MASSACHUSETTS
watershed-based plans

WATERSHED-BASED PLAN

Waushakum Pond

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Prepared For:

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

Contents

Executive Summary

Lake Waushakum viewed from Waushakum Beach during ice-out in Spring 2020. Photo source: Weston & Sampson

Waushakum Pond, locally known as Lake Waushakum, is an 87-acre kettle pond located on the border of Framingham and Ashland, Massachusetts. The pond's watershed covers roughly 150 acres in Framingham and 280 acres in Ashland. Water quality in Waushakum Pond has been a concern since the 1970s, and it has been listed on every available Massachusetts Integrated List of Waters for a variety of impairments, including phosphorus. The purpose of this Watershed Based Plan (WBP) is to convey information about the Waushakum Pond watershed in an organized manner that aids in its continued management and during the planning and implementation of future improvements. WBPs provide an analytical framework for managing efforts to restore water quality in degraded areas and to protect overall watershed health.

This WBP focuses on the drainage area within the City of Framingham, with additional content provided by the Town of Ashland to support the overall plan, and is designed to aid in the City's organization of information related to phosphorus load reduction. Consistent with Massachusetts Department of Environmental Protection requirements, there are nine elements that are addressed within this WBP, which include: Impairment Causes and Pollution Sources, Pollutant Load Reductions, Management Measures, Financial Assistance, Public Information and Education, Implementation Schedule and Measurable Milestones, Progress Evaluation Criteria, and Long-term Monitoring.

Impairment Causes and Pollution Sources: While Waushakum Pond is currently impaired for chlorophyll-a, non-native aquatic plants, dissolved oxygen, total phosphorus, and turbidity, a Total Maximum Daily Load (TMDL) has yet to be published for the waterbody. These impairments are linked to stormwater pollution entering the pond, which is generated by the highly developed nature of the watershed. The most common land use categories around Waushakum Pond are tax-exempt and medium-density residential properties, of which the medium density residential properties are the largest contributor to pollutant loading in stormwater. Tax-exempt properties include properties owned by the City of Framingham as well as properties owned by religious organizations. The Framingham portion of the watershed is approximately 20% impervious cover; the Ashland portion is almost 30% impervious cover. Stormwater runoff from these impervious surfaces enters Waushakum Pond through multiple stormwater outfalls, 10 of which are owned by Framingham, contributing 43.16 total pounds per year of phosphorus to the waterbody. Septic systems within Framingham are estimated to contribute an additional 5.2 pounds per year of phosphorus to the pond.

Pollutant Load Reductions: According to the Watershed Based Plan tool provided by MassDEP, the existing total phosphorus load entering Waushakum Pond from the entire watershed, including the portion of the watershed in Ashland , is 352 pounds per year. To meet water quality standards, the load must be reduced to 293 pounds per year, meaning the overall watershed needs to reduce the amount of annual phosphorus loading by 58 pounds per year, about a 17% overall reduction. Once the baseline water quality data and monitoring program have been established, interim and long-term reduction goals can be re-evaluated after three years and adjusted based on results.

Management Measures: Currently, neither the City of Framingham nor the Town of Ashland has any structural BMPs for reducing phosphorus concentrations within the Waushakum Pond watershed, though Framingham is in the planning and design phases for multiple improvements within the watershed. A table is presented in this section summarizing the proposed management measurements and their estimated pollutant load reductions and costs. The proposed BMPs within Framingham are estimated to reduce phosphorus loading by 8.3 pounds per year; however, it will be necessary to effectively utilize public education campaigns and other nonstructural BMPs to reach the overall phosphorus load reduction goal in the watershed.

Financial Assistance: This section summarizes the funding necessary to implement the management measures proposed in the previous section (Management Measures). The required funding includes upfront capital costs as well as long-term operations and maintenance costs.

Waushakum Beach on a Summer Day. Photo source: City of Framingham Parks & Recreation

Public Information and Education: The goal of the public education program included in this plan is to leverage existing engagement with residents in the neighborhood to distribute information in a manner that is easily accessible and garners public approval for implementation of the plan. Target audiences for the public education program include all property owners or residents within the Waushakum Pond watershed, specifically those in highest priority catchment areas and those who do not live directly on the shoreline, but are recreational users of the Waushakum Pond public areas. Several methods are being planned to distribute the necessary information to target audiences, such as flyers, social media posts, website posts, and involving residents through public meetings and school programs. The overall efficacy of the program will be evaluated through the collection of water quality data and the comparison to the baseline data.

Implementation Schedule and Measurable Milestones: This section summarizes the implementation schedule of this WBP and when interim phosphorus load reduction goals are expected to be reached. It is estimated that the overall Waushakum Pond watershed will be able to achieve a phosphorus load reduction of 20 pounds per year by 2028 and its long-term goal of 58 pounds per year by 2040.

Progress Evaluation Criteria and Monitoring: Several indirect indicators of the WBP's progress in phosphorus load reductions have been identified, such as the number and duration of beach closures and the presence of plant growth and nuisance algae. These are all key measures that do not directly measure water quality but are highly indicative of its state. However, specific numbers regarding implementation of the WBP should also be measured, such as attendance at public meetings related to the watershed, number of geese observed on the beach, or number of structural BMPs installed. The City of Framingham will continue to fund its annual in-lake monitoring program and water quality testing. The WBP will be revisited every three years using new data collected and adjusted to better reflect the current state of the Waushakum Pond watershed.

Introduction

What is a Watershed-Based Plan?

1. Purpose & Need

The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" watershed plans, as described below.

All states are required to develop WBPs, but not all states have taken the same approach. Most states develop WBPs only for selected watersheds. Massachusetts Department of Environmental Protection's (MassDEP's) approach has been to develop a tool to support statewide development of WBPs so that good projects in all areas of the state may be eligible for federal watershed implementation grant funds under Section 319 of the Clean Water Act.

EPA guidelines promote the use of Section 319 funding for developing and implementing WBPs. WBPs are required for all projects implemented with Section 319 funds and are recommended for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both.

2. Watershed-Based Plan Outline

This WBP includes nine elements (A through I) in accordance with EPA Guidelines:

a) An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBP and to achieve any other watershed goals identified in the WBP, as discussed in item (b) immediately below.

b) An estimate of the load reductions expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.

c) A description of the nonpoint source (NPS) management measures needed to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in this WBP and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d) An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, United States Department of Agriculture's (USDA's) Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant federal, state, local, and private funds that may be available to assist in implementing this plan.

e) An **information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f) A **schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious.

g) A description of **interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented.

h) A set of **criteria to determine if loading reductions are being achieved** over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this WBP needs to be revised or, if a NPS total maximum daily load (TMDL) has been established, whether the TMDL needs to be revised.

i) A **monitoring component** to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (h) immediately above.

3. Data Sources

This WBP was developed using the framework and data sources provided by MassDEP's WBP Tool and supplemented by data from stakeholders, past studies, site visits, and additional analysis. Supplemental data sources were reviewed and included in subsequent sections of this WBP if relevant.

4. Summary of Completed Work – Non-Structural Controls

The City of Framingham has non-structural controls, like street sweeping and catch basin cleaning, in place city-wide, with an emphasis on cleaning activities in the streets tributary to Lake Waushakum. Street sweeping and catch basin cleaning remove road debris, which include sediments and other pollutants like phosphorus, from the road and drainage system before it reaches the waterbody during a storm event, which reduces stormwater pollution.

Street Sweeping in Framingham. Photo source: City of Framingham

The City of Framingham has a robust street sweeping program city-wide. Streets categorized as "Downtown", "Mains", and "Urban" are swept daily, five days per week, and monthly, respectively. The remaining streets are swept at least once annually. The current street sweeping schedule can be found here: Urban Street Sweeping Program | City of Framingham, MA Official Website (framinghamma.gov). The City is also in the process of increasing its catch basin cleaning frequency in the area so that no catch basin sump is ever more than 50% full. Changes to the catch basin cleaning schedule will be outlined in the City's Catch Basin Cleaning Optimization Plan, which is being developed to meet the requirements of the City's stormwater permit. The City is working to collect the data it needs to make changes to the catch basin cleaning schedule.

The Town of Ashland sweeps all streets twice per year—once in the fall and once in the spring—to meet the requirements of its stormwater permit. Catch basins are currently cleaned annually, though Ashland is also required to develop a catch basin cleaning schedule that ensures no catch basin is ever more than 50% full.

Element A: Identify Causes of Impairment & Pollution Sources

Element A: Identify the causes and sources or groups of similar sources that need to be controlled to achieve the necessary pollutant load reductions estimated in the watershed based plan (WBP).

1. General Watershed Information

Waushakum Pond, known locally as Lake Waushakum, is an 87-acre stratified kettle pond located in Framingham and Ashland, Massachusetts. While most of the pond's surface area is in Framingham, most of the contributing watershed area is in Ashland. A 2001 study conducted by ESS determined that the maximum depth of Waushakum Pond was 47 feet and that the flushing rate is between 1.8 to 2.0 times per year. As summarized in Figure A-1, the total drainage area in Framingham tributary to Waushakum Pond is 281.2 acres, of which 149 acres drain directly to the City's drainage system, or MS4. The total drainage area in Ashland tributary to Waushakum Pond is 752 acres, of which 281.9 acres is directly tributary to their drainage system. Areas tributary to the drainage system are more likely to contribute pollution to the pond, as stormwater runoff enters the pond as a point source and does not pass over vegetated areas prior to entering the pond like in overland areas.

Figure A-1: Waushakum Pond Watershed Area Characterization
Total Area = 1,033 ac (1.6 sq. mi.)

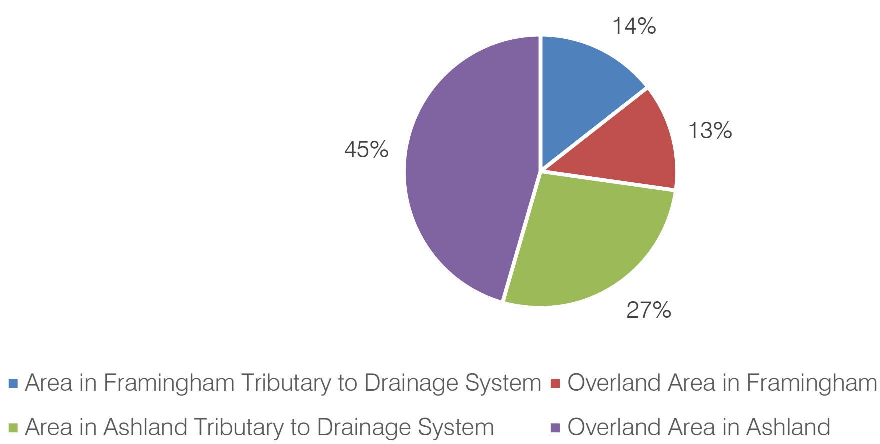


Table A-1: General Watershed Information	
Watershed Name (Assessment Unit ID):	Waushakum Pond (MA82112)
Major Basin:	CONCORD (SuAsCo)
Watershed Area (within MA):	1033.2 (ac); 281.2 (ac) in Framingham
Water Body Size:	87 (ac)

The pond is in the greater Sudbury-Assabet-Concord River watershed (HUC 0107005), which is also known as SuAsCo. Figure A-2 depicts the overall Waushakum Pond watershed boundary. The pipes, drain manholes, and catch basins in the Framingham portion of the watershed are over 100 years old—GIS data indicates that most of the structures were installed in 1915. Based on the age of development in the Ashland portion of the watershed, drainage infrastructure in Ashland is estimated to be between 30 and 70 years old. Appendix A illustrates the drainage infrastructure within the catchment areas in Framingham that directly drain into Waushakum Pond as well as a map showing stormwater catchment areas in Ashland.

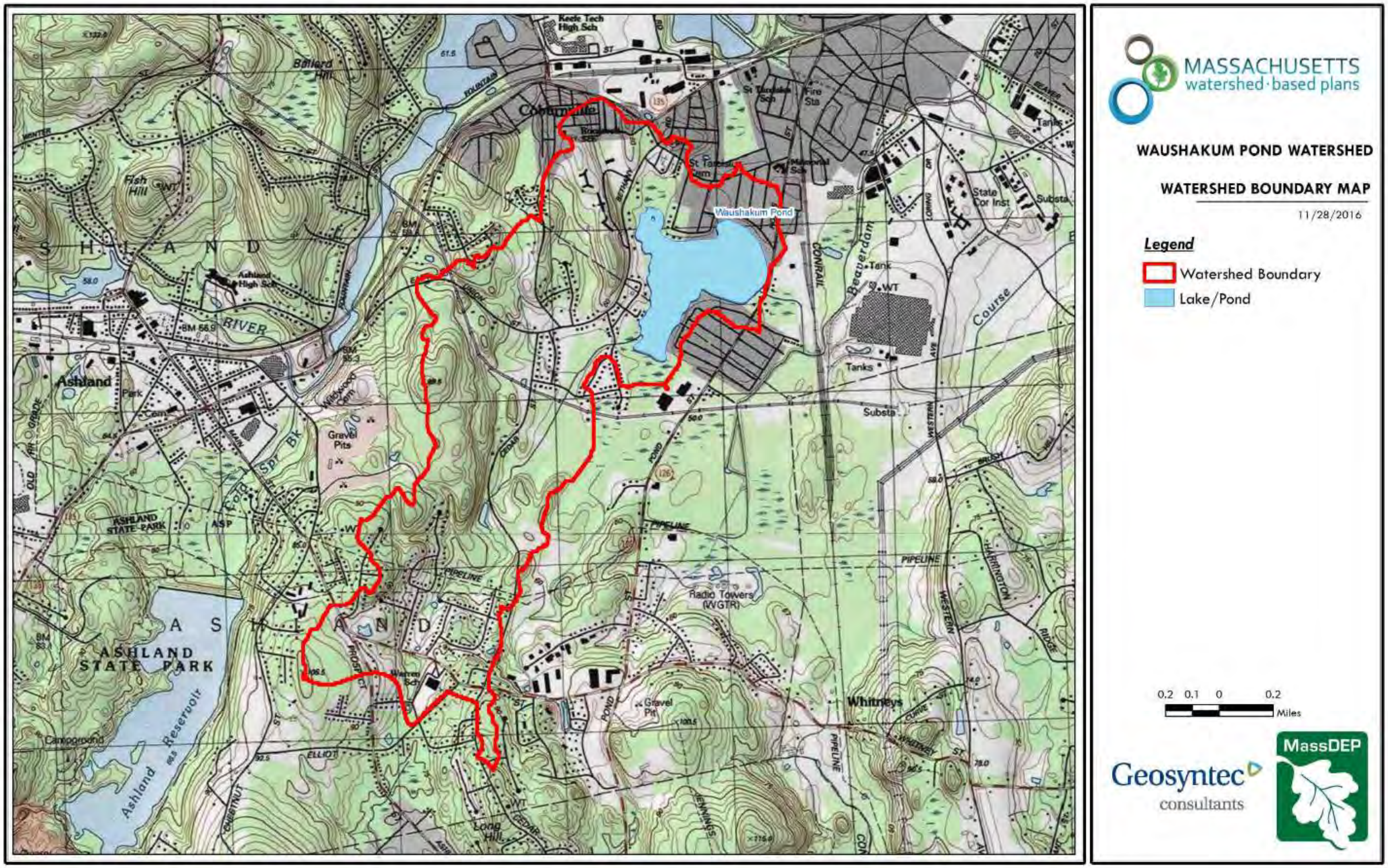


Figure A-2: Watershed Boundary Map (MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Waushakum Pond is a popular recreational resource for the local population, with a public swimming beach owned and operated by the City of Framingham, a public boat access point in Ashland, and numerous residents partaking in boating, fishing, and other recreational activities.

Waushakum Beach, located along the northern shore of the pond, has closed to swimmers multiple times during recent swimming seasons due to elevated bacteria counts resulting from stormwater pollution and waterfowl droppings. Nuisance aquatic plants must be controlled by in-lake chemical treatment, creating recurring expenses for both Framingham and Ashland.

2. MassDEP Water Quality Assessment Report and TMDL Review

The following reports are publicly available online and were consulted during the development of this WBP:

- Diagnostic Feasibility Study For Waushakum Pond, Town Of Ashland, Mass. Dated December 2001
- Suasco Watershed 2001 Water Quality Assessment Report, Suasco Watershed Lake Assessments
- Waushakum Pond Diagnostic Feasibility Study Framingham Ashland, Mass. Draft Final Report. 1988.
- City of Framingham Stormwater Management Plan, last updated June 2022
- Town of Ashland Stormwater Management Plan, last updated September 2022
- Lake Waushakum Phosphorus Source Identification Report, prepared by Weston & Sampson for the City of Framingham, dated May 2022
- Phosphorus Source Identification Report, prepared by Fuss & O'Neill for the Town of Ashland, dated November 2021
- Framingham Open Space and Recreation Plan, dated July 2008

Excerpts from the SuAsCo Watershed 2001 Water Quality Assessment are included in the box below. Note that relevant information has been included directly from the document for informational purposes and has not been modified.

SuAsCo Watershed 2001 Water Quality Assessment Report (MA82112 - Waushakum Pond)
There is a public boat launch on Waushakum Pond. A non-native aquatic species (M. heterophyllum) was identified by MassDEP's Division of Watershed Management (DWM) during the 1996 synoptic survey. In October/November 2001 a Diagnostic/Feasibility study was conducted by ESS for the Town of Ashland (ESS 2001). Due to the presence of the non-native macrophyte species, the Aquatic Life Use is assessed as impaired. There is a public bathing beach on Waushakum Pond that is tested weekly during the swimming season by the Framingham Board of Health. Sources of bacteria to the pond include geese and stormwater. There is a stormwater outfall that discharges to the beach (Cooper 2004). Beach closure information was not readily available so the Primary Contact Recreation Use is currently not assessed. Waushakum Pond is on the 2002 Integrated List of Waters in Category 4c because of exotic species (MA DEP 2003a). In 1985 a septic leachate detection survey was performed for East Waushakum Pond by IEP Inc (MA DEP 2005). Results of that survey were not included in the 2001 report.

