	Monitor each WPR every two years; monitor high-priority ones annually.	NR	EQ, EP, F
3.	Maintain good working relationships with landowners and resolve WPR violations.	NR	EP, F, EQ, P
4.	Maintain records and distribute information as necessary. Enhance field inspections by integrating use of ArcGIS online.	NR	GIS
5.	Collaborate with other divisions of DCR, EOEEA, and other statewide conservation programs.	NR	
C. Land Management *Goal: Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.*			
1.	Implement the 2017 Land Management Plan.	RD	F, NR, EQ
2.	Research and monitor, including long-term water quality sampling, to verify the effectiveness of existing statewide and DWSP-specific forestry Best Management Practices (BMPs) in protecting the water supply.	EQ	F, NR

#	Objective	Lead	Additional Staff
3.	Continue forestry operations and follow all documented management techniques including oversight and water quality monitoring of active timber harvesting.	F	EQ
4.	Develop and implement a Terrestrial Invasive Plant Species Plan.	F	NR
5.	Assess forest health in Quabbin Reservoir and Ware River watersheds by monitoring regeneration and other indicators of forest health, especially in areas of timber harvesting operations.	F	NR
6.	Assess and monitor status of encroachments onto DWSP property in Quabbin and Ware River watersheds, and take follow-up actions to resolve encroachments.	F	CE, WR
7.	Coordinate monitoring and analysis efforts with National Ecological Observatory Network (NEON) regarding climate change.	RD	F
8.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on land management in the water supply.	D	All
D. Wildlife Management *Goal: Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.*			
1.	Continue year-round bird observations and harassment efforts on the reservoir.	EQ	NR, CE, RD, WM
2.	Control the resident Canada goose population on the Quabbin Reservoir.	NR	EQ, WM, RD, CE
3.	Reduce the amount of food available to gulls in Central Massachusetts by controlling public feeding and identifying and controlling alternative food sources.	NR	
4.	Monitor, assess, and control aquatic and burrowing mammals that threaten water quality or infrastructure.	NR	WM, WR, EQ, F
5.	Monitor moose populations and their impact on forest dynamics through browsing surveys, annual moose sign surveys, and exclosure studies.	NR	F
6.	Administer the White-tailed Deer Management Program in the Quabbin watershed, including the application, permit, biological data collection, and orientation components of the program.	NR	RD, IS, WM, P, WR
7.	Develop a deer management program for Quabbin Park.	RD	NR
8.	Test mammal and bird fecal samples for the presence of *Giardia* and *Cryptosporidium*.	NR	
9.	Manage habitat for rare species; monitor populations of select species.	NR	F, WM
10.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wildlife in the water supply.	D	All
E. Public Access Management *Goal: Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.*			
1.	Implement Quabbin Public Access Management Plan.	RD	EQ, WR, IS
2.	Evaluate, update, and implement Ware Public Access Management Plan.	RD	IS, WR, EQ, F
3.	Develop improved, uniform signage and maps; improve online mapping of recreational opportunities.	RD	IS, WR
4.	Maintain working relationships with State, Environmental, and local police.	RD	WR

#	Objective	Lead	Additional Staff
5.	Monitor DWSP lands and water to ensure compliance with rules and regulations designed to protect the water supply and protect the public.	RD	WR, F, EQ
6.	Implement existing protocol for maintaining gates and other structural controls.	WR	WM
7.	Expand use of electronic media to disseminate information.	IS	WR
8.	Prepare and implement Quabbin Park Operations and Maintenance Plan.	RD	WR, WM, NR
9.	Operate the shoreline and boat fishing program in designated portions of Quabbin Reservoir in a manner that minimizes threats to water quality and accommodates visitors with accessibility needs. Implement the Quabbin Boat Seal program.	RD	WM, IS, EQ
10.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on public access in the water supply.	D	All
F. Watershed Security *Goal: Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to protect the watershed system from potential threats .*			
1.	Coordinate with MWRA in order to maintain comprehensive system-wide approach on all security issues.	D	RD, WR
2.	Continue Watershed Ranger patrols on all DWSP properties, with particular focus on highly vulnerability sites.	WR	
3.	Work with local, state and federal responders and ensure they receive current agency emergency contact information on a regular basis.	WR	
4.	Remain up to date with any guidance materials available from EPA, American Water Works Association, and Department of Homeland Security.	CE	EQ
5.	Improve physical access control structures, as necessary, and implement a maintenance program.	WM	
G. Infrastructure Maintenance *Goal: Maintain the integrity of all high hazard dams under DWSP control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.*			
1.	Maintain and rehabilitate DWSP facilities and roads, including evaluation of Quabbin Administration Building drinking water system. Investigate road alignment and stream crossing improvements when possible for purposes of emergency response and land management needs.	CE	WM, EQ
2.	Evaluate need for reservoir maintenance in vicinity of hangar ramp and Winsor intake.	RD	CE, EQ
3.	Work with MWRA on renovation of Quabbin Administration Building.	RD	CE
4.	Complete construction of maintenance building on Blue Meadow Road	RD	CE, WM
5.	Assess infrastructure needs and explore alternative mechanisms for funding to make needed repairs to small dams and bridges	CE	
6.	Maintain DWSP fuel storage facilities in proper working order and in compliance with all applicable codes and regulations. Investigate feasibility of upgrading or converting underground storage tanks to above ground structures.	CE	
7.	Reduce energy use through energy efficiency practices.	RD	

