United States Environmental Protection Agency



# Green Infrastructure Implementation Strategy for the Town of Franklin, Massachusetts

## An Evaluation of Projects, Programs, and Policies

Photo: Town of Franklin

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## About the Green Infrastructure Technical Assistance Program

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby waterbodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. These neighborhood or site-scale green infrastructure approaches are often referred to as *low impact development*.

EPA encourages the use of green infrastructure to help manage stormwater runoff. In April 2011, EPA renewed its commitment to green infrastructure with the release of the *Strategic Agenda to Protect Waters and Build More Livable Communities through Green Infrastructure*. The agenda identifies technical assistance as a key activity that EPA will pursue to accelerate the implementation of green infrastructure.

In February 2012, EPA announced the availability of $950,000 in technical assistance to communities working to overcome common barriers to green infrastructure. EPA received letters of interest from over 150 communities across the country, and selected 17 of these communities to receive technical assistance. Selected communities received assistance with a range of projects aimed at addressing common barriers to green infrastructure, including code review, green infrastructure design, and cost-benefit assessments. The Town of Franklin was selected to receive assistance to quantify the benefits of existing green infrastructure projects, identify green infrastructure barriers and opportunities in the Town's local codes, and develop a green infrastructure implementation strategy for the Town.

For more information, visit http://water.epa.gov/infrastructure/greeninfrastructure/gi_support.cfm.

# Acknowledgements

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# 1.0 Introduction

## 1.1 Purpose

The Town of Franklin is seeking to improve local water quality, as well as preserve and recharge groundwater resources while also saving money, by implementing green infrastructure in Town and private projects. The Town already has a history of utilizing green infrastructure in certain road and stormwater projects where possible, but would like to expand their use through the development of a Town-wide implementation strategy. This document is intended to help the Town of Franklin develop a comprehensive strategy for implementing green infrastructure through practices, programs, and policies. It summarizes the Town's existing efforts, provides recommendations for improving existing programs and policies, and proposes new approaches for incorporating green infrastructure. Each section highlights techniques that are best suited for the Town, based on the Town's land uses and physical constraints, their experience with the implementation of existing practices, and the findings of recently completed reviews of the Town's current programs and policies.

> *"Green infrastructure is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways (CNT, 2010)."*

## 1.2 What is Green Infrastructure?

The term "green infrastructure," which is thought to have originated sometime in the mid-1990s, can mean different things to different people. For example, some may refer to trees in an urban environment as green infrastructure because of the "green" or environmental benefits they provide, while others use the term to refer to an interconnected network of green spaces (Benedict and McMahon, 2001). The US Environmental Protection Agency (US EPA) and many other environmental organizations today use the term green infrastructure to refer to engineered systems, such as rain gardens or green roofs, which are designed to maintain natural hydrologic functions, and mitigate the impacts of development on the environment. Some of these similar definitions are provided in the call-out boxes. For the purposes of this report, green infrastructure is similarly defined as *a network of decentralized stormwater management practices, such as rain gardens, bioretention systems, and green roofs that can capture, infiltrate and treat stormwater thereby reducing stormwater runoff and improving the health of receiving waters*.

> *"Green Infrastructure refers to natural systems that capture, cleanse and reduce stormwater runoff using plants, soils and microbes. On the regional scale, green infrastructure consists of the interconnected network of open spaces and natural areas (such as forested areas, floodplains and wetlands) that improve water quality while providing recreational opportunities, wildlife habitat, air quality and urban heat island benefits, and other community benefits. At the site scale, green infrastructure consists of site-specific management practices (such as interconnected natural areas) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls (CWP, 2013)."*

*“Green infrastructure is an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainable communities. Unlike single-purpose gray stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also flood mitigation, air quality management, and much more (US EPA, 2013).”*


**Figure 1-1. Elements of Green Infrastructure (EPA, 2013)**

One way to conceptualize green infrastructure is to think about it as an alternative to conventional or “gray” infrastructure (see Figure 1-2). Gray infrastructure is what we often think of when we hear the word infrastructure: roads, pipes, sewers, utility lines, etc. Traditional gray stormwater infrastructure consists of a system of concrete curbs, gutters, pipes, tanks, outfalls, and other engineered systems intended to capture and convey stormwater and discharge it offsite, typically to a nearby surface water. Although these systems provide local flood control, they usually provide little if any treatment or groundwater recharge and can cause significant environmental damage to receiving waters through the introduction of pollutants, erosion, flooding, and warming. These impacts can be detrimental to the aquatic species living in the waterbodies as well as their recreational and public health benefits. In fact, stormwater runoff is the number one cause of stream impairment in urban areas (CWP, 2013).

**Figure 1-2. Examples of Gray (top) and Green (bottom) Infrastructure**

To mitigate the impacts of stormwater runoff on receiving waters, many communities have transitioned from gray infrastructure to green infrastructure. As a result of converting from "gray to green," these communities have seen improvement in their waterbodies. They have also experienced additional, sometimes unforeseen benefits, such as greater wildlife biodiversity, increased green space available for the public to enjoy, and even increased property values (CNT, 2010). The next section will describe how Franklin, specifically, has already started to benefit from green infrastructure, and how a comprehensive green infrastructure strategy could further these benefits.

## 1.3 Benefits of Green Infrastructure in Franklin

To fully examine the potential benefits of green infrastructure in Franklin, it is important to first provide the context of the existing conditions of its water resources. The Town of Franklin is located within the Charles River Watershed, and its municipal separate storm sewer (MS4) discharges contribute to the existing impairments in the Charles River. The primary pollutant of concern is phosphorus, a nutrient found in stormwater runoff originating in fertilizers, animal waste, and other sources. The Charles River has been plagued by algal blooms in recent years as a result of stormwater-associated phosphorus loading. These algal blooms threaten recreational use of the river and degrade fish habitat and aesthetics. EPA's goal is to reduce phosphorus discharges to the lower Charles by 54% to restore the river to a healthier ecological state and has set load reduction targets for each town in the watershed as a part of the Charles

River Total Maximum Daily Load (TMDL). In an effort to help the towns meet the TMDL, the EPA has issued a Draft General Permit under the Residual Designation Authority (RDA) of the federal Clean Water Act (CWA) for three pilot communities in the watershed (Franklin along with Milford and Bellingham) that would ultimately require certain industrial, commercial, and high-density residential facilities to take measures to reduce phosphorus loading from stormwater discharges.

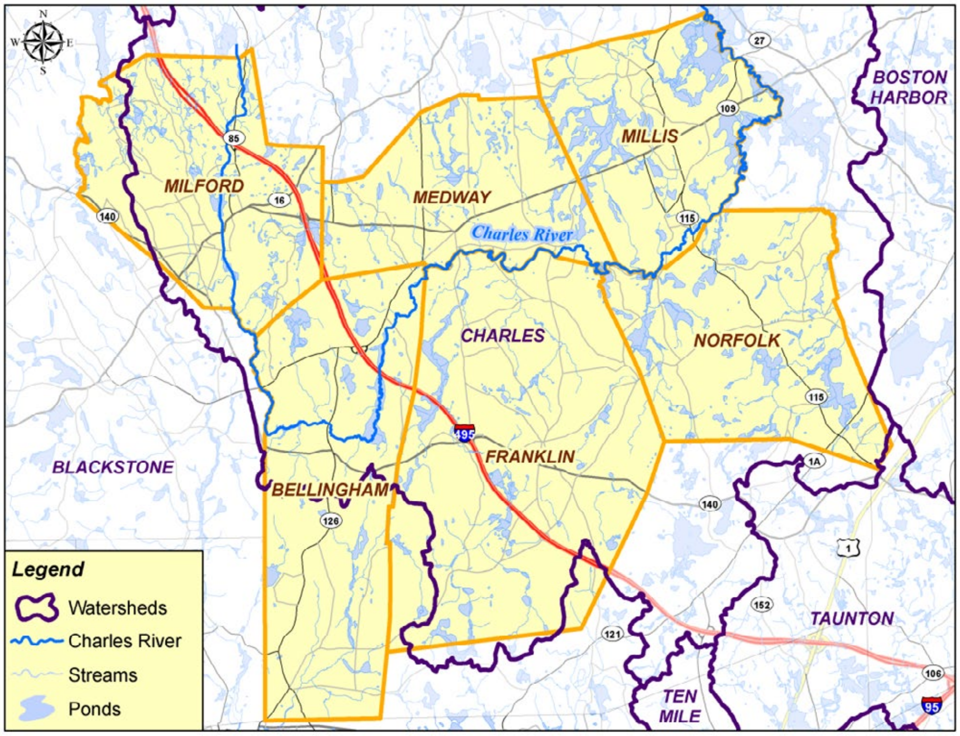



**Figure 1-3. Map of Upper Charles River Watershed**

In an effort to ameliorate the impacts of stormwater runoff and associated phosphorus pollution on receiving waters, the Town of Franklin has already installed a number of green infrastructure projects. Six of these projects are highlighted in Attachment 1 (*Quantification of Benefits from Existing Infrastructure Projects – Town of Franklin*, 2013). Overall, these projects, which include bioretention, infiltration basins, rain gardens, pavement reduction, and application of zero-phosphorus fertilizer, remove a total of about 76 pounds of phosphorus per year (Table 1-1). The implementation of additional green infrastructure projects will further reduce phosphorus loading to the Charles River and other receiving waters improving the health of these waters.

