City of Fitchburg, Massachusetts

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

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

Image from: https://www.womenscenter.com/wp-content/uploads/2019/07/Fitchburg-Massachusetts.jpg

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

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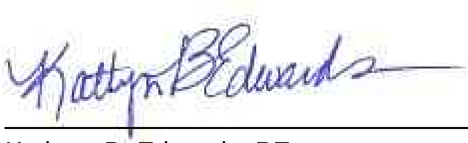

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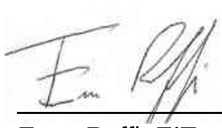

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Contents

Acronyms and Abbreviations vi
Executive Summary 1
1 Introduction 3
1.1 Stormwater System and Waterbodies 3
1.2 MS4 Permit – Phosphorus Source Identification 4
1.3 MS4 Permit – BMP Retrofit Requirements 5
2 Phosphorus Source Identification 8
2.1 Nutrient Pollution 8
2.2 Regulatory Requirements 8
2.3 Phosphorus Loading, IA, and DCIA – Data Sources and Methods 9
2.4 Drainage Areas 11
2.5 Impervious Area and DCIA 12
2.6 Phosphorus Loading Results and Prioritization 12
2.7 Phosphorus Control Best Management Practices 13
3 Potential Sites 16
3.1 Municipally Owned Sites 16
3.2 Municipal Owned MS4 Infrastructure 18
4 Site Selection Criteria 19
4.1 Phosphorus Average Annual Load 19
4.2 Amount of Impervious Area 19
4.3 Soil Infiltration Capacity 19
4.4 Depth to Groundwater Table 19
4.5 Flooding Frequency 20
4.6 Planned Capital Improvements 20
4.7 Ease of Maintenance 20
4.8 Sensitive Receptors 20
4.9 Benefits Vulnerable Populations 20
5 Scoring Methodology 21
5.1 Phosphorus Average Annual Load 21
5.2 Amount of Impervious Area 21
5.3 Soil Infiltration Capacity 22
5.4 Depth to Groundwater Table 22

5.5 Flooding Frequency 23
5.6 Planned Capital Improvements 23
5.7 Ease of Maintenance 24
5.8 Sensitive Receptors 24
5.9 Benefits Vulnerable Populations 27
5.10 Exclusion Criteria 27
6 Conclusion 27
6.1 Site Scores 27
6.2 Year 4 BMP Retrofit Site Selections 30
6.2.1 Goodrich Academy 30
6.2.2 Longsjo Middle School 33
6.2.3 Babe DiConza Memorial Park 35
6.2.4 Goodrich Playground 37
6.2.5 Howarth Park 39
6.3 Next Steps 41

Tables

Table 1: BMP Retrofit Site Selection Criteria and Corresponding Priority 1
Table 2: MS4 Permit Year 4 BMP Retrofit Site Selections 2
Table 3: Receiving Waters for the City of Fitchburg 3
Table 4: Phosphorus Source Identification Plan Requirements 4
Table 5: GIS Datasets 9
Table 6: Average annual distinct phosphorus load (P Load) export rates for use in estimating phosphorus load reduction credits the MA MS4 Permit 11
Table 7: Summary of Impervious Area and DCIA 12
Table 8: Top Impervious Catchments 12
Table 9: Top Phosphorus Loading Catchments 12
Table 10: New and Existing Retrofit Locations and Examples 13
Table 11: Guide to Nonpoint Source (NPS) Control of Phosphorus and Erosion 14
Table 12: Examples of Best Management Practices for Phosphorus Control 15
Table 13: Municipally Owned Sites 16
Table 14: Phosphorus Average Annual Load Definition 21
Table 15: Amount of Impervious Area Score Definition 22
Table 16: Soil Infiltration Capacity Score Definition 22
Table 17: Depth to Groundwater Table Score Definition 23
Table 18: Flooding Frequency Score Definition 23
Table 19: Planned Capital Improvements Score Definition 23
Table 20: Ease of Maintenance Score Definition 24
Table 21: Sensitive Receptors Score Definition 25

Table 22: Benefits Vulnerable Populations Score Definition ... 27
Table 23: Composite Scores of Municipal Sites from Site Selection Matrix ... 28
Table 24: MS4 Permit Year 4 BMP Retrofit Site Selections ... 30

Figures

Figure 1: Preliminary BMP Site Identification ... 7
Figure 2: Sensitive Receptors in the City of Fitchburg ... 26
Figure 3: Map of Proposed Retrofits at Goodrich Academy ... 32
Figure 4: Map of Proposed Retrofits at Longsjo Middle School ... 34
Figure 5: Map of Proposed Retrofits at Babe DiConza Memorial Park ... 36
Figure 6: Map of Proposed Retrofits at Goodrich Playground ... 38
Figure 7: Map of Proposed Retrofits at Howarth Park ... 40

Appendices

Appendix A. Impervious Area and DCIA Results
Appendix B. Estimated Phosphorus Loading Results
Appendix C. Site Selection Matrix

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
NRCS	United States Department of Agriculture Natural Resources Conservation Services
NHESP	Massachusetts 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 City of Fitchburg's Municipal Separate Storm Sewer System (MS4) permit requires the development of a Phosphorus Source Identification Plan and then identification of five City-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 City and locate municipal owned properties where BMP retrofits could be implemented to aid in reducing phosphorus loads. The objective of these BMP retrofits is to also reduce the frequency, volume, and other pollutant loads of stormwater that is discharged through Fitchburg's MS4 and reduce the amount of impervious area throughout the City. In accordance with the MS4 Permit, the City 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 Fitchburg were evaluated using a matrix incorporating site selection criteria and their consideration priority. The five sites and corresponding addresses 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 can be found in Table 2.

Table 1: BMP Retrofit Site Selection Criteria and Corresponding Priority

BMP Retrofit Site Selection Criteria	Priority
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
Goodrich Academy	111 Goodrich Street
Longsjo Middle School	98 Academy Street
Babe DiConza Memorial Park	Beekman Street
Goodrich Playground	Goodrich Street and Boutelle Street
Howarth Park	Rollstone Street and Laurel Street

1 Introduction

1.1 Stormwater System and Waterbodies

The City of Fitchburg 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 City's MS4 Permit became effective on July 1st, 2018, and the City must comply with MS4 permit requirements to discharge stormwater legally. The City's stormwater system discharges and/or is conveyed to the following waterbodies:

Table 3: Receiving Waters for the City of Fitchburg

Receiving Waterbody and Segment ID	Surface Water Class	TMDL Category	Impairment(s)
Baker Brook (MA81-62)	Class B	Category 5	E. Coli
Baker Pond	Class B	Category 3	Insufficient Information
Falulah Brook (MA81-99)	Class B	Category 5	E. Coli
Flag Brook (MA81-10)	Class B	Category 2	Not Assessed
Goodfellow Pond	Class A	Category 3	Insufficient Information
Greenes Pond	Class B	Category 3	Insufficient Information
Lowell Reservoir (MA81074)	Class A	Category 3	Insufficient Information
McTaggarts Pond	Class B	Category 3	Insufficient Information
Mirror Lake (MA81084)	Class B	Category 3	Insufficient Information
Monoosnuc Brook (MA81-13)	Class B	Category 5	E. Coli, Non-Native Aquatic Plants
North Nashua River (MA81-01)	Class B	Category 5	E. Coli
North Nashua River (MA81-02)	Class B	Category 5	Ambient Bioassays - Chronic Aquatic Toxicity, Benthic Macroinvertebrate, Fish Bioassessments, E. Coli, Lead
Notown Reservoir (MA81092)	Class A	Category 3	Insufficient Information
Overlook Reservoir	Class A	Category 3	Insufficient Information
Pearl Hill Brook (MA81-80)	Class B	Category 5	Enterococcus
Phillips Brook (MA81-12)	Class B	Category 5	Temperature
Sand Brook	Class B	Category 3	Insufficient Information
Sawmill Pond (MA81118)	Class B	Category 4c	Non-Native Aquatic Plants

Receiving Waterbody and Segment ID	Surface Water Class	TMDL Category	Impairment(s)
Scott Reservoir (MA81119)	Class A	Category 3	Insufficient Information
Shea Brook	Class B	Category 3	Insufficient Information
Sheldon Brook	Class B	Category 3	Insufficient Information
Snows Millpond (MA81127)	Class B	Category 3	Insufficient Information
Summond Pond	Class B	Category 3	Insufficient Information
Whitman River (MA81-11)	Class B	Category 5	Lead, Temperature, Non-Native Aquatic Plants
Wymans Brook	Class B	Category 3	Insufficient Information
Nashua River (MA81-05)*	Class B	Category 5	Total Phosphorus, Benthic Macroinvertebrates, Escherichia Coli (E. Coli), Sediment Bioassay [Acute Toxicity Freshwater], Water Chestnut
Source: *Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle*			

* There are no direct stormwater discharges to the Nashua River (Segment MA81-05). However, the City of Fitchburg and all drainage catchment areas and waterbodies are located within the Nashua River Watershed.

