

STORMWATER MANAGEMENT MASTER PLAN

Volume 2: Long-Term Capital Improvement Plan

December 2018 - Revised February 2019

WESTFORD





Westford Stormwater Management Master Plan

Volume 2: Long-Term Capital Improvement Plan

December 2018

Revised February 2019

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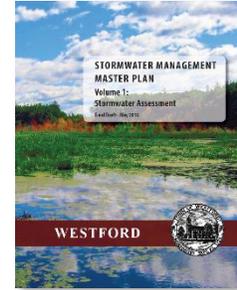
Stormwater Management Master Plan Contents

The Stormwater Management Master Plan is organized into the following four volumes:

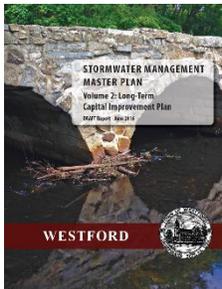
- Volume 1: Stormwater Assessment
- Volume 2: Long-Term Capital Improvement Plan (CIP)
- Volume 3: Operation & Maintenance (O&M) Plan
- Volume 4: NPDES Stormwater Program Compliance Plan

The Town has also explored funding and financial alternatives, which are available under a separate cover from the Stormwater Management Master Plan.

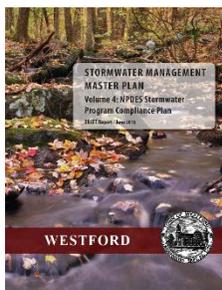
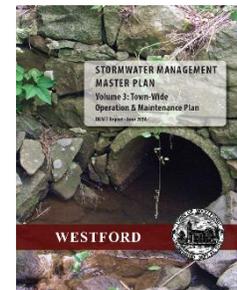
Volume 1, the **Stormwater Assessment**, includes a summary of existing and future conditions (e.g., demographics, land use, water resources), a summary of the current and anticipated future municipal separate storm sewer system (MS4) programs, infrastructure needs, and operations and maintenance. This volume also clarifies drivers for an enhanced stormwater program.



Volume 2, the **Long-Term CIP** includes prioritization of capital projects to address identified drainage and/or water quality needs, recommendations for additional investigation of stormwater infrastructure, and recommendations for the purchase of equipment and hiring of additional staff to meet needs. This plan also incorporates upcoming projects and priorities in Westford that may lend themselves to strategic and cost-effective add-on drainage improvements. For each sub-basin, a menu of appropriate stormwater BMPs that are best to meet that basin's water quality challenges are presented, which can inform future Town projects and also be used to advise local developers during design and permitting for private projects. The Long-term CIP includes an implementation schedule and an opinion of probable costs.



Volume 3, the **Town-wide O&M Plan** includes an inventory of municipal facilities and operations. For the types of activities that the Town routinely conducts, this plan includes town-wide and site specific standard operating procedures (SOPs) for Town staff to follow with the goal of reducing pollutants in stormwater runoff. SOPs are presented in "fact sheets" that can be easily accessed or carried by staff responsible for operations, in some cases at various facilities. The SOPs are consistent with MassDEP's and EPA's most current guidelines.



Volume 4, the **NPDES Stormwater Program Compliance Plan** is equivalent to the written Stormwater Management Program required to satisfy EPA's 2016 Massachusetts Small MS4 General Permit. This Plan documents the best management practices the town will implement to comply with the six minimum control measures (MCMs) within the timeline specified in the reissued General Permit.

Commonly Used Abbreviations	Definitions
AST	Aboveground Storage Tank
BMP	Best Management Practice
CB	Catch Basin
CCTV	Closed-Circuit Television
CIP	Capital Improvement Plan
CMR	Code of Massachusetts Regulations
CPA	Community Preservation Act
CWA	Clean Water Act
DCIA	Directly Connected Impervious Area
DCR	Department of Conservation and Recreation
DO	Dissolved Oxygen
EOEEA, EEA	Executive Office of Energy and Environmental Affairs
EPA	Environmental Protection Agency
ESS	ESS Group, Inc.
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GIS	Geographic Information System
GPS	Global Positioning System
HAB	Harmful Algal Bloom
ICM	Impervious Cover Model
ID	Identification
IDDE	Illicit Discharge Detection and Elimination
MACP	Manhole Assessment Certification Program
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MCM	Minimum Control Measure
MESA	Massachusetts Endangered Species Act
MH	Manhole
MS4	Municipal Separate Storm Sewer System
NHESP	National Heritage and Endangered Species Program
NMCOG	Northern Middlesex Council of Governments
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollution Discharge System
NRCC	Northeast Regional Climate Center
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
OSRP	Open Space and Recreation Plan
PACP	Pipeline Assessment Certification Program

Commonly Used Abbreviations	Definitions
RVA	Regina Villa Associates
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
SwAG	Stormwater Advisory Group
SWAP	Source Water Assessment Report
SWMI	Sustainable Water Management Initiative
SWMMP	Stormwater Management Master Plan
SWMP	Stormwater Management Plan in accordance with General Permit Section 1.10
SWPPP	Stormwater Pollution Prevention Plan
TIP	Transportation Improvement Program
TMDL	Total Maximum Daily Load
TP	Technical Paper
TSS	Total Suspended Solids
WCT	Westford Conservation Trust
WMA	Water Management Act
WPA	Wetland Protection Act
WRPOD	Water Resource Protection Overlay District

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Section 1



Section 1

Introduction

The Town of Westford's Stormwater Management Master Plan (SWMMP) presents a strategic and sustainable plan that will guide Westford in meeting its long-term water quantity, water quality, and operations and maintenance goals while simultaneously meeting economic and environmental needs. The overall plan approach is to present a compelling case for stormwater management, facilitate local coordination for cost-effective solutions, incorporate emerging local and regional issues, and integrate the overarching tenants of sustainability to:

This Capital Improvement Plan provides recommendations to support long-term, cost-effective, and comprehensive stormwater management in Westford.

- Preserve the **water quality** of lakes and streams for **public health, recreation, and wildlife habitat**.
- Provide a sustainable, high-quality **drinking water** source for residents and industry.
- **Operate and maintain Westford's drainage system** to protect public health and property, which includes 52 miles of drain pipes, approximately 5,160 drainage structures (catch basins and manholes), more than 600 outfalls, over 150 miles of publicly maintained roadways plus culverts, dams, and stormwater treatment facilities as well as natural drainage conveyances.
- **Comply with Federal and State environmental regulations** such as the Town's own Stormwater Management and Illicit Discharge bylaws, National Pollutant Discharge Elimination System permits, Massachusetts Stormwater Management Standards, Massachusetts Wetlands Protection Act, Total Maximum Daily Load provisions of the Clean Water Act, and the Safe Drinking Water Act.
- Identify a **sustainable funding strategy** that is **adequate** and **equitable**.

This Long-Term Capital Improvement Plan (CIP) was developed for the purpose of identifying, prioritizing, and budgeting for stormwater infrastructure improvements and other capital projects over a ten-year planning horizon. The plan will provide the Town with the ability to rank expenditures, plan for and normalize expenditures over the planning period, and minimize operating and maintenance costs. As explained previously, this CIP also includes a summary of all SWMMP recommendations and costs as well as programmatic recommendations.

An important component of this CIP is consideration for drainage as an asset that needs to be proactively managed to optimize Town's expenditures, staff time, and overall effort. This CIP provides an overview of asset management, an inventory of Town drainage assets, an evaluation of condition and performance, and identification of critical assets. The results of this work inform projects, schedule, and budgetary costs included in this CIP.

1.1 Stormwater System

Stormwater infrastructure serves several important functions which can be broadly organized into two groups: drainage and water quality. The original goal of stormwater infrastructure was to remove water from roadways and other improved surfaces to prevent icing and flooding. The systems were designed to collect runoff and quickly discharge it to the nearest water course.

Now that we better understand the role of stormwater as a transport mechanism for non-point source pollution, the scope of stormwater infrastructure design has expanded to include water quality treatment, groundwater infiltration, and peak flow attenuation.

Westford is responsible for operating and maintaining the extensive town-owned drainage system, which includes 60 miles of drainage piping, approximately 6,300 drainage structures (including catch basins, manholes, and outfalls), 150 miles of public roadways, almost 285 culverts that total 3.2 miles in length, three municipally-owned and operated dams, numerous structural best management practices, and natural drainage conveyances. Further details on the Town's drainage system is provided in Section 3.

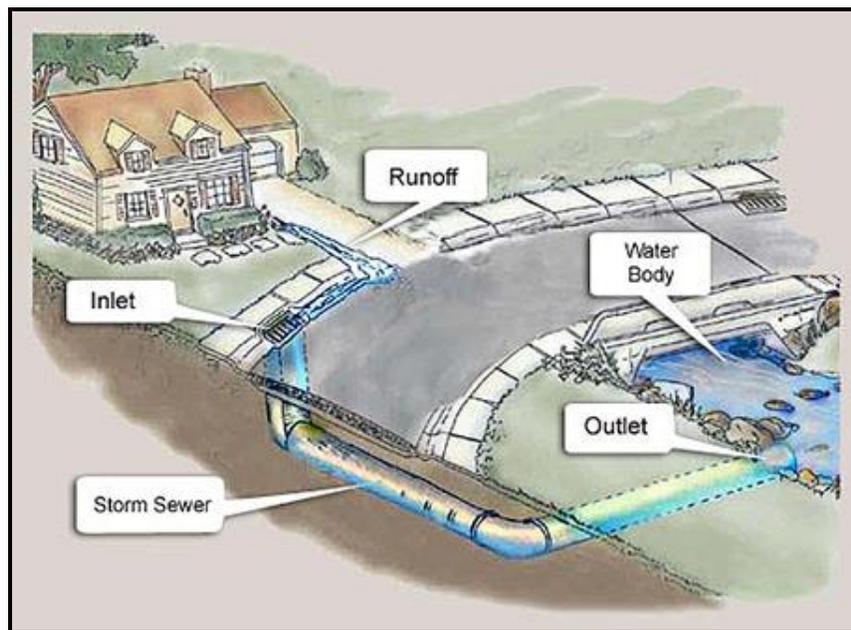


Figure 1-1 Stormwater Runoff Transports Pollutants into Nearby Waterbodies

Photo source: City of Kent, Washington at <http://kentwa.gov/stormwater/>

1.2 Regulatory Drivers

The U.S. EPA nationally regulates the discharge of stormwater runoff that is transported into local water bodies through Municipal Separate Storm Sewer Systems (MS4) that are located in Urbanized Areas (also known as "regulated areas"). The Town of Westford meets EPA's regulatory threshold, and therefore is required to be covered under a National Pollutant Discharge Elimination System (NPDES) permit for its stormwater discharges from the MS4 in its Urbanized Area. Figure 1-2 includes a map prepared by EPA Region 1

showing Westford's Urbanized Area based on the 2000 census and the 2010 census, where the red hatching denotes the urbanized area in Town.

In Massachusetts, the EPA Region 1 and the Massachusetts Department of Environmental Protection (MassDEP) jointly administer the municipal stormwater program, and authorized Westford to discharge stormwater under the 2003 *NPDES General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems*, known as the "Small MS4 General Permit." Under this permit, the Town has developed and implemented a Stormwater Management Program to reduce the contamination of stormwater runoff. The Small MS4 Program contains six (6) elements called *minimum control measures* (MCMs) that, when implemented, should result in a significant reduction in pollutants discharged into receiving waters. The MCMs are:

1. Public Education and Outreach;
2. Public Involvement and Participation;
3. Illicit Discharge Detection and Elimination (IDDE);
4. Construction Site Stormwater Runoff Control;
5. Post-Construction Stormwater Management; and
6. Good Housekeeping and Pollution Prevention.

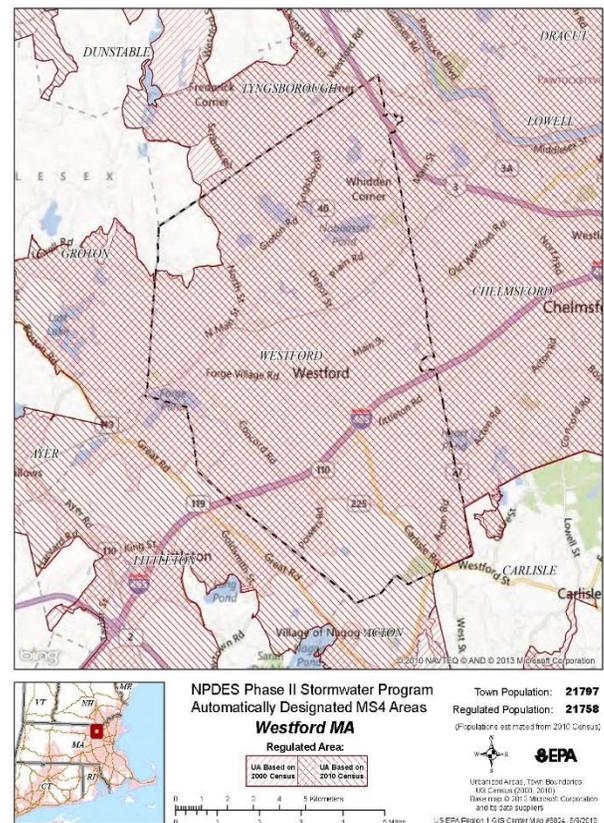


Figure 1-2 Westford's Urbanized Area

The 2003 Small MS4 Permit expired in May 2008 but remained in full force and effect until a replacement permit was released on April 13, 2016. The reissued NPDES *General Permit for Stormwater Discharges from Small MS4 in Massachusetts* will be effective as of July 1, 2018¹, and substantially increases stormwater management requirements and mandates specific timelines for compliance.

After the effective date of July 1, 2018, the Town must comply with the requirements and schedule within the Permit. Volume 4 of this SWMMP, the NPDES Stormwater Program Compliance Plan, is equivalent to the written Stormwater Management Program required to satisfy EPA's Massachusetts Small MS4 General Permit. The Compliance Plan documents the best management practices the town will implement to comply with the six MCMs within the timeline specified in the reissued General Permit. As part of the SWMMP effort,

¹ In June 2017, EPA issued a written statement that the General Permit effective date would be delayed one year from the original effective date of July 1, 2017.

Tighe & Bond developed a memorandum entitled *Draft NPDES Phase II Small MS4 Permit Requirements and Budgetary Planning Estimates for the Westford, MA*, which outlines estimated compliance costs and scheduling. NPDES General Permit compliance costs are discussed in further detail in Section 6.2. The budgetary planning estimates memorandum is included in Appendix A.

1.3 CIP Development

This Long-Term CIP goes beyond the scope of a typical drainage system CIP and provides recommendations for not only capital projects, but also purchase of equipment, non-capital stormwater compliance, and programmatic items to address stormwater management needs identified during development of the overall SWMMP.

Development of this CIP consisted of numerous steps that included of inventorying stormwater assets, identifying existing capital improvements, assessing condition and performance of drainage infrastructure including known problem areas and previously uninspected infrastructure, identifying criticality of inventoried drainage assets, defining projects and expenditures, and prioritizing capital improvements and preparing an implementation schedule. Key components of the CIP development included:

- Identifying known drainage issues, which consisted of obtaining input from Engineering, Highway, Police, Fire, and Schools staff about areas with known drainage problems (e.g., flooding, infrastructure in need of repairs, frequent maintenance locations, etc.) and site visits to locations with concerns;
- Identifying planned capital projects and schedule for completion;
- Completing a desktop evaluation of the drainage system mapping and data (see Volume 1) and digitizing additional drainage system maps;
- Conducting a representative condition assessment for various drainage pipes, manholes, and catch basins using an Envirosight QuickView zoom inspection camera;
- Assessing the known drainage issues and evaluating results of the rapid condition assessment;
- Defining capital needs to support infrastructure improvements, operation & maintenance, and NPDES compliance;
- Developing additional programmatic recommendations for SWMMP implementation;
- Summarizing all SWMMP expected costs; and
- Holding meetings with Town Staff and the Stormwater Advisory Group to obtain input on capital projects and needs.

Section 2



Section 2

Asset Management Considerations

Drainage infrastructure, much like the Town's water system, is a necessary Town utility and therefore should be considered a valuable asset. Westford's stormwater system, which includes drain pipes, structures, outfalls, culverts, channels, dams, roadways and curb, and stormwater management and/or treatment structures, serves important functions to remove water from roadways and other impervious surfaces to prevent icing and flooding and to reduce the transport of non-point source pollution through water quality controls. The cost to replace Westford's drainage system is approximately \$150 million. It only makes sense to proactively maintain this investment. Likewise, managing these assets is critical to protect public health and safety and limit environmental impacts.

By adopting an asset management approach, Westford can proactively maintain its investment in drainage infrastructure, which is worth approximately \$150 million.

EPA defines asset management as "maintaining a desired level of service for what you want your assets to provide at the lowest life cycle cost. Lowest life cycle cost refers to the best appropriate cost for rehabilitating, repairing or replacing an asset." Asset management includes the planning, design, construction, operation, maintenance, rehabilitation, and replacement of infrastructure that performs a function for the Town in a cost-effective manner. There are numerous benefits of asset management that include but are not limited to:

- An improved understanding of the Town's drainage assets, desired level of services, and costs associated with drainage operation and maintenance;
- An ability to better communicate and justify investments to the community and demonstrate a responsible investment in infrastructure;
- An increased ability to budget based on improved understanding about the timing and expense of rehabilitation, repair, and/or replacement needs;
- Prolonging asset life;
- Meeting level of service expectations;
- Addressing regulatory requirements; and
- Improving responses to emergencies.

The general process of asset management involves defining the following items:

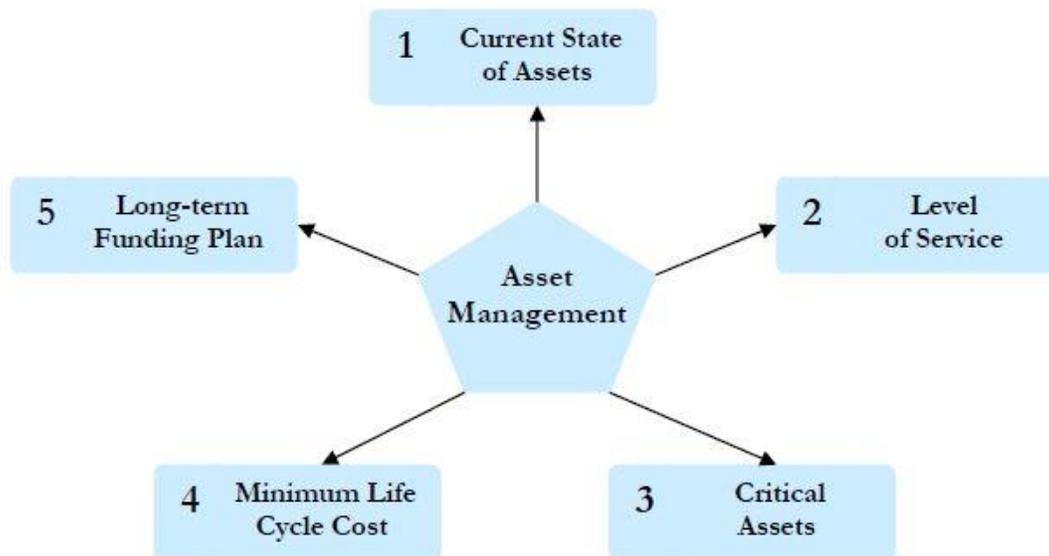


Figure 2-1 Five Core Questions for Implementing Asset Management²

1. **Current State of Assets:** Create an inventory of what assets are included in the drainage system, their location, their condition, their service life, and their value.
2. **Level of Service:** Determine how the system should be operated, considering water quality, water quantity, system reliability, regulatory requirements, and environmental standards.
3. **Critical Assets:** Determine which assets are critical for continued system performance. These may include assets that have a high risk of failing due to their condition, significant consequences in the event of failure, or a high cost of repair or replacement in the event of failure.
4. **Minimum Life Cycle Cost:** Analyze existing operation and maintenance (O&M) procedures and activities to determine how they may be optimized based on cost, criticality, and level of service.
5. **Long-Term Funding Plan:** Determine whether there is enough funding to maintain drainage assets at the desired level of service, and revisit funding opportunities if there is not.

² U.S. EPA, "Asset Management: A Best Practices Guide," April 2008.

Often communities conduct O&M on a reactive basis, with resources allocated to emergency response and rehabilitation or replacement of failed assets. This is classified as a Run-to-Failure Management Model, as shown in Figure 2-2³.

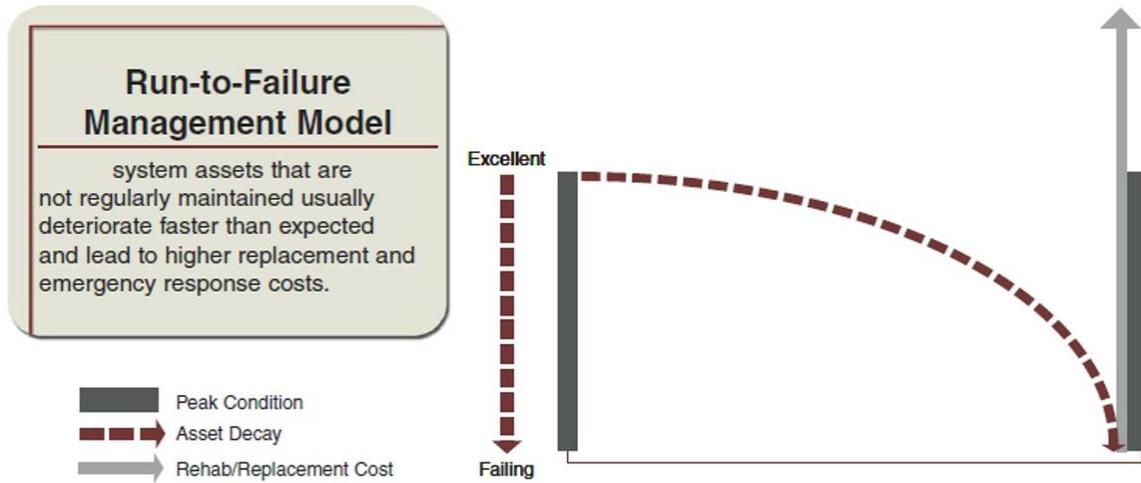


Figure 2-2 Run-to-Failure Management Model

Under this model, assets that have not yet failed are aging, defects are worsening, and the future problems are developing. Ultimately, this can lead to higher costs for maintenance and replacement or repair. Alternatively, utilizing an asset management approach, as shown in Figure 2-3³, allows aging infrastructure to be maintained and replaced prior to failure. This prevents negative consequences of failure and distributes costs over the service life of the asset.

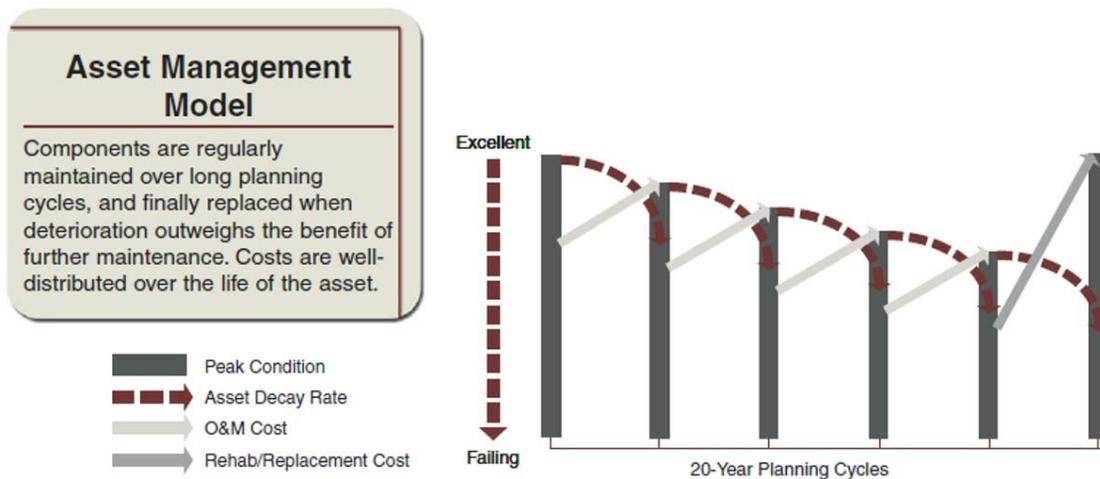


Figure 2-3 Asset Management Model

³ U.S. EPA, "Fact Sheet: Asset Management for Sewer Collection Systems," April 2002.

2.1 Service Life

The Town's stormwater infrastructure varies in age and condition. It is important to understand the generally expected service life for each infrastructure component. We rely on our experience and on manufacturer recommendations and guidance from professional organizations to determine the expected service life. Table 2-1 summarizes the expected service life for a variety of infrastructure in Westford's stormwater system.

Table 2-1 Estimated Service Life for Drainage Assets⁴

Asset	Estimated Service Life (years)
Gravity Main/Culvert (Concrete, Brick, Vitrified Clay, Ductile Iron)	100
Gravity Main (HDPE, PVC, Truss Pipe, Cast Iron)	75
Gravity Main/Catch Basin Lateral/Culvert (Corrugated Metal)	65
Catch Basin Lateral (Concrete, Brick, Vitrified Clay, Ductile Iron, HDPE, PVC, Truss Pipe)	50
Pressurized Main	75
Manhole/Catch Basin (Brick, Concrete, Block, Precast, Fieldstone)	100
Outfall	50
Detention Basin	50
Infiltration Basin	100

It must be noted that some infrastructure components have longer or shorter useful lives depending on the original quality of the infrastructure, the specific environment and conditions, and notable O&M difficulties. For example, most pipes are assumed to have a service life of 100 years, but if a 95-year-old pipe is inspected and found to be in excellent condition, the service life could be adjusted to 125 years.

2.2 Probability of Failure and Consequence of Failure

The likelihood that a stormwater infrastructure component will fail is a function of the component's condition, performance, reliability, and maintenance history. There are several modes of failure⁵ that may occur, including:

- **Mortality** – The asset stops functioning due to a physical collapse or break;
- **Capacity** – The asset is functioning but will not provide the quantity of service required (e.g., a pipe that will not pass a sufficient quantity of flow);
- **Level of service** – Changes in customer needs or in regulations demand a higher level of service than the asset can deliver; and

⁴ Infrastructure Optimization (IO) Toolset software developed by Woolpert, Inc. (ESRI® ArcGIS extension package), documented in the City of Grand Rapids, MI Environmental Protection Services Department, "Stormwater Asset Management and Capital Improvement Plan," May 2013.

⁵ Modes of failure: University of Southern Maine Issue Brief, "Asset Management for Stormwater," April 2014. Available at: http://digitalcommons.usm.maine.edu/cgi/viewcontent.cgi?article=1000&context=sustainable_communities.

- **Financial inefficiency** – The asset is costing more to repair than it would to replace.

In Sections 4 and 5 of this CIP, Tighe & Bond summarizes the condition of Westford’s drainage infrastructure and identifies specific locations in Town at increased risk of failure. If a component of Westford’s stormwater system fails, the resulting consequence of that failure differs depending on a number of factors:

- **Size** of a pipe, channel, or structure – Failure of larger pipes or structures reduces the amount of flow the system can convey and costs more to repair or replace.
- **Depth** of a pipe – Deeper pipes have larger construction areas and higher construction costs.
- **Proximity to Floodplains** – A failure within a floodplain will have a greater impact during a flooding event, leading to accelerated flooding.
- **Proximity to Environmental Hazards** – Pipes that may require replacement in areas of known environmental issues may require special handling and/or disposal during construction.
- **Proximity to Buildings** – Pipes close to or directly under buildings can result in increased construction costs.
- **Proximity to Streets** – Failure may have a greater impact on nearby infrastructure and require greater construction and traffic control coordination depending on the proximity of the pipe to the road and the criticality of the road.
- **Destination** – Failure of pipes or outfalls discharging to impaired or priority receiving waterbodies may result in increased cost of repair due to difficulty of construction and stringent permitting requirements.
- **Location** – Failure of infrastructure within a more populated area will have greater consequences.
- **Channel Bank Slope** – Channels with steep slopes may be more prone to bank erosion and may lead to higher construction or redesign costs.
- **Type of Channel** – Streams, rivers, and different channel types will have varied costs associated with permitting, design, and construction.

In Westford, where drainage systems are typically small and decentralized, the predominant consequences of failing drainage infrastructure are safety-related (road closures limit the passage of emergency vehicles and other traffic) and water quality-related for the Town’s receiving waters.

The relationship between the probability and consequence of failure determines the criticality of an asset, as demonstrated in Figure 2-4. An asset in new condition (low probability of failure) with a low consequence of failure is considered a low risk asset. Conversely, an asset that is in poor condition and has a high consequence of failure is considered a critical asset with a high risk for the Town and should be monitored.

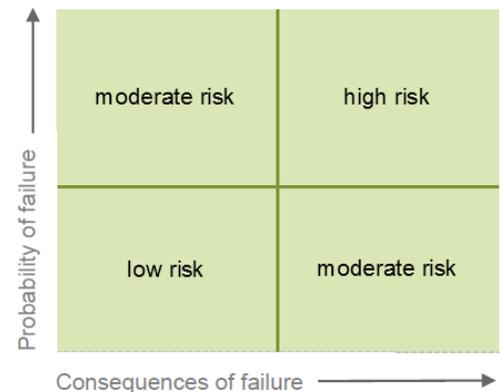


Figure 2-4 Criticality as a Function of Probability and Consequence of Failure

Section 3



Section 3

Inventory of Stormwater Assets

The Town of Westford's stormwater assets include the municipal separate storm sewer system (including drain pipes, drain manholes, catch basins, outfalls, channels, roadways and curb, and stormwater management and/or treatment structures), in-stream infrastructure (such as culverts, dams, and bridges) and vehicles and equipment that support stormwater management.

The Town maintains an inventory of drainage infrastructure assets through a robust Geographic Information System (GIS). Westford employs a dedicated GIS Coordinator that oversees and maintains the GIS inventory. A list of Town-owned vehicles is also kept up to date.

The inventory of stormwater assets presented in this section was completed using the following sources:

- GIS mapping available as of the date of this report;
- Town Five-Year Capital Plans and supporting documents;
- Town Five-Year Capital Request (September 2018); and
- Town-Wide Vehicle Inventory (June 2018).

3.1 Small MS4 General Permit Considerations

The 2016 MS4 General Permit requires the Town to complete its MS4 system mapping in two Phases. **Phase I** must be completed by July 1, 2020, and the system map must include outfalls and interconnections, Best Management Practices (BMPs), receiving waters and impaired waters, and initial catchment delineations. The **Phase II** requirements include updating the stormwater map annually and, within ten years, mapping drainage structures and connectivity, refining the location of outfalls and catchment delineations, and mapping the municipal sanitary sewer system. There are also many mapping elements recommended in the General Permit to improve mapping and capture more detail about the drainage and sanitary sewer systems in Town. More specific information is provided in Table 3-2 in Volume 1 of this SWMMP.

While Westford's stormwater mapping is sufficient to meet the 2003 General Permit requirements, there is substantial work to be completed on the mapping to meet the requirements of the 2016 General Permit. We recommend that the Town maintain an up-to-date inventory of stormwater assets, including attribute information described in this section, in addition to completing the permit required mapping improvements, in order to inform proactive operation and maintenance and capital improvements.

