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Town of Stoneham, Massachusetts

MS4 Phosphorus Source Identification Report & Best Management Practice (BMP) Retrofit Site Selection

An Evaluation of Phosphorus Loading Sources and Town-Owned Properties to Determine Five Site Selections for BMP Retrofits

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An Evaluation of Phosphorus Loading Sources and Town-Owned Properties to Determine Five Site Selections for BMP Retrofits

June 2022

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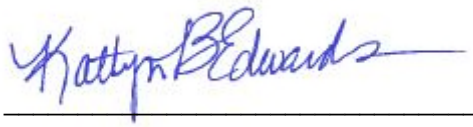

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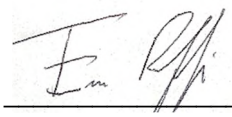

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Version Control

Revision No.	Date Issued	Description	Reviewed By
REV 1	9/16/2022	Updates made to retrofit maps and potential retrofit implementation.	Kathryn B. Edwards, PE

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Acronyms and Abbreviations

AC	Acre
BMP	Best Management Practice
CDC	Center of Disease Control
DCIA	Directly Connected Impervious Area
DPW	Department of Public Works
EPA	United States Environmental Protection Agency
GIS	Geographic Information Systems
IA	Impervious Area
LBS	Pounds
MassDEP	Massachusetts Department of Environmental Protection
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
NPS	Nonpoint Source
NRCS	United States Department of Agriculture Natural Resources Conservation Services
NHESP	MA Division of Fisheries & Wildlife Natural Heritage and Endangered Species Program
SCM	Stormwater Control Measure
SVI	Social Vulnerability Index
USDA	United States Department of Agriculture
YR	Year

Executive Summary

The Town of Stoneham's Municipal Separate Storm Sewer System (MS4) permit requires the development of a Phosphorus Source Identification Plan and then identification of five Town-owned sites for Best Management Practice (BMP) retrofits in permit year 4 (July 1, 2021 – June 30, 2022). The objectives of the Phosphorus Source Identification Report are to identify high pollutant loading locations with the Town and locate municipal owned properties where BMP retrofits could be implemented to aid in reducing phosphorus loads. The goal of these BMP retrofits is to also reduce the frequency, volume, and other pollutant loads of stormwater that is discharged through Stoneham's MS4 and reduce the amount of impervious area throughout the Town. In accordance with the MS4 Permit, the Town at a minimum shall consider and analyze the existing conditions of municipal properties with significant impervious cover (including parking lots, buildings, and maintenance yards) that could be modified or retrofitted for stormwater treatment. The EPA also recommends that permittees consider factors such as MS4 receiving waterbody uses and water quality impairments, retrofit operation and maintenance access, existing soil conditions, depth to groundwater table and upcoming capital improvements. Arcadis identified additional BMP retrofit site selection criteria and in total, all ten site selection criteria and their consideration priority are listed in Table 1. All the municipally owned properties in Stoneham were evaluated using a matrix incorporating site selection criteria and their consideration priority. The five sites that were deemed the highest priority for BMP retrofits have been selected to fulfill the Year 4 BMP retrofit site selection requirements of the MS4 permit. Table 2 lists the five sites selected for Permit Year 4 and their addresses.

Table 1: BMP Retrofit Site Selection Criteria and Corresponding Priority

BMP Retrofit Site Selection Criteria	Priority
Phosphorus Impaired Subwatershed	Highest
Phosphorus Average Annual Load	Highest
Amount of Impervious Area	Highest
Soil Infiltration Capacity	High
Depth to Groundwater Table	Moderate
Flooding Frequency	Moderate
Planned Capital Improvements	Moderate
Ease of Maintenance	Moderate
Sensitive Receptors	Low
Benefits Vulnerable Populations	Low

Table 2: MS4 Permit Year 4 BMP Retrofit Site Selections

MS4 Permit Year 4 BMP Retrofit Site Name	Site Address
South Elementary School	11 Summer St.
Stoneham Arena	101 Montvale Ave.
Old Central School	25-29 William St.
Colonial Park Elementary School	30 Avalon Rd.
Department of Public Works (DPW) Garage and Office	16 Pine St.

1 Introduction

1.1 Stormwater System and Waterbodies

The Town of Stoneham discharges stormwater under the regulation of a Municipal Separate Storm Sewer System (MS4) permit, which is issued jointly by United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP). The Town's MS4 Permit became effective on July 1st, 2018, and the Town must comply with MS4 permit requirements to discharge stormwater legally. Stormwater from the Town's MS4 is discharged and/or conveyed to the following waterbodies:

Table 3: Receiving Waters for the Town of Stoneham

Receiving Waterbody and Segment ID	Surface Water Class	TMDL Category	Impairment(s)
Buckman Pond	Class B	Category 3	Insufficient Information
Burbank Stream	Class B	Category 3	Insufficient Information
Crystal Lake (MA93018)	Class A	Category 3	Insufficient Information
Dark Hollow Pond	Class B	Category 3	Insufficient Information
Doleful Pond	Class B	Category 3	Insufficient Information
North Stream	Class B	Category 3	Insufficient Information
Quarter Mile Pond	Class B	Category 3	Insufficient Information
Spot Pond (MA71039)	Class B	Category 3	Insufficient Information
Spot Pond Brook (MA71-17)	Class B	Category 2	Insufficient Information
Sweetwater Brook	Class B	Category 3	Insufficient Information
Aberjona River (MA71-01)*	Class B	Category 5	Total Phosphorus, Un-ionized Ammonia, Arsenic in Sediment, Benthic Macroinvertebrates, Chloride, Dissolved Oxygen, Escherichia Coli, Fish Bioassessments, Sediment Bioassay
Source: *Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle*			

* There are no direct stormwater discharges to the Aberjona River (Segment MA71-01). However, the Town of Stoneham and multiple drainage catchment areas and waterbodies are located within the Aberjona River Subwatershed.

1.2 MS4 Permit – Phosphorus Source Identification Requirements

With a portion of the Town being located in the Aberjona River Subwatershed, which has a total phosphorus impairment according to the *Final Massachusetts Integrating List of Waters for the Clean Water Act 2018/2020*

Reporting Cycle, the Town is required to develop a Phosphorus Source Identification Plan. This report has been developed to satisfy this requirement of the MS4 Permit. In accordance with the MS4 Permit, communities discharging stormwater to waterways that are listed by MassDEP as impaired for phosphorous, or that flow into impaired waterways, and for which a total maximum daily load does not exist, shall prepare this report as detailed in Appendix H of the Permit. As stated in Appendix H Part II of the MS4 Permit the following elements in the table below must be included in the report and submitted within four year of the permit effective date (ending on June 30, 2022).

Table 4: Phosphorus Source Identification Plan Requirements

MS4 Permit Appendix H Requirements	Report Section
Calculation of total MS4 area draining to the water quality limited receiving water segments or their tributaries, incorporating updated mapping of the MS4 and catchment delineations produced pursuant to part 2.3.4.6 of the MS4 Permit	*Section 2.4 – Drainage Areas*, **Appendix B** – Estimated Phosphorus Loading Results
Reporting of screening and monitoring results pursuant to part 2.3.4.7.b., targeting the receiving water segment(s)	NA: no phosphorus samples taken as there are no direct stormwater outfall discharges to impaired water segments
Impervious area and directly connected impervious area (DCIA) for the target catchments	*Section 2.5 – Impervious Area and DCIA*, **Appendix A** – Impervious Area and DCIA Results
Identification, delineation and prioritization of potential catchments with high phosphorus loading	*Section 2.6 – Phosphorus Loading Results and Prioritization*, **Appendix B** – Estimated Phosphorus Loading Results
Identification of potential retrofit opportunities or opportunities for the installation of structural BMPs during redevelopment, including the removal of impervious area	*Section 6.2 – Year 4 BMP Retrofit Site Selections*, **Appendix C** – Site Selection Matrix

1.3 MS4 Permit – BMP Retrofit Requirements

Another requirement for Year 4 of the MS4 permit is the identification of a minimum of five (5) Town-owned sites that can be retrofitted with stormwater best management practices (BMPs) that are designed to alleviate the stormwater system. The following is an excerpt taken directly from the Town's MS4 Permit regarding BMP retrofits:

"Four (4) years from the effective date of this permit, the permittee shall identify a minimum of 5 permittee-owned properties that could potentially be modified or retrofitted with BMPs designed to reduce the frequency, volume, and pollutant loads of stormwater discharges to and from its MS4 through the reduction of impervious area. Properties and infrastructure for consideration shall include those with the potential for reduction of on-site impervious area (IA) as well as those that could provide reduction of off-site IA. At a minimum, the permittee shall consider municipal properties with significant impervious cover (including parking lots, buildings, and maintenance yards) that could be modified or retrofitted. MS4 infrastructure to be considered includes existing street right-of-ways, outfalls and conventional stormwater conveyances and controls (including swales and detention practices) that could be readily modified or retrofitted to provide reduction in frequency, volume or pollutant loads of such discharges through reduction of impervious cover.

In determining the potential for modifying or retrofitting particular properties, the permittee shall consider factors such as access for maintenance purposes; subsurface geology; depth to water table; proximity to aquifers and subsurface infrastructure including sanitary sewers and septic systems; and opportunities for public use and education. In determining its priority ranking, the permittee shall consider factors such as schedules for planned capital improvements to storm and sanitary sewer infrastructure and paving projects; current storm sewer level of service; and control of discharges to water quality limited waters, first or second order streams, public swimming beaches, drinking water supply sources and shellfish growing areas.

Beginning with the fifth-year annual report and in each subsequent annual report, the permittee shall identify additional permittee owned sites and infrastructure that could be retrofitted such that the permittee maintains a minimum of 5 sites in their inventory, until such a time as when the permittee has less than 5 sites remaining. In addition, the permittee shall report on all properties that have been modified or retrofitted with BMPs to mitigate IA that were inventoried in accordance with this part. The permittee may also include in its annual report non-MS4 owned property that has been modified or retrofitted with BMPs to mitigate IA."

A structural stormwater BMP is an engineered method that is implemented to prevent or reduce pollution from stormwater discharge. Structural BMPs can be divided into two categories: gray infrastructure and green infrastructure.

Multiple factors must be considered when choosing optimal sites for BMP retrofits. The purpose of BMP retrofits is to reduce flooding and pollution caused by stormwater, and the determining factor of infiltration BMP success is the soil type on which it is built. A visual analysis of the following four factors can serve as a starting point for BMP retrofit site selection:

- Impairments and classifications of waterbodies receiving MS4 discharge
- Areas with a hydrologic soil group that are compatible with infiltration BMPs
- Town-owned properties
- Town-owned properties with opportunity to reduce impervious area
- Areas prone to flooding caused by stormwater

Figure 1 is a town-wide map of Stoneham illustrating several of the factors listed above. Figure 1 also shows the classification of Stoneham's receiving waterbodies, areas with higher and highest probability for infiltration BMP success, and Town-owned properties.

This report includes the results of a comprehensive desktop assessment of all the Town-owned properties in Stoneham and sets priorities for implementation of BMP retrofits throughout the lifetime of the MS4 permit. The assessment uses 10 selection criteria to rank sites for implementation BMP retrofits and allows the Town to choose additional appropriate sites throughout the implementation time period set forth in the MS4 permit. It should be noted that some sites are not suitable for BMP retrofits due to site location, underlying soils, and other constraints.