1.2 MS4 Permit – Phosphorus Source Identification

With the entire City being located in the Nashua River Watershed, 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 City 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

MS4 Permit Appendix H Requirements	Report Section
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 the fourth year of the MS4 permit is the identification of a minimum of five (5) City-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 City'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 rights of way, 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."

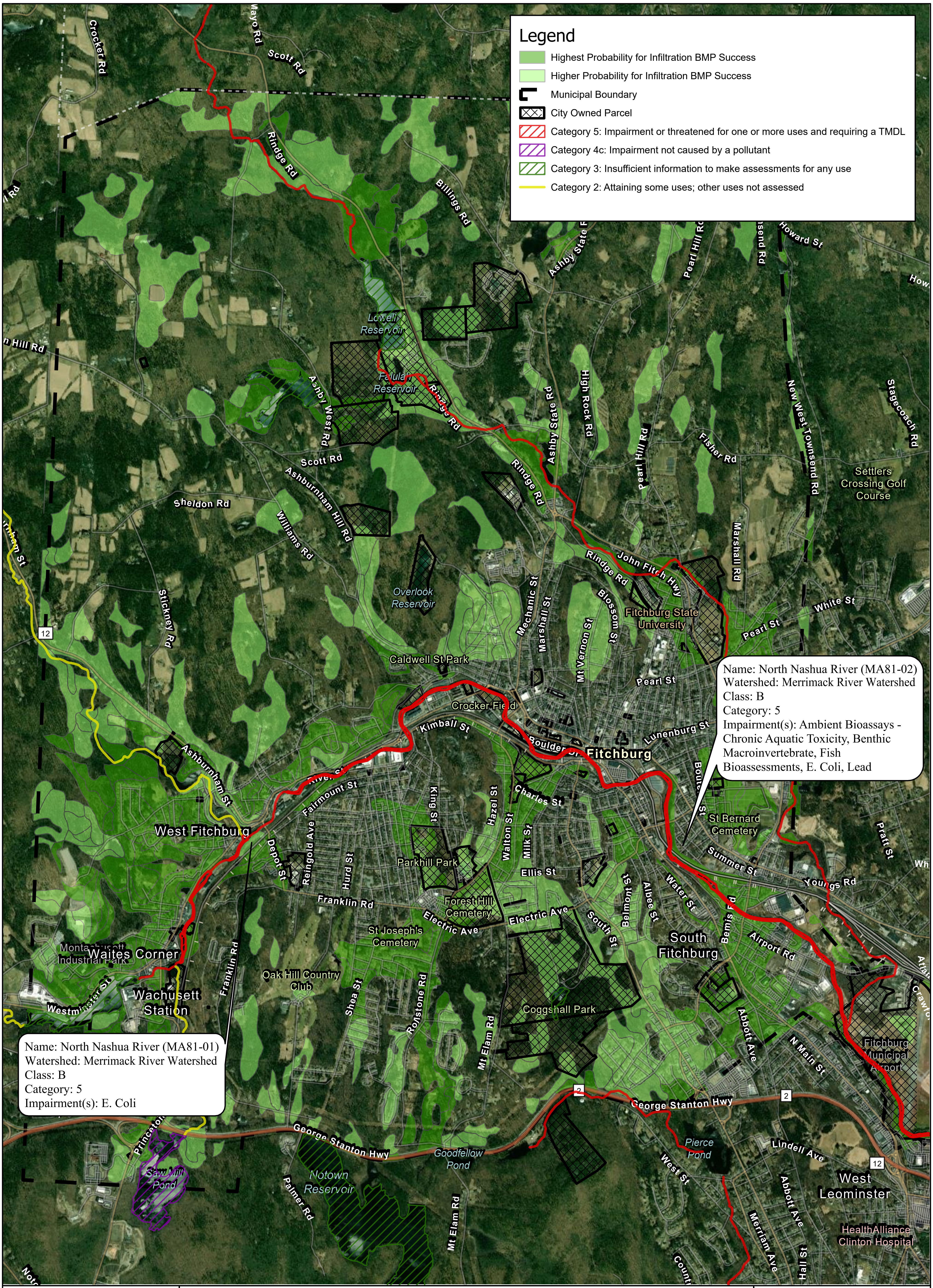
A structural stormwater BMP is an engineered method that is implemented to prevent or reduce pollution from stormwater discharge. Structural BMPs can be divided into two categories: gray infrastructure and green infrastructure.

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
- City-owned properties
- City-owned properties with opportunity to reduce impervious area
- Areas prone to flooding caused by stormwater

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

This report includes the results of a comprehensive desktop assessment of all the City-owned properties in Fitchburg and sets priorities for implementation of BMP retrofits throughout the lifetime of the MS4 permit. The assessment uses 9 selection criteria to rank sites for implementation BMP retrofits and allows the City 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.



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City of Fitchburg, Massachusetts
Phosphorus Source Identification Report & BMP Retrofit Site Selection

Figure 1: Preliminary BMP Site Identification

A TOWN FEB. 3, 1764. A CITY. MAR. 8, 1872. FITCHBURG

ARCADIS

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 naturally occurring 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 these 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, caused 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 City 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 City of Fitchburg 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 City 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 Nashua River Watershed which encompasses the entire City. This 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 and is 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 in order 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/UPDATED	LINK
Fitchburg Stormwater Drainage Structures and Conveyances	City of Fitchburg	March 2022	NA
Fitchburg Stormwater Drainage Catchments	City of Fitchburg	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 Fitchburg 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 city. A phosphorus loading map and tabular loading results can be found in **Appendix B.**

Impervious area is the portion of the City 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 City 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 City'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. The table below displays 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 City of Fitchburg is approximately 17,995 acres, all of which is an MS4 regulated area and located within the Nashua River Watershed. The MS4 regulated area consisted of 237 stormwater outfalls. 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.

2.5 Impervious Area and DCIA

The table below summarizes the total impervious area and estimated DCIA throughout the entire City.

Table 7: Summary of Impervious Area and DCIA

Criteria	Acres
Total Impervious Area in City	2,005
Total Estimated DCIA in City	1,152

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

Table 8: Top Impervious Catchments

Catchment ID	Total Drainage Area (acres)	Impervious Area (acres)	Percent Impervious	DCIA (acres)	Percent DCIA
C330	651	188	29%	100	16%
C435	308	115	38%	57	19%
C612	298	113	38%	57	20%
C442	352	102	29%	57	16%
C444	163	102	63%	62	38%

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 City's MS4 stormwater outfalls was calculated. The table below summarizes the five catchments with the highest estimated phosphorus average annual loading throughout the City.

Table 9: Top Phosphorus Loading Catchments

Catchment ID	Estimated Phosphorus Average Annual Load (lbs/yr)
C330	4,730
C204	3,950
C435	2,680
C612	2,630
C442	2,580

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 City 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 4.1* and *Section 5.1* 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 10: 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 • 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 11: Guide to Nonpoint Source (NPS) Control of Phosphorus and Erosion

Type of NPS Pollution	Whom To Contact	Types of Remedial Actions
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, City 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.
Residential, urban areas		
Septic Systems	Homeowner, Lake associations, City Board of Health, City 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.

Type of NPS Pollution	Whom To Contact	Types of Remedial Actions
Runoff from Housing lots	Homeowner, Lake associations	Divert runoff to vegetated areas, plant buffer strips between house and lake
Urban Runoff	Landowner, City 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	City 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 12: 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 • Cover cropping • Crop residue usage • Cropland irrigation management	•Forestry preharvest •Streamside management areas •Forest chemical management •Fire management •Forest vegetation of disturbed reas	• Land use planning and management • Public acquisition of watershed land • Minimum lot size zoning restrictions • Buffer zones and setbacks • 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

Agricultural Activities	Forestry Activities	Urban Activities
		• 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 City-owned properties with significant impervious cover. All City-owned facilities and properties have previously been inventoried to comply with the City's MS4 permit Good Housekeeping Minimum Control Measures requirements. This report considers all properties owned by the City of Fitchburg.