#	Objective	Lead	Additional Staff
8.	Evaluate gravel resources in Quabbin and Ware watersheds. Follow gravel management procedures as outlined in the Land Management Plan and develop a plan for future DWSP gravel needs.	EQ	CE, WM
9.	Evaluate the feasibility of removing or repairing unsafe small dams.	CE	RD, NR, EQ
10.	Develop Ware River Watershed Road Plan.	RD	CE, EQ, WM
11.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on infrastructure in the water supply.	D	All
H. Watershed Protection Act *Goal: Enhance protection of the water supply through implementation of the Watershed Protection Act, which regulates land use in critical areas of the watersheds.*			
1.	Implement the Watershed Protection Act and regulations.	EP	RD, P
2.	Maintain good relations with building inspectors and other town permitting staff and boards to enhance the notification of potentially affected parties of WsPA requirements.	EP	EQ
3.	Provide professional support on land use planning or other associated topics related to DWSP mission to watershed communities.	EP	
4.	Review WsPA applications for stormwater applicability, including NPDES construction general permit, MA Stormwater Performance Standards, and/or town stormwater bylaws. Coordinate with other DWSP staff to ensure that WsPA projects comply with other environmental regulations.	EP	EQ
I. Education and Outreach *Goal: Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.*			
1.	Maintain and/or initiate information sites, such as kiosks, and programs in watersheds. Expand interpretive signage opportunities to enhance public understanding of the water supply system.	IS	EQ, ATS, WR
2.	Operate Quabbin Visitor Center.	IS	
3.	Implement and amend, as needed, the Quabbin Interpretive Services Plan.	IS	WR
4.	Conduct and monitor established program of public education. Expand educational outreach efforts on aquatic invasive species and climate change.	IS	EQ
5.	Participate in environmental programs with other environmental groups, including environmental education teacher training and Mass Envirothon.	IS	
6.	Develop interactive electronic interpretation for visitors.	IS	
7.	Complete the Interpretive Services Plan for the Ware River watershed.	IS	
8.	Promote outreach to user groups in the Ware River watershed.	RD	IS, WR
9.	Produce and distribute *Downstream* newsletters to watershed residents.	NR	IS, P
10.	Utilize the DWSP website to provide information and resources for the public.	P	IS, EQ, WR, F, NR, RD

#	Objective	Lead	Additional Staff
J. Water Quality and Hydrologic Monitoring *Goal: Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.*			
1.	Conduct routine tributary and reservoir sampling program to identify potential water quality problems and maintain the historical record for long-term trend analysis, with annual adjustments to the sampling plan to adapt to changing conditions.	EQ	
2.	Improve water quality data management using program to compile data from water quality sampling, weather, reservoir, and stream flow monitoring, plankton, etc. Meet periodically with Wachusett staff on app use and improvement.	EQ	CE, F, NR
3.	Assure that water entering the Winsor Intake meets MassDEP standards for microbial and physicochemical parameters.	EQ	
4.	Conduct short- and long-term water quality monitoring program of timber harvest sites to assess for potential impacts to water quality.	EQ	NR
5.	Develop and implement streamflow monitoring at selected watershed sites. Evaluate permitting requirements, equipment needs, and staff hours for implementation and maintenance. Coordinate implementation with sampling plans and new database.	EQ	
6.	Engage researchers to investigate climate change questions related to algae blooms and invasive species in the Quabbin Reservoir.	RD	
7.	Conduct targeted sampling at sites with potential for water quality impacts in the Ware River watershed.	EQ	
8.	Collect, interpret, and manage meteorological and reservoir data. Coordinate data sharing. Investigate and implement wind monitoring to help determine wind impacts to changes in water quality parameters, such as turbidity and fecal coliform levels.	CE	EQ
9.	Utilize long-term water quality data to investigate increases in turbidity at Winsor Intake.	EQ	
10.	Finalize and implement a *Cryptosporidium* and *Giardia* Action Plan with MWRA to establish guidelines for inter-agency notifications and coordination.	EQ	
11.	Work with MWRA to install continuous water quality monitoring buoy at Quabbin Reservoir.	EQ	RD
12.	Use water quality and hydrologic data to assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.	D	All
K. Watershed Monitoring and Assessment *Goal: Use Environmental Quality Assessments, site inspections, local board meetings, and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.*			
1.	Conduct Environmental Quality Assessments (EQAs) as scheduled. Incorporate recommendations from EQAs into annual Work Plans. Present findings and proposed mitigation measures annually to DWSP staff.	EQ	CE
2.	Use fieldwork, local contacts, and EQAs to find violations of environmental regulations.	EQ	WR