**Table 1-1. Cost of Phosphorus Removal for Six Town of Franklin Projects**

| Project Name | | Type of BMP(s) | TP Reduction (lb/yr) | Project Cost | Cost of TP Reduction ($/lb/yr) |
|---|---|---|---|---|---|
| **Lockewood Drive** | | Bioretention, Infiltration Basin | 7.90 | $13,000 | $1,645 |
| **Panther Way** | | Infiltration Basin | 15.45 | $75,388 | $4,880 |
| **Wachusett Street** | Small Fletcher Lot | Bioretention | 0.65 | $71,612 | $27,768 |
| | Parmenter School-1 | Bioretention | 0.53 | | |
| | Parmenter School-2 | Bioretention, Infiltration Chambers | 1.40 | | |
| **Wyllie Road/ Miller Street** | Miller at Green | Bioretention, Infiltration Chambers | 11.72 | $122,000 | $10,409 |
| | Wyllie Rd | Infiltration Chambers | 4.26 | $112,289 | $26,363 |
| **Greensfield Road** | | Rain Garden, Pavement Reduction | 0.29 | -$10,000 | -$34,634 |
| **Town Property – P-free Fertilizer** | | Phosphorus-free Fertilizer | 34 | -$5,978 | -$173 |
| | **Total:** | NA | 76.2 | $378,311 | $4,964.71 |

Green infrastructure has a number of other benefits to the Town of Franklin in addition to phosphorus reduction. Green infrastructure also reduces loading of other pollutants, such as sediments, nitrogen, hydrocarbons, metals, and bacteria. The use of green infrastructure can also mitigate the warming effect that stormwater runoff has as rainwater collects on hot paved surfaces and is then quickly discharged to downstream water bodies.

Green infrastructure can also save the Town money, which can be used to support other municipal needs. For example, two of the projects highlighted in the 2012 Memo (pavement reduction and conversion to phosphorus-free fertilizer for municipal properties) had a net negative project cost, saving the Town over $15,000. Reducing the annual runoff volume through the use of green infrastructure also lessens the load on storm sewer systems and downstream water resources, which reduces maintenance costs and streambank erosion issues. Maintenance costs also tend to be lower with above-ground stormwater management systems, such as bioretention facilities, due to easier access and the mostly landscape-related activities.

In addition to the pollutant removal and fiscal benefits of green infrastructure, green infrastructure can have other benefits that, while not always easily quantifiable, are important to the Town. For example, green infrastructure, which incorporates natural vegetation as a primary means to mimic natural hydrology, often increases habitat and offers greater wildlife biodiversity compared to traditional stormwater practices. Green infrastructure practices also tend to provide green spaces for the public to enjoy. The creation and preservation of open space is important to the Town of Franklin, and through its Master Plan, the Town has committed "to assure that our preservation of open space and recreational land keeps pace with the Town's buildout, protects our environmental resources and preserves our New England character" (Town of Franklin, 1997). Lastly, green infrastructure has been linked to higher property values (CNT, 2010). In general, property values tend to increase when they abut landscaped, open areas (such as those used for green infrastructure) versus abutting uninterrupted paved areas such as parking lots and streets. Further discussion of all of the benefits described here is provided in Attachment 1. The next section will introduce how new green infrastructure projects, programs and policies can further these benefits that Franklin is already starting to experience.

**Figure 1-4. Multiple Community Benefits of Green Infrastructure**

## 1.4 Implementing Green Infrastructure: Projects, Programs, and Policies

The implementation of green infrastructure, transitioning from "gray to green," can occur through the implementation of projects, programs, and policies. Table 1-2 summarizes the definition of projects, programs, and policies and provides an example of each. In general, projects can be thought of as unique installations with a start and end date. For example, the installation of a green roof on a school or a bioretention retrofit to a municipal parking lot can be thought of as projects. A program can be thought of as an ongoing initiative that often includes a group of projects, such as a public education campaign on the benefits of green infrastructure or training program on how to install residential-scale green infrastructure. A policy is usually a document developed by a government or business that identifies a plan, often times for implementing a program. For example, Franklin recently instituted a local government policy to switch from conventional fertilizer to phosphorus-free fertilizer on all municipal properties. The following sections of this report will describe how existing and proposed Town projects, programs, and policies will fit into the Town's Green Infrastructure Strategy.

**Table 1-2. Green Infrastructure Projects, Programs and Policies**

| | Definition | Example |
|---|---|---|
| **Project** | Temporary undertaking with a defined start and end point and specific objectives to create a unique installation or service that, when attained, signify completion. | New bioretention retrofit project at a municipal parking lot |
| **Program** | A group of related projects managed in a coordinated way to obtain benefits not available from managing the projects individually. A program may also include elements of on-going, operational work. | Public "Build-your-own-rain-garden" training program |
| **Policy** | A plan or course of action, either set by a government or business, intended to influence and determine decisions, actions, and other matters. | Local government policy to switch to phosphorus-free fertilizer on all municipal properties. |

## 1.5 Franklin's Green Infrastructure Goals and Objectives

The Town has identified several goals and objectives for the implementation of green stormwater infrastructure. The goals and objectives are summarized in Table 1-3. These are intended to help the Town identify what potential barriers may exist for practices, programs and policies and how they may address them. They also provide guidance for implementing new practices, programs, and policies that will help provide effective stormwater management of the Town's MS4 and individual private properties.

Table 1-3. Goals and Objectives for the Town of Franklin's Green Stormwater Infrastructure Implementation

| Goal Description | Objective | | | | | |
|---|---|---|---|---|---|---|
| *Minimize directly-connected impervious area* | Minimize impervious area associated with streets | Minimize impervious area associated with parking | Minimize impervious area associated with driveways and sidewalks | Promote permeable pavements | | |
| *Preserve the hydrologic function of natural features* | Minimize building foot print | Preserve topsoil | Preserve trees | Preserve existing topography | Preserve open space | Preserve wetlands |
| *Allow and encourage multi-functional stormwater controls* | Promote green infrastructure in landscaped areas | Promote green infrastructure in open areas | Promote green infrastructure on roofs | Promote green infrastructure in rights-of-way | Redirect stormwater from gray to green infrastructure | Encourage green infrastructure approaches |
| *Increase public involvement, education, and outreach* | Add public signage | Increase green infrastructure in public areas | Develop public/private partnerships | Provide public training sessions/ workshops | Develop an education program for phosphorus fertilizer ban | |
| *Address the Upper Charles River TMDL* | Reduce phosphorus for new and redevelopment projects | Reduce phosphorus from existing development | Provide phosphorus pollutant non-point source control | | | |
| *Provide cost effective stormwater management* | Integrate green infrastructure into other development projects | Identify green infrastructure opportunities that address multiple community goals | Create guidance for interdepartmental and review board coordination | Create maps and databases to support and monitor data | Develop an incentives program | |

# 2.0 Projects

The Town of Franklin has been implementing green infrastructure practices into their projects to help them meet their goals and objectives as described in Section 1. This section provides a summary of the green infrastructure practices that are already in place as well as those that may be available to the Town for future projects, including:

- Bioretention/Green Streets
- Infiltration
- Rain Harvesting
- Permeable Pavement
- Constructed Wetlands
- Green/Blue Roofs
- Non-structural

Each subsection has a discussion of the practice, including short descriptions of the various applications, a summary of existing projects, and a description of potential future project applications.

## 2.1 Bioretention/Green Streets

Bioretention systems are shallow landscaped areas that are designed for small drainage areas. These practices mimic the hydrologic processes of pre-developed land, including infiltration, storage, filtration and pollutant uptake, primarily through the use of engineered soils and native plantings. Underdrain systems can be installed to provide flow control for poorly-draining soils.

Bioretention applications can take several different forms, such as bioretention cells, tree filters, stormwater planters, rain gardens, and bioswales. Green Streets incorporate the various types of bioretention as well as other tools, like stormwater bumpouts, to address stormwater runoff from streets and sidewalks. Green Streets are implemented in rights-of-way and are designed to maximize stormwater management while maintaining the primary functions for pedestrians, bicyclists and vehicles.

Descriptions of these applications are provided in Table 2-1 below. The applications can be applied in new development, redevelopment and retrofit projects and can be a stand-alone practice or integrated with other multifunctional green infrastructure practices.

**Table 2-1. Descriptions of Bioretention/Green Street Practices**

| Application | Description | Example Photo |
|---|---|---|
| Bioretention Cells | Shallow depressions that accept flows from small, gently sloping drainage areas. Designed with a planting soil mix and a variety of plants, selected based on the site condition (e.g., shade, underlying soil types, etc.). May or may not have an underdrain system. These systems are applicable in both urban and suburban locations. |  |
| Tree Filters | Compact, self-contained systems filled with a soil mixture, vegetation and an underdrain system. These systems are often seen in urban settings along sidewalks to collect and filter runoff from roadways and parking lots. |  |
| Stormwater Planters or Planter Boxes | Vertical walled containers, often constructed within concrete, that include filter media and vegetation. These systems are designed to treat limited volumes of runoff, typically from rooftops via downspouts or small areas of sidewalk. Planters may have an open bottom that allows infiltration or may be planter boxes, which have a closed bottom that requires use of an underdrain. Both practices are typically used in high density urban areas. |  |
| Rain Gardens | Similar to bioretention cells, but generally excavated into native soils with only modest soil amendments, such as compost and/or sand and no underdrain. These practices are well-suited for installation in residential areas. |  |

| Application | Description | Example Photo |
|---|---|---|
| Bioswales | Similar to bioretention cells, but are designed to convey stormwater when maximum ponding depth is exceeded. Bioswales are typically seen in residential areas. |  |

*2.1.1 Existing Bioretention/Green Street Practices*

The Town has completed a number of green infrastructure projects using bioretention applications. Representative projects include:

**Lockewood Drive**

This project incorporated a retrofit of an existing dry “detention pond” that had modest detention and limited treatment due to an at-grade outlet pipe. The modifications included a plunge pool, sediment forebay and bioretention cell which overflows into an infiltration basin.

**Wachusett Street**

Retrofits and upgrades along this busy street were installed in two sub-watersheds: Parmenter School and Fletcher Field. At Parmenter School, four bioretention areas were installed as pre-treatment to underground infiltration chambers. At the Fletcher Field Lot, flow was directed to a sediment forebay which discharged into a standalone bioretention cell.

**Miller Street (at the intersection of Green Street)**

Scheduled to be completed in 2013, this project will include removing excess pavement and replacing it with grass and a rain garden. The rain garden will serve as pre-treatment to underground infiltration chambers.