Name: Crystal Lake (MA93018)
Watershed: North Coastal
Class: A
Category: 3
Impairment(s): No Uses Assessed

Name: Aberjona River (MA71-01)
Watershed: Boston Harbor - Mystic
Class: B
Category: 5
Impairment(s): Total Phosphorus, Un-ionized Ammonia, Arsenic in Sediment, Benthic Macroinvertebrates, Chloride, Dissolved Oxygen, Escherichia Coli, Fish Bioassessments, Sediment Bioassay

Name: Spot Pond (MA71039)
Watershed: Boston Harbor - Mystic
Class: B
Category: 3
Impairment(s): No Uses Assessed

Legend

- Highest Probability for Infiltration BMP Success
- Higher Probability for Infiltration BMP Success
- Category 5: Impairment or threatend for one or more uses and requiring a TMDL
- Category 3: Insufficient information to make an assessment for any use
- Aberjona Sub-Watershed in Stoneham
- Stoneham Boundary
- Town Owned Parcel

N
W E
S

0 0.1 0.2 0.4 Miles

Town of Stoneham, Massachusetts
Phosphorus Source Identification Report & BMP Retrofit Site Selection
Figure 1: Preliminary BMP Site Identification

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2 Phosphorus Source Identification

2.1 Nutrient Pollution

Nutrients such as phosphorus and nitrogen are naturally occurring and are essential to the development and survival of many organisms. They can be found in organic debris such as leaf litter, grass clippings, and animal and pet waste. Phosphorus and nitrogen are also abundant in lawn and agricultural fertilizers and farm waste. These nutrients become a pollutant when there are high nutrient concentrations and excess nutrients in streams, rivers, lakes, bays, and coastal waters. During precipitation events, many of the sources of nutrients are collected with stormwater runoff and enter the stormwater drainage system will little to no treatment for nutrient removal. In urban environments with significant impervious cover, stormwater runoff bypasses natural processes such as soil infiltration and nutrient uptake via vegetation that aid in the removal of nutrients such as phosphorus before discharging or being conveyed to the nearest waterbody.

Nutrient pollution can result in serious environmental and human health issues and can also lead to economic impacts. High nutrient loads and nutrient pollution lead to a changing chemical composition in these waterbodies and cause algae and aquatic plants to grow faster than usual. While the algae and aquatic plants provide food, nutrients, and a habitat for fish, shellfish, and other smaller aquatic organisms, an excess of this vegetation can be very harmful to the aquatic ecosystem. Large growths of algae, known as algal blooms, resulting from nutrient pollution decrease the oxygen levels in the aquatic ecosystem, using the natural resources that the other aquatic organisms rely on for survival. Many fish and organisms are either forced out of their natural habitat or die due to the decreased oxygen levels. Some algal blooms can be harmful to humans because they produce toxins and bacterial growth that can make people sick if they come into contact with polluted water, consume contaminated fish or shellfish, or drink the polluted water.

2.2 Regulatory Requirements

To maintain compliance with the MS4 Permit, the Town must submit this report with the elements identified in *Section 1 Introduction* within four years of the permit effective date. The nutrient of concern addressed through this requirement for the Town of Stoneham is phosphorus. Phosphorus sampling was not conducted as part of the screening and monitoring results pursuant to part 2.3.4.7.b., targeting the receiving water segment(s) because the Town does not discharge stormwater directly into a water quality limited water or a water subject to an approved TMDL as indicated in Appendix F.

This report also provides a recommended potential site for implementation of a structural BMP retrofit as a demonstration project. The site is located within the impaired waterbody drainage area, in this case the Aberjona River Subwatershed. The demonstration project is intended to reduce phosphorus loads in a high load potential catchment and will be installed within six years of the permit effective date, as required by Appendix H Part II. The remainder of the proposed structural BMPs will be implemented in accordance with the plan and schedule in this report to be submitted, at the latest, in the Year 5 Annual Report.

2.3 Phosphorus Loading, IA, and DCIA – Data Sources and Methods

Multiple existing geographic information system (GIS) datasets were utilized to create figures shown in this report and to calculate estimated phosphorus loadings, impervious area cover, and DCIA. The table below summarizes the datasets used for these analyses.

Table 5: GIS Datasets

Data Set	Origin Source	Data Published or Updated	Link
Stoneham Stormwater Drainage Structures and Conveyances	Town of Stoneham	March 2022	NA
Stoneham Stormwater Drainage Catchments	Town of Stoneham	June 2020	NA
2016 Land Cover/Use	MassGIS	May 2019	https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use
Drainage Sub-Basins	MassGIS	December 2007	https://www.mass.gov/info-details/massgis-data-drainage-sub-basins
Soils SSURGO-Certified NRCS	MassGIS	November 2021	https://www.mass.gov/info-details/massgis-data-soils-ssurgo-certified-nrcs
Municipal Boundaries	MassGIS	April 2022	https://www.mass.gov/info-details/massgis-data-municipalities
Property Tax Parcels	MassGIS	March 2022	https://www.mass.gov/info-details/massgis-data-property-tax-parcels
MassDEP 2016 Integrated List of Waters (305(b)/303(d))	MassGIS	December 2020	https://www.mass.gov/info-details/massgis-data-massdep-2016-integrated-list-of-waters-305b303d

Phosphorus pollutant loads were calculated for the entire municipality of Stoneham using the PLOAD model. The Pollutant Loading Estimator (PLOAD) is watershed GIS-based model that computes nonpoint source loads from

different subwatersheds based on landuses and BMPs. The PLOAD model was developed by CH2M HILL as a model plug-in extension for the EPA BASINS framework.

PLOAD estimates nonpoint sources (NPS) of pollution on an annual average basis, for any user-specified pollutant. The user may calculate the NPS loads using either of two approaches, using Export Coefficients or the EPA's Simple Method. Optionally, best management practices (BMPs), which serve to reduce NPS loads, point source loads, and loads from stream bank erosion may also be included in computing total watershed loads.

PLOAD was designed to be generic so that it can be applied as a screening tool in typical NPDES stormwater permitting, watershed management, or reservoir protection projects. The Better Assessment Science Integrating Point and Non-point Sources (BASINS) is a multipurpose environmental analysis system that brings together modeling tools and environmental spatial and tabular data into a geographic information system (GIS) interface. It was developed by the U.S. Environmental Protection Agency to assist in watershed management and TMDL development by integrating environmental data, analysis tools, and watershed and water quality models. BASINS can be used for investigations and analysis on a variety of geospatial scales from small watersheds within a single municipality, to a large watershed across several states. Prior to determining the total phosphorus pollutant load within PLOAD, catchment areas were refined for the entire town. A phosphorus loading map and tabular loading results can be found in **Appendix B.**

Impervious area is the portion of the Town that is paved, covered by buildings, or otherwise deemed unable to absorb water naturally due to development and existing land cover. Impervious area for the Town was calculated using the MassGIS 2016 Land Cover/Land Use data layer which was published in 2019. This data layer maps impervious and pervious land cover by land use type based on aerial photography and other data sources. This was overlaid with the Town's data layer for outfall catchment areas to estimate total drainage areas and total impervious area for catchments.

The source for the Annual total phosphorus load rates per land use was obtained from the MA MS4 General Permit documentation. Table 6 display the current P values utilized at the PLOAD model to determine the phosphorus load per catchment.

Table 6 - Average annual distinct phosphorus load (P Load) export rates for use in estimating phosphorus load reduction credits the MA MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	P Load Export Rate, lbs/acre/year	P Load Export Rate, kg/ha/yr
Commercial (Com) and Industrial (Ind)	Directly connected impervious	1.78	2.0
	Pervious	See* DevPERV	See* DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.32	2.6
	Pervious	See* DevPERV	See* DevPERV
Medium -Density Residential (MDR)	Directly connected impervious	1.96	2.2
	Pervious	See* DevPERV	See* DevPERV
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	1.34	1.5
	Pervious	See* DevPERV	See* DevPERV
Forest (For)	Directly connected impervious	1.52	1.7
	Pervious	0.13	0.13
Open Land (Open)	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (Ag)	Directly connected impervious	1.52	1.7
	Pervious	0.45	0.5
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group A	Pervious	0.03	0.03
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group B	Pervious	0.12	0.13
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Pervious	0.21	0.24
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C/D	Pervious	0.29	0.33
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D	Pervious	0.37	0.41

Directly connected impervious area (DCIA) is the amount of impervious area that is directly connected to the storm drain system. DCIA estimates were based on the Sutherland equations and an EPA guidance document entitled “Estimating Change in Impervious Area (IA) and Directly Connected Impervious Areas (DCIA) for Massachusetts Small MS4 Permit” (Revised April 2014).

2.4 Drainage Areas

The total area of the Town of Stoneham is approximately 4,254 acres, all of which is an MS4 regulated area. An estimated 2,842 acres of the total drainage area throughout the Town falls within the Aberjona River Subwatershed, which is impaired for total phosphorus and has multiple other impairments as shown in Table 3. The portion of the Aberjona River Subwatershed that is located within the Town can be found in Figure 1. The table below shows a breakdown of the drainage areas and stormwater outfalls throughout town.

Table 7: Summary of Drainage Areas in Stoneham

Drainage Area Name	Drainage Area [acres]	Number Of Stormwater Outfalls
Total Area of Town	4,254	*89
Area Draining to Phosphorus Impaired Waters (Aberjona River Subwatershed in Town)	2,842	50
*Catchment delineations, estimated phosphorus loading, impervious area, and directly connected impervious area were not completed for all individual MS4 stormwater outfall catchments due hydraulic connectivity of discharge locations, open conveyances, and excluded outfalls in accordance with the MS4 Permit. Additionally, field investigations and modeling results led to additional MS4 outfalls being identified.		

2.5 Impervious Area and DCIA

The table below summarizes the total impervious area and estimated DCIA throughout the Town's MS4 drainage catchments and within the portion of Town that falls within the Aberjona River Subwatershed.

Table 8: Summary of Impervious Area and DCIA

Criteria	Acres
Total Impervious Area in Town	1,044
Total Estimated DCIA in Town	614
Total Impervious Area in Aberjona River Subwatershed	742
Total Estimated DCIA in Aberjona River Subwatershed	484

Appendix A of this report provides impervious area and estimates of DCIA for all outfall catchments in the Town. The table below shows the same information for the five catchments with the most impervious area. The catchments are labeled using the Town's identifier for the outfall to which they discharge.

Table 9: Top Impervious Catchments

Catchment ID	Located in Aberjona River Subwatershed	Total Drainage Area (acres)	Impervious Area (acres)	Percent Impervious	DCIA (acres)	Percent DCIA
OF055	Yes	1,342	610	46%	411	31%
OF023	Yes	1,164	526	46%	354	31%
OF013	Yes	487	240	50%	169	35%
OF040	Yes	512	213	42%	137	27%
OF061	Yes	265	134	51%	95	36%

2.6 Phosphorus Loading Results and Prioritization

Using the methods described in *Section 2.3*, an estimate of the phosphorus loading for each of the Town's MS4 stormwater outfalls was calculated. The table below summarizes the five catchments with the highest estimated phosphorus loading throughout the Town.

Table 10: Top Phosphorus Loading Catchments

Catchment ID	Located in Aberjona River Subwatershed	Estimated Phosphorus Load (lbs/yr)
OF055	Yes	13,965
OF023	Yes	12,017
OF013	Yes	5,498
OF040	Yes	4,873
OF061	Yes	3,058

Actual loading may vary on a catchment by catchment and site by site basis based on changing land uses during redevelopment and new development and implementation of structural BMPs. The estimates shown above and remainder of the results presented in **Appendix B** provide the Town with valuable information on where to prioritize stormwater treatment and implementation of BMP retrofits. There are not estimated phosphorus loadings for every catchment due to hydraulic connectivity and the discharge locations of outfalls into open conveyances. Phosphorus loading estimates were utilized in the site selection matrix as described in *Section 4.2* and *Section 5.2* in order to prioritize sites for retrofit opportunities.

2.7 Phosphorus Control Best Management Practices

Stormwater retrofits are a unique group of structural BMPs that provide nutrient and sediment reduction on existing development that is currently untreated by any BMP or is inadequately treated by an existing BMP. Retrofits can be classified into primarily two categories, new retrofit opportunities and retrofits of existing BMPs. For new retrofit facilities, a retrofit is implemented on a site to provide storage and water quality treatment for land that is not currently receiving any stormwater treatment. Existing retrofit practices convert the BMP into a different BMP that utilizes more effective treatment mechanism(s), works towards increasing the BMPs treatment volume and/or hydraulic retention time, or renews the BMPs treatment performance and storage through major sediment cleanouts, vegetative harvesting, or filter media upgrades. A summary table of new versus existing retrofit practices can be found below.