3.1 Municipally Owned Sites

A total of 72 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 13: Municipally Owned Sites

Municipally Owned Site Name	Address
Airport Complex	563 Crawford Street
Amiot Field	River Street, across from Broad Street
Babe DiConza Memorial Park	Beekman Street
Bird Sanctuary	581 Ashburnham Hill Road
Brigham Park	Brigham Park
Caldwell Park	Main & Caldwell Streets

Municipally Owned Site Name	Address
Central Fire Station	33 North Street
City Hall (New)	166 Boulder Drive
City Hall (Old)	718 Main Street
Coggshall Park	Electric Avenue
Coolidge Park	198 Townsend Street
Crocker Elementary School	200 Bigelow Road
Crocker Field	25 Circle Street
Crocker Playground	Westminster & Wachusett Streets
Daniels Park	Daniels & Fairmount Streets
Day Street Lot	Day Street
Dean Hill Cemetery	304 Caswell Road
East WWTF	24 Lanides Lane
Falulah Treatment Plant	1200 Rindge Road
Fitchburg High School	140 Arn-How Farm Road
FLLAC School	44 Wanoosnoc Road
Forest Hill Cemetery	115 Mt. Elam Road
Forest Park Island	Forest Park
Former Central Fire Station Lot	28 Oliver Street
Gateway Park	41 Sheldon Street
Goodrich Academy	111 Goodrich Street
Goodrich Playground	Goodrich & Boutelle Streets
Green Corners Park	North & Willow Streets
Harwell Cemetery	Ashby West Road & Scott Road
Henry P. Dextraze Circle	Daniels Street at River Street
Heritage Park	Boulder & Main Streets
Hosmer School	110 South Street
Howarth Park	Laurel Street
Lacava Pump Station	Great Wolf Drive
Laurel Hill Cemetery	167 Laurel Street
Longsjo Middle School	98 Academy Street
Lowe Playground	174 Elm Street
Main Street Parking Garage	412 Main Street
Marshall PRV Station	Main Street
Memorial Middle School	615 Rollstone Street
Montachusett Industrial Park Pump Station	19 Industrial Road
Monument Park	Main Street, Hartwell Street & Wallace Ave
Moran Field	445 Ashburnham Street

Municipally Owned Site Name	Address
Nikitas Field/Parkhill Park	Rollstone Street & Franklin Road
Oak Hill Fire Station	234 Fairmount Street
Oak Hill Pump Station	1071 Franklin Road
Oak Hill Tank and Controls/Valve Building	End of Oak Leaf Road
Overlook Storage Tank and Controls/Valve Building	Flat Rock Road
Phillips Playground	Phillips Street
Police Station	20 Elm Street
Public Library	610 Main Street
Public Works Complex	301 Broad Street
Putnam Park Island	Putnam Park
Putnam Street Parking Garage	133 Boulder Drive
Reingold Elementary School	70 Reingold Avenue
Riverfront Park	Commercial Street
Rollstone/Laurel Schools	260 Rollstone Street
Route 2/Fitchburg City Forest	Route 2
Sadie Quatrale Park	John T. Centrino Memorial Drive and Middle Street
Scott Storage Tank and Controls/Valve Building	Ashby West Road
Senior Center	14 Wallace Avenue
South Fitch Playground	Abbot Avenue and Water Street
South Street Cemetery	South Street
South Street Elementary School	376 South Street
State Pool	Wanoosnoc Road
Summer Street Fire Station	42 John Fitch Highway
Upper Common	857 Main Street
Vacant Parcel	Mount Elam Road
West Fitchburg Streamline Trail Park	465 Westminster Street
West Street Cemetery	Main Street
West WWTF	230 Princeton Road
Woods Haven	Rice Street and Lincoln Street

3.2 Municipal Owned MS4 Infrastructure

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

4 Site Selection Criteria

Arcadis has identified 9 site selection criteria to evaluate each of the City-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 City of Fitchburg: areas identified as high flood frequency and sensitive receptors/historic sites. The final priority criteria is a social factors: benefits vulnerable populations. Each site selection criteria carries a weight that is proportional to its priority in BMP retrofit site selection, 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, which will be discussed further in this section.

4.1 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 City 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.

4.2 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 Fitchburg'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.

4.3 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 green infrastructure 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.

4.4 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 the 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.

4.5 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.

4.6 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.

4.7 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.

4.8 Sensitive Receptors

Fitchburg 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.

4.9 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 City-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 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 City. 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 14: Phosphorus Average Annual Load Definition

Score	1	2	3	4	5
Phosphorus Average Annual Load	0-99 lbs/year	100-199 lbs/year	200-299 lbs/year	300-399 lbs/year	loading ≥ 400 lbs/year

5.2 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 15: 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

5.3 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 16: 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

5.4 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 17: 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

5.5 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 City's input on recorded observations of stormwater flooding and any observed flooding events during wet weather sampling or additional MS4 field work conducted throughout City. 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 18: 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

5.6 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 19: 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

5.7 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 City 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 20: 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

5.8 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 Fitchburg. 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 21: 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

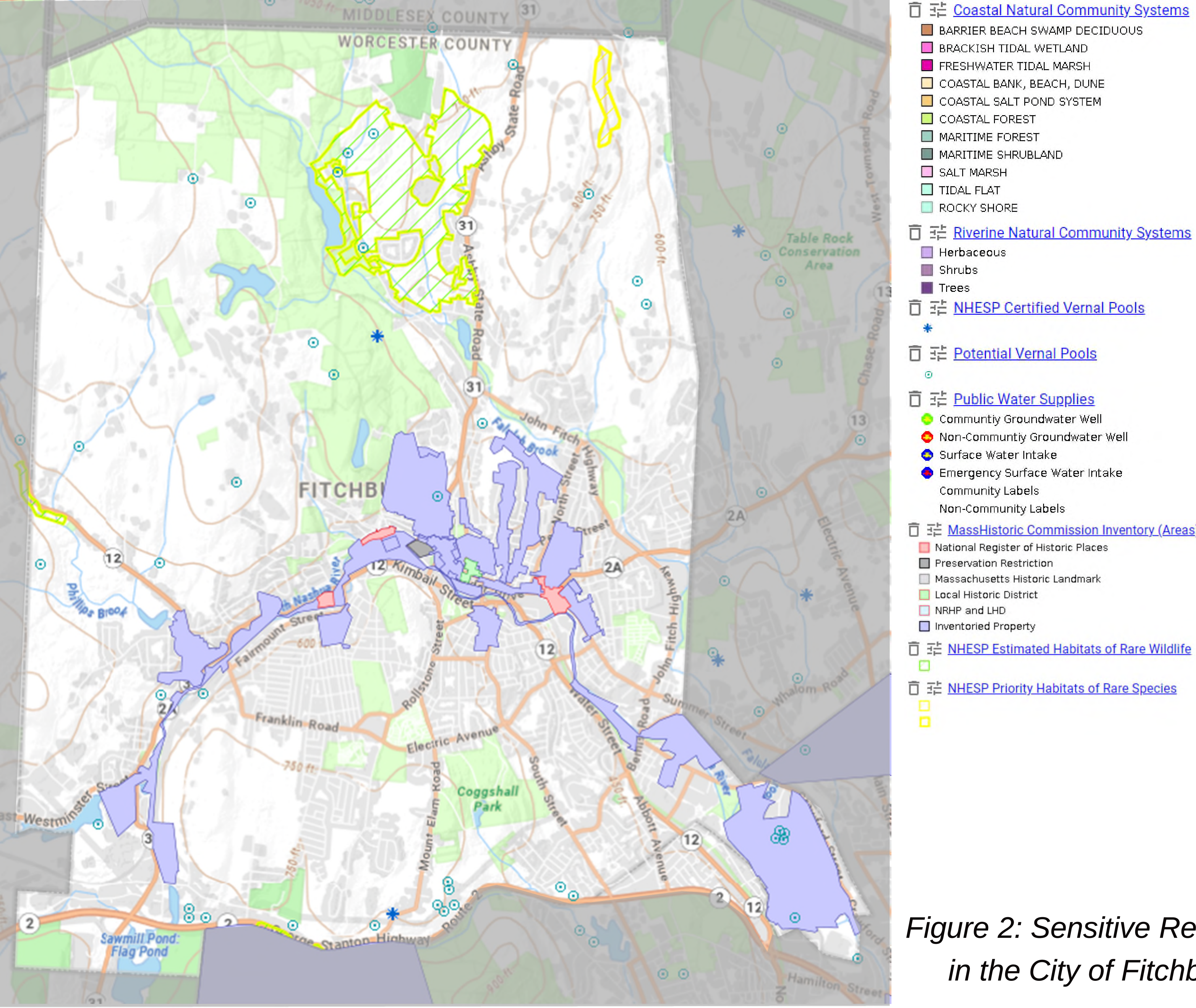


Figure 2: Sensitive Receptors in the City of Fitchburg

5.9 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 22: 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

5.10 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 City operations or private business.
- The site has recently been improved.
- The site has an insignificant amount of impervious area.