**Greensfield Road**

Greensfield Road was an existing cul-de-sac that had excess, unnecessary pavement once a spur road was added. For this project, the Town Department of Public Works (DPW) removed the pavement, replaced the impervious cover with grass, and installed a rain garden to manage stormwater runoff from a portion of the road.

**Downtown Franklin Roadway and Streetscape Improvement Project**

This project incorporates improvements to the roadways, rights-of-way and adjacent areas in downtown Franklin to revitalize the area. The Town is working with the Massachusetts Department of Transportation (MassDOT) to complete the project. The Town’s portion of this project included tree filters and rain gardens at a public parking lot.

Results from a recently completed assessment of the benefits of these projects show that annual total phosphorus reductions of greater than 20% up to 84% were able to be achieved using bioretention practices or a combination of bioretention and other green infrastructure practices. Project cost evaluations indicated that the annual cost to reduce total phosphorus ranged from $2,000 to $30,000 per lb of phosphorus; the costs varied due to the variable drainage areas and the variability of the practices that made up the projects. Overall, the assessment concluded that bioretention systems were successful at addressing the Town's phosphorus loading and were cost effective, particularly when compared to underground stormwater management practices.

### *2.1.2 Proposed Bioretention/Green Street Practices*

The Town can incorporate bioretention practices into both existing and proposed stormwater management systems, particularly in public areas, such as parking lots and parks, and along roadways, creating green streets. Green streets not only manage and treat runoff from the adjacent roadways but offer added visual quality which can attract residents and local businesses and provide for stormwater education opportunities. The Town should continue to work with MassDOT as part of their Downtown Roadway and Streetscape Improvement Project to incorporate bioretention practices into MassDOT's portion of the project. To increase public involvement and encourage bioretention on private properties, the Town could provide rain garden workshops, develop support materials, or even help fund private installations. Table 2-2 below provides guidance on design, benefits, limitations, operations and maintenance needs, and potential costs for bioretention systems.

**Table 2-2. Guidance for Implementation of Bioretention/Green Street Practices**

| | |
|---|---|
| **Design** | • Should be used in conjunction with pretreatment practices to increase efficiency.<br>• Should be sized for small drainage areas (generally less than 10 acres).<br>• Can be used for practices when vertical separation from bedrock or ground water is less than one foot (requires design provisions).<br>• Native, hardy plants should be used to increase likelihood of survival. |
| **Benefits** | • Helps maintain the natural water balance of a site.<br>• Helps to recharge the groundwater and drinking water supply when practices are unlined.<br>• Creates a green space which is ideal for increased biodiversity and aesthetically pleasing to the public.<br>• Can easily be modified for stormwater retrofits for small existing drainage areas.<br>• Excellent opportunities for educational outreach. |
| **Limitations** | • Bioretention cells and rain gardens are not ideal for steep slopes, but can be implemented with design provisions.<br>• Long-term landscape-oriented maintenance is required to ensure adequate performance and aesthetic value.<br>• Requires measures to divert large flows, whether by structural overflows or being installed off line from a treatment train. |
| **Operation and Maintenance** | • Regular landscape activities such as mulching and weeding.<br>• Sediment removal as needed.<br>• Specific attention to health of plantings and diligence in replacing dead, diseased, and invasive species. |
| **Costs** | • Bioretention cells typically run $20-$30 per square foot (HW, 2012).<br>• Rain gardens are almost half of the above cost.<br>• Tree boxes and planters are typically more expensive due to street side installation.<br>• Bioswales are similar in cost to bioretention cells. |

## 2.2 Infiltration Practices

Infiltration practices are designed to manage stormwater though infiltration of runoff into the soil. These practices increase groundwater recharge and have excellent pollutant removal capability. Infiltration practices are only suited for sites with adequate soils and separation distance to groundwater. They can be above or below ground, and through their capture and storage of runoff, help attenuate large flows. Infiltration practices must have pretreatment by a prior BMP.

Table 2-3 below has brief descriptions of various infiltration practices applicable to Franklin. These practices can be used during new or redevelopment, and are appropriate for suburban and urban areas. Franklin can initiate public interest by highlighting projects it has already completed and should continue to construct infiltration practices as a part of both retrofit and new development projects.

**Table 2-3. Descriptions of Infiltration Practices**

| Application | Description | Example Photo |
|---|---|---|
| Infiltration Basins | Above ground excavated areas. They are typically capable of temporarily storing larger amounts of runoff, which is exfiltrated through the bottom of the basin into the underlying soils. Infiltration basins do not generally include significant landscaping but can certainly be designed with plantings as a project amenity. |  |
| Infiltration Trenches | Trenches are typically narrow, elongated excavations filled with stone or prefabricated materials to provide void space. The voids between the stone allow for storage and infiltration into the soil below. The linear shape allows trenches to be used effectively along buildings, parking lots, or roadways. |  |

| Application | Description | Example Photo |
|---|---|---|
| Underground Chambers | A variety of shapes and sizes of structural products can be used. The structures are buried underground and surrounded by stone to provide storage and support. An overflow is typically provided for large storm events. They can be designed to withstand the heavy loading of parking lots and roadways, which can be ideal for sites with space limitations. |   |
| Dry Wells | Small excavated pits, filled with stone, with or without structural components. Downspouts are attached to dry wells to manage roof drainage; an overflow pipe is typically provided for large storm events. Dry wells are ideal for smaller rooftop areas. |  |

*2.2.1 Existing Infiltration Practices*

Infiltration practice applications have been used by the Town in retrofits of past projects. Two of these projects are described below.

**Panther Road**

A diversion manhole, new sediment forebay, and new infiltration basin were installed to provide stormwater management for a police station parking lot as well as the existing storm sewer system on Highwood Drive, which had runoff from a condominium development with no prior stormwater management. The system relieved existing flood issues and now provides water quality treatment and groundwater recharge to a stream system that feeds Mine Brook, a tributary of the Charles River.

**Wyllie Road**

Wyllie Road is part of the larger Miller Street- Wyllie Road grant project. An existing stormwater sewer system was retrofitted with underground infiltration chambers in combination with other green infrastructure practices to provide stormwater management prior to discharge.

The recent assessment of Franklin green infrastructure projects shows decreased phosphorus loading and runoff volume of greater than 80% and 75%, respectively. These reductions are some of the highest found from the assessment. Costs of annual phosphorus removal were approximately $5,000 and $26,000 per pound; the large difference in costs can be attributed to the increased costs of underground chambers versus above ground basins.

*2.2.2 Proposed Infiltration Practices*

The Town should consider the benefits of infiltration practices when working on new and redevelopment projects. Much of Franklin has well draining soils (approximately 50% of the soils are classified as being hydrologic soil group A or B), so infiltration is an appropriate practice for stormwater management. Also, infiltration practices help to meet Franklin's zoning bylaws which require groundwater recharge for all projects within the Water Resource District, unless it is infeasible due to contaminants or soil restrictions. Infiltration practices also have the highest phosphorus removal capability, especially when coupled with bioretention cells as pretreatment (HW, 2012). Both aboveground and underground applications can be used in Franklin, depending on the project location and available land area. While above ground practices cost much less, underground chambers are effective where site limitations exist, such as under parking lots and roadways. Further guidance for designing and implementing infiltration practices is provided in Table 2-4.

**Table 2-4. Guidance for Implementation of Infiltration Practices**

| | |
|---|---|
| **Design** | • Need to be placed in adequate soils (well draining, sandy soils are preferred).<br>• Can be sized for any storm event or drainage area.<br>• Must have vertical separation from bedrock and groundwater of at least two feet.<br>• Must be used with pre-treatment practices (dry wells can be used without pre-treatment if accepting roof runoff only). |
| **Benefits** | • Helps to recharge groundwater and drinking water supply.<br>• Temporary storage and attenuation help reduce peak discharge rates and local flooding issues.<br>• Infiltration and filtering through soil media provide high pollutant and nutrient removal.<br>• Reduces the need for other stormwater management practices. |
| **Limitations** | • Regular maintenance is essential to prevent clogging.<br>• Requires highly permeable soils and adequate distance to groundwater to infiltrate stored water<br>• Some potential for groundwater contamination if not designed or sited properly. |
| **Operation and Maintenance** | • Regular sediment removal.<br>• Semi-annual inspections for erosion and scouring.<br>• Direct access in the form of observation wells are needed for underground systems. |
| **Costs** | • Costs can vary widely with infiltration practices based on design and site constraints.<br>• In general, infiltration trenches are usually in the range of $20-30/sf, and above ground structures cost about half of those below ground (HW, 2012). |

## 2.3 Rain Harvesting

Rain harvesting stores stormwater runoff in some kind of holding tank for future use. Nearly all rain water harvesting involves collection and storage of rooftop runoff, but other applications have been done. These practices can range from simple (e.g., installation of a rain barrel) to complex (e.g., installation of an underground cistern with flow-controlling systems and pumps), as described in Table 2-5. Installation of flow-control valves can help to reduce peak flows and runoff volume to downstream drainage areas. Harvesting can also reduce the need for groundwater pumping. Water can be used for irrigation (e.g., for gardens/ landscaping on private properties, golf courses, parks, etc.), toilet flushing, construction activities as well as a variety of other activities. Rain harvesting is an easy first step for making the switch from gray to green and is an adequate retrofit option for almost any building.

**Table 2-5. Descriptions of Rain Harvesting Practices**

| Application | Description | Example Photo |
|---|---|---|
| Rain Barrels | Plastic barrels (typically under 100 gallons) used to store roof runoff. They are excellent stormwater management additions to residential or small lots. |  |
| Cisterns | These systems capture runoff from larger buildings or multiple buildings (such as housing complexes) or occasionally from paved surfaces (like patios, driveways, sidewalks, etc.). Cisterns can be placed above or below ground. Above ground cisterns generally store from 1,000 to 5,000 gallons. Below ground tanks typically range in size from 5,000 to 20,000 gallons and use pumps to distribute water. Below ground tanks are more expensive due to excavation and higher strength materials (reinforced plastic or concrete). Cisterns are appropriate for medium to high density residential and industrial/commercial areas. |  |

*2.3.1 Existing Rain Harvesting Practices*

During the spring of 2009 and 2010 Franklin offered rain barrels to Town residents at a discounted price. This is an excellent form of outreach to help the public become aware of stormwater issues and management. This also provides small scale peak flow reductions, which can contribute to an overall decreased peak flow discharge.