#	Objective	Lead	Additional Staff
3.	Coordinate with other agencies, such as MassDEP and Attorney General, to enforce all environmental regulations.	EQ	EP, P
4.	Monitor status of agricultural operations, above ground storage tanks, hazardous waste generators, spills, and hazardous materials use through field inspections and records reviews.	EQ	
5.	Monitor activities in utility Rights-of-Way (e.g., powerlines, highways).	EQ	P
6.	Monitor climate change research, data, and recommendations.	EQ	
7.	Use watershed monitoring information to help assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.	D	All
L. Aquatic Invasive Species Management *Goal: Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, and decontamination measures at potential entry points. Implement active management when appropriate.*			
1.	Implement and update, as needed, the 2010 Aquatic Invasive Species Management Plan.	EQ	
2.	Operate the Quabbin Boat Seal Program, and evaluate ways to streamline program.	EQ	WM, WR, IS
3.	Survey, monitor, and prevent the spread of aquatic invasive macrophytes in the Quabbin Reservoir and throughout water bodies in the Quabbin and Ware River watersheds.	EQ	
4.	Conduct pre-diversion surveys of AIS at Shaft 8 to help prevent spread of AIS. Monitor condition of fragment barriers, replacing or adjusting as needed.	EQ	RD, CE
5.	Inspect equipment and gear to be used in or on Quabbin Reservoir. Notify other agencies and/or consultants of decontamination requirements.	EQ	RD, CE
6.	Control populations of AIS, when possible and necessary, in Quabbin Reservoir and surrounding water bodies.	EQ	RD, CE
7.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on aquatic invasive species in the water supply.	D	All
M. Wastewater Management *Goal: Monitor on-site wastewater disposal systems and operation of Rutland-Holden sewer to ensure proper treatment of waste.*			
1.	Review water quality data and other pertinent information to identify potential problem sites.	EQ	
2.	Monitor and enforce the provisions of Title 5, working with local Boards of Health and MassDEP.	EP	
3.	Provide technical assistance, upon request, to towns regarding onsite wastewater management issues.	EQ	CE
4.	Identify larger on-site systems with inspection requirements under MassDEP regulations in the Ware River watershed.	EQ	
5.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wastewater in the water supply.	D	All
N. Stormwater Management *Goal: Reduce water quality problems caused by uncontrolled stormwater.*			
1.	Provide input into state and local road reconstruction projects to influence storm water management design aspects of projects.	EQ	

#	Objective	Lead	Additional Staff
2.	Integrate, maintain, and monitor structural storm water Best Management Practices (BMPs) needed and/or constructed on DWSP property.	CE	EQ
3.	Inspect all construction sites greater than one acre to ensure compliance with Stormwater Pollution Prevention Plans (SWPPPs).	EQ	
4.	Examine DWSP stormwater management as part of Ware River Watershed Road Plan.	CE	EQ
5.	Initiate plan to inventory, monitor, and assess performance of stormwater BMPs on privately-owned property.	EQ	CE
6.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on stormwater impacts in the water supply.	D	All
O. Emergency Response *Goal: Maintain and improve short- and long-term emergency response capabilities to protect the water supply.*			
1.	Provide emergency response support services; maintain response supplies and up-to-date contact lists.	RD	WR, WM, EQ
2.	Provide Incident Command System (ICS) training to appropriate staff.	CE	
3.	Coordinate with MWRA and local emergency officials to provide ICS, emergency response training, and annual tabletop or field exercises.	RD	WR, EQ
4.	Construct additional structural controls to reduce likelihood of spills reaching the Quabbin Reservoir.	CE	
5.	Evaluate, monitor, and oversee spills that threaten water quality or DWSP property and work with appropriate federal, state, and local agencies to contain and remediate.	EQ	
6.	Review, finalize, and implement the Emergency Response Manual for the Quabbin and Ware River watersheds.	RD	EQ, WR, WM, CE
7.	Produce spill response plans and spill notification cards for timber harvesting operations, and continue to offer spill response training for timber harvesters working on the Quabbin and Ware River watersheds.	F	EQ
8.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on emergency response in the water supply.	D	All