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 City of Fitchburg'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 City 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 23: Composite Scores of Municipal Sites from Site Selection Matrix

Site Name	Composite Score
Goodrich Academy	88
Longsjo Middle School	88
Babe DiConza Memorial Park	75
Goodrich Playground	74
Howarth Park	73
Rollstone/Laurel Schools	73
Woods Haven	71
Former Central Fire Station Lot	70
Police Station	70
State Pool	70
Hosmer School	69
Central Fire Station	68
City Hall (New)	68
Day Street Lot	68
South Fitch Playground	67
Caldwell Park	66
Laurel Hill Cemetery	66
Marshall PRV Station	66
Coggshall Park	64
Forest Hill Cemetery	64
Memorial Middle School	64
West Street Cemetery	64
Falulah Treatment Plant	63
Forest Park Island	63
Phillips Playground	63
Crocker Elementary School	62
Harwell Cemetery	62
Senior Center	62
South Street Elementary School	62
FLLAC School	61
Nikitas Field/Parkhill Park	61
Coolidge Park	60
Crocker Playground	60
Main Street Parking Garage	60
Public Library	60

Site Name	Composite Score
Putnam Street Parking Garage	60
Summer Street Fire Station	60
Putnam Park Island	58
Gateway Park	57
Reingold Elementary School	57
Daniels Park	56
Fitchburg High School	55
Montachusett Industrial Park Pump Station	55
Green Corners Park	52
Heritage Park	52
Lowe Playground	52
Public Works Complex	52
South Street Cemetery	52
Bird Sanctuary	49
Oak Hill Fire Station	49
City Hall (Old)	48
Monument Park	48
Oak Hill Tank and Controls/Valve Building	48
Scott Storage Tank and Controls/Valve Building	48
Brigham Park	47
East WWTF	46
Amiot Field	45
Riverfront Park	44
Henry P. Dextraze Circle	40
Lacava Pump Station	40
Oak Hill Pump Station	40
Crocker Field	38
Overlook Storage Tank and Controls/Valve Building	38
Moran Field	36
Upper Common	36
Vacant Parcel	35
Dean Hill Cemetery	33
Route 2/Fitchburg City Forest	33
Sadie Quatrale Park	33
West Fitchburg Streamline Trail Park	33
West WWTF	33
Airport Complex	31

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 5.10*, there are sites determined to be infeasible for retrofits and are excluded from site selection. It is anticipated that this list will be continually updated, and inserted below when compiled, as site improvements and modifications throughout the City are ongoing.

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 5.10*, 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 City preference and resources available. Additionally, the City has completed an inventory of City-owned structural BMPs; these BMPs could be retrofitted in the future. Lastly, BMPs can be installed in city-owned rights of way, as appropriate when streets are redesigned.

Table 24: MS4 Permit Year 4 BMP Retrofit Site Selections

MS4 Permit Year 4 BMP Retrofit Site Name	Site Address
Goodrich Academy	111 Goodrich Street
Longsjo Middle School	98 Academy Street
Babe DiConza Memorial Park	Beekman Street
Goodrich Playground	Goodrich & Boutelle Streets
Howarth Park	Laurel Street
City-owned Structural BMPs	Various
City-owned Rights of way	Various

6.2.1 Goodrich Academy

Goodrich Academy (shown in Figure 3) is located at 111 Goodrich St. with access to the school also along Saint Bernard St. The parcel consists of impervious surfaces from the parking lot, building rooftop, and concrete walkway adjacent to 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 this site. 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 in front of the building along Goodrich St, which is the northern edge of the parcel. This location is an excellent candidate for infiltration BMPs because it has a combination of well-draining soils and a depth to water table of over 6 feet. The site is also located in a high phosphorus loading catchment, making it a high priority location for infiltrating BMPs, and has a significant amount of impervious area that can be disconnected through the implementation of retrofits. Infiltrating bioretention areas could be implemented in the open green space along Goodrich St. for collection and treatment of stormwater from the building downspouts and parking lot runoff. This bioretention area would also add to the aesthetic appeal of the front of the building. There is also an existing drain line in the parking lot and an adjacent drainage system to the west that can be utilized for overflow connections from the proposed infiltrating BMPs. 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. Existing catch basin 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. During future parking lot re-design or repaving, porous pavement could be installed to reduced impervious area and promote infiltration.

Figure 3: Proposed Retrofits

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

GOODRICH ACADEMY

Address: 111 Goodrich Street

6.2.2 Longsjo Middle School

Longsjo Middle School (shown in Figure 4) is located at 98 Academy St. This site is nearly entirely impervious area with impervious surfaces consisting of the parking lot, building rooftop, and concrete walkway adjacent to 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 school. This school is an excellent candidate for infiltration BMPs because it has a combination of well-draining soils and a depth to water table of over 6 feet. The site is also located in a high phosphorus loading catchment, making it a high priority location for infiltrating BMPs, and has a significant amount of impervious area that can be disconnected through the implementation of retrofits. A rain garden could be implemented in the open impervious space adjacent to Pleasant St. with access from Academy St. for collection and treatment of stormwater from the building downspouts and localized runoff. This rain garden would also add to the aesthetic appeal of the parcel. The existing combined sanitary and drainage system along Academy St. can be utilized for overflow connections from the proposed infiltrating BMP. It is anticipated that sanitary sewer and storm drainage separation will be completed in this area by 2025 and this timeline will drive the implementation of a retrofit at this site. 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. Existing catch basins in the parking lot can also be replaced with infiltrating catch basins to allow for parking lot runoff treatment and groundwater recharge. During future parking lot re-design or repaving, porous pavement could be installed to reduced impervious area and promote infiltration.

N

0 40 80 160 Feet

Figure 4: Proposed Retrofits

City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

LONGSJO MIDDLE SCHOOL

Address: 98 Academy Street

6.2.3 Babe DiConza Memorial Park

Babe DiConza Memorial Park (shown in Figure 5) is located at the corner of Beekman St. and Cliff St. The parcel consists of almost entirely pervious surfaces from the open green space and mulch-layered playground. Impervious surfaces on site include a picnic area with a roof and concrete base and adjacent basketball courts. This location is an excellent candidate for infiltration BMPs because it has a combination of well-draining soils and a depth to water table of over 6 feet. The site is also located in a high phosphorus loading catchment, making it a high priority location for infiltrating BMPs. Based on the surrounding grades of adjacent streets and existing conditions of the site, an infiltrating bioretention area could be implemented in the open green space at the southwestern corner of the parcel. New drainage infrastructure could be installed along Cliff St. and convey flows to the proposed bioretention area for stormwater treatment, in addition to treatment of localized runoff from the park at the bioretention area. An alternative to excavating the roadway and installing new drainage infrastructure along Cliff St. could be the installation of curb cuts or swales to convey stormwater flows to the bioretention areas for treatment, if grading and existing conditions are sufficient. This bioretention area would also add to the aesthetic appeal of the site. The existing drainage system along Beekman St. can be utilized for overflow connections from the proposed infiltrating 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.

N

Feet 0 25 50 100

Figure 5: Proposed Retrofits

City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

BABE DICONZA MEMORIAL PARK

Address: Beekman Street

6.2.4 Goodrich Playground

Goodrich Playground (shown in Figure 6) is located at the corner of Goodrich St. and Boutelle St. The parcel consists of almost entirely pervious surfaces from the open green space and mulch-layered playground. The only impervious surface on site is a concrete walkway. This location is an excellent candidate for infiltration BMPs because it has a combination of well-draining soils and a depth to water table of over 6 feet. The site is also located in a high phosphorus loading catchment, making it a high priority location for infiltrating BMPs. Based on existing conditions and grades of the site, an infiltrating bioretention area could be implemented in the low-lying open green space at the northwestern corner of the parcel, adjacent to the playground. Existing drainage infrastructure could be rerouted along Boutelle St. and to convey flows to the proposed bioretention area for stormwater treatment, in addition to treatment of localized runoff from the playground at the bioretention area. An alternative to excavating the roadway and rerouting drainpipes on Boutelle St. could be the installation of curb cuts or swales to convey stormwater flows to the bioretention areas for treatment, if grading and existing conditions are sufficient. There is also potential for an infiltration BMP in the open green space at the low lying corner of Boutelle St. and Goodrich St. Both of these bioretention areas would add to the aesthetic appeal of the playground. The existing drainage system along Boutelle St. can be utilized for overflow connections from the proposed infiltrating 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.