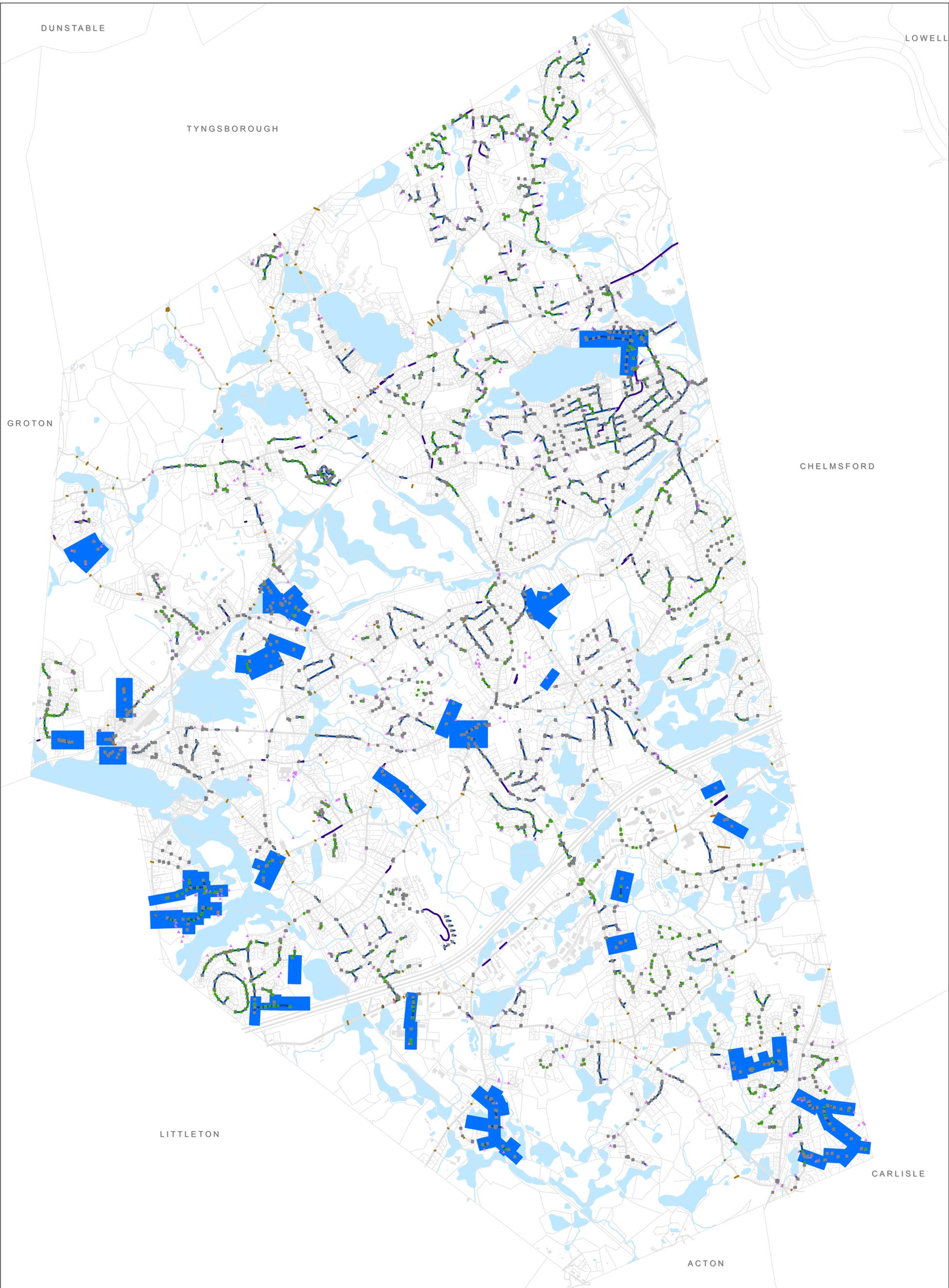
3.2 Supplementary Inventory Data Development

As part of developing the SWMMP, Tighe & Bond completed a desktop review of GIS mapping and data management (see Section 3.2.2 in Volume 1 of the SWMMP). This evaluation showed there is a need to improve the spatial extent of drainage system mapping, improve connectivity, remedy conflicts between field located structures and as-built plans, identify and differentiate between public and private structural stormwater BMPs, and populate attribute information for inventoried assets (material, diameter, age, date installed, type, condition, etc.).

Because the Town's GIS was generally lacking detail on pipe material, condition, age, and previous problems, it was not possible to determine condition and criticality of drainage system assets based on the existing information alone.

Additional as-built and definitive subdivision plans were digitized into ArcGIS, as shown in Figure 3-1, with the primary goals of increasing the extent of Westford's mapped drainage area, adding attribute information, and developing more complete mapping and data to inform the SWMMP, and the secondary goal of meeting the EPA's NPDES MS4 General Permit mapping requirements. Plan sheets were selected as follows:

- **Unmapped Areas:** Based on the desktop assessment of the Town's current stormwater mapping, Tighe & Bond identified over 50 neighborhoods that had no drainage system mapping, incomplete mapping, or incorrect mapping. Tighe & Bond compared the streets in the neighborhoods identified to the Town's list of accepted and private roads to identify accepted roads (as private roads are not part of the Town's MS4). This list resulted in gathering plans for 13 neighborhoods and digitizing 33 plan sheets.
- **Mapping Discrepancies:** The Engineering Department intern, through his work on drainage system GIS during summer 2015, determined that six areas in Town were not mapped correctly or completely. Based on his evaluation, a total of 17 additional plan sheets in six neighborhoods that were digitized in GIS.
- **Attributes for Representative Decades of Development:** To identify the remaining plan sheets to digitize, Tighe & Bond looked at the overall distribution of development in Westford by decade. Figure 3-2 and Table 3-1 present the breakdown of subdivision and as-built plans by decade. The majority of development has occurred in Westford since the early 1980s, and over 70 percent of the subdivisions in Westford were constructed in the 1980s and 1990s. This is also reflected in the population growth chart presented as Figure 2-2 in Volume 1 of the SWMMP. To capture this distribution, remaining plan sheets were selected to capture each decade (e.g., the most sheets were selected from the 1990s, less from the 1980s, even fewer from the 1970s, and the least from the 1960s and 2010s). For plans from 1980 and later, Tighe & Bond selected recommended sheets from the list of as-builts. From plans earlier than 1980, recommended sheets were selected from the list of definitive subdivisions. Our review also found lack of drainage system mapping on plans earlier than 1960, and limited drainage mapping on plans in the 1960s.



Legend

- Catch Basin
- Catch Basin / Flat Level Top
- Drop Inlet
- Manhole
- ▲ Outfalls
- Channels
- Culverts
- Drain Pipes
- Plan Extent



1:18,000
0 1,500 3,000
Feet



Based on MassGIS Data

**FIGURE 3-1
AREAS OF WESTFORD WHERE AS-BUILT PLANS WERE DIGITIZED**

Westford, Massachusetts

January 2016



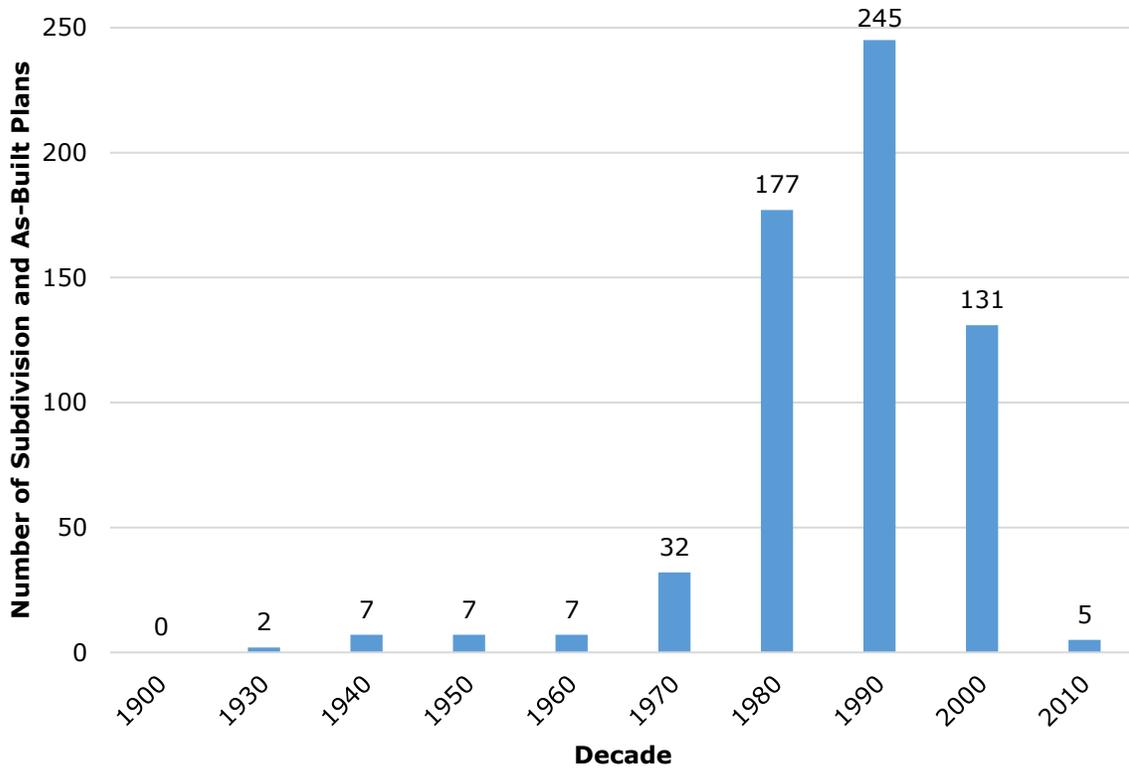


Figure 3-2 Distribution of Development in Westford by Decade based on Definitive Subdivision and As-Built Plans

Table 3-1
Record Drawings for Westford per Decade

Decade	Approximate Percentage of Overall Development
1930s	<1%
1940s	1%
1950s	1%
1960s	1%
1970s	5%
1980s	29%
1990s	40%
2000s	21%
2010s	1%

As discussed previously, the greatest amount of development in Town occurred in the 1980s and 1990s, as reflected in the number of available definitive subdivision and as-built plans. This indicates that much of the drainage in Town is approximately 30 to 40 years old, and depending on the type of infrastructure and material, installation practices, and site conditions, some of this infrastructure likely needs repair and/or replacement in the short-term.

3.3 Stormwater Assets by Category

The Town of Westford owns, operates, and maintains the following stormwater infrastructure assets⁶:

- 60 miles of drain pipes;
- 5,630 drainage structures (catch basins and manholes);
- 675 outfalls;
- 285 culvert pipes totaling 3.2 miles in length;
- 3.5 miles of natural drainage conveyances;
- 3 dams;
- 150 miles of publicly maintained roadways;
- 110 miles of roadway curb;
- Numerous vehicles and equipment necessary for operating and maintaining the drainage infrastructure; and
- An unknown number of stormwater management and/or treatment structures.



Figure 3-3 Reinforced Concrete Pipe Outfalls

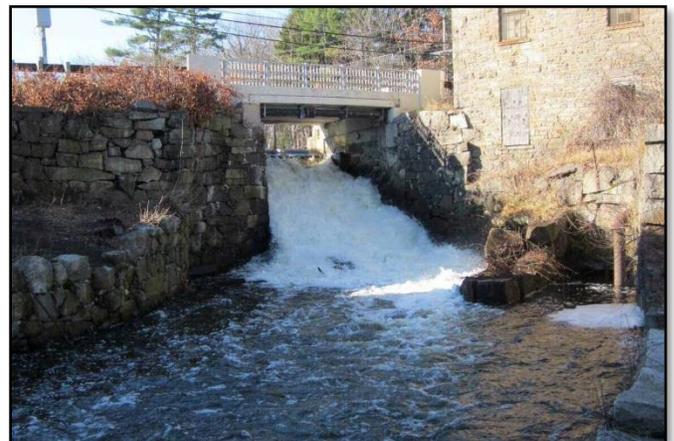
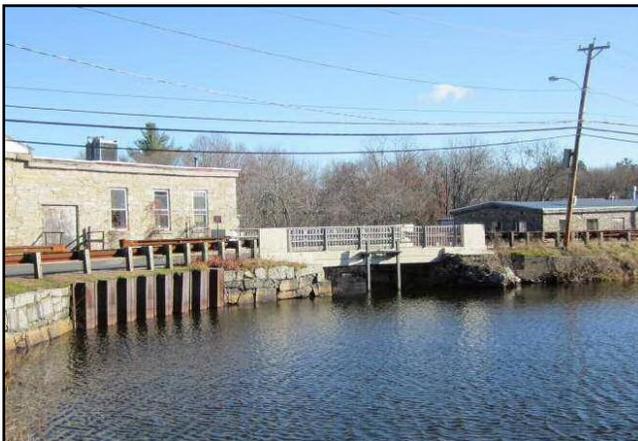
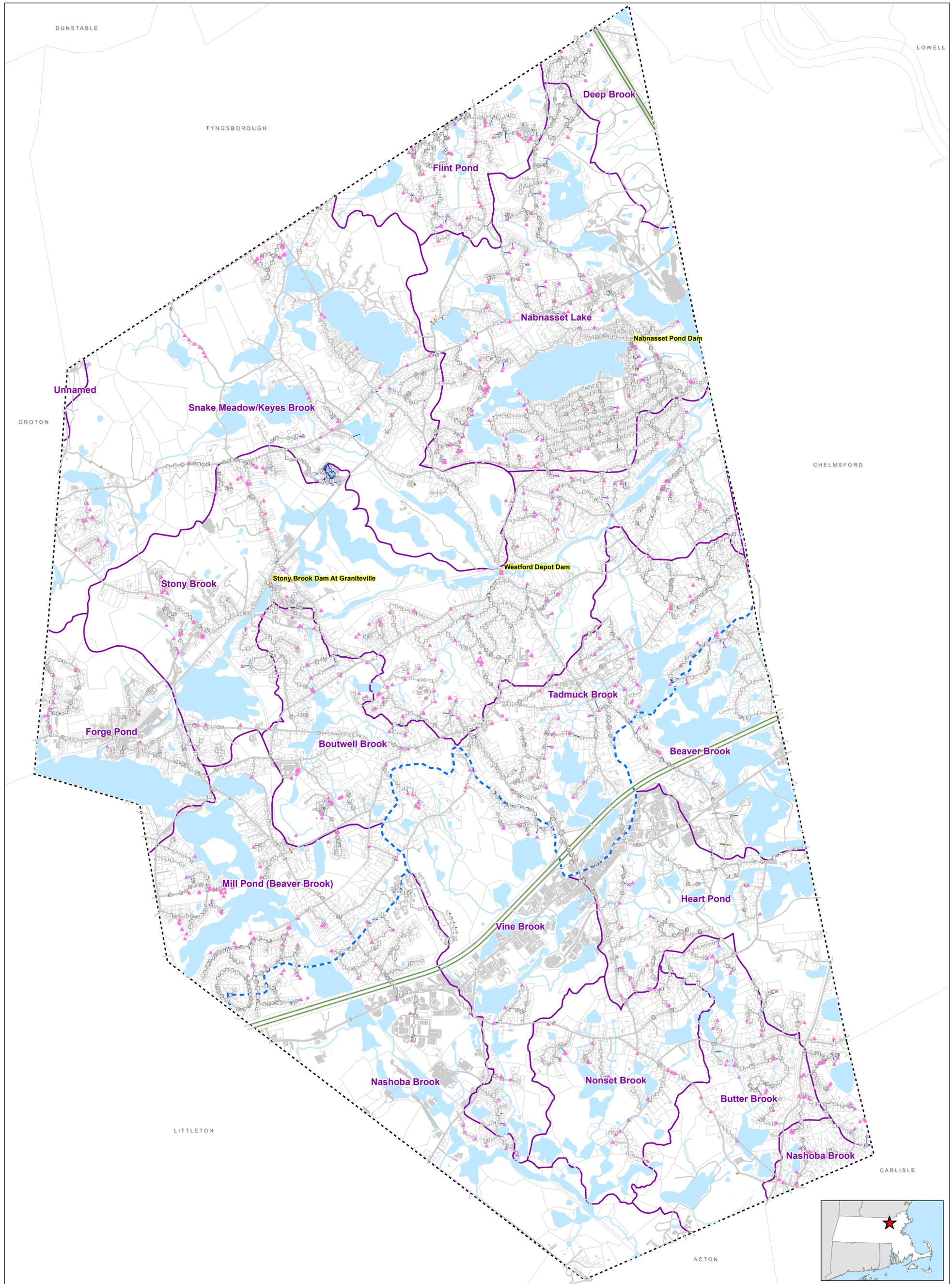


Figure 3-4 Stony Brook Dam (Left: Upstream View, Right: Downstream View)

Figure 3-5 includes a map of the Westford Drainage System, including drain pipes, catch basins, drain manholes, inlets, outfalls, headwalls, and culverts.

⁶ These quantities were obtained from the Town's GIS mapping as of the date of this report. Quantities may change as mapping is improved.



- Legend**
- Dams
 - Impervious Surface
 - Ponds
 - Town Boundary
 - Rivers and Streams
 - Major Basin Boundary
 - Sub-basin Boundary
 - Catch Basins
 - Inlets
 - Manholes
 - ▲ Outfalls
 - Drain Pipes
 - Culverts

1:18,000

0 1,500 3,000

Feet

Based on MassGIS Data and Town of Westford Data

**FIGURE 3-5
WESTFORD DRAINAGE
SYSTEM MAP**

Westford, Massachusetts

April 2017

3.3.1 Municipal Separate Storm Sewer System

All of the drainage pipes, drain structures, and outfalls listed at the beginning of Section 3.3 are part of Westford's MS4. A summary of known attribute information for these MS4 assets is summarized in this Section.

A municipal separate storm sewer system is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) that is owned and operated by a public entity, designed or used for collecting or conveying stormwater, not a combined sewer, and not part of a Publicly Owned Treatment Works.

3.3.1.1 Drainage Pipes

The distribution of pipe material and pipe diameters is categorized in Table 3-2 and Table 3-3, respectively, by length of pipes. Length was estimated based on data provided in GIS and should be considered planning level. A number of structures are mapped but are not categorized in the Town's GIS, and therefore are listed as "Unknown" in the tables and charts.

Table 3-2
System Drainage Pipe Materials

Pipe Material	Length (feet)	Percent of System
Asphalt-Coated Corrugated Metal	616	0.2%
Cast Iron	1,060	0.3%
Clay	3,278	1.0%
Concrete	9,209	2.9%
Corrugated Metal	29,182	9.3%
Corrugated Polyethylene	3,943	1.3%
Ductile Iron	497	0.2%
PVC	7,790	2.5%
Ductile Iron to PVC	178	0.1%
High-Density Polyethylene	12,953	4.1%
Perforated PVC	2,560	0.8%
Reinforced Concrete Pipe (RCP)	232,912	73.8%
Steel	361	0.1%
Steel Box	29	0.0%
Unknown	10,895	3.5%
Total (feet)	315,463	100%
Total (miles)	60	

Table 3-3
System Drainage Pipe Sizes

Pipe Diameter	Length (feet)	Percent of System
2"	46	0.0%
3"	191	0.1%
4"	2,507	0.8%
6"	2,996	0.9%
8"	3,475	1.1%
10"	1,354	0.4%
12"	196,842	62.4%
14"	726	0.2%
15"	40,753	12.9%
16"	275	0.1%
18"	29,971	9.5%
21"	4,152	1.3%
22"	124	0.0%
24"	16,839	5.3%
27"	1,165	0.4%
30"	2,757	0.9%
36"	1,713	0.5%
42"	51	0.0%
Unknown	9,527	3.0%
Total (feet)	315,463	100.0%
Total (miles)	60	

Almost three-quarters of the drainage pipes are reinforced concrete pipes (RCP). At nine percent, the next most prevalent pipe material is corrugated metal pipe (CMP), which has a substantially shorter service life than RCP (see Table 2-1). Other pipe materials in Westford's drainage system include high-density polyethylene (HDPE), concrete, polyvinyl chloride (PVC), corrugated polyethylene (PE), asphalt-coated corrugated metal (ACCM), ductile iron (DI), cast iron (CI), clay, and steel.

A majority of the drainage pipes are 12 inches in diameter. 15-, 18-, and 24-inch diameter pipes comprise an additional 28 percent of the system. Figure 3-6 and Figure 3-7 demonstrate the proportions of pipe material and diameter in Westford’s drainage system, respectively. Note that only categories containing at least one percent of the system were included.

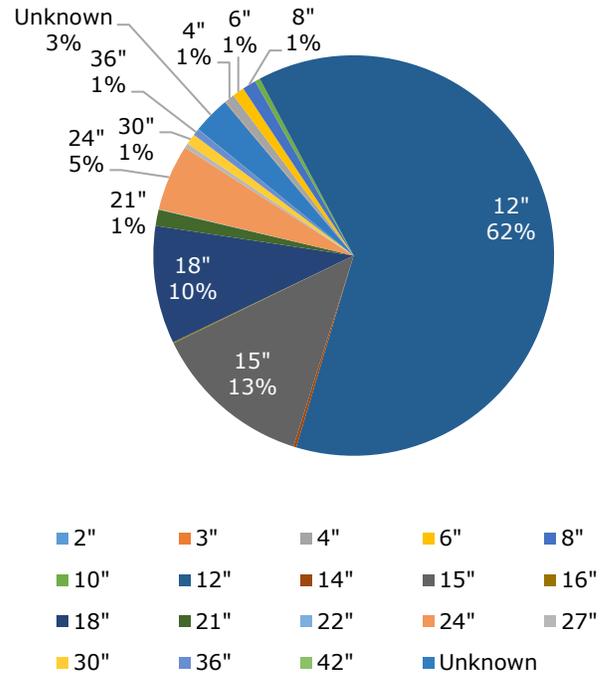
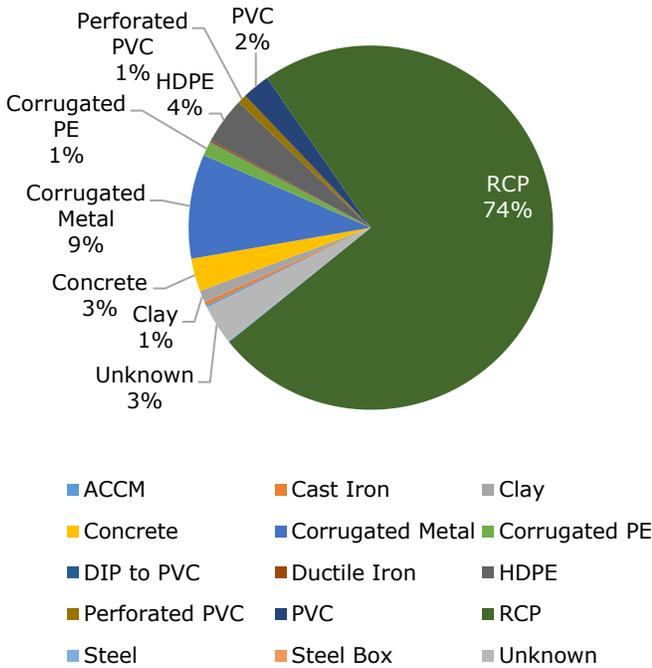


Figure 3-6 Distribution of System Drainage Pipes by Material

Figure 3-7 Distribution of System Drainage Pipes by Diameter

3.3.1.2 Drainage Structures

According to the Town’s mapping in GIS as of the date of this report, the drainage system contains approximately 5,630 structures, including catch basins and drain manholes. The breakdown of type of structure is presented in Table 3-4 and Figure 3-8.

Table 3-4

Type of Drainage Structures

Type of Structure	Quantity	Percent of System
Catch Basin	3,071	54.5%
Catch Basin/Flat Level Top	421	7.5%
Drop Inlet	16	0.3%
Manhole	1,055	18.7%
Flared End Section	60	1.1%
Inlet	28	0.5%
Outlet	13	0.2%
Overflow Structure	25	0.4%
Water Quality Inlet	5	0.1%
Unknown	937	16.6%
Total	5,631	100.0%

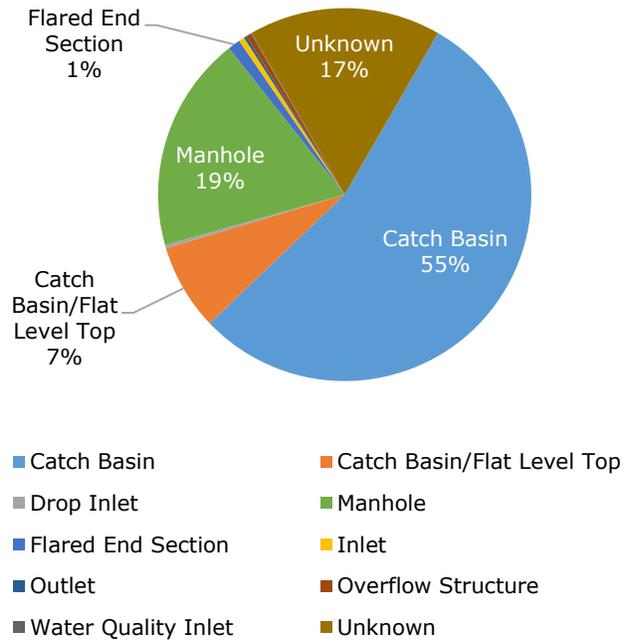


Figure 3-8 Distribution of Drainage Structures by Type

3.3.1.3 Drainage Outfalls

The Town maintains 674 drainage outfalls, which are located throughout Westford. This total number of outfalls may include private outfalls, culvert inlets/outlets, and/or inlets to structural stormwater BMPs, and may change as mapping is improved.

Tables 3-5 through 3-7 and Figures 3-9 through 3-11 include the distribution of the outfalls by material, diameter, and outfall type. Like the drainage piping, the majority of the outfalls are RCP, and almost half are 12-inch pipes.

Table 3-5
Drainage Outfalls by Material

Outfall Material	Quantity	Percent of System
Clay	17	2.5%
Corrugated Metal	84	12.5%
Ductile Iron	7	1.0%
Steel	5	0.7%
Plastic	64	9.5%
Reinforced Concrete	416	61.7%
Stone	25	3.7%
Unknown	56	8.3%
Total	674	100%

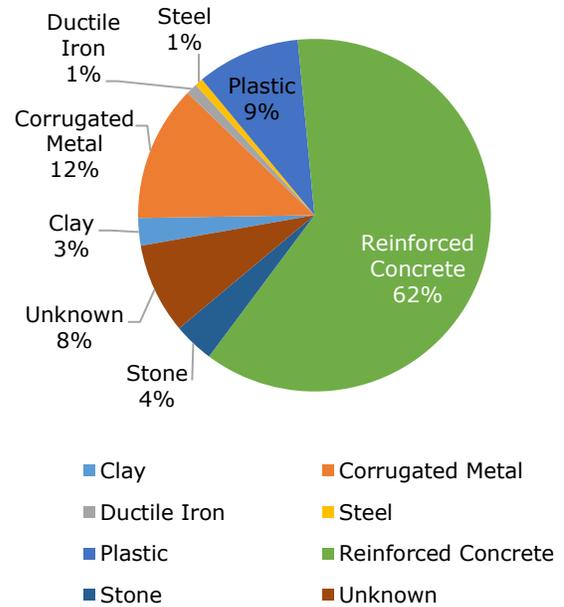


Figure 3-9 Distribution of Drainage Outfalls by Material

Table 3-6
Drainage Outfalls by Size

Outfall Diameter	Quantity	Percent of System
4"	3	0.4%
6"	10	1.5%
8"	14	2.1%
10"	2	0.3%
12"	330	49.0%
14"	3	0.4%
15"	85	12.6%
18"	48	7.1%
24"	44	6.5%
26"	1	0.1%
27"	1	0.1%
30"	18	2.7%
36"	12	1.8%
60"	1	0.1%
Unknown	102	15.1%
Total	674	100%

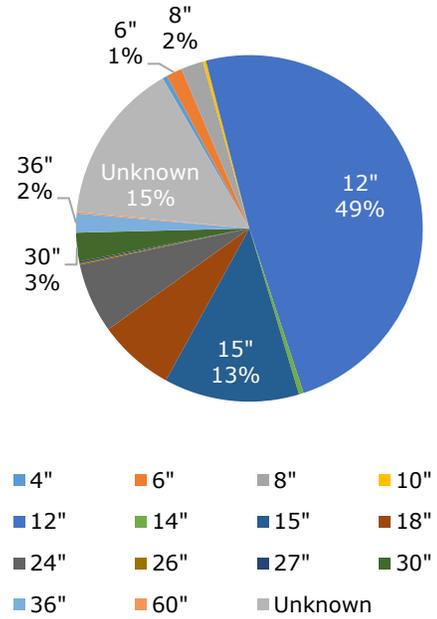


Figure 3-10 Distribution of Drainage Outfalls by Diameter

Table 3-7
Type of Drainage Outfalls

Type of Outfall	Quantity	Percent of System
Flared End Section	232	34.4%
Headwall	118	17.5%
Open End	276	40.9%
Unknown	48	7.1%
Total	674	100%

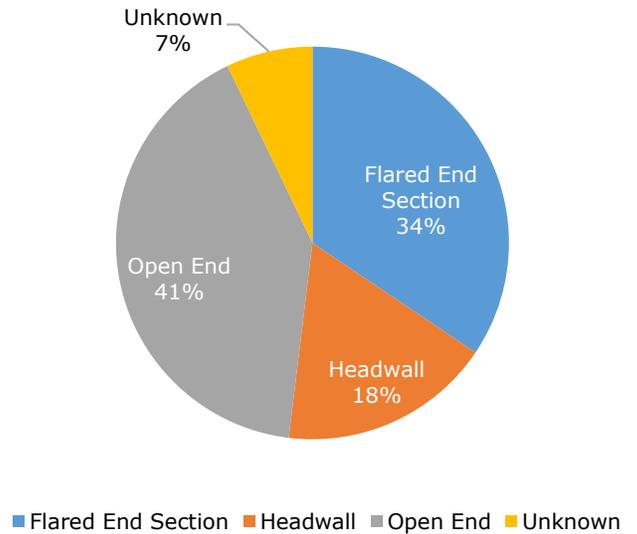


Figure 3-11 Distribution of Drainage Outfalls by Outfall Type

The drainage outfalls discharge to a variety of locations within Westford, including surface water bodies, wetlands, and woodland areas. Figure 3-12 includes the distribution of discharge locations for the Town’s stormwater outfalls. A specific breakdown of outfalls related to receiving waters will be included in Volume 4 of the SWMMP (NPDES Stormwater Program Compliance Plan).

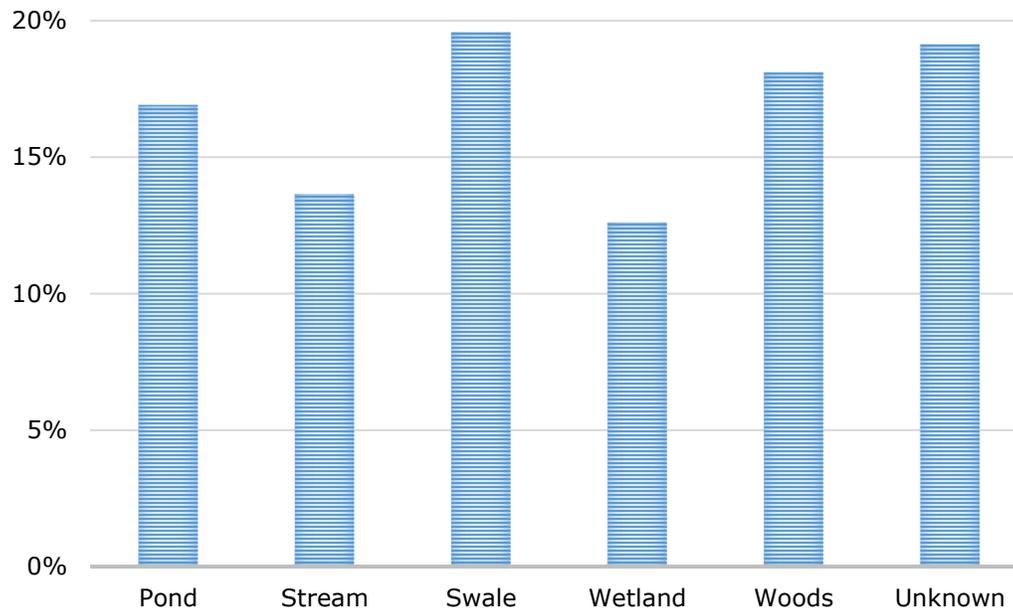


Figure 3-12 Drainage Outfall Discharge Locations

3.3.2 Stormwater Best Management Practices

Stormwater BMPs are structures designed to manage post-construction stormwater runoff through conveyance, treatment, infiltration, retaining, attenuation, and storage of stormwater runoff.⁷ In most cases, these BMPs simultaneously manage water quantity and improve water quality. In Massachusetts, MassDEP divides stormwater BMPs into several basic classes. Some BMPs fit into multiple categories because they serve more than one function.

- **Structural Pretreatment BMPs:** The first BMPs in a treatment train, these measures typically remove the coarse sediments that can clog other BMPs. The most common pretreatment BMPs include deep sump catch basins, oil grit separators, proprietary separators, sediment forebays, and vegetated filter strips.
- **Treatment BMPs:** The three main types of treatment BMPs are stormwater treatment basins (e.g., extended dry detention basins, wet basins), constructed stormwater wetlands, and filtration BMPs (e.g., rain gardens, bioretention areas, media filters, sand filters/organic filters, treebox filters).
- **Conveyance BMPs:** These BMPs collect and transport stormwater to BMPs for treatment and/or infiltration. These practices may also treat runoff through infiltration, filtration, or temporary storage. Conveyance BMPs include drainage channels, grass channels, and water quality swales.
- **Infiltration BMPs:** Infiltration systems are designed primarily to reduce the quantity of stormwater runoff from a particular site. Infiltration techniques reduce the

⁷ MassDEP Stormwater Handbook, Volume 2, Chapter 2: Structural BMP Specifications for the Massachusetts Stormwater Handbook

amount of surface flow and direct the water back into the ground. Infiltration practices typically cannot provide channel protection and overbank or extreme flood detention storage. Infiltration BMPs include bioretention areas and rain gardens, dry wells, infiltration basins and trenches, leaching catch basins, and other sub-surface infiltration structures.