8.3.2 Wachusett/Sudbury Operational Section Five Year Implementation Plan

Table 8-3: Wachusett/Sudbury Operational Section Five Year Implementation Table

Wachusett/Sudbury Staff: A=Administration; CE=Civil Engineers; EP=Environmental Planning; EQ=Environmental Quality; F=Forestry; GIS=Geographic Information Services; IS=Interpretive Services; RD=Regional Director, Assistant Regional Director; WM=Watershed Maintenance; WR=Watershed Rangers

Boston/Division Staff: AF=Administration and Finance; D=Division Director; GIS =Geographic Information Services; NR= Natural Resources; P=Planning

#	Objective	Lead	Additional Staff
A. Land Acquisition *Goal: Purchase critical lands by fee and Watershed Preservation Restriction (WPR) using money allocated for land acquisition in MWRA's capital budget as well as other funding sources and gifts.*			
1.	Identify opportunities for land procurement and forward information to the Land Acquisition Panel.	NR	GIS
2.	Using Land Acquisition models and other criteria, purchase lands in fee or, whenever possible, through a Watershed Preservation Restriction (WPR).	NR	GIS, P, A, AF
3.	Review existing Land Acquisition models and modify as necessary.	NR	D, RD, EQ, F, GIS, P
4.	Collaborate with Land Trusts and other land protection groups to acquire lands through gifts and other means.	NR	
B. Watershed Preservation Restriction Monitoring *Goal: Maintain control of watershed lands through stewardship of Watershed Preservation Restrictions.*			
1.	Complete baseline documentation reports prior to WPR acquisition.	NR	GIS
2.	Monitor each WPR every two years; monitor high-priority ones annually.	NR	EQ, EP, F
3.	Develop strategy to meet WPR monitoring goal.	NR	D, RD
4.	Maintain good working relationships with landowners and resolve WPR violations.	NR	EP, F, EQ
5.	Maintain records and distribute information as necessary. Enhance field inspections by integrating use of ArcGIS online.	NR	GIS
6.	Collaborate with other divisions of DCR, EOEEA, and other statewide conservation programs.	NR	
C. Land Management *Goal: Maintain a vigorously growing, multi-aged, multi-species forest using forest management programs developed by DWSP staff. Manage all lands to minimize potential water quality impacts.*			
1.	Implement the 2017 Land Management Plan.	RD	F, NR, EQ
2.	Research and monitor, including long-term water quality sampling, to verify the effectiveness of existing statewide and DWSP-specific forestry Best Management Practices (BMPs) in protecting the water supply.	EQ	F, NR
3.	Continue forestry operations and follow all documented management techniques including oversight and water quality monitoring of active timber harvesting.	F	EQ
4.	Develop and implement a Terrestrial Invasive Plant Species Plan.	F	NR

#	Objective	Lead	Additional Staff
5.	Assess forest health in Wachusett Reservoir and Sudbury Reservoir watersheds by monitoring regeneration and other indicators of forest health, especially in areas of timber harvesting operations.	F	NR
6.	Support cooperative efforts to monitor and control Asian Longhorned Beetle.	F	
7.	Identify all encroachment activities and work with Watershed Rangers to resolve all conflicts in Wachusett and Sudbury watersheds.	F	WR
8.	Manage hayfields and other open areas.	F	EQ
9.	Maintain efforts to prevent bluff erosion.	F	
10.	Continue forestry operations that are feasible in the presence of a high deer population and follow all documented management techniques including oversight of active timber harvesting in Sudbury Watershed.	F	
11.	Monitor for gypsy moth activity and tree conditions, especially if drought conditions arise.	F	
12.	Transfer of DWSP lands at Reservoir No. 1 and 2 to State Parks.	D	RD, P
13.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on land management in the water supply.	D	All
D. Wildlife Management *Goal: Protect the water supply and infrastructure from adverse impacts caused directly or indirectly by wildlife. Protect common, rare, and significant wildlife species and their habitats.*			
1.	Continue year-round bird observations and harassment efforts on the reservoir.	EQ	NR, CE, RD, WM
2.	Control the resident Canada goose population on the Wachusett and Sudbury Reservoirs.	NR	CE, RD, WM
3.	Reduce the amount of food available to gulls in Central Massachusetts by controlling public feeding and identifying and controlling alternative food sources.	NR	
4.	Monitor, assess, and control aquatic and burrowing mammals that threaten water quality or infrastructure.	NR	
5.	Monitor moose populations and their impact on forest dynamics through browsing surveys, annual moose sign surveys, and exclosure studies.	NR	F
6.	Implement an expanded white-tailed deer hunting program in the Wachusett watershed.	RD	NR
7.	Monitor deer populations and their impact on forest dynamics through browsing surveys, annual deer sign surveys, and/or exclosure studies in Sudbury watershed.	NR	
8.	Test mammal and bird fecal samples for presence of *Giardia* and *Cryptosporidium*.	NR	
9.	Manage habitat for rare species; monitor populations of select species.	NR	F, WM
10.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wildlife in the water supply.	D	All