Table 11: New and Existing Retrofit Locations and Examples

Retrofit Type	Potential Locations and Examples
New Retrofits	• Near existing stormwater outfalls • Within existing stormwater conveyance system • Adjacent to large parking lots • Green street retrofits • On-site low-impact development retrofits
Existing BMP Retrofits	• Dry Pond to a Constructed Wetland to allow for more effective treatment of stormwater

Retrofit Type	Potential Locations and Examples
	• Adding a berm to increase the flow path thus extending the hydraulic retention time within the practice leading to better treatment • Increasing performance of a BMP by conducting major repairs or upgrades: an underperforming pond is dredged for sediment thus restoring it to its full performance capacity
Source: *Chesapeake Bay - Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Project, https://www.chesapeakebay.net/documents/Final_CBP_Approved_Expert_Panel_Report_on_Stormwater_Retrofits-_short.pdf*	

Table 12: Guide to Nonpoint Source (NPS) Control of Phosphorus and Erosion

Type of NPS Pollution	Whom to Contact	Types of Remedial Action
Agricultural		
Erosion from Tilled Fields	Landowner and NRCS	Conservation tillage (no-till planting); contour farming; cover crops; filter strips; etc.
Fertilizer leaching	Landowner and NRCS and UMass Extension	Conduct soil P tests; apply no more fertilizer than required. Install BMPs to prevent runoff to surface waters.
Manure leaching	Landowner and NRCS and UMass Extension	Conduct soil P tests. Apply no more manure than required by soil P test. Install manure BMPs.
Erosion and Animal related impacts	Landowner and NRCS	Fence animals away from streams; provide alternate source of water.
Construction		
Erosion, pollution from development and new construction.	Conservation Commission, Town officials, planning boards	Enact bylaws requiring BMPs and slope restrictions for new construction, zoning regulations, strict septic regulations. Enforce Wetlands Protection Act
Erosion at construction sites	Contractors, Conservation Commission, Building Inspector	Various techniques including seeding, diversion dikes, sediment fences, detention ponds etc.
Resource Extraction		
Timber Harvesting	Landowner, logger, Regional DEM forester	Check that an approved forest cutting plan is in place and BMPs for erosion are being followed
Gravel Pits	Pit owner, Regional DEP, Conservation Commission	Check permits for compliance, recycle wash water, install sedimentation ponds and berms. Install rinsing ponds.

Type of NPS Pollution	Whom to Contact	Types of Remedial Action
Residential, urban areas		
Septic Systems	Homeowner, Lake associations, Town Board of Health, Town officials	Establish a septic system inspection program to identify and replace systems in non-compliance with Title 5. Discourage garbage disposals in septic systems.
Lawn and Garden fertilizers	Homeowner, Lake associations	Establish an outreach and education program to encourage homeowners to eliminate the use of phosphorus fertilizers on lawns, encourage perennial plantings over lawns.
Runoff from Housing lots	Homeowner, Lake associations	Divert runoff to vegetated areas, plant buffer strips between house and lake
Urban Runoff	Landowner, Town or City Dept. Public Works	Reduce impervious surfaces, institute street sweeping program, batch basin cleaning, install detention basins etc.
Highway Runoff	MassHighway,	Regulate road sanding, salting, regular sweeping, and installation of BMPs.
Unpaved Road runoff	Town or City Dept. Public Works or other owner	Pave heavily used roads, divert runoff to vegetated areas, install riprap or vegetate eroded ditches.
Other stream or lakeside erosion	Landowner, Conservation Commission	Determine cause of problem; install riprap, plant vegetation.
Source: *NASHUA RIVER, MASSACHUSETTS - Total Maximum Daily Load for the Nutrient Phosphorus (MassDEP DWM TMDL),* *https://www.mass.gov/doc/draft-phosphorus-tmdl-for-the-nashua-river-0/download*		

Table 13: Examples of Best Management Practices for Phosphorus Control

Agricultural Activities	Forestry Activities	Urban Activities
Nonstructural		
• Tillage and cropland erosion control • Pesticide and fertilizer application • Range and pasture management • Contour faring and strip cropping • Confined feedlot management	• Forestry preharvest • Streamside management areas • Forest chemical management • Fire management • Forest vegetation of disturbed areas	• Land use planning and management • Public acquisition of watershed land • Minimum lot size zoning restrictions • Buffer zones and setbacks

Agricultural Activities	Forestry Activities	Urban Activities
• Cover cropping • Crop residue usage • Cropland irrigation management		• Public information and education • Citizen advisory committees • Watershed sign posting • Stormwater drain stenciling • Illegal dumping and illicit connection controls • Material exposure controls • Material disposal and recycling • Household hazardous pickup days • Used motor oil collection • Wastewater disposal restrictions • Septic tank management • Community wastewater systems control • Sanitary sewer facilities planning and management • Catch basin and street cleaning • Construction site land stabilization
Structural		
• Animal waste management • Terrace systems • Diversion systems • Sediment basins • Filter strip and field borders	• Erosion and sediment controls • Access roads • Skid trials • Stream crossings • Filter strip sediment controls	• Detention / retention facilities • Wet detention ponds • Extended detention ponds • Vegetated swales and strips • Constructed wetlands • Infiltration ponds and trenches • Drainage structure controls • Inlet floatable controls • Oil water separators • Media filtration • Erosion and sediment control • Stream bank stabilization and riparian buffer restoration
Source: *Water Quality Improvement on the Nashua River, https://users.wpi.edu/~mathisen/web_page_update_0307/WPI_MQP_Nashua_River_Final_Draft.pdf*		

3 Potential Sites

A minimum requirement of the MS4 permit is to consider all Town-owned properties with significant impervious cover. All Town-owned facilities and properties have previously been inventoried to comply with the Town's MS4 permit Good Housekeeping Minimum Control Measures requirements. This report considers all properties owned by the Town of Stoneham.

3.1 Municipally Owned Sites

A total of 30 municipally owned sites were analyzed to determine the suitability and benefit on site BMP retrofits would provide. These sites include schools, parks, municipal administration offices, fire stations, and sewer lift stations. The table below shows the complete list of municipally owned sites being considered for BMP retrofits and their addresses.

Table 14: Municipally Owned Sites

Municipally Owned Site Name	Address
Citation Avenue Pumping Station	Citation Ave.
Colonial Park Elementary School	30 Avalon Rd.
DPW Garage and Office	16 Pine St.
DPW Yard	48 Stevens St.
Fallon Road Pumping Station	Fallon Rd.
Fire Department	25 Central St.
Fuller Street Parking Lot	Fuller St.
Joseph C. Cerrone Memorial Park	255 Broadway
Lindenwood Cemetery	Montvale Ave.
North Street Pumping Station	207 North St.
Old Central School	25-29 William St.
Police Department	47 Central St.
Pomeworth Field	Calthea St.
Recreation Park	99 Dale Ct.
Rita Road Pumping Station	Rita Rd.
Robin Hood Elementary School	70 Oak St.
Rounds Playground	MacArthur Rd.
Senior Center	136 Elm St.
South Elementary School	11 Summer St.
Stoneham Arena	101 Montvale Ave.
Stoneham Central Middle School	101 Central St.
Stoneham High School	149 Franklin St.
Stoneham Historical Society	36 William St.
Stoneham Oaks	101 Rear Montvale Ave.

Municipally Owned Site Name	Address
Stoneham Public Library	445 Main St.
Stoneham Town Common	340 Main St.
Town Hall	35 Central St.
Unicorn Golf Course	460 William St.
Upland Road Pumping Station	Upland Rd.
Whip Hill Park	Whip Hill Rd.

3.2 Municipal Owned MS4 Infrastructure

Town owned MS4 infrastructure can also be considered for BMP retrofits. At this time, site selection has been focused primarily on municipal properties. However, the Town continues to implement programs to maintain and repair the MS4 and other infrastructure within Town. If a retrofit or modification opportunity is identified during the course of that work, the Town will evaluate potential options at that time.

4 Site Selection Criteria

Arcadis has identified 10 site selection criteria to evaluate each of the Town-owned properties. Three of the criteria are factors that relate directly to accomplishing the goals set in the MS4 permit: reducing impervious area and improving the water quality of impaired waterbodies. Four of the criteria are factors that assess sites' feasibility for BMP retrofits: planned upcoming improvements, soil infiltration capacity, depth to groundwater table, and ease of maintenance. Two of the criteria are unique to the Town of Stoneham: areas identified as high flood frequency and sensitive receptors/historic sites. The final priority criterion is a social factor: benefits vulnerable populations. Each site selection criteria carries a weight that is proportional to its priority in BMP retrofit site selection as it relates to the MS4 requirements, and each municipal property will be given a score for each criterion. The selection criteria, their weights, and their scores form the site selection matrix.

4.1 Phosphorus Impaired Subwatershed

The receiving waterbody for each site was determined using catchment area delineation which was completed in compliance with the year one requirements of the Town's MS4 permit. A portion of the Town is located within the Aberjona River Subwatershed for the Aberjona River (Segment MA71-01). Catchment areas have been reviewed to determine if they and/or the receiving waterbody are located within the Aberjona River Subwatershed. Since the Aberjona River Subwatershed is impaired for total phosphorus, the Town is targeting sites for BMP retrofits that are located in the Subwatershed to achieve phosphorus loading reductions. Among the site selection criteria, the location of a site in the phosphorus impaired subwatershed was weighted as the highest priority category.

4.2 Phosphorus Average Annual Load

Each municipally owned site's location was documented regarding its relation to which stormwater outfall catchment it is located in. Those sites located in a catchment with a high phosphorus loading were targeted and deemed high priority for retrofits. The Town is prioritizing these sites as potential retrofit locations in order to aid in reducing catchments and locations where there are estimated high phosphorus loads. Among the site selection criteria, the location of a site in a high phosphorus average annual loading catchment was weighted as the highest priority category.

4.3 Amount of Impervious Area

In the MS4 permit, the EPA encourages permittees to consider the reduction of impervious areas as one of the primary methods to reduce the frequency, volume, and pollutant load of MS4 discharge. To effectively reduce impervious area in Stoneham's properties, this selection criterion targets parcels with a high percentage of impervious area. The amount of impervious area for a site is measured by the percentage of the surface area that is covered by pavement, rooftop, and other nonporous surfaces. Sites with a higher percentage of impervious area are given a higher score, elevating them on the priority list of BMP retrofit sites. Among the site selection criteria, the amount of impervious area was weighted as the highest priority category.

4.4 Soil Infiltration Capacity

A site must have a soil type with a sufficient infiltration capacity to allow for successful installation and operation of infiltrating BMPs. Soils classified as Hydrologic Group A and Hydrologic Group B are compatible with infiltrating BMPs. Soils classified as Hydrologic Group C and Hydrologic Group D are not very compatible with infiltrating

BMPs. Each municipal property's soil classification is considered to evaluate the likelihood of BMP success. Among the site selection criteria, soil infiltration capacity was weighted as high priority.

4.5 Depth to Groundwater Table

The Massachusetts Stormwater Handbook requires a minimum separation of two feet between the bottom of an infiltration BMP and the site's seasonal high groundwater table. A site with a greater depth from the surface to the seasonal high groundwater table can hold a greater volume of stormwater per unit area, making infiltration BMPs more effective. Because sites with higher depths to the seasonal high groundwater table allow more effective infiltration BMPs, those sites receive higher priority during site selection. Among the site selection criteria, depth to groundwater table was weighted as moderate priority.

4.6 Flooding Frequency

In the MS4 permit, the EPA encourages permittees to consider the level of storm sewer service of a given site during BMP retrofit site selection. The frequency at which a municipal property or the catchment area in which it is located floods is an indicator of the level of storm sewer service in the area. A property or catchment area that floods frequently is underserved by the current storm sewer system and receives higher priority in BMP retrofit site selection. Among the site selection criteria, flooding frequency was weighted as moderate priority.

4.7 Planned Capital Improvements

In the MS4 permit, the EPA lists planned capital improvements as a factor that should be considered during BMP retrofit site selection. A municipal property that has upcoming planned capital improvements is better suited for BMP retrofits than a property with no upcoming projects because a BMP can be incorporated into the existing plans for capital improvement. Incorporating a BMP into an established project saves the time and money associated with permitting, public review, and finding a funding source associated with starting a new project with the sole purpose of a BMP retrofit. Among the site selection criteria, planned capital improvements was weighted as moderate priority.