SuAsCo Watershed 2001 Water Quality Assessment Report (MA82112 - Waushakum Pond)
Report Recommendations: WATERSHED WIDE LAKE RECOMMENDATIONS (2001) • Coordinate with MA DCR and/or other groups that conduct lake surveys to generate quality-assured lake data. Conduct more intensive lake surveys to better determine the lake trophic and use support status and identify causes and sources of impairment. As sources are identified within lake watersheds they should be eliminated or, at least, minimized through the application of appropriate point or non-point source control techniques. • Work with the Massachusetts Department of Public Health and local municipalities to collect quality-assured data under the “Beaches Bill,” which requires water quality testing (bacteria sampling) at all formal bathing beaches. When available, review data and beach closure information to assess the status of the recreational uses. • Review the MA DEP Drinking Water Program SWAP evaluations when they are completed to develop and implement recommendations for the protection of Class A lakes in the SuAsCo Watershed. • Work with the MA DCR Weed Watchers Program to monitor ponds in the SuAsCo Watershed for the presence of exotic invasive species and to develop a removal plan if an infestation is found. Additional information may be obtained from the MA DEM website: http://www.mass.gov/dcr/waterSupply/lakepond/lakepond.htm • Quick action is necessary to manage non-native aquatic or wetland plant species that are isolated in one or a few location(s) in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from recorded locations to determine the extent of the infestation. And, "spot" treatments [refer to the Generic Environmental Impact Report (GEIR) for Eutrophication and Aquatic Plant Management in Massachusetts (Mattson et al. 2004) for advantages and disadvantages of each] should be undertaken to control populations at these sites. These treatments may include careful hand-pulling of individual plants in small areas. In larger areas other techniques, such as selective herbicide application, may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These actions will minimize the spreading of the populations. This GEIR (Mattson et al. 2004) should be consulted prior to the development of any lake management plan to control non-native aquatic or wetland plant species. • Where non-native plant infestations are more extensive conduct additional monitoring to determine the extent of the problem. The Generic Environmental Impact Report for Eutrophication and Aquatic Plant Management in Massachusetts (Mattson et al 2004) should be consulted prior to the development of any lake management plan to control non-native aquatic plant species. Plant control options can be selected from several techniques (i.e., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for some invasive species to reproduce and spread vegetatively (from cuttings). • Prevent spreading of non-native plants. Once the extent of the problem is determined and control practices are exercised vigilant monitoring needs to be practiced to guard against infestations in unaffected areas and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake-users to the transport mechanisms and their ability/responsibility to reduce the spread of these species. • Implement recommendations identified in TMDLs and lake diagnostic/feasibility studies, including lake watershed surveys, to identify sources of impairment. The single draft TMDL report for total phosphorus, which is being developed for the eight lakes sampled by DWM in 2001 has been delayed (Mattson 2004).

Historical Water Quality Data

Historical and current Technical Memoranda (TM) produced by the MassDEP Watershed Planning Program (WPP) are available here: [Water Quality Technical Memoranda | Mass.gov]() and are organized by major watersheds in Massachusetts. Waushakum Pond is a part of the Concord River watershed, which includes the Sudbury and Assabet Rivers, earning the moniker of the "SuAsCo" watershed. Most of these TMs present the water chemistry and biological sampling results of WPP monitoring surveys. The TMs pertaining primarily to biological information (e.g., benthic macroinvertebrates, periphyton, fish populations) contain biological data and metrics that are currently not reported elsewhere. The data contained in the water quality TMs are also provided on the "Data" page ([Water Quality Monitoring Program Data | Mass.gov]()). Many of these TMs have helped inform Clean Water Act 305(b) assessment and 303(d) listing decisions.

The pond was first flagged for poor water quality during a year-long water quality survey conducted by the Massachusetts Division of Water Pollution Control (DWPC) between 1975 and 1976. It has since been listed on every available Massachusetts Integrated List of Waters, or 303(d) list, for non-native aquatic plants, macrophytes, chlorophyll-a, turbidity, dissolved oxygen, and total phosphorus impairments.

More Recent Sampling Data

Sampling data from Waushakum Pond is available from 2000 to 2021 from Year-End reports completed by Aquatic Control Technologies Inc. and SOLitude Lake Management for the City of Framingham's Conservation Commission. Water quality data parameters include pH, alkalinity, turbidity, ammonia, nitrate, phosphorus, true color, apparent color, E. Coli, Secchi depth, dissolved oxygen, and temperature. The annual water quality data was compiled into Tables A-2, A-3, and A-4. No water quality analysis was available from 2018.

Table A-2: Water Quality Data from 2000-2021

Year	pH	Alkalinity (mg $CaCO_3$/L)	Turbidity (NTU)	Ammonia (mg/L)	Nitrate (mg/L)	Total Phosphorus (mg/L)	True Color (APCU)	Apparent Color (APCU)	E Coli (MPN/100 mL)	Secchi Depth (Ft)
2000	7.41	16	ND	0.2	ND	ND	25	35	ND	ND
2001	7.42	22	ND	0.2	ND	0.013	ND	ND	ND	ND
2002	7.72	26	2.7	0.07	0.27	0.021	24	33	15	6.2
2003	7.45	24	1.9	0.07	0.8	0.013	14	27	10	9.1
2004	7.35	24	0.71	0.05	0.56	0.016	30	33	10	7.7
2005	8.23	27	2.04	0.05	0.5	0.011	15	28	88	5.5
2006	7.34	26	0.54	0.05	0.21	0.012	18	25	10	8.9
2007	8.3	26	0.99	0.32	0.18	0.014	20	29	10	7.1
2008	7.42	24	2.19	0.29	0.1	0.02	17	25	13	8.6
2009	7.44	29.6	0.78	0.12	0.1	0.018	13	20	10	8.88
2010	8.55	32.1	5.3	0.1	0.1	0.091	30	56	13.3	2.63
2011	7.06	29.1	1.7	0.13	0.1	0.06	30.3	45.3	56.7	6.88
2012	7.61	30.5	3.7	ND	0.1	0.0345	17.5	27.5	10	5.25
2013	7.22	24	0.71	ND	0.12	0.03	20	20	5	6.35
2014	6.95	25	1.75	ND	ND	0.019	ND	ND	30	10

Table A-2: Water Quality Data from 2000-2021										
Year	pH	Alkalinity (mg $CaCO_3$/L)	Turbidity (NTU)	Ammonia (mg/L)	Nitrate (mg/L)	Total Phosphorus (mg/L)	True Color (APCU)	Apparent Color (APCU)	E Coli (MPN/100 mL)	Secchi Depth (Ft)
2015	7.6	26	2	ND	0.05	0.021	5	10	ND	8.3
2016	7.2	26	3.4	ND	ND	0	0	10	ND	9
2017	7	26	3.7	0.09	ND	0	0	10	ND	8.5
2018	-	-	-	-	-	-	-	-	-	-
2019	8.2	26.7	2.8	ND	ND	0.018	17	26	12.97	ND
2020	7.4	27.9	0.92	-	0.105	0.017	24	30	9.69	-
2021	7.15	3.85	26.75	0.0595	ND	0.0215	33	45	109.87	-
* ND = Not Detected										

Table A-3: Average Annual Temperature (˚C) Profile in Waushakum Pond								
Date	Surface	1m	2m	3m	4m	5m	6m	7m
2008	21.35	19.85	18.35	17.85	17.1	14.45	11.15	8.7
2009	17.7	17.25	17.2	16.6	15.8	14.1	-	-
2014	18.4	18.15	17.9	17.65	17.05	16.05	14.3	13.6
2015	18.2	18	17.9	17.65	16.95	16.45	14.55	13
2017	27.8	27.6	27.6	27.6	27.2	22.5	18.5	14.5

Table A-4: Average Annual DO (mg/L) Readings in Waushakum Pond								
Date	Surface	1m	2m	3m	4m	5m	6m	7m
2008	10.045	10.24	9.815	9.155	7.53	4.925	4.09	4.13
2009	10.405	10.06	10.04	9.93	9.825	7.01	-	-
2014	9.915	9.725	9.745	9.52	9.16	8.275	6.17	4.65
2015	9.975	9.725	9.71	9.4	9.06	8.175	6.22	4.45
2017	8.5	8.6	8.58	8.55	8.5	3.3	2.85	0.8

Additionally, the Year-End reports compiled by Aquatic Control Technologies Inc. and SOLitude Lake Management also discuss the annual actions taken to manage nuisance aquatic plants. These actions include targeted herbicide application, hand removal of plants in certain zones, and, depending on the year and conditions, no actions. The reports also provide recommendations for the management program for the following year. Overall, water quality has been relatively constant in Lake Waushakum for the past 20 years, with 2021 the only year showing deviations in turbidity and e. coli concentrations. Phosphorus concentrations are variable, but have neared or exceeded EPA's target concentration of 0.025 mg/L for ponds and reservoirs four times in the last 20 years.

As part of the City's efforts to comply with the 2016 Massachusetts MS4 Permit, dry and wet-weather outfall screening and sampling, as well as dry weather catchment investigations of the tributary drainage infrastructure, has been completed for each of the 10 outfalls discharging to Lake Waushakum from Framingham. Dry and wet-weather outfall screening and sampling were completed in Fall 2020; catchment investigations were completed in Spring 2022. Ashland completed dry-weather outfall screening and sampling of the 45 outfalls within the Waushakum Pond watershed in 2021, and identified three outfalls that will require wet-weather investigations. At the time of plan development, catchment investigation data for Ashland's drainage system was not yet available.

Waushakum Pond Diagnostic/Feasibility Study by IEP, Inc. & Camp, Dresser and McKee, Inc., Oct. 1988

The 1988 Diagnostic/Feasibility study included a bathymetric survey of the pond, in-lake sampling, stormwater outfall sampling, the calculation of hydrologic and nutrient budgets, and recommendations for in-lake and watershed management strategies. The study also calculated phosphorus input to Waushakum Pond based on non-point source nutrient export from different land uses in the watershed. In 1988, most of the watershed was either forest (47% of watershed) or residential use (35%). Today, the watershed is 47% residential land and 36% forest.

Each outfall discharging to Waushakum Pond was sampled during a wet-weather event in June 1986, and follow-up sampling at outfalls with elevated nutrient levels was performed in April 1987. The sampling results were correlated to the land use characteristics of the tributary drainage area. Water quality was monitored over the course of one year from various in-lake stations. Impervious coverage was not considered in the study, but a nutrient budget was calculated for the pond. The following is an excerpt from the 1988 report:

> "The largest source of phosphorus is storm drains which contribute 81 kg/year, or 36% of the total input. Although storm drains contribute only a small portion of the water flowing into Waushakum Pond, the flows are of degraded quality as shown by storm sampling results".

The highest phosphorus concentration observed in 1988 was at Drain 7, now known as OF-2000203, between 60 and 124 Lake Avenue. Land use in the catchment area tributary to this outfall today is mostly residential with 32% impervious coverage.

The 1988 study concluded that the two most significant problems at Waushakum Pond are dense aquatic vegetation and occasionally high algal biomass. As these are typically problems associated with elevated nutrient levels, the report proposed various programs to address the nutrient loading from stormwater, the sediment loading from stormwater, and the internal nutrient cycling of the pond.

IEP eventually proposed a watershed management program including the diversion of stormwater to leaching catch basins, annual cleaning of all catch basins in the tributary area, public education, and enhanced erosion and sediment control components, as well as in-lake management strategies including aeration, alum treatment, and hydro-raking.

Diagnostic/Feasibility Study for Waushakum Pond by Environmental Science Services, Inc., Dec. 2001

The 2001 Diagnostic/Feasibility Study also included collection of water quality samples from the inlet stream, outlet stream, and two in-lake stations at Waushakum Pond. The pond was again found to have elevated phosphorus levels, with high concentrations measured at the bottom of the pond and in the pond's tributary stream. This report proposed management strategies including a “pollutant source investigation” in the watershed contributing to Waushakum Pond, a public education campaign, increased street sweeping and catch basin cleaning, and a “build-out-analysis” which would analyze how development in the watershed might affect nutrient loading and the resultant water quality in the pond. The recommended street sweeping frequency was once per month; the recommended catch basin cleaning frequency was twice per year. Many of these recommendations meet or exceed the requirements of the 2016 MS4 Permit. Additionally, the report discusses several kinds of in-pond aquatic plant management strategies before providing a final recommendation for the overall waterbody management program for Waushakum Pond. These recommendations included herbicide treatment, which Framingham has been contracting with Solitude Lake Management to apply periodically at Waushakum Pond to control invasive species.

Additional Information

A proposal provided in 2015 by Aquatic Control Technology provided insight into the types of treatment and remediation initiatives that have been undertaken at Waushakum Pond, which include application of herbicides and regular vegetation surveys. The Aquatic Control Technology proposal was for in-lake chemical treatment to control nuisance aquatic vegetation such as milfoils (*myriophyllum*), waterweeds (*elodea canadensis*), and coontail (*ceratophyllum demersum*). In-lake treatment has been conducted many times in Waushakum Pond, as it is a relatively inexpensive, albeit temporary, solution to the pond’s nuisance aquatic vegetation concerns.

In 2008, the Town of Ashland, received funding from an EPA Clean Water Act Section 319 Grant, designed and installed multiple rain gardens within the watershed area. According to a July 2019 article in the Metrowest Daily News, three rain gardens were installed as part of that effort, but two of them have been dismantled in the past decade.

3. Water Quality Impairments

Impairment categories from the Massachusetts Department of Environmental Protection (MassDEP) Integrated List of Waters are as follows:

Table A-5: 2018/2020 MA Integrated List of Waters Categories	
Integrated List Category	Description
1	Unimpaired and not threatened for all designated uses.
2	Unimpaired for some uses and not assessed for others.
3	Insufficient information to make assessments for any uses.
4	Impaired or threatened for one or more uses, but not requiring calculation of a Total Maximum Daily Load (TMDL), including: 4a: TMDL is completed 4b: Impairment controlled by alternative pollution control requirements 4c: Impairment not caused by a pollutant - TMDL not required
5	Impaired or threatened for one or more uses and requiring preparation of a TMDL.

Known water quality impairments, as documented in the Final 2018/2020 Massachusetts Integrated List of Waters (MassDEP, 2022), are listed below in Table A-6.

Table A-6: Water Quality Impairments (MassDEP 2022)				
Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause
MA82112	Waushakum Pond	5	Aesthetic	Aquatic Plants (Macrophytes) Turbidity
MA82112	Waushakum Pond	5	Fish, other Aquatic Life and Wildlife	Chlorophyll-a Non-Native Aquatic Plants Dissolved Oxygen Phosphorus, Total Turbidity
MA82112	Waushakum Pond	5	Primary Contact Recreation	Aquatic Plants (Macrophytes) Turbidity
MA82112	Waushakum Pond	5	Secondary Contact Recreation	Aquatic Plants (Macrophytes) Turbidity

4. Water Quality Goals

Water quality goals may be established for a variety of purposes, including the following:

a.) For **water bodies with known impairments**, a Total Maximum Daily Load (TMDL) is established by MassDEP and the United States Environmental Protection Agency (USEPA) as the maximum amount of the target pollutant that the waterbody can receive and still safely meet water quality standards. This is not applicable as no TMDL has been established for Lake Waushakum.

b.) For **water bodies without a TMDL for total phosphorus** (TP), a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (USEPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 micrograms per liter (ug/L) in any stream at the point where it enters any lake or reservoir, nor 25 ug/L within a lake or reservoir. For the purposes of developing WBPs, MassDEP has adopted 50 ug/L as the TP target for all streams at their downstream discharge point, regardless of which type of water body the stream discharges to. Waushakum Pond falls into this category.

c.) Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. Waushakum Pond is a Class 'B' waterbody. The water quality goal for fecal coliform bacteria is based on the Massachusetts Surface Water Quality Standards.

d.) **Other water quality goals set by the community** (e.g., protection of high-quality waters, in-lake phosphorus concentration goal to reduce recurrence of cyanobacteria blooms, etc.). In addition to reducing phosphorus loading to the pond, which will decrease the presence of nuisance aquatic plants, Framingham is also concerned with reducing the frequency of beach closures due to elevated bacteria concentrations at Waushakum Beach, the public swimming area along the northern shore of the pond.