- Other BMPs: Some BMPs do not fit into any of the categories set forth above. These BMPs include dry detention basins, green roofs, porous pavement, and rain barrels and cisterns.

As part of EPA’s NPDES Phase II Small MS4 Stormwater Program, the Town will need to know where public and private BMPs are located and if/when they are being maintained. As of the date of this CIP, the Town lacks information on the location and ownership status of stormwater BMPs built on Town property or in Subdivisions or other private developments sufficient to meet this requirement. Section 6 of this volume includes a recommendation to identify, map, determine ownership, and develop maintenance procedures and schedules for BMPs. Likewise, under the Good Housekeeping MCM, the Town will need to formalize operation of BMPs on town properties or within the right-of-way in the Town-wide Operation and Maintenance Plan, Volume 3 of the SWMMP.

3.3.3 Culverts

According to the Town’s GIS mapping as of the date of this report, there are 285 mapped culvert segments, totaling approximately 17,000 linear feet, or 3.2 miles. The Town’s GIS system maps each culvert pipe individually, though many of the culverts consist of two or three separate pipes which would be grouped and considered one culvert. However, culverts are individually counted in the analysis in this section.

While the 2016 General Permit does not require monitoring at all culverts, the outlet of culverts “longer than a simple road crossing” should be included in the outfall inventory due to a “high illicit discharge potential” and will need to be included in the Town’s IDDE Plan and initially monitored as an outfall.

Most of the culverts in Westford are made of stone (approximately 40 percent), and concrete boxes and pipes make up another quarter of the culverts. Half of the culverts are in excellent/good condition or require partial repair, according to available GIS information. The longest culvert is just over 400 feet long, and the shortest are about 10 feet long. The average culvert length is 60 feet. A breakdown of culvert size is shown in the chart to the right. The most common culvert diameters are 12 and 24 inches, with 20 percent of the system diameter unavailable in the available GIS.

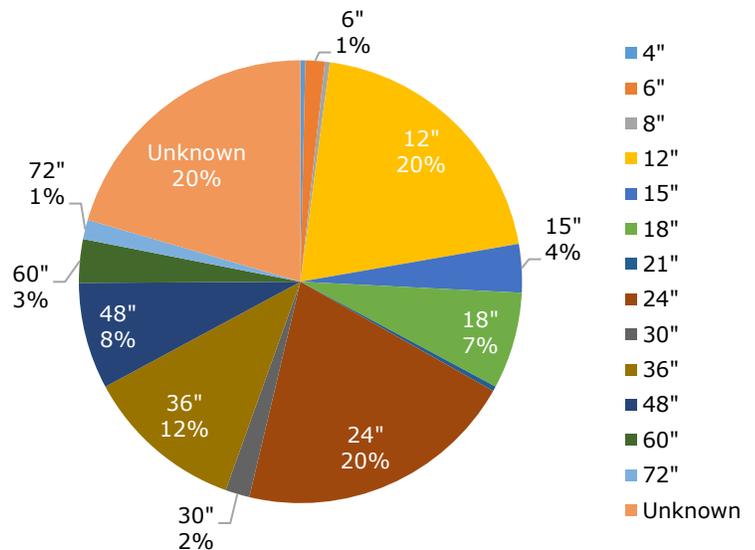


Figure 3-13 Culvert Size by Diameter

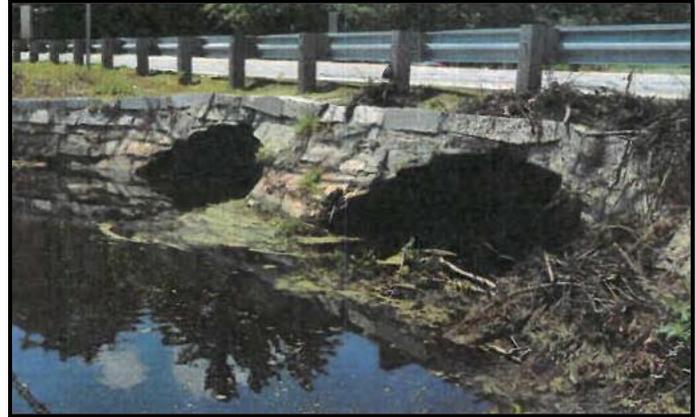


Figure 3-14 Stony Brook Road (Left) and Beaver Brook Road (Right) Culverts

3.3.4 Dams and Bridges

There are more than ten dams in Westford, however, the Town owns and operates only three of them, including the following:

- Nabnasset Lake Dam (Byrne Avenue at Nabnasset Lake);
- Westford Depot Dam (Depot Street at Stony Brook); and
- Stony Brook Dam (Broadway Street at Stony Brook).

Maintenance is conducted annually, and inspections are completed every five years for these dams as part of the Highway Department's operating budget.

The Town is also responsible for the maintenance of many bridges, including the following:

- Brookside Road over Stony Brook;
- Stony Brook Road over Stony Brook;
- Depot Street over Stony Brook;
- River Street over Stony Brook;
- Broadway Street over Stony Brook;
- Bridge Street over Stony Brook;
- Town Farm Road over Stony Brook;
- Pleasant Street over Stony Brook;



Figure 3-15 Nabnasset Lake Dam at Byrne Avenue

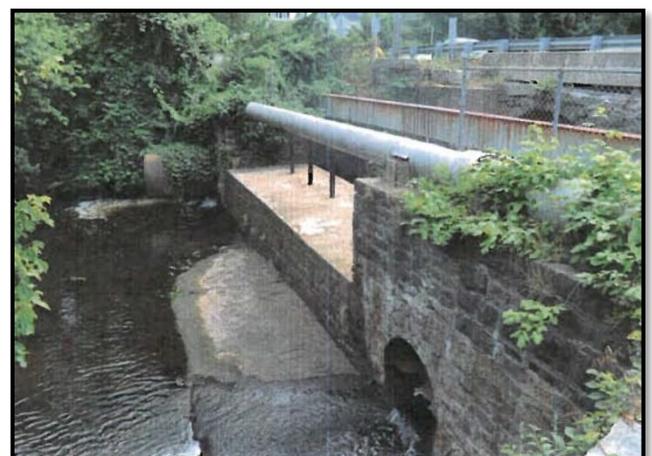


Figure 3-16 Depot Street Dam and Bridge

- Beaver Brook Road over Beaver Brook;
- Russells Way over Turtle Crossing; and
- Russells Way over Gilson Brook.

3.3.5 Vehicles and Equipment

Vehicles and equipment are owned and operated by numerous departments in Town and include passenger cars and vans, dump trucks, ambulances, fire trucks, tractors, loaders, street sweepers, backhoes, and mowers. They are utilized for a variety of purposes, including student and senior citizen transportation, emergencies and public safety, public works operations, and inspections. Table 3-8 summarizes, by department, the number of vehicles in Town used at least partially for stormwater management.⁸ Highway Department vehicles and equipment generally includes dump trucks, tractors, loaders, sweepers, trailers, excavators, and staff vehicles. Some equipment not specifically included in Table 3-8 may include generators (stationary or portable), plows, etc.

Table 3-8

Inventory of Vehicles

Department	Number of Vehicles
Cemetery	4
DPW	2
Highway	56
Parks	15
Total	77

An up-to-date inventory of Town-owned vehicles and equipment is available from the Town Accountant, who maintains an updated list of assets in Town.

⁸ Inventory is up to date as of June 2018.

3.3.6 Discussion of Drainage Asset Age

Implementing asset management requires knowledge about the age of infrastructure. The drainage system was installed as needed and as additional streets were developed within Town. The lengths of drainage pipes are categorized in Table 3-9 and Figure 3-17 by the decade of installation (pipe age). Note that only decades containing at least one percent of the system were included in Figure 3-17.

Table 3-9
System Drainage Pipe Age

Decade	Length (feet)	Percent of System
1970s	4,766	1.5%
1980s	8,073	2.6%
1990s	11,574	3.7%
2000s	4,073	1.3%
2010s	1,381	0.4%
Unknown	285,595	90.5%
Total (feet)	315,463	100.0%
Total (miles)	60	

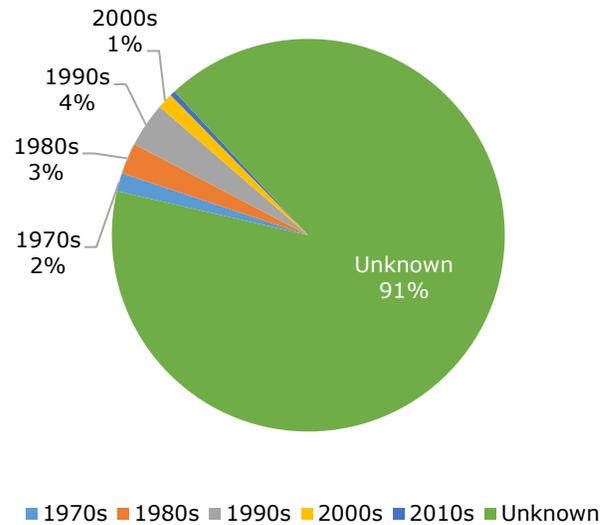


Figure 3-17 Distribution of Drainage Installation Decade

It is apparent from Figure 3-17 that the age of most of Westford’s drainage system is unknown based on the GIS mapping available as of the date of this report. The only readily available date of installation information was compiled from the record drawings that were digitized as a part of this SWMMP effort. The accepted street dates for the Town were added as an attribute to the drainage GIS mapping. However, more than 60 percent of the accepted street dates do not correlate correctly with the known drainage plan dates. For example, drainage systems were installed in many developments in Westford during construction, but the street was only accepted decades later. In this case, the accepted streets date cannot be used as a representative date of installation of the drainage components. For this reason, Tighe & Bond determined that only dates of installation from record drawings could be used for further analysis. Dates of installation for all drainage system components that did not have an associated record drawing were categorized as “unknown.”

Figure 3-18 includes the quantity of municipal vehicles at least partially used for stormwater management per model year.⁹ While approximately three-quarters of these vehicles have a model year of 2000 or later, there are some municipally-owned vehicles that are more than 15 years old. The distribution of vehicle model years in Figure 3-18 also indicates that Westford regularly replaces aging vehicles with newer models.

⁹ Inventory is up to date as of June 2018.

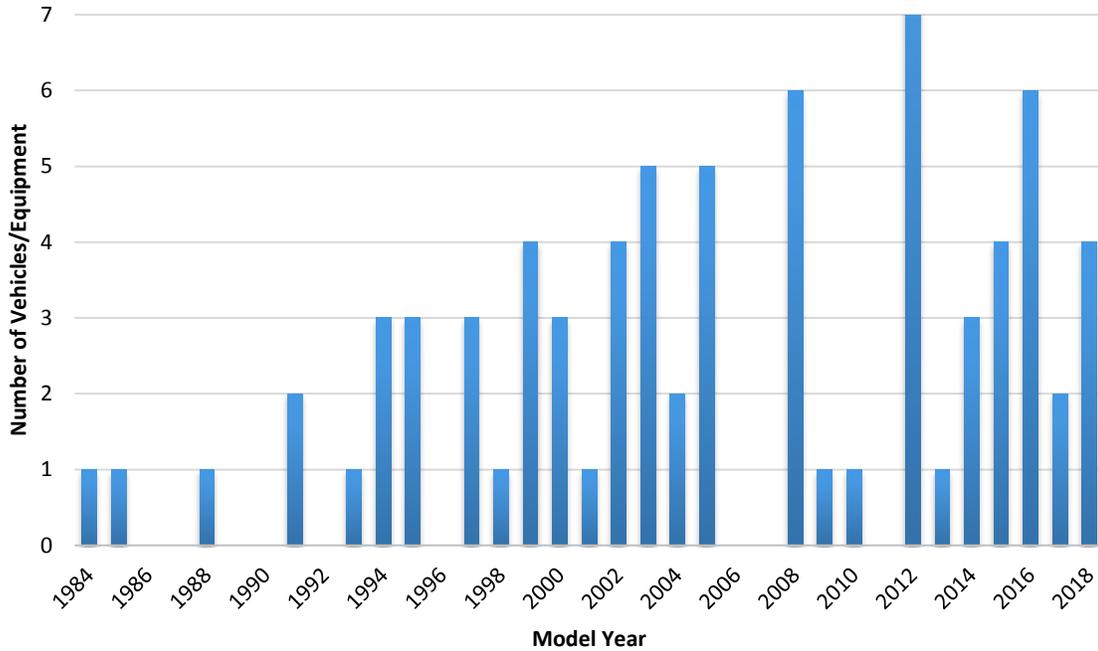


Figure 3-18 Distribution of Vehicle Age

Highway and Engineering Department employees are aware of many drainage areas that are in need of maintenance due to regular drainage issues or flooding, as well as occasional residential complaints. Aging or damaged infrastructure, such as the CMP outfall in Figure 3-19, are noted, prioritized, and replaced when possible. The Town often requests funding for improvements to or replacements for MS4 infrastructure through its annual capital improvement budget.



Figure 3-19 Example of Rusted and Broken Outfall at Keyes Road

Section 4



Section 4

Condition and Performance Assessments

Understanding the current state of drainage assets is the first step to undertaking an asset management program for stormwater. As was described in Section 2, the first step to asset management is to evaluate the current state of all stormwater assets, including condition and performance. Combined with other factors, this information will help the Town determine remaining service life and value.

4.1 Selection of Locations for Assessment

Because the Town does not have sufficient staff or budget to systematically inspect their entire drainage system, Tighe & Bond worked with Town staff to identify areas of known drainage concerns within the MS4 and to select representative areas for targeted inspections. As part of the SWMMP, the goal of these targeted field assessments was to better understand the Town-wide drainage system condition, performance, and improvement needs, including both operation and maintenance and capital projects.

4.1.1 Town Staff Input on Known Drainage System Deficiencies

Westford maintains a five-year Capital Plan that includes improvements projects for Town-owned infrastructure, such as roadways, drainage, and dams and bridges (as discussed in detail in Section 6.1 of this Volume). To identify and better understand drainage system deficiencies (e.g., capacity limitations and flooding, failing drainage infrastructure, chronic maintenance problems, etc.) not already addressed in the Town's Capital Plan, information on known problem areas was collected from the Police, School, Fire, and Highway Departments. On March 9, 2015, Tighe & Bond also interviewed Highway and Engineering Department staff to obtain more detail on these known deficiencies. Information provided by the Town is summarized in Table 3-2 and Figure 3-4 of the Stormwater Assessment, Volume 1 of this report. While some of the drainage areas of concern will require future capital improvements, others were categorized as operation and maintenance needs to be addressed in the MS4 Infrastructure section of the Operation & Maintenance Plan, Volume 3 of the SWMMP.

4.1.2 Identification of Representative Areas of Town for Rapid Condition Assessment

The condition of Westford's drainage pipes and structures are largely unknown. With the assistance of a MassDEP *Water Infrastructure Planning and Technical Assistance Grant*, awarded to the Town of Westford in 2015, Tighe & Bond was able to complete one week of video inspections of the drainage system. This effort provided representative information about the variety pipe sizes and materials within the drainage system.

The process to identify areas to complete a rapid condition assessment of drainage infrastructure to visually confirm the condition and attributes of mapped drain pipes and structures included a number of steps:

- As part of developing the SWMMP, Tighe & Bond completed a desktop review of GIS mapping and data management (see Section 3.2.2 in Volume 1 of the SWMMP). This evaluation identified locations with a need for improved drainage system mapping, including unmapped developed areas in Town, areas in need of

- improved connectivity and locations in need of conflicts between field located structures and as-built plans remedied.
- As previously discussed in Section 3.1, Tighe & Bond used plans to add drainage system components to the overall GIS map based on the GIS mapping and data management assessment, input from the Engineering Department's intern research, and an understanding of the overall distribution of development in Westford by decade.
 - Rapid condition assessment was recommended for the following:
 - Areas where plans were used to complete drainage system mapping and add data to the GIS map including material, diameter, and age;
 - Older areas of Town based on historic USGS mapping (i.e., Town Center and the Villages); and
 - Areas recommended by Town Staff including stormwater manholes and piping that had been replaced and/or modified to provide infiltration abilities at that location, and Corrugated Metal Pipes that may be deteriorating and underperforming.

4.2 Field Work to Assess Condition and Performance

Once the record drawings were digitized and Town input was received, Tighe & Bond and Town staff completed multiple stages of field work to evaluate the condition and performance of stormwater assets within Westford, as described further in this Section. The results of the desktop and field assessments are summarized in Section 5, Identification of Critical Infrastructure.

4.2.1 Field Verification of Known Drainage System Deficiencies

Based on the input from Town staff, Tighe & Bond staff completed two days of field work on July 8 and July 30, 2015 to further evaluate the identified locations. Of the 50 identified locations with known deficiencies, 21 high-priority sites were assessed in the field over the two days. The Tighe & Bond and Town staff typically completed the following tasks at each site:

- Discussed drainage or flooding deficiency;
- Looked at drainage connectivity and outfalls, if applicable;
- Evaluated the condition of the asset; and
- Discussed potential solutions to deficiency.

Additionally, photographs were taken of the asset in question, a GPS point was collected at each location, and any evidence of flooding or potential drainage deficiencies was documented. Table 5-1 in Section 5 summarizes the findings of these investigations.

4.2.2 Representative Areas of Town Field Work

A rapid condition assessment was completed for various drainage pipes, manholes, and catch basins using an EnviroSight QuickView zoom inspection camera, as shown in Figure 4-1. Utilizing this camera allowed high-resolution video logs of pipes and structures without confined space entry equipment or prior drainage pipe cleaning. The zoom camera allowed for rapid inspection of pipelines and did not require any cleaning prior to inspecting the line. Renting this zoom camera also presented a significant cost savings when compared to CCTV.

The inspections were completed following the National Association of Sewer Service Companies Pipeline and Manhole Assessment Certification Program (PACP/MACP) protocols. Following the PACP/MACP guidelines and using the zoom inspection camera allowed for a quick, in-field determination of size, condition, material, and connectivity of the drainage system, as well as the identification of any visible pipe defects or instances of obstructed flow.

During the field assessment, Tighe & Bond and Town staff utilized a GIS tablet application to identify target structure identification, location, and applicable attributes, as shown in Figure 4-2. The inspectors inserted the QuickView zoom camera into a structure and aimed the camera down the first pipe to be inspected. The camera was controlled by staff to visually zoom down the pipe as far as possible while the camera recorded. Once the inspection footage was captured, the camera was zoomed out and rotated to the next pipe to be inspected, where the process was repeated. In this way, each pipe within a structure was inspected. A photograph was also taken of each structure during the inspection to document the condition of the structure, as well as any apparent structural or sediment buildup issues.



Figure 4-1 Tighe & Bond and Town Staff Use an EnviroSight QuickView Zoom Camera to Inspect Drainage Pipes

A field inspection report was filled out for each structure that was inspected. This form included the following information:

- Date and time of inspection;
- Weather conditions;
- Inspector;
- Location and identification number of inspected structure;
- Internal structure observations (material and condition of structure, frame, etc.);
- Observations of any illicit connection or odor;
- Sketch of the connectivity for that structure; and
- Any notes about the inspected structures and/or pipes.

As shown in Table 4-1, 74 drain manholes and catch basins and the associated drainage pipes were inspected over five days between November 30 and December 7, 2015, excluding December 2 (due to bad weather conditions) and weekend days. 219 pipe segments were inspected, and four of those 219 pipes were inspected from both the upstream and downstream end, for a total of 223 pipe inspection videos.

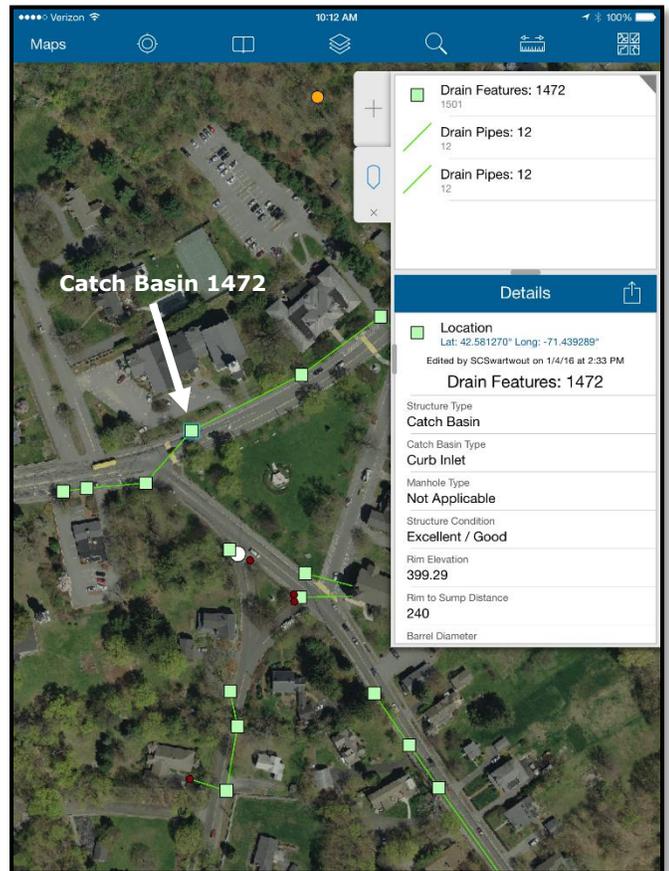


Figure 4-2 Example of Drainage Structure Attributes on Tablet GIS Application

Table 4-1

Quantity of Drainage System Components Inspected During Rapid Condition Assessment

	Nov. 30	Dec. 1	Dec. 3	Dec. 4	Dec. 7	Total
No. of structures inspected	8	15	16	14	21	74
No. of pipes inspected	26	42	49	44	62	223

Approximately six percent of the drainage pipes and one percent of the drain manholes in the entire system were inspected as part of the rapid condition assessment of representative areas, as shown in Table 4-2. Note that the percent of system inspected for drain pipes in Table 4-2 is categorized by the length of the pipes inspected.

Table 4-2

Percent of Drainage System Inspected During Rapid Condition Assessment

	Length of Pipes	Number of Structures
Total Objects Mapped	315,463	5,631
Total Objects Inspected	~ 20,000	74
% System Inspected	6.3%	1.3%

Note: 219 segments of mapped pipe were inspected, however, in some cases the zoom camera was not able to inspect the full length of pipe in each segment, so the total length of pipe inspected is approximate.

Results of the rapid condition assessment are presented in Section 5.2. Once the field work was completed, the captured video files were renamed with a unique identification related to the inspected pipe segment and the direction of the inspection. The object identification numbers within GIS were used for this purpose. For example, if a pipe segment with the ID "123" was video inspected from drain manhole "456" to catch basin "789", the video file was renamed as "123from456to789." The renamed files are indicative of the direction of the inspection, as they are named from the structure the QuickView camera was inserted into, towards the terminal structure for that pipeline.

The renamed files were uploaded to a Tighe & Bond YouTube webpage, and each YouTube video link was included in the attributes of its respective pipe segment within the Town's GIS drainage map. When a pipe segment that was inspected during this field effort is selected within the GIS, a link to its YouTube video is listed as an attribute. The Town also maintains these images and videos in the GIS.

The information recorded in the field inspection reports was also included in Town's GIS mapping. The condition, material, and connectivity were confirmed, updated, or added to the mapping, depending on the status of the existing information. The estimated service life (see Table 2-1 in Section 2.1 for reference) was also included as an attribute for each drain structure and pipeline.



Figure 4-3 A Raccoon was Found in a Drain During Inspection

Section 5



Section 5

Identification of Critical Infrastructure

5.1 Results of Known Drainage System Deficiencies Assessment

The fieldwork conducted by Tighe & Bond and Town staff to assess areas in Town with known drainage system deficiencies is summarized in Table 5-1. The problem areas are typically localized. Flooding typically does not impact sensitive populations such as schools, elderly care facilities, or commercial areas. The majority of known drainage issues result from culverts needing maintenance, beavers, and/or poorly performing country drainage. Generally, if a roadway floods during a rain event, the road is either still passable or accessible via an alternate route. Therefore, the flooding events do not impede residential access to homes or travel of safety officials during response to emergency events.

The majority of the identified problem areas flood rarely and minimally, excluding the following streets. However, flooding on the following streets still does not impede access to and from homes.

- Gould Road (Location ID 14 in Table 5-1) can flood up to 1 foot in depth with a 2- to 3-inch storm event, and typically floods up to ten times per year. However, impacted residents can still access their homes using Groton Road and Keyes Road as an alternate route.
- Steeple Chase Circle (Location ID 32 in Table 5-1) is a development with a single point of access for Steeple Chase Circle, Buckskin Lane, and Dobbins Road. Steeple Chase Circle floods with every storm event due to a failing structural stormwater BMP. When flooding occurs, all 32 residential homes along these roadways are impacted because there are no alternate routes to the entrance off of Vose Road. However, the roadway is typically passable by vehicles during flooding.
- Carlisle Road (Location ID 40 in Table 5-1) is a major road in Westford that floods up to 1.5 feet in depth between Applewood Drive and Whitney Drive, which makes the roadway impassable to vehicles in that area. However, impacted residents and emergency vehicles can still access homes and destinations using alternate routes.

Table 5-1 summarizes the above issues and other known drainage system deficiencies within Westford. The Town should consider implementing a culvert asset management program to proactively identify culverts that are underperforming. Many of the issues resulting from an older drainage system and country drainage could be solved by replacing or otherwise upgrading drainage during roadway improvement projects. Additionally, the Town could consider installing stormwater BMPs instead of converting existing country drainage to closed system drainage.