4.8 Ease of Maintenance

BMPs require regular maintenance to remain effective. Improperly maintained BMPs can cause flooding, groundwater contamination, and point source pollution. Municipal properties that are accessible to maintenance personnel and equipment receive higher priority in BMP retrofit site selection than municipal properties that are not easily accessed for maintenance. Considering ease of maintenance during BMP retrofit site selection increases the likelihood that installed BMPs will be properly maintained. Among the site selection criteria, ease of maintenance was weighted as moderate priority.

4.9 Sensitive Receptors

Stoneham is home to many sites of cultural, historic, and ecological significance on which development can be subject to special regulation or even outright prohibited. These sensitive receptors affect the constructability of BMPs and must be considered during site selection. Among the site selection criteria, sensitive receptors criteria was weighted as low priority.

4.10 Benefits Vulnerable Populations

The Center of Disease Control (CDC) developed the Social Vulnerability Index (SVI) the quantify the negative impacts on human health caused by external stresses. The SVI rates neighborhoods based on how vulnerable the community members are to external stresses. A site that is in a more vulnerable area as defined by the CDC's SVI is given priority over sites that are less vulnerable according to the CDC's SVI. Among the site selection criteria, benefits vulnerable populations was weighted as low priority.

5 Scoring Methodology

A site selection matrix was created using the list of Town-owned properties, the score that the property received for each site selection criteria, and the corresponding weight of each site selection criteria. Each property was given a score ranging from 1-5 for most site selection criteria, with a few criteria being scored on a different scale as described in the corresponding sub-sections below. This section details how the scores were calculated for each criterion. Each of the site selection criteria were given a weight ranging from 1-4 based on its priority during site selection. A property's composite score was calculated by summing the score that the property received in each site selection criterion multiplied by the weight assigned to each criterion. The properties with the highest composite scores are the highest priority for BMP retrofits.

5.1 Phosphorus Impaired Subwatershed

Based on the site's location with respect to the Aberjona River Subwatershed, each site was given a score of either 0 or 1, with 0 being the site is not located in the Subwatershed and 1 being located within the Subwatershed. The table below shows how site location and Subwatershed translates into a numerical score. In the site selection matrix, site located in the total phosphorus impaired Subwatershed was given a weight of 4.

Table 15: Phosphorus Impaired Subwatershed Definition

Score	0	1
Phosphorus Impaired Subwatershed	Not located in Aberjona Subwatershed	Located in Aberjona Subwatershed

5.2 Phosphorus Average Annual Load

The phosphorus average annual load for each stormwater catchment area was calculated based on land use data and the modeling method described in *Section 2.3*. Based on the estimated loading within each catchment and location of properties within a certain catchment, each property was given a score ranging from 1-5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. In relation to phosphorus loading, the priority is placed on retrofitting sites within higher phosphorus loading catchments in order to maximize phosphorus reduction throughout the Town. The table below shows how the estimated phosphorus average annual load translates into a numerical score. In the site selection matrix, the phosphorus average annual load was given a weight of 4.

Table 16: Phosphorus Average Annual Load Definition

Score	1	2	3	4	5
Phosphorus Average Annual Load	0-999 lbs/year	1,000-1,999 lbs/year	2,000-2,999 lbs/year	3,000-3,999 lbs/year	loading ≥ 4,000 lbs/year

5.3 Amount of Impervious Area

The amount of impervious area of a site was evaluated by the approximate percentage of the parcel that is covered by pavement, rooftops, and other nonporous surfaces. The percentage of impervious area covering the parcel was determined using satellite images from Google Earth. The surface area of impervious surfaces on the site was divided by the total surface area of the site to calculate the property's percentage of impervious area. Based on the percentage of impervious area, each property was given a score ranging from 1-5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how percentages of impervious area translate into a numerical score. In the site selection matrix, the amount of impervious area was given a weight of 4.

Table 17: Amount of Impervious Area Score Definition

Score	1	2	3	4	5
Percentage of impervious area	Less than 30% impervious area	30% - 49% impervious area	50% - 69% impervious area	70% - 89% impervious area	Greater than 90% impervious area

5.4 Soil Infiltration Capacity

The soil infiltration capacity was evaluated based on the hydrologic soil group of each site. There are four hydrologic soil groups: A, B, C, and D. Infiltration BMPs installed in hydrologic group A soil are the most successful, followed by those installed in hydrologic group B soil, then hydrologic group C soil, and lastly hydrologic group D soil. The classification of each sites soil type was determined using the United States Department of Agriculture's (USDA) web soil survey. Each municipal property was studied as an area of interest with the web soil survey. The study results showed the types of soil within the site boundary and their hydrologic soil group classification. Based on the hydrologic soil group, each site was given a score ranging from 1-5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how the sites soil classification translates into a numerical score. In the site selection matrix, the soil infiltration capacity was given a weight of 3.

Table 18: Soil Infiltration Capacity Score Definition

Score	1	2	3	4	5
Soil Infiltration Capacity	Mostly Hydrologic Group D Soil	Mostly Hydrologic Group C Soil	Mostly Hydrologic Group B Soil	Mix of Hydrologic Group A/B Soil	Mostly Hydrologic Group A Soil

5.5 Depth to Groundwater Table

The depth from the ground surface to the groundwater table determines the capacity of infiltration BMPs per unit area. The depth to groundwater table was estimated using the USDA's web soil survey tool. Each municipal parcel was studies as an area of interest and the approximate depth to water table was recorded. Based on the depth to groundwater table each site was given a score ranging from 1-5, with 1 being the lowest priority for BMP

retrofit site selection and 5 being the highest. The table below shows how the depth to water table in feet was translated into a numerical score. In the site selection matrix, the depth to groundwater table was given a weight of 2.

Table 19: Depth to Groundwater Table Score Definition

Score	1	2	3	4	5
Depth to Groundwater Table	Less than 2 feet	2.01 – 3 feet	3.01 – 4 feet	4.01 – 5 feet	More than 5 feet

5.6 Flooding Frequency

Flooding potential serves as an indication of the level of storm sewer service in a given area. An area with a high flooding potential is underserved and is a higher priority for BMP retrofits. Each sites flooding potential was determined from the Town's input on recorded observations of stormwater flooding and any observed flooding events during wet weather sampling or additional MS4 field work conducted throughout town. Based on flooding potential, each site was given a score ranging from 1-5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how flooding potential translates into a numerical score. In the site selection matrix, flooding was given a weight of 2.

Table 20: Flooding Frequency Score Definition

Score	1	2	3	4	5
Flooding Frequency	No history of flooding	Floods less than once every 10 years	Floods every 5 – 10 years	Floods every 5 years	Floods annually or more frequently

5.7 Planned Capital Improvements

Planned capital improvements scores were based on the timeline of when anticipated capital improvements would be implemented, with sites being given a score ranging from 1-5, 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how upcoming planned capital improvements translate into a numerical score. In the site selection matrix, planned capital improvements was given a weight of 2.

Table 21: Planned Capital Improvements Score Definition

Score	1	2	3	4	5
Planned Capital Improvements	No planned improvements within 5 years	Planned improvements within 5 years	Planned improvements within 4 years	Planned improvements within 3 years	Planned improvements within 2 years

5.8 Ease of Maintenance

Sites with a clear pathway for maintenance personnel and equipment are more likely to have properly maintained and thus more effective BMPs. Each site was analyzed using satellite images from Google Earth and Google Street View and input from Town employees. The ease of maintenance was evaluated visually by the identification of clear pathways that would support access by maintenance personnel and equipment, similar to a small excavator or tractor. Based on the ease of maintenance, each site was given a score of 1, 3, or 5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how ease of maintenance evaluation translates into a numerical score. In the site selection matrix, ease of maintenance was given a weight of 2.

Table 22: Ease of Maintenance Score Definition

Score	1	2	3	4	5
Ease of Maintenance	Not accessible to maintenance personnel or equipment	-	Accessible to maintenance personnel but not equipment	-	Accessible to maintenance personnel and equipment

5.9 Sensitive Receptors

Cultural, historical, and ecological factors that can impact the permitting of a BMP retrofit project were considered during site selection. The presence of sensitive receptors in the vicinity of a site can make it more challenging to obtain the necessary permits for BMP retrofit projects and slow down construction schedules. Sensitive receptors were mapped using the MassMapper tool from MassGIS. The five sensitive receptors identified and details on what they encompass are listed below. Each municipal property was located on the sensitive receptors map, and the number of sensitive receptors in the site's vicinity was recorded. Figure 2 shows the map sensitive receptors throughout Stoneham. Based on the number of sensitive receptors in the site's vicinity, each site was given a score ranging from 1-5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how a site's number of sensitive receptors translates into a numerical score. In the site selection matrix, sensitive receptors was given a weight of 1.

- Public Water Supplies
- MA Historic Commission Inventory Areas
    - National register of historic places
    - Preservation restrictions
    - MA historic landmarks
    - Local Historic Districts
    - National Register of Historic Places
    - Inventoried properties
- MA Natural Heritage and Endangered Species Program (NHESP) estimated habitats of rare wildlife
- MA Natural Heritage and Endangered Species Program (NHESP) priority habitats of rare species
- Priority Natural Vegetation Communities
    - NHESP certified and potential vernal pools

- Riverine natural community systems
- Coastal natural community systems

Table 23: Sensitive Receptors Score Definition

Score	1	2	3	4	5
Number of Sensitive Receptors	More than three sensitive receptors in site's vicinity	Three sensitive receptors in site's vicinity	Two sensitive receptors in site's vicinity	One sensitive receptor in site's vicinity	No sensitive receptors in site's vicinity

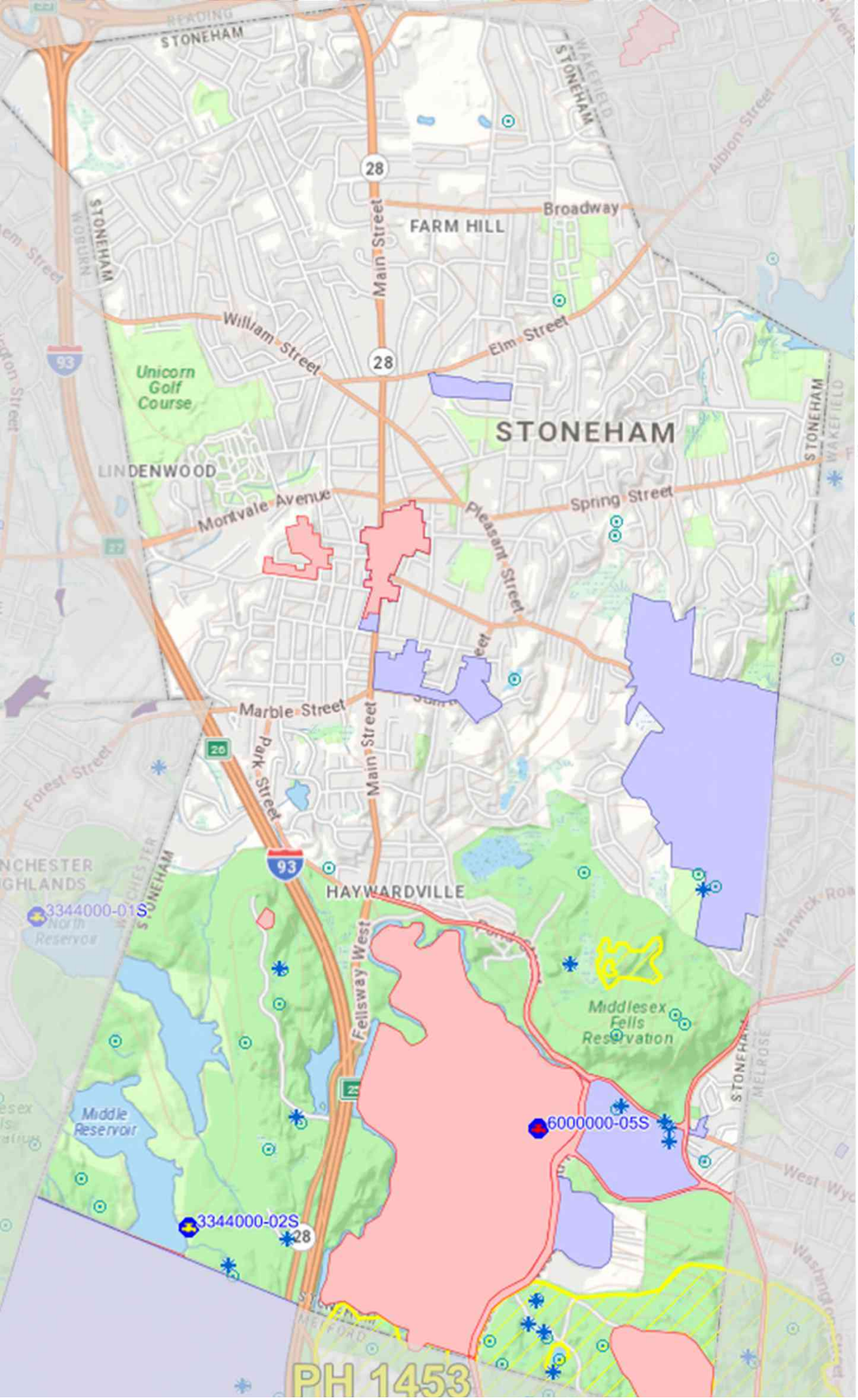


Figure 2: Sensitive Receptors

5.10 Benefits Vulnerable Populations

Sites where BMP retrofits would provide benefit to more vulnerable populations were prioritized over sites where BMP retrofits would not benefit vulnerable populations. Each site's benefit to vulnerable populations was evaluated by the CDC's Social Vulnerability Index (SVI) classification of the site's location. The SVI classifies neighborhoods with a score ranging from 0 to 1, with 0 being the least socially vulnerable and 1 being the most socially vulnerable. Based on the site's SVI overall classification, each site was given a score ranging from 1-5, with 1 being the lowest priority for BMP retrofit site selection and 5 being the highest. The table below shows how a site's SVI classification translates into a numerical score. In the site selection matrix, benefits to vulnerable populations was given a weight of 1.