*2.3.2 Proposed Rain Harvesting Practices*

Rain harvesting systems are ideal for both residential and commercial areas; they are simple and require minimal space and design, as detailed in Table 2-6. Most buildings with external downspouts can be retrofitted to use one of the above practices. In addition, recharge and storage in these systems can easily be managed through the use of an automated system of valves and pumps that are triggered by weather forecasts to transfer or release stored water.

Franklin should continue to offer rain barrels to homeowners to promote their commitment to green infrastructure. The Town could promote rain harvesting practices by installing rain barrels and/or cisterns at public buildings, such as at Town Hall, the library or schools where the projects would be highly visible. Rain harvesting projects are particularly beneficial for buildings adjacent to grounds requiring irrigation. For example, large underground cisterns at a school can provide the majority of watering needs for athletic fields. Water can also be reused for toilet flushing inside schools or other buildings, assuming plumbing and any other relevant codes are followed.

**Table 2-6. Guidance for Implementation of Rain Harvesting Practices**

| | |
|---|---|
| **Design** | • Roof top area and rainfall depth to be captured are the two main factors in sizing.<br>• A minimum setback of ten feet from buildings is required.<br>• Leaf litter and other debris will need to be blocked with a screening device. |
| **Benefits** | • Require little space and are therefore easily employed in urban areas.<br>• Can reduce potable water supply demand for irrigation applications.<br>• Reduces runoff to stormwater management systems. |
| **Limitations** | • Must be sealed to prevent mosquito breeding.<br>• No direct pollutant or nutrient removal.<br>• Require overflow mechanism for larger storm events.<br>• Can only hold some of the total volume if not emptied between storms (flow control technologies can optimize storage).<br>• Use for flushing of toilets requires special plumbing requirement to meet plumbing codes. |
| **Operation and Maintenance** | • Regular inspection of gutters, downspouts, and screens for clogging.<br>• Planning ahead for water use so the unit can store the next storm.<br>• During the winter months drains should be left open to prevent freeze-thaw damage. |
| **Costs** | • Costs are $2-3 per gallon for rain barrels and $1-2 per gallon for larger tanks (HW, 2012).<br>• Below ground cistern units generally cost more than above ground ones because of the additional cost of excavation. |

## 2.4 Permeable Pavement

Permeable pavements help provide better stormwater management without sacrificing the usefulness provided by hardscapes. These systems consist of a porous surface with underlying layers of sand and/or stone. Alternative pavements can be built on fast infiltrating soils to provide groundwater recharge and water quality benefits, but can also be installed in slower infiltrating soils with the use of an underdrain system. They are recommended on pedestrian and low traffic sites to extend their lifetime and decrease risk of failure. The four types of permeable surfaces appropriate for use in Franklin are described below in Table 2-7.

### Table 2-7. Descriptions of Permeable Pavement Practices

| Application | Description | Example Photo |
|---|---|---|
| Permeable Pavers | Pavers are impervious blocks that are installed with spaces between them. These spaces are filled with sand or gravel to allow drainage between the blocks and into the soil. Pavers are typically used in patio and walkway settings. |  |
| Porous Asphalt | Porous pavement is similar to traditional blacktop, but has less fine aggregate to increase void space. These spaces allow stormwater to percolate through the asphalt to the underlying subbase. Porous asphalt is used in place of traditional asphalt, on parking lots and driveways. |  |
| Pervious Concrete | Pervious concrete looks similar to traditional concrete pavement, but has less fine aggregate to increase void spaces and to allow rain to infiltrate through the cover to the sub base. Pervious concrete is a good choice for sidewalks. |  |
| Pervious Concrete Slabs | These function the same as porous concrete but are manufactured in a controlled environment, which allows for greater quality control. Because they are small and uniform, slabs can be removed for cleaning or replaced easily without disturbing the rest of the cover. Slabs are appropriate for sidewalks or other smaller applications. |   |

### *2.4.1 Existing Permeable Pavement Practices*

There are currently no known existing permeable pavement practices in Franklin.

### *2.4.2 Proposed Permeable Pavement Practices*

The Town should consider the use of permeable pavement practices in place of traditional pavement during the planning stages of future public projects. The Town should also consider pervious covers when repaving and resetting public parking lots, sidewalks, or bike paths. Sidewalks and pedestrian ways are ideal for these practices because pervious covers with less vehicular traffic are easier to maintain. Although the initial cost of pervious walkways may be greater than traditional sidewalk construction (depending on other requirements), the cost over the life of pervious walkways are generally less. Cost savings are a result of reduced maintenance (e.g., less sand would be required during winter months) and reduced need for additional stormwater management infrastructure. Permeable pavements are applicable to all future Town projects involving sidewalks and courtyard type areas. They are also relevant to low-volume roads, parking lots, and driveways. In general, the Town should not consider these practices for higher traffic roads.

**Table 2-8. Guidance for Implementation of Permeable Pavement Practices**

| | |
|---|---|
| **Design** | • Poorly drained soils need an underdrain system.<br>• Depth of sub base is directly related to amount of available storage.<br>• Must have vertical separation from bedrock and ground water of at least two feet.<br>• Should only be used in low traffic or pedestrian areas. |
| **Benefits** | • Promotes filtration and groundwater recharge.<br>• Reduces the need for salt and sand application during the winter months.<br>• Reduces need for curbing and “gray” stormwater infrastructure. |
| **Limitations** | • Regular maintenance (such as street sweeping) is essential to prevent clogging.<br>• Have strict site limitations for groundwater and soil needs to promote infiltration and prevent groundwater contamination.<br>• Not suitable for land uses with potential higher pollutant loads. |
| **Operation and Maintenance** | • Regular cleaning with vacuum assisted street sweeper.<br>• Annual inspection to check for deterioration.<br>• Requires reduced or no sand usage during winter months to prevent clogging. |
| **Costs** | • Costs can vary widely with size of area.<br>• Permeable asphalts can range from as low as $3-5 per square foot (depending on size of project and subbase requirements) (HW, 2012).<br>• Porous concrete and pavers can range from $9-15 per square foot (HW, 2012). |

## 2.5 Constructed Wetlands

Constructed stormwater wetlands are engineered systems designed to mimic natural wetlands. They require larger drainage areas, at least ten acres per Massachusetts Stormwater Management Standards (MASWMS), to ensure the system stays sufficiently wet. Often, they are sited in soils with slow or no infiltration to create a permanent pool. Sediment forebays are required on all types of stormwater wetlands.

Pollutant, sediment, and nutrient removal are highly effective in these systems due to the wetland plantings uptake and retention/settling from the permanent pool. The MASWMS lists the removal efficiencies of constructed wetland systems as: 80% of total suspended solids (TSS), 20-55% of total nitrogen (TN), 40-60% of total phosphorus (TP), and up to 75% of bacteria. These are some of the highest of all the green infrastructure practices. In Table 2-9, brief descriptions of the five basic types of constructed wetlands acknowledged by MASWMS are provided.

**Table 2-9. Descriptions of Constructed Wetland Practices**

| Application | Description | Example Photo |
|---|---|---|
| Shallow Marsh Systems | These manage stormwater through shallow pools, shallow marshes, and high marshes. They may require a larger drainage area than other constructed wetlands because they lack deep pools. |  |
| Basin/Wetland | These practices contain all the components of a shallow marsh system and in addition have a wet basin and plunge pool. |  |
| Extended Detention Wetland | A smaller footprint than other constructed wetland systems can be achieved because of the vertical storage. The deeper ponding depth resulting from temporary ponding during storm events require special attention to plant selection. |  |
| Pocket Wetland | Adequate for drainage areas of one to ten acres, these smaller practices should be excavated into the groundwater table to ensure they stay wet. |  |

| Application | Description | Example Photo |
|---|---|---|
| Gravel Wetland | Gravel wetlands use sub surface, horizontal flow to manage runoff. They consist of a gravel subbase with an option to add organic soil to accommodate plantings. |  |

*2.5.1 Existing Constructed Wetland Practices*

Franklin currently has no existing constructed wetlands.

*2.5.2 Proposed Constructed Wetland Practices*

Constructed wetlands can be used to manage drainage from large public areas, such as schools. An example of this type of application is a recently completed constructed gravel wetland in Harvard, MA that was designed to manage drainage of athletic fields at Bromfield High/Middle School. The Town may also consider the suggestions from the recent Spruce Pond Brook Subwatershed plan, which identified an area behind Fletcher Field as ideal for a gravel wetland system.

Franklin should consider constructed wetlands in locations where other practices are inadequate due to groundwater or lack-of-elevation constraints. In addition, these systems can have high pollutant removal efficiencies and can greatly help reduce phosphorus loading to the Charles River. Table 2-10 provides guidance information for the implementation of constructed wetlands within the Town.