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
1	<p style="text-align: center;">Tyngsboro Road</p> 	<p>There is an open paved swale with an outdated drop inlet that needs to be replaced with new catch basin with sump. Due to the current configuration, there are issues with debris buildup, and therefore there is some ponding and water backup.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation/ Improvement:</p> <p>Improve mapping of drainage system in area, including swales, and replace inlet structure with a deep sump catch basin.</p>
2	<p style="text-align: center;">Forrest Road at Tyngsboro Road</p> 	<p>There is an existing open drainage system that results in road flooding every Spring.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation/ Improvement:</p> <p>Improve mapping of drainage in area including swales and other open conveyances, complete hydraulic and hydrologic modeling, and define conceptual improvements. May require survey and identification of easements.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
3	<p style="text-align: center;">North Hill Road</p> 	<p>This subdivision was installed with country drainage and ditches. Lack of maintenance and illegal dumping of yard waste have limited capacity of the system and resulted in road flooding every Spring.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation/ Maintenance, Education:</p> <p>Need to evaluate drainage in the subdivision (including additional mapping and hydraulic and hydrologic modeling), conduct maintenance, and educate property owners about illegal dumping and flooding impacts. It may be necessary to educate owners and possibly seek enforcement to under the Town’s Wetlands Bylaw or the Discharges to the Municipal Storm Drain System Bylaw.</p>
4	<p style="text-align: center;">Hidden Valley Road</p> 	<p>Open drainage ditches need maintenance, and some segments of closed drainage system (i.e., piping and catch basins) need replacement.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement:</p> <p>The open drainage ditches may be considered wetlands resource areas under the jurisdiction of the Westford Conservation Commission. Prior to drainage improvements being completed, a site visit with the Conservation Agent should be completed and potential solutions should be discussed. At a minimum, removal of sediment and organic debris buildup is recommended to be completed under a permit from the Commission.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
5	<p>Dunstable Road (near intersection with Tenney Road)</p> 	<p>The road grade is low, and beaver activities have elevated the wetlands and waterbody surface elevations, thereby causing flooding. Historically, the flooding has closed either one lane or the entire road approximately every other year. The existing culvert is buried by sediment and is typically mostly submerged. and needs replacement or upsizing. The road was recently repaved.</p> <p>Source: Highway and Police Departments</p>	<p>Culvert Replacement, Road Redesign:</p> <p>300 linear feet of road raising and reconstruction, replace culverts, permitting.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
6	<p>Long Sought for Pond Road Area</p> 	<p>Beavers cause flooding, and one nearby driveway is flooded periodically. Need to clear obstructions in wetland abutting culvert and address the beaver conflict.</p> <p>Source: Highway and Police Departments</p>	<p>Drainage Improvements:</p> <p>The solution to the flooding issue would be to install a new closed drainage system. The closed drainage system would discharge near the existing culvert and would extend to the east near #9 Long Sought For Pond Road and Gristone Road. The system would likely require up to 2 catch basins, a manhole, and approximately 300 feet of 12-inch drain pipe.</p> <p>Resolving the flooding issues caused by beavers will require routine maintenance and keeping the culvert openings clear.</p>
7	<p>Tenney Road (south of Long Sought for Pond Road and north of Keyes Road)</p> 	<p>Beavers cause flooding, however, the flood waters have never crossed the crest of the road. Need to replace the existing culvert, which is located off the road on a trail, just downstream and to the west of the existing Tenney Road culvert. This culvert is deteriorated and may be undersized. Potentially need to install a control structure.</p> <p>Source: Highway Department</p>	<p>Culvert Replacement:</p> <p>This culvert (approximately 60 linear feet) is smaller than the existing Tenney Road culvert and probably needs to be replaced and upsized to promote improved water flow in this area. The existing Tenney Road culvert is in good condition and does not need to be replaced.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
8	<p style="text-align: center;">Wing Road at Keyes Road</p> 	<p>Beaver dams in the area have raised the water surface elevation. There has been at least one significant flood event in the past five years. The existing corrugated metal culvert is rusted and needs to be replaced.</p> <p>Source: Highway Department</p>	<p>O&M Issue, Culvert Replacement:</p> <p>At a minimum, site needs maintenance to remove built up debris abutting culvert and impeding passage of flow. Installation of “beaver deceivers” should be considered for the beaver dams.</p> <p>Upgrade culvert to improve flow passage and wildlife passage, add guard rails to improve safety. Prior to construction this project requires design and permitting through the Westford Conservation Commission.</p>
9	<p style="text-align: center;">Dunstable Road</p> 	<p>This road has an open ditch drainage system. When debris or snow accumulates, it impedes flow and causes icing on the road. The system should be evaluated and maintained. A subdivision is planned for the area between those described under Location ID #9, #10, and #11, which may help solve drainage concerns.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement:</p> <p>Design and install a new closed drainage system with discharge to pond down side street. Approximately 500 linear feet of drainage pipe and drainage structures. Prior to construction this project requires design and permitting through the Westford Conservation Commission.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
10	<p>Dunstable Road at Pond Road</p> 	<p>This road has an open ditch drainage system. When debris or snow accumulates, it impedes flow and causes icing on the road. The system should be evaluated and maintained. A subdivision is planned for the area between Location ID #9, #10, and #11, which may help solve drainage concerns.</p> <p>Source: Highway Department</p>	<p>Maintenance:</p> <p>Further investigation is necessary to determine the solution and whether additional drainage would be necessary. Regular maintenance is also required to keep the channel and drainage clear of debris and obstructions.</p>
11	<p>Keyes Road at Slifer</p> 	<p>The existing road elevation is low, and the swamp floods the road. The road typically floods once every five years when there is at least a 3- to 4-inch rain event in 24 hours. Flooding can cause safety issues when emergency vehicles need to pass. The road needs to be raised to solve the flooding issue. The Town has done some hydraulic modeling of the area as part of a Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant. This project could be completed in conjunction with the project described under Location ID #13.</p> <p>Source: Highway and Police Departments</p>	<p>Drainage Investigation:</p> <p>Complete investigation of drainage area and prepare design alternatives for improvements.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
12	<p style="text-align: center;">Groton Road at Boat Launch</p> 	<p>The DCR parking lot at the boat launch (across the street from the photo) does not have a clear connection to the drainage system and needs to be investigated to reduce localized ponding in the parking area. This project may overlap with the Dunstable Transportation Improvement Project (TIP) project on Route 40, which is funded by MassDOT.</p> <p>Source: Highway Department</p>	<p>Erosion Control Improvement:</p> <p>Coordinate with the DCR on erosion control and slope stabilization.</p>
13	<p style="text-align: center;">Groton Road at Pages Hill</p>	<p>The Keyes Brook culvert crosses under Groton Road and needs replacement. This project is already planned under the Town’s CIP and will be funded through the FEMA Hazard Mitigation Grant.</p> <p>Source: Highway Department</p>	<p><i>Project has been completed.</i></p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
14	<p style="text-align: center;">Gould Road</p> 	<p>Gould Road floods approximately 10 times per year with a 2- to 3-inch rain event. The flood waters can reach up to 1 foot deep. The existing culvert needs to be replaced and the road grade needs to be raised to prevent flooding. May need to up size the culvert to aid in this issue. Upstream of Keyes Pond is a beaver dam, which has had flooding impacts mitigated by installing a number of 12-inch pipes. This project will include impacts to bordering vegetated wetlands due to the need for new headwalls and retaining walls.</p> <p>Source: Highway and Police Departments</p>	<p>Culvert Replacement, Road Work:</p> <p>Design and permit a replacement culvert, raise road, and guard rails.</p>
15	<p style="text-align: center;">Groton Road at Snake Meadow Brook</p>	<p>Beavers at the existing culvert cause flooding of one house. The culvert requires routine clearing and maintenance.</p> <p>Source: Highway Department</p>	<p>Maintenance:</p> <p>Complete routine maintenance of culvert.</p>
16	<p style="text-align: center;">Groton Road at Commerce Way</p>	<p>This area is low-lying with country drainage, and wetlands are only 6 inches below drainage outlets. There is a large amount of silt and sediment. A solution to the country drainage is needed, and long-term maintenance will be an issue. A private solution already attempted was not effective.</p> <p>Source: Highway Department</p>	<p>Road Work:</p> <p>Work with private property owners to determine whether road grade modification, driveway entrance regrading, and/or installation of BMPs would be effective.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
17	<p>Groton Road at Gilson Brook</p> 	<p>The existing culvert is undersized and failing and should be upgraded.</p> <p>Source: Highway Department</p>	<p>Capital:</p> <p>This culvert will be replaced as part of the Route 40 & Oak Hill Road intersection improvement project. The existing 30-inch pipe will most likely be replaced with a new 12-foot by 7-foot embedded box culvert. The project is currently on schedule to be constructed in the summer of 2019. Construction will be funded by MassDOT through the Dunstable TIP project on Route 40.</p>
18	<p>Forrest Road between Lawson Road and Pollyanna Lane</p>	<p>There are leaching catch basins with no outfalls in this area. Flooding occurs on the side of the road. Investigation of drainage problems and connectivity is needed.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation:</p> <p>Need to improve mapping in this area and determine if drainage improvements are necessary.</p>
19	<p>Pine Road at Birch Road</p>	<p>There is an issue with a failing leaching structure. Water does not infiltrate and therefore causes minor flooding.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation:</p> <p>Evaluate cause of problem (structure, high groundwater, poor soils?). If needed, replace structure and repair associated drainage pipes.</p>
20	<p>88 Plain Road</p>	<p>According to Highway Department staff, based on inspections and operations, the existing basin and pipe needs replacement.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement:</p> <p>Replace catch basin and associated piping.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
21	<p style="text-align: center;">Polley Road</p> 	<p>The existing open ditches behind houses flow into Stony Brook, and maintenance is a challenge due to existing conditions and conflicts with private property.</p> <p>Source: Highway Department</p>	<p>Maintenance/Drainage Investigation:</p> <p>This area needs maintenance and assessment of optimal solution given wetlands permitting constraints. Assessment would include field inspections, mapping, hydrologic and hydraulic analysis, and discussions with Conservation Commission.</p>
22	<p style="text-align: center;">Lowell Road</p>	<p>There are repeated ice issues in the winter on this road due to residences sump pump discharges. The discharges also cause flooding at foot of hill and erosion of yards.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement, Education:</p> <p>Connect sump pump discharges into the existing drainage system. Educate owners about need for improvement.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
23	<p style="text-align: center;">Chamberlain Road and Swedes Crossing</p> 	<p>This road has an open ditch drainage system. Sump pump discharges drain into the ditch. This causes winter ice issues on the road.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement, Education:</p> <p>The solution may include installing a new closed drainage system in or along Chamberlain Road, extending from Hunt Road and connecting into the Swedes Crossing drainage system. The system may only be necessary on one side of the road based on topography.</p>
24	<p style="text-align: center;">West Prescott Street</p>	<p>This is an area of Forge Village with old pipe. Some of East Prescott Street had open drainage in the center of the street which discharged into a common septic/storage system. There used to be connections from each basement (and maybe sewer) into the 10-inch drainage system.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation:</p> <p>Need to evaluate connectivity and drainage system update alternatives. Work includes video inspections, mapping, and dye testing, preparation of a conceptual design for improvement and development of probable costs. This area should be considered a high priority for the Town’s IDDE program.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
25	East Prescott Street	<p>The existing system consists of old fieldstone brick storm drains that pass under buildings. The drainage system needs to be investigated and replaced where applicable. There is also a conflict with railroad crossing.</p> <p>Source: Highway and Police Departments</p>	<p>Drainage Investigation:</p> <p>Need to evaluate connectivity and drainage system improvement options. Includes preparation of a conceptual design for improvements and development of probable costs.</p>
26	Woodland Drive	<p>This is a slow draining area with a pipeline traveling through back yards. The connectivity of the drainage system is unknown, but the bottom of the hill floods and backs up with water and debris.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation:</p> <p>Need to evaluate connectivity and drainage system improvement options. Includes preparation of a conceptual design for improvements and development of probable costs.</p>
27	Hartford Road at Westford Academy	<p>Wetlands have high water elevation and accumulated sediment/organic debris. This area also experiences higher water levels due to presence of beavers coupled with flat low-lying area, may need to remove sediment organic debris and restore channel.</p> <p>Source: Highway and Police Departments</p>	<p>Stream Restoration/Maintenance:</p> <p>This area needs assessment of optimal solutions given wetlands permitting constraints. Assessment would include field inspections, discussions with Conservation Commission about a conceptual design, and development of probable costs.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
28	Forge Village Road	<p>Wetlands have high water elevation and accumulated sediment/organic debris. This area also experiences higher water levels due to presence of beavers coupled with flat low-lying area, may need to remove sediment organic debris and restore channel.</p> <p>The road is built through the wetlands and raising the road grade may be a solution.</p> <p>Source: Highway and Police Departments</p>	<p>Stream Restoration/Assessment:</p> <p>This area needs assessment of optimal solutions given wetlands permitting constraints. Assessment would include field inspections, discussions with Conservation Commission about a conceptual design, and development of probable costs.</p>
29	Providence Road at Jester Road	<p>There is a flooding issue in this area. The road elevation may need to be raised, and/or the culvert may need to be upgraded. The project would include hydrologic and hydraulic evaluation of Tadmuck Brook. The downstream culvert is likely undersized.</p> <p>Source: Highway and Police Departments</p>	<p>Drainage Investigation:</p> <p>Need to evaluate watershed through hydrologic and hydraulic modeling. This work includes site visits and additional mapping. Includes preparation of a conceptual design improvement and development of probable costs.</p>
30	Providence Road at Palace Road	<p>There is a flooding issue due to undersized culvert.</p> <p>Source: Highway Department</p>	<p>Culvert Improvement:</p> <p>Need to evaluate watershed through hydrologic and hydraulic modeling. This work includes site visits, along with design and construction.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
31	<p style="text-align: center;">Vose Road</p> 	<p>The existing culvert has been replaced, but beavers create dens in the area and have caused flooding.</p> <p>Source: Highway Department</p>	<p>Maintenance:</p> <p>Routine maintenance of culvert and continued beaver management.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
32	<p style="text-align: center;">Steeple Chase Circle</p> 	<p>There is a failing structural stormwater BMP in this location that was installed in the mid-1990s. There is an inlet to the system, but no outlet to allow water out. The system may be undersized and may not infiltrate. When the system is full, it causes surcharges out of drainage system. For these reasons, the street floods almost every rain event and impacts all residential homes along Steeple Chase Circle, Buckskin Lane, and Dobbins Road.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement and Maintenance:</p> <p>Identify original design plans and sizing, open system and ownership. Complete maintenance. Identify recommended improvement alternatives and associated cost.</p>
33	<p style="text-align: center;">Old Lowell Road</p>	<p>New drainage was needed to address the existing flooding issue. Leaching basins were replaced and installed as needed.</p> <p>Source: Highway and Police Departments</p>	<p><i>Project has been completed.</i></p>
34	<p style="text-align: center;">Acton Road at Bruce Freeman Rail Trail Bike Path</p>	<p>The Bruce Freeman Rail Trail bike path has two drains that routinely flood. The state owns the trail but the Town maintains it. New drainage was needed along the trail.</p> <p>Source: Highway Department</p>	<p><i>Project has been completed.</i></p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
35	<p align="center">Acton Road at Old Road</p>	<p>Replace drainage due to age, condition, and functionality.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement:</p> <p>Replace existing drainage and add new drainage to improve conveyance.</p>
36	<p>Open drainage swale from Spruce Road to Williams Avenue to Pine Tree Trail to downstream outlet Nabnasset Pond</p> 	<p>All of the water flows into the golf course area, where it floods the golf course. Throughout neighborhood, houses experience wet basements. There are many places where pipes go under buildings and under roads (e.g., Oak Hill Road). Some of the ditches are full of organic materials from residents dumping leaves and yard waste. Overall, there are issues with capacity in the drainage system. The culvert may need replacement. This area could benefit from additional investigation.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation:</p> <p>This area should be investigated. A potential long-term solution would be to install a closed system from Woodbine Terrace or Williams Avenue to the golf course near Nabnasset Pond. This could reduce the yearly maintenance and sediment and organic debris filling that typically occurs over the years. The Highway Department spends time each spring and fall clearing the open channels, removing trees, removing sediment, etc. by hand.</p> <p>Need to educate residents, study, map, wetlands evaluation, and permit project. Need to look at old mapping to see where stream would have been. Consider culvert replacement.</p>
37	<p align="center">Pine Hill Road</p> 	<p>Flooding has been reported in this area, and the culvert capacity likely needs to be increased given current sizing and overall watershed.</p> <p>Source: Highway and Police Departments</p>	<p>Culvert Replacement:</p> <p>Design, permit, and replace culvert with larger box culvert.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
38	<p style="text-align: center;">Shannon Circle</p>	<p>Shannon Circle is currently an unaccepted private way that may become public in the future. The last four catch basins are leaching structures, but they do not function properly which results in some flooding. There are limited, if any, locations to connect drainage system for discharge.</p> <p>Source: Highway Department</p>	<p>Drainage Improvement:</p> <p>Evaluate area for a long-term drainage solution if Shannon Circle becomes a public way.</p>
39	<p style="text-align: center;">Concord Road between Powers Road and Banbury Drive</p> 	<p>The existing culvert is not performing as designed. After three inches of steady rain, the culvert does not have enough capacity due to maintenance and structural integrity issues and Concord Road floods slightly.</p> <p>Source: Highway and Police Departments</p>	<p>Culvert Replacement:</p> <p>Culvert is scheduled to be replaced by the end of 2018.</p>
40	<p style="text-align: center;">Carlisle Road between Applewood Drive and Whitney Drive</p>	<p>Carlisle Road experiences flooding, sometimes up to 1.5 feet deep, due to high groundwater and discharges from private parcels. A few leaching catch basins have been installed in the area. There is an infiltration system under the parking lot of the daycare facility at 26 Carlisle Road.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation:</p> <p>Need to evaluate area through hydrologic and hydraulic modeling. This work includes site visits and additional mapping, identification of ownership for drainage systems. Includes preparation of a conceptual design improvement and development of probable costs.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
41	<p>Boston Road at Crown Road</p> 	<p>An improperly designed existing drainage layout results flooding of the street. Roadway and drainage improvements are included as part of capital planning. The existing drainage is clay pipe and may be capped at Providence Street. The impact on downstream problem areas (as described under Location ID #29 and #30) would need to be assessed.</p> <p>Source: Highway Department</p>	<p>Drainage Investigation and Improvement:</p> <p>Confirm mapping in this area and CCTV inspect the drainage system. Drainage will be addressed in the future TIP project.</p>
42	<p>East Boston Camps</p>	<p>Puddles form due to undersized drainage discharging in the area of the railroad. The catch basin in the East Boston Camps parking area and another directly across the street at #1 Plain Road are connected and discharge to Stony Brook after passing under the railroad tracks. It is possible that the outlet pipe has failed.</p> <p>Source: Highway and Police Departments</p>	<p>Drainage Investigation:</p> <p>Need to investigate how the drainage is currently connected, where it discharges, and condition of infrastructure. The drainage to the north at the intersection of Plain Road and Depot Street should also be investigated to determine if it is currently connected to this system, or, if improvements are recommended, if it should be connected to the system in the area of the railroad.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
43	Graniteville Pond at Bridge Street	<p>Stony Brook crosses under the road. The culvert is undersized to accommodate the brook, and development has created increased impervious cover in areas near the brook, creating increased stormwater runoff and overall drainage issues that result in about 1 foot of flooding on Pine Ridge Road every 1 to 3 years. In addition, there has been limited maintenance of the culvert over recent years.</p> <p>Source: Police Department</p>	<p>Drainage Investigation:</p> <p>Project consists of design and construction of a replacement culvert along with investigation of the existing drainage system condition and connectivity in the contributing watershed area, including updating existing mapping to reflect as-built conditions.</p>
44	Hildreth Street north of Wright Lane	<p>This area experiences icing issues. Groundwater breaks out of the side of the hill, which may be due to a nearby recently constructed subdivision. Town staff have cited concerns about utilities and grading in the new subdivision.</p> <p>Source: Police Department</p>	<p>Drainage Investigation:</p> <p>Investigate existing conditions including a site visit and obtain plans from subdivision. Possible improvements include adding drainage controls along road.</p>
45	Robinson School	<p>There is a sunken catch basin by the gazebo.</p> <p>Source: School Department</p>	<p>Drainage Improvement:</p> <p>The catch basin frame and grate need to be reset.</p>
46	Blanchard Middle School	<p>A catch basin near the Café is clogged with sand from erosion of the abutting hill. The front entrance to the school sinks in winter, most likely due to poor soils that move with the freeze/thaw cycle. There is also an area by the basketball court that has sunk over the years and no longer is consistently level due to improperly functioning drainage structures. Overall drainage at the school is a concern.</p> <p>Source: School Department</p>	<p>Drainage Improvement, Maintenance:</p> <p>The clogged catch basins and overall drainage system require additional routine cleaning and maintenance.</p>

Table 5-1
Locations of Known Drainage System Deficiencies

Location ID	Location	Description of Conditions	Project Description
47	Westford Academy	<p>The area near the ticket booth served by one catch basin does not drain properly.</p> <p>Source: School Department</p>	<p>Maintenance:</p> <p>May be a maintenance issue with catch basin or a clogged pipe. Cleaning and/or jetting is recommended.</p>
48	Nabnasset School	<p>The drainage system that was installed as part of the addition to the school does not perform as designed. Stone was not used around the leaching basins that were installed and several of those structures have subsequently failed over the years due to improper design resulting in poor functionality. The catch basin in the back of the school is installed at a point of higher elevation than the surrounding area and therefore does not provide a drainage pathway for runoff.</p> <p>Source: School Department</p>	<p>Drainage Investigation:</p> <p>Further investigation is needed to determine the solution. This investigation includes CCTV inspection of the drainage system and correcting existing mapping, along with preparing a design to address the conditions identified.</p>
49	Stony Brook School	<p>There was a sunken catch basin in the back parking lot of the school. The catch basin near the football field ticket booth was filled with sand and did not drain. Maintenance was required.</p> <p>Source: School Department</p>	<p><i>Project has been completed.</i></p>
50	John Crisafulli School	<p>Catch basins do not drain.</p> <p>Source: School Department</p>	<p>Maintenance:</p> <p>This issue requires further investigation. According to Town staff, the cause is most likely the result of poor construction of the drainage system (e.g., slope, connectivity, alignment). At a minimum, the catch basins should be cleaned, and existing connectivity mapping should be updated.</p>

5.2 Results of Representative Rapid Condition Assessment

As described in Section 4.2.2, the purpose of this rapid assessment was to better understand the condition and operation of Westford’s drainage infrastructure. The field effort associated with assessing the condition of various drainage components in representative areas of Town covered 74 drain structures and 219 drain pipe segments. This is equivalent to just over one percent of the drainage structures in Town and just over six percent of the total drain pipes, or four of the 60 miles of total drain pipes in Westford. Therefore, the field effort inspected only a small portion of the system in terms of length and diameter of pipes, and structures. We are using this information to make assumptions about the overall capital and maintenance needs of the drainage system, however additional investigation is needed.

5.2.1 Drainage System Attributes

The following tables and charts include information about the MS4 components that were inspected during the field effort.

5.2.1.1 Pipe Material

Table 5-2 and Figure 5-1 demonstrate the breakdown of material of the inspected pipe segments. Most the inspected pipelines were reinforced concrete pipes, and almost 15 percent were corrugated metal pipes. This is a representative sample of the pipe materials within the Town’s entire inventoried drainage system, which consists of 74 percent RCP and nine percent CMP (discussed in Section 3.2.1.1).

Table 5-2
Length of Inspected Drainage Pipes by Material

Pipe Material	Length (feet)	Percent of Inspected Segments	Percent of System
Cast Iron	484	2.4%	0.2%
Clay	187	0.9%	0.1%
Corrugated Metal	2,802	14.0%	0.9%
HDPE	1,045	5.2%	0.3%
Perforated PVC	47	0.2%	0.0%
PVC	132	0.7%	0.0%
RCP	15,256	76.4%	4.8%
Unknown	5	0.0%	0.0%
Total (feet)	19,959	100%	6.3%
Total (miles)	4		

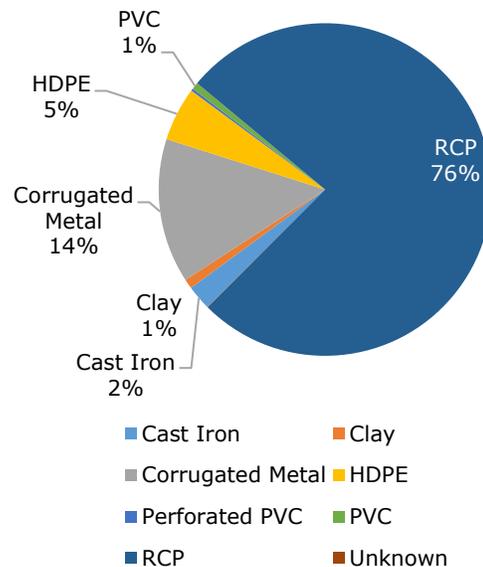


Figure 5-1 Distribution of Inspected Drainage Pipes by Material

5.2.1.2 Pipe Diameter

The diameters of the inspected pipelines are included in Table 5-3 and Figure 5-2. Approximately half of the inspected pipes were 12 inches in diameter. 15-, 18-, and 24-inch diameter pipes made up another 38 percent of the inspected pipe segments. This is representative of the Town’s drain pipe diameters, which are a majority of 12-inch pipes and another approximately 30 percent of 15-, 18-, and 24-inch pipes.

Table 5-3
Inspected Drainage Pipe Diameters

Pipe Diameter	Length (feet)	Percent of Inspected Segments	Percent of System
2"	25	0.1%	0.0%
6"	81	0.4%	0.0%
10"	76	0.4%	0.0%
12"	10,266	51.4%	3.3%
14"	49	0.2%	0.0%
15"	3,018	15.1%	1.0%
18"	3,066	15.4%	1.0%
21"	440	2.2%	0.1%
22"	101	0.5%	0.0%
24"	1,517	7.6%	0.5%
27"	385	1.9%	0.1%
30"	22	0.1%	0.0%
Unknown	913	4.6%	0.3%
Total (feet)	19,959	100.0%	6.3%
Total (miles)	4		

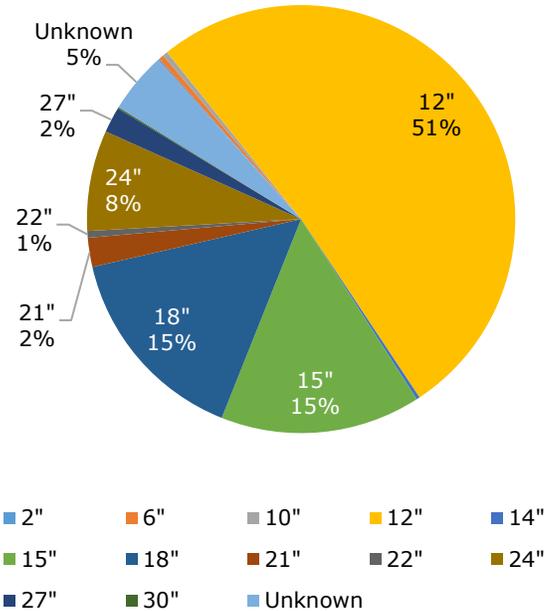


Figure 5-2 Distribution of Inspected Drainage Pipes by Diameter

5.2.1.3 Structure Type

Of the 74 structures that were inspected as part of the rapid condition assessment, just more than half were catch basins, as shown in Figure 5-3. While catch basins are much more widespread than drain manholes in the entire Westford MS4 (55 percent and 19 percent respectively), inspecting drain manholes as part of the field effort allowed for confirmation of more drainage connectivity.

5.2.1.4 Structure Material

During the rapid condition assessment, the inspector observed the material of each drain structure inspected and included that information in the Drainage Structure Inspection Reports included in the GIS. Over 60 percent of the inspected structures were block structures, and another 22 percent were precast concrete structures. Examples of a block and a precast structure are included in Figure 5-7 in the next section.

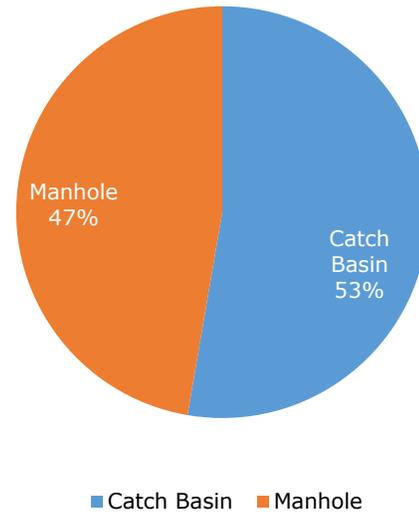


Figure 5-3 Type of Inspected Structures

Table 5-4
Distribution of Inspected Drainage Structures by Material

Structure Material	Quantity of Inspected Structures	Percent of Inspected Structures
Block	45	60.8%
Precast	16	21.6%
Brick	3	4.1%
Fieldstone	2	2.7%
Block Corbel, Precast Walls	1	1.4%
Precast Corbel, Block Walls	7	9.5%
Total	74	100%

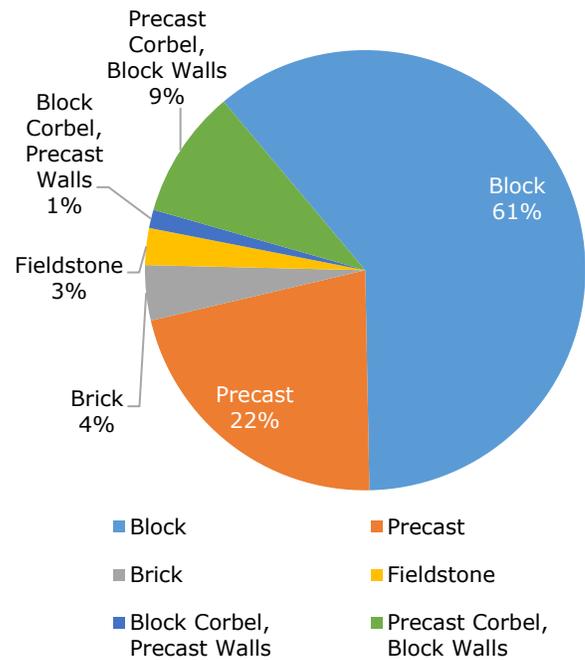


Figure 5-4 Distribution of Inspected Drainage Structures by Material

5.2.2 Inspected Drainage Structure Condition

The condition of various components of each structure was recorded in the field inspection reports during the inspection, including the structure frame or cover, corbel, steps, walls, and floors. When the condition of the inspected MS4 structures were recorded in the Town’s GIS mapping attributes (as described in Section 4.2.2), the portion of the structure with the worst condition was recorded as the condition of the overall structure. For example, if the access steps for a drain manhole were corroded or broken, but the rest of the structure was in great condition, the entire structure was denoted as being in “poor” condition, and the situation was explained in the “Condition Notes” section of the attributes. Therefore, some structures that are generally in good condition may be classified as “poor” condition in the Town’s GIS. This allows the Town to quickly identify any structures that are not fully in acceptable condition.

Figure 5-5 includes the condition of each of the inspected drain structures by material. **84 percent of the inspected structures were in good or excellent condition. Only 16 percent were in fair condition, and no structures were in poor condition.**

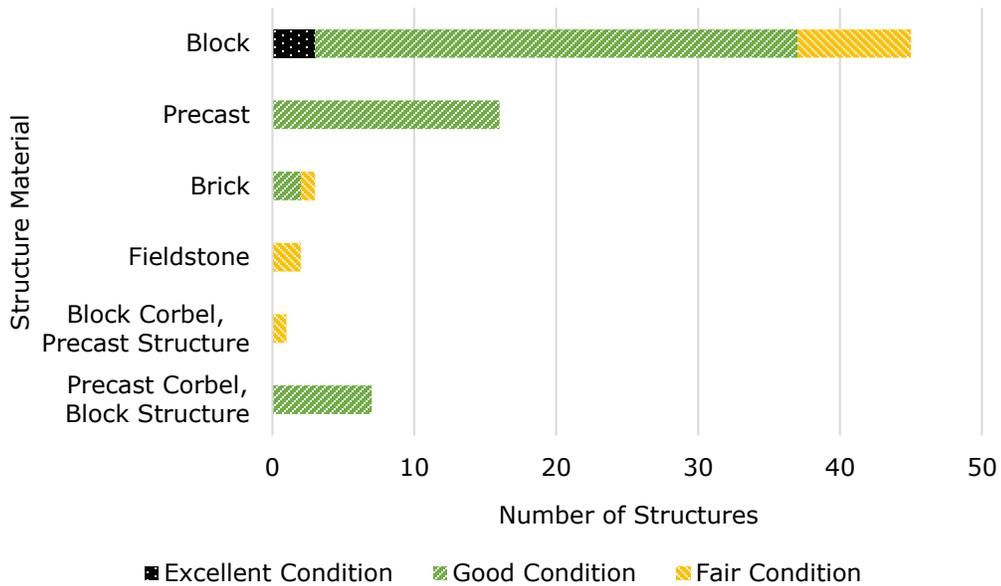


Figure 5-5 Condition of Inspected Structures by Material

Figure 5-7 includes two examples of drain structures that are in good or excellent condition. Figure 5-6 is an example of a drain structure that is in fair condition. While some repairs could be made to improve the structure in fair condition, it can still perform its intended function for the MS4.



Figure 5-6 Example of Structure in Fair Condition



Figure 5-7 Example of Precast (top) and Block (bottom) Drain Structures in Good Condition

Table 5-5 includes a list of all structures that are in fair or poor condition or have a portion of the structure that is in poor condition (e.g., steps), which resulted in a worse condition rating for the entire structure.

Table 5-5
Inspected Drain Structures in Fair or Poor Condition

Structure Type	Condition	Quantity	Notes
Catch Basin	Fair	5	Structure in fair condition
Catch Basin	Fair	1	Slotted frame and gate is broken and should be replaced; structure in fair condition
Manhole	Good	1	Depressed frame and cover
Manhole	Fair	4	Structure in fair condition
Manhole	Poor	1	Steel steps in poor condition, rest of the structure in good condition

Catch basin frames and grates and drain manholes frames and covers were typically in good condition. The two frames and grates that had structural issues are included in Table 5-5. Some drain manhole covers did not have a cover that said "DRAIN" and should be replaced with the correct covers. Other covers had asphalt on them and should be cleared of any obstruction.

84 percent of the inspected structures were in good or excellent condition. Only 16 percent were in fair condition, and no structures were in poor condition.

5.2.3 Inspected Drainage Pipe Condition

More than 90 percent the drainage pipes inspected during the rapid condition assessment were in good condition. Figure 5-8 includes an example of a reinforced concrete drain pipe that is in good condition and a corrugated metal pipe that is in fair condition due to corrosion.

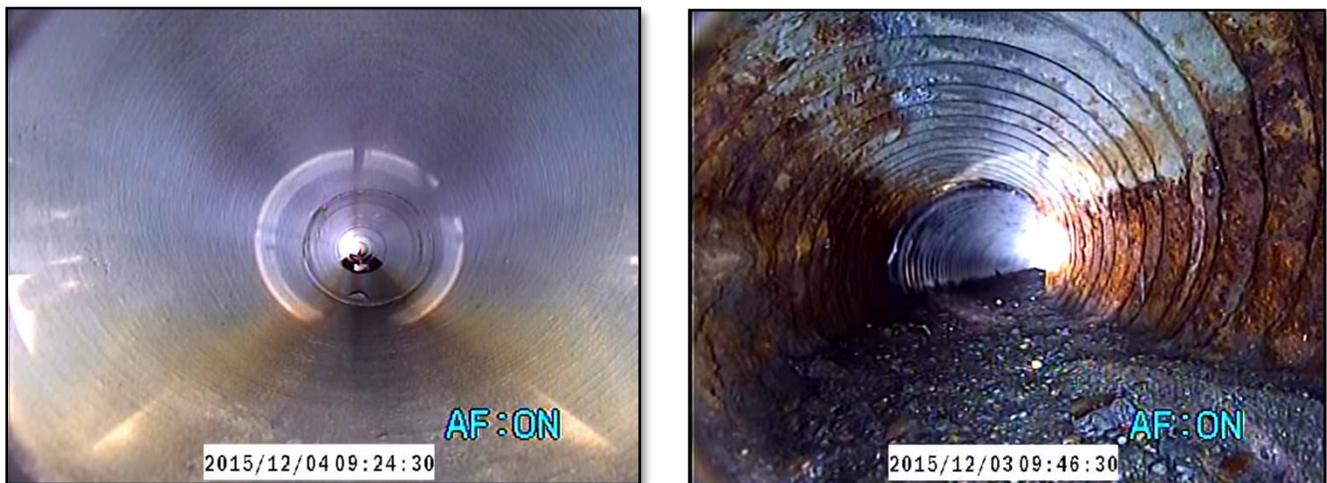


Figure 5-8 Example of Inspected Drain Pipe in Good Condition (left) and Fair Condition (right)

The following figures include charts of the condition of the inspected pipes. Figure 5-9 includes the drain pipes in "good", "fair", and "poor" condition by the decade of installation. Since most of the pipes do not have known installation dates (reference discussion in Section 3.2.6 for more details), most of the pipes are in an "Unknown" installation date category.

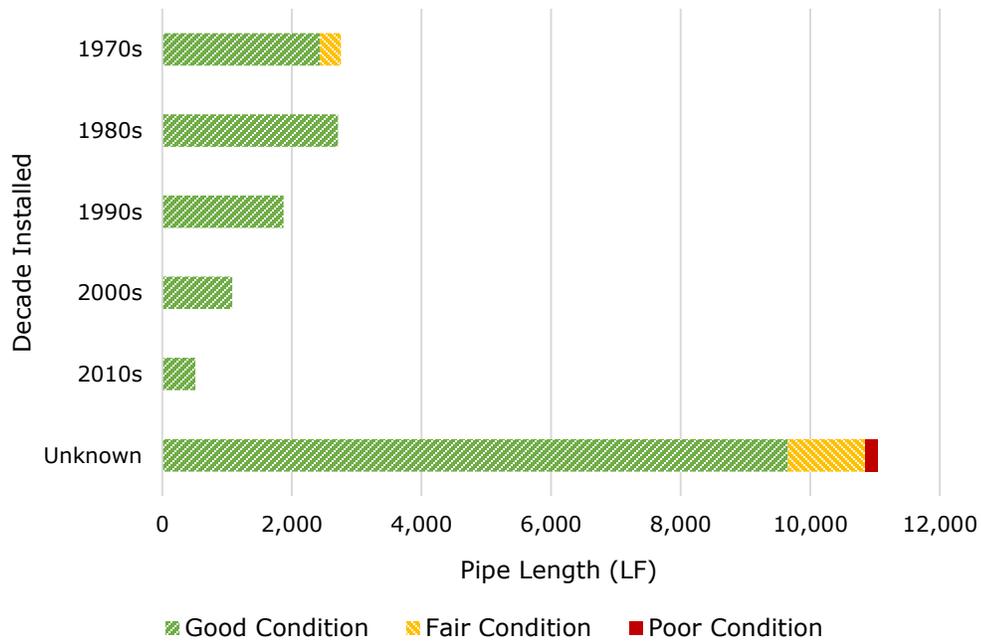


Figure 5-9 Distribution of Pipe Condition of Inspected Pipes by Date Installed

Figure 5-10 includes the breakdown of pipe condition by pipe material. Almost all of the reinforced concrete pipes inspected were in good condition. Almost half of the corrugated metal pipes were in fair or poor condition. It is evident from Figure 5-10 that corrugated metal pipes are in worse condition than the rest of the pipe materials in the drainage system.