Table 24: Benefits Vulnerable Populations Score Definition

Score	1	2	3	4	5
CDC SVI Overall Classification	SVI 0-0.2	SVI 0.201-0.4	SVI 0.401-0.6	SVI 0.601-0.8	SVI 0.801-1.0

5.11 Exclusion Criteria

Not all sites are feasible for BMP retrofits. Sites that are determined to be infeasible for retrofits are excluded from site selection. These excluded sites meet one or more of the following exclusion criteria:

- Space constraints would not allow for BMP retrofits.
- BMP retrofits on site would impede Town operations or private business.
- The site has recently been improved.
- The site has an insignificant amount of impervious area.
- BMP retrofits or similar developments on site would be subject to strong public opposition.

6 Conclusion

Appendix A shows the full site selection matrix, including scores for site selection criteria categories and the composite scores of each site. The five sites with the highest composite scores have been deemed as the highest priority sites for BMP retrofits at this time. To continue to fulfill the requirements of the Town of Stoneham's MS4 permit, each year the sites with the five highest composite scores will be reviewed and considered for future design and implementation. It is anticipated that the Town will implement one retrofit project per MS4 permit year, as funding and resources allow.

6.1 Site Scores

For the details of the score each site received in each site selection criteria, please see **Appendix A**. The table below shows the composite score that each site received sorted in order of highest to lowest. The composite score is a metric of the priority each site takes in the rolling BMP retrofit site selections throughout the MS4 permit. Each site's composite score is a function of the score it received in each site selection criteria and the weight of each site selection criteria. Sites with the highest composite scores are the highest priority for BMP retrofits.

Table 25: Composite Scores of Municipal Sites from Site Selection Matrix

Site Name	Composite Score
Robin Hood Elementary School	78
South Elementary School	71
Stoneham Arena	69
Stoneham Central Middle School	69
Old Central School	67
Stoneham High School	67
Colonial Park Elementary School	66
Citation Avenue Pumping Station	62
Lindenwood Cemetery	60
DPW Garage and Office	59
Recreation Park	59
Fire Department	59
Fuller Street Parking Lot	59
Rita Road Pumping Station	59
Stoneham Oaks	59
Unicorn Golf Course	59
Rounds Playground	58
Police Department	55
Senior Center	55
Town Hall	55
Pomeworth Field	53
Upland Road Pumping Station	50

Site Name	Composite Score
Stoneham Public Library	49
Joseph C. Cerrone Memorial Park	47
DPW Yard (Steven's Street)	45
Stoneham Historical Society	44
Fallon Road Pumping Station	42
North Street Pumping Station	38
Whip Hill Park	37
Stoneham Town Common	35

A detailed scoring summary for each site, in addition to a scoring criteria table, can be found in **Appendix C**. Based on exclusion criteria defined in *Section 5.11*, the sites listed below are determined to be infeasible for retrofits and are excluded from site selection. It is anticipated that this list will be continually updated as site improvements and modifications throughout the Town are ongoing.

- Robin Hood Elementary School – underground stormwater stormceptor in recreational field, recent stormwater and building improvements completed
- Stoneham Central Middle School – recent stormwater and building improvements completed
- Stoneham High School – stormwater and building improvements currently under construction
- Citation Avenue Pumping Station – spatial and operational restraints
- Lindenwood Cemetery – socially and spiritually sensitive area

6.2 Year 4 BMP Retrofit Site Selections

The five municipal properties with the highest composite scores, factoring in some excluded sites per the criteria in *Section 5.11*, have been selected as the MS4 Permit Year 4 sites for BMP retrofits and can be found in the table below. These 5 sites are prioritized based on highest composite site score. Design and implementation of retrofits at these sites may be based on Town preference and resources available. Additionally, the Town has completed an inventory of Town-owned structural BMPs; these BMPs could be retrofitted in the future. Lastly, BMPs can be installed in town-owned rights of ways, as appropriate when streets are redesigned.

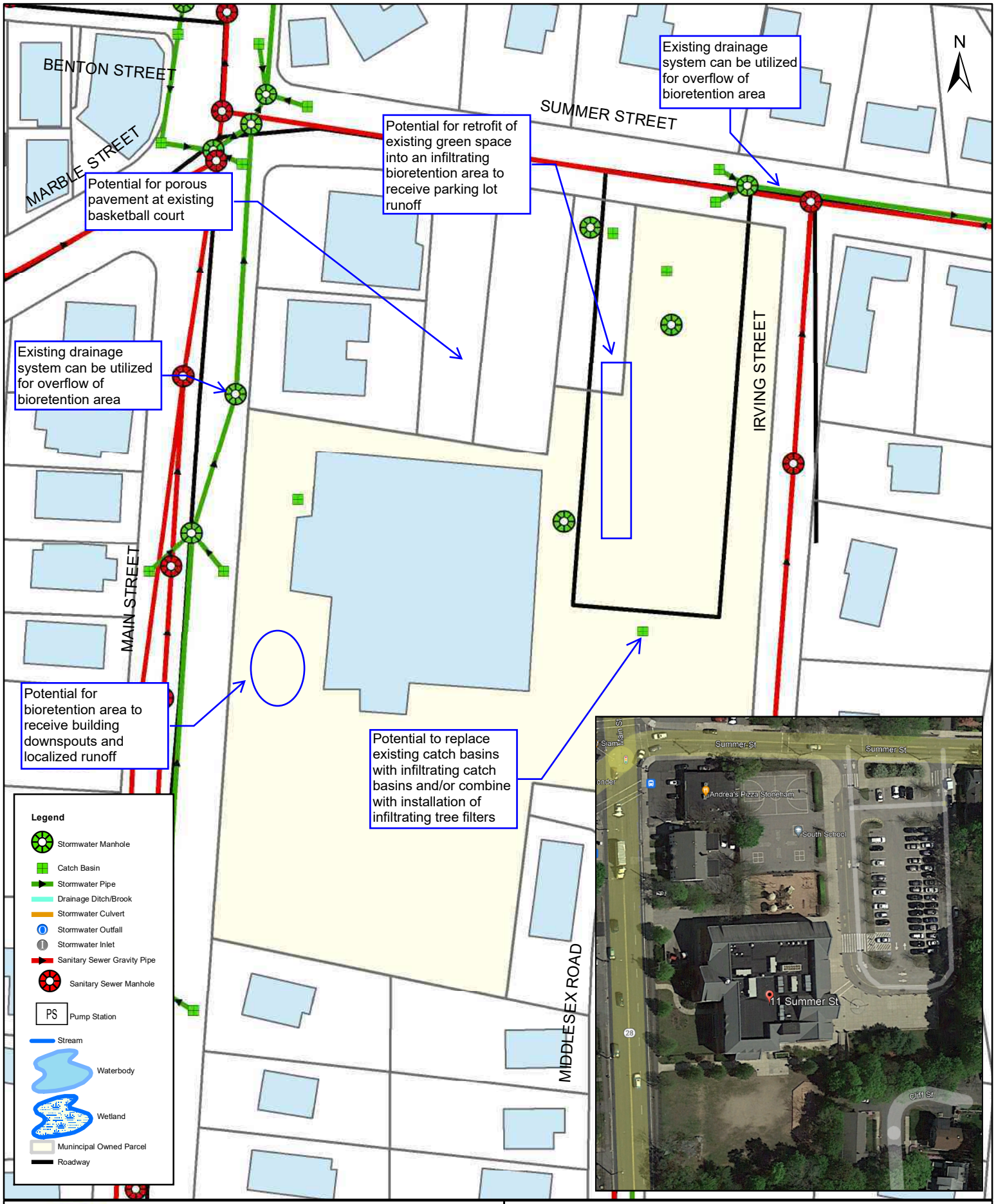
Table 26: MS4 Permit Year 4 BMP Retrofit Site Selections

MS4 Permit Year 4 BMP Retrofit Site Name	Site Address
South Elementary School	11 Summer St.
Stoneham Arena	101 Montvale Ave.
Old Central School	25-29 William St.
Colonial Park Elementary School	30 Avalon Rd.

MS4 Permit Year 4 BMP Retrofit Site Name	Site Address
Department of Public Works (DPW) Garage and Office	16 Pine St.
Town-owned Structural BMPs	Various
Town-owned Right-of-ways	Various

6.2.1 South Elementary School

The South Elementary School (shown in Figure 3) is located at 11 Summer St. with access to the school also along Main St. The parcel consists of impervious surfaces from the parking lot, building rooftop, and concrete walkway adjacent to the building. There is existing open green space in front of the building along Route 28, in the south corner of the parcel, and existing vegetated strips in the parking lot. The school is an excellent candidate for infiltration BMPs because it has a mixture of well-draining soils and a depth to water table of over 6 feet. A bioretention area could be implemented in the open green space along Main St. for collection and treatment of stormwater from the building downspouts and localized runoff. This bioretention area would also add to the aesthetic appeal of the front of the building on Route 28. Existing vegetated strips in the parking lot can be retrofitted into bioretention areas with overflow connections to the existing stormwater system in the parking lot and along Summer St. A capacity assessment on the existing drainage infrastructure must be conducted for any retrofit that is anticipated to utilize the nearby drainage system for stormwater conveyance or overflow piping. If a parking lot assessment and re-design is conducted at this site, the Town will consider feasibility and implementation of additional infiltrating structural BMPs. There is potential to reduce impervious area and provide infiltration in the adjacent basketball court with the installation of porous pavement. Existing catch basins in the parking lot can also be replaced with infiltrating catch basins or retrofitted with the installation of infiltrating tree filters to allow for parking lot runoff treatment and groundwater recharge.



TOWN OF STONEHAM, MASSACHUSETTS
Figure 3 - Proposed Retrofits

Facility: South Elementary School
Address: 11 Summer St.