#	Objective	Lead	Additional Staff
E. Public Access Management *Goal: Manage public access to DWSP lands and waters to protect water quality in compliance with Watershed Protection regulations (313 CMR 11.00) and all other applicable laws (including 310 CMR 22.00) through policies established in Public Access Management Plans.*			
1.	Implement Watershed Access Management Plans for Wachusett Reservoir and Sudbury Reservoir watersheds.	RD	WR, EQ
2.	Evaluate and modify, if necessary, specific access plan policies within a *Wachusett Reservoir Watershed 2020 Public Access Plan Update.* Provide periodic review of policies with updates, as needed.	RD	WR, EQ
3.	Update the Sudbury Public Access Management Plan. Provide periodic review of policies with updates, as needed.	EQ	WR
4.	Reconstruct and improve, where appropriate, universal access sites.	RD	CE, EQ, WR
5.	Maintain working relationships with State, Environmental, and local police.	WR	
6.	Monitor DWSP lands and water to ensure compliance with rules and regulations designed to protect the water supply and protect the public.	WR	
7.	Maintain gates and other structural controls using existing protocol.	WR	WM
8.	Continue to develop improved, uniform signage and maps.	RD	WR, WM
9.	Expand use of electronic media to disseminate information.	WR	
10.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on public access in the water supply.	D	All
F. Watershed Security *Goal: Maintain and improve watershed security programs and provide surveillance of critical watershed facilities to protect the watershed system from potential threats .*			
1.	Coordinate with MWRA in order to maintain comprehensive system-wide approach on all security issues.	D	RD, WR
2.	Continue Watershed Ranger patrols on all DWSP properties, with particular focus on highly vulnerability sites.	WR	
3.	Work with local, state and federal responders and ensure they receive current agency emergency contact information on a regular basis.	WR	
4.	Remain up to date with any guidance materials available from EPA, American Water Works Association, and Department of Homeland Security.	CE	EQ
5.	Improve physical access control structures, as necessary, and implement a maintenance program.	WM	
G. Infrastructure Maintenance *Goal: Maintain the integrity of all high hazard dams under DWSP control, maintain and improve DWSP facilities and equipment, and maintain internal roadways to allow them to sufficiently support their use for the water supply protection program.*			
1.	Monitor and maintain large dams, spillways, and dikes, and periodically update Emergency Action Plan in conjunction with MWRA.	CE	
2.	Conduct annual inspection of roads and develop annual plan for repairs.	CE	
3.	Assess infrastructure and oversee repairs, maintenance, and renovation projects at DWSP facilities.	CE	
4.	Maintain existing BMPs to manage stormwater and assess need for additional control measures.	CE	EQ

#	Objective	Lead	Additional Staff
5.	Reduce energy use through simple energy efficiency practices.	CE	All
6.	Maintain fire roads for water supply operations as necessary in Sudbury Watershed.	CE	WM
7.	Pursue improvements to Reservoirs No 1 and 2, as identified in the Phase II Reports.	CE	
8.	Size replacement culverts and other infrastructure to address likely changes in flow due to ongoing climate change.	CE	EQ
9.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on infrastructure in the water supply.	D	All
H. Watershed Protection Act *Goal: Enhance protection of the water supply through implementation of the Watershed Protection Act, which regulates land use in critical areas of the watersheds.*			
1.	Implement the Watershed Protection Act and regulations.	EP	RD, P
2.	Review building permits and sales and notify property owners of their need to file.	EP	
3.	Inspect previous filings for compliance with decisions and conditions.	EP	
4.	Provide professional support on land use planning or other associated topics related to DWSP mission to watershed communities.	EP	P
5.	Maintain good relations with building inspectors and other town permitting staff and boards to enhance the notification of potentially affected parties of WsPA requirements.	EP	EQ
6.	Review WsPA applications for stormwater applicability, including NPDES construction general permit, MA Stormwater Performance Standards, and/or town stormwater bylaws. Coordinate with other DWSP staff to ensure that WsPA projects comply with other environmental regulations.	EP	EQ
I. Education and Outreach *Goal: Provide educational opportunities and materials to inform the public about watershed protection and drinking water issues.*			
1.	Review, implement, and amend as needed, the Wachusett Interpretive Services Plan.	IS	WR, EQ
2.	Conduct, record, and evaluate public education programs with a focus on water supply, water quality, Aquatic Invasive Species, and climate change.	IS	WR, EQ
3.	Conduct programs at Stillwater Farm interpretive site.	IS	WR
4.	Conduct environmental education teacher training and support Mass Envirothon.	IS	EQ
5.	Participate in environmental programs with other environmental groups.	IS	
6.	Research and implement electronic media to enhance interpretation programs.	IS	
7.	Support stormwater education efforts in Wachusett Reservoir watershed towns that must meet federal Small Municipal Separate Storm Sewer Systems (MS4) requirements.	EQ	
8.	Provide programs that reduce threats from public access (e.g., Earth Day cleanups, fishing line collections, etc.)	WR	
9.	Educate the public of the importance of Sudbury and Foss Reservoirs as a reserve drinking water supply and natural resource through informal education as staff availability allows.	IS	EQ