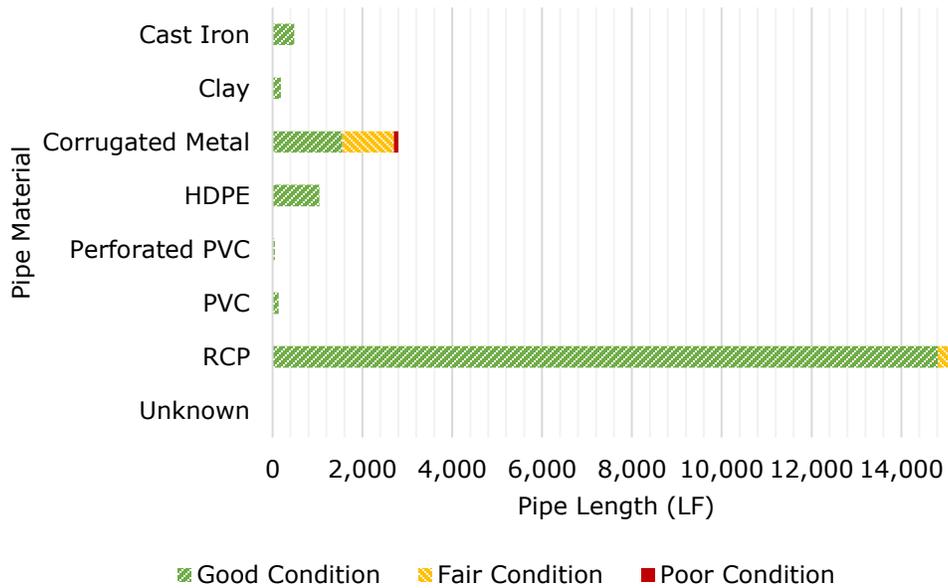


Figure 5-10 Distribution of Pipe Condition of Inspected Pipes by Material

Figure 5-11 includes the distribution of inspected drain pipe condition by pipe size.

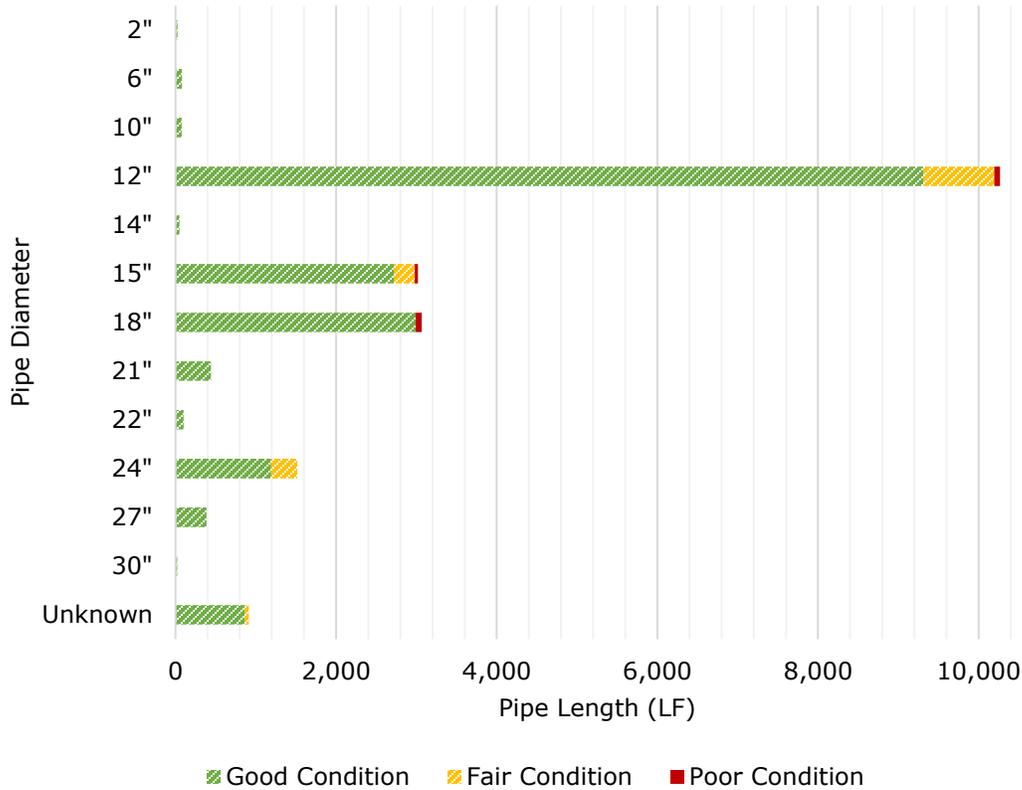


Figure 5-11 Distribution of Pipe Condition of Inspected Pipes by Diameter

It is evident from these charts that the majority of the inspected pipelines were in good condition.

Table 5-6 includes a summary of all drain pipes that were inspected and found to be in **good condition**. The table is broken down by pipe diameter, pipe material, and decade installed, if known. Table 5-7 includes the drain pipes that were found to be in **fair or poor condition** during the inspection. Often, pipelines were classified as fair or poor condition when mineral deposits, rusting, or roots were observed during the inspection. This table is broken down by street, pipe diameter and material, and condition.

Table 5-6
Inspected Drain Pipes in Good Condition

Diameter	Material	Decade Installed	Length (feet)	Percent of Inspected Pipes
2"	PVC	Unknown	25	0.1%
6"	PVC	Unknown	34	0.2%
	Perforated PVC	Unknown	47	0.3%
10"	Corrugated Metal	1990s	76	0.4%
	Cast Iron	Unknown	435	2.4%
	Clay	Unknown	164	0.9%
12"	Corrugated Metal	1970s	82	0.4%
		Unknown	1,001	5.5%
	HDPE	1990s	5	0.0%
		Unknown	848	4.6%
	PVC	Unknown	41	0.2%
		1970s	1,402	7.7%
		1980s	494	2.7%
		1990s	581	3.2%
		2000s	197	1.1%
		2010s	510	2.8%
Unknown	3,558	19.5%		
14"	Cast Iron	Unknown	49	0.3%
	HDPE	1980s	147	0.8%
15"	RCP	1970s	220	1.2%
		1980s	1,108	6.1%
		1990s	682	3.7%
		2000s	44	0.2%
		Unknown	518	2.8%
18"	Corrugated Metal	1970s	281	1.5%
		1970s	345	1.9%
		1980s	247	1.4%
		2000s	713	3.9%
		Unknown	1,405	7.7%
21"	RCP	1980s	50	0.3%
		Unknown	390	2.1%
22"	Corrugated Metal	1970s	101	0.6%
		1980s	281	1.5%
24"	RCP	1990s	530	2.9%
		2000s	124	0.7%
		Unknown	258	1.4%
27"	RCP	1980s	385	2.1%
30"	RCP	Unknown	22	0.1%
		Unknown	23	0.1%
		Unknown	10	0.1%
		Unknown	46	0.3%
		Unknown	33	0.2%
		Unknown	745	4.1%
Unknown	Unknown	Unknown	5	0.0%
		Unknown	5	0.0%
		Unknown	5	0.0%
		Unknown	5	0.0%
		Unknown	5	0.0%
		Unknown	5	0.0%
Total (feet)			18,258	100%
Total (miles)			3	

Table 5-7
Inspected Drain Pipes in Fair or Poor Condition or Needing Maintenance

Street ⁽¹⁾	Diameter	Material	Condition	Condition Notes
Blackthorn Drive	12"	RCP	Fair	Mineral deposits in joints
Blackthorn Drive	12"	RCP	Fair	Mineral deposits in joints
Boston Road	12"	Corrugated Metal	Fair	Has point repair
Bradford Street	12"	RCP	Good	Evidence of past surcharging, some sediment
Bradford Street	12"	RCP	Good	Evidence of past surcharging, some sediment
Bradford Street	12"	RCP	Good	Evidence of past surcharging, some sediment
Broadway Street	12"	Corrugated Metal	Poor	Sediment and pieces of broken pipe in segment
Broadway Street	12"	RCP	Poor	Sediment and pieces of broken pipe in segment
Broadway Street	15"	Corrugated Metal	Poor	Sediment and pieces of pipe in segment
Colonial Drive Ext.	24"	Corrugated Metal	Fair	Elliptical CMP with asphalt coating in invert; small buckling deformity
First Street	12"	HDPE	Good	Unknown connectivity
Fletcher Road	15"	RCP	Fair	Mineral deposits in joints
Fletcher Road	Unknown	RCP	Fair	Mineral deposits in joints
Groton Road	12"	Corrugated Metal	Fair	Pipe rusted with deposits
Groton Road	12"	Corrugated Metal	Fair	Pipe rusted with deposits
Mark Vincent Drive	24"	Corrugated Metal	Fair	Some rusting of corrugations
Moore Avenue	12"	RCP	Fair	Roots in joint, good condition otherwise
Moore Road	15"	Corrugated Metal	Fair	Protruding object in segment
North Street	12"	Corrugated Metal	Poor	Deposits encrusted on wall, rusting
Oak Hill Road	12"	Corrugated Metal	Fair	CMP rusted
Oak Hill Road	12"	HDPE	Good	Shows evidence of past surcharge
Oak Hill Road	Unknown	Corrugated Metal	Fair	CMP rusted
Pleasant Street	12"	Corrugated Metal	Good	Minor fine roots at some points
Pleasant Street	12"	Corrugated Metal	Good	Minor fine roots at some points
Pleasant Street	12"	Corrugated Metal	Good	Minor fine roots at some points
Rome Drive	18"	RCP	Poor	Gasket visible in DMH2479 segment (believed to be in structure); RCP in good condition
Vine Brook Road	18"	RCP	Good	Potential pipe defect, ground depression noted above pipe alignment
West Prescott Street	12"	Corrugated Metal	Fair	Some roots coming through pipe
West Prescott Street	12"	Corrugated Metal	Fair	Some roots coming through pipes
Williams Avenue	12"	Corrugated Metal	Fair	Some roots
Windsor Way	12"	RCP	Good	Outlet partially grown over with grass

(1) The 24" CMP on Colonial Drive and Mark Vincent Road were installed in the 1970s, based on definitive subdivision plan dates. The installation decade of the other drain pipes is unknown.

When debris or sediment buildup was noted during the rapid condition assessment, it was noted on the Field Inspection Reports and subsequently added to the Town’s GIS mapping as an attribute. This will allow Town staff to identify priority areas for cleaning by locating the pipelines with the most debris (i.e., pipes with a higher percentage of the pipe full). As shown in Table 5-8, **80 percent of the pipes that were inspected during the rapid condition assessment of representative areas contained no debris or sediment** (i.e., the pipes were zero percent full). Figure 5-12 is a good representation of what was observed in drain pipes with no debris or sediment buildup.

Table 5-8
Inspected Drain Pipes with Debris/Sediment Buildup

% of Pipe Filled with Debris	Quantity Containing Debris	% of Inspected Segments with Debris
0	176	80.4%
10	4	1.8%
15	7	3.2%
20	10	4.6%
25	2	0.9%
30	5	2.3%
40	4	1.8%
50	1	0.5%
60	8	3.7%
75	1	0.5%
80	1	0.5%
Total	219	100.0%



Figure 5-12 Example of RCP Drain Pipe with No Debris or Sediment Buildup

Figure 5-13 includes the distribution of pipelines with debris. The photos in the chart demonstrate examples of pipelines that were observed to be empty of debris, 20 percent full of debris, and 60 percent full of debris during the field inspections.

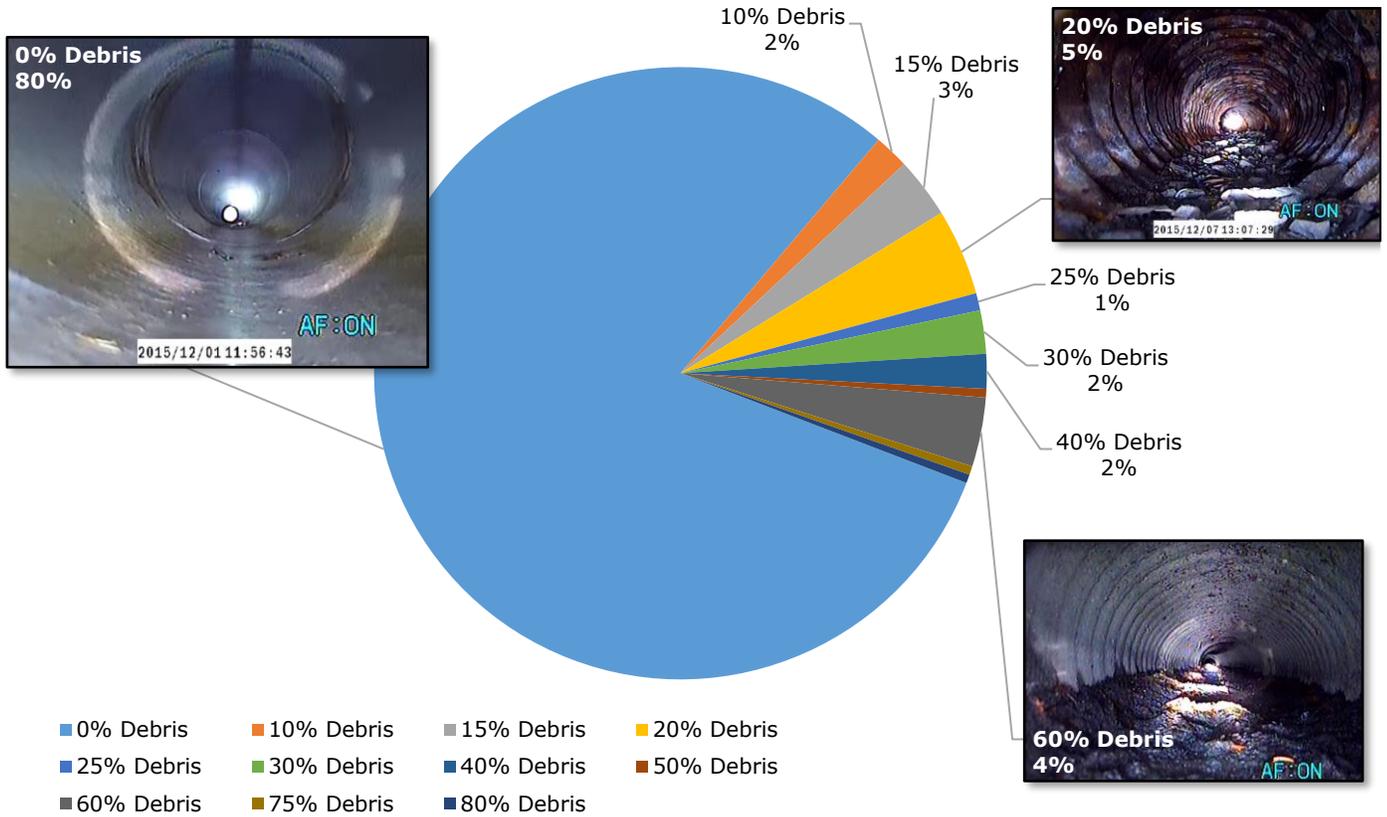


Figure 5-13 Distribution of Inspected Pipes Containing Debris/Sediment Buildup

Figure 5-14 demonstrates examples of conclusions that were drawn from the rapid condition assessment field work completed by Tighe & Bond and Town staff. The blue rectangles indicate the plan extents of record drawings that were scanned and added to the Town's GIS.

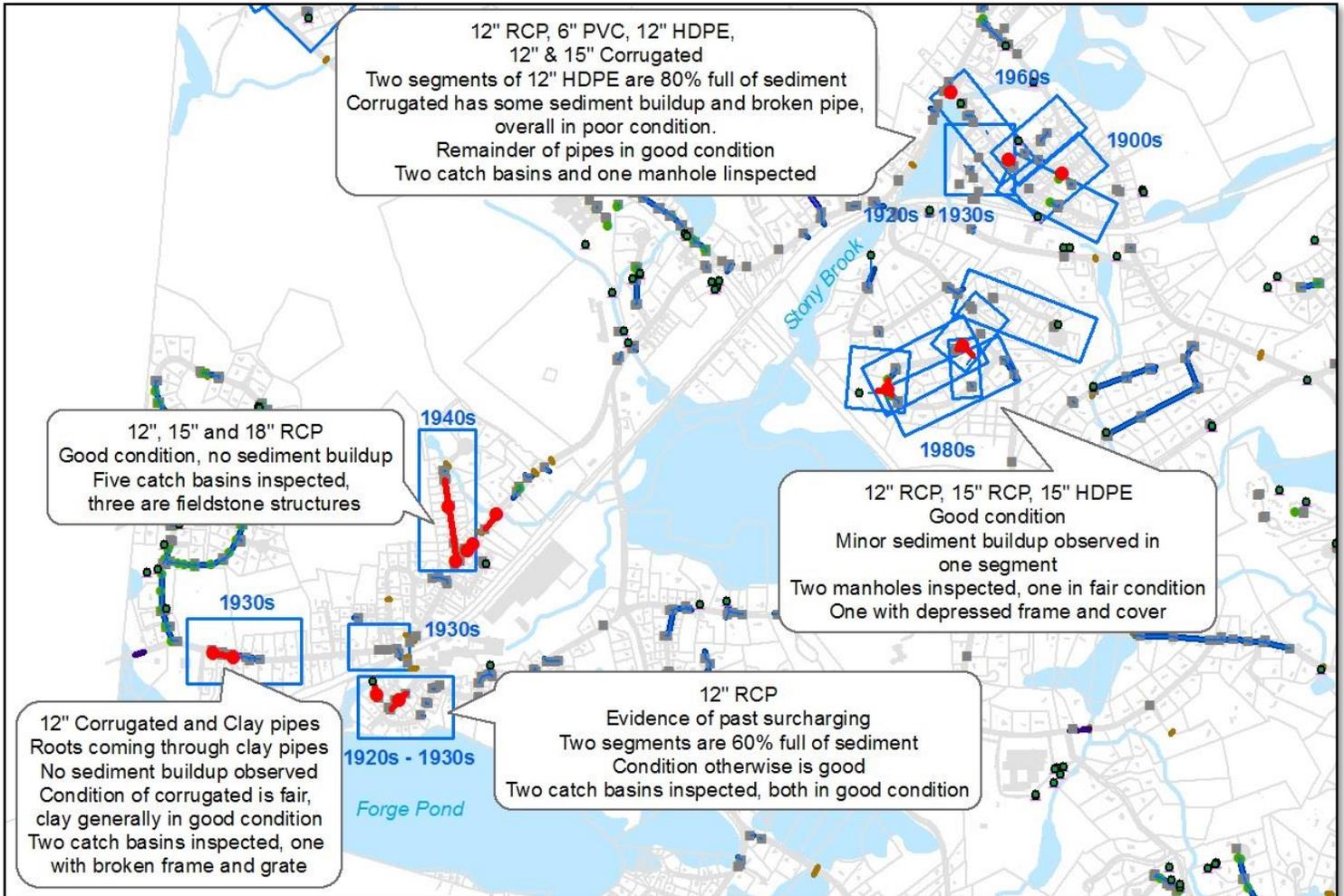


Figure 5-14 Example of Results from Rapid Condition Assessment Field Work

5.3 Conclusions about Overall Drainage Condition and Performance

As outlined in Section 5.1, many of the known drainage issues within Town result from underperforming culverts, beaver damming, and maintenance problems. Based on the results of the rapid condition assessment described in Section 5.2, Westford's drainage pipes, catch basins, and drain manholes are in good condition. Of the corrugated metal pipes that were inspected as part of the rapid condition assessment field work, more than 40 percent were either rusting, had tree roots growing through joints, or had a potential structural issue. However, no substantial issues were found during the field inspections.

While some drain pipes that were inspected do need maintenance, none were in danger of failure. The inspected pipelines and drain structures exhibited none of the modes of failure (mortality, capacity, level of service, or financial inefficiency). Therefore, the MS4 components inspected during the rapid condition assessment have a **low probability of failure**.

As discussed in Section 3.2.6, the age of much of the Town's drainage system is unknown. Just over 50 drain pipe segments, those that were added to the Town's GIS mapping as part of the digitizing effort described in Section 3.1, have dates of installation. Therefore, we cannot extrapolate an age-based risk of failure to the rest of the Town's drainage system.

Installation dates for various drainage assets were added to GIS as an attribute if available on record drawings. 377 drain pipes and 381 structures had installation dates added. The useful service life (included in Table 2-1) was also added as an attribute field for each of the inspected pipes and structures. Of the 377 drain pipes, 51 were inspected. Of the 381 drain structures, 31 were inspected. For these assets, the hypothetical date the asset will need replacement was determined and added to the GIS in a field called "Replace By Year."

The majority of Westford's drain pipes are on residential roads. However, some drain pipes are along major roadways such as Plain Road, Main Street, Forge Village Road, and Pleasant Street. The drain features that are located within minor, residential roadways have a lower consequence of failure than those within the major routes in Town.

Section 6



Section 6

Capital Improvement Plan

This Long-Term CIP presents stormwater infrastructure and other capital improvements along with associated budgets identified through the planning and evaluation process described throughout this report. In addition, the Long-term CIP includes programmatic recommendations and associated budgets identified through the overall SWMMP process (i.e., NPDES MS4 permit compliance, capital programs, operation and maintenance including equipment, and staffing). Recommendations may be for one-time costs or annual costs. Capital and programmatic recommendations were evaluated against the goals of the SWMMP, and a five-year CIP was developed with consideration for desired level of service, local priorities, and available funding.

This CIP provides the Town with the ability to rank expenditures, plan for and normalize expenditures over the planning period, and minimize operating and maintenance costs.

6.1 Current Program Costs

To understand the total annual stormwater management program cost, we reviewed financial information provided by the Town to determine existing staff salaries, operation and maintenance, program management and compliance, and capital improvement projects related to stormwater management. These include costs itemized under the Engineering Department, Highway Department, and Stormwater Management, including salaries and expenses, and the Town's capital plan. Table 6-1 presents an estimate of the annual cost for the Town's existing stormwater management program. This estimate is an update to the costs developed for the *Stormwater Funding and Financing Alternatives* report in December 2016.

Table 6-1

Estimate of Current SWMMP Budget (Fiscal Year 2020 Budget)

Category	Opinion of Probable Cost
Staff Salaries	\$240,000
Operation & Maintenance	\$121,000
Program Management and Compliance	\$80,000
Capital Improvement Projects	\$158,000
Total Annual Program Cost	\$600,000

Additional detail for the current program costs is located in Appendix B, including allocations from the Fiscal Year 2020 budget and a summary of stormwater-related capital projects since Fiscal Year 2015.

6.2 SWMMP Recommendations and Future Program Costs

Various capital and programmatic expenditures were identified during the development of the SWMMP. The expenditures address both one time and annual costs associated with the following capital and programmatic needs:

- General stormwater management;
- Drainage improvements;
- Areas that are in need of additional investigation;
- Compliance with EPA's Phase II Small MS4 General Permit;
- Equipment needs to support O&M;
- Ongoing O&M; and
- Staffing.

There are other projects planned in the Town of Westford that are not reflected in these cost estimates but may include or overlap with potential stormwater and/or drainage improvement projects and should be considered part of implementation of the SWMMP.

- Roadway projects: Many roadway improvement projects include drainage system improvements and are a cost-effective way to design and constructed needed drainage improvements.
- Water system projects: Water system projects, such as water main replacements, present an opportunity to improve existing drainage system components in the area of the water project.
- Facilities maintenance and/or upgrades: Improvement plans for town buildings provide an excellent opportunity to consider improving water quality or reducing runoff quantity through reduction of impervious cover and installation of structural stormwater BMPs, and also are optimal sites for installation of educational information.
- New development and redevelopment projects: Private entities that develop or redevelop land in Westford will be required to manage stormwater on the site-level.

Drainage projects should also improve water quality to the maximum extent possible. Appendix C includes recommendations for BMPs that address specific water quality issues in Westford.

As each year progresses, additional improvement projects are identified by the Town, and are added to the Capital Plan for the next year's funding requests. Completing facilities, roadway, water, and/or drainage projects simultaneously would benefit the Town by reducing engineering and construction costs that would be required for separate projects and by addressing goals of the SWMMP. Requiring developers do their share of stormwater management also lessens the burden on the Town.

6.2.1 SWMMP Program Categories

The recommendations identified throughout the development of the SWMMP are located in Table 6-3. Each recommendation is listed in one of the following categories.

General Stormwater Management (Projects SWM-1 to SWM-5)

This category of expenditures consists of developing and implementing ongoing programs that support a more robust and comprehensive stormwater management program. These general improvements have an annual effort associated with them and make results in identifying specific projects for capital improvement expenditures. These efforts include an asset management program, a culvert and bridge inventory and inspection program, a CMP replacement program, drainage system inspection (CCTV and/or Zoom Camera), and water quality improvements integrated with public and private new and redevelopment, including roadway projects. In addition, Westford should consider if improvements to local code are necessary to address the impacts on water resources from tear-downs, where small houses are torn down and replaced with larger houses and more impervious cover.

Design and Permitting of Drainage Improvements (Projects DPDI-1 to DPDI-16)

This category of expenditures consists of design and permitting for capital improvement projects that were identified through the process to identify and better understand drainage system deficiencies (e.g., capacity limitations and flooding, failing drainage infrastructure, chronic maintenance problems, etc.) not already addressed in the Town's Capital Plan. This included collecting information on known problem areas from Police, School, Fire, and Highway Departments and interviewing Highway and Engineering Department staff to obtain more detail on these known deficiencies. Refer to Section 5 for additional information about this effort.

Construction of Drainage Improvements (Projects CDI-1 to CDI-2)

This category of expenditures consists of construction of the capital improvement projects identified in the "Design and Permitting" phase ("DPDI") as well as repair and replacement of culverts identified during the Culvert and Bridge Inventory and Inspection Program.

Areas in Need of Additional Investigation (Projects AI-1 to AI-27)

This category of expenditures consists of capital improvement projects that were identified through Town Staff input and interviews as well as the field effort consisting site visits to areas with known drainage issues and results of a rapid condition assessment of drainage infrastructure using a Zoom camera.

Ongoing Maintenance (Projects OM-1 to OM-7)

This category of expenditures includes ongoing O&M costs required for the drainage system, including increased expenditures to meet requirements of the 2016 General Permit.

EPA's Small MS4 General Permit Compliance (Projects MS4-1 to MS4-4)

This category of expenditures includes costs to meet the 2016 General Permit. Appendix A includes a table that presents the associated adjustments to the preliminary cost projections for the major requirements of the 2016 General Permit. These numbers for planning and budgeting purposes only. Actual costs may vary depending on whether the Town elects to use in-house resources to complete some of requirements. Any drainage system maintenance (including catch basin cleaning and street sweeping), correction of

illicit discharges and connections, and design and construction of stormwater management facilities are not included in this estimate.

As shown in Appendix A, annual compliance costs range from just over \$40,000 to just over \$250,000 annually with an estimate of \$115,000 for a minimum compliance level of service.

Equipment Needs to Support O&M (Projects E-1 to E-3)

This category of expenditures consists of equipment needed to support O&M of the drainage system to meet 2016 General Permit requirements. Depending on level of service, these costs can vary and may include purchase of new equipment or annual costs to increase street sweeping, catch basin cleaning, inspections and assessment, or other O&M efforts. For an advanced level of service, these costs would likely include outsourcing catch basin cleaning and other activities (e.g., BMP inspections and maintenance).

Staffing (S-1)

Staffing is discussed in the Stormwater Funding and Financing Alternatives Report. Staffing will need to increase to implement the SWMMP but will depend on desired level of service. Our recommendations to address staffing for a protective level of service are detailed in Table 6-4.

6.2.2 Screening and Ranking of Recommendations

To tie the recommendations back to the original goals of the SWMMP, we prepared a ranking system that shows generally how well each project meets our screening criteria related to the overall SWMMP goals described in Section 1 of this report. Table 6-2 presents the ranking and scoring criteria for projects identified in Westford's SWMMP.

Table 6-2
Selected Screening Criteria for Project Ranking

Screening Criteria	Definition of Criteria: Ability of Project to...
Human Health and Safety	...protect human health and safety.
Critical Infrastructure Performance	...improve or maintain performance of critical infrastructure.
Drinking Water Quality or Groundwater Recharge Improvement	...improve drinking water quality in Westford water supplies or recharge groundwater to Westford's aquifers.
Flood Reduction	...reduce potential for flooding that causes health and safety issues.
Regulatory Compliance	...comply with Federal, State, and Local regulatory requirements.
Surface Water Quality and/or Habitat Improvement	...improve surface water quality in local waterbodies and waterways and/or protect or preserve animal species or other habitat.
Climate Change Resiliency	...increase the resiliency of Westford's infrastructure.

We applied these ranking criteria to the recommendations included in Table 6-3 to understand what projects that are recommended should be a higher priority as they meet more of the SWMMP goals.

In Table 6-3, the blue dots (●) indicate that a project provides a benefit under the applicable screening criteria, and blank cells indicate that a project does not provide a benefit under the applicable screening criteria. The "Location ID" associated with some projects in Table 6-3 refers to the project Location ID in Table 5-1 of this Plan and Figure 3-4 in Volume 1 of the SWMMP.