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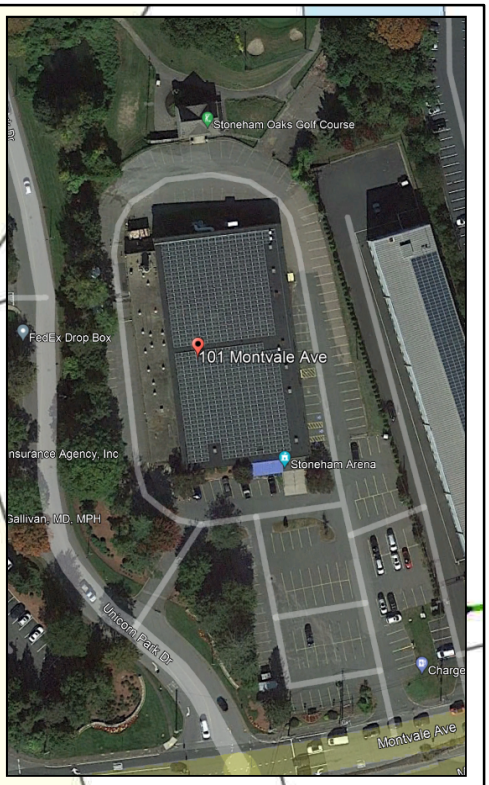
6.2.2 Stoneham Arena

The Stoneham Area (shown in Figure 4) is a hockey arena located at 101 Montvale Ave. near Interstate 93 and adjacent to Stoneham Oaks Golf Course. This site is nearly all impervious surfaces, which consist of the parking lot for hockey games and events, and the building. A parking analysis could be conducted to determine the necessary number of parking spaces to serve the number of visitors and workers at the arena. If it is deemed that the current number of parking spaces is superfluous, part of the existing parking lot can be replaced with green space. The arena is an excellent candidate for infiltration BMP retrofit implementation due to the extensive amount of impervious area that can be removed and/or disconnected and because it has fair-draining soils and a depth to water table between 3-4 feet. The existing vegetated strip in the parking lot can be retrofitted into a bioretention area with overflow connections to the existing stormwater system along Montvale Ave. A capacity assessment on the existing drainage infrastructure must be conducted for any retrofit that is anticipated to utilize the nearby drainage system for stormwater conveyance or overflow piping. Additional bioretention areas in parallel with the proposed existing vegetated strip could be implemented to provide stormwater treatment for the parking lot runoff. There are also multiple catch basins throughout the property that could be replaced with infiltrating catch basins. One last potential retrofit opportunity is a retrofit and restoration of the existing pond behind the arena and implementation of pretreatment structure(s) upstream of the pond in the rear parking lot.

Potential for retrofit and restoration of existing pond with pretreatment structures upstream of pond

Burbank Pond

Hockey Arena



Potential to replace existing catch basins with infiltrating catch basins

Potential for retrofit of existing green space into an infiltrating bioretention area to receive parking lot runoff

Potential for new bioretention areas in the parking lot to receive localized runoff

Parking analysis could be completed to determine feasibility of parking lot size reduction

Existing drainage system can be utilized for overflow of bioretention areas

MONTVALE AVENUE

MAPLE STREET

MONTVALE AVENUE

Legend

- Stormwater Manhole
- Catch Basin
- Stormwater Pipe
- Drainage Ditch/Brook
- Stormwater Culvert
- Stormwater Outfall
- Stormwater Inlet
- Sanitary Sewer Gravity Pipe
- Sanitary Sewer Manhole
- PS Pump Station
- Stream
- Waterbody
- Wetland
- Munincipal Owned Parcel
- Roadway

TOWN OF STONEHAM, MASSACHUSETTS
Figure 4 - Proposed Retrofits

Facility: Stoneham Arena
Address: 101 Montvale Ave.

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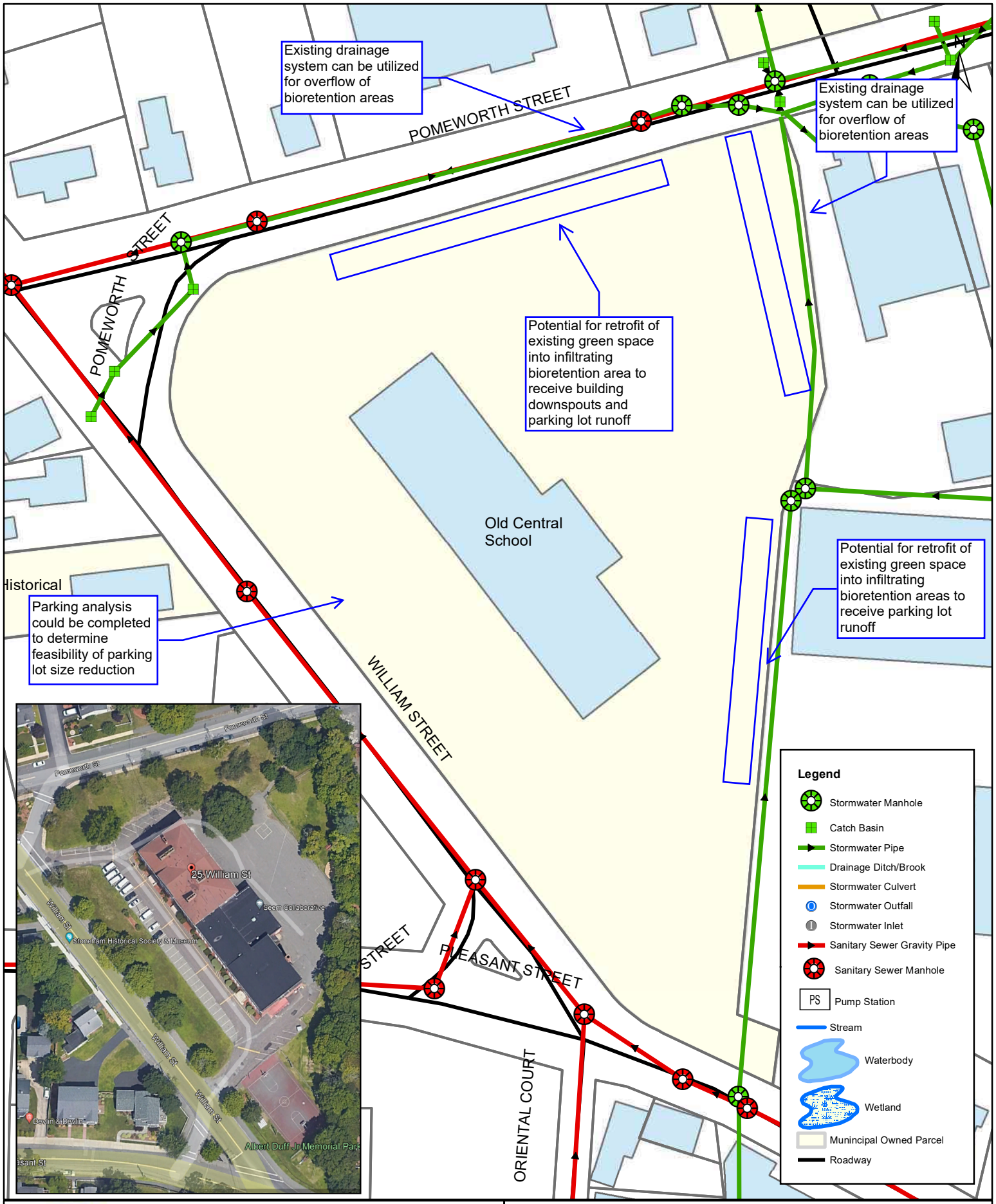
6.2.3 Old Central School

The Old Central School (shown in Figure 5) is located at 25 Williams St. with the northern parcel boundary being adjacent to Pomeworth St. The parcel consists of impervious surfaces from the parking lot, building rooftop, and paved recreational area in the northern corner of the paved lot. A parking analysis could be conducted to determine the necessary number of parking spaces to serve the number of visitors and workers at the school. If it is deemed that the current number of parking spaces is superfluous, part of the existing parking lot can be replaced with green space. The school is a good candidate for infiltration BMP retrofit implementation due to the extensive amount of green space available for retrofits and due to its location within a high phosphorus loading drainage catchment. There is existing open green space along the northern edge of the parcel at Pomeworth St where a bioretention strip could be installed to treat runoff from the building downspouts and additional parking lot runoff. Existing drainage along Pomeworth St. could be used for overflow connections for this BMP. A capacity assessment on the existing drainage infrastructure must be conducted for any retrofit that is anticipated to utilize the nearby drainage system for stormwater conveyance or overflow piping. Finally, there is an opportunity to remove impervious area behind the building with the installation of bioretention areas along the eastern boundary of the parcel to collect and treat parking lot stormwater runoff.



TOWN OF STONEHAM, MASSACHUSETTS
Figure 5 - Proposed Retrofits

Facility: Old Central School
Address: 25 William St.

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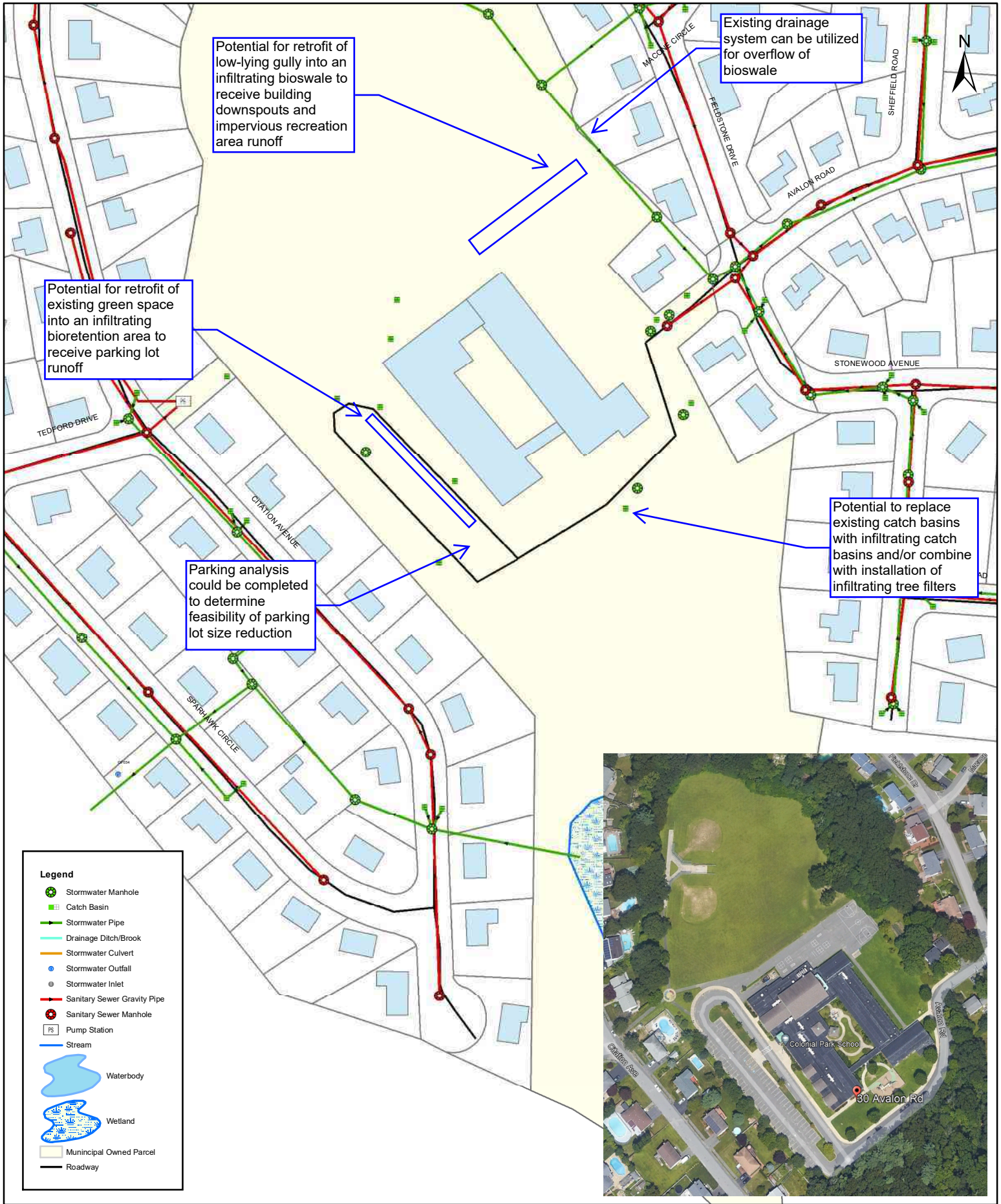
6.2.4 Colonial Park Elementary School

The Colonial Park Elementary School (shown in Figure 6) is located at 30 Avalon Rd. near Whip Hill park in the southern portion of the Town. The parcel consists of impervious surfaces from the parking lot, building rooftop, and paved recreational area off the northern corner of the building. A parking analysis could be conducted to determine the necessary number of parking spaces to serve the number of visitors and workers at the elementary school. If it is deemed that the current number of parking spaces is superfluous, part of the existing parking lot can be replaced with green space. There is existing open green space along the entryway on Avalon Rd, recreational field(s) in the northwest corner of the parcel, and existing vegetated strips in the parking lot. The school is an excellent candidate for infiltration BMPs because it has well-draining soils and a depth to water table of over 6 feet. Existing vegetated strips in the parking lot can be retrofitted into bioretention areas with overflow connections to the existing stormwater system in the parking lot and along Avalon Rd. A capacity assessment on the existing drainage infrastructure must be conducted for any retrofit that is anticipated to utilize the nearby drainage system for stormwater conveyance or overflow piping. Catch basins in the parking lot and along Avalon Rd. can also be replaced with infiltrating catch basins or retrofitted with the installation of infiltrating tree filters to allow for parking lot runoff treatment and groundwater recharge. Another retrofit opportunity is off the northern corner of the building where there is a low lying gully than can be transformed into a bioswale to collect and treat localized stormwater runoff and runoff from the building downspouts and paved recreation area.