#	Objective	Lead	Additional Staff
10.	Maintain and/or initiate information sites, such as kiosks, and programs in watersheds. Expand interpretive signage opportunities to enhance public understanding of the water supply system.	IS	
11.	Produce and distribute *Downstream* newsletters to watershed residents.	NR	IS, P
12.	Utilize the DWSP website to provide information and resources for the public.	P	IS, EQ, WR, F, NR, RD
J. Water Quality and Hydrologic Monitoring *Goal: Conduct tributary and reservoir sampling. Identify short-term water quality problems and maintain the historical record for long-term trend analyses. Use data analyses and assessments in management decisions.*			
1.	Conduct routine and non-routine reservoir and tributary sampling, compile data, and interpret in annual report. Make necessary monitoring changes to identify causal factors for significant trends.	EQ	
2.	Monitor hydrologic budget (stream flow, precipitation data, snow pack) and continue to make necessary improvements. Work with USGS to supplement in-house monitoring.	EQ	
3.	Expand stormwater sampling program to quantify stormwater loading.	EQ	
4.	Manage new contract with UMass and review project scope annually. Improve water quality models and develop new research topics.	EQ	
5.	Develop database backed tools and applications to facilitate data management, review and analysis, writing reports, and modeling efforts.	EQ	
6.	Publish a pair of thirty-year Water Quality Summary reports that include assessment of possible correlation of a range of factors with tributary and reservoir water quality. Include an assessment of possible impacts of climate change on water quality and hydrology.	EQ	
7.	Implement long-term paired subbasins assessment of the impacts of forestry on water quality and quantity in the Wachusett watershed.	EQ	
8.	Increase understanding of reservoir dynamics by collecting profiles in South Basin, Andrews Harbor, etc. in late summer or early fall when the interflow is well established. Investigate interaction between plankton and interflow water quality with Roger Williams University.	EQ	
9.	Investigate potential water quality problems, including water sampling, in Sudbury watershed as needed and as staff time allows.	EQ	
10.	Develop Wachusett/Sudbury notification protocol for cyanobacteria blooms	EQ	
11.	Finalize and implement a *Cryptosporidium* and *Giardia* Action Plan with MWRA to establish guidelines for inter-agency notifications and coordination.	EQ	
12.	Use water quality and hydrologic data to assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.	D	All

#	Objective	Lead	Additional Staff
K. Watershed Monitoring and Assessment *Goal: Use Environmental Quality Assessments, site inspections, local board meetings, and information from Watershed Rangers and other DWSP staff to identify and address potential water quality threats and possible violations of state or federal regulations.*			
1.	Use field inspections and review of state and federal databases to identify sources of pollution and develop mitigation measures for one Environmental Quality Assessment (EQA) per year. Develop and implement EQA recommendations and include recommendations as specific tasks in annual workplans. Present findings and proposed mitigation measures annually to DWSP staff..	EQ	
2.	Use fieldwork, local contacts, and EQAs to find violations of environmental regulations.	EQ	
3.	Coordinate with other agencies, such as MassDEP and Attorney General, to enforce all environmental regulations.	EQ	
4.	Update wetland resources using plans, field observations, and other available data. Add centerlines to streams and wetlands and correct any inaccurate wetland boundaries.	EQ	
5.	Improve tracking of local road projects and local updates to stormwater infrastructure. Add new information to appropriate GIS datalayer.	EQ	
6.	Add information on agricultural operations, hazardous waste generators, spills, USTs, and hazardous materials use to the electronic database through field inspections and record review.	EQ	
7.	Assess status of municipal facilities and practices, including DPW yards, closed landfills and road maintenance practices. Work with towns and MassDEP to resolve any water quality issues.	EQ	
8.	Monitor climate change research, data, and recommendations.	EQ	
9.	Use watershed monitoring information to help assess potential impacts of climate change on the water supply as part of a watershed-wide vulnerability assessment.	D	All
L. Aquatic Invasive Species *Goal: Prevent introduction and spread of Aquatic Invasive Species through monitoring, public education, exclusion, and decontamination measures at potential entry points. Implement active management when appropriate.*			
1.	Inspect reservoirs, lakes, ponds and tributaries for presence of AIS. Make recommendations for management actions if/when new infestations are found.	EQ	
2.	Perform aquatic vegetation survey work prior to Thomas, Oakdale, and cove vegetation management. Provide report to MWRA and contractors to guide plant removal efforts. Monitor, advise, and assist contractors with any necessary removal operations.	EQ	
3.	Conduct aquatic vegetation surveys prior to and after aquatic treatments planned for the Lily Ponds and South Meadow Pond complex.	EQ	
4.	Use appropriate methods to prevent the spread of pioneering stands of Phragmites along the Wachusett Reservoir shoreline.	EQ	
5.	Enforce the decontamination procedures for all watercraft entering the reservoir by inspecting each vessel and collecting completed decontamination certification forms.	EQ	
6.	Protect infrastructure from harmful effects of *Water Chestnut* and other invasive species in the Sudbury watershed	EQ	