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
General Stormwater Management (SWM)										
SWM-1	<p>Stormwater Asset Management Program. The Town should implement the Stormwater Management Master Plan recommendations using an Asset Management Approach that considers level of service, probability of failure and consequence of failure, life cycle, and costs. The "roadmap" for asset management includes software and GIS, coordination among multiple departments, and data tracking and collection both in the field and in offices. It will also include a program to guide ongoing inspections of the drainage system (see SWM-4). The program builds off the work completed to develop this CIP and result in continued drainage inspection annually. SWM-1 includes program oversight and ongoing prioritization and data management. We assume that Town staff will be primarily responsible for this and a minimal annual budget has been provided for limited outside assistance.</p>	Town-wide	●	●	●	●	●	●	●	H
SWM-2	<p>Culvert Inventory and Inspection Program Development and Implementation. The Town should develop a program to inventory culverts and complete inspections and implement it on an annual basis. This program should include a coding and rating system to create a consistent set of criteria for the inventory and inspection work. The key goal is to identify the potential for failure (including beaver and other maintenance issues) and the risk of failure, and define inspection frequencies. This effort also includes identifying the potential locations of currently unmapped culverts that should be mapped. According to the Town's GIS mapping as of the date of this report, there are 285 mapped culvert segments, totaling approximately 17,000 linear feet, or 3.2 miles. The Town's GIS system maps each culvert pipe individually, though many of the culverts consist of two or three separate pipes which would be grouped and considered one culvert. The program should include developing a tablet application that integrates with the Town's ArcGIS and/or paper forms for data entry for the inventory and inspection items. This budget assumes culvert inspections by a contractor (excluding bridges), preparation of a risk-based culvert asset management plan with criticality ratings, prioritization, and an opinion of probable costs for replacement/repair of high priority culverts and conceptual recommendations.</p>	Town-wide	●	●		●	●	●	●	H
SWM-3	<p>Opportunistic Water Quality Improvements. Town projects, whether they be roadway- or facility-related should consider implementing structural and/or non-structural Best Management Practices (BMPs) to target pollutants of concern for specific sub-basins in Westford. This is a best practice to address requirements of EPA's Phase II Small MS4 General Permit (see Appendix A). A memorandum describing BMPs by pollutant of concern is included in Appendix B. The recommended BMPs are not specific capital recommendations, but the Town should consider a funding line item for water quality improvements. In addition, this guidance can be used in discussions with private developers about site design as part of Planning Board or Stormwater Permit reviews. We assume that Town staff will implement this recommendation and cost is included in staff time.</p>	Town-wide	●		●		●	●	●	H
SWM-4	<p>Advanced Monitoring of Corrugated Metal Pipe (CMP) Drainage. During the representative condition assessment, segments of CMP pipe were inspected. Of those pipes, a number of segments were found to be in fair or poor condition. Many more could be nearing the end of their expected service life. As the Town completes water and/or roadway reconstruction projects, the CMP drainage pipes should be replaced to reduce the potential for flooding (due to collapse) and reduce the potential for discharges that could harm water quality and wildlife habitat (due to the rust). This includes a budget for an enhanced inspection program that includes annual location, inspections of CMP pipe, and evaluation of criticality and alternatives for replacement/repair (if necessary).</p>	Town-wide	●	●	●	●		●	●	H

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)	
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency		
General Stormwater Management (SWM)											
SWM-5	Regulatory Updates. As part of updating and evaluating local code under EPA's NPDES Permit compliance (see Appendix A), consider regulatory updates needed to address tear downs and climate change.	Town-wide			●	●			●	●	M
Design and Permitting of Drainage Improvements (DPDI)											
DPDI-1	Drainage Improvement. Open drainage ditches need maintenance, and some segments of closed drainage system (i.e., piping and catch basins) need replacement. The open drainage ditches may be considered wetlands resource areas under the jurisdiction of the Westford Conservation Commission. Prior to drainage improvements being completed, a site visit with the Conservation Agent should be completed and potential solutions should be discussed. At a minimum, removal of sediment and organic debris buildup is recommended to be completed under a permit from the Commission.	Hidden Valley Road (Location ID 4)	●			●					L
DPDI-2	Culvert Replacement, Road Redesign. The road grade is low, and beaver activities have elevated the wetlands and waterbody surface elevations, thereby causing flooding. Historically, the flooding has closed either one lane or the entire road approximately every other year. The existing culvert is buried by sediment and is typically mostly submerged, and needs replacement or upsizing. The road was recently repaved. 300 linear feet of road raising and reconstruction, replace culverts, permitting.	Dunstable Road, near intersection with Tenney Road (Location ID 5)	●	●		●			●	●	H
DPDI-3	Drainage Improvement. Beavers cause flooding, and one nearby driveway is flooded periodically. Need to clear obstructions in wetland abutting culvert and address the beaver conflict. The solution to the flooding issue would be to install a new closed drainage system. The closed drainage system would discharge near the existing culvert and would extend to the east near #9 Long Sought For Pond Road and Gristone Road. The system would likely require up to 2 catch basins, a manhole, and approximately 300 feet of 12-inch drain pipe. Resolving the flooding issues caused by beavers will require routine maintenance and keeping the culvert openings clear.	Long Sought for Pond Road (Location ID 6)	●	●		●			●	●	H
DPDI-4	Culvert Replacement. Beavers cause flooding, however, the flood waters have never crossed the crest of the road. Need to replace the existing culvert, which is located off the road on a trail, just downstream and to the west of the existing Tenney Road culvert. This culvert is deteriorated and may be undersized. Potentially need to install a control structure. This culvert (approximately 60 linear feet) is smaller than the existing Tenney Road culvert and probably needs to be replaced and upsized to promote improved water flow in this area. The existing Tenney Road culvert is in good condition and does not need to be replaced.	Tenney Road, south of Long Sought for Pond Road and north of Keyes Road (Location ID 7)	●	●		●			●	●	H

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
Design and Permitting of Drainage Improvements (DPDI)										
DPDI-5	O&M Issue, Culvert Replacement. Beaver dams in the area have raised the water surface elevation. There has been at least one significant flood event in the past five years. The existing corrugated metal culvert is rusted and may need to be replaced. At a minimum, site needs maintenance to remove built up debris abutting culvert and impeding passage of flow. Installation of "beaver deceivers" should be considered for the beaver dams. Upgrade culvert to improve flow passage and wildlife passage, add guard rails to improve safety. Cost includes hiring outside assistance to visually review the site and provide the Town with a brief technical memorandum summarizing findings. The memo will include structural conditions assessment and conceptual repair or replacement recommendations. In addition, we will present a conceptual hydraulic evaluation to advise the Town of the hydraulic circumstances. As part of the technical memo we will include our opinion of the probable construction costs associated with the recommended modifications at each site, including structural, hydraulic and the anticipated permitting required to complete the modifications.	Wing Road at Keyes Road <i>(Location ID 8)</i>	●	●		●		●	●	H
DPDI-6	Drainage Improvement. This road has an open ditch drainage system. When debris or snow accumulates, it impedes flow and causes icing on the road. The system should be evaluated and maintained. A subdivision is planned for the area between those described under Location ID #9, #10, and #11, which may help solve drainage concerns. Design and install a new closed drainage system with discharge to pond down side street. Approximately 500 linear feet of drainage pipe and drainage structures. Cost includes site survey, H&H analysis, design, permitting, and design plans.	Dunstable Road <i>(Location ID 9)</i>	●			●		●	●	M
DPDI-7	Erosion Control Improvement. The DCR parking lot at the boat launch (across the street from the photo) does not have a clear connection to the drainage system and needs to be investigated to reduce localized ponding in the parking area. This project may overlap with the Dunstable Transportation Improvement Project (TIP) project on Route 40, which is funded by MassDOT. Coordinate with the DCR on erosion control and slope stabilization.	Groton Road at Boat Launch <i>(Location ID 12)</i>				●		●		L
DPDI-8	Culvert Replacement, Road Work. Gould Road floods approximately 10 times per year with a 2- to 3-inch rain event. The flood waters can reach up to 1 foot deep. The existing culvert needs to be replaced and the road grade needs to be raised to prevent flooding. May need to up size the culvert to aid in this issue. Upstream of Keyes Pond is a beaver dam, which has had flooding impacts mitigated by installing a number of 12-inch pipes. This project will include impacts to bordering vegetated wetlands due to the need for new headwalls and retaining walls. Design and permit a replacement culvert, raise road, and guard rails.	Gould Road <i>(Location ID 14)</i>	●	●		●		●	●	H
DPDI-9	Drainage Improvement, Education. This road has an open ditch drainage system. Sump pump discharges drain into the ditch. This causes winter ice issues on the road. The solution may include installing a new closed drainage system in or along Chamberlain Road, extending from Hunt Road and connecting into the Swedes Crossing drainage system. The system may only be necessary on one side of the road based on topography.	Chamberlain Road and Swedes Crossing <i>(Location ID 23)</i>	●		●	●				M

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)	
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency		
Design and Permitting of Drainage Improvements (DPDI)											
DPDI-10	Culvert Improvement. There is a flooding issue due to undersized culvert. Cost includes hiring outside assistance to visually review the site and provide the Town with a brief technical memorandum summarizing findings. The memo will include structural conditions assessment and conceptual repair or replacement recommendations. In addition, we will present a conceptual hydraulic evaluation to advise the Town of the hydraulic circumstances. As part of the technical memo we will include our opinion of the probable construction costs associated with the recommended modifications at each site, including structural, hydraulic and the anticipated permitting required to complete the modifications.	Providence Road at Palace Road (Location ID 30)	●	●		●			●	●	H
DPDI-11	Drainage Improvement. Replace drainage due to age, condition, and functionality. Replace existing drainage and add new drainage to improve conveyance.	Acton Road at Old Road (Location ID 35)				●					M
DPDI-12	Culvert Replacement. Flooding has been reported in this area, and the culvert capacity likely needs to be increased given current sizing and overall watershed. Cost includes hiring outside assistance to visually review the site and provide the Town with a brief technical memorandum summarizing findings. The memo will include structural conditions assessment and conceptual repair or replacement recommendations. In addition, we will present a conceptual hydraulic evaluation to advise the Town of the hydraulic circumstances. As part of the technical memo we will include our opinion of the probable construction costs associated with the recommended modifications at each site, including structural, hydraulic and the anticipated permitting required to complete the modifications.	Pine Hill Road (Location ID 37)	●			●			●	●	M
DPDI-13	Culvert Replacement. The existing culvert on Concord Road at Vine Brook is comprised of two 48" diameter metal pipes. The pipes are buried approximately 2' to 3' on the upstream side, and 4' to 5' on the downstream side. From an initial visual review, the pipes are deteriorated with section loss, and show some deformation. The culvert appears to have reached the end of its useful life, and will require significant repairs or replacement. From conversations with the Town, the culvert has overtopped in the past, and frequently backs up during heavy rain events. The openings are likely undersized for the flows, and the deformed and deteriorated metal has not improved the situation. Immediately downstream of the culvert is a low-lying area with a residence on the property. Further downstream there are other residences. Cost includes site survey, H&H, geotechnical assessment, permitting, hydraulic design, alternatives analysis, construction documents and a construction OPC.	Concord Road between Powers Road and Banbury Drive (Location ID 39)	●			●			●	●	H
DPDI-14	Drainage Investigation and Improvement. An improperly designed existing drainage layout results flooding of the street. Roadway and drainage improvements are included as part of capital planning. The existing drainage is clay pipe and may be capped at Providence Street. The impact on downstream problem areas (as described under Location ID #29 and #30) would need to be assessed. Confirm mapping in this area and CCTV inspect the drainage system. Drainage may be addressed in the future TIP project.	Boston Road at Crown Road (Location ID 41)	●			●			●	●	H

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
Design and Permitting of Drainage Improvements (DPDI)										
DPDI-15	Drainage Investigation and Improvement. Stony Brook crosses under the road. The culvert is undersized to accommodate the brook, and development has created increased impervious cover in areas near the brook, creating increased stormwater runoff and overall drainage issues that result in about 1 foot of flooding on Pine Ridge Road every 1 to 3 years. In addition, there has been limited maintenance of the culvert over recent years. Project consists of design of a replacement culvert along with investigation of the existing drainage system condition and connectivity in the contributing watershed area, including updating existing mapping to reflect as-built conditions. Note - this project is included in the Town's current capital request for design and permitting as "Bridge Street Drainage & Water System Improvements Design & Permitting."	Graniteville Pond at Bridge Street (Location ID 43)	●			●		●	●	H
DPDI-16	Drainage Improvement. There is a sunken catch basin by the gazebo. Reset the catch basin frame and grate. Cost assumes completed by Highway staff and costs carried elsewhere.	Robinson School (Location ID 45)	●			●				L
Construction of Drainage Improvements (CDI)										
CDI-1	Drainage System Repair and Replacement. Replace and/or repair drainage system components identified in the Design and Permitting phase (DPDI). This cost assumes 0.25% of the drainage infrastructure (catch basins, manholes, or pipes) will need to be replaced by contractors. Note that given the expected service life of Westford's infrastructure, this budget could be increased greatly to improve level of service. We expect the advanced O&M activities and increased staff proposed herein to extend the service life of Westford's infrastructure.	Town-wide	●	●	●	●	●	●	●	H
CDI-2	Culvert Repair and Replacement Program. Replace and/or repair culverts identified during the Culvert Inventory and Inspection Program discussed in SWM-2. Assume cost will include repair or replacement of three culverts per year (1% of total) with some construction completed by Highway Department.	Town-wide	●	●	●	●	●	●	●	H
Additional Investigation (AI)										
AI-1	Investigation Identified by Representative Condition Assessment. IDDE effort at the drainage manhole at intersection of Lake Shore Drive and Oak Hill Road (object ID 1322/structure ID 1454) as sanitary odor was observed in the manhole.	Lake Shore Drive at Oak Hill Road	●					●	●	H
AI-2	Investigation Identified by Representative Condition Assessment. Investigate evidence of surcharging in pipes on Bradford Street and Oak Hill Road. Could be indicative of capacity issues downstream.	Bradford Street, Oak Hill Road				●			●	M
AI-3	Investigation Identified by Representative Condition Assessment. Multiple pipe segments in Broadway contained pieces of broken pipe – investigate upstream to see if there is a broken pipe. Assumes one day of CCTV.	Broadway				●			●	M
AI-4	Investigation Identified by Representative Condition Assessment. Investigate deformity in pipe (potential pipe defect) – ground depression noted above the pipe alignment. Assumes one day of CCTV.	Vine Brook Road				●				L

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
Additional Investigation (AI)										
AI-5	Drainage Investigation/Improvement. There is an open paved swale with an outdated drop inlet that needs to be replaced with new catch basin with sump. Due to the current configuration, there are issues with debris buildup, and therefore there is some ponding and water backup. Improve mapping of drainage system in area, including swales, and replace inlet structure with a deep sump catch basin. Evaluate whether additional improvements are necessary.	Tyngsboro Road (Location ID 1)				●			●	L
AI-6	Drainage Investigation/Improvement. There is an existing open drainage system that results in road flooding every Spring. Improve mapping of drainage in area including swales and other open conveyances, complete hydraulic and hydrologic modeling, and define conceptual improvements. May require survey and identification of easements.	Forrest Road at Tyngsboro Road (Location ID 2)	●				●		●	M
AI-7	Drainage Investigation/Maintenance, Education. This subdivision was installed with country drainage and ditches. Lack of maintenance and illegal dumping of yard waste have limited capacity of the system and resulted in road flooding every Spring. Need to evaluate drainage in the subdivision (including additional mapping and hydraulic and hydrologic modeling), conduct maintenance, and educate property owners about illegal dumping and flooding impacts. It may be necessary to educate owners and possibly seek enforcement to under the Town's Wetlands Bylaw or the Discharges to the Municipal Storm Drain System Bylaw.	North Hill Road (Location ID 3)	●				●		●	H
AI-8	Maintenance. This road has an open ditch drainage system. When debris or snow accumulates, it impedes flow and causes icing on the road. The system should be evaluated and maintained. A subdivision is planned for the area between Location ID #9, #10, and #11, which may help solve drainage concerns. Further investigation is necessary to determine the solution and whether additional drainage would be necessary. Regular maintenance is also required to keep the channel and drainage clear of debris and obstructions.	Dunstable Road at Pond Road (Location ID 10)	●				●		●	H
AI-9	Drainage Investigation. The existing road elevation is low, and the swamp floods the road. The road typically floods once every five years when there is at least a 3- to 4-inch rain event in 24 hours. Flooding can cause safety issues when emergency vehicles need to pass. The road needs to be raised to solve the flooding issue. The Town has done some hydraulic modeling of the area as part of a Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant. This project could be completed in conjunction with the project described under Location ID #13. Complete investigation of drainage area and prepare design alternatives for improvements.	Keyes Road at Slifer (Location ID 11)	●				●		●	H
AI-10	Drainage Investigation. There are leaching catch basins with no outfalls in this area. Flooding occurs on the side of the road. Investigation of drainage problems and connectivity is needed. Need to improve mapping in this area and determine if drainage improvements are necessary.	Forrest Road between Lawson Road and Pollyanna Lane (Location ID 18)	●				●		●	L
AI-11	Drainage Investigation. There is an issue with a failing leaching structure. Water does not infiltrate and therefore causes minor flooding. Evaluate cause of problem (structure, high groundwater, poor soils?). If needed, replace structure and repair associated drainage pipes.	Pine Road at Birch Road (Location ID 19)	●				●		●	M

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
Additional Investigation (AI)										
AI-12	Drainage Improvement. According to Highway Department staff, based on inspections and operations, the existing basin and pipe needs replacement. Replace catch basin and associated piping.	88 Plain Road (Location ID 20)				●				L
AI-13	Maintenance/Drainage Investigation. The existing open ditches behind houses flow into Stony Brook, and maintenance is a challenge due to existing conditions and conflicts with private property. This area needs maintenance and assessment of optimal solution given wetlands permitting constraints. Assessment would include field inspections, mapping, hydrologic and hydraulic analysis, and discussions with Conservation Commission.	Polley Road (Location ID 21)	●			●				M
AI-14	Drainage Improvement, Education. There are repeated ice issues in the winter on this road due to residences sump pump discharges. The discharges also cause flooding at foot of hill and erosion of yards. Connect sump pump discharges into the existing drainage system. Educate owners about need for improvement. Assume Town staff will address this issue.	Lowell Road (Location ID 22)	●			●		●	●	M
AI-15	Drainage Investigation. This is an area of Forge Village with old pipe. Some of East Prescott Street had open drainage in the center of the street which discharged into a common septic/storage system. There used to be connections from each basement (and maybe sewer) into the 10-inch drainage system. Need to evaluate connectivity and drainage system update alternatives. Work includes video inspections, mapping, and dye testing, preparation of a conceptual design for improvement and development of probable costs. This area should be considered a high priority for the Town's IDDE program.	West Prescott Street (Location ID 24)	●			●	●	●	●	H
AI-16	Drainage Investigation. The existing system consists of old fieldstone brick storm drains that pass under buildings. The drainage system needs to be investigated and replaced where applicable. There is also a conflict with railroad crossing. Need to evaluate connectivity and drainage system improvement options. Includes preparation of a conceptual design for improvements and development of probable costs.	East Prescott Street (Location ID 25)	●			●	●	●	●	H
AI-17	Drainage Investigation. This is a slow draining area with a pipeline traveling through back yards. The connectivity of the drainage system is unknown, but the bottom of the hill floods and backs up with water and debris. Need to evaluate connectivity and drainage system improvement options. Includes preparation of a conceptual design for improvements and development of probable costs.	Woodland Drive (Location ID 26)	●			●		●	●	M
AI-18	Stream Restoration/Maintenance. Wetlands have high water elevation and accumulated sediment/organic debris. This area also experiences higher water levels due to presence of beavers coupled with flat low-lying area, may need to remove sediment organic debris and restore channel. This area needs assessment of optimal solutions given wetlands permitting constraints. Assessment would include field inspections, discussions with Conservation Commission about a conceptual design, and development of probable costs.	Hartford Road at Westford Academy (Location ID 27)				●		●	●	M

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
Additional Investigation (AI)										
AI-19	Stream Restoration/Assessment. Wetlands have high water elevation and accumulated sediment/organic debris. This area also experiences higher water levels due to presence of beavers coupled with flat low-lying area, may need to remove sediment organic debris and restore channel. The road is built through the wetlands and raising the road grade may be a solution. This area needs assessment of optimal solutions given wetlands permitting constraints. Assessment would include field inspections, discussions with Conservation Commission about a conceptual design, and development of probable costs.	Forge Village Road (Location ID 28)	●			●		●	●	M
AI-20	Drainage Investigation. There is a flooding issue in this area. The road elevation may need to be raised, and/or the culvert may need to be upgraded. The project would include hydrologic and hydraulic evaluation of Tadmuck Brook at this culvert. This work includes site visits and additional mapping. Includes preparation of a conceptual design improvement and development of probable costs.	Providence Road at Jester Road (Location ID 29)	●	●		●		●	●	H
AI-21	Drainage Improvement and Maintenance. There is a failing structural stormwater BMP in this location that was installed in the mid-1990s. There is an inlet to the system, but no outlet to allow water out. The system may be undersized and may not infiltrate. When the system is full, it causes surcharges out of drainage system. For these reasons, the street floods almost every rain event and impacts all residential homes along Steeple Chase Circle, Buckskin Lane, and Dobbins Road. Identify original design plans and sizing and determine ownership. Complete maintenance. Identify recommended improvement alternatives and associated cost.	Steeple Chase Circle (Location ID 32)	●			●		●	●	H
AI-22	Drainage Investigation. All of the water flows into the golf course area, where it floods the golf course. Throughout neighborhood, houses experience wet basements. There are many places where pipes go under buildings and under roads (e.g., Oak Hill Road). Some of the ditches are full of organic materials from residents dumping leaves and yard waste. Overall, there are issues with capacity in the drainage system. The culvert may need replacement. This area could benefit from additional investigation. A potential long-term solution would be to install a closed system from Woodbine Terrace or Williams Avenue to the golf course near Nabnasset Pond. This could reduce the yearly maintenance and sediment and organic debris filling that typically occurs over the years. The Highway Department spends time each spring and fall clearing the open channels, removing trees, removing sediment, etc. by hand. Need to educate residents, study, map, wetlands evaluation, and permit project. Need to look at old mapping to see where stream would have been. Consider culvert replacement. Cost includes site investigation, coordination with Conservation Commission, and development of conceptual design alternatives.	Open drainage swale from Spruce Road to Williams Avenue to Pine Tree Trail to downstream outlet Nabnasset Pond (Location ID 36)	●			●		●	●	H
AI-23	Drainage Investigation. Carlisle Road experiences flooding, sometimes up to 1.5 feet deep, due to high groundwater and discharges from private parcels. A few leaching catch basins have been installed in the area. There is an infiltration system under the parking lot of the daycare facility at 26 Carlisle Road. Need to evaluate area through hydrologic and hydraulic modeling. This work includes site visits and additional mapping, identification of ownership for drainage systems. Includes preparation of conceptual design alternatives.	Carlisle Road between Applewood Drive and Whitney Drive (Location ID 40)	●			●		●	●	H

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)	
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency		
Additional Investigation (AI)											
AI-24	Drainage Investigation. Puddles form due to undersized drainage discharging in the area of the railroad. The catch basin in the East Boston Camps parking area and another directly across the street at #1 Plain Road are connected and discharge to Stony Brook after passing under the railroad tracks. It is possible that the outlet pipe has failed. Need to investigate how the drainage is currently connected, where it discharges, and condition of infrastructure. The drainage to the north at the intersection of Plain Road and Depot Street should also be investigated to determine if it is currently connected to this system, or, if improvements are recommended, if it should be connected to the system in the area of the railroad.	East Boston Camps (Location ID 42)				●					L
AI-25	Drainage Investigation. This area experiences icing issues. Groundwater breaks out of the side of the hill, which may be due to a nearby recently constructed subdivision. Town staff have cited concerns about utilities and grading in the new subdivision. Investigate existing conditions including a site visit and obtain plans from subdivision. Possible improvements include adding drainage controls along road.	Hildreth Street north of Wright Lane (Location ID 44)	●								L
AI-26	Drainage Investigation. The drainage system that was installed as part of the addition to the school does not perform as designed. Stone was not used around the leaching basins that were installed and several of those structures have subsequently failed over the years due to improper design resulting in poor functionality. The catch basin in the back of the school is installed at a point of higher elevation than the surrounding area and therefore does not provide a drainage pathway for runoff. Further investigation is needed to determine the solution. This investigation includes CCTV inspection of the drainage system and correcting existing mapping, along with preparing a design to address the conditions identified.	Nabnasset School (Location ID 48)	●			●					M
AI-27	Maintenance. Catch basins do not drain. This issue requires further investigation. According to Town staff, the cause is most likely the result of poor construction of the drainage system (e.g., slope, connectivity, alignment). At a minimum, the catch basins should be cleaned, and existing connectivity mapping should be updated. Assume this is completed by Town staff.	John Crisafulli School (Location ID 50)	●			●					M
Ongoing Maintenance (OM)											
OM-1	Culvert Maintenance. Beavers at the existing culvert cause flooding of one house. The culvert requires routine clearing and maintenance. Complete routine maintenance of culvert. Assume completed by Town staff.	Groton Road at Snake Meadow Brook (Location ID 15)	●			●			●	●	H
OM-2	Culvert Maintenance. The existing culvert has been replaced, but beavers create dens in the area and have caused flooding. Routine maintenance of culvert and continued beaver management. Assume completed by Town staff.	Vose Road (Location ID 31)	●			●			●	●	H
OM-3	Drainage Improvement, Maintenance. A catch basin near the Café is clogged with sand from erosion of the abutting hill. The front entrance to the school sinks in winter, most likely due to poor soils that move with the freeze/thaw cycle. There is also an area by the basketball court that has sunk over the years and no longer is consistently level due to improperly functioning drainage structures. Overall drainage at the school is a concern. The clogged catch basins and overall drainage system require additional routine cleaning and maintenance. Assume improvement done by Highway Department.	Blanchard Middle School (Location ID 46)							●		L

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
Ongoing Maintenance (OM)										
OM-4	Maintenance. The area near the ticket booth served by one catch basin does not drain properly. May be a maintenance issue with catch basin or a clogged pipe. Cleaning and/or jetting is recommended. Assume completed by Highway Department.	Westford Academy (Location ID 47)	●			●				M
OM-5	Improved Sweeping Program and Tracking. Develop and implement an improved sweeping program for municipal streets and parking lots in accordance with 2016 Small MS4 General Permit requirements. Disposal of material.	Town-wide	●			●	●	●		H
OM-6	Improved Catch Basin Cleaning Program and Tracking. Develop and implement an improved catch basin cleaning program. Track program in accordance with 2016 Small MS4 General Permit requirements. Disposal of material.	Town-wide	●			●	●	●	●	H
OM-7	Ongoing Highway Department Drainage Infrastructure Operations. This includes Highway budget allocated to drainage maintenance, flood control, storm debris removal, and a portion of vehicle maintenance, equipment maintenance, pipe & pipe supplies, and other misc. supplies and expenses.	Town-wide	●			●	●	●	●	H
MS4 Compliance (MS4)										
MS4-1	Annual MS4 General Permit Compliance. EPA's 2016 Small MS4 General Permit is effective as of July 1, 2018. The Town must comply with the requirements and schedule within the Permit. Volume 4 of this SWMMP, the NPDES Stormwater Program Compliance Plan, is equivalent to the written Stormwater Management Program required to satisfy EPA's Massachusetts Small MS4 General Permit. The Compliance Plan documents the best management practices the town will implement to comply with the six MCMS within the timeline specified in the reissued General Permit. As part of the SWMMP effort, Tighe & Bond developed a memorandum entitled NPDES Phase II Small MS4 Permit Requirements and Budgetary Planning Estimates for the Westford, MA, which outlines estimated compliance costs and scheduling. This memorandum is included in Appendix A. This budget has been updated to reflect work completed while the permit was delayed for 1 year.	Town-wide	●		●		●	●		H
MS4-2	Identification of Publicly Owned Structural BMPs. To support EPA's requirement to inspection and maintain town-owned structural stormwater BMPs, the Town first needs to identify Town owned and/or operated BMPs. This effort includes review of available documentation, including wetlands permitting files, planning board files, etc. and field work to map locations of Town BMPs.	Town-wide		●	●		●	●		H
MS4-3	Annual MS4 General Permit Implementation. The costs presented in Appendix A of this report reflect baseline compliance costs. Costs associated with isolating and removing illicit connections or illicit discharges, construction of structural stormwater BMPs, monitoring construction stormwater runoff and post-construction stormwater management permitting and reporting, implementing SWPPPs and addressing issues identified are above and beyond the basic compliance costs. We have assumed this work will be completed by Town staff (Engineering and Highway) and have provided a minimal allowance for outside assistance.	Town-wide			●		●	●		H

Table 6-3
Screening Criteria and Ranking for Projects Identified through the SWMMP

Project ID	Project Description	Location	Project Benefits							Rank (H/M/L)
			Human Health and Safety	Critical Infrastructure Performance	Drinking Water Quality or Groundwater Recharge Improvement	Flood Reduction	Regulatory Compliance	Surface Water Quality and/or Habitat Improvement	Climate Change Resiliency	
MS4 Compliance (MS4)										
MS4-4	<p>Stormwater Fee Development and Start-Up. The SWMMP will help protect the health of Westford's water resources for current and future generations, and identifying an equitable, long-term source of revenue for stormwater is the key to this program's success. Investing in drainage infrastructure improvements before there is a problem is the sensible solution. Healthy ponds and rivers and clean drinking water will require greater investments in the future. Stormwater funding alternatives were evaluated as part of the SWMMP. The Town should move forward with developing a stormwater fee with input from town departments and decision makers to present to residents at the 2019 Annual Town Meeting. If the fee is approved at Annual Town Meeting, the Town should proceed with the start-up and implementation of the fee program.</p>	Town-wide	●	●	●	●	●	●	●	H
Equipment (E)										
E-1	<p>GPS System. Utilizing a GPS system in the street sweeping, catch basin cleaning, and winter road maintenance vehicles combined with an ArcGIS or other software package to monitor the procedures and routes of these activities. Data collected can include dates and times, truck names, ignition status, current speed, average speed, odometer reading, total distance traveled, latitude and longitude, etc. ArcGIS can be used to illustrate the routes and work locations. This allows field inspectors to determine the information at a glance. Programs can integrate with invoicing and tracking materials collected and disposed of. GIS staff developed automated programs for the generation of the maps, the creation of the database, and the management of the process.</p>	Town-wide		●			●			M
E-2	<p>Annualized Budget for New Major Equipment. Includes budget for catch basin truck replacement and a portion of the cost of new highway trucks such as dump trucks, excavators, and other heavy equipment used to maintain the drainage system and BMPs.</p>	Town-wide	●			●	●			H
E-3	<p>Sweeper Replacement. This assumes a \$400,000 expense every 13 years.</p>	Town-wide	●	●			●	●		H
Staffing (S)										
S-1	<p>Future Staff Salaries. Staffing is discussed in the Stormwater Funding and Financing Alternatives Report. Staffing will need to increase to implement the SWMMP but will depend on levels of service:</p> <p><u>Minimum Compliance.</u> Salaries include the following staff at 20% of FY20 salary unless noted: Town Engineer, Asst. Town Engineer, GIS Coordinator (15%), Project Inspector (50%), Highway Superintendent, Crew Supervisors, Operations Supervisor, and Equipment Operators/Laborers. This corresponds to the increasing staff time required to implement the new Small MS4 permit and SWMMP.</p> <p><u>Needs for Protective Level of Service.</u> Starting in FY20, a full-time administrative assistant will need to be hired for stormwater fee billing, collections, and data management. In FY21, a full-time stormwater coordinator will need to be hired to oversee implementation of Westford's Stormwater Management Program. In FY22, 1 FTE operator/laborer will need to be hired to assist with increasing drainage system O&M needs.</p>	N/A	●	●	●	●	●	●	●	H

6.3 Five-Year SWMMP Implementation Plan

The prioritization completed for Table 6-3 followed these general guidelines:

- **High priority (H)** improvements are required to meet regulatory requirements, address critical system needs, and have the most impact on correcting flooding issues. Complete these projects within five years.
- **Medium priority (M)** improvements are less critical but address deficiencies or may require preliminary engineering to develop the specific scope of the project. Complete these projects in six to ten years.
- **Low priority (L)** improvements are required to address future conditions and correct less critical deficiencies. Monitor these projects over the next five years and reprioritize as needed.

The projects and activities that resulted in a “High” prioritization became part of a five-year SWMMP Implementation Plan that will allow the Town to budget, fund, and implement improvements in a prioritized manner. To implement the SWMMP in an affordable, phased program, a five-year improvement program has been outlined in Table 6-4. The goal is to develop an affordable program that can be planned, financed, and implemented.

Figure 6-1 presents the budget allocations detailed in Table 6-4 for Staff Salaries, Operation and Maintenance, Program Management and Compliance, and Capital Improvement Projects. While the MS4 program has increased the needed budget for staff, O&M, and program management and compliance, more than half of the projected cost increases are due to the need to more proactively fund and implement capital improvements of drainage infrastructure, particularly culverts.