Figure 6: Proposed Retrofits

CITY OF FITCHBURG, MASSACHUSETTS

ARCADIS

GOODRICH PLAYGROUND

Address: Goodrich & Boutelle Streets

6.2.5 Howarth Park

Howarth Park (shown in Figure 7) is located at the corner of Rollstone St. and Laurel St. The parcel consists of almost entirely pervious surfaces from the open green space and mulch-layered playground along Rollstone St. Impervious surfaces on site include concrete walkways and a basketball court. This location is an excellent candidate for infiltration BMPs because it has a combination of well-draining soils and a depth to water table of over 6 feet. The site is also located in a high phosphorus loading catchment, making it a high priority location for infiltrating BMPs. An infiltrating bioretention area could be implemented in the open green space at the low lying area along the western side of the parcel adjacent to the playground. Existing drainage infrastructure could be rerouted along Rollstone St. to convey flows to the proposed bioretention area for stormwater treatment, in addition to treatment of localized runoff from the playground and green space at the bioretention area. An additional bioretention area could be installed in the park along Walton St., adjacent to the basketball courts. Existing drainage infrastructure could be rerouted along Walton St. to convey flows to the proposed bioretention area for stormwater treatment, in addition to treatment of localized runoff from the impervious courts and surrounding green space at the bioretention area. An alternative to excavating the roadway and rerouting pipes in both locations could be the installation of curb cuts or swales to convey stormwater flows to the bioretention areas for treatment, if grading and existing conditions are sufficient. Both bioretention areas would also add to the aesthetic appeal of the site. The existing drainage system along Laurel St. and Walton St. can be utilized for overflow connections from the proposed infiltrating BMPs. 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.

N

0 37.5 75 150 Feet

City Owned Parcel
Waterbody
Stormwater Pipe
Drain Manhole
Outfall
Catch Basin
Sanitary Sewer Pipe
Sanitary Sewer Manhole
Sanitary Sewer Regulator
Sanitary Sewer Cleanout

Figure 7: Proposed Retrofits

ARCADIS

CITY OF FITCHBURG, MASSACHUSETTS

HOWARTH PARK

Address: Rollstone & Laurel Streets

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 City of Fitchburg 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 City of Fitchburg will select the five sites with the highest composite scores in the matrix for BMP retrofits. The City 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 City 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 City 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	Total Drainage Area [ac]	Impervious Area [ac]	Impervious Area [%]	DCIA [ac]	DCIA [%]
ARC_10	2.6	0.8	32.1	0.5	18.9
ARC_11	25.3	3.5	13.7	1.8	7.3
ARC_12	6.6	1.4	21.2	1.0	14.6
ARC_13	51.2	27.8	54.3	14.4	28.1
ARC_14	12.6	1.3	10.3	0.8	6.2
ARC_2	16.5	12.4	75.2	8.8	53.3
ARC_3	18.4	4.6	25.2	3.1	17.0
ARC_4	253.0	50.1	19.8	25.1	9.9
ARC_5	70.4	6.6	9.4	3.1	4.3
ARC_6	0.8	0.4	46.5	0.4	43.6
ARC_7	3.8	3.2	83.3	2.2	57.1
ARC_8	7.9	5.3	66.3	3.8	48.4
C101	2.0	1.0	50.2	0.9	46.0
C102	6.0	1.9	31.5	1.6	27.4
C107	8.0	2.6	32.2	1.6	20.1
C108	1.9	0.6	29.1	0.4	22.1
C109	22.3	5.0	22.5	3.4	15.2
C110	12.3	2.5	20.0	1.5	12.3
C201	2.5	1.0	40.4	0.8	32.9
C202	11.9	4.2	35.2	3.2	27.0
C203	6.1	2.6	41.8	2.0	33.1
C204	823.6	70.5	4.6	28.4	1.9
C205	5.0	1.5	31.0	1.0	19.0
C206	71.9	7.5	10.4	3.1	4.3
C209	10.0	2.2	21.8	1.5	15.1
C210	2.0	1.3	64.3	0.8	40.0
C211	18.9	2.8	15.0	1.6	8.7
C212	16.8	2.2	13.3	1.2	7.4
C213	28.2	3.1	10.9	1.8	6.5
C214	5.9	0.1	2.3	0.0	0.4
C216	172.8	6.7	3.9	2.8	1.6
C217	191.9	12.2	6.4	6.4	3.4
C218	14.3	2.4	16.8	1.2	8.4
C219	51.3	9.6	18.8	6.5	12.7
C222	3.2	2.5	78.1	2.2	69.0
C223	132.4	11.5	8.7	5.7	4.3
C225	11.1	4.3	38.8	3.1	27.8
C227	23.8	10.4	43.6	6.4	27.1
C228	7.0	1.5	20.9	1.0	14.7
C229	3.9	1.0	26.8	0.8	19.6
C230	4.1	0.2	5.1	0.2	3.8
C232	4.4	0.1	1.9	0.1	1.9
C233	8.1	0.5	6.1	0.4	4.3
C234	0.3	0.1	35.3	0.1	31.7
C235	0.0	0.0	95.6	0.0	95.6
C236	23.5	4.8	20.3	3.2	13.5
C237	6.0	1.4	24.3	1.0	16.3
C238	11.2	2.6	23.5	1.7	15.3
C239	2.5	0.9	34.1	0.6	25.0
C241	7.5	1.4	18.7	0.9	11.8
C242	9.1	1.6	17.9	1.0	10.6
C243	13.7	3.1	22.7	1.9	14.2
C244	1.4	0.7	51.4	0.6	44.9
C301	10.4	6.7	64.2	4.0	38.9
C302	0.5	0.5	94.8	0.4	74.8
C303	13.3	10.0	75.5	6.0	45.3
C304	48.6	17.9	36.9	10.1	20.7
C3102	6.8	1.2	17.1	0.8	11.3
C3103	4.4	0.8	18.2	0.4	10.0
C3105	8.9	2.7	30.9	1.5	17.0
C3106	143.0	16.8	11.8	7.6	5.3
C3108	27.6	2.9	10.6	0.7	2.5
C3109	62.9	18.2	28.9	11.1	17.6
C3110	191.4	31.7	16.6	17.9	9.4
C3112	1.9	1.1	56.4	1.0	52.4
C3113 / C3114	45.0	16.6	36.8	7.9	17.6
C3116	18.0	6.7	37.2	3.9	21.7
C3118	4.2	0.7	17.7	0.5	10.9
C3119	371.1	78.8	21.2	34.8	9.4
C312	356.2	26.3	4.0	13.5	2.1
C3122	33.1	3.4	10.2	1.8	5.4
C3127	29.9	3.2	10.7	1.7	5.8
C3129	16.1	3.9	24.2	2.1	13.2
C313	0.2	0.2	85.1	0.2	77.2
C314	7.0	5.2	74.4	3.2	45.1
C317	168.7	7.1	4.2	3.7	2.2
C320	3.8	2.3	61.7	1.5	40.4
C321	85.2	11.4	13.4	6.7	7.9
C322	15.7	4.9	31.1	3.3	20.9
C325	23.2	3.4	14.4	2.3	9.9