#	Objective	Lead	Additional Staff
7.	Continue established program of public education on AIS. Educate fishermen on the harmful effects of AIS and encourage proper fishing equipment cleaning. Assess feasibility of adding educational signage at popular fishing areas and town owned fields adjacent to the reservoir.	IS	WR, EQ
8.	Develop and implement study to determine if water quality is the primary vector for AIS distribution in the reservoir coves and basins	EQ	
9.	Assess the feasibility of continued fanwort removal in the Sudbury Reservoir.	EQ	
10.	Communicate with SuAsCo Cooperative Invasive Species Management Area and keep informed of their activities and outreach.	EQ	
11.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on aquatic invasive species in the water supply.	D	All
M. Wastewater Management *Goal: Monitor on-site wastewater disposal systems and operation of Rutland-Holden sewer to ensure proper treatment of waste.*			
1.	Monitor and enforce provisions of Title 5, using water quality data and working with Boards of Health and MassDEP. Provide technical assistance, upon request.	EQ	
2.	Track new connections to sewer lines and maintain database and GIS datalayer.	EQ	GIS
3.	Compile data on all onsite septic systems and enter into database.	EQ	
4.	Manage with MWRA, the Rutland-Holden trunk sewer and Rutland-Holden Relief trunk sewer.	CE	
5.	Pursue updated sewer agreements with Worcester and DCR sewer communities	RD	
6.	Design a study, once all known sewer and septic connections are mapped, to determine if populated areas that experienced significant conversion from septic to sewer have seen statistically significant reduction in nutrient loading.	EQ	
7.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on wastewater in the water supply.	D	All
N. Stormwater Management *Goal: Reduce water quality problems caused by uncontrolled stormwater.*			
1.	Locate, assess, and require maintenance of public and private stormwater BMPs and BMPs on DWSP property.	EQ	
2.	Work with MassDOT and local DPWs to improve infrastructure to control stormwater and with conservations commissions, MassDEP, and EPA for compliance with state and federal stormwater requirements.	EQ	
3.	Work with town officials to implement program of public education and outreach related to stormwater and the MS4 permit where applicable.	EQ	
4.	Update map of stormwater conveyance structures and define stormwater subbasins.	EQ	
5.	Inspect all construction sites greater than one acre to ensure compliance with Stormwater Pollution Prevention Plans (SWPPPs).	EQ	
6.	Review, summarize, and assist in the development of bylaws to manage construction site runoff and post-construction runoff if requested, and assist communities with mapping and impervious surfaces analysis	EQ	

#	Objective	Lead	Additional Staff
7.	Provide regional training on stormwater issues for town employees, DWSP staff, and others.	EQ	
8.	Design and conduct water quality monitoring studies to evaluate effectiveness of and optimize performance of direct discharge project structural BMPs.	EQ	
9.	Design a prioritization model using stormwater network and storm sewer delineations that takes into account land cover, proximity to tributaries, and other criteria to categorize watershed areas for relative stormwater treatment needs.	EQ	
10.	Coordinate with Planning Boards to ensure that all construction projects that have a stormwater management component are reviewed and that any new or changed stormwater infrastructure is added to DWSP GIS datalayers.	EQ	
11.	Raise awareness of stormwater as a pollutant in the Sudbury watershed, including techniques for reducing runoff and improving the quality of stormwater runoff, as an effort to create a behavior change among watershed residents that will protect natural resources. Provide stormwater programs, resources and/or support as resources allow to town departments, boards and commissions in the Sudbury watershed.	EQ	WR, IS
12.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on stormwater impacts in the water supply.	D	All
O Emergency Response *Goal: Maintain and improve short- and long-term emergency response capabilities to protect the water supply.*			
1.	Provide emergency response support services; maintain response supplies and up-to-date contact lists.	CE	
2.	Provide Incident Command System training to appropriate staff.	CE	
3.	Coordinate with MWRA and local officials to provide emergency response training and annual tabletop or field exercises.	CE	RD
4.	Construct additional structural controls to reduce likelihood of spills reaching the reservoir.	CE	EQ
5.	Monitor sites of releases or spills that occur near a resource area and follow submitted reports until remediation efforts have been completed under Mass Contingency Plan.	EQ	
6.	Implement Multi-year Training and Exercise Plan.	CE	
7.	Ensure that DWSP and town emergency responders are aware of emergency protocols put in place by DWSP and are provided emergency contact phone numbers on a regular basis and when changes occur.	CE	
8.	Provide emergency response training for new DWSP employees and refresher training for veteran staff.	CE	
9.	Conduct emergency response training events with the local first responders.	CE	
10.	Update, as needed Comprehensive Emergency Management Plan for Wachusett and Sudbury Reservoirs.	CE	
11.	Produce spill response plans and spill notification cards for timber harvesting operations.	F	EQ
12.	Prepare a summary report of information related to containment structures associated with direct discharge abatement projects for use in case of an accidental spill.	EQ	CE
13.	Complete a watershed-wide vulnerability assessment to identify potential impacts of climate change on emergency response in the water supply.	D	All