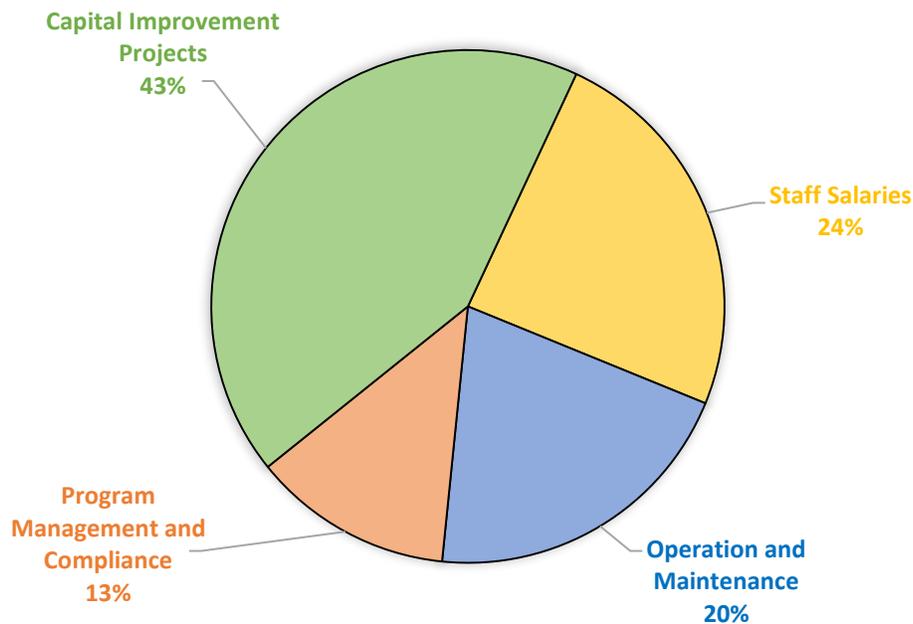


Figure 6-1 Proposed Budget Allocations (Protective)

Table 6-4
Five-Year SWMMP Implementation Plan for High Priority Projects (Protective Level of Service)

Category/Projects		FY21	FY22	FY23	FY24	FY25
Staff Salaries		5-Year Average: \$397,000				
S-1	Future Staff Salaries. Baseline salaries include the following staff at 20% of FY20 salary unless noted: Town Engineer, Asst. Town Engineer, GIS Coordinator (15%), Project Inspector (50%), Highway Superintendent, Crew Supervisors, Operations Supervisor, and Equipment Operators/Laborers. This corresponds to the increasing staff time required to implement the new Small MS4 permit and SWMMP. Needs for Protective Level of Service. Starting in FY20, a full-time administrative assistant should be hired for stormwater fee billing, collections, and data management. In FY21, a full-time stormwater coordinator should be hired to oversee implementation of Westford's Stormwater Management Program and Town Engineer, Asst. Town Engineer time is reduced by 5%. In FY22, 1 FTE should be hired to assist with increasing drainage system O&M needs.	\$296,000	\$357,000	\$435,000	\$444,000	\$453,000
Operation and Maintenance		5-Year Average: \$335,000				
OM-1 through OM-7 ⁽¹⁾	Continue existing O&M plus Culvert Maintenance, Improved Sweeping Program and Tracking, Improved Catch Basin Cleaning Program and Tracking, Ongoing Highway Department Drainage Infrastructure O&M	\$321,000	\$328,000	\$335,000	\$342,000	\$349,000
Program Management and Compliance		5-Year Average: \$207,000				
SWM-1	Stormwater Asset Management Program	\$10,000	\$10,200	\$10,500	\$10,800	\$11,100
SWM-2	Culvert Inventory and Inspection Program Development and Implementation	\$100,000	\$10,000	\$10,200	\$10,500	\$10,800
SWM-3	Opportunistic Water Quality Improvements	Assume Engineering Department staff will implement. Cost of oversight included in S-1.				
SWM-4	Advanced Monitoring of Corrugated Metal Pipe (CMP) Drainage	\$10,000	\$10,200	\$10,500	\$10,800	\$11,100
MS4-1 through MS4-4	Annual MS4 General Permit Compliance, Identification of Publicly Owned Structural BMPs, Annual MS4 General Permit Implementation, Stormwater Fee Development and Start-Up. Starting FY22 reduced outside services because of full-time stormwater coordinator.	\$120,000	\$135,500	\$126,500	\$37,500	\$20,500
AI-1 through AI-27 ⁽²⁾	Investigation Identified by Representative Condition Assessment, Drainage Investigation, Drainage Improvement, Maintenance, Education	\$65,500	\$67,000	\$69,000	\$71,000	\$73,000
Subtotal		\$306,000	\$233,000	\$227,000	\$141,000	\$127,000
Capital Improvement Projects		5-Year Average: \$700,000				
DPDI-1 through DPDI-16 ⁽³⁾	Design and Permitting for Culvert Replacement/Improvements, Road Redesign, Drainage Improvements, O&M Issues	\$105,000	\$108,000	\$111,000	\$114,000	\$117,000
CDI-1 and CDI-2	Drainage System Repair and Replacement, Culvert Repair and Replacement Program	\$460,000	\$470,000	\$480,000	\$490,000	\$500,000
E-2 and E-3 ⁽⁴⁾	Annualized Budget for New Major Equipment, Sweeper Replacement	\$100,000	\$102,000	\$105,000	\$108,000	\$111,000
Subtotal		\$665,000	\$680,000	\$696,000	\$712,000	\$728,000
TOTALS		\$1,590,000	\$1,600,000	\$1,700,000	\$1,640,000	\$1,660,000

Notes:

- ⁽¹⁾ High priority "Ongoing Maintenance" projects include OM-1, OM-2, and OM-5 through OM-7 only.
- ⁽²⁾ High priority "Additional Investigation" projects include AI-1, AI-7 through AI-9, AI-15, AI-16, and AI-20 through AI-23 only.
- ⁽³⁾ High priority "Design and Permitting of Drainage Improvements" projects include DPDI-2 through DPDI-5, DPDI-8, DPDI-10, and DPDI-13 through DPDI-15 only.
- ⁽⁴⁾ High priority "Equipment" purchases include E-2 and E-3 only.

6.4 Level of Service

Good, output-oriented management is driven by a defined standard or “level of service.” Level of service can be defined as characteristics of a service (for example, how much, of what nature, and how frequently) that fulfill a required level of performance. It is important to define the desired and required level of service at the beginning of implementing a comprehensive stormwater management program as it helps focus resources and efforts and communicate service expectations and choices.

To understand the level of service options for Westford, we considered some key questions including:

- What do the regulators require?
- What are the performance goals for the stormwater system (i.e., water quality and flooding)?
- What are the expectations of Westford’s residents and the demands for stormwater services?
- What are the overall goals of and vision for the SWMMP? Refer to Section 1.
- What are the physical capabilities and actual performance of the stormwater system (i.e., how well does the system function and where are the problems)?

Based on evaluation of these questions we proposed three options for level of service for discussions with Town staff and decision makers through the public education and outreach process:

- **C - Minimum compliance:** Meet basic regulatory (i.e., EPA NPDES MS4 General Permit) requirements each year with existing staff. Fund only highest priority capital improvements and respond to immediate needs to keep the stormwater system operational and avoid flooding.
- **B - Protective:** Strategically address MS4 General Permit requirements each year. Begin proactively addressing capital improvements and operation & maintenance needs. Increased coordination of town-wide water resources goals.
- **A - Advanced:** Full-scale use of technology to complete asset inventory, proactively address capital and O&M needs, and measure program results. Increased staffing and equipment.

As the level of service increases, an increasing number of the overall SWMMP goals and elements of the vision are met, but expenditures associated with meeting each level also increase.

Costs associated with each of the three levels of service were developed for the *Stormwater Funding and Financing Alternatives* report, dated December 2016. Tighe & Bond provided an updated cost estimate for each level of service in Table 6-5.

Based on input from the Stormwater Advisory Group, Tighe & Bond recommends the protective level of service. The Town must make a policy decision if they are able and willing to support implementation of this program and associated costs presented in this report.



Westford Stormwater Management Master Plan Updated Opinion of Probable Costs February 2019

	Staff Salaries	Operation and Maintenance	Program Management and Compliance	Capital Improvement Projects	Annual Program Cost
Existing (FY20)	\$240,000	\$121,000	\$80,000	\$158,000	\$600,000
Future (FY21-FY25)					
Level of Service					
A - Advanced	\$453,000	\$369,000	\$228,000	\$1,370,000	\$2,420,000
B - Protective	\$397,000	\$335,000	\$207,000	\$700,000	\$1,640,000
C - Minimum Compliance	\$296,000	\$230,000	\$115,000	\$320,000	\$970,000

Notes: This table updates the stormwater program budget provided in the 2015 *Preliminary Opinion of Probable Costs*. Levels of service are defined as follows:

A - Advanced: Full-scale use of technology to complete asset inventory, proactively address capital and O&M needs, and measure program results to continually improve program efficiency. Increased staffing and equipment.

B - Protective: Strategically address EPA's Small MS4 program requirements each year. Begin proactively evaluating needs areas, addressing capital improvements, and meeting improved O&M performance goals. Increased coordination of town-wide water resources goals.

C - Minimum Compliance: Meet basic General Permit requirements each year. Fund only highest priority capital improvements as problems arise.

6.5 Funding Sources

A discussion of funding and financing alternatives, entitled *Town of Westford Stormwater Funding and Financing Alternatives*, was completed under separate cover by Raftelis Financial Consultants in 2016. This report includes information about funding through property taxes, a municipal infrastructure fund, and a stormwater utility.

Additional options for funding portions of the SWMMP include grants and loans, as further discussed in Appendix D (up to date as of June 2016). While grants are not a substantial or reliable funding alternative, Westford should continue to seek grants for planned projects.

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Appendix A

Final 2016 NPDES Phase II Small MS4 Permit Requirements and Budgetary Planning Estimates for Westford, MA

Final 2016 NPDES Phase II Small MS4 Permit Requirements and Budgetary Planning Estimates for Westford, MA

TO: Paul Starratt, P.E., Town Engineer
Jeremy Downs, P.E., Assistant Town Engineer

FROM: Emily Scerbo, Tighe & Bond

COPY: Todd Brown, Tighe & Bond

DATE: May 6, 2016

On April 13, 2016, EPA published the final 2016 National Pollutant Discharge Elimination System (NPDES) *General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) in Massachusetts*. The 2016 General Permit substantially increases stormwater management requirements and mandates specific timelines for compliance. The reissued General Permit will become effective on July 1, 2017, the start of Fiscal Year 2018.

The final 2016 General Permit, while largely including the same requirements as the draft permit EPA released in 2014, does require minor adjustments to Tighe & Bond's memorandum delivered to the Town in January 2015. This memorandum provides additional details regarding these modifications to the permit requirements, compliance schedule, and costs.

The following table presents the associated adjustments to the preliminary cost projections for the major requirements of the 2016 General Permit. These numbers are preliminary and are for planning and budgeting purposes only. Actual costs may vary depending on whether the Town elects to use in-house resources to complete some of requirements. Any drainage system maintenance (including catch basin cleaning and street sweeping), correction of illicit discharges and connections, and design and construction of stormwater management facilities are not included in this estimate.

Anticipated Schedule

Tighe & Bond recommends the following schedule for implementation of the Action Plan and initial permit compliance activities.

April 13, 2016	General Permit final .
Fall 2016 – Summer 2017	Hold collaborative multi-department meetings to finalize Westford's NOI and Stormwater Management Plan . The Town must provide for the Public Participation requirements in developing these documents. <i>This effort can be completed prior to the General Permit effective date.</i>
	Identify and complete additional Permit Year 1 requirements.
2017 Annual Town Meeting	Request and secure stormwater funding FY18 (Permit Year 1).
July 1, 2017	General Permit effective . Begin implementing requirements.
September 29, 2017	Submit Notice of Intent to EPA.
July 1, 2018	Finalize Stormwater Management Plan .

Preliminary Costs Based on the 2016 Final MA General Permit Requirements – Years 1 Through 5

Note: This table is to be used to facilitate understanding about EPA's requirements and potential level of effort to comply.

Major Requirements	Details and Assumptions	Schedule Details	Year 1	Year 2	Year 3	Year 4	Year 5	Total
PART 1.0 Introduction			FY18	FY19	FY20	FY21	FY22	
Notice of Intent (NOI) and Stormwater Management Program (SWMP)	Assumes that the NOI and SWMP are prepared concurrently during careful planning. The SWMP elements will be completed as a part of the NPDES Stormwater Program Compliance Plan under the Town-wide Stormwater Management Master Plan. Budget includes updates that may be needed to address final permit, hold required public meeting, and submit NOI to EPA and DEP.	Submit signed NOI to EPA and MassDEP by September 29, 2017. Develop and sign updated written SWMP by July 1, 2018. These requirements can be started or completed prior to the effective date of the 2016 General Permit (July 1, 2017).	\$5,000	\$0	\$0	\$0	\$0	\$5,000
PART 2.0 Non-Numeric Effluent Limitations								
Impaired Waterbody Requirements								
Meet the Phosphorus Reduction Requirements for the Assabet River Watershed	Public Education & Outreach: Distribute an annual message in the spring that encourages the proper use and disposal of grass clippings and encourages the proper use of slow-release and phosphorus-free fertilizers; in the summer encouraging the proper management of pet waste, noting any existing bylaws and regulations where appropriate; and in the fall encouraging the proper disposal of leaf litter. New Development: Ensure BMPs selected optimize for phosphorus reduction. Good Housekeeping: Properly manage grass cuttings and leaf litter on permittee property, increase street sweeping frequency.	See schedules and budgets for Part 2.3.2 Public Education, Part 2.3.6 Stormwater Management in New Development and Redevelopment, and Part 2.3.7 Good House Keeping and Pollution Prevention.	This budget was carried under Public Education and Outreach, Stormwater Management in New Development and Redevelopment, and Good Housekeeping and Pollution Prevention.					
Meet Requirements to Manage Discharges to Waterbodies Impaired by Bacteria or Pathogens	Public Education: Include pet waste and, as applicable, septic system maintenance information in education program. Illicit Discharge: Implement IDDE program, consider areas discharging to bacteria or pathogen impaired waterbodies high priority.	See schedules and budgets for Part 2.3.2 Public Education and Part 2.3.4 IDDE.	This budget was carried under Public Education and Outreach and IDDE.					
Meet Requirements to Manage Discharges to Waterbodies Impaired by Solids	New Development: Ensure that stormwater management systems incorporate designs for shutdown and containment in the event of an emergency spill. Good Housekeeping: Increase street sweeping frequency in target areas with potential for high pollutant loads. Prioritize inspection and maintenance for catch basins.	See schedules and budgets for Part 2.3.6 Stormwater Management in New Development and Redevelopment and Part 2.3.7 Good House Keeping and Pollution Prevention.	This budget was carried under Stormwater Management in New Development and Redevelopment and Good Housekeeping and Pollution Prevention.					
Requirements to Reduce Pollutants to the Maximum Extent Practicable								
Part 2.3.2 Public Education and Outreach								
Education	Distribute a minimum of two (2) educational messages to each of four audiences – residential, business/commercial/institutional, developers/construction, and industrial. This does not include any audiences that are not present in a community. Include budget for program evaluation method, such as a survey, to evaluate effectiveness of education effort. Cost is for assistance with development of materials. Note that costs do not include postage or other distribution efforts.	The distribution of materials to each audience shall be spaced at least a year apart and extend over the permit term. Document in Annual Reports.	\$5,000	\$2,000	\$2,000	\$2,000	\$2,000	\$13,000
Part 2.3.3 Public Involvement and Participation								
Public Meeting	Provide the public an opportunity to participate in the review and implementation of the SWMP.	Annually. The Year 1 budget is included in the SWMP.	\$0	\$500	\$500	\$500	\$500	\$2,000

Major Requirements	Details and Assumptions	Schedule Details	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Part 2.3.4 Illicit Discharge Detection and Elimination (IDDE) Program								
Identify and Document Sanitary Sewer Overflows (SSOs)	Develop an inventory of known locations of SSOs that occurred within the previous five years. Not applicable to Westford given age, type, and extent of sewer collection system.	Develop an inventory of all known SSOs within one (1) year of the effective date of permit. Document in SWMP, summarize in Annual Reports, and update inventory annually. Provide oral notice to EPA within 24 hours of identifying an SSO. Provide written notice to EPA and MassDEP within five (5) days.	\$0	\$0	\$0	\$0	\$0	\$0
Outfall/Interconnection Inventory & Dry Weather Screening	Inventory outfalls and interconnections discharging from the MS4. Assumes all 620 outfalls need to be revisited. The number of outfalls may be able to be reduced if the outfalls are identified as "problem" or "excluded" outfalls. For dry weather screening, we assume 1 field staff will complete effort together with 1 Town staff. To be conservative, we assume 10 outfalls/interconnections visited per day and 25% of the outfalls/interconnections (approximately 160) will have dry weather flow. For each flowing outfall, we assume analysis will cost approximately \$150 (laboratory analysis). In addition, a YSI meter is assumed to be rented for \$200 a day and GPS unit rented for \$1,500 per month. Labor assumes 10-hour days and time for planning and summary report development. Our estimate also includes contingency. Costs also include analysis of impaired waterbody parameters. Cost does not include follow up activities to identify source, remove source, or complete follow up sampling.	Inventory to be completed no later than one (1) year from the effective date of the permit. Include the inventory in Annual Reports. Update annually. Label all outfalls by the end of the permit term. Dry weather sampling must be completed no later than three (3) years from the effective date of the permit. However, to save costs of duplicate field efforts, we budgeted all dry weather screening to be completed in PY1 in conjunction with the inventory. EPA's focus in the 2016 General Permit has shifted such that the inventory is more of a paper exercise and requires knowledge of only outfall location and general condition. The remainder of the inventory items can now be collected at the same time as dry weather sampling. However, EPA has increased emphasis on reprioritizing and refocusing IDDE work each year, so the annual effort will be greater.	\$95,000	\$1,500	\$1,500	\$1,500	\$1,500	\$101,000
Drainage System Mapping	Work to develop a more complete GIS-based storm drain system map within the MS4, including all outfalls, interconnections with other MS4s (i.e., MassDOT), catch basins, manholes, pipes, flow direction, and public and private BMPs. This includes incorporating necessary data attributes. The costs presented in the table are placeholders until the recommendations of the Stormwater Management Master Plan are finalized and reviewed by Town staff. This cost assumes plans will be digitized, research to identify interconnections and Town-owned BMPs, field work to verify location of structures, and other data management efforts.	Complete Phase 1 (outfalls, interconnections, Town-owned BMPs, and initial catchments) within two (2) years of the effective date of permit, document progress in annual reports. Complete Phase 2 (GPS locating outfalls, full connectivity) within ten (10) years.	\$100,000	\$100,000	\$10,000	\$10,000	\$10,000	\$230,000
Written IDDE Program (including Delineation and Prioritization of Catchments)	Update IDDE Plan with new permit requirements, including delineation of catchments and ranking as "excluded," "problem," "high priority," or "low priority" for its potential to have illicit discharge. Review current protocol for eliminating illicit discharges, called "Catchment Investigation Procedure," for consistency with new permit requirements. Append the <i>Town of Westford Stormwater Sampling Manual</i> for screening and sampling outfalls and interconnections from the MS4 in dry and wet weather as needed. Develop a written procedure for catchment investigation. Update the priority ranking of all catchments annually as new data become available based on mapping and catchment delineation, monitoring, complaints, etc.	Complete within one (1) year of the effective date of the permit. Document information in Annual Reports. Year 1 cost includes budget to update IDDE plan and to delineate, assess, and priority rank catchment areas for all outfalls. We carried an allowance for annual updates and record keeping.	\$13,000	\$1,000	\$1,000	\$1,000	\$1,000	\$17,000

Major Requirements	Details and Assumptions	Schedule Details	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Outfall Monitoring (Wet Weather)	<p>Wet weather monitoring requirements will be based on the outcome of the written IDDE program. Document the number of outfalls screened and any monitoring results each year in SWMP and annual reports.</p> <p>Wet weather assumptions are as follows: 130 outfalls (approx. 20% of total have Vulnerability Factors), \$150 cost per outfall for laboratory analysis, 1 field staff accompanied by Town staff, 15 outfalls sampled per day, sampling all outfalls in wet weather. Rental of YSI meter for \$200 per day. Labor assumes 10-hour days and time for planning and summary report development. Our estimate also includes contingency.</p> <p>Cost also includes analysis for impairments in Beaver Brook and Stony Brook.</p> <p>Cost does not include follow up activities to identify source, remove source, or complete follow up sampling.</p>	Complete dry weather screening by Year 3. Perform wet weather screening in the spring only for those catchments that indicate the presence of one or more System Vulnerability Factors.	\$12,000	\$12,000	\$12,000	\$0	\$0	\$36,000
Catchment Investigation	<p>Begin systematic implementation of the illicit discharge detection procedure in all "Problem Catchments" and catchments identified as priorities with the highest rankings. Includes key junction manhole inspections and screening.</p> <p>The actual budget will depend on Delineation and Prioritization of Catchments in the IDDE Plan, number of structures to investigate, and cost to remove any illicit discharges identified.</p> <p>Our cost assumes 1 key junction manhole per outfall (total of approximately 620 key junction manholes), screen 40% for ammonia, surfactants, and chlorine using field kits (\$8 per sample). We assume up to five days of police detail will be needed for a total of \$800. Assuming 15 manholes a day can be inspected by 1 field staff and 1 Town staff together. Labor assumes 10 hour days and time for planning and summary report development. Our estimate also includes contingency.</p> <p>Cost does not include follow up activities to identify source, remove source, or complete follow up sampling.</p>	<p>Investigations for problem outfalls must begin by Year 2 and be completed by Year 7. Investigations for high and low priority areas should be completed in conjunction with monitoring and prioritizing catchments by Year 10. Complete 100% of all catchments by Year 10.</p> <p>A written plan for catchment investigation must be completed within 1.5 years of the effective date of the permit and included in the IDDE plan.</p> <p>We carried a budget allowance here because the work required and schedule depends on mapping, priority ranking, and sampling/screening results. Some field investigations and corrective measures may be completed by Town staff.</p>	\$6,000	\$10,000	\$10,000	\$10,000	\$15,000	\$51,000
Annual Employee Training	Provide annual training for employees involved in the IDDE program about the program, and how to recognize illicit discharges and SSOs.	<p>Report on the frequency and type of training in Annual Reports.</p> <p>These costs assume a combination of Town staff-lead trainings using low-cost materials developed by others and Year 1 customized training developed by the Town's stormwater consultant to accompany other components of the MS4 Program.</p>	\$7,000	\$1,000	\$1,000	\$1,000	\$1,000	\$11,000
Part 2.3.5 Construction Site Stormwater Runoff Control								
Regulatory Updates and Review	<p>Complete in conjunction with effort under Part 2.3.6.</p> <p>Review existing bylaws & regulations for consistency with permit requirements. Confirm documents define responsibility for site inspections and person with authority to enforce, etc.</p>	Complete within one (1) year from effective date of permit.	Cost included in Regulatory Updates and Review Section.					

Major Requirements	Details and Assumptions	Schedule Details	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Written procedures for site plan review and inspection and enforcement	<i>Complete in conjunction with effort under Part 2.3.6.</i> Develop written procedures that detail review categories and timing, and procedures for long-term tracking.	Complete development within one (1) year from effective date of permit.	Cost included in Regulatory Updates and Review Section.					
Parts 2.3.6 Stormwater Management in New Development and Redevelopment (Post Construction Stormwater Management)								
Regulatory Updates and Review	Amend or modify existing bylaws and regulations for development of 1 or more acre to retain runoff from all impervious area or provide equivalent pollutant removal. New development must retain the first 1 inch, and redevelopment must retain the first 0.80 inches of runoff (or equal pollutant removal must occur on or offsite within the same watershed). Municipal roadway projects work/improvements are exempt from infiltration/pollutant removal requirements. BMPs must be consistent with the MA Stormwater Handbook. Modify existing bylaws and regulations to require submission of as-built plans and long-term O&M procedures. Develop a report assessing current street design and parking lot guidelines to support low impact design, and develop a report assessing existing regulations to determine feasibility of making green infrastructure practices allowable. This task will also include the regulatory requirements under Part 2.3.5 Construction Site Stormwater Runoff Control.	Procedures for site inspections and enforcement of sediment and erosion control measures, site plan review and requirements for as-built plans and O&M procedures shall be completed within one (1) year from the effective date of the permit. Modifications to bylaws & regulations to be completed within two (2) years of effective date of permit. The cost to develop additional legal language, including regulations. Additional costs shown are for updates, including forms and guidance. Street design and parking lot assessment to be completed four (4) years after effective date of the permit. Local regulatory assessment for green infrastructure practices must be completed in four (4) years from effective date of the permit. Costs assume these efforts will be completed concurrently and finalized in Permit Year 3.	\$10,000	\$7,500	\$12,500	\$500	\$500	\$31,000
Retrofit Inventory	Report on those MS4 owned properties and infrastructure that have the potential to be retrofitted with BMPs designed to reduce the frequency, volume, and peak intensity of stormwater discharges as well as their pollutant loadings. Annually report on MS4-owned properties that have been retrofitted with BMPs to mitigate impervious area and directly connected impervious area.	Assess feasibility of retrofits within four (4) years from the effective date of the permit. Provide annual report BMP retrofits at MS4-owned property annually beginning in Year 5. Costs in PY3-5 include identifying potential retrofit locations using a desktop process to pre-screen sites and then limited field visits to further evaluate potential sites. Budget also includes applying for grants/loans to assist with BMP implementation and may be completed by Town Staff.	\$0	\$0	\$25,000	\$25,000	\$3,000	\$53,000
Part 2.4.7 Good House Keeping and Pollution Prevention for Permittee Owned Operations								
Inventory Town-Owned Facilities and Floor Drains, and Develop Written O&M Procedures for Parks, Buildings/Facilities, Vehicles/Equipment, and Infrastructure	Develop inventory of municipally-owned facilities and equipment. Develop written operations and maintenance procedures for the municipal activities. Establish a program to repair and rehabilitate its MS4 infrastructure in a timely manner to reduce or eliminate the discharge of pollutants from the MS4. Completed as a part of the Stormwater Management Master Plan.	Within two (2) years from the effective date of permit. Include written procedures in SWMP.	\$0	\$0	\$0	\$0	\$0	\$0
Stormwater Pollution Prevention Plans (SWPPPs) for Highway Garage and School Maintenance Garage	Assume one SWPPP is needed for Highway Garage. Assumes minor updates to the existing SWPPP. One SWPPP needed for School Maintenance Garage. Assumes new SWPPP must be developed. Year 3 – 5 Budget carried for annual training by contractor.	Two (2) years from the effective date of the permit. Report on annual inspections in Annual Report.	\$0	\$10,000	\$1,000	\$1,000	\$1,000	\$13,000

Major Requirements	Details and Assumptions	Schedule Details	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Catch Basin Cleaning	Use GPS application to track catch basin inspection and cleaning. Optimize catch basin cleaning program to ensure that no catch basin is more than 50% full. Assume these budget items carried elsewhere. Completed by Town staff or contractor.	Annually, beginning in Year One.	\$0	\$0	\$0	\$0	\$0	\$0
Street Sweeping	Sweep streets and parking lots directly connected to MS4 once in the spring. For areas discharging to waterbodies impaired by solids (i.e. Beaver Brook and Stony Brook from Forge Pond to Brookside Road), sweeping frequency will need to be increased. Assume these budget items carried elsewhere. Completed by Town staff or contractor.	Annually, beginning in Year One.	\$0	\$0	\$0	\$0	\$0	\$0
Winter Road Maintenance	Establish procedures for winter road maintenance, including use and storage of salt and sand. Consider documenting salt use in wellhead protection areas. Assume these budget items carried elsewhere. Completed by Town staff or contractor.	No schedule provided.	\$0	\$0	\$0	\$0	\$0	\$0
Storm Drain System Inspection	Inspect and maintain the storm drain system and all stormwater treatment structures. Use GPS application to track system inspection and maintenance. Assume these budget items carried elsewhere. Completed by Town staff or contractor.	Annually, beginning in Year One.	\$0	\$0	\$0	\$0	\$0	\$0
PART 4.0 Program Evaluation, Record Keeping, and Reporting								
Annual Reports and Record Keeping	Self-evaluate compliance with the terms and conditions of the permit. Keep all records required by the permit for at least five (5) years. Report on outfall monitoring. The Town currently prepares reports in-house. Cost assumes a contractor will provide some assistance.	Submit Annual Reports each year. Reporting period is from one year; Annual report due ninety (90) days from the close of each reporting period.	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$25,000
Total Estimated Budget			\$258,000	\$150,500	\$81,500	\$57,500	\$40,500	\$588,000



Appendix B

Budget Detail for Existing Program Expenditures

**APPENDIX C
BUDGET DETAIL FOR EXISTING PROGRAM EXPENDITURES**

FY2020 STAFF SALARIES - EXISTING PROGRAM

FY2020 Operating Budget Line Item	FY2020 REQUEST	EST. % FOR STORMWATER	STORMWATER TOTAL
<u>410 ENGINEERING</u>			
1410100 511020 TOWN ENGINEER	\$ 110,211	15%	\$ 16,532
1410100 511030 ASST TOWN ENGINEER	\$ 94,529	15%	\$ 14,179
1410100 511540 PROJECT INSPECTOR - FACILITIES TECH (0.5)	\$ 39,118	5%	\$ 1,956
<u>115 TECHNOLOGY</u>			
1155100 511040 GIS COORDINATOR	\$ 78,235	5%	\$ 3,912
<u>421 HIGHWAY DEPARTMENT</u>			
1421100 511020 HIGHWAY SUPERINTENDENT	\$ 113,074	15%	\$ 16,961
1421100 511610 CREW SUPERVISORS (2)	\$ 143,237	15%	\$ 21,486
1421100 511611 OPERATIONS SUPERVISOR	\$ 80,696	15%	\$ 12,104
1421100 511660 EQUIPMENT OPERATORS / LABORERS (12)	\$ 818,900	15%	\$ 122,835
<u>ESTIMATED FRINGE BENEFITS</u>			
19.5 TOTAL FTEs & Est. Budget per FTE	\$10,000	15%	\$ 29,250
			\$ 240,000

FY2020 OPERATIONS & MAINTENANCE - EXISTING STORMWATER

FY2020 Operating Budget Line Item	FY2020 REQUEST	EST. % TIME FOR STORMWATER	STORMWATER TOTAL
<u>421 HIGHWAY DEPARTMENT - EXPENSES</u>			
1421200 524020 VEHICLE MAINTENANCE	\$ 178,635	15%	\$ 26,795
1421200 524030 EQUIPMENT MAINTENANCE	\$ 55,500	5%	\$ 1,260
	<i>Subtract Snow & Ice Equip Maint from Equip Budget</i>		<i>\$ 30,292</i>
1421200 525020 Drainage Maintenance	\$ 34,000	100%	\$ 34,000
1421200 530920 Contracted Services	\$ 8,000	100%	\$ 8,000
1421200 541020 Diesel Fuel	\$ 44,000	5%	\$ 2,200
<u>427 STORMWATER MANAGEMENT - EXPENSES</u>			
1427200 529060 Street Waste Disposal	\$ 30,000	100%	\$ 30,000
1427200 529080 Testing / Water Qual Serv	\$ 5,000	100%	\$ 5,000
1427200 530700 Engineering Services	\$ 5,000	100%	\$ 5,000
1427200 530920 System Upgrade Services	\$ 8,000	100%	\$ 8,000
			\$ 121,000

FUNDED CAPITAL PROJECTS - FY15-FY20

FISCAL YEAR	EXAMPLE CAPITAL EXPENDITURES	APPROVED BUDGET
FY2020	<i>Pending Approval</i> : MS4 Compliance, Highway Vehicles	\$ 100,622
FY2019	Beaver Brook Culvert Design, Boston Rd Design, Plain Rd-Oak Hill-Moore Rd Design, Complete Streets Design, Highway Vehicles	\$ 231,550
FY2018	Pre-design Engineering Boston Rd Reconstruction, Highway Vehicles	\$ 9,563
FY2017	Main St Reconstruction, Plain Rd Sidewalk, MS4 Compliance, Groton Rd Culvert, Highway Vehicles	\$ 847,000
FY2016	Pleasant St Drainage Improvements, Graniteville Rd Drainage Improvements, Engineering & Highway Vehicles	\$ 161,835
FY2015	Main Street Reconstruction Design, Highway Vehicles	\$ 72,000
AVERAGE		\$ 238,000

Note: The above capital does not include grants received or projects that were funded through MassDOT. Examples include Keyes Brook culvert replacement using FEMA HMGP funds(\$650k) and Route 40 MassDOT TIP projects at Oak Hill Road (\$2.5 million) and Dunstable Road (\$2.7 million).

TOTAL STORMWATER BUDGET FOR FY2020 - EXISTING PROGRAM

\$ 600,000

**APPENDIX C
BUDGET DETAIL FOR EXISTING PROGRAM EXPENDITURES**

DETAILS AND ASSUMPTIONS FOR STORMWATER PROGRAM CAPITAL APPROPRIATIONS

Est. % Stormwater	Total	FY20 Town Meeting (March 23, 2019)	\$ 100,622
		\$210,000 - Complete Streets Sidewalk Project Construction (<i>recommended by Cap Com</i>) -	
<5%	\$ 9,500	Less than \$10K of the construction budget will be used for drainage work.	
100%	\$ 80,000	\$80,000 – NPDES MS4 Year 2 Compliance (<i>pending review by Cap Com</i>)	
15%	\$ 11,122	\$74,146 – One-ton Truck for Highway Department (<i>recommended by Cap Com</i>)	

Est. % Stormwater	Total	FY19 Town Meeting (March 24, 2018)	\$ 231,550
100%	\$ 65,000	\$65,000 – Beaver Brook Culvert Transportation Project (TIP) Design – Supplemental funding to complete the design to replace existing culverts with a bridge. An additional \$155,000 of capital funding was obtained prior to FY17 for this project.	
20%	\$ 52,000	\$260,000 – Boston Road Reconstruction Design – This project will include complete replacement of the drainage system and construction of stormwater BMPs. An additional \$90,000 was appropriated by TM for the Water Department to install new water main. Construction will be funded by MassDOT.	
20%	\$ 40,000	\$200,000 – Plain Road, Oak Hill Road, and Moore Road Design - This project will include replacement of the drainage system and addition of stormwater BMPs. An additional \$130,000 was appropriated by TM for the Water Department to install new water main. Construction funding will be requested from the Capital Committee in March 2020. Construction costs may require phasing over different fiscal years.	
5%	\$ 2,250	\$45,000 – Complete Streets design - This project includes very minor drainage improvements.	
15%	\$ 33,300	\$222,000 – Heavy Dump Truck for Highway Department	
15%	\$ 39,000	\$260,000 – Front End Loader for Highway Department	

Est. % Stormwater	Total	FY18 Town Meeting (March 25, 2017)	\$ 9,563
5%	\$ 2,813	\$56,250 – Pre-design Engineering Work for Boston Road Reconstruction - This included survey work and some conceptual design. An additional \$18,750 was appropriated for the Water Department to support the project.	
15%	\$ 6,750	\$45,000 – Pickup Truck for Highway Department	

Est. % Stormwater	Total	FY17 Town Meeting (April 2, 2016)	\$ 847,000
~30%	\$ 590,000	\$1,895,000 – Main Street Reconstruction - This job is complete. A review of the pay requisitions show we spent approximately \$590,000 on drainage specific items. A percentage or portion of other items and costs could also be accounted for as drainage related work (i.e. mobilization, erosion controls, excavation, backfill, police details, etc.) however it would be difficult to determine what those numbers would be. An additional \$1,370,000 was appropriated by TM for Water Department to install new water main.	
~25%	\$ 127,000	\$510,725 – Plain Road Sidewalk - This project is complete. A review of the pay requisitions show we spent approximately \$127,000 on drainage specific items. A percentage or portion of other items and costs could also be accounted for as drainage related work (i.e. mobilization, erosion controls, excavation, backfill, etc.) however it would be difficult to determine what those numbers would be.	
100%	\$ 80,000	\$80,000 - NPDES MS4 Year 1 Compliance	
100%	\$ 50,000	\$50,000 – Design culvert on Groton Road east of Oak Hill Road - This design was for a culvert replacement that will be paid for by MassDOT as part of the Route 40 & Oak Hill Road TIP project which will be replaced in the summer of 2019.	