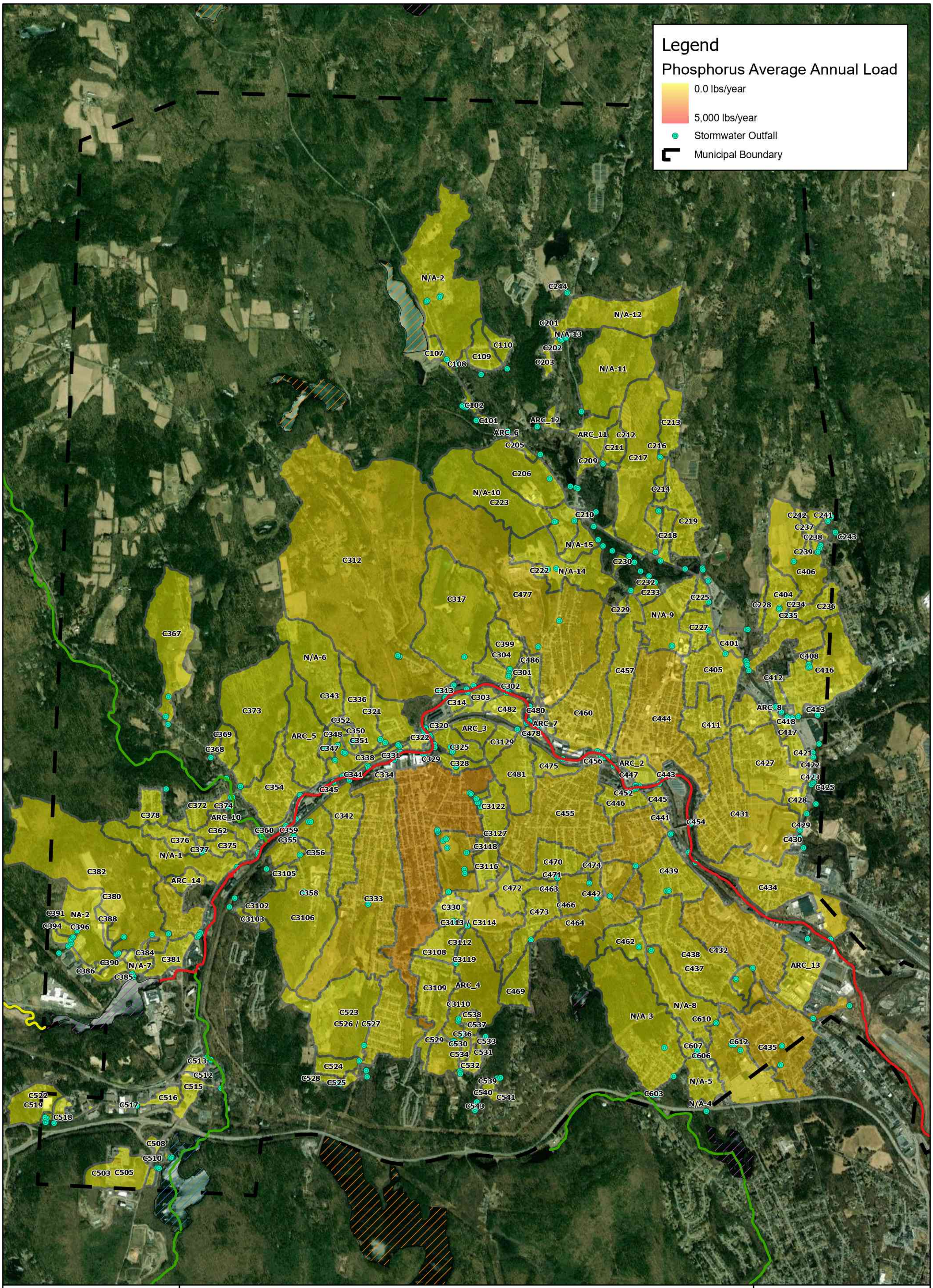
Catchment ID	Total Drainage Area [ac]	Impervious Area [ac]	Impervious Area [%]	DCIA [ac]	DCIA [%]
C328	12.9	2.8	21.6	1.9	14.6
C329	2.0	1.4	73.5	1.0	53.3
C330	650.6	187.6	28.8	99.8	15.3
C331	3.6	2.1	58.5	1.8	49.9
C333	242.8	72.6	29.9	44.2	18.2
C334	3.7	2.9	78.1	2.2	60.5
C336	51.5	5.0	9.7	2.6	5.0
C338	4.0	1.4	34.6	1.0	26.3
C341	1.8	1.1	60.2	1.0	56.3
C342	64.0	24.6	38.5	16.8	26.3
C343	134.1	13.0	9.7	7.6	5.7
C345	2.5	0.9	36.4	0.6	22.5
C347	0.4	0.2	44.1	0.1	32.1
C348	6.5	1.0	16.0	0.6	8.5
C350	10.6	3.0	28.5	2.2	20.6
C351	4.3	1.3	31.3	1.0	24.1
C352	3.6	1.3	37.2	1.0	29.1
C354	62.6	22.2	35.5	15.0	24.0
C355	0.6	0.3	50.6	0.2	34.7
C356	4.0	1.3	31.2	0.8	20.1
C358	191.4	28.6	15.0	14.4	7.5
C359	0.1	0.1	65.6	0.1	64.7
C360	3.4	1.6	48.1	1.4	40.4
C362	27.8	11.0	39.5	6.9	24.9
C367	101.6	6.0	5.9	3.6	3.5
C368	4.0	0.4	10.6	0.3	6.9
C369	16.3	2.0	12.2	1.1	6.5
C372	16.8	5.2	31.2	3.2	19.2
C373	143.4	1.8	1.2	0.8	0.6
C374	0.8	0.4	43.7	0.3	32.1
C375	15.6	7.4	47.2	4.5	28.4
C376	21.4	5.9	27.6	3.9	18.2
C377	0.6	0.3	47.0	0.3	46.0
C378	24.8	7.0	28.4	4.7	19.1
C380	380.4	36.7	9.6	15.5	4.1
C381	23.4	11.1	47.3	7.2	30.6
C382	342.7	24.9	7.3	9.1	2.6
C384	3.7	2.0	53.6	1.5	40.7
C385	2.2	0.2	8.3	0.1	2.6
C386	14.8	7.4	49.9	5.1	34.3
C388	7.2	2.2	31.1	1.4	18.8
C390	4.2	3.0	70.7	2.4	55.7
C391	12.3	3.3	26.7	2.2	17.5
C394	7.3	1.9	26.5	1.2	16.9
C396	0.4	0.1	37.2	0.1	36.3
C399	27.5	7.1	25.8	3.4	12.3
C401	9.2	2.6	28.5	1.4	15.2
C404	36.0	5.8	16.1	3.6	10.0
C405	64.6	31.5	48.8	20.8	32.2
C406	146.0	20.9	14.3	11.4	7.8
C408	2.1	0.6	29.8	0.4	18.7
C411	69.8	41.7	59.7	24.3	34.8
C412	7.5	4.8	63.8	3.4	45.6
C413	0.9	0.7	78.2	0.6	63.6
C416	42.7	21.1	49.5	11.0	25.8
C417	8.3	5.5	66.0	4.0	48.2
C418	0.3	0.3	96.6	0.3	83.0
C421	13.6	10.0	73.0	7.3	53.7
C422	1.2	0.8	69.7	0.7	57.5
C423	0.5	0.4	77.8	0.3	68.3
C425	0.6	0.6	92.6	0.6	89.1
C427	89.0	39.8	44.7	17.6	19.8
C428	12.8	6.2	48.5	4.2	33.0
C429	0.5	0.3	64.1	0.3	61.9
C430	0.9	0.9	93.7	0.7	75.9
C431	162.0	64.7	39.9	35.4	21.9
C432	263.9	91.5	34.7	49.6	18.8
C434	105.3	48.2	45.7	25.2	23.9
C435	307.8	114.6	37.2	57.0	18.5
C437	131.3	30.0	22.9	16.7	12.8
C438	119.1	28.6	24.0	16.5	13.8
C439	61.8	20.7	33.4	13.5	21.9
C441	3.9	2.9	74.3	2.0	51.0
C442	351.8	101.4	28.8	56.1	15.9
C443	0.7	0.6	85.4	0.5	71.5
C444	162.8	101.2	62.2	61.1	37.6
C445	8.5	6.3	74.5	4.3	50.3
C446	24.6	12.8	51.9	9.3	37.9
C447	0.9	0.9	99.6	0.8	89.8
C452	0.1	0.1	97.4	0.1	92.9

City of Fitchburg, Massachusetts
MS4 Phosphorus Source Identification Report and
Best Management Practice (BMP) Retrofit Site Selection
Appendix A - Impervious Area and DCIA Results