References

DCR Division of Water Supply Protection Publications, Reference Reports, and Other Documentation

Legal References

Session Laws

- Chapter 262, Acts of 1932. Rutland-Holden Trunk Sewer Legislation
- Chapters 460 and 501, Acts of 1938. Rutland-Holden Trunk Sewer Legislation
- Chapters 286 & 287, Acts of 1939. Rutland-Holden Trunk Sewer Legislation
- Chapter 737 of the Acts of 1972. Kelly-Whetmore Act
- Chapter 372 of the Acts of 1984. MWRA Enabling Act
- Chapter 36 of the Acts of 1992. Watershed Protection Act
- Chapter 15, Acts of 1996, § 2420-7961. Holden and West Boylston Sewer Construction/Expansion
- Chapter 26 of the Acts of 2003, § 290. Creation of Department of Conservation and Recreation
- Chapter 149 of the Acts of 2004, s. 27. Creation of Water Supply Protection Trust

Massachusetts General Laws

- MGL c. 10, § 73 . Water Supply Protection Trust General Law.
- MGL c. 92A½. DCR Watershed Management General Laws.

Code of Massachusetts Regulations

- 313 CMR 11.00. Watershed Protection regulations.
- Other Environmental Regulations: www.mass.gov/eea/agencies/massdep/service/regulations/

Other Legal Documents

- DCR/MWRA Memorandum of Understanding
- Executive Order No. 484: Leading by Example – Clean Energy and Efficient Buildings

Documentation by Program

Unless otherwise noted, all publications by Department of Conservation and Recreation, Division of Water Supply Protection.

Watershed Preservation Restrictions (WPR):

- WPR Working Group worksheets
  - Baseline Documentation Procedure
  - Monitoring Procedure
  - Landowner Relations Procedure
  - Enforcement Procedure
  - Reserved Rights Procedure

- Baseline Documentation Reports
- Annual Monitoring Reports

Land Management

- Continuous Forestry Inventory (CFI) Data
- *From Here Forward: Proposed Changes to the Department of Conservation and Recreation Division of Water Supply Protection's Watershed Forest Management Program* (2013)
- *Land Management Plan* (2017-2027)
  Previous Land Management Plans
  - *Quabbin Land Management Plan* (2007 – 2017)
  - *Sudbury Land Management Plan* (2004 – 2013)
  - *Wachusett Land Management Plan* (2001 – 2010)
  - *Ware Land Management Plan* (2003-2013)
- *Terrestrial Invasive Plant Species Management Strategy* (2011)
- *Science and Technical Advisory Committee (STAC) Report* (2012)

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- Annual Canada Goose Population Control Program Report
- Annual Common Loon Summary report
- Long-term Wildlife Resource Monitoring Program Report (2005)
- Quabbin Gull Harassment Program Reports (2010-2013)
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- *Quabbin Public Access Management Plan Evaluation* (2011)
- *Quabbin Public Access Management Plan Update* (2006)
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- MWRA Vulnerability Assessment (2003)

Infrastructure

- Building Inspection Reports
- Dam and Facility Inspection Reports
- MWRA Emergency Action Plan for the Wachusett Reservoir Dam (2011)
- MWRA Vulnerability Assessment (2003)
- Quabbin Park Plan (2013)

Watershed Protection Act

- Guidance Document for Making Applications under the Watershed Protection Act
- Watershed Protection Act Brochures
  - Horses and the Watershed Protection Act
  - Landscaping and the Watershed Protection Act
  - Watershed Protection Act Fact Sheet

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- Quabbin Reservoir Watershed and Ware River Watershed Annual Water Quality Reports (2006-2017)
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- Wachusett Tributaries Ten Year Water Quality Summaries (1988–1997, 1998–2007)

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- West Branch Ware River Sanitary District 2010-2011 (2011, 2015)
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