Table A-7: Water Quality Goals for Impairments Included in Table A-6		
Pollutant	Goal	Source
Total Phosphorus (TP)	Total phosphorus should not exceed: --25 ug/L within any lake or reservoir	Quality Criteria for Water (USEPA, 1986)
Bacteria	Class B Standards • Public Bathing Beaches: For E. coli, geometric mean of all recent samples collected within a 90-day window shall not exceed 126 colonies (CFU)/ 100 mL and no more than 10% of all such samples shall exceed 410 CFU/100 mL. For enterococci, geometric mean of samples collected in a 90-day period shall not exceed 35 CFU/100 mL and no more than 10% of such samples shall exceed 130 CFU/100 mL. Geometric means and statistical threshold values shall be calculated and reassessed ever 30 days at a minimum for public bathing beaches.	Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2022)

Note: *There may be more than one water quality goal for bacteria due to different Massachusetts Surface Water Quality Standards Classes for different Assessment Units within the watershed.*

5. Land Use and Impervious Cover Information

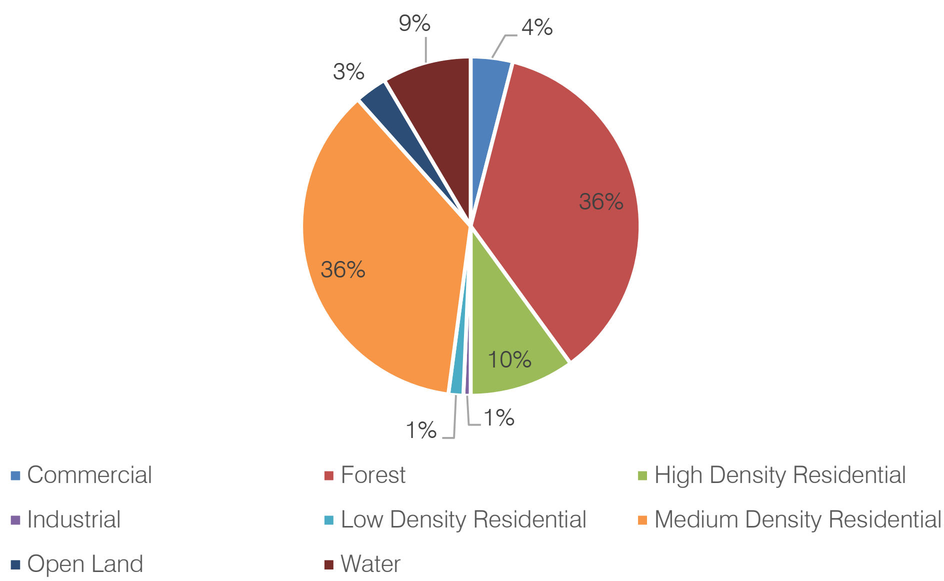
Watershed Land Uses

Land use in the Waushakum Pond watershed is typical of suburban areas. Land use information and impervious cover for Ashland and Framingham is presented in the tables and figures below. Land use source data from 2005 was obtained from MassGIS (2009b) for Table A-8 and Figures A-3 and A-4.

Table A-8: Overall Watershed Land Uses

Land Use	Area (acres)	% of Watershed
Agriculture	0	0
Commercial	40.29	4
Forest	372.09	36
High Density Residential	103.42	10
Highway	0	0
Industrial	7.47	0.7
Low Density Residential	14.93	1.4
Medium Density Residential	375.14	36.3
Open Land	32.48	3.1
Water	87.33	8.5
Total	1033.15	100

Figure A-3: Land Use in the Overall Waushakum Pond Watershed
Total Area = 1,033 ac (1.6 sq. mi.)



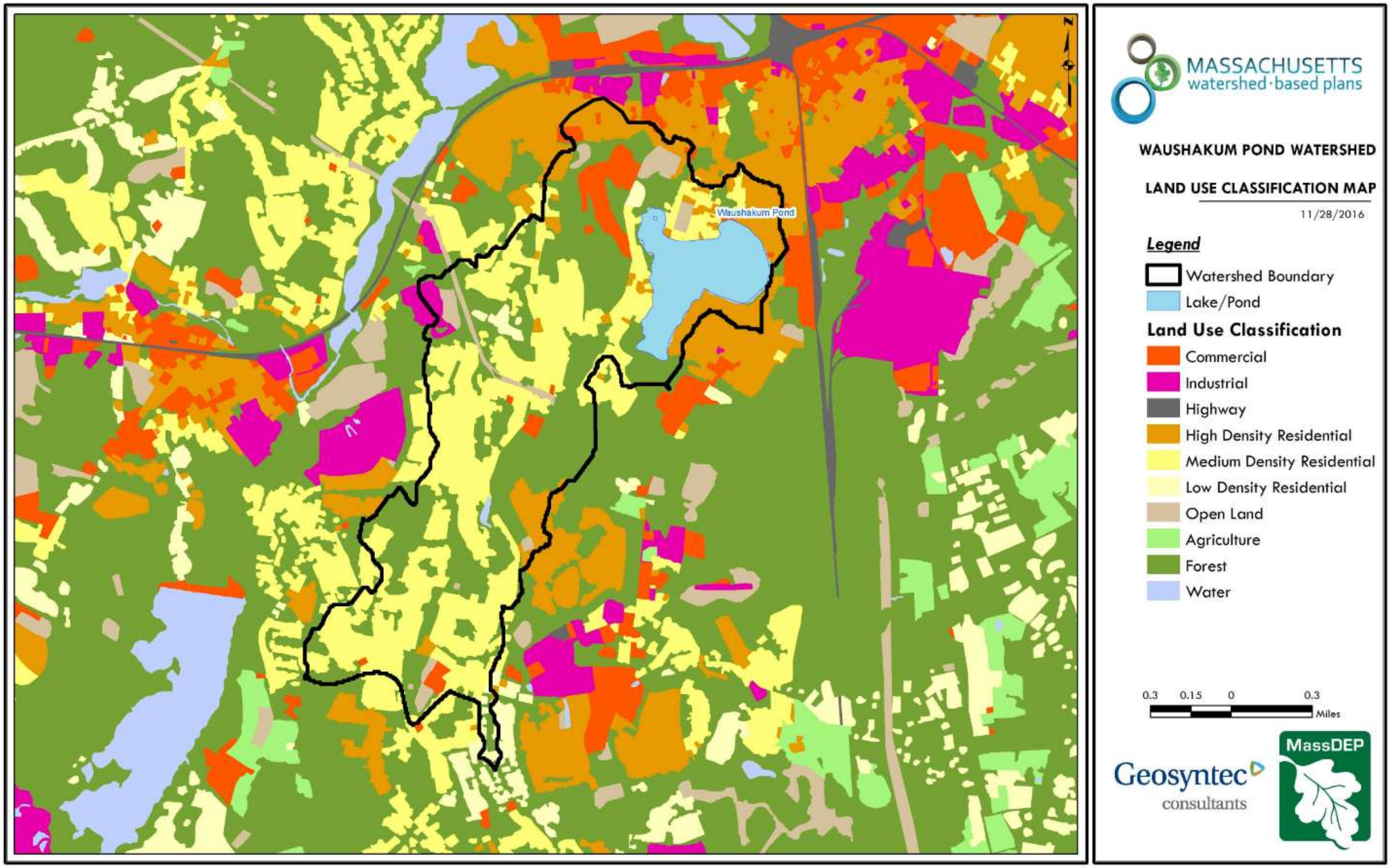


Figure A-4: Watershed Land Use Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

To better quantify the amount of polluted stormwater runoff the City could manage by retrofitting the storm drain system, land use data for the properties within the area tributary to Framingham's drainage system was collected from MassGIS' most recent (2016) land use data layer. Table A-9 presents a summary of land use in Framingham's tributary area. Appendix B illustrates the catchment areas that directly drain to Waushakum Pond via Framingham's drainage system and depicts their land use categories. A similar analysis was performed by Fuss & O'Neill for Ashland as part of their Phosphorus Source Identification Report. A table summarizing land use and impervious cover in catchment areas in Ashland is included in Appendix C.

Table A-9: Land Use in Waushakum Pond Watershed Tributary to Framingham's Drainage System		
Land Use	Acres	% of Overall Catchment Area
Tax exempt*	53.29	35.84%
Residential - single family	49.56	33.33%
Residential - multi-family	16	10.76%
Right-of-way	15.09	10.15%
Open land	8.36	5.62%
Water	5.37	3.61%
Commercial	0.68	0.46%
Unknown	0.35	0.23%
Grand Total	**148.70**	**100.00%**
*The tax-exempt land use includes all publicly owned land including schools, parks, and government buildings, as well as property that is exempt from taxation such as property owned by religious groups, housing/utility authorities, hospitals, museums, etc.		

The largest percentage of land use in Framingham is tax-exempt property (which includes all publicly owned land and property that is exempt from taxation). Most tax-exempt land in the watershed is attributable to two properties: St. Tarcisius Cemetery, located to the northwest of the pond, and Bethany Hill Place, an assisted living facility also located northwest of Lake Waushakum. Neither of these parcels are owned by the City of Framingham. Anna Murphy Park and Waushakum Beach are also larger tax-exempt properties located in the watershed; both are owned by the City. After tax-exempt property, the next largest percentages of land usages are residential living, both multi-family and single-family properties. Medium-density residential land is the largest percentage of land use in the Ashland portion of the watershed.

Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc.

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land. Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent vegetated areas.

An estimate of DCIA for the watershed was calculated based on the Sutherland equations. USEPA provides guidance (USEPA, 2010) on the use of the Sutherland equations to predict relative levels of connection and disconnection based on the type of stormwater infrastructure within the total impervious area (TIA) of a watershed. The total areas of each land use category were summed and used to calculate the percent TIA. The entire Waushakum Pond watershed has an estimated TIA of 20.1% and an estimated DCIA of 12.5%. Figure A-5 illustrates a map of the impervious area within the watershed.

The relationship between TIA and water quality can generally be categorized as shown in Table A-10 (Schueler et al. 2009):

Table A-10: Relationship between Total Impervious Area (TIA) and Water Quality (Schueler et al. 2009)

% Watershed Impervious Cover	Stream Water Quality
0-10%	Typically high quality, and typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects.
11-25%**	Clear signs of degradation. Elevated storm flows begin to alter stream geometry, with evident erosion and channel widening. Streams banks become unstable, and physical stream habitat is degraded. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.
26-60%	Typically no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Biological quality is typically poor, dominated by pollution tolerant insects and fish. Water quality is consistently rated as fair to poor, and water recreation is often no longer possible due to the presence of high bacteria levels.
>60%	These streams are typical of "urban drainage", with most ecological functions greatly impaired or absent, and the stream channel primarily functioning as a conveyance for stormwater flows.
** Applicable category for Waushakum Pond watershed	

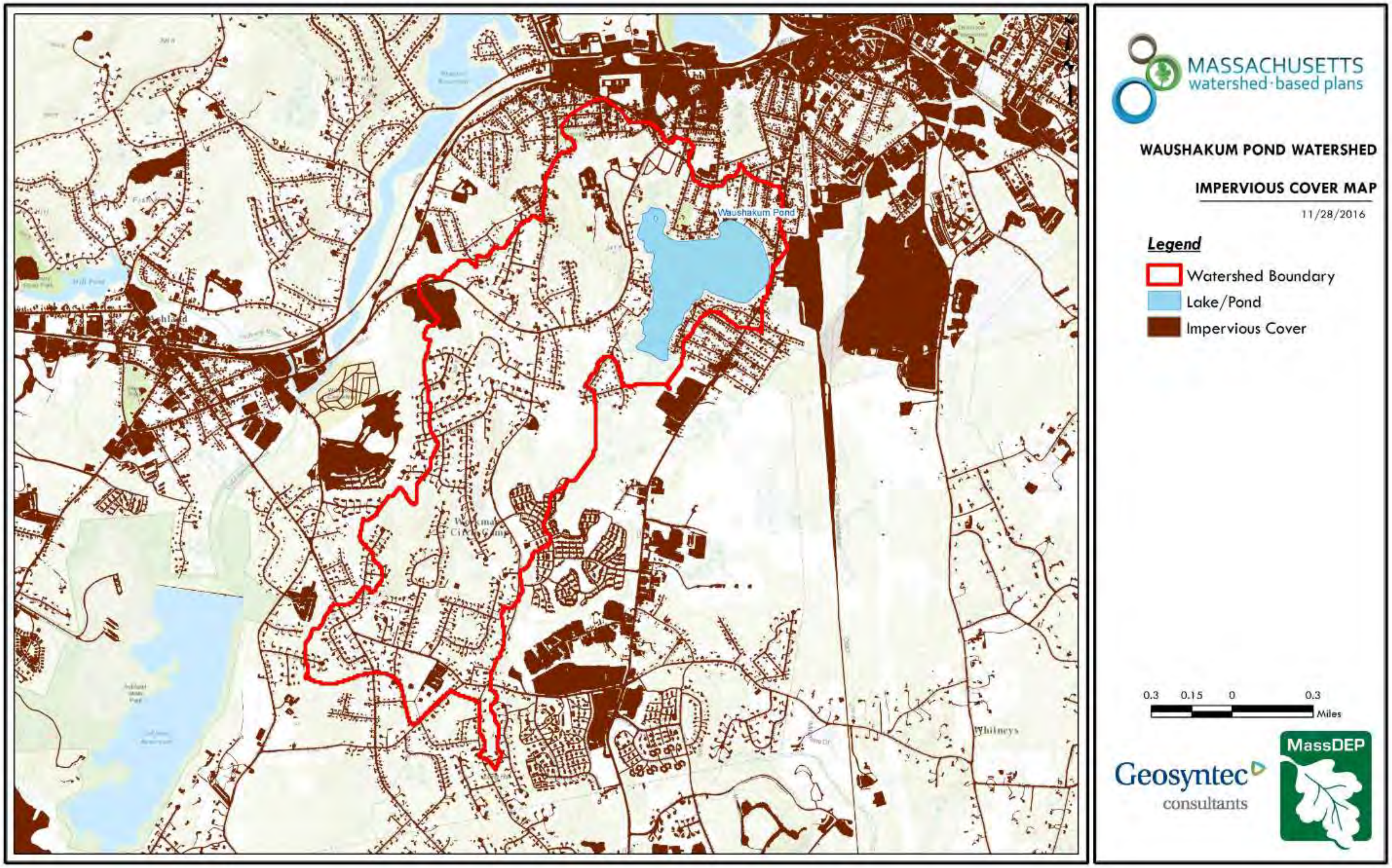


Figure A-5: Watershed Impervious Surface Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Available GIS mapping was used to determine land use characteristics and complete an impervious area delineation for each of the 10 **catchment areas** that contribute runoff to Waushakum Pond via Framingham's drainage system. Each **catchment area** contributes runoff to a **stormwater outfall**, which discharges directly to the pond. Impervious area data was used to calculate percent impervious cover and percent directly connected impervious area in each catchment. Table A-11 presents impervious area and DCIA statistics for each catchment within Framingham.

<u>Some terms to know:</u>

Catchment area: an area within a larger watershed contributing stormwater runoff to a specific point, like a catch basin or outfall

Stormwater outfall: the point, usually a pipe end, where the drainage system discharges to a waterbody

Table A-11: Total Impervious Area (TIA) and DCIA Statistics for Waushakum Pond Stormwater Catchment Areas in Framingham

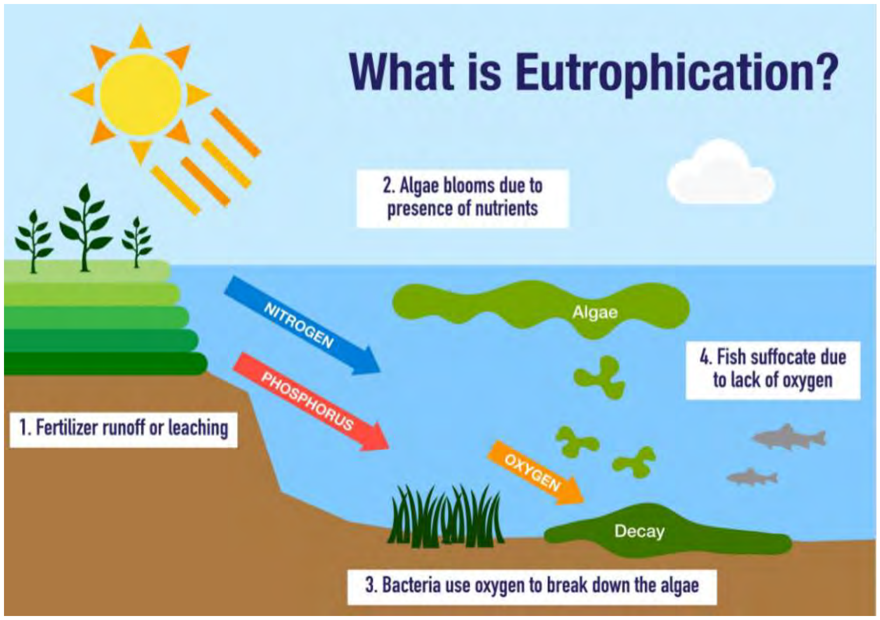
Catchment	Outfall	Impervious Area (Acres)	DCIA (Acres)	Catchment Area (Acres)	Percent IA	Percent DCIA	Percent Connectivity
1003	2000006	1.6	1.12	3.26	49.10%	34.20%	70%
2366	2000200	1.1	0.42	4.2	26.20%	10.10%	39%
2367	2000201	8.14	2.77	38.54	21.10%	7.20%	34%
2368	2000203	2.23	0.76	7.04	31.70%	10.80%	34%
2369	2012000	4.53	1.63	13.78	32.90%	11.80%	36%
2371	2006433	2.31	1.21	3.94	58.60%	30.60%	52%
2372	2000204	4.62	2.27	9.71	47.60%	23.30%	49%
2373	2000197	2.58	1.39	4.55	56.70%	30.60%	54%
2482	2000199	1.54	0.74	3.15	48.80%	23.60%	48%
2484	2000197	0.07	0.05	0.12	63.30%	42.70%	68%
2485	2000206	0.14	0.06	0.7	20.00%	9.10%	45%
2370G	2000205	2.9	1.37	5.78	50.20%	23.80%	47%
Overland	-	8.33	2.21	53.94	15.40%	4.10%	27%
Watershed in Framingham	-	40.09	16.00	148.71	27.0%	10.8%	40%

Note: Percent Connectivity is the percent of total impervious area which is connected.

According to the Town of Ashland's Phosphorus Source Identification Report, Ashland has 45 regulated outfalls within the Waushakum Pond watershed, 3 of which discharge directly to Waushakum Pond. A similar method to that of Framingham was used in Ashland to calculate the TIA and DCIA. The Ashland portion of the Waushakum Pond watershed has a TIA of 29.9% (84.3 acres) and a DCIA of 15.8% (44.4 acres). Appendix C presents impervious area and DCIA statistics for each catchment within Ashland, as presented by the Town of Ashland.

Many studies have been published in the past 15 years discussing the relationship between urban, impervious land cover and waterbody hydrology, habitat, biology, and ecosystem function. These studies have more recently included correlations between DCIA and biological indicators such as fish assemblages and algal blooms. Watersheds with as low as 4-6% IA and 1-5% DCIA typically begin to show water quality impacts. The DCIA within the Waushakum Pond watershed in Framingham is about 11%, which means that the water quality of Waushakum Pond can be expected to show signs of degradation. While the DCIA in the Waushakum Pond drainage area exceeds this threshold, the calculated range of percent DCIA is expected for municipalities like Framingham.

6. Pollutant Loading



Eutrophication is the gradual process of nutrient enrichment and accumulation of plants and sediments in aquatic ecosystems that results in increased biological productivity and decreased depth. Nutrients such as phosphorus and nitrogen can stimulate abundant growth of algae and rooted plants in water bodies. Over time, this enhanced plant growth leads to reduced dissolved oxygen in the water, as plant material decomposes and consumes oxygen. There are numerous natural and anthropogenic sources for phosphorus and nitrogen, but this process is often accelerated by human activities in the watershed, such as application of fertilizers and failing septic systems.

The presence of sediments in stormwater runoff that discharges to waterbodies also contributes to accelerated eutrophication. Land development not only increases the sources of nutrients, but also decreases opportunities for natural uptake before they can reach a water body. Phosphorus is typically the "limiting nutrient" for freshwater lakes, which means that plant productivity is most often controlled by the supply of this nutrient. As such, increases in phosphorus load in a lake watershed are closely correlated with increases in plant productivity and accelerated eutrophication. Therefore, it is important to reduce the amount of phosphorus that enters watersheds to prevent the acceleration of eutrophication and damage to the receiving waters.

A pollutant loading analysis was conducted to better understand the amount of stormwater pollution entering Lake Waushakum from the watershed and contributing to eutrophication. Geographic Information Systems (GIS) was used for the pollutant loading analysis. Land use data (MassGIS, 2009b) was intersected with impervious cover data (MassGIS, 2009a) and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils data (USDA NRCS and MassGIS, 2012) to create a combined land use/land cover grid. The grid was used to sum the total area of each unique land use/land cover type.

The amount of DCIA for each land use was estimated using the Sutherland equations as described above. Disconnected impervious area, or the difference between TIA and DCIA, was modeled as pervious area in Hydrologic Soil Group (HSG) D for that land use to simulate that some infiltration will likely occur after runoff from disconnected impervious surfaces passes over pervious surfaces.

Pollutant loading for key nonpoint source pollutants in the watershed was estimated by multiplying each land use/cover type area by its pollutant load export rate (PLER) as follows:

$$L_n = A_n * P_n$$

Where L_n = Loading of land use/cover type n (lb/yr); A_n = area of land use/cover type n (acres); P_n = pollutant load export rate of land use/cover type n (lb/acre/yr)

The PLERs are an estimate of the annual total pollutant load exported via stormwater from a given unit area of a particular land cover type. The PLER values for TN, TP and TSS were obtained from USEPA (USEPA, 2020; UNHSC, 2018, Tetra Tech, 2015) (see values provided in Appendix A). EPA has not provided PLERs for bacteria to-date, therefore no estimate of bacteria loading in stormwater runoff was quantified as part of this analysis. Table A-12 presents the estimated land-use based TN, TP and TSS pollutant loading in the entire watershed.

Table A-12: Estimated Pollutant Loading for Key Nonpoint Source Pollutants

Land Use Type	Pollutant Loading[1]		
	Total Phosphorus (TP) (lbs/yr)	Total Nitrogen (TN) (lbs/yr)	Total Suspended Solids (TSS) (tons/yr)
Agriculture	0	0	0.00
Commercial	32	286	3.58
Forest	58	313	13.53
High Density Residential	93	600	9.09
Highway	0	0	0.00
Industrial	10	86	1.08
Low Density Residential	5	46	0.64
Medium Density Residential	137	1,151	16.15
Open Land	17	134	3.30
TOTAL	352	2,616	47.37

[1]These estimates do not consider loads from point sources or septic systems.

The land use type that is the biggest contributor to the TP, TN, and TSS loading in the Waushakum Pond watershed are medium density residential properties. Potential sources of phosphorus from this land use type include leaf litter, grass clippings, pet waste, and other sediment and debris that accumulates on roadways.

Pollutant Loading Analysis for Framingham Catchment Areas

The same procedure described above was performed at the stormwater catchment area scale to determine the phosphorus loading attributable to each of the 10 outfalls discharging to the pond in Framingham. The results of this analysis, which was originally performed as part of the Phosphorus Source Identification Report developed for the waterbody in accordance with MS4 Permit requirements, are included in Table A-13.

Table A-13: Phosphorus Loading Analysis in Framingham					
Catchment ID	Receiving Outfall	Catchment Area (Ac.)	DCIA (Ac.)	Disconnected IA (Ac.)	Catchment P Load (lbs/year)
2367	2000201	38.54	2.77	5.36	12.48
2372	2000204	9.71	2.27	2.36	5.7
2369	2012000	13.78	1.63	2.11	5.07
Overland	-	53.94	0.00*	8.33	4.29
2373	200197	4.55	1.39	1.19	3.52
2370G	2000205	5.78	1.37	1.52	3.34
2371	2006433	3.94	1.21	1.11	2.88
1003	2000006	3.26	1.12	0.49	2.24
2368	2000203	7.04	0.76	1.47	2.09
2482	2000199	3.15	0.74	0.79	1.77
2366	2000200	4.2	0.42	0.68	1.54
2485	2000206	0.7	0.06	0.08	0.37
2484	200197	0.12	0.05	0.02	0.11
Total	-	148.71	12.67	25.02	43.16
*Since runoff generated from impervious surfaces in the areas that contribute overland flow to Lake Waushakum is not collected by a storm sewer, it was considered disconnected impervious area and modeled as pervious land in HSG D.					

Table A-13 allows the City to identify those areas of the Waushakum Pond watershed that contribute higher phosphorus loads per year and should therefore be targeted for watershed management measures like stormwater retrofits and public education. While catchment 2367 has less high and medium-density residential land than most of the other catchments tributary to Waushakum Pond—and those residential uses have the highest PLERs—the significant amount of DCIA attributable to the parcel owned by the Congregation of the Sisters of St. Joseph and Bethany Road outweighs the lower PLER assigned to tax-exempt uses. Smaller catchments with fewer acres of DCIA and disconnected impervious area have lower potential phosphorus loads, even when a higher percent of the catchment area is covered with impervious surfaces. This analysis is validated by the pollutant hot spot map generated by the MassDEP watershed-based plan tool, which is included as Figure A-6, below. Parcels with higher hotspot scores contribute more stormwater pollution and are a higher priority for BMP retrofit.

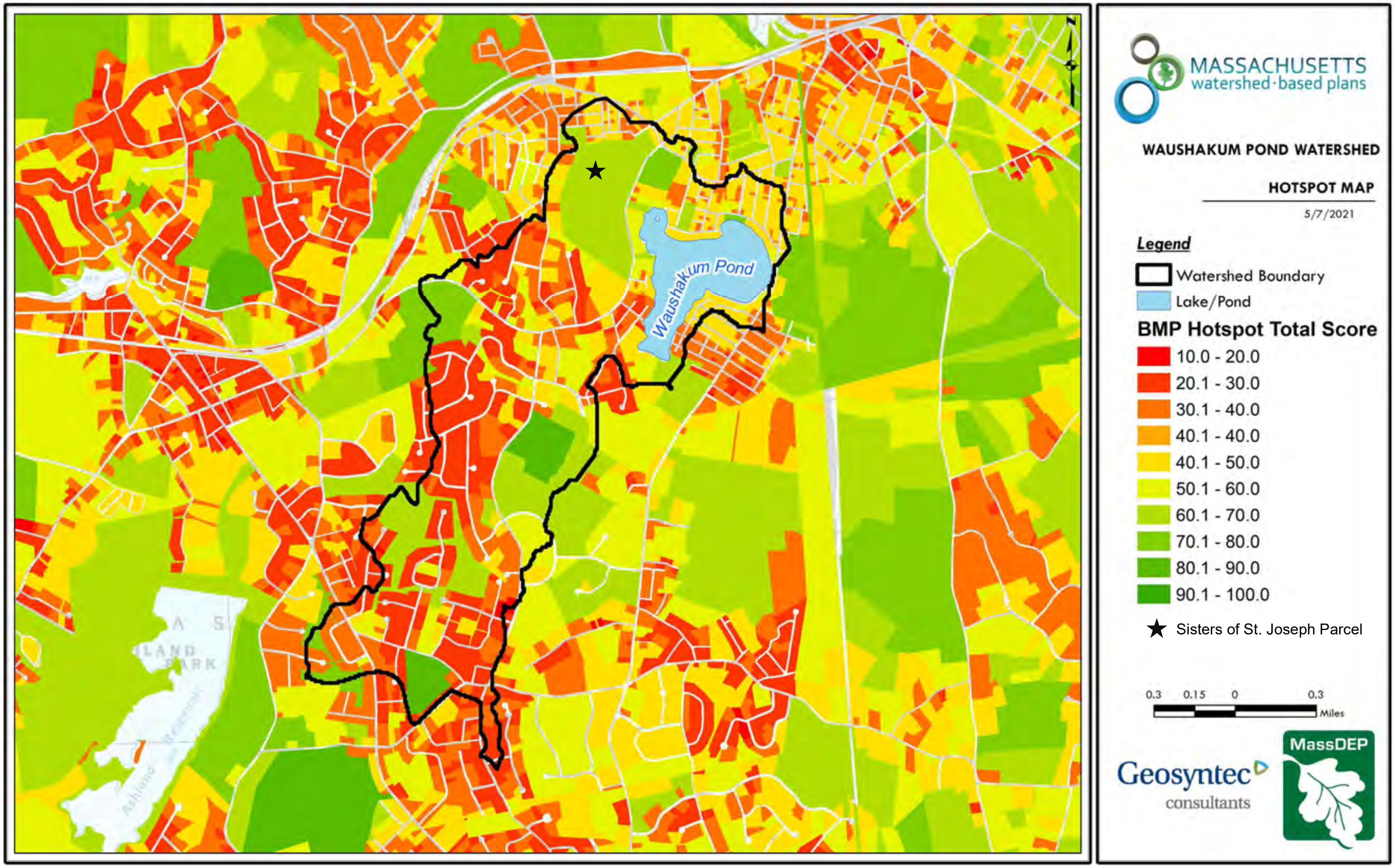


Figure A-6: Waushakum Pond Watershed Hotspot Map

In Ashland, mean concentrations of different pollutants commonly found in stormwater (nitrogen, phosphorus, total suspended solids, and fecal coliform) were calculated for different land uses as part of a Watershed Treatment Model. This model was used to identify areas contributing the most phosphorus to Lake Waushakum and presented results on a parcel or road scale rather than a catchment scale. Parcels or roads contributing the most phosphorus were prioritized for the installation of stormwater treatment BMPs. These areas included Henry Warren Elementary School, which is responsible for 2.58 lb/year of phosphorus loading, Williams Road & Wenzell Road, which contribute up to 7.03 lb/year of phosphorus loading, and Waushakum Ave, which contributes 0.89 lb/year of phosphorus loading to the pond.

Non-point source runoff is also a significant source of potential phosphorus loading to Waushakum Pond, as there are 53.94 acres of land around Waushakum Pond within Framingham city limits that contribute overland flow. Since there are so many residential properties abutting the shores of the lake, runoff is generated from impervious area on those properties and discharges overland to the lake. Soils in this area are all HSG A; however, it is unlikely that the soil will be able to infiltrate all the runoff that occurs. Some of that runoff is likely infiltrated by lawns on the property, but what does reach the lake has a relatively high potential phosphorus load based on any lawn care products and the amount of organic matter, such as leaf litter, grass clippings, soils, and dog waste that the runoff encounters. The estimated land-use based phosphorus load to Waushakum Pond in Framingham is 43.16 pounds per year, or about 12% of the total phosphorus load to Waushakum Pond.

A septic survey completed by the City of Framingham as part of the development of this plan indicated that many properties on Bethany Road, which is on the western edge of Waushakum Pond, have septic systems. There are an estimated 36 systems within the watershed in Framingham, 17 of which are on waterfront properties. Some of these systems are within the 100-year flood plain. The presence of these systems increases the potential phosphorus loading from non-point sources. There is an estimated 5.2 pounds per year phosphorus load from septic systems in the areas surrounding Waushakum Pond within Framingham. The number of septic systems in the Waushakum Pond watershed in Ashland was estimated to be 28, with an associated phosphorus loading of 1 lb/year. The exact number and location of septic systems in Ashland is unknown. A map showing the location of septic systems around Waushakum Pond is included in Figure A-7.

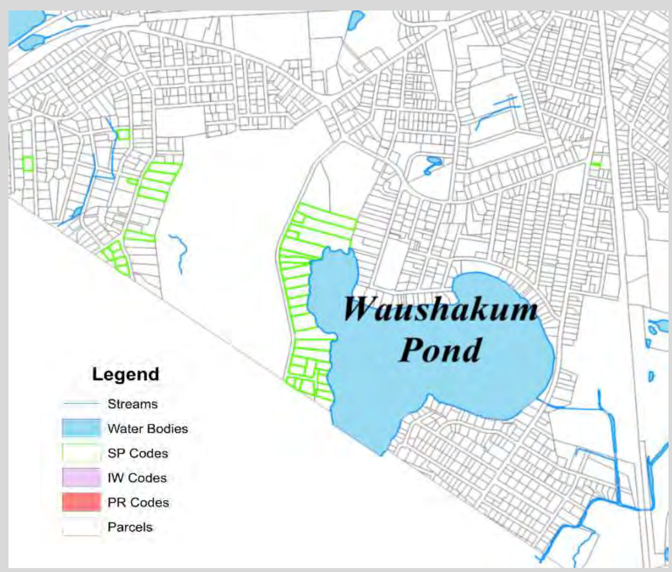


Figure A-7: Septic Systems around Waushakum Pond in Framingham

Element B: Determine Pollutant Load Reductions Needed to Achieve Water Quality Goals

Element B of your WBP should:
Determine the pollutant load reductions needed to achieve the water quality goals established in Element A. The water quality goals should incorporate Total Maximum Daily Load (TMDL) goals, when applicable. For impaired water bodies, a TMDL establishes pollutant loading limits as needed to attain water quality standards.

1. Estimated Pollutant Loads

Table B-1 lists estimated pollutant loads in Waushakum Pond for the following primary nonpoint source (NPS) pollutants: total phosphorus (TP), total nitrogen (TN), total suspended solids (TSS). These estimated loads are based on the pollutant loading analysis presented in Section 4 of Element A.

2. Water Quality Goals

Water quality goals for primary NPS pollutants are listed in Table B-1 based on the following:

- TMDL water quality goals (if a TMDL exists for the water body);
- For all water bodies, including impaired waters that have a pathogen TMDL, the water quality goal for bacteria is based on the Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) that apply to the Water Class of the selected water body.
- If the water body does not have a TMDL for TP, a default target TP concentration is provided which is based on guidance provided by the USEPA in Quality Criteria for Water (1986), also known as the "Gold Book". Because there are no similar default water quality goals for TN and TSS, goals for these pollutants are provided in Table B-1 only if a TMDL exists or alternate goal(s) have been optionally established by the WBP author. Goals for TSS are based on the MA Surface Water Quality Standards.
- According to the USEPA Gold Book, total phosphorus should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir. The water quality loading goal was estimated by multiplying this target maximum phosphorus concentration (50 ug/L) by the estimated annual watershed discharge for the selected water body. To estimate the annual watershed discharge, the mean flow was used, which was estimated based on United States Geological Survey (USGS) "Runoff Depth" estimates for Massachusetts (Cohen and Randall, 1998). Cohen and Randall (1998) provide statewide estimates of annual Precipitation (P), Evapotranspiration (ET), and Runoff (R) depths for the northeastern U.S. According to their method, Runoff Depth (R) is

defined as all water reaching a discharge point (including surface and groundwater), and is calculated by:

$$P - ET = R$$

A mean Runoff Depth *R* was determined for the watershed by calculating the average value of R within the watershed boundary. This method includes the following assumptions/limitations:

a. For lakes and ponds, the estimate of annual TP loading is averaged across the entire watershed. However, a given lake or reservoir may have multiple tributary streams, and each stream may drain land with vastly different characteristics. For example, one tributary may drain a highly developed residential area, while a second tributary may drain primarily forested and undeveloped land. In this case, one tributary may exhibit much higher phosphorus concentrations than the average of all streams in the selected watershed.

b. The estimated existing loading value only accounts for phosphorus due to stormwater runoff. Other sources of phosphorus may be relevant, particularly phosphorus from on-site wastewater treatment (septic systems) within close proximity to receiving waters. Phosphorus does not typically travel far within an aquifer, but in watersheds that are primarily unsewered, septic systems and other similar groundwater-related sources may contribute a significant load of phosphorus that is not captured in this analysis. As such, it is important to consider the estimated TP loading as "the expected TP loading from stormwater sources."

c. If the calculated water quality goal is higher than the existing estimated total load; the water quality goal is automatically set equal to the existing estimated total load.

Table B-1: Pollutant Load Reductions Needed for Lake Waushakum			
Pollutant	Existing Estimated Total Load	Water Quality Goal	Required Load Reduction
Total Phosphorus	352 lbs/yr	293 lbs/yr	58 lbs/yr
Total Nitrogen	2617 lbs/yr	-	-
Total Suspended Solids	47 tons/yr	Class B Standards: Waters shall be free from floating, suspended, and settleable solids in concentrations and combinations that would	-

Table B-1: Pollutant Load Reductions Needed for Lake Waushakum			
Pollutant	Existing Estimated Total Load	Water Quality Goal	Required Load Reduction
		impair any use assigned to this Class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.	
Bacteria	*MSWQS for bacteria are concentration standards (e.g., colonies of fecal coliform bacteria per 100 ml), which are difficult to predict based on estimated annual loading.*	Class B. Class B Standards • Public Bathing Beaches: For E. coli, geometric mean of all recent samples collected within a 90-day window shall not exceed 126 colonies (CFU)/ 100 mL and no more than 10% of all such samples shall exceed 410 CFU/100 mL. For enterococci, geometric mean of samples collected in a 90-day period shall not exceed 35 CFU/100 mL and no more than 10% of such samples shall exceed 130 CFU/100 mL. Geometric means and statistical threshold values shall be calculated and reassessed ever 30 days at a minimum for public bathing beaches. .	

3. Pollutant Load Reduction Information

There are currently no TMDL Pollutant Load Criteria established for Waushakum Pond at the time of the writing of this WBP.

The existing phosphorus load to Waushakum Pond from the entire drainage area is estimated at 352 pounds per year by the WBP Tool. The existing phosphorus load to Waushakum Pond from Framingham is estimated at 48.4 pounds per year, of which 43.16 pounds comes from catchment areas that discharge to Waushakum Pond via Framingham's drainage system. The phosphorus loading from Ashland is estimated at 303.6 pounds per year. To improve water quality, a long-term reduction of overall watershed annual phosphorus loading of 58 pounds by 2050 is proposed to approach oligotrophic conditions (approximately a 17% overall reduction). The responsibility for meeting this phosphorus reduction goal is divided between Ashland and Framingham—since Framingham contributes 48.4 lb/year of phosphorus, or 14% of the total annual phosphorus loading, to the waterbody, the City is responsible for meeting 14% of the overall reduction goal. Framingham must therefore reduce its annual phosphorus loading to Lake Waushakum by at least 8.12 pounds per year, which will be rounded to 8.5 for planning purposes. Ashland is responsible for meeting the remaining 49.88 pounds per year of phosphorus reduction. A breakdown of existing phosphorus loading and required reductions between the communities is included in Table B-2.

Table B-2: Current Phosphorus Loading and Required Phosphorus Reduction to Lake Waushakum from Framingham and Ashland

Community	Total Area in Watershed (ac.)	Total Area in Watershed (%)	Existing Phosphorus Loading (lb/year)	Existing Phosphorus Loading (% of total)	Minimum Required Phosphorus Reduction (lb/year)	Minimum Required Phosphorus Reduction (% of existing loading)
Framingham	281	27%	48.4	14%	8.12	17%
Ashland	752	73%	303.6	86%	49.88	17%
Total	1,033	100%	352	100%	58	17%

In addition, the following adaptive sequence is recommended to improve and track load reduction goals:

1. Establish a long-term and interim phosphorus load reduction goal. Establish a baseline monitoring program in accordance with Element I.
2. Based on the annual monitoring data, re-evaluate long-term reduction goal and establish a realistic 3-year interim load reduction goal.
3. Re-evaluate long-term and interim goals at least once every 3 years and adaptively adjust based on future monitoring results.

Element C: Management Measures

Element C: A description of the nonpoint source management measures needed to achieve the pollutant load reductions presented in Element B, and a description of the critical areas where those measures will be needed to implement this plan.

In order for the City of Framingham to meet its phosphorus load reduction goal of 8.5 pounds per year, it is necessary for the City to implement several types of structural and nonstructural BMPs in varying locations. Catchment areas tributary to the City's drainage system with the highest potential phosphorus load are considered the highest priority to implement structural and nonstructural BMPs.

To identify higher priority catchments, a priority ranking matrix of the catchment areas tributary to Waushakum Pond in Framingham was created. While phosphorus is the driver of this WBP, implementation of structural and nonstructural BMPs will reduce concentrations of other pollutants of concern, like bacteria, in stormwater discharges to Waushakum Pond.

Catchments where no wet-weather flow was observed were determined to be lower priority, despite higher potential phosphorus load, since the lack of flow indicates that there is adequate storage in the system to prevent stormwater runoff from reaching Waushakum Pond during smaller storm events. Catchments contributing less than one pound per year of phosphorus were also determined to be lower priority. The catchment priority ranking matrix can be seen in Table C-1.

Table C-1: Framingham Catchment Priority Ranking by Phosphorus Loading

Rank	Catchment ID	Receiving Outfall	Catchment P Load (lb/year)	Total Phosphorus Sampling Result (mg/L)	Catchment Designation
1	2367	2000201	12.48	0.12	High Priority
2	2373 & 2484	2000197	3.64	0.077	High Priority
3	2370G	2000205	3.34	0.1	High Priority
4	2368	2000203	2.09	0.26	High Priority
5	2366	2000200	1.54	0.19	High Priority
6	2485	2000206	0.37	0.13	Low Priority
7	2369	2012000	5.07	0.09	Low Priority
8	2372	2000204	5.70	-	Low Priority
9	1003	2000006	2.24	-	Low Priority
10	2371	2006433	2.88	-	Low Priority
11	2482	2000199	1.77	-	Low Priority

Proposed Management Measures/BMP Recommendations
There are currently no structural BMPs in the portion of the watershed in Framingham. During Year 4 of the MS4 General Permit, the City of Framingham completed a Phosphorus Source Identification Report for the areas tributary to Waushakum Pond. In this report, five potential structural BMP and retrofit locations were identified and explored for the viability of their implementation. There are three detention basins within the Ashland portion of the Lake Waushakum watershed, though the amount of phosphorus removal attributable to those systems is unknown. Ashland's Phosphorus Source Identification Report also included five potential structural BMP retrofit locations.

Table C-2 presents the proposed management measures as well as the estimated pollutant load reductions and costs. The planning level cost estimates and pollutant load reduction estimates and estimates of BMP footprint were determined using information obtained from the following sources and were also adjusted to 2022 values using the Consumer Price Index (CPI) (United States Bureau of Labor Statistics, 2022):

- Geosyntec Consultants, Inc. (2014);
- Geosyntec Consultants, Inc. (2015);
- King and Hagen (2011);
- Leisenring, et al. (2014);
- King and Hagen (2011);
- MassDEP (2016a);
- MassDEP (2016b);
- University of Massachusetts, Amherst (2004);
- USEPA (2020);
- UNHSC (2018);
- Tetra Tech, Inc. (2015);

The design goal for the proposed BMPs would be to size the BMP to treat and infiltrate the water quality volume to the maximum extent practicable. The water quality volume is defined in the Massachusetts Stormwater Handbook as the volume equal to 0.5 inches of runoff times the total impervious area that drains to the BMP. Each proposed BMP should be designed to achieve the most treatment that is practical given the size and logistical constraints of the intended site.

Proposed Management Measures, Estimated Pollutant Load Reductions and Costs

Table C-2: Small Surface Structural BMPs					
BMP Type	Bioretention & Rain Garden	Bioretention & Rain Garden	Bioretention & Rain Garden	Bioretention & Rain Garden	Bioretention & Rain Garden
BMP Size (storm depth; inches)	1.5	1.5	1.5	1.5	1.5
Drainage Area (acres)	0.07	1	0.1	0.35	1.15
BMP Location	Intersection of Bethany Road & Barbieri Road	Berry St	#37 Cove Avenue (Anna Murphy Park)	#53 Cove Ave (Anna Murphy Park)	Nipmuc Road
Land Use, Cover Type (in drainage area)	Percent of Drainage Area				
Forest, Pervious	10	-	-	-	-
Industrial, Impervious (Roadway)	85	85	85	85	80
Low Density Residential, Impervious	5	-	-	-	-
Medium Density Residential, Pervious	-	6	8	5	15
Medium Density Residential, Impervious	-	9	5	3	3
Open Land, Pervious	-	-	2	7	1
Open Land, Impervious	-	-	-	-	1
Estimated Pollutant Load Reductions					
TN (lbs/yr)	0.78	11.60	1.12	3.84	12.05
TP (lbs/yr)	0.095	1.44	0.14	0.47	1.48
TSS (lbs/yr)	24.20	362.06	34.57	118.12	375.23
Estimated Footprint (sf)	185	2,740	265	910	2,890
Estimated Cost ($)	$4,100	$58,600	$5,900	$20,500	$67,400

Table C-3: Subsurface or Larger Structural BMPs			
BMP Type	Filterra Boxes (Tree Box Filters)	Bioretention System and Riparian Buffer	Wetland Maintenance
BMP Location	Gilbert St and Nipmuc Rd	54 Nipmuc Rd (Waushakum Beach)	180 Winthrop St
Description	The city is planning drainage improvements on Gilbert Street, which will include replacing existing pipe, installing deep sump catch basins and two Filterra boxes, which are proprietary tree box filters.	Installation of a bioretention system with specific plantings for P removal and a riparian buffer area to deter geese from congregating at the site, which will reduce phosphorus and bacteria loading from waterfowl.	Wetland restoration at Outfall 2012000 to ensure that phosphorus removal is maximized. Drainage in this area needs repair or reconfiguration and the easement requires maintenance.
Estimated Phosphorus Load Reductions	0.5-0.75 lb/year	3.34 lb/year	60-90% of catchment phosphorus loading (3.04 - 4.5 lb/year)
Estimated Cost ($)	$200,000-$265,000	$298,000	$1.12 million

Non-Structural BMPs		
BMP Type	Street Sweeping	Geese Deterrence Program
BMP Location	Around Waushakum Pond	Around Waushakum Pond
Description	Street sweeping. Some portions of catchment areas tributary to Waushakum Pond are swept once a month from May to November. The city should continue enhanced street sweeping in this area.	Continue program to deter geese population from congregating at Waushakum Beach, including use of decoys, scare tape, and other interventions.
Estimated Pollutant Load Reductions	1-2 lb/year	1-5 lb/year
Estimated Cost ($)	Included in current operations	Included in current operations

The proposed BMPs in Framingham will reduce the phosphorus loading into Waushakum Pond from stormwater inputs. However, these are not the only things that can be done to decrease the phosphorus loading. By utilizing public education campaigns and other nonstructural BMPs effectively, the baseline phosphorus loads can be reduced drastically. This is necessary to be able to meet the phosphorus load reduction goal of 58 pounds per year in the entire Waushakum Pond watershed, which will require collaboration with the Town of Ashland. The City of Framingham and the Town of Ashland will work together to explore the benefits of an intermunicipal agreement as part of implementation of this plan.

In Permit Year 6 (FY2024) of the MS4 General Permit, the City of Framingham will plan and install one of the retrofit projects identified as a demonstration project in the Waushakum Pond watershed. The remainder of the retrofit projects, where implementation is feasible from an engineering and permitting perspective, will be installed according to the schedule included in the Year 5 annual report. Future availability of funding will also be considered in developing the schedule. Framingham will track any structural BMPs installed in the watershed and calculate the estimate phosphorus removal attributable to those BMPs. The BMP type, area treated, design storage volume, and estimated phosphorus removed in pounds per year by each BMP will be included in the City's future MS4 annual reports and used to reassess this WBP.

Element D: Technical and Financial Assistance Needed

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

Table D-1 presents the funding needed to implement the management measures presented in this watershed plan. The table includes costs for structural and non-structural BMPs, operation and maintenance activities, information/education measures, and monitoring/evaluation activities. A combination of in-house resources and outside engineering services or other technical assistance will be utilized to complete the projects included in this plan.

Table D-1: Summary of Funding Needed to Implement the Watershed Plan			
Management Measures	Location	Capital Costs ($)	Annual Operation & Maintenance Costs ($)
Structural and Non-Structural BMPs (from Element C)			
Bioretention And Rain Gardens	Intersection of Bethany Road and Barbieri Road	$4,100	$1,500
Bioretention And Rain Gardens	Berry St	$58,600	$2,000
Bioretention And Rain Gardens	#37 Cove Ave	$20,000	$1,500
Bioretention And Rain Gardens	#53 Cove Ave	$5,900	$1,500
Bioretention And Rain Gardens	Nipmuc Road	$67,400	$2,000
Hydrodynamic Filterra Boxes and Stormwater System Improvements	Gilbert St and Nipmuc Rd	$265,000	$1,500
Bioretention system and riparian buffer combo	54 Nipmuc Rd (Waushakum Beach)	$298,000	$2,800
Wetland maintenance	180 Winthrop St	$1.12 million	$2,000
Information/Education (see Element E)			
Disseminating information to waterfront property owners	Waushakum Pond		$1,500
Implement storm drain stenciling program	Waushakum Pond		$2,500

Table D-1: Summary of Funding Needed to Implement the Watershed Plan			
Management Measures	Location	Capital Costs ($)	Annual Operation & Maintenance Costs ($)
Information/Education (see Element E)			
Implement signage around Waushakum Pond and constructed BMPs	Waushakum Pond	$2,000	$500
Monitoring and Evaluation (see Element H/I)			
Water Quality Monitoring	Waushakum Pond		$17,000
Vegetation Monitoring Studies	Waushakum Pond		$6,000
Vegetation Management Program	City Wide		$50,000
Total		$1,841,000	$92,300
Funding Sources:			
1. The City of Framingham's Capital/Operating Budget 2. American Rescue Plan Act (ARPA) 3. 319 Grant 4. Municipal Vulnerability Preparedness (MVP) Grant 5. Other grant programs as opportunities arise			

Element E: Public Information and Education

Element E: Information and Education (I/E) component of the watershed plan used to:

1. Enhance public understanding of the project; and
2. Encourage early and continued public participation in selecting, designing, and implementing the NPS management measures that will be implemented.

Step 1: Goals and Objectives

This section discusses the goals and objectives for the watershed information and education program, which include:

1. Provide information about sources of pollution to the public;
2. Provide information and generate public support regarding proposed improvements (such as stormwater infrastructure improvements and structural BMPs) and their anticipated water quality benefits;
3. Combining some public education efforts from MS4 permit requirements and other projects in the watershed to maximize efficacy;
4. Provide information to promote watershed stewardship in an easily accessible manner.

Step 2: Target Audience

The following are target audiences that need to be reached to meet the goals and objectives identified above:

1. All watershed residents, not just those with property along the shoreline;
2. Residents in areas tributary to Waushakum Pond that have septic systems;
3. Recreational users of Waushakum Pond public areas (boaters, beach-goers, etc.);
4. Citizen groups, environmental organizations, and other user groups (Waushakum Pond Lake Association, Keep Framingham Beautiful, Organization for the Assabet River (OARS), Framingham High School Environmental Club, SuAsCo Watershed Community Council, Coburnville-Tripoli Neighborhood Assocation, etc.);
5. Ashland Stormwater Advisory Committee;
6. Businesses within the watershed;
7. General public.

Step 3: Outreach Products and Distribution

Public information and education efforts can be used to enhance public understanding of lake and watershed management issues, such as control/prevention of non-native species and phosphorus loading reduction projects. Public information and education about lake management efforts can be provided via city and/or lake association websites, social media, print brochures, local newspaper articles, and other media.

The following outreach products and/or activities are anticipated:

- Flyers/social media posts encouraging the use of slow-release and phosphorus-free fertilizers
  - Examples that can be used:
    - Fertilizer poster (epa.gov)
    - Microsoft Word - 2.LawnCareResFactsheet.doc (uri.edu)
- Flyers/social media posts/bulletin messaging encouraging proper maintenance of septic systems
  - Example from Newbury, MA posted on ThinkBlue Massachusetts
- Flyers/social media posts/bulleting messaging/posters emphasizing the importance of increasing the health of the watershed's water quality and best ways to reduce phosphorus loading
- Posting the most recent version of the Waushakum Pond Watershed Based Plan to the City's website and periodically updating the website as the WBP is implemented (e.g., BMP construction, monitoring results, etc.)
- Website posts encouraging practices that reduce loading of phosphorus and other pollutants
  - The following links can also be posted on the City's website:
    - Massachusetts Nonpoint Source Pollution Management Manual - https://megamanual.geosyntec.com/npsmanual/
    - Innovative Land Planning Techniques – A Handbook for Sustainable Development - http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm
- Local student involvement in the stormwater projects (e.g., design, monitoring/sampling, plant surveys, etc.)
- Storm drain marking program to discourage dumping into Waushakum Pond and its receiving waters
- Informational signage to highlight BMPs that are installed throughout the watershed on public land
- Leaf litter cleanup/disposal days to make it easier for watershed residents to remove leaves during the fall and prevent them from entering the waterways
- Participation during public meetings regarding the watershed and its health and best practices for protecting Waushakum Pond's water quality
- Workshops for watershed residents providing educational information for residential-scale stormwater BMPs that can improve water quality
- Continued participation in the Central Massachusetts Regional Stormwater Coalition (CMRSWC)

The following distribution methods can be used:

- Flyers
  - Pass out flyers at city/neighborhood events
  - Mail out flyers to residents, making sure to target those who live in areas tributary to Waushakum Pond and especially those within the highest priority catchment areas
  - Tape up posters/flyers in visible locations around Waushakum Pond or onto watershed residents' front doors

- Post cards
    - Post cards with stormwater tips are available at City offices (Department of Public Works & City Clerk)
- Social Media Posts
    - Post online copies of flyers onto City-owned social media
    - Generate social media specific content regarding relevant information
- Website
    - Post relevant information under the City's Stormwater/DPW/home page
    - Post online versions of the flyers/bulleting messaging/social media postings on the City's website to allow for ease of access and greater outreach potential
- Bulletin Boards
    - Post information/posters at the Department of Public Works or on a bulletin board in relevant public areas (i.e. Waushakum Beach)
- Storm Drain Marking Program
    - The storm drain marking program can be implemented as part of a Boy/Girl Scout project or other community-based organization. The storm drain marking program has been initiated in the immediate vicinity of Waushakum Pond as part of the Lake Association's efforts to improve water quality and can be expanded to other groups. These groups will assist if markers need replacing.
- Adopt a Storm Drain Program
    - The City is hoping to join the "adopt a storm drain" program offered by the Central Massachusetts Regional Stormwater Coalition, which encourages residents to keep a drain in their neighborhood clear of leaves, trash, and other debris.
- Public Meetings
    - Information regarding watershed health can be integrated into any public meetings regarding projects occurring within the Waushakum Pond watershed, especially those relating to this WBP

Step 4: Evaluate Information/Education Program

The education program will be evaluated in the following ways:

- Flyers – Track number of flyers distributed to residents
- Post Cards – Track number distributed
- Social Media – Track number of social media post interactions
- Website – Track number of website views and clicks; Ensuring that the website is up to date and relevant
- Bulletin Boards – Ensure that the information is up to date
- Storm Drain Marking Program – Track number of markers placed
- Informational signage – Track number of BMPs with signage
- Overall – Take water quality measurements and determine if a statistically significant difference in the sampling results from the baseline monitoring results begins to appear throughout the public education campaign and BMP implementation process

Other Information

The public education and information campaign above are not the only ways that the public can be involved and informed about what is going on in the Waushakum Pond watershed. The City of Framingham and Town of Ashland are dedicated to involving their residents and community members in such projects as those undertaking stormwater and climate resiliency efforts, especially those around Waushakum Pond.

For example, the City of Framingham has been involved in several public engagement projects regarding climate change and environmental justice efforts, including:

- The MetroWest Climate Equity Project: sponsored by the Metropolitan Area Planning Council (MAPC) and the Municipal Vulnerability Preparedness (MVP) program (Metro West Climate Equity – MAPC)
    - This project revolves around empowering communities and learning from those who may be disproportionally impacted by the effects of climate change. The City of Framingham has been working with numerous community organizations as project partners, such as the Coburnville-Tripoli Neighborhood Association, Waushakum Pond Association, Downtown Framingham, Inc., Framingham Parks & Recreation, and Framingham High School Environmental Awareness Club, among other key players, to assist with the success of the project. In doing so, the community members have engaged several key players in local communities empowering them to help the City take action and care for the areas in which they live. The City has been gathering information from the public on aspects regarding design and improving climate resiliency at Waushakum Beach and has hosted an "adventure day" in the summer months. The Framingham High School Environmental Awareness Club has been instrumental throughout the project's timeline, assisting with a City-wide tree planting project and making surveys for collecting feedback on heat waves and beach improvements from the public.
- SuAsCo Natural Climate Solutions: sponsored by the MVP program and the joint efforts of the Town of Hudson, Town of Natick, and City of Framingham (Natural Climate Solutions Project)
- Walnut Street Flood Mitigation Project: sponsored by the MVP program and the City of Framingham. (Walnut Street MVP Project)
    - This project includes a wetland restoration and boardwalk construction in the Walnut Street neighborhood, an area with environmental justice populations and a history of chronic flooding. The project includes engagement with the Framingham Environmental Club, Hoops & Homework Youth Program, and Council on Aging.
- Southeast Framingham Action Plan: sponsored by MAPC (Southeast Framingham Action Plan 2017-2024 – MAPC)
- "Voices of the Community": Sponsored by the City of Framingham (Voices of the Community: Innovation through Listening in South Framingham - Metrowest Health Foundation (mwhealth.org))
- "Protecting Our Water, Protecting Our Community": sponsored by the Framingham DPW and schools. (Protecting Our Water, Protecting Our Community)
- Information regarding the planned improvements at Waushakum Beach have already been posted to the City's website at Waushakum Beach Improvements | City of Framingham, MA Official Website (framinghamma.gov).

- Notification letters have been distributed to affected residents whenever sampling work is being performed that requires traversing on homeowners' property
- Public meetings are held to garner public input on stormwater improvement projects when possible

Elements F & G: Implementation Schedule and Measurable Milestones

Element F: Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

Element G: A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

Table FG-1 presents an implementation schedule and interim measurable milestones for the watershed-based plan. As this plan has been developed for the City of Framingham, Table FG-1 only includes activities to be undertaken by the City with the intent to meet their portion of the anticipated phosphorus reduction requirement of 8.5 lb/year. Implementation of structural BMPs has been included through 2028— projects further in the future will be added to Table FG-1 in WBP updates as project plans, designs, and funding sources become more detailed.

Table FG-1: Implementation Schedule and Interim Measurable Milestones

Category	Action	Year	Completed
Monitoring/Vegetation	Perform baseline water quality analysis	2021	Yes
	Perform annual water quality sampling per Element H&I monitoring guidance.	Annual	-
	Establish interim 3-year phosphorus reduction goal based on baseline monitoring results	2028	
	Perform aquatic vegetation monitoring and control (per existing program)	Annual	-
Structural BMPs to be installed through first Implementation Phase (2023-2028)	Evaluate and obtain funding sources (e.g., s.319 DEP Grant Funding)	Annual	
	Perform individual BMP feasibility studies in Framingham and Ashland as part of their respective PSIR Implementation Plans (MS4 Permit Requirement)	2023	
	Complete Construction of Gilbert Street Drainage Repair Project with Green Infrastructure	2023	
	Complete Construction of Waushakum Beach Bioretention System (Preliminary Design Completed 2021, Funding Allocated 2022-2023)	2025	
	Reassess potential implementation of additional recommended structural BMPs	2024	
	Complete construction of one small surface structural BMP within Framingham portion of the watershed	2027	
	Track implemented BMPs and their potential pollutant removals, including BMPs above and beyond Element C of this WBP (e.g., required subdivision BMPs, etc.)	Ongoing	-

Table FG-1: Implementation Schedule and Interim Measurable Milestones			
Category	Action	Year	Completed
Non-structural BMPs	Perform non-structural BMP assessment for Framingham (street sweeping, catch basin cleaning, etc.) and document potential pollutant removals	2024	
	Work with the Town of Ashland to explore benefits of an intermunicipal agreement	Ongoing	
	Implement non-structural BMP practices consistently throughout watershed	2025/Annually	
Public Education and Outreach	Post completed WBP to websites and perform periodic updates	2022 / Bi-Annual	
	Develop a Public Education brochure and distribute to target audience	2023	
	Implement storm drain marking program	2022	Yes
	Increase signage around Waushakum Pond	2025	
	Implement information signage on installed BMPs	As Completed	
	Participate in community events related to project subject matter (FSU Science on State Street, City of Framingham Earth Day Festival)	2023/ As appropriate	
Adaptive Management and Plan Updates	Provide project updates to City Commissions (Parks and Recreation, Sustainability, Disability, Conservation Commission) at regular commission meetings	2023/ As appropriate	
	Re-evaluate Watershed Based Plan at least once every three (3) years and adjust, as needed, based on ongoing efforts (e.g., based on monitoring results, 319 funding, etc.)	2025	
	Reach Interim Framingham Phosphorous Load Reduction Goal (4 lb/yr)	2028	
	Reach Long-Term Framingham Phosphorus Load Reduction Goal (8.5 lb/yr)	2050	

Elements H & I: Progress Evaluation Criteria and Monitoring

Element H: A set of criteria used to determine (1) if loading reductions are being achieved over time and (2) if progress is being made toward attaining water quality goals. Element H asks "**how will you know if you are making progress towards water quality goals?**" The criteria established to track progress can be direct measurements (e.g., E. coli bacteria concentrations) or indirect indicators of load reduction (e.g., number of beach closings related to bacteria).

Element I: A monitoring component to evaluate the effectiveness of implementation efforts over time, as measured against the Element H criteria. Element I asks "**how, when, and where will you conduct monitoring?**"

The water quality target concentration(s) is presented under Element A of this plan. To achieve target phosphorus concentrations, the overall annual phosphorus loading must be reduced by 58 pounds per year. Element C of this plan describes the various management measures that will be implemented to achieve this targeted load reduction. The evaluation criteria and monitoring program described below will be used to measure the effectiveness of the proposed management measures (described in Element C) in improving the water quality of Waushakum Pond.

Indirect Indicators of Load Reduction

Waushakum Beach has had to close numerous times in recent years due to bacteria counts exceeding safe levels for swimming areas during routine water quality testing, impeding the public's enjoyment of the pond. The number and duration of beach closures due to bacteria will be tracked to better understand the timing of such occurrences and potentially isolate their cause/timing. Ideally, a reduction in beach closures would be measured. This measurement will assist in monitoring the progress made towards reducing bacteria counts within Waushakum Pond.

Reduced aquatic plant growth is another indirect indicator of phosphorus load reduction within the pond. Currently, there are two visual plant surveys being performed, one during pre-season (spring) and one during mid-season (summer). Continuing this practice will help determine if excess plant growth slows as the WBP is implemented, testing the efficacy of these management methods.

As previously discussed, nuisance algae and vegetation are managed on an as-needed basis and are monitored annually to track progress. Annual monitoring will be continued and used as a metric for understanding water quality trends in response to implementation of measures recommended as part of this WBP.

Project-Specific Indicators

Nonstructural BMPs:

Specifics regarding public education programs should be measured to track progress of the campaign throughout the watershed. The number of flyers and other methods of information distribution should be tracked to determine if the current campaign is effectively reducing the phosphorus loads to Waushakum Pond.

Geese and other animal populations present around the Waushakum Pond watershed should continue to be monitored before implementation of any preventative measures to obtain a baseline population estimate. Local birdwatching groups or residents with property on the shoreline, like the Lake Waushakum Lake Association, are an effective resource to consult with for this task. The populations should continue to be monitored throughout the implementation of the WBP to determine if there are any reductions in geese and other animal populations. Reductions in these populations would lead to a reduction in phosphorus loading to Waushakum Pond. The phosphorus load reduction could be estimated based on the number of geese typically seen on and around the pond during the year and an estimation of the phosphorus loading that one goose contributes.

Element C of this WBP recommends that an assessment of non-structural BMPs be performed to document potential additional pollutant removals. Ongoing and additional non-structural BMP practices that are initiated as part of this assessment can be included as indirect indicators of load reduction (for example, street sweeping and catch basin cleaning). The number of miles that are swept and the amount of debris removed during catch basin cleanings within the watershed area are already being tracked and reported within the City's submission of their MS4 Annual Report. These measurements will assist in estimating the phosphorus load reductions associated with these nonstructural BMPs and during later re-evaluation of the WBP.

Structural BMPs:

Element C of this WBP recommends the installation of structural BMPs at multiple locations. The anticipated pollutant load reduction has been documented for each proposed BMP, where applicable. The number of BMPs that were installed will be tracked and quantified as part of this monitoring program, as well as the phosphorus reductions attributable to them once installed. After the successful implementation and monitoring of a structural BMP, the phosphorus load expectations for the watershed and the WBP can be adjusted accordingly with the actual load reductions from the estimated load reduction values.

It is also recommended that pollutant removals of any other BMPs that are implemented (above and beyond the Element C recommendations) be tracked and documented. This can include pre-existing BMPs and BMPs that are implemented as part of future development on private property.

TMDL Criteria

There is no approved TMDL for Waushakum Pond. However, monitoring by DEP staff continue on a regular basis according to the five-year watershed cycle. Completed baseline surveys on the pond include Secchi disk transparency, nutrient analyses, temperature and oxygen profiles and aquatic vegetation maps of distribution and density. Additional surveys and management activities to monitor pond health and water quality will be continued on an annual basis. The effectiveness in reducing plant cover and reducing total phosphorus concentrations can be re-evaluated with this new data as needed. Additional monitoring by volunteer groups is encouraged.

Direct Measurements

The City of Framingham already has an in-lake monitoring program to collect baseline data for the water quality of Waushakum Pond. The City will continue to fund the in-lake monitoring program to monitor the progress of the implementation of the WBP. Currently, the program conducts visual surveys of plant populations, and collects samples and tests for phosphorus, pH, nitrogen, turbidity, alkalinity, actual color, and apparent color, among other common water quality parameters. The pond is sampled at the water's surface of the mid-pond station and 20 ft below the surface of the mid-pond. It is sampled once a year during the summer months. In-lake phosphorus measurements will provide the most direct means of evaluating the effects of the measures in the plan which have been proposed specifically to reduce phosphorus loading. Ensuring that the same tests are ran annually will help to best compare the baseline results from the City's in-lake monitoring program to the results after the implementation of this WBP.

Because Waushakum Pond is stratified, regular monitoring of phosphorus levels from a profile (samples from the epilimnion, metalimnion and hypolimnion) at the proposed monitoring locations is recommended to provide accurate data on overall phosphorus concentration trends in response to implementation of the measures described in Element C.

Waushakum Pond is also sampled for E. Coli as part of the in-lake monitoring program and weekly throughout the swimming season. The City of Framingham will continue performing these bacteria sampling events at Waushakum Beach and track bacteria counts as they relate to the water quality standards summarized in Element B, Section 2. The percentage of the sampling season that the beaches are closed (i.e., the number of days closed / the number of days open) will be tracked and evaluated for the changes in the bacteria counts over time.

Results from monitoring data can be used to reassess the loading reduction estimations and adjust the WBP management strategies accordingly.

Adaptive Management

The monitoring data will be reassessed every three years to determine if the expected phosphorus load reductions are occurring as predicted through the implementation of the suggested BMPs within this WBP. The following adaptive sequence is recommended to improve and track load reduction goals:

1. Establish long term phosphorus loading reduction goals. Establish a baseline monitoring program in accordance with Element I.
2. Based on monitoring data, re-evaluate progress on long-term reduction goals and establish a realistic 3-year interim load reduction goal.
3. Re-evaluate progress on long-term and interim goals at least once every 3 years and adjust based on additional monitoring results.

If interim targets are not met and water quality data does not begin to show improvements in the phosphorus concentrations after 2 years of implementation of each structural BMP, then the goals and targets will be reassessed. The remaining proposed structural BMP methods will also be revisited to determine if there is another, more efficient way to reduce phosphorus concentration.

As discussed by Section 3 of Element B, the baseline monitoring program (recommended Options 1 and 2) will be used to establish a 3-year interim phosphorus load reduction goal, and to re-evaluate the long-term reduction goal. The interim and long-term goals will be re-evaluated at least once every three years and adaptively adjusted based on future refinements to the model, additional monitoring results, and other indirect indicators. If monitoring results and indirect indicators do not show improvement to the total phosphorus concentrations measured within Waushakum Pond, the management measures and loading reduction analysis (Elements A through D) will be revisited and modified accordingly.

References

314 CMR 4.00 (2013). "*Division of Water Pollution Control, Massachusetts Surface Water Quality Standards*"

ArcGIS (2020a). "*USA Soils Hydrologic Group*" Imagery Layer

ArcGIS (2020b). "*USA Soils Water Table Depth*" Imagery Layer

Aquatic Control Technology. (2008). *"Year-End Report for the 2008 Aquatic Management Program at the Framingham Ponds."*

Aquatic Control Technology. (2009). *"Year-End Report for the 2009 Aquatic Management Program at the Framingham Ponds."*

Aquatic Control Technology. (2014). *"Year-End Report for the 2014 Aquatic Management Program at the Framingham Ponds."*

Aquatic Control Technology. (2015). *"Year-End Report for the 2015 Aquatic Management Program at the Framingham Ponds."*

Aquatic Control Technology. (2015). *"2015 Proposal for Aquatic Management Program at Waushakum Pond."*

Cohen, A. J.; Randall, A.D. (1998). "*Mean annual runoff, precipitation, and evapotranspiration in the glaciated northeastern United States, 1951-80.*" Prepared for United States Geological Survey, Reston VA.

Davis, D.; Massachusetts Department of Environmental Protection. (2013). *"Concord River Watershed 2006 DWM Water Quality Monitoring Data."*

Environmental Science Services, Inc. (2001). *"Diagnostic/Feasibility Study for Waushakum Pond."*

Framingham DPW. (2020). *"Catchment Delineations within Framingham."*

Framingham DPW. (2021). *"Outfall investigations, site visits, and Best Management Practices (BMP) recommendations for the City of Framingham."*

Framingham Health Department. (2021). " Bacteria Monitoring Data for Waushakum Beach."

Fuss & O'Neill. (2021). *"Phosphorus Source Identification Report for the Town of Ashland, MA."*

Geosyntec Consultants, Inc. (2014). "*Least Cost Mix of BMPs Analysis, Evaluation of Stormwater Standards Contract No. EP-C-08-002, Task Order 2010-12.*" Prepared for Jesse W. Pritts, Task Order Manager, U.S. Environmental Protection Agency

Geosyntec Consultants, Inc. (2015). "*Appendix B: Pollutant Load Modeling Report, Water Integration for the Squamscott-Exeter (WISE) River Watershed.*"

IEP, Inc. and Camp, Dresser and McKee, Inc. (1988). *"Waushakum Pond Diagnostic/Feasibility Study."*

King, D. and Hagan, P. (2011). "*Costs of Stormwater Management Practices in Maryland Counties.*" University of Maryland Center for Environmental Science Chesapeake Biological Laboratory. October 11, 2011.

Leisenring, M., Clary, J., and Hobson, P. (2014). "*International Stormwater Best Management Practices (BMP) Database Pollutant Category Statistical Summary Report: Solids, Bacteria, Nutrients and Metals.*" Geosyntec Consultants, Inc. and Wright Water Engineers, Inc. December 2014.

MA Department of Revenue Division of Local Services (2016). "*Property Type Classification Codes, Non-arm's Length Codes and Sales Report Spreadsheet Specifications*" June 2016

MassDEP (2012). "*Massachusetts Year 2012 Integrated List of Waters Final Listing of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act*"

MassDEP (2016a). "*Massachusetts Clean Water Toolkit*"

MassDEP (2016b). "*Massachusetts Stormwater Handbook, Vol. 2, Ch. 2, Stormwater Best Management Practices*"

MassDEP (2019). "*Massachusetts Year 2016 Integrated List of Waters Final Listing of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act*" December 2019.

MassDEP (2022). "Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle." November 2021.

MassDEP and Geosyntec Consultants, Inc. "*Massachusetts Watershed Based Plans.*" Available at: WBP - Home (geosyntec.com)

MassGIS (1999). "*Networked Hydro Centerlines*" Shapefile

MassGIS (2001). "*USGS Topographic Quadrangle Images*" Image

MassGIS (2005). "*Elevation (Topographic) Data (2005)*" Digital Elevation Model

MassGIS (2007). "*Drainage Sub-basins*" Shapefile

MassGIS (2009a). "*Impervious Surface*" Image

MassGIS (2009b). "*Land Use (2005)*" Shapefile

MassGIS (2012). "*2010 U.S. Census Environmental Justice Populations*" Shapefile

MassGIS (2013). "*MassDEP 2012 Integrated List of Waters (305(b)/303(d))*" Shapefile

MassGIS (2015a). "*Fire Stations*" Shapefile

MassGIS (2015b). "*Police Stations*" Shapefile

MassGIS (2017a). "*Town and City Halls*" Layer

MassGIS (2017b). "*Libraries*" Layer

MassGIS (2020). "*Massachusetts Schools (Pre-K through High School)*" Datalayer

MassGIS (2021). "*Standardized Assessors' Parcels*" Mapping Data Set

Metcalf & Eddy. (1968). *"Master Plan for Additions and Improvements to Sewerage and Drainage Systems."*

Obropta, C.C. & Del Monaco, N. (2018). "Reducing Directly Connected Impervious Areas with Green Stormwater Infrastructure". *Journal of Sustainable Water in the Built Environment.* Available at: https://ascelibrary.org/doi/pdf/10.1061/JSWBAY.0000833

Open Space and Recreation Planning Committee, Department of Parks and Recreation, and the Department of Community and Economic Development. (2008). *"Framingham Open Space and Recreation Plan."*

Schueler, T.R., Fraley-McNeal, L, and K. Cappiella (2009). "*Is impervious cover still important? Review of recent research*" Journal of Hydrologic Engineering 14 (4): 309-315.

SEA Consultants Inc. (2006). "Supplemental Stormwater Services Summary Report."

SEA Consultants Inc. (2008). "Final Report Stormwater Management Plan for the Beaver Dam Brook and Farm Pond Drainage Sub-Basins."

SOLitude Lake Management. (2017). *"Year-End Report for the 2017 Aquatic Management Program at the Framingham Ponds."*

SOLitude Lake Management. (2018). *"Year-End Report for the 2018 Aquatic Management Program at the Framingham Ponds."*

SOLitude Lake Management. (2019). *"Framingham Ponds 2019 Aquatic Management Summary."*

SOLitude Lake Management. (2020). *"Framingham Ponds Year-End Report.*

SOLitude Lake Management. (2021). *"Framingham 2021 Aquatic Management Year-End Report."*

"*SuAsCo Watershed 2001 Water Quality Assessment Report, SUASCO WATERSHED LAKE ASSESSMENTS*"

Tetra Tech, Inc. (2015). "*Update of long-term runoff time series for various land uses in New England.*" Memorandum in Opti-Tool zip package. 20 November 2015. Available at: Opti-Tool: EPA Region 1's Stormwater Management Optimization Tool | US EPA

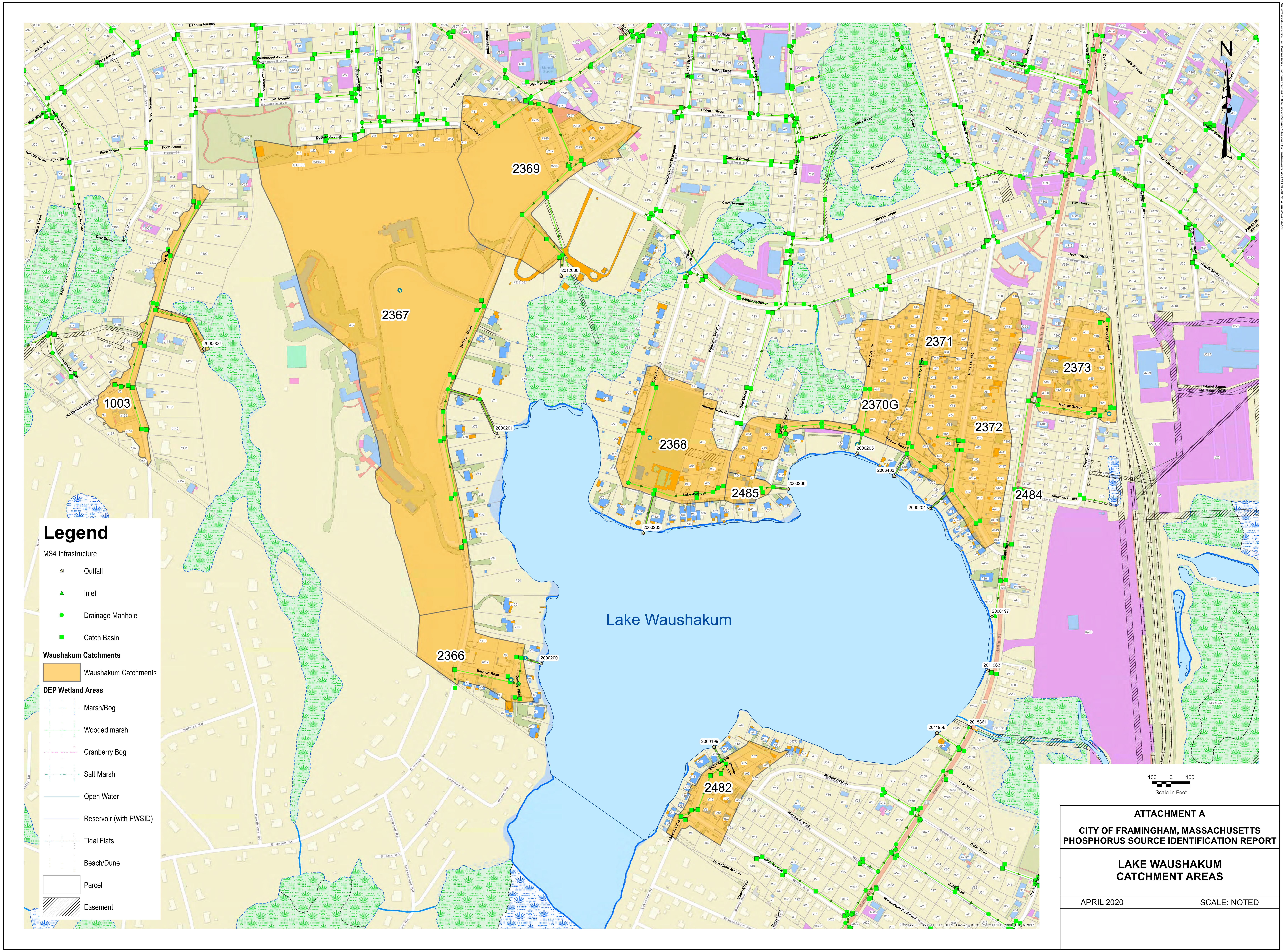
United States Bureau of Labor Statistics (2016). "*Consumer Price Index*"

United States Geological Survey (2016). "*National Hydrography Dataset, High Resolution Shapefile*"

University of Massachusetts, Amherst (2004). "*Stormwater Technologies Clearinghouse*"

Appendices

Appendix A - Lake Waushakum Catchment Areas in Framingham, MA



Appendix A - Lake Waushakum Catchments in Ashland, MA

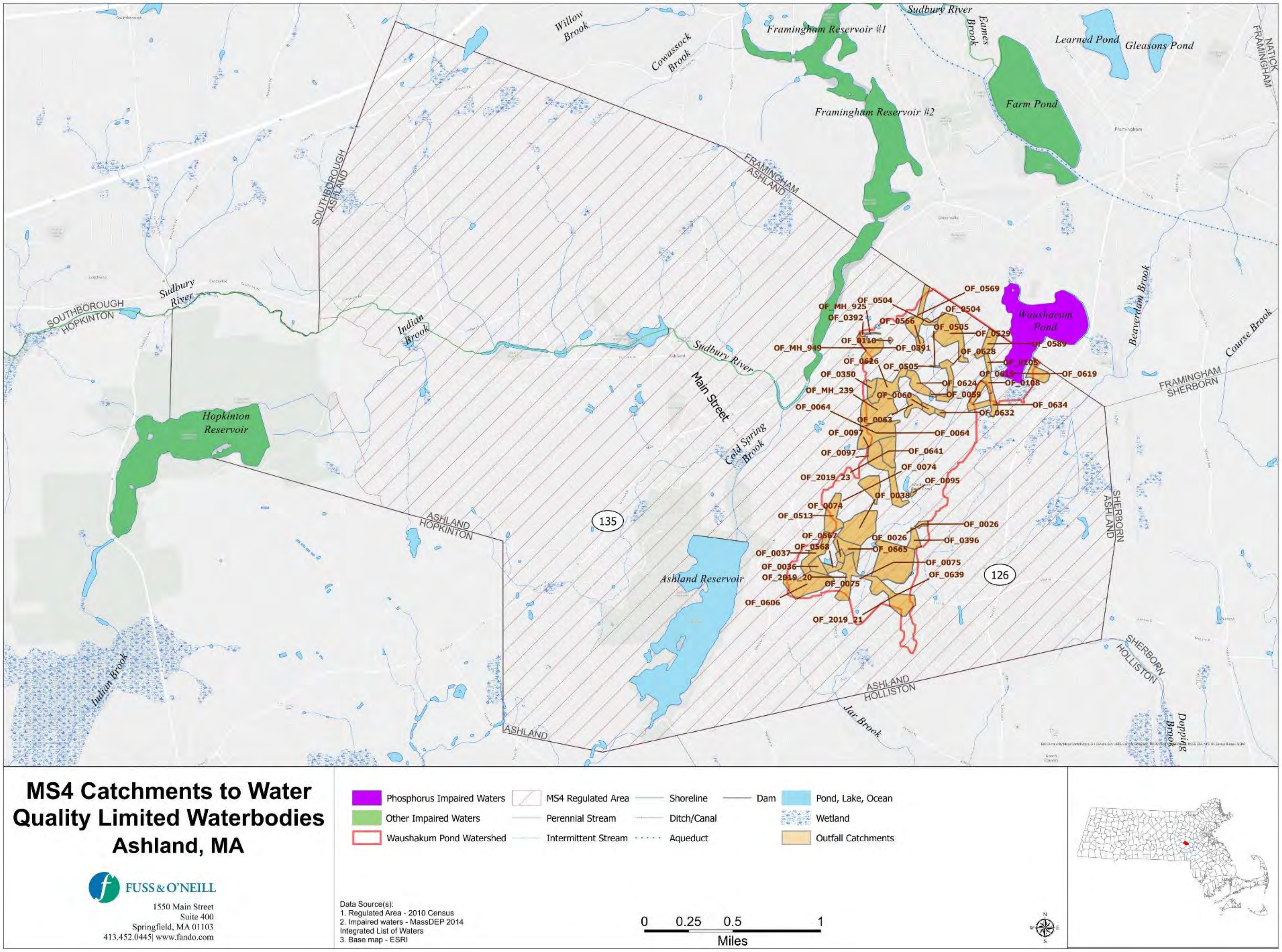
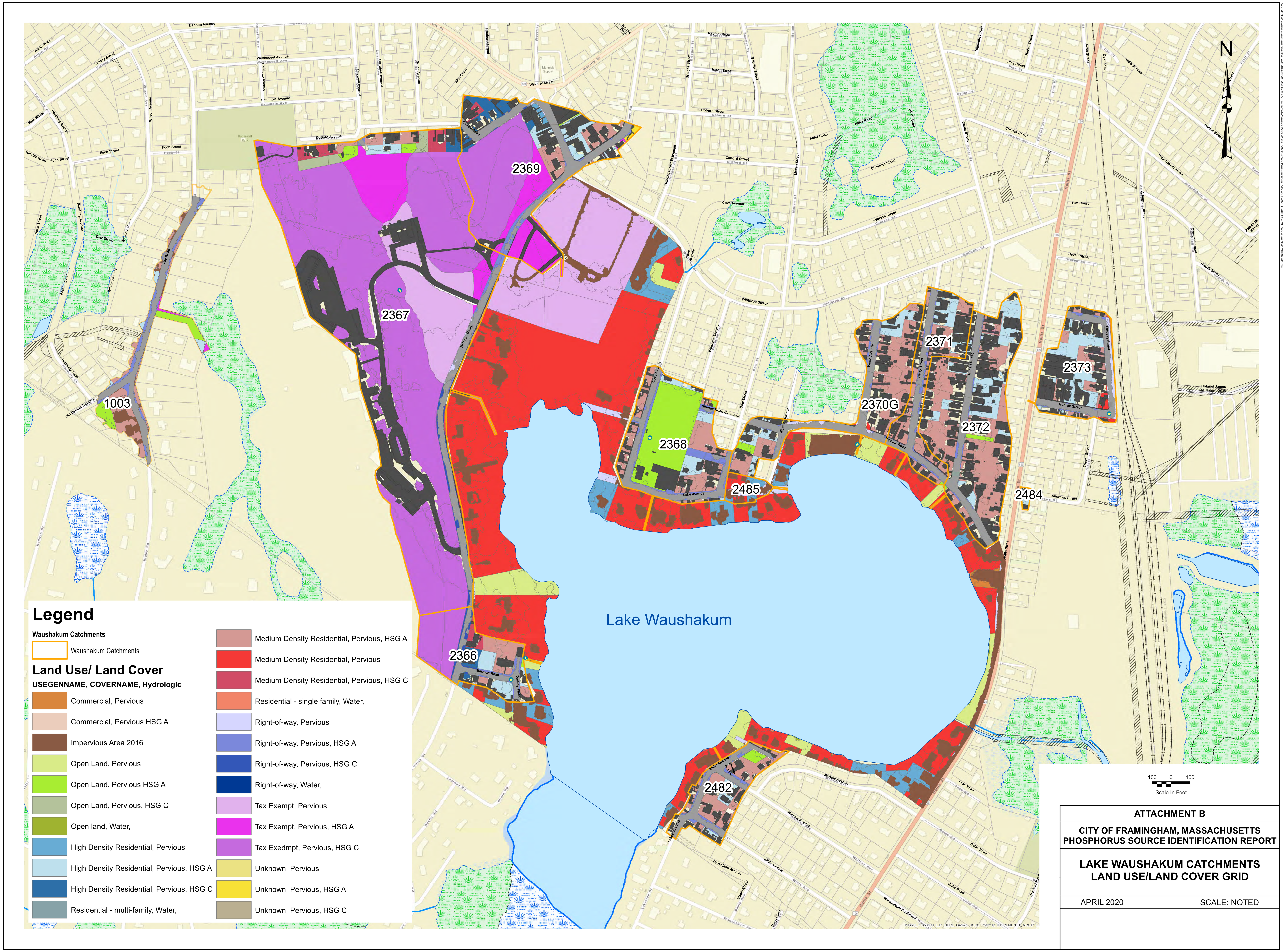


Figure 1: Phosphorus-Impaired Catchments and Water Quality Limited Waterbodies in the Town of Ashland

Appendix B - Land Use in Framingham Portion of Lake Waushakum Watershed



Appendix C - Land Use Pollutant Loadings in Ashland

Table 3 – Developed Land Uses
Event Mean Concentrations (TN, TP, TSS in mg/L and Fecal Coliform in MPN/100ml)

TN = Total Nitrogen   TP = Total Phosphorus   TSS = Total Suspended Solids   FC = Fecal Coliform

	WTM Default				MA DEP QAPP (BETA, 2006)				Selected for this Project			
Pollutant	TN	TP	TSS	FC	TN	TP	TSS	FC	TN	TP	TSS	FC
Low Density Residential	2.1	0.31	49	20,000	3.18	0.27	34	2,950	3.18	0.27	34	2,950
Medium Density Residential	2.1	0.31	49	20,000	3.5	0.41	49	12,360	3.5	0.41	49	12,360
High Density Residential	2.1	0.31	49	20,000	3.81	0.64	102	16,901	3.81	0.64	102	16,901
Highway	-	-	-	-	2.65	0.43	141	600	2.65	0.43	141	600
Commercial	2.1	0.22	43	20,000	1.85	0.15	44	9,306	1.85	0.15	44	9,306
Industrial	2.2	0.25	81	20,000	4	0.11	42	1,467	4	0.11	42	1,467
Urban Open	-	-	-	-	1.74	0.11	51	5,000	1.74	0.11	51	5,000

Appendix C - Land Use Pollutant Loadings in Ashland

Table 4 – Rural Land Uses

Annual Loads (TN, TP, and TSS in lb/ac/yr and Fecal Coliform in billion/ac/yr)

Source	WTM Default				MA DEP QAPP (BETA, 2006)				Selected				Comments
Pollutant	TN	TP	TSS	FC	TN	TP	TSS	FC	TN	TP	TSS	FC	
Forest	2.0	0.2	100	12	2.5	0.2	100	12	2.5	0.2	100	12	Selected regional TN value
Wetland	2.5	0.2	100	12	-	-	-	-	2.5	0.2	100	12	Selected WTM Default values
Rural	4.6	0.7	100	39	-	-	-	-	4.6	0.7	100	39	Selected WTM Default values
Pasture	5.0	0.75	100	39	1.9 (2); 7.7 (3); 5.6 (4)	0.1 (2); 1.3 (3); 0.5 (4)	47 (2); 591 (4)	7 (2)	5.1	0.63	319	7	Selected the average of regional values
Open Water	12.8	0.5	155	-	0.4 (2)	0.03 (2)	2 (2)	0.4 (2)	0.4	0.03	2	0.4	Selected regional values

Notes:

TN = Total Nitrogen   TP = Total Phosphorus   TSS = Total Suspended Solids   FC = Fecal Coliform

Conversion equation used for Pasture/Orchard

NSQD (2005) does not provide rural land use data.

MA DEP QAPP does not provide rural land use data

Sources:

Maestre & Pitt and Center for Watershed Protection (2005). The National Stormwater Quality Database, Version 1.1.

Caraco, D. and Center for Watershed Protection, Inc. (2013). Watershed Treatment Model (WTM) 2013 Documentation.

Regional EMC or Other Sources identified by number:

1. CDM (2004). Merrimack River Watershed Assessment Study - Screening Level Model.
2. BETA Group, Inc. (2006). Quality Assurance Project Plan. Development of a Watershed Based Plan for Massachusetts. Converted values presented in mg/L into lb/ac/yr assuming 0% impervious area for Forest and 2% impervious area, 46 inches of rain per year, for agricultural land uses.
3. Reckhow et al. (1980): "Modeling Phosphorus Loading and Lake Response under Uncertainty: A Manual and Compilation of Export Coefficients." From Lin, J. (2005) Review of Published Export Coefficient and Event Mean Concentration (EMC) Data. Converted values from kg/ha/yr to lb/ac/yr.
4. CH2M HILL (2001). PLOAD version 3.0, An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects: User's Manual.

Appendix C - DCIA and Impervious Area Statistics for Stormwater Catchments in Ashland, MA

Data Source: Town of Ashland, MA Phosphorus Source Identification Report (November 2021)

FUSS & O'NEILL

Directly Connected Impervious Area

General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts

Ashland, Massachusetts

March 25, 2021

					Highly Connected				Moderately Connected				Somewhat Connected				Mostly Disconnected							
Outfall Catchment #	Updated Outfall ID	Outfall ID	Total Catchment Area (acres)	Total Impervious Area (IA) (acres)	Area (acres)	Impervious Area (IA) (acres)	Percent Impervious Area (%IA)	Percent Directly Connected Impervious Area (%DCIA)	Area (acres)	Impervious Area (IA) (acres)	Percent Impervious Area (%IA)	Percent Directly Connected Impervious Area (%DCIA)	Area (acres)	Impervious Area (IA) (acres)	Percent Impervious Area (%IA)	Percent Directly Connected Impervious Area (%DCIA)	Area (acres)	Impervious Area (IA) (acres)	Percent Impervious Area (%IA)	Percent Directly Connected Impervious Area (%DCIA)	Total DCIA (acres)	DCIA / IA (%)	IA as % of Catchment Area	DCIA as % of Catchment Area
1	OF_0391	OF_MH_949	8.2	7.7	6.0	5.9	98.0	98.1	1.3	1.2	94.3	91.5	0.6	0.3	52.7	33.8	0.3	0.2	64.4	41.5	7.4	97.3	93.8	**90.4**
2	OF_0392	OF_0392	0.4	0.2	0.1	0.1	95.8	95.4	0.0	0.0	0.0	0.0	0.2	0.1	43.2	24.1	0.0	0.0	0.0	0.0	0.2	81.5	63.9	**51.0**
3	OF_MH_925	OF_MH_925	0.4	0.4	0.1	0.1	93.7	92.9	0.0	0.0	0.0	0.0	0.1	0.1	89.7	83.5	0.1	0.1	100.0	100.0	0.3	97.2	94.6	**91.6**
4	OF_0639	OF_2019_21	15.0	5.2	1.4	1.1	78.3	74.9	1.1	0.9	81.6	73.7	8.3	2.8	33.5	15.7	4.1	0.4	10.2	1.0	3.2	61.7	34.5	**21.5**
5	OF_0110	OF_0110	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	37.1	18.6	0.2	0.1	35.9	12.9	0.1	41.1	35.1	**14.9**
6	OF_0569	OF_0569	8.1	2.6	0.0	0.0	0.0	0.0	1.5	0.7	43.3	28.5	2.9	1.0	33.4	15.6	3.7	1.0	26.2	6.9	1.1	43.8	32.0	**14.0**
7	OF_0589	OF_0589	5.7	1.4	0.0	0.0	0.0	0.0	2.0	0.7	36.4	21.9	1.0	0.4	45.2	26.1	2.7	0.1	4.1	0.2	0.7	54.5	24.1	**12.2**
8	OF_0529	OF_0529	17.0	3.8	0.0	0.0	0.0	0.0	3.5	1.3	36.0	21.6	7.8	1.8	23.4	8.5	5.6	0.6	11.5	1.3	1.5	40.0	22.5	**8.8**
9	OF_0504	OF_0504	1.5	0.4	0.0	0.0	0.0	0.0	0.2	0.1	48.5	33.8	1.2	0.4	31.1	13.8	0.1	0.0	0.0	0.0	0.2	49.0	28.5	**15.3**
10	OF_566	OF_0564	2.3	0.6	0.0	0.0	0.0	0.0	1.1	0.5	51.4	36.8	1.0	0.1	14.2	3.6	0.2	0.0	3.1	0.1	0.4	61.6	28.4	**19.1**
11	OF_0105	OF_0105	1.8	0.7	0.0	0.0	0.0	0.0	1.1	0.5	43.0	28.2	0.6	0.3	39.3	20.5	0.1	0.0	16.5	2.7	0.4	60.1	37.4	**24.4**
12	OF_0108	OF_0108	2.4	0.9	0.0	0.0	0.0	0.0	1.3	0.5	42.0	27.2	1.1	0.4	32.4	14.8	0.0	0.0	0.0	0.0	0.5	57.1	38.7	**21.4**
13	OF_0634	OF_2019_15	2.8	1.0	0.0	0.0	0.0	0.0	0.9	0.3	40.5	25.8	1.7	0.5	30.6	13.4	0.3	0.1	39.1	15.3	0.5	50.4	35.7	**17.4**
14	OF_0574	OF_0574	5.6	2.0	0.0	0.0	0.0	0.0	3.0	0.9	31.1	17.3	2.0	0.6	30.0	13.0	0.7	0.3	41.0	16.8	0.9	49.3	34.9	**15.7**
15	OF_0619	OF_0619	5.3	2.5	0.0	0.0	0.0	0.0	1.6	0.6	38.6	23.9	3.7	1.8	48.9	29.8	0.0	0.0	99.0	98.0	1.5	61.5	46.2	**28.3**
16	OF_0606	OF_0606	16.0	3.5	0.0	0.0	0.0	0.0	2.7	1.0	37.7	23.2	6.4	2.0	32.0	14.5	7.0	0.4	6.4	0.4	1.6	45.0	21.8	**9.8**
17	OF_0037	OF_0037	7.8	2.4	0.0	0.0	0.0	0.0	2.9	1.1	37.5	23.0	3.4	1.0	29.8	12.8	1.5	0.5	32.7	10.7	1.3	48.8	31.4	**16.2**
18	OF_0036	OF_0036	4.0	1.0	0.0	0.0	0.0	0.0	0.8	0.4	44.6	29.8	1.6	0.4	24.5	9.2	1.5	0.3	17.2	2.9	0.4	43.1	24.4	**11.2**
19	OF_0513	OF_0513	10.0	3.1	0.0	0.0	0.0	0.0	0.3	0.1	34.0	19.8	8.2	2.7	32.4	14.8	1.4	0.3	19.7	3.9	1.3	43.8	31.1	**13.4**
20	OF_0064	OF_0064	14.6	4.2	0.0	0.0	0.0	0.0	4.3	1.8	41.8	27.0	8.3	2.1	25.2	9.6	2.0	0.5	23.8	5.7	2.1	47.6	28.8	**14.2**
21	OF_0063	OF_0068	4.5	1.3	0.0	0.0	0.0	0.0	1.6	0.5	29.5	16.0	1.9	0.7	35.1	17.0	1.1	0.2	18.6	3.5	0.6	45.9	29.1	**13.4**
22	OF_0632	OF_2019_13	1.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	38.5	19.9	0.2	0.1	32.2	10.4	0.2	49.2	37.2	**18.5**
23	OF_0060	OF_0060	2.2	0.6	0.0	0.0	0.0	0.0	0.3	0.0	11.4	3.9	1.9	0.6	31.7	14.2	0.0	0.0	14.0	2.0	0.3	44.3	29.8	**12.9**
24	OF_MH_239	OF_MH_239	16.0	4.3	0.0	0.0	0.0	0.0	3.5	1.1	30.3	16.7	8.4	2.4	28.9	12.2	4.2	0.9	20.8	4.3	1.8	41.1	26.8	**11.1**
25	OF_0626	OF_2019_07	9.7	3.2	0.0	0.0	0.0	0.0	3.4	1.3	39.1	24.4	4.8	1.6	33.8	15.9	1.5	0.3	22.0	4.8	1.7	50.7	33.2	**17.1**
26	OF_0350	OF_0350	2.9	0.7	0.0	0.0	0.0	0.0	1.2	0.5	41.6	26.8	0.7	0.1	13.4	3.3	0.9	0.1	7.7	0.6	0.4	52.9	24.4	**12.5**
27	OF_0624	OF_2019_05	6.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	1.3	24.6	9.2	0.7	0.2	28.7	8.3	0.5	36.4	25.0	**9.1**
28	OF_0628	OF_2019_09	6.3	2.2	0.0	0.0	0.0	0.0	3.0	1.3	43.6	28.8	3.2	1.1	33.1	15.4	0.1	0.1	37.9	14.4	1.4	56.8	34.9	**21.7**
29	OF_0505	OF_0505	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.2	100.9	101.3	0.0	0.0	2.5	0.2	0.1	0.1	63.2	39.9	0.2	92.0	65.5	**82.4**
30	OF_0567	OF_0567	1.8	0.6	0.0	0.0	0.0	0.0	1.3	0.5	35.8	21.4	0.2	0.1	34.9	16.8	0.3	0.0	15.7	2.5	0.3	55.0	33.0	**18.0**
31	OF_0665	OF_MH_87	7.3	2.1	0.0	0.0	0.0	0.0	1.2	0.2	19.7	8.8	3.9	1.5	38.2	19.5	2.3	0.3	14.4	2.1	0.9	44.5	28.6	**12.4**
32	OF_0038	OF_0038	18.7	3.6	0.0	0.0	0.0	0.0	2.3	0.8	34.5	20.3	7.0	1.9	26.4	10.4	9.4	1.0	10.3	1.1	1.3	36.0	19.2	**7.0**
33	OF_0568	OF_0568	2.6	0.9	0.0	0.0	0.0	0.0	1.0	0.4	36.7	22.3	1.3	0.4	33.9	16.0	0.3	0.1	32.8	10.8	0.5	51.4	33.2	**17.9**
34	OF_0638	OF_2019_20	10.1	3.0	0.0	0.0	0.0	0.0	4.1	1.3	31.7	17.8	5.2	1.4	27.7	11.3	0.8	0.3	41.4	17.1	1.4	47.4	30.2	**14.4**
35	OF_0075	OF_0075	27.7	6.7	0.0	0.0	0.0	0.0	5.6	2.1	38.0	23.4	14.2	3.9	27.3	11.0	7.8	0.8	10.4	1.1	3.0	43.5	24.2	**10.7**
36	OF_0396	OF_0396	3.6	1.2	0.0	0.0	0.0	0.0	0.5	0.2	42.0	27.2	2.5	0.7	28.7	12.0	0.6	0.2	37.4	14.0	0.5	45.5	32.4	**14.6**
37	OF_0026	OF_0026	1.2	0.5	0.0	0.0	0.0	0.0	0.5	0.2	37.2	22.7	0.6	0.2	42.7	23.6	0.1	0.1	42.3	17.9	0.3	56.2	40.3	**22.7**
38	OF_0074	OF_0074	7.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	1.0	36.6	18.2	4.7	0.2	4.9	0.2	0.5	41.3	16.5	**6.8**
39	OF_0095	OF_0095	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	40.9	22.0	0.4	0.1	35.4	12.5	0.1	41.8	37.1	**15.5**
40	OF_0097	OF_0097	14.4	4.2	0.0	0.0	0.0	0.0	3.7	1.2	33.0	19.0	8.7	2.6	29.6	12.7	2.1	0.4	19.6	3.8	1.9	44.8	29.1	**13.0**
41	OF_0641	OF_2019_23	7.8	1.7	0.0	0.0	0.0	0.0	2.2	0.9	38.8	24.1	3.4	0.8	22.1	7.7	2.2	0.2	8.6	0.7	0.8	45.3	22.1	**10.4**
42	OF_0059	OF_0059	0.5	0.3	0.0	0.0	0.0	0.0	0.1	0.1	42.9	28.1	0.4	0.2	45.1	26.0	0.0	0.0	91.5	83.7	0.2	61.1	46.3	**27.9**
Total			**281.9**	**84.3**	**7.6**	**7.2**	**94.3**	**37.3**	**65.2**	**25.4**	**39.0**	**2.4**	**137.8**	**41.7**	**30.3**	**0.5**	**71.3**	**10.6**	**14.9**	**0.02**	**44.4**	**52.3**	**29.9**	**15.8**

Appendix D - Pollutant Load Export Rates (PLERs)

Data Source: 2016 Massachusetts Small
Municipal Separate Storm Sewer Systems (MS4) Permit

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
AGRICULTURE, HSG A	0.45	7.14	2.6
AGRICULTURE, HSG B	0.45	29.4	2.6
AGRICULTURE, HSG C	0.45	59.8	2.6
AGRICULTURE, HSG D	0.45	91	2.6
AGRICULTURE, IMPERVIOUS	1.52	650	11.3
COMMERCIAL, HSG A	0.03	7.14	0.3
COMMERCIAL, HSG B	0.12	29.4	1.2
COMMERCIAL, HSG C	0.21	59.8	2.4
COMMERCIAL, HSG D	0.37	91	3.7
COMMERCIAL, IMPERVIOUS	1.78	377	15.1
FOREST, HSG A	0.12	7.14	0.5
FOREST, HSG B	0.12	29.4	0.5
FOREST, HSG C	0.12	59.8	0.5
FOREST, HSG D	0.12	91	0.5
FOREST, HSG IMPERVIOUS	1.52	650	11.3
HIGH DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.3
HIGH DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.2
HIGH DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.4
HIGH DENSITY RESIDENTIAL, HSG D	0.37	91	3.7
HIGH DENSITY RESIDENTIAL, IMPERVIOUS	2.32	439	14.1
HIGHWAY, HSG A	0.03	7.14	0.3
HIGHWAY, HSG B	0.12	29.4	1.2
HIGHWAY, HSG C	0.21	59.8	2.4
HIGHWAY, HSG D	0.37	91	3.7
HIGHWAY, IMPERVIOUS	1.34	1,480	10.5
INDUSTRIAL, HSG A	0.03	7.14	0.3
INDUSTRIAL, HSG B	0.12	29.4	1.2
INDUSTRIAL, HSG C	0.21	59.8	2.4
INDUSTRIAL, HSG D	0.37	91	3.7

INDUSTRIAL, IMPERVIOUS	1.78	377	15.1
LOW DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.3
LOW DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.2
LOW DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.4
LOW DENSITY RESIDENTIAL, HSG D	0.37	91	3.7
LOW DENSITY RESIDENTIAL, IMPERVIOUS	1.52	439	14.1
MEDIUM DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.3
MEDIUM DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.2
MEDIUM DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.4
MEDIUM DENSITY RESIDENTIAL, HSG D	0.37	91	3.7
MEDIUM DENSITY RESIDENTIAL, IMPERVIOUS	1.96	439	14.1
OPEN LAND, HSG A	0.03	7.14	0.3
OPEN LAND, HSG B	0.12	29.4	1.2
OPEN LAND, HSG C	0.21	59.8	2.4
OPEN LAND, HSG D	0.37	91	3.7
OPEN LAND, IMPERVIOUS	1.52	650	11.3
[1]HSG = Hydrologic Soil Group			

University of New Hampshire Stormwater Center (UNHSC) (2018). "*Stormwater Control Measure Nomographs with pollutant removal and design cost estimates.*" Available at: Stormwater Tools in New England | US EPA.

USDA NRCS and MassGIS (2012). "*NRCS SSURGO-Certified Soils*" Shapefile

USEPA (1986). "*Quality Criteria for Water (Gold Book)*" EPA 440/5-86-001. Office of Water, Regulations and Standards. Washington, D.C.

USEPA. (2010). "*EPA's Methodology to Calculate Baseline Estimates of Impervious Area (IA) and Directly Connected Impervious Area (DCIA) for Massachusetts Communities.*"

USEPA. (2020). "*General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts (as modified); Appendix F – Requirements for MA Small MS4s Subject to Approved TMDLs.*" 7 December 2020

Weston & Sampson Engineers, Inc. (2021). *"Lake Waushakum Resilience Design Stormwater Calculations, 50% Design, and Permitting Strategy."*

Weston & Sampson Engineers, Inc. (2021). *"Lake Waushakum Resilience Design Discussion of Design Alternatives."*

Weston & Sampson Engineers, Inc. (2021). *"Lake Waushakum Outfall Screening and Sampling."*

Weston & Sampson Engineers, Inc. (2022). "MS4 Compliance Lake Waushakum Phosphorus Source Identification Report."