Catchment ID	Total Drainage Area [ac]	Impervious Area [ac]	Impervious Area [%]	DCIA [ac]	DCIA [%]
C454	0.3	0.3	76.9	0.2	61.5
C455	159.9	73.8	46.1	50.3	31.4
C456	3.0	1.6	54.1	1.1	35.1
C457	62.5	19.2	30.8	12.4	19.8
C460	112.4	67.0	59.6	39.3	35.0
C462	31.6	7.2	22.7	3.7	11.8
C463	159.8	44.5	27.9	24.1	15.1
C464	258.1	61.7	23.9	33.1	12.8
C466	279.0	68.6	24.6	35.5	12.7
C469	26.7	2.5	9.4	1.4	5.3
C470	36.7	11.2	30.4	6.9	18.7
C471	1.2	0.3	27.9	0.2	15.9
C472	31.6	10.2	32.1	5.3	16.7
C473	46.7	13.9	29.9	8.9	19.1
C474	6.2	2.2	35.0	1.5	23.3
C475	18.7	4.0	21.2	3.1	16.6
C477	311.6	62.5	20.1	31.3	10.0
C478	2.9	2.5	86.2	2.4	79.9
C480	2.8	2.6	90.7	1.5	52.3
C481	52.7	11.8	22.4	7.5	14.2
C482	19.9	13.4	67.3	7.4	37.4
C486	12.1	6.9	57.1	4.7	38.9
C503	44.2	16.3	36.8	9.6	21.8
C505	47.9	17.8	37.2	10.2	21.4
C508	6.4	3.2	49.8	2.6	39.8
C510	6.4	3.2	49.8	2.6	39.8
C512	1.9	1.2	59.4	0.8	42.2
C513	6.5	3.5	53.7	2.4	36.8
C515	18.4	8.1	44.2	4.9	26.9
C516	12.2	7.7	62.9	4.7	38.1
C517	4.6	2.8	61.5	2.3	50.6
C518	7.7	3.6	47.3	2.6	33.9
C519	38.3	5.4	14.0	2.0	5.3
C522	36.3	4.8	13.3	1.8	5.0
C523	113.4	7.8	6.9	3.0	2.6
C524	16.8	2.5	15.1	1.6	9.4
C525	11.3	3.9	34.8	2.7	24.3
C526 / C527	206.6	33.0	16.0	17.6	8.5
C528	2.1	1.2	57.3	1.0	46.2
C529	2.1	0.8	38.6	0.6	29.6
C530	0.2	0.2	87.7	0.2	86.1
C531	9.2	3.1	33.6	2.1	22.9
C532	10.2	3.1	30.8	2.1	20.7
C534	5.0	1.4	29.1	0.9	18.2
C535	3.2	1.4	42.4	1.1	33.5
C536	0.1	0.1	78.2	0.1	78.2
C537	4.1	1.3	33.1	1.0	24.3
C538	4.8	1.3	27.4	0.9	18.5
C539	3.8	1.0	26.9	0.6	15.7
C540	4.5	1.1	24.6	0.6	13.9
C541	5.5	1.4	26.4	1.1	19.7
C543	6.5	1.4	22.0	1.1	16.2
C603	0.3	0.2	54.4	0.2	50.5
C606	0.4	0.3	65.3	0.2	56.0
C607	15.0	7.4	49.2	4.7	31.2
C610	181.2	63.9	35.3	32.3	17.8
C612	298.0	112.7	37.8	56.9	19.1
N/A-1	93.3	16.9	18.1	9.2	9.9
N/A-10	104.5	1.7	1.6	0.8	0.8
N/A-11	106.0	2.4	2.2	1.2	1.1
N/A-12	87.7	6.2	7.0	3.6	4.2
N/A-13	0.6	0.3	56.1	0.3	53.2
N/A-14	78.7	16.4	20.8	8.0	10.2
N/A-15	16.8	2.6	15.2	1.1	6.7
N/A-2	184.4	9.9	5.4	5.4	2.9
N/A-3	166.5	17.2	10.3	9.0	5.4
N/A-4	0.9	0.1	8.8	0.1	6.1
N/A-5	47.1	19.6	41.7	12.2	26.0
N/A-6	105.6	7.0	6.7	4.0	3.8
N/A-7	9.6	3.7	38.2	1.9	19.9
N/A-8	96.7	18.4	19.0	9.2	9.6
N/A-9	64.1	21.0	32.8	11.3	17.7
NA-2	57.7	9.3	16.1	4.1	7.1

Appendix B

Estimated Phosphorus Loading Results



N
W E
S
Miles
0 0.2 0.4 0.8

City of Fitchburg, Massachusetts
Phosphorus Source Identification Report & BMP
Retrofit Site Selection

Appendix B - Phosphorus Loading Heat Map

ARCADIS

Catchment ID	Phosphorus Average Annual Load [lbs/year]
ARC_10	19
ARC_11	107
ARC_12	37
ARC_13	602
ARC_14	36
ARC_2	254
ARC_3	134
ARC_4	1360
ARC_5	234
ARC_6	9
ARC_7	67
ARC_8	108
C101	23
C102	45
C107	61
C108	14
C109	133
C110	67
C201	24
C202	104
C203	61
C204	3950
C205	37
C206	254
C209	57
C210	29
C211	86
C212	71
C213	117
C214	12
C216	489
C217	626
C218	76
C219	307
C222	53
C223	415
C225	104
C227	241
C228	45
C229	27
C230	10

Catchment ID	Phosphorus Average Annual Load [lbs/year]
C232	8
C233	21
C234	2
C235	0
C236	137
C237	43
C238	78
C239	22
C241	47
C242	55
C243	92
C244	18
C301	152
C302	10
C303	208
C304	435
C3102	33
C3103	25
C3105	69
C3106	580
C3108	84
C3109	457
C3110	921
C3112	24
C3113 / C3114	354
C3116	157
C3118	21
C3119	2070
C312	1590
C3122	134
C3127	124
C3129	103
C313	4
C314	107
C317	377
C320	50
C321	348
C322	121
C325	123
C328	84
C329	30

Catchment ID	Phosphorus Average Annual Load [lbs/year]
C330	4730
C331	49
C333	1950
C334	59
C336	176
C338	32
C341	24
C342	593
C343	450
C345	20
C347	4
C348	28
C350	68
C351	30
C352	30
C354	542
C355	6
C356	32
C358	893
C359	2
C360	37
C362	256
C367	411
C368	13
C369	67
C372	124
C373	237
C374	9
C375	168
C376	136
C377	7
C378	165
C380	1240
C381	256
C382	946
C384	43
C385	6
C386	154
C388	50
C390	61
C391	90

Catchment ID	Phosphorus Average Annual Load [lbs/year]
C394	54
C396	4
C399	180
C401	79
C404	198
C405	764
C406	787
C408	17
C411	929
C412	113
C413	15
C416	473
C417	112
C418	7
C421	200
C422	17
C423	8
C425	11
C427	872
C428	132
C429	8
C430	17
C431	1570
C432	2200
C434	1090
C435	2680
C437	819
C438	776
C439	521
C441	67
C442	2580
C443	12
C444	2320
C445	139
C446	309
C447	18
C452	2
C454	6
C455	1750
C456	38
C457	485

Catchment ID	Phosphorus Average Annual Load [lbs/year]
C460	1490
C462	196
C463	1130
C464	1640
C466	1810
C469	94
C470	283
C471	9
C472	237
C473	349
C474	56
C475	98
C477	1740
C478	54
C480	52
C481	328
C482	286
C486	161
C503	357
C505	397
C508	72
C510	72
C512	25
C513	72
C515	179
C516	160
C517	60
C518	78
C519	155
C522	142
C523	385
C524	76
C525	100
C526 / C527	1050
C528	28
C529	20
C530	4
C531	78
C532	81
C533	0
C534	38

Catchment ID	Phosphorus Average Annual Load [lbs/year]
C535	32
C536	2
C537	32
C538	33
C539	27
C540	30
C541	38
C543	39
C603	4
C606	6
C607	161
C610	1470
C612	2630
N/A-1	437
N/A-10	182
N/A-11	202
N/A-12	266
N/A-13	7
N/A-14	449
N/A-15	75
N/A-2	475
N/A-3	578
N/A-4	3
N/A-5	434
N/A-6	299
N/A-7	82
N/A-8	500
N/A-9	505
NA-2	250