APPENDIX C
BUDGET DETAIL FOR EXISTING PROGRAM EXPENDITURES

Est. % Stormwater	Total	FY16 Town Meeting (March 28, 2015)	\$ 161,835
15%	\$ 4,200	\$28,000 – Engineering Vehicle – New Ford Explorer.	
100%	\$ 44,770	\$44,770 – Pleasant Street Drainage Improvements – Funds were appropriated for repairing catch basin and manhole castings.	
100%	\$ 24,365	\$24,365 – Graniteville Road Drainage Improvements – Funds were appropriated for repairing catch basin and manhole castings.	
15%	\$ 6,750	\$45,000 – One ¾-ton Truck for Highway Department	
15%	\$ 15,000	\$100,000 – Two One-ton Trucks for Highway Department	
15%	\$ 33,000	\$220,000 – Ten-wheel Dump Truck for Highway Department	
15%	\$ 33,750	\$225,000 – Excavator for Highway Department	

Est. % Stormwater	Total	FY15 Town Meeting (March 22, 2014)	\$ 72,000
20%	\$ 45,000	\$225,000 – Main Street Reconstruction Design – An additional \$75,000 was appropriated for the Water Department to replace the water main.	
15%	\$ 10,500	\$70,000 – Two Pickup Trucks for Highway Department	
15%	\$ 16,500	\$110,000 – Bobcat with Trailer for Highway Department	



Appendix C

Stormwater Best Management Practices for Westford's Water Quality Impairments

Stormwater Best Management Practices for Westford's Water Quality Impairments

The Town of Westford is a water-rich community with extensive water resources that provide a public drinking water supply, support recreational opportunities, and protect the community's quality of life. A variety of groups, including the Town, stream teams, watershed organizations, and the Massachusetts Department of Environmental Protection (MassDEP), actively work to protect the watersheds through activities such as public education, water quality sampling and environmental monitoring, open space planning and land preservation/acquisition, water supply assessments, identification of contamination problems, and collaboration.

Westford falls within two major watersheds, the Merrimack River and Sudbury-Assabet-Concord (SuAsCo) River watersheds. The Merrimack River watershed covers the northern 20 square miles of Westford and can be divided into nine (9) subbasins. There is also an unnamed subbasin in the northwest corner of Town that was not included in the list below, or the subbasin analysis that was completed as part of Westford's Stormwater Management Master Plan (SWMMP), because it is largely forested and outside of the Town's regulated urbanized area. The Merrimack River watershed subbasins include:

- Main Stem Stony Brook;
- Nabnasset Lake;
- Snake Meadow Brook/Keyes Brook;
- Boutwell Brook;
- Mill Pond/Beaver Brook;
- Forge Pond;
- Flint Pond;
- Deep Brook; and
- Tadmuck Brook.

The SuAsCo River watershed covers the southwestern 10.5 square miles of Westford and can be divided into the following six (6) subbasins:

- Main Stem Nashoba Brook (2 separate portions in Town);
- Vine Brook;
- Nonset Brook;
- Heart Pond;
- Beaver Brook; and
- Butter Brook.

Waterbodies in Westford's subbasins, including lakes, ponds, rivers, streams, and wetlands, receive stormwater runoff from impervious areas throughout Town. Historically, the primary goal of stormwater management was to manage stormwater runoff such that immediate threats to life and property due to flooding were prevented, including maintaining safe and passable streets. To maintain the Town's extensive water resources, including the public drinking water supply, recreational opportunities, and the community's quality of life,

stormwater runoff must also be managed to address the serious adverse impacts that increased runoff quantity, temperature, and the nutrients, bacteria, sediment, and other pollutants carried by this runoff are having on the Town's waterbodies. In addition, in the last decade, federal and state regulations have imposed increasingly stringent and onerous requirements on communities to locally manage stormwater runoff.

As further described in Volume 1 of the SWMMP, common impairments in Westford water bodies include mercury, bacteria, and total suspended solids, among others. Figure 1 shows the impairments in Westford's water bodies.

Figure 1: Impairments in Westford's Water Bodies

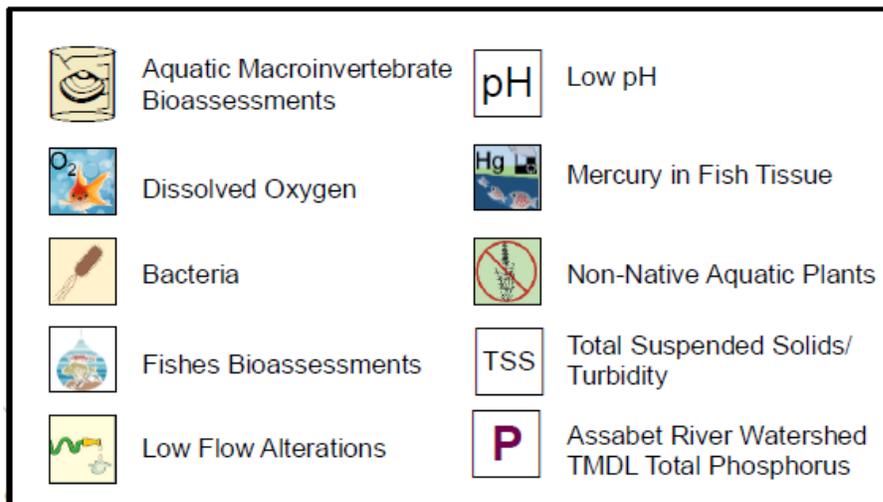
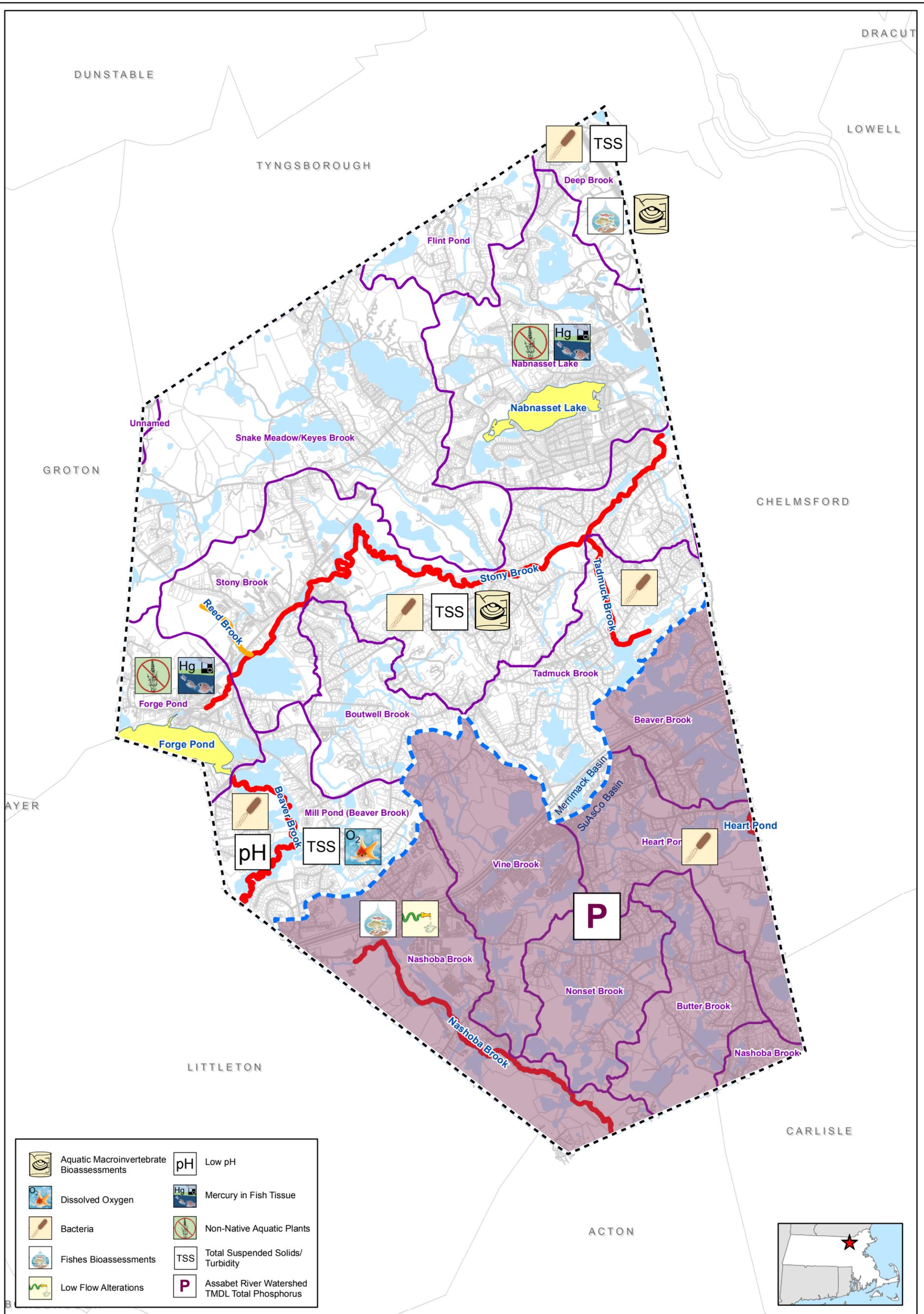


Figure 2 shows the delineation of the major watersheds and subbasins within Westford and their associated water quality impairments.

To help mitigate negative impacts on Westford's water resources, this memorandum presents structural and non-structural stormwater Best Management Practices (BMPs) to address water quality challenges specific to subbasins throughout Town. These BMPs can be considered by the Town for when capital projects are implemented. This list could also be used to advise local developers when selecting water quality BMPs for private projects within a subbasin.

In addition to those impairments listed above, there are also impairments of waterbodies in Westford related to Aquatic Macroinvertebrate Bioassessments, Fish Bioassessments, Non-Native Aquatic Plants, and Low Flow Alterations. Bioassessment data is a reflection of the overall health of the waterbody and should improve with improving water quality. Non-native aquatic plants are prevalent throughout New England and Westford should explore programs to limit the spread of invasive plant species. Low Flow Alterations are managed through limiting water withdrawals from the subbasin. These are not required to be specifically addressed with structural or non-structural BMPs, however, improvements to water quality will benefit these impairments.



	Aquatic Macroinvertebrate Bioassessments		Low pH
	Dissolved Oxygen		Mercury in Fish Tissue
	Bacteria		Non-Native Aquatic Plants
	Fishes Bioassessments		TSS
	Low Flow Alterations		Assabet River Watershed TMDL Total Phosphorus

Legend

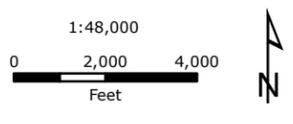
- ▲ Outfalls
- ▭ Ponds
- Rivers and Streams
- ▭ Impervious Surface
- Town Boundary
- Major Basin Boundary
- Sub-basin Boundary
- ▭ Assabet River Watershed

2014 Impairments - Ponds

- ▭ Category 4A - TMDL Complete
- ▭ Category 5 ("303(d)")

2014 Impairments - Rivers and Streams

- Category 2
- Category 5 ("303(d)")



Note: Impairments shown are from Proposed 2014 Massachusetts Integrated List of Waters are not yet finalized as of the date of this map, but are expected to be accepted by the EPA.

**FIGURE 2
IMPAIRED WATERBODIES
AND TMDLS**

Westford, Massachusetts

April 2016



Summary of Water Quality Impairments

The objective of the Federal Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. As a step to reach this goal, under Section 305(b) of the CWA, MassDEP is tasked with monitoring and assessing the quality of waters of Massachusetts, and to evaluate whether the water bodies can support designated uses. Designated uses include aquatic life support, fish and shellfish consumption, drinking water supply, and primary (e.g., swimming) and secondary (e.g., boating) contact recreation as identified in the State Surface Water Quality Standards (314 CMR 4.00). Under Section 303(d) of the CWA, the State is required to identify those waterbodies that are *Impaired* (not expected to meet surface water quality standards and designated uses after the implementation of technology-based controls) and develop a plan and schedule to bring the impaired waters back into compliance with the water quality standards through a Total Maximum Daily Load (TMDL), which is further discussed in the next section. The Integrated List of Waters identifies specific segments of each water body based on the following categories:

- Category 1 Waters – “Waters attaining all designated uses”
- Category 2 Waters – “Attaining some uses; other uses not assessed”
- Category 3 Waters – “No uses assessed”
- Category 4a Waters – “TMDL is completed”
- Category 4b Waters – “Impairment controlled by alternative pollution control requirements”
- Category 4c Waters – “Impairment not caused by a pollutant”
- Category 5 Waters – “Waters requiring a TMDL”

Water bodies identified as Category 5 waters on the Integrated List are equivalent to the “303(d) list” of water quality impaired waters under the Clean Water Act.

The Final Massachusetts Year 2014 Integrated List of Waters was approved by EPA in February 2016¹.

Waterbodies within Westford, their category on the Final 2012 Integrated List and Final 2014 Integrated List, respective impairments (pollutants of concern), and State water body classification are listed in the SWMMP Volume 1 (Appendix E). The Subbasin Profiles included in SWMMO Volume 1 Appendix B list impaired waterbodies within each sub-basin and associated pollutants of concern.

Total Maximum Daily Loads

Once a body of water is identified as a Category 5 water body on the Integrated List of Waters, MassDEP is required by the CWA to develop a “pollution budget” designed to restore the health of the impaired body of water. The process of developing this budget, generally referred to as a TMDL, includes identifying the source(s) of the pollutant from direct discharges (point sources) and indirect discharges (non-point sources), determining the

¹ Massachusetts Year 2014 Integrated List of Waters: Final Listing of the Condition of Massachusetts' Waters pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act available online: <http://www.mass.gov/eea/docs/dep/water/resources/07v5/14list2.pdf>

maximum amount of the pollutant that can be discharged to a specific water body to meet water quality standards, and assigning pollutant load allocations to the sources.

Merrimack River Watershed

A Draft Pathogen TMDL was developed for the Merrimack River Watershed, which applies to the 303(d) listed segments of Stony Brook and Beaver Brook in Westford, and to Tadmuck Brook in the finalized 2014 Integrated List of Waters. Waterborne pathogens, such as disease-causing bacteria, viruses, and protozoa, can be difficult to identify and isolate, so non-pathogenic bacteria are used as easily measurable indicators of contamination from sewage or feces of warm-blooded wildlife (birds and mammals). The TMDL establishes indicator bacteria limits for fecal coliform and outlines corrective actions to achieve these limits. Table 1 presents the waste location allocation and load allocation limits for various pathogen sources for applicable waterbodies in Westford. It is important to note that these fecal coliform limits were established based on the Surface Water Quality Standards in effect at the time of release of the draft TMDL, and have since been updated. The new water quality standards are for E. coli and are reflected in Table 1.

Table 1
Sources and Expectations for Limiting Bacterial Contamination in the Merrimack River Watershed²

Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL) ³	Load Allocation Indicator Bacteria (CFU/100 mL) ¹²
Illicit discharges to storm drains	0	N/A
Leaking sanitary sewer lines	0	N/A
Failing septic systems	N/A	0
Stormwater runoff Phase I and II	The geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml ^{4,5}	N/A
Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	The geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml ^{13,14}

The Draft Pathogen TMDL for the Merrimack River has identified leaking sewer pipes, illicit connections to the municipal separate storm sewer system (MS4), sanitary sewer overflows

² This table represents waste load and load reductions based on current water quality standards. Any future changes made to the Massachusetts water quality standards will become the governing water quality standards for these TMDLs.

³ For Class B waterbodies

⁴ The expectation for WLAs and LAs for stormwater discharges is that they will be achieved through the implementation of BMPs and other controls.

⁵ Previous water quality standard was for Fecal Coliform bacteria, and therefore TMDL was "Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms"

(SSOs), failing septic systems, recreational activities, and wildlife and domesticated animals as potential sources of disease-causing pathogens.⁶

Sudbury-Assabet-Concord (SuAsCo) River Watershed

As shown on the Figure 2, there are two impaired waterbodies in Westford within the SuAsCo River watershed: Nashoba Brook and Heart Pond. There are no draft or Final TMDLs that apply to Nashoba Brook, but MassDEP and EPA recommends that the information contained in the Final Total Phosphorus TMDL for the Assabet River and the Draft Pathogen TMDLs for the Concord River Watershed, which apply to waterbodies downstream of Westford, guide management activities for other waters throughout the watersheds to help maintain and protect existing water quality. As development in the Nashoba Brook watershed continues, it is possible that stormwater runoff, septic tanks, and illicit MS4 connections may contain phosphorus and pathogens and lead to degradation of water quality.

However, the Draft Pathogen TMDL for the Concord River Watershed applies to Heart Pond. Much like the Draft Pathogen TMDL for the Merrimack River Watershed, the TMDL establishes limits for indicator organisms (fecal coliform, E. coli, and enterococcus bacteria) and outlines corrective actions to achieve these limits. The waste load and load allocations for the Concord River Draft Pathogen TMDL match those of the Merrimack River Watershed as presented in Table 1, and therefore a redundant table is not included in this report.

BMPs to Address Impairments

The following pages present *structural* and *non-structural* BMPs to address the water quality impairments within Westford. These BMPs were identified based on requirements provided in EPA's 2016 Small MS4 General Permit and guidance in the Massachusetts Stormwater Handbook.

⁶ Draft Pathogen TMDL for the Merrimack River Watershed

TSS

Total Suspended Solids and Turbidity

Applicable subbasins:

- Deep Brook
- Mill Pond/Beaver Brook
- Stony Brook

Sediments, classified as TSS, turbidity, and sedimentation/siltation, are a common impairment in Westford subbasins. TSS is the measure of how much sediment is suspended in water, and a prevalent stormwater pollutant. Many different structural BMPs remove TSS from stormwater at varying levels. Determinations for TSS removal from particular BMPs can be found in Chapter 2 of the Massachusetts Stormwater Handbook, "Structural BMP Specifications for the Massachusetts Stormwater Handbook".

A list of recommended structural and non-structural BMPs to address TSS impairments is below.

Structural

Porous Pavement

Tree pit

Deep Sump Catch Basin

Bioretention

Rain Garden

Hydrodynamic Separator

Three Chamber System

Constructed Stormwater Wetland

Extended Dry Detention Basin

Media Filter

Sand and Organic Filter

Wet Basin

Non-structural

Reduce impervious areas

Disconnect roof gutters or drain to lawn areas

Increased Street sweeping

Trash pickup/street cleanup/river & lake cleanup days

Catch Basin stencils – "Drains to River/Lake"

Curbside collection for lawn and landscape trimmings and/or education about composting

Catch Basin cleaning



Pathogens/Bacteria

Applicable subbasins:

- Deep Brook
- Mill Pond/Beaver Brook
- Stony Brook
- Tadmuck Brook
- Heart Pond

Bacteria is one of the most common stormwater pollutants and unfortunately one of the most difficult to remove due to its prevalence in the environment. In addition, there is a lack of significant data to support bacteria removals by many structural BMPs. Infiltration and bioretention practices are recommended by the Massachusetts Stormwater Handbook to remove bacteria.

Filtration BMPs are efficient at removing bacteria from stormwater. However, installing new filtration BMPs throughout the subbasins could be cost-prohibitive. Installing filters in select areas with higher concentrations of pathogens could help decrease the water quality impairment while still being affordable.

Utilizing detention ponds is not recommended for reducing pathogens. The results of the analysis show that detention ponds typically increase the *E. coli* and fecal coliform concentrations.

In addition to structural BMPs listed below, there are nonstructural BMPs that can be effective at reducing bacteria and pathogens in stormwater. Public education and outreach on management of pet waste and septic system maintenance can help to reduce bacteria from these sources. In addition, the implementation of an illicit discharge detection and elimination (IDDE) program can reduce the impacts of illegal sewage discharges into the stormwater system.

Structural

Bioretention

Media Filter

Sand and Organic Filter

Tree Pit

Infiltration Basin

Constructed Stormwater Wetlands

Infiltration Trench

Non-structural

Educate citizens about proper disposal of pet waste and septic system management

Install more containers for disposal of pet waste

Locate and remove illicit discharges



Metals

Applicable subbasins:

- Forge Pond
- Nabnasset Lake

Mercury in fish tissue is an impairment that can be improved by implementing BMPs that reduce overall metal concentrations. BMPs that remove metals are noted below. Metals removal is often most successfully accomplished by source control. Westford should identify any industrial, commercial, or municipal sources of mercury in the watersheds noted above and implement an outreach and education program on proper disposal of waste and spill cleanup.

Structural

Porous Pavement

Tree Pit

Bioretention

Constructed Stormwater Wetlands

Dry Detention Basin

Sand and Organic Filters

Wet Basins

Infiltration Basins

Non-structural

Educate industrial, commercial, municipal workers about spill cleanup and management of metals waste



Dissolved Oxygen

Applicable subbasins:

- Mill Pond/Beaver Brook

There are no structural BMPs that will directly change the dissolved oxygen concentration in the subbasins. However, implementing BMPs that reduce TSS and temperature will aid in an increase in DO. Additionally, the implementation of BMPs that address nutrient levels can have a positive impact on dissolved oxygen concentrations. As nutrient concentration increases, plant and algae growth and eventual decay also increase. The decay of plant material causes a net reduction in dissolved oxygen due to aerobic bacteria. Reducing nutrient concentrations can prevent this overgrowth and decay, and help to keep dissolved oxygen levels high.

Structural

Infiltration Trench

Infiltration Basin

Bioretention

Constructed Stormwater Wetlands

Porous Pavement

Wet Pond

Dry Detention Basin

Grass Swales

Non-structural

Increased Street sweeping

Trash pickup/street cleanup/river & lake cleanup days

Catch Basin stencils – “Drains to River/Lake”

Curbside collection for lawn and landscape trimmings and/or education about composting

Catch Basin cleaning

pH **pH**

Applicable subbasins:

- Mill Pond/Beaver Brook

Impairments related to pH cannot be treated with structural BMPs and should be addressed with non-structural BMPs including outreach to businesses and residents about proper disposal of hazardous and industrial wastes.

Structural

None

Non-structural

Public Education and Outreach related to waste disposal

Household Hazardous Waste Day



Phosphorus

Applicable subbasins:

- Vine Brook
- Nashoba Brook
- Nonset Brook
- Butter Brook
- Heart Pond
- Beaver Brook

The southern portion of Westford falls within the watershed of the Assabet River. This river has a TMDL for phosphorus⁷. All of the subbasins within this watershed should have a focus on BMP implementation as it relates to phosphorus. There are many BMPs that reduce phosphorus in stormwater, including several specifically described in Appendix F of the 2016 MA MS4 Permit. Methodology for calculating phosphorus removal from various BMPs is contained in Attachments 2 and 3 of Appendix F of the 2016 MA MS4 Permit.

Structural

Infiltration Trench

Infiltration Basin

Bioretention

Constructed Stormwater Wetlands

Porous Pavement

Wet Pond

Dry Detention Basin

Grass Swales

Non-structural

Increased Street sweeping

Trash pickup/street cleanup/river & lake cleanup days

Catch Basin stencils – “Drains to River/Lake”

Curbside collection for lawn and landscape trimmings and/or education about composting

Catch Basin cleaning

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⁷ Assabet River Total Maximum Daily Load for Total Phosphorus available online at: <http://www.mass.gov/eea/docs/dep/water/resources/a-thru-m/anuttmdl.pdf>



Appendix D

Potential Grant and Loan Opportunities to Fund Stormwater

APPENDIX D

Stormwater Management Grant and Loan Programs

Name and Description	Application Timeline	Amount	Matching Requirements	Contacts
<p>Section 319 Nonpoint Source Competitive Grants Program:</p> <p>This grant program’s goal is to prevent/control/decrease pollution arising from rainwater and snowmelt via structural and nonstructural best management practices. Majority of funding will be provided to projects that lead to the improvement of impaired waterways. A smaller pool of funding will also be available to projects that focus on Education & Outreach, Healthy Watersheds & Protection of High-Quality Waters and/or Developing Stormwater utilities/other funding methods for Stormwater Management.</p>	<p>Deadline: June</p>	<p>Average: \$250,000 FY 2016 Spending: \$1.28 Million</p>	<p>40%</p>	<p>Malcolm Harper Malcolm.Harper@state.ma.us (508) 767-2795</p> <p>Link: http://www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html#2</p>
<p>Federal 604B Water Quality Management Planning Grant Program:</p> <p>Funds are eligible for any program focusing on nonpoint source assessment and planning projects that will lead to the determination of the nature, extent, and causes of water quality problems, development of local and regional approaches to stormwater issues, determination of pollutant load reductions necessary to meet water quality standards, development of green infrastructure focused on managing wet weather to maintain/restore natural hydrology, and development of plans to address water quality impairments in impaired watersheds.</p>	<p>Deadline: March</p>	<p>Average: \$50,000 FY 2016 Spending: \$201,812</p>	<p>Not required but encouraged</p>	<p>Gary Gonyea Gary.gonyea@stat.ma.us (617) 556-1152</p> <p>Link: http://www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html#3</p>
<p>Massachusetts Environmental Trust:</p> <p>Funding eligible for any effort to restore, protect, and improve water and water-related resources in Massachusetts.</p>	<p>Letter of Inquiry due October</p>	<p>Typical: \$10,000-40,000 per year for up to three years</p> <p>FY 2016 Spending: \$480,000</p>	<p>None</p>	<p>Bill Hinkley William.hinkley@state.ma.us (617) 626-1045</p> <p>Link: http://www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/mass-enviro-trust/</p>

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Stormwater Management Grant and Loan Programs

Name and Description	Application Timeline	Amount	Matching Requirements	Contacts
<p>Clean Water State Revolving Fund (Loan):</p> <p>Funding is available for several projects including those that focus on identifying nonpoint source pollution and offering potential remediation strategies. Many are eligible for 0% interest including those that focus primarily on remediation/prevention of nutrient enrichment of a surface water body and/or a water supply source.</p>	<p>Deadline: August</p>	<p>Average: \$4 Million</p> <p>Annual Spending: \$400-475 Million</p> <p>Interest: 2% 0% Possible</p>	<p>None</p>	<p>DEP Boston office: Yvette DePeiza Yvette.depeiza@state.ma.us (617) 292-5857</p> <p>Municipal Services staff Boston: Steve McCurdy Steven.mccurdy@state.ma.us (617) 292-5779</p> <p>Link: http://www.mass.gov/eea/docs/dep/service/regulations/srfqa.pdf</p>
<p>Dam and Seawall Repair or Removal Program:</p> <p>Funding available for projects that repair/remove dams, levees, seawalls, and other forms of flood control if the project's mission is congruent with the mission of the Office of Energy and Environmental Affairs.</p>	<p>Deadline: TBD</p>	<p>Request limit: \$1-3 Million per project</p> <p>FY 2014 Spending: \$13 Million</p> <p>IF LOAN, Interest: 2%</p>	<p>25%</p>	<p>John Clarkeson John.clarkeson@state.ma.us (617) 626-1175</p> <p>Marissa Fimiani Marissa.fimiani@state.ma.us (617) 626-1133</p> <p>Link: http://www.mass.gov/eea/waste-mgmt-recycling/water-resources/preserving-water-resources/water-laws-and-policies/water-laws/draft-regs-re-dam-and-sea-wall-repair-or-removal-fund.html</p>

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Stormwater Management Grant and Loan Programs

Name and Description	Application Timeline	Amount	Matching Requirements	Contacts
<p>Massachusetts Chapter 90 Program:</p> <p>This funding available for roadway projects includes allotments for roadside drainage, landscape, and tree planting, etc.</p>	<p>Deadline: None</p>	<p>Allotment: \$880,000</p>	<p>None</p>	<p>Michael O'Hara (508) 929-3944</p> <p>James Marine (508) 929-3946</p> <p>Jonathan Gulliver (508) 929-3800</p> <p>Link: http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/LocalAidPrograms/Chapter90Program.aspx</p>
<p>Water Infrastructure Assessment and Planning Grants:</p> <p>This grant was created to assist in meeting Commonwealth and Federal Clean Water Act requirements. Planning projects that have been authorized include: Asset Management & Fiscal Sustainability Planning and Comprehensive Wastewater Management Planning.</p>	<p>Deadline: February</p>	<p>Allotment: up to \$40,000</p>	<p>10-25%</p>	<p>Joseph Delaney Joseph.delaney@state.ma.us (617) 292-5808</p> <p>Link: http://www.mass.gov/eea/agencies/massdep/water/grants/water-infrastructure-assessment-and-planning-grants.html</p>
<p>MA Statewide Water Management Act Grant:</p> <p>This is a reimbursement program that aims to mitigate the impacts of water withdrawals from a watershed/community. Projects can include anything from stormwater management aimed at reducing inflow and infiltration, to improving water quality, to habitat improvement.</p>	<p>Deadline: January</p>	<p>Average: ~\$80,000</p> <p>FY 2016 Spending: \$1 Million</p>	<p>20%</p>	<p>Jen D'Urso Jen.durso@state.ma.us (617) 654-6591</p> <p>Link: http://www.mass.gov/eea/agencies/massdep/water/grants/water-management-act-grant-program.html</p>

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Stormwater Management Grant and Loan Programs

Name and Description	Application Timeline	Amount	Matching Requirements	Contacts
<p>Rivers and Harbors Grant Program:</p> <p>A grant program geared towards improving coastal waterways for commercial and recreational navigation, improving inland waterways to improve recreational use, water quality, and wildlife habitats, and improved erosion and flood controls.</p>	Rolling	<p>Average: Varies</p> <p>FY 2011 Spending: \$461,000</p>	25%	<p>Kevin P. Mooney Kevin.mooney@state.ma.us (781) 740-1600 x103</p> <p>Link: http://www.mass.gov/eea/agencies/dcr/services-and-assistance/grants-and-technical-assistance/</p>
<p>Five Star and Urban Waters Restoration Grant Program:</p> <p>Any projects that address water quality issues (i.e. pollution from stormwater runoff, erosion, etc.) in priority watersheds. Applicants must have 'on-the-ground' activities, integrated education, outreach and training into the project through broad community engagement, measurable ecological, education, and community benefits and united community partners striving to achieve ecological and educational outcomes.</p>	Deadline: February	Average: \$25,000	None	<p>Myra Price Price.myra@epa.gov (202) 566-1225</p> <p>Links: http://www.nfwf.org/fivestar/Pages/home.aspx</p> <p>https://www.epa.gov/wetlands/5-star-wetland-and-urban-waters-restoration-grants</p>
<p>NRCS Watershed Protection and Flood Prevention Programs:</p> <p>Funding available to projects that conserve soil and water and prevent flooding.</p>			25%	<p>Westford USDA Office 319 Littleton Rd Suite 205</p> <p>Dan Lenthall Daniel.lenthall@ma.usda.gov (978) 692-1904 ext 107</p> <p>Link: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ma/programs/planning/wpfp/#</p>

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Stormwater Management Grant and Loan Programs

Name and Description	Application Timeline	Amount	Matching Requirements	Contacts
<p>EPA Wetlands Program Development Grant:</p> <p>Funding available to eligible projects that are related to or focus on the “causes, effects, extent, prevention, reduction and elimination of water pollution” to increase the quantity and quality of wetlands in the U.S.</p>	<p>Deadline: May</p>	<p>Allotment: \$50-500,000</p> <p>FY 2016 Spending: \$1.5 Million</p>	<p>25%</p>	<p>Kristen Conroy Conroy.kristen@epa.gov (617) 918-1069</p> <p>Link: https://www.epa.gov/wetlands/wetland-program-development-grants</p>