**Table 2-10. Guidance for Implementation of Constructed Wetlands**

| | |
|---|---|
| **Design** | • Constructed wetlands need sufficiently large drainage area and/or groundwater influence to remain wet.<br>• Must have a sediment forebay or other BMP as pretreatment.<br>• Proportions of "depth zones" must be in accordance with MASWMS.<br>• Medium to fine texture soils are best for establishing vegetation, retaining surface water, facilitating groundwater discharge and capturing pollutants.<br>• Water budget must demonstrate a continuous supply of water is available to sustain the constructed wetland. |
| **Benefits** | • Reduces peak discharge rates and runoff volume.<br>• Effectively reduce sediment and pollutant loads.<br>• Offers marsh like habitat, which increases biodiversity in areas lacking such ecosystems.<br>• Enhances the aesthetics of the site. |
| **Limitations** | • Potentially require larger footprint than other BMPS.<br>• Does not provide groundwater recharge.<br>• Require native plantings (e.g. *Carex, Scirpus, Juncus,* and *Lemna)*.<br>• Can be difficult to maintain during extended dry periods. |

| | |
|---|---|
| **Operation and Maintenance** | • Constructed wetlands require small-scale maintenance at regular intervals.<br>• Should be inspected during growing and non-growing seasons.<br>• When inspecting look for: invasive species, distribution of wetland plants, standing water without plantings, and stability of original "depth zones."<br>• Removal of built up sediment from the forebay. |
| **Costs** | • Constructed wetlands costs vary widely depending on drainage area treated and site constraints; median cost for new construction is approximately $3,000 to $10,000 per impervious acre treated (Schueler, et al., 2007). |

## 2.6 Green/Blue Roof Practices

Green and blue rooftop systems are alternatives to traditional roof construction in which precipitation is managed beyond a gutter system. They are typically better suited for new construction projects versus redevelopment and retrofits, but can be used in both. One important design consideration with these systems is the additional structural loading due to the increased load, which will require consultation with a structural engineer prior to installation. Both green and blue roof systems are designed to provide detention and can potentially provide some volume reduction through evaporation. Table 2-11 below discusses the differences between these two practices.

**Table 2-11. Descriptions of Green/Blue Roof Practices**

| Application | Description | Example Photo |
|---|---|---|
| Green Roof | Soil media, an underdrain system, and vegetation are used to store and slow rainfall before it becomes runoff. Voids in the sub base provide attenuation and storage of water while plantings provide uptake, treatment, and runoff reduction through evapotranspiration. Extensive green roofs have a shallow soil media for small, ground cover type, plants and are not intended for public access. Intensive green roofs have a deeper soil structure, capable of growing larger plants; these practices are designed for public access. Green roofs are appropriate for large public buildings, such as schools, offices, and libraries. |  |

| Application | Description | Example Photo |
|---|---|---|
| Blue Roof | Blue roofs provide storage and detention through chambers, trays, check dams, or outlet restrictions. Evaporation can occur in small amounts and provide minimal runoff reduction. Typically the main goal of these systems is to reduce peak flows through attenuation. Blue roof options are adequate for retrofits of existing public buildings. |   |

*2.6.1 Existing Green/Blue Roof Practices*

Franklin currently has no existing green or blue roofs.

*2.6.2 Proposed Green/Blue Roof Practices*

Green and blue roof systems are best suited for new construction projects, when all options can be discussed in advance to ensure the structural design of the building incorporates the above average loading from the roof system. Green roofs can offer energy savings through the natural heating and cooling properties of soils and evapotranspiration. Intensive green roofs can also offer unique opportunities for education, green public space, and possibly local gardening projects. Franklin should consider these options when planning a new public building such as Town offices or schools.

The Town should also investigate simple retrofits of existing roofs, both on Town-owned and private property (institutional, commercial and residential). Several retrofits have already been completed in the New England area: a green roof at Underground Art Gallery in Brewster; a food roof at Ledge Kitchen and Drinks Restaurant in Dorchester; and green roofs at private residences in Newton, Winchester, and Boston. A case study of a green roof retrofit at Whipple Riverview Place in Ipswich conducted after its completion in 2006 found that the green roof was particularly effective at delaying and retaining stormwater runoff.

**Table 2-12. Guidance for Implementation of Green/Blue Roof Practices**

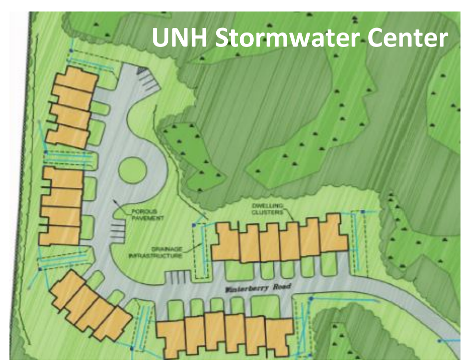
| | |
|---|---|
| **Design** | • Need a structural engineer to verify loading capacities for both types.<br>• Need high quality impermeable barriers to prevent leaking for both types.<br>• Need to take into consideration public access when designing green roofs. |
| **Benefits** | • Both systems provide detention and peak flow rate reduction.<br>• Both can provide some volume reduction.<br>• Green roofs provide energy savings through natural heating and cooling properties of ground and plant transpiration.<br>• Green roofs have longer life spans than traditional roofs.<br>• Green roofs can provide wildlife habitat and green space. |

| | |
|---|---|
| **Limitations** | • Must adhere to local building codes and load restrictions.<br>• Pollutant removal capabilities have not been adequately studied.<br>• Does not recharge groundwater. |
| **Operation and Maintenance** | • Need periodic landscape related maintenance for green roofs.<br>• Need periodic inspection to ensure water tightness and prevent clogging for both types. |
| **Costs** | • Typically cost between $144-$420 per cubic foot treated (Schueler, 2007). |

## 2.7 Non-Structural Practices

Green infrastructure practices are not limited to constructed structural methods. Non-structural practices include: open space preservation, encouraging site fingerprinting, encouraging natural landscaping, reducing impervious cover, and providing source control, such as enhanced street sweeping. This variety of options promotes maintaining existing hydrologic patterns and dissuades adding extraneous impervious cover. These practices also help prevent runoff and pollution, which helps reduce the burden on stormwater management systems. Table 2-13 lists five different non-structural practices appropriate to the Town.

**Table 2-13. Descriptions of Non-Structural Practices**

| Application | Description | Example Photo |
|---|---|---|
| Open Space Preservation | Conservation practices such as protecting sensitive areas like wetlands helps maintain existing hydrologic patterns. Open space can also be recreation areas, such as hiking trails or athletic fields. |  |
| Encourage Site Fingerprinting | Site fingerprinting is a land development strategy that incorporates an analysis prior to site development to identify key natural features to be protected during construction. This includes: mapping existing trees, drainage divides, and highly permeable soils. |  |

| Application | Description | Example Photo |
|---|---|---|
| Encourage Natural Landscaping | Native vegetation is well adapted to its region. It tends to require less irrigation and fertilizer while performing better than exotic species. Natural landscaping can be done in place of most conventional landscaping with less impact on the environment. |  |
| Reduce Impervious Cover | Today's standards and requirements for paved surfaces may be less strict than those from the past when many roads and sidewalks were built. When repaving roads or resetting sidewalks, opportunities exist for reducing the size of the original impervious cover and replacing with a green cover. |  |
| Provide Source Control | Source control can include: using less fertilizer, using less salt during winter months, and providing adequate street sweeping. |  |

*2.7.1 Existing Non-Structural Practices*

Several non-structural practices have been implemented in the Town. Two of these projects are described below.

**Greensfield Road**

As described in Section 2.1.1, the DPW recently replaced excess impervious area in a former cul-de-sac with pervious lawn cover and a small rain garden. This project provided a net cost savings because the Town no longer has to maintain the excess pavement.

**Town Properties**

In 2008, the Town of Franklin began using zero phosphorus fertilizer on all Town-owned property, which includes active use turf (e.g., sports fields) and passive use turf (e.g., lawn around buildings and in parks). By switching to zero phosphorus fertilizer, Franklin implemented source control and reduced the phosphorus loading to nearby storm sewers and surface waters by over 30 pounds per year.

### *2.7.2 Proposed Non-Structural Practices*

For future paving projects, the Town should consider reducing impervious cover, such as reducing road widths or using pervious pavements in public parking lots. Reducing salt and sand use on roadways during winter months is an effective source control that not only helps to improve water quality and provide cost savings, but also limits negative effects on other green infrastructure practices.

For future public projects (buildings, schools, parks), the Town should strive to maintain natural hydrologic patterns and vegetation and conserve trees and open spaces to the extent possible. In addition, natural landscaping should be considered instead of conventional landscaping (i.e., turf grass). Not only will this reduce irrigation and fertilizer needs, but it will also provide an example to the community.

**Table 2-14. Guidance for Implementation of Non-Structural Practices**

| | |
|---|---|
| **Design** | • Street sweeping for source control should be performed by a vacuum-assisted sweeper and done at least twice per year for enhanced removal efficiency. |
| **Benefits** | • Maintains pre-development hydrologic and drainage patterns.<br>• Open space provides aesthetic appeal, recreational opportunity, and wildlife habitat.<br>• Increased natural vegetation reduces irrigation and fertilizer needs.<br>• Increased natural vegetation provide uptake of nutrients, pollutants, and water.<br>• Replacing impervious cover reduces life time costs of repaving, and reduces volume of stormwater runoff. |
| **Limitations** | • Street sweeping requires efficient sweeper and regular sweeping to be effective.<br>• Site fingerprinting requires more attention and time during initial site design.<br>• Reduction in use of salt and sand can pose safety hazards. |
| **Operation and Maintenance** | • Natural landscaping requires general landscape related tasks, but less often than conventional methods. |
| **Costs** | • Zero phosphorus fertilizer can be less expensive than conventional.<br>• Reducing salt and sand usage is a cost savings.<br>• Natural plantings can incur lifetime savings by reducing need for fertilizer, watering, and other maintenance.<br>• Cost of conservation land depends on many factors.<br>• Site fingerprinting requires finer attention to detail in early stages of design and thus can be more expensive than traditional design.<br>• Vacuum-assisted sweepers are on the order of $200,000, generally one and a half to two times the price of a conventional mechanical sweeper (HW, 2012). |

# 3.0 Programs

The Town of Franklin has several existing programs under the Town's departments that utilize green infrastructure practices for stormwater management. This section provides a summary of those green infrastructure programs as well as suggestions for potential improvements to strengthen those programs. In addition, recommendations for new programs are provided to help the Town further integrate the green infrastructure practices described in Section 2 as well as meet the Town's goals and objectives described in Section 1. This section is sub-divided based on the Town's major program activities: Education, Community Planning and Development, and Operations and Maintenance.