Appendix C

Site Selection Matrix

ARCADIS

Site Name	Site Address	Receiving Waterbody	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 Population(s)	Total Score
Goodrich Academy	111 Goodrich Street	Baker Brook	5	5	5	5	1	1	5	5	4	88
Longsjo Middle School	98 Academy Street	North Nashua River	5	5	5	5	1	1	5	4	5	88
Babe DiConza Memorial Park	Beekman Street	North Nashua River	5	1	5	5	1	2	5	5	5	75
Goodrich Playground	Goodrich & Boutelle Streets	Baker Brook	5	1	5	5	2	1	5	5	4	74
Howarth Park	Laurel Street	North Nashua River	5	1	5	5	1	1	5	5	5	73
Rollstone/Laurel Schools	260 Rollstone Street	North Nashua River	5	1	5	5	1	1	5	5	5	73
Woods Haven	Rice Street and Lincoln Street	Falulah Brook	5	1	5	5	1	1	5	5	3	71
Former Central Fire Station Lot	28 Oliver Street	North Nashua River	5	5	1	1	2	1	5	4	5	70
Police Station	20 Elm Street	North Nashua River	5	5	1	1	2	1	5	4	5	70
State Pool	Wanoosnoc Road	North Nashua River	5	2	5	5	1	1	3	5	2	70
Hosmer School	110 South Street	North Nashua River	4	5	2	2	1	1	5	4	5	69
Central Fire Station	33 North Street	North Nashua River	5	5	1	1	2	2	3	4	5	68
City Hall (New)	166 Boulder Drive	North Nashua River	5	5	1	1	1	1	5	4	5	68
Day Street Lot	Day Street	North Nashua River	5	5	1	1	1	1	5	4	5	68
South Fitch Playground	Abbot Avenue and Water Street	North Nashua River	5	1	4	5	1	1	5	5	2	67
Caldwell Park	Main & Caldwell Streets	North Nashua River	4	1	5	5	1	1	5	4	3	66
Laurel Hill Cemetery	167 Laurel Street	North Nashua River	5	1	4	5	1	1	3	5	5	66
Marshall PRV Station	Main Street	North Nashua River	4	2	5	5	1	1	3	4	3	66
Coggshall Park	Electric Avenue	Unnamed Pond off Laurel Ave	5	1	3	5	1	1	5	5	2	64
Forest Hill Cemetery	115 Mt. Elam Road	Sand Brook	5	1	4	5	1	1	3	5	3	64
Memorial Middle School	615 Rollstone Street	Sand Brook	2	3	4	5	1	1	5	5	3	64
West Street Cemetery	Main Street	North Nashua River	4	1	5	5	1	1	3	4	5	64
Falulah Treatment Plant	1200 Rindge Road	Falulah Brook	5	1	3	5	1	1	5	3	3	63
Forest Park Island	Forest Park	Unnamed Pond off Laurel Ave	4	1	3	5	1	1	5	5	5	63
Phillips Playground	Phillips Street	Phillips Brook	2	2	5	5	1	1	5	5	3	63
Crocker Elementary School	200 Bigelow Road	Greene's Pond/Falulah Brook	3	3	2	5	1	1	5	5	3	62
Harwell Cemetery	Ashby West Road & Scott Road	Scott Brook	5	1	4	4	1	1	3	5	3	62
Senior Center	14 Wallace Avenue	North Nashua River	5	5	1	1	2	1	1	4	5	62
South Street Elementary School	376 South Street	Tributary to North Nashua River	5	2	2	2	1	1	5	5	5	62
FLLAC School	44 Wanoosnoc Road	North Nashua River	5	1	4	2	1	1	5	5	2	61
Nikitas Field/Parkhill Park	Rollstone Street & Franklin Road	Sand Brook	5	1	3	3	1	1	5	5	3	61
Coolidge Park	198 Townsend Street	Falulah Brook	5	1	2	3	2	1	5	5	3	60
Crocker Playground	Westminster & Wachusett Streets	North Nashua River	3	1	4	5	1	1	5	5	3	60
Main Street Parking Garage	412 Main Street	North Nashua River	5	5	1	1	1	1	1	4	5	60
Public Library	610 Main Street	North Nashua River	5	5	1	1	1	1	1	4	5	60
Putnam Street Parking Garage	133 Boulder Drive	North Nashua River	5	5	1	1	1	1	1	4	5	60
Summer Street Fire Station	42 John Fitch Highway	Baker Brook	5	5	1	1	1	1	1	5	4	60
Putnam Park Island	Putnam Park	North Nashua River	5	1	2	2	1	1	5	5	5	58
Gateway Park	41 Sheldon Street	Sand Brook	5	1	2	2	1	1	5	4	5	57
Reingold Elementary School	70 Reingold Avenue	North Nashua River	5	2	1	2	1	1	5	5	3	57
Daniels Park	Daniels & Fairmount Streets	North Nashua River	5	1	2	2	1	1	5	5	3	56
Fitchburg High School	140 Arn-How Farm Road	Tibutary to Saima Pond	5	1	2	2	1	1	5	4	3	55
Montachusett Industrial Park Pump Station	19 Industrial Road	Snows Millpond	2	1	5	5	1	1	3	5	3	55
Green Corners Park	North & Willow Streets	North Nashua River	5	1	1	1	1	1	5	4	5	52
Heritage Park	Boulder & Main Streets	North Nashua River	5	1	1	1	1	1	5	4	5	52
Lowe Playground	174 Elm Street	North Nashua River	5	1	1	1	1	1	5	4	5	52
Public Works Complex	301 Broad Street	North Nashua River	1	5	1	1	1	1	5	4	5	52
South Street Cemetery	South Street	North Nashua River	1	1	5	5	1	1	3	4	5	52
Bird Sanctuary	581 Ashburnham Hill Road	Tributary to North Nashua River	5	1	2	3	1	1	1	4	3	49

Site Name	Site Address	Receiving Waterbody	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 Population(s)	Total Score
Oak Hill Fire Station	234 Fairmount Street	North Nashua River	1	5	2	2	1	1	1	4	5	49
City Hall (Old)	718 Main Street	North Nashua River	1	5	1	1	1	1	3	4	5	48
Monument Park	Main Street, Hartwell Street & Wallace Ave	North Nashua River	5	1	1	1	1	1	3	4	5	48
Oak Hill Tank and Controls/Valve Building	End of Oak Leaf Road	Flag Brook	5	2	1	1	1	1	1	5	4	48
Scott Storage Tank and Controls/Valve Building	Ashby West Road	Scott Brook	5	1	2	2	1	1	1	5	3	48
Brigham Park	Brigham Park	North Nashua River	5	1	1	1	1	1	3	4	4	47
East WWTF	24 Lanides Lane	North Nashua River	1	1	3	3	1	1	5	5	4	46
Amiot Field	River Street, across from Broad Street	North Nashua River	3	1	1	1	2	1	5	3	5	45
Riverfront Park	Commercial Street	North Nashua River	1	5	1	1	1	1	1	4	5	44
Henry P. Dextraze Circle	Daniels Street at River Street	North Nashua River	2	1	1	2	1	1	5	4	3	40
Lacava Pump Station	Great Wolf Drive	Sawmill Pond	1	1	4	3	1	1	1	5	3	40
Oak Hill Pump Station	1071 Franklin Road	Flag Brook	1	1	3	5	1	1	1	5	2	40
Crocker Field	25 Circle Street	North Nashua River	3	1	1	1	1	1	3	3	4	38
Overlook Storage Tank and Controls/Valve Building	Flat Rock Road	North Nashua River	4	1	1	1	1	1	1	4	3	38
Moran Field	445 Ashburnham Street	Phillips Brook	1	1	2	2	1	1	3	5	3	36
Upper Common	857 Main Street	North Nashua River	2	1	1	1	1	1	3	4	5	36
Vacant Parcel	Mount Elam Road	Monoosnoc Brook	1	1	2	3	1	1	1	5	4	35
Dean Hill Cemetery	304 Caswell Road	Overland Flow	1	1	1	2	1	1	3	5	3	33
Route 2/Fitchburg City Forest	Route 2	Monoosnoc Brook	1	1	2	2	1	1	1	5	4	33
Sadie Quatrale Park	John T. Centrino Memorial Drive and Middle Street	North Nashua River	1	1	1	1	1	1	3	5	5	33
West Fitchburg Streamline Trail Park	465 Westminster Street	Flag Brook	1	1	2	1	1	1	3	4	3	33
West WWTF	230 Princeton Road	Flag Brook	1	1	2	1	1	1	3	4	3	33
Airport Complex	563 Crawford Street	Overland Flow	1	1	2	2	1	1	1	3	4	31

Appendix C - BMP Retrofit Site Selection Scoring Criteria

Scoring Criteria	1	2	3	4	5	Category Weight	Multiplier
Phosphorus Average Annual Load [lbs/year]	0-99 lbs/year	100-199 lbs/year	200-299 lbs/year	300-399 lbs/year	loading ≥ 400 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