TOWN OF STONEHAM, MASSACHUSETTS
Figure 6 - Proposed Retrofits

Facility: Colonial Park Elementary School
Address: 30 Avalon Rd.

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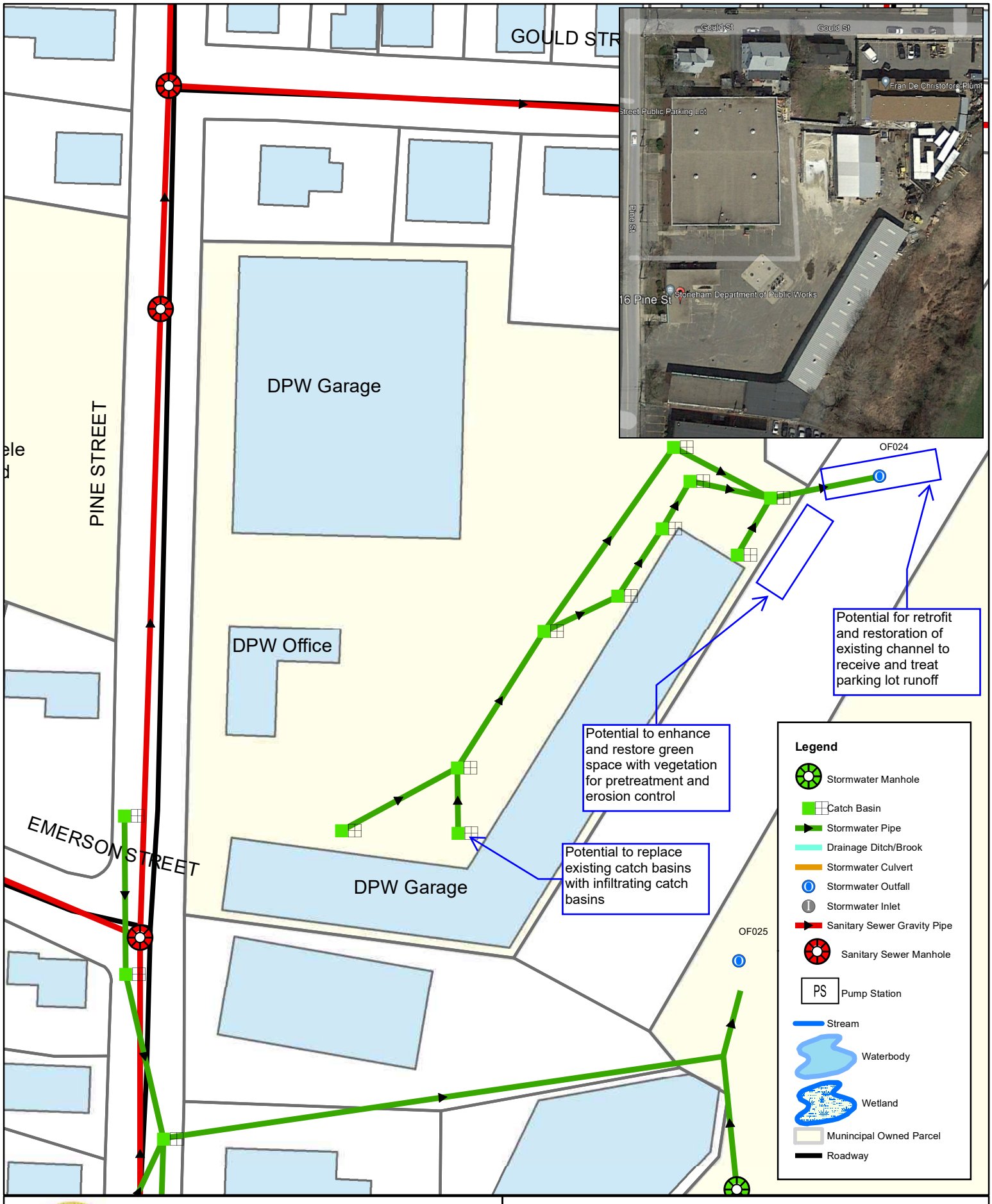
6.2.5 DPW Garage and Office

The DPW Garage and Office (shown in Figure 7) is located at 16 Pine St. The parcel consists of nearly all impervious surfaces. Which is made up from the parking lot, office rooftop, and garage rooftops. The DPW facility is a good candidate for infiltration BMP retrofit implementation due to the extensive amount of impervious area which can be removed and/or disconnected and having fair-draining soils. With existing drainage infrastructure and catch basins on site, there is potential to replace existing catch basins with infiltrating catch basins to allow for parking lot runoff treatment and groundwater recharge. The drainage system discharges to a low lying channel on the east side of the parcel where there is an opportunity to implement a retrofit and restoration practices to provide increased storage and stormwater treatment. Adjacent to this channel there is also prospective land to enhance and restore the green space with vegetation for stormwater pretreatment and erosion control.



TOWN OF STONEHAM, MASSACHUSETTS
Figure 7 - Proposed Retrofits

Facility: DPW Garage and Office
Address: 16 Pine St.

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6.3 Next Steps

Now that the highest priority BMP retrofit sites have been identified, BMP retrofit planning and design can follow. A preliminary assessment of potential retrofit opportunities has been conducted for the top 5 sites and can be found in *Section 6.2*. Once the preliminary assessment and BMP retrofit options have been further refined and developed, a concept design and feasibility review can determine the optimal BMP retrofit(s) for each site. The detailed design and construction of the optimal BMP retrofit will follow. The Town of Stoneham will report its progress on BMP retrofits in the annual MS4 report submitted to the EPA and MassDEP.

The BMP Retrofit Site Selection Matrix will continue to be maintained. It will be updated with new information regarding the site selection criteria as it becomes available. Each MS4 permit year, the Town of Stoneham will select the five sites with the highest composite scores in the matrix for BMP retrofits. The Town will aim to retrofit one municipally owned parcel with an infiltration BMP each MS4 Permit Year, if there are adequate funding and labor resources available for the proposed BMP retrofit.

In accordance with Appendix H of the MS4 Permit, the Town will also provide a plan and schedule for BMP retrofit implementation in the Year 5 Annual Report and install a retrofit as a demonstration project within six years of the permit effective date. The Town will prioritize the municipally owned parcel with the highest composite score in the BMP retrofit site selection matrix, but additional sites may be deemed most suitable due to funding, timing of capital improvements or repairs, and other changing conditions. The Department of Public Works relies heavily on consultants and contractors to assist with design and in some cases operation and maintenance of these types of projects. The DPW would need additional resources allocated to design, operate, and maintain these BMPs.