## 3.1 Education

*3.1.1 Existing Education Programs*

The Department of Public Works currently has a stormwater education program as part of the NPDES MS4 permit. This stormwater education program includes: information provided on the Town's website and the newspaper, water resource information and protection signs, classroom stormwater education, and educational materials concerning waste disposal and water conservation. Potential improvements to the existing stormwater education program to promote green infrastructure could include:

- Updating the current stormwater education program to include information specific to green infrastructure and its benefits for phosphorus reduction and options for pollution prevention.
- Expanding stormwater education in public areas to increase public outreach. For example, adding signs in parks to address potential pollutants, such as pet waste, or providing additional stormwater and green infrastructure educational materials in mailings or at the local library.

*3.1.2 Proposed Education Programs*

Implementing additional education programs can help the Town to gain and broaden community knowledge and support, which will help ensure success of green infrastructure programs in the long-term. The potential new education programs to support green infrastructure are described in Table 3-1.

**Table 3-1. Descriptions of Proposed New Education Programs**

| Program Description | Benefits | Limitations |
|---|---|---|
| Use existing green infrastructure projects as demonstration projects (e.g., Lockewood Drive, Panther Way, Wachusett Street, etc.) | • Increases public knowledge about the benefits of green infrastructure<br>• Helps gain community support for future green infrastructure projects | • Current projects may be in areas where public access, and therefore public education, may be limited |
| Create a community partnership with local stakeholders, including private partners (e.g., local developers) and academic partners (e.g., Dean College). | • Helps to gain community support for green infrastructure<br>• Increases public knowledge about green infrastructure<br>• Creates shared marketing opportunities across stakeholders | • Requires interest from local organizations |
| Hold periodic information/training sessions on green infrastructure applications. Training sessions can be held internally for maintenance crews, engineers, and local government officials and externally for potential developers and members of the general public. | • Helps all parties involved in new and redevelopment projects understand the green infrastructure concepts, how they may apply and how they need to be maintained<br>• Helps the interested public to understand the technical details, ask questions and provide feedback | • May require additional staff time and funds |
| Create an education program to provide information on the upcoming statewide ban on phosphorus-containing fertilizers that expands to non-municipal properties starting January 1, 2014. | • Helps prepare local residents and businesses to prepare in advance of the statewide ban | • May require additional staff time and funds |

## 3.2 Community Planning and Development

### *3.2.1 Existing Community Planning and Development Programs*

There are three departments that address local bylaws, regulations, and guidelines for new and redevelopment projects: the Conservation Department, the Planning and Community Development Department, and the Building/Inspections/Zoning Department. These departments have Boards that review projects to determine their compliance with the local code. Currently, the Town of Franklin's Best Development Practices (BDP) Guidebook is the primary guidance used to encourage the implementation of green infrastructure.

Potential improvements to promote green infrastructure could include:

- Modifying Town codes to support the implementation of green infrastructure.  A recent review of the local codes was conducted (HW, 2013b), which can be referenced to assist the Town with revisions to policies, removal of potential barriers, and to encourage green infrastructure practices.  Language should be consistent between all policies to avoid conflicting design requirements and ensure green infrastructure is implemented to the maximum extent possible.
- Modifying wetlands regulations to encourage green infrastructure and require applicants to design stormwater management based on the BDP guide, where applicable.  Consider adding requirements for applicants to document phosphorus loading and directly connected impervious area (DCIA) reductions.
- Updating the BDP Guidebook to improve consistency with Town codes and include green infrastructure practices and methods, such as infiltration practices.  BDP goals should be expanded to:
    - Include treatment practices with a documented capability to reduce phosphorus loading;
    - Provide methods and approach for documenting reductions in DCIA; and
    - Promote a minimum requirement for redevelopment projects in place of a maximum extent possible requirement.
- Updating the Design Review Commission Design Guidelines to reference green infrastructure and its goals, specifically as they relate to the site layout, parking, site design and landscaping, paving materials and rooftop design (e.g., encourage green roofs for large retail/commercial projects).
- Updating the Open Space and Recreation Plan to specifically describe green infrastructure and its benefits, including references to the impacts of phosphorus and the benefits of phosphorus reduction to support the restoration goals of the Upper Charles River TMDL.
- Promoting following or obtaining Leadership in Energy and Environment Design (LEED) certification or other green infrastructure-related certifications (e.g., the Sustainable Sites Initiative).  The criteria for these programs can be used to supplement the existing guidance in the BDP Guidebook.
- Educating review boards, Town engineers, and potential developers on any revisions to codes, policies, or guidance documents, particularly those related to green infrastructure, to help ensure proper implementation.

### *3.2.2 Proposed Community Development Programs*

New community development programs can help the Town provide pathways for the Town, developers, residents, and businesses to successfully implement green infrastructure practices while also providing incentives to encourage additional green infrastructure practices.  The potential new community development programs to support green infrastructure are described in Table 3-2.

**Table 3-2. Descriptions of Proposed New Community Development Programs**

| Program Description | Benefits | Limitations |
|---|---|---|
| Create a checklist for the review boards that include steps for coordinating with other departments and review boards to ensure that project site plans and design strategies use green infrastructure to the maximum extent. | • Provides a consistent pathway for interdepartmental communication during the review process<br>• Ensures developers are receiving consistent feedback during reviews | • May result in longer internal design review periods |
| Develop an incentives program for developers that utilize green infrastructure. Incentives programs can vary, but generally involve a cost savings or potential for increased revenue. Examples of incentives include an expedited permitting process, waiving of permitting fees, or density bonuses. | • Encourages green infrastructure on private property<br>• May attract more developers and businesses, providing economic benefits | • Incentive programs can be complex and costly to initiate and administer<br>• Incentives need to be reasonable for the Town (i.e., appropriate for the Town's budget) but significant enough for developers to be willing to participate |

## 3.3 Operations and Maintenance

The Department of Public Works and the Facilities Department are the two main departments that are involved with operations and maintenance (O&M) of Town's infrastructure. The Department of Public Works has six different divisions that manage the daily O&M programs and activities:

- Engineering Division
- Highway Division
- Water and Sewer Division
- Recycling and Solid Waste Division
- Parks and Grounds Division

### *Engineering Division*

*3.3.1 Existing Engineering Division Programs*

The Engineering Division includes engineering, map and GIS services for the Town. Current programs under this division that help to promote green infrastructure include:

- Designing internal construction projects that include green infrastructure
- Providing technical review of both internal and external designs
- Mapping of Town resources, including water resources (including wellhead protection areas), streets, parcels, etc.
- Mapping of O&M routes and schedules (e.g., street sweeping, snow removal, etc.)

Potential improvements to promote green infrastructure could include:

- Providing data on the Town's website (Public Map Viewer) for mapping of green infrastructure site suitability, including: soil groups, slopes, watershed areas, depth to water table, and depth to bedrock.

### *3.3.2 Proposed Engineering Division Programs*

The Engineering Division can use its existing services in designing and mapping to develop new programs that promote green infrastructure in internal projects as well as track the progress of green infrastructure project implementation throughout the Town. The potential new programs are described in Table 3-3.

**Table 3-3. Descriptions of Proposed New O&M Programs under the Engineering Division**

| Program Description | Benefits | Limitations |
| --- | --- | --- |
| Create a checklist for projects designed internally by the Town engineers to ensure that green infrastructure is used to the maximum extent possible for site plans and design strategies for new and retrofitted stormwater management projects. | • Helps promote green infrastructure (particularly, phosphorus reduction and use of permeable pavements) for internal projects that are not currently under the jurisdiction of Town codes and regulations | • Longer internal design review periods initially<br>• Difficult to use for emergency projects |
| Establish a DCIA tracking system using GIS and/or a database to support the annual reporting to be in accordance with the draft MS4 permit. | • Helps to meet a regulatory requirement<br>• Can make annual reporting more efficient as a result of continuous updating | • May require additional staff time and funds<br>• May require additional coordination between applicants, engineers, and outside agencies |
| Establish a maintenance tracking system for new green infrastructure using GIS or a database. | • Can be incorporated into existing maintenance maps to increase efficiency<br>• Easier to develop maintenance schedules and work orders | • May require additional staff time and funds<br>• May require additional coordination between applicants, engineers, and outside agencies |
| Develop and maintain a green infrastructure database and GIS data for tracking of green infrastructure projects. Examples of green infrastructure data to be collected include project locations, green infrastructure design elements, costs, performance (e.g., phosphorus reduction), etc. | • Helps to track on-going and future projects<br>• Helps to identify areas of improvement for future green infrastructure designs<br>• Helps support the draft MS4 permit requirement for GIS mapping of all drainage infrastructure | • May require additional staff time to collect green infrastructure data, funds, and coordination with applicants and engineers |

### *Highway Division*

#### *3.3.3 Existing Highway Division Programs*

The Highway Division is responsible for the roadways, sidewalks and stormwater drainage systems in the Town. The current programs under this division that contribute to the implementation of green infrastructure include:

- Snow and ice removal,
- Street sweeping, and
- Catch basin cleaning.

These nonstructural practices help to limit potential pollutants from entering the stormwater system and improve water quality.

Potential improvements to promote green infrastructure could include:

- Reducing the amount of salt and sand used on lower priority streets. Calibration devices help vary the amount of salt applied based on site-specific characteristics, such as road width and design, traffic concentration, and proximity to surface waters.
- Identifying proper sites for snow disposal and develop site maintenance procedures.
- Ensuring street sweeping occurs during the period immediately following winter snowmelt, when there is a large amount of sand and other accumulated sediment and debris on the roads.
- Sweeping the entire width of the roadway.
- Sweeping slower to achieve maximum efficiency.

#### *3.3.4 Proposed Highway Division Programs*

New programs under the Highway Division can help to further promote the implementation of green infrastructure practices in roadways and rights-of-way as well as provide greater efficiency between departments when new green infrastructure projects are being planned. The suggested new programs under the Highway Division to support green infrastructure are described in Table 3-4.

**Table 3-4. Descriptions of Proposed New O&M Programs under the Highway Division**

| Program Description | Benefits | Limitations |
|---|---|---|
| Develop an enhanced street sweeping program as defined in guidance in the draft Residual Designation Authority (RDA) General Permit to receive non-structural phosphorus reduction credit. Additional phosphorus reduction credit can be obtained by increasing frequency of sweeping from monthly to weekly and/or using a regenerative air/vacuum assisted sweeper in place of a mechanical sweeper. | • Decreases the phosphorus load reduction needed through structural methods to meet the goals established under the Upper Charles River TMDL | • Requires additional staff time and funding, including purchasing new street sweepers |

| Program Description | Benefits | Limitations |
|---|---|---|
| Implement coordination meetings and/or inter-departmental memoranda of agreement (MOA) between the highway, water and sewer, and engineering divisions to identify opportunities for green infrastructure (e.g., including infiltration and/or impervious area reduction when roads and/or sidewalks are being installed or redeveloped). | • Greater efficiency addressing Town needs<br>• Potentially reduced project costs | • May require additional coordination and staff time |
| Develop a Green Streets program to integrate green infrastructure practices into existing stormwater management in rights-of-way. Green Streets can be integrated into broader transportation improvements (e.g., during roadway maintenance and infrastructure improvements (water, sewer, utilities, etc.). | • Improves water quality<br>• Increases safety for pedestrians and bicyclists<br>• Improves street aesthetics<br>• Potentially reduced future paving costs<br>• May increase the lifespan of the existing drainage infrastructure | • May require additional coordination with other departments |

### *Water and Sewer Division*

#### *3.3.5 Existing Water and Sewer Division Programs*

The Water and Sewer Division is responsible for managing the water and sewer systems. This division currently has a water conservation program which helps to reduce the amount of water used by residents. The water conservation program is part of their groundwater conservation plan and includes an irrigation water use restriction to only one day a week between Memorial Day and Labor Day.

Potential improvements to promote green infrastructure could include:

- Providing educational materials about climate-suitable vegetation and landscaping that can help to reduce the need to water.
- Provide workshops for residential greenscaping.

#### *3.3.6 Proposed Water and Sewer Division Programs*

The Water and Sewer Division can help promote the implementation of green infrastructure practices on private properties by developing new programs that provide incentives and educational resources that will encourage homeowner and business participation. The potential new programs that can be initiated under the Water and Sewer division are described in Table 3-5.

**Table 3-5. Descriptions of Proposed New O&M Programs under the Water and Sewer Division**

| Program Description | Benefits | Limitations |
|---|---|---|
| Promote rainwater harvesting and infiltration activities as part of the groundwater conservation program. Examples of potential activities include expanding the existing rain barrel distribution program and holding rain garden workshops. | • Reduces the use of tap water<br>• Decreases stormwater runoff<br>• Potentially reduces pollutants to the stormwater drainage system | • May require additional staff time and funding |
| Develop an incentives program for to promote green infrastructure for homeowners and/or businesses. The program could include installation financing, which provides a refund of a percentage of the installation cost (or material cost) of green practices (e.g., rain barrels). | • Encourages green infrastructure on private property<br>• Increases public participation | • Incentive programs can be complex and costly to initiate and administer<br>• Incentives need to be reasonable for the Town (i.e., appropriate for the Town's budget) but significant enough for the public to be willing to participate |

## *Recycling and Solid Waste Division*

### *3.3.7 Existing Recycling and Solid Waste Division Programs*

The Recycling and Solid Waste Division currently manages the collection of trash, hazardous waste and leaves as well as the recycling of various materials including household items, hazardous waste and yard waste. These green infrastructure programs help improve water quality and reduce the opportunities for waste and other contaminants to enter the stormwater systems.

Potential improvements to promote green infrastructure could include:

- Providing educational materials on proper yard management, including composting guidelines and application of pesticides and fertilizers (including timing, application reduction and buffer areas), in residential mailings.

### *3.3.8 Proposed Recycling and Solid Waste Division Programs*

The Recycling and Solid Waste Division can promote green infrastructure by developing new composting programs, both for homeowners and the Town, that can further reduce the waste and provide new sources of soil amendments for green infrastructure practices like bioretention systems. Suggested new programs to support green infrastructure through the Recycling and Solid Waste Division are provided in Table 3-6.

**Table 3-6. Descriptions of Proposed New O&M Programs under the Recycling and Solid Waste Division**

| Program Description | Benefits | Limitations |
|---|---|---|
| Develop a residential composting program (i.e., distribution of backyard composting bins and related educational materials) | • Decreases food and yard waste going into the waste stream | • Requires homeowner interest and maintenance<br>• May attract pests, such as raccoons |

### *Parks and Grounds Division*

*3.3.9 Existing Parks and Grounds Division Programs*

The Parks and Grounds division is responsible for managing the parks and open spaces in the Town. Currently, they have a turf management program which utilizes zero phosphorus fertilizer on all Town-owned properties, including both active and passive turf. A recent review of the turf management program (HW, 2013a) indicated that this program has an annual total phosphorus reduction of approximately 34 lbs/year based on the type of fertilizer previously used. In addition, the cost per pound of the phosphorus-free fertilizer is actually less expensive per year than the conventional fertilizer by approximately $6,000.

*3.3.10 Proposed Parks and Grounds Division Programs*

New programs under the Parks and Grounds Division can help to integrate green infrastructure practices, such as the use of pervious/porous pavers and native landscaping, into parks and other available spaces where the community can gain first-hand experience and learn about green infrastructure benefits. Table 3-7 describes the potential new programs that could be implemented under the Parks and Grounds Division.

**Table 3-7. Descriptions Proposed New O&M Programs under the Parks and Grounds Division**

| Program Description | Benefits | Limitations |
|---|---|---|
| Develop a park paths program that promotes the construction of walking paths and/or sidewalks within and between parks using green infrastructure practices, such as permeable pavement | • Increases physical activity<br>• Provides a potential for interconnected parks for pedestrians<br>• Decreases maintenance to fix footpaths | • Slopes and/or landscape may limit path length or width |
| Develop a native landscaping program to promote the installation of native plants and trees in place of turf grass for areas not used for specific recreational purposes (e.g., ball fields, soccer fields, etc.) | • Reduces maintenance time and related costs<br>• Increases infiltration potential, which reduces ponding and flooding of recreational areas | • Space may be limited in some parks |

### *Facilities Department*

#### *3.3.11 Existing Facilities Department Programs*

The Facilities Department is responsible for the construction and maintenance of Town-owned buildings needs. There are currently no existing programs that promote the use of green infrastructure.

#### *3.3.12 Proposed Facilities Department Programs*

The Facilities Department can promote green infrastructure on Town-owned properties through a new program that provides guidance for identifying green infrastructure opportunities as well as coordinating with other departments for interdepartmental opportunities. This program is described in detail in Table 3-8.

**Table 3-8. Proposed New O&M Programs under the Facilities Department**

| Program Description | Benefits | Limitations |
|---|---|---|
| Develop a checklist for department staff that identifies all potential green infrastructure opportunities for various types of facilities-related needs, such as existing building maintenance and repairs and new building design and construction. The checklist can also identify cross-departmental green infrastructure opportunities for site improvements. | • Increase opportunities for green infrastructure on Town-owned properties | • Requires coordination between departments |

# 4.0 Policies

The Town of Franklin has several existing policies that help to support the use of green infrastructure practices for stormwater management and help them meet their goals and objectives as described in Section 1. However, some of the existing policies may also hinder or conflict with green infrastructure goals. The recent review of Town's local codes identified potential barriers and obstacles to green infrastructure implementation, as well as where codes and policies could be strengthened (HW, 2013b). This section provides a discussion of the regulatory drivers that influence policies as well as a summary of the policy review conducted, including recommended revisions to the existing policies.

## 4.1 Regulatory Drivers

Local policies are often driven by requirements at the federal, state, and/or regional level. The most influential likely being the federal Clean Water Act, which establishes a number of permitting programs and policies at the national level for regulating discharges to surface waters that then must be met at the state and local level. Sections 305(b) and 303(d) of the federal Clean Water Act require states to monitor and report on the status of their waters as well as develop a list of waterbodies that are not attaining or not expected to meet water quality standards, often referred to as the "303(d) list." The Clean Water Act then requires that states establish priority rankings for the waters on the 303(d) list and develop a Total Maximum Daily Load (TMDL) for these waters. As is well documented, TMDLs have been written and approved for the Charles River Watershed, which require substantial total phosphorus reduction throughout the watershed. The Town of Franklin's share is approximately 52% load reduction for stormwater-derived sources.

Franklin is currently operating under the extended 2003 MS4 permit; however, two new draft general permits—the "Small Municipal Storm Sewer Systems in the North Coastal Watershed" (hereafter the MS4 General Permit) and the Residual Designation Authority (RDA) from "Designated Discharges in the Charles River Watershed" (hereafter the RDA General Permit) —were issued by EPA in 2010. These two permits, as currently written, propose additional control measures to meet phosphorus reduction targets through more effective stormwater management of Franklin's MS4 and on individual private properties. Details on the draft requirements can be found at www.epa.gov/region1/npdes/stromwater/index.html.

The Town of Franklin has taken measurable steps towards meeting some of the anticipated requirements of these new draft permits; however, there are a few additional requirements that will require the Town to modify current practices. For example, the draft permits require an evaluation of local development codes and street design standards to identify opportunities for reducing impervious cover, integrating low impact development (LID), and removing barriers to green stormwater infrastructure practices.

## 4.2 Policy Review and Recommendations

Existing development codes can serve as a barrier to green infrastructure in a number of ways, whether they are silent on, ambiguous towards, or in direct conflict with green infrastructure principles. The recent review of the Town's policies, including local bylaws, regulations, plans and guidelines, provides a vehicle to help identify which Town goals and objectives were being hindered by the Town Codes and what approach could be used to address or remove the barriers. The recommendations include specific actions that would best support the Town's goals and objectives. A summary of the findings and recommendations is provided within the subsections for each of the Town's goals for implementing green infrastructure.

*4.2.1 Minimize Directly-Connected Impervious Area*

There are several provisions in the Town's policies which act as barriers to minimizing directly-connected impervious area. For example, the Town's Zoning Bylaws have minimum parking and sidewalk requirements as well as minimum dimensions of drive aisles and parking spaces (Sections 21 and 28). Similarly, the Town's Subdivision Rules and Regulations require minimum roadway widths, turnaround dimensions and curbing. Neither of these codes provides provisions for alternative materials, such as those mentioned in Section 2.4 in this report. To support the Town's goal, it was recommended that these policies be updated to provide flexibility in the required paving dimensions (e.g., reducing the minimum dimensions for compact parking spaces) and materials for roads, parking lots and sidewalks. To promote green infrastructure practices further, language should be added in the policies to encourage the use of permeable materials where appropriate and the Town should provide more flexibility in curbing to support the use of street-side green infrastructure practices. These provisions will also help the Town to meet the potential regulatory requirements in the draft MS4 permit.

*4.2.2 Preserve the Hydrologic Function of Natural Features*

Although the Town has several policies which address site disturbance, these scarcely mention specific standards to limit the disturbance or preserve natural features. For example, the Town's Zoning Bylaws currently have no standards for minimum land disturbance, stabilizing soils during construction, minimizing site grading or preserving existing landscaping (Section 23.C). The review recommended that specific standards be created to provide minimum or maximum limits for site disturbance. For example, the Town should consider requiring applicants to document that disturbed area is minimized to the maximum extent practical. To preserve natural features, such as mature tree stands, it was recommended that applicants be required to identify and preserve trees to the maximum extent possible and provide tree protection measures at the drip line during construction. These standards will help to maintain existing hydrologic patterns, including infiltration, which helps to support the Town's groundwater recharge requirements.

*4.2.3 Allow and Encourage Multi-Functional Stormwater Controls*

The Best Development Practices (BDP) Guidebook is the primary guidance document that is used to address stormwater management in the Town. While this document provides guidance for the implementation of green infrastructure practices, it does not specifically use green infrastructure language, not all of the latest green infrastructure practices are included, and the use of green infrastructure could be more strongly mandated. Similarly, the Design Review Commission Design Guidelines does not reference the use of green infrastructure or the Town goals and objectives when developing site layouts, site designs, landscaping, and other site elements. It was recommended that the Town update the BDP Guidebook and other policies with green infrastructure-specific language that allow and require the use of green infrastructure practices to the maximum extent possible. In addition, the BDP Guidebook should expand the available green infrastructure practices, such as including infiltration and rainwater harvesting applications.

*4.2.4 Increase Public Involvement, Education and Outreach*

The Town currently has several existing programs that promote public involvement, education and outreach that are conducted under the Town's existing MS4 permit. However, the Town can strengthen these programs further by addressing the Town's objectives for this goal in other policies and planning documents, such as the Open Space and Recreation Plan. Example revisions to the Open Space and Recreation Plan include: providing signage at demonstration projects; identifying specific properties that are key for phosphorus load reduction and using them as demonstration areas; and installing rain gardens or rain barrels at existing recreation areas for public outreach and education. By incorporating these objectives, the Town can help to expand knowledge and support of green infrastructure practices in the community.

*4.2.5 Address the Upper Charles River TMDL*

The review of the existing Town policies found that there was no mention of the Upper Charles River TMDL for phosphorus loading reduction target in any of the policies, nor were there any standards in place to help the Town meet its goal. It is recommended that the phosphorus load reduction target be mentioned in all guidelines and planning documents, including:

- Section 31.D of the Zoning Bylaws,
- Chapter 300 Section 9.B.2 of the Subdivision Rules and Regulations,
- Section XIV of the Wetlands Regulations (Performance Standards),
- Part II and II of the Design Review Commission Design Guidelines,
- Sections 4.G and 8 of the Open Space and Recreation Plan, and
- Sections I and II of the BDP Guidebook.

By incorporating specific language that is consistent and addresses Upper Charles River TMDL as well as the Town's associated goals and objectives, it will make the Town's phosphorus reduction target well known to the community and easier for developers to understand and comply.

*4.2.6 Provide Cost Effective Stormwater Management*

The Town can address this goal through by removing potential barriers to green infrastructure practices, strengthening existing policies to create clear and consistent standards, and encouraging the use of green infrastructure in lieu of traditional stormwater infrastructure. Green infrastructure can be more cost-effective than gray infrastructure because it is often cheaper to install, easier to maintain, and more effectively treats stormwater runoff. In addition, it provides other social and economic benefits, such as enhanced neighborhood aesthetics and reduced energy costs.

# 5.0 Implementation Recommendations

## 5.1 A Vision for Green Infrastructure Implementation

As discussed throughout this document, green infrastructure is much more than a stormwater management strategy; it has the potential to meet multiple Town objectives and cumulatively save the Town, residents, businesses, and developers money. Perhaps the most important recommendation for fostering more widespread implementation of green infrastructure in Franklin would be for the Town to embrace these potential cumulative benefits and implement an integrated program approach. In short, the Town will see the benefits when all departments, elected and appointed officials, and the citizens of Franklin work towards a common goal. Thus, the Town should consider adopting a Vision Statement as an early step in implementation of a green infrastructure approach Town-wide.

## 5.2 Specific Recommendations for Implementing Project, Programs, and Policies

The following sections offer an approach to green infrastructure implementation across the spectrum of activities. Several specific recommendations are offered ranging from changes to existing codes, updating guidance documents, streamlining town communications, and involving the Town's residents and business owners in the process. As discussed previously, the Town is subject to a range of existing and proposed regulations that govern how new development and redevelopment projects are implemented, how state-derived resources are expended, and if the pending draft MS4 and RDA permits are enacted, how existing citizens and businesses may be affected.

*5.2.1 Implementing Green Infrastructure Projects*
The following five recommendations are offered to provide a framework for implementation of green infrastructure projects into the future:

1. Update Best Development Practices Guidebook to incorporate latest Green Infrastructure practices and specifications. This is one of the more important steps the Town might take to establish a consistent reference document for project proponents. As discussed in previous sections, a revised manual could serve as both a guidance reference for design, as well as a regulatory tool.

2. Convene a Town Green Infrastructure Committee to establish and update performance standards (e.g., phosphorus reduction, runoff reduction, etc.). This committee would likely serve the role of directing the update to the Best Development Practices Guidebook as well as establishing a baseline for the Town's overall green infrastructure program. Establishing performance goals for a range of projects will help the Town achieve compliance with both existing and future permits. The Committee should include Town decision-makers and interested stakeholders (e.g., Town Administrator, Fire Chief, DPW Director, Town Planner, local developer, land-use attorney, etc).

3. Update relevant codes to require the use of practices that meet minimum Green Infrastructure performance standards. As stated previously, code modifications will have a long-term impact on both public and private projects. The Town Green Infrastructure Committee would presumably review and agree on key code changes that can be implemented (e.g., revised road widths, parking standards, lots setbacks, sidewalks, etc).

4. Develop and institute an inter-departmental Memorandum of Agreement (MOA) to incorporate green infrastructure practices into new projects. Examples include new schools and/or additions, fire and safety facilities, road resurfacing, and park amenities. An MOA would serve to provide a common set of objectives for all new capital projects and would help ensure a consistent approach to incorporating green infrastructure into future projects.

5. Coordinate green infrastructure projects with on-going Massachusetts Department of Environmental Protection (DEP) draft Sustainable Water Management Initiative (SWMI) efforts. Under the SWMI framework, the Town is evaluating potential locations and practices to promote infiltration to replenish groundwater levels and enhance streamflow. The efforts to date have identified five preferred sites; a 30% design was developed to retrofit a detention basin into an infiltration basin at Scarboro Court and preliminary concept designs were developed for the other four locations.

*5.2.2 Implementing Green Infrastructure Programs*
The following two recommendations are offered to ensure that green infrastructure becomes standard operating procedure across all of the Town's programs.

1. Prioritize the identified programs (see Section 3) for staged implementation; identify the responsible party/department, costs, and implementation schedule. Section 3 identifies a range of potential program enhancements. Not all of these should be treated equally, as costs and potential benefits will vary. A Town Green Infrastructure Committee could undertake this prioritization

2. Combine programs, where feasible, to minimize costs and maximize implementation. As discussed previously, green infrastructure has a range of potential benefits, but also involves costs for both capital projects as well as ongoing operations. The Town can maximize the potential return on investment by combining programs. A few examples include:
    - DPW Maintenance Programs (e.g. , street sweeping, leaf litter pickup, catch basin cleaning) updated to maximize pollutant removal and runoff reduction;
    - Town-wide Educational Program developed/refined to foster better understanding of green infrastructure benefits and how residents and businesses can benefit; and
    - Town-sponsored "build a rain-garden" program for residential property owners.

*5.2.3 Implementing Green Infrastructure Policies*

Depending on the regulatory drivers and timing for implementation of these, new policies may be necessary. In the short-term, it makes sense to begin the process of how the Town might develop and implement a Town-wide Phosphorus Control Plan (PCP). The initial elements would likely include convening a PCP subcommittee, identifying the methods and locations for controls, and quantifying load reduction from various strategies. The Town Green Infrastructure Committee, cited above, could undertake this task.

The recommendation to convene a Town Green Infrastructure Committee could review the identified opportunities to strengthen existing policies and prioritize recommendations. Particular emphasis might be on those policies that would impact major projects such as the "Downtown Franklin Roadway and Streetscape Improvement Project." The following table is offered to illustrate examples of what the Committee might address related to prioritizing projects, programs, and policies for green infrastructure implementation.

**Table 5-1. Example Format for Prioritizing Identified