Appendix A

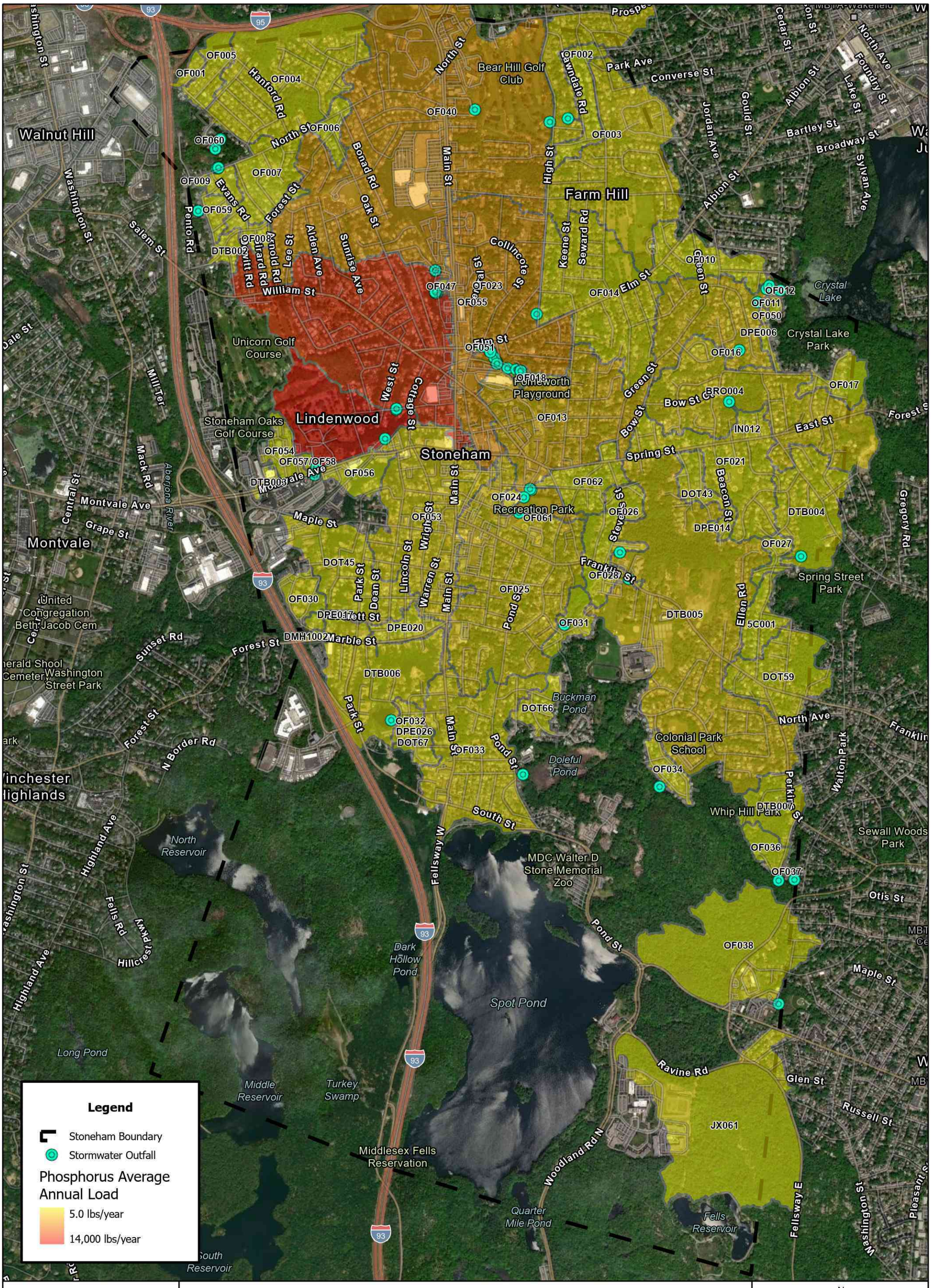
Impervious Area and DCIA Results

Catchment ID	Area [ac]	Impervious Area [ac]	IA [%]	DCIA [ac]	DCIA [%]
5C001	14.6	5.2	36.0%	3.2	21.6
BRO004	244.5	94.5	38.6%	58.7	24.0
DMH1002	1.7	1.0	58.8%	0.8	45.1
DOT43	9.9	4.9	49.1%	3.4	34.5
DOT45	50.7	23.9	47.1%	16.4	32.3
DOT59	40.5	15.1	37.2%	9.2	22.7
DOT66	11.2	5.1	45.1%	3.4	30.2
DOT67	7.7	3.3	42.5%	2.1	27.7
DPE006	2.9	1.7	59.4%	1.3	45.8
DPE014	3.9	1.8	45.4%	1.2	30.6
DPE017	3.9	1.7	43.1%	1.1	28.3
DPE020	11.1	6.5	58.3%	4.9	44.5
DPE026	2.1	1.2	57.0%	0.9	43.1
DTB002	5.6	2.8	49.1%	1.9	34.4
DTB003	3.2	2.6	81.7%	2.3	73.9
DTB004	51.6	18.1	35.1%	8.7	16.9
DTB005	258.3	81.0	31.4%	36.2	14.0
DTB006	81.2	30.8	37.9%	15.7	19.3
DTB007	19.9	4.0	20.3%	1.3	6.7
IN012	158.7	60.1	37.8%	37.0	23.3
JX061	134.3	9.4	7.0%	0.7	0.5
OF001	3.8	1.4	37.6%	0.9	23.0
OF002	19.6	8.6	43.6%	5.7	28.8
OF003	157.0	58.2	37.1%	35.5	22.6
OF004	92.9	31.1	33.5%	18.0	19.4
OF005	13.8	5.8	41.7%	3.7	26.9
OF006	8.9	4.4	49.3%	3.1	34.6
OF007	26.5	10.0	37.7%	6.1	23.2
OF008	16.4	7.8	47.3%	5.3	32.6
OF009	1.3	0.5	40.4%	0.3	25.7
OF010	28.5	12.3	43.1%	8.1	28.3
OF011	0.5	0.2	45.3%	0.2	30.5
OF012	1.7	0.7	44.7%	0.5	29.9
OF013	486.7	239.8	49.3%	168.3	34.6
OF014	86.5	33.7	39.0%	21.1	24.3
OF016	0.7	0.4	65.6%	0.4	53.1
OF017	13.0	4.1	31.7%	1.9	14.2
OF018	4.0	1.4	35.4%	0.7	17.2
OF021	57.6	23.6	41.0%	15.1	26.3
OF023	1163.1	525.5	45.2%	353.2	30.4
OF024	2.3	2.1	91.9%	2.0	88.1
OF025	142.0	72.8	51.2%	52.1	36.7

Catchment ID	Area [ac]	Impervious Area [ac]	IA [%]	DCIA [ac]	DCIA [%]
OF026	21.0	8.2	38.9%	5.1	24.2
OF027	6.5	3.2	49.1%	2.2	34.4
OF028	8.4	4.6	54.6%	3.4	40.4
OF030	10.8	6.2	57.3%	4.7	43.3
OF031	5.5	0.4	8.1%	0.1	1.4
OF032	5.1	2.2	43.1%	1.4	28.3
OF033	89.3	41.3	46.3%	28.1	31.5
OF034	9.8	4.8	48.7%	3.3	33.9
OF036	8.6	1.7	19.7%	0.3	3.9
OF037	0.4	0.3	72.8%	0.3	62.1
OF038	88.5	10.6	12.0%	1.3	1.4
OF040	511.7	212.4	41.5%	136.8	26.7
OF047	1.1	1.0	97.9%	1.0	97.9
OF050	0.9	0.5	57.4%	0.4	43.4
OF051	0.3	0.3	98.6%	0.3	98.8
OF053	97.1	62.8	64.7%	50.5	52.1
OF054	12.1	7.2	60.0%	5.6	46.5
OF055	1341.6	609.6	45.4%	410.9	30.6
OF056	14.2	7.8	54.9%	5.1	36.2
OF057	1.3	0.5	37.9%	0.2	19.3
OF059	6.2	2.8	45.2%	1.9	30.4
OF060	0.5	0.4	75.7%	0.4	65.9
OF061	264.9	133.7	50.5%	95.0	35.8
OF062	21.3	10.6	49.8%	7.5	35.2

Appendix B

Estimated Phosphorus Loading Results



Town of Stoneham, Massachusetts
Phosphorus Source Identification Report & BMP Retrofit Site Selection

Appendix B - Phosphorus Loading Heat Map

N W E S

0 0.1 0.2 0.4 Miles

ARCADIS

Catchment ID	Phosphorus Average Annual Load [lbs/year]
5C001	121
BRO004	2192
DMH1002	22
DOT43	113
DOT45	545
DOT59	356
DOT66	112
DOT67	78
DPE006	37
DPE014	38
DPE017	37
DPE020	150
DPE026	28
DTB002	60
DTB003	52
DTB004	429
DTB005	2020
DTB006	750
DTB007	107
IN012	1414
JX061	356
OF001	35
OF002	191
OF003	1356
OF004	736
OF005	144
OF006	96
OF007	227
OF008	170
OF009	12
OF010	273
OF011	5
OF012	13
OF013	5498
OF014	790
OF016	10
OF017	97
OF018	34
OF021	557
OF023	12017
OF024	41
OF025	1657

Catchment ID	Phosphorus Average Annual Load [lbs/year]
OF026	198
OF027	73
OF028	111
OF030	159
OF031	16
OF032	50
OF033	944
OF034	104
OF036	45
OF037	6
OF038	345
OF040	4873
OF047	20
OF050	11
OF051	6
OF053	1392
OF054	178
OF055	13965
OF056	166
OF057	13
OF059	62
OF060	9
OF061	3058
OF062	248

Appendix C

Site Selection Matrix

Site Name	Site Address	Receiving Waterbody	Phosphorus Impaired Subwatershed?	Phosphorus Impaired Subwatershed	Phosphorus Average Annual Load (lbs/yr)	Phosphorus Average Annual Load	Amount of Impervious Area	Soil Infiltration Capacity	Depth to Groundwater Table	Flooding Frequency	Planned Capital Improvements	Ease of Maintenance	Sensitive Receptors	Benefits Vulnerable Populations	Total Score
Robin Hood Elementary School	70 Oak St.	Sweetwater Brook	Yes	1	4874	5	2	5	5	1	1	5	5	2	78
South Elementary School	11 Summer St.	Unnamed Wetland	Yes	1	1658	2	3	4	5	1	3	5	5	2	71
Stoneham Arena	101 Montvale Ave.	Sweetwater Brook	Yes	1	2760	3	5	2	3	1	1	5	5	2	69
Stoneham Central Middle School	101 Central St.	Unnamed Stream	Yes	1	5516	5	4	1	2	1	1	5	5	3	69
Old Central School	25-29 William St.	Unnamed Stream	Yes	1	3093	4	3	1	2	1	4	5	5	3	67
Stoneham High School	149 Franklin St.	Unnamed Wetland	Yes	1	2020	3	2	2	4	1	5	5	5	2	67
Colonial Park Elementary School	30 Avalon Rd.	Unnamed Wetland	No	0	2294	3	2	5	5	1	1	5	5	2	66
Citation Avenue Pumping Station	Citation Ave.	Unnamed Wetland	No	0	2294	3	3	5	5	1	1	1	5	2	62
Lindenwood Cemetery	Montvale Ave.	Sweetwater Brook	Yes	1	13622	5	1	3	5	1	1	1	5	2	60
DPW Garage and Office	16 Pine St.	Unnamed Wetland	Yes	1	41	1	5	2	2	1	1	5	5	2	59
Recreation Park	99 Dale Ct.	Unnamed Wetland	Yes	1	3093	4	1	2	4	1	1	5	5	2	59
Fire Department	25 Central St.	Sweetwater Brook	Yes	1	1658	2	5	1	2	1	3	3	4	2	59
Fuller Street Parking Lot	Fuller St.	Sweetwater Brook	Yes	1	1658	2	5	1	2	1	1	5	4	2	59
Rita Road Pumping Station	Rita Rd.	Crystal Lake	No	0	2188	3	2	5	5	1	1	1	5	3	59
Stoneham Oaks	101 Rear Montvale Ave.	Sweetwater Brook	Yes	1	2760	3	1	4	5	1	1	3	5	2	59
Unicorn Golf Course	460 William St.	Sweetwater Brook	Yes	1	2760	3	1	4	5	1	1	3	5	2	59
Rounds Playground	MacArthur Rd.	Unnamed Stream	Yes	1	1356	2	1	5	5	1	1	3	5	2	58
Police Department	47 Central St.	Sweetwater Brook	Yes	1	1658	2	5	1	2	1	1	3	4	2	55
Senior Center	136 Elm St.	Unnamed Stream	Yes	1	2188	3	2	2	2	1	1	5	5	2	55
Town Hall	35 Central St.	Sweetwater Brook	Yes	1	1658	2	5	1	2	1	1	3	4	2	55
Pomeworth Field	Calthea St.	Unnamed Stream	Yes	1	3093	4	1	1	2	1	1	5	5	3	53
Upland Road Pumping Station	Upland Rd.	Doleful Pond	No	0	944	1	2	5	5	1	1	1	5	2	50
Stoneham Public Library	445 Main St.	Sweetwater Brook	Yes	1	1393	2	4	1	3	1	1	1	4	2	49
Joseph C. Cerrone Memorial Park	255 Broadway	Unnamed Stream	Yes	1	1356	2	1	2	2	1	1	5	5	2	47
DPW Yard (Steven's Street)	48 Stevens St.	Unnamed Wetland	No	0	2020	3	1	2	1	1	1	5	5	2	45
Stoneham Historical Society	36 William St.	Unnamed Stream	No	0	3093	4	2	1	2	1	1	1	5	2	44
Fallon Road Pumping Station	Fallon Rd.	Unnamed Stream	Yes	1	1170	2	1	1	5	1	1	1	5	2	42
North Street Pumping Station	207 North St.	Unnamed Wetland	Yes	1	2760	3	1	1	1	1	1	1	5	2	38
Whip Hill Park	Whip Hill Rd.	Unnamed Stream	No	0	108	1	1	1	5	1	1	3	4	2	37
Stoneham Town Common	340 Main St.	Sweetwater Brook	Yes	1	275	1	2	1	2	1	1	1	4	2	35

Scoring Criteria	1	2	3	4	5	Category Weight	Multiplier	Notes
Phosphorus Impaired Subwatershed	Located in Aberjona River Subwatershed	-	-	-	-	highest	4	0 = Not located in Aberjona River Subwatershed
Phosphorus Average Annual Load [lbs/year]	0-999 lbs/year	1,000-1,999 lbs/year	2,000-2,999 lbs/year	3,000-3,999 lbs/year	loading ≥ 4,000 lbs/year	highest	4	
Percentage of Impervious Area	Parcel is < 30% impervious surface	Parcel is 30%-49% impervious surface	Parcel is 50%-69% impervious surface	Parcel is 70%-89% impervious surface	Parcel is > 90% impervious surface	highest	4	
Soil Infiltration Capacity	Mostly Hydrologic Group D Soil	Mostly Hydrologic Group C Soil	Mostly Hydrologic Group B Soil	Mix of Hydrologic Group A/B Soil	Mostly Hydrologic Group A Soil	high	3	
Depth to Groundwater Table	< 2ft to seasonal high groundwater table	2ft - 3 ft to seasonal high groundwater table	3ft - 4ft to seasonal high groundwater table	4ft - 5ft to seasonal high groundwater table	> 5ft to seasonal high groundwater table	moderate	2	
Flooding Frequency	No history of flooding	Floods less than once every 10 years	Floods every 5-10 years	Floods every 5 years	Floods annually or more frequently	moderate	2	
Planned Capital Improvements	No planned improvements within 5 years	Planned improvements within 5 years	Planned improvements within 4 years	Planned improvements within 3 years	Planned improvements within 2 years	moderate	2	
Ease of Maintenance	Is not accessible to maintenance personnel or equipment		Accessible to maintenance personnel, but not equipment		Accessible to maintenance personnel and equipment	moderate	2	
Number of Sensitive Receptors	More than 3 sensitive receptors in site vicinity	3 sensitive receptors in site vicinity	2 sensitive receptors in site vicinity	1 sensitive receptor in site vicinity	No sensitive receptors in site vicinity	low	1	
CDC SVI Overall Classification	0-0.2 Overall Social Vulnerability	0.201-0.4 Overall Social Vulnerability	0.401-0.6 Overall Social Vulnerability	0.601-0.8 Overall Social Vulnerability	0.801-1.0 Overall Social Vulnerability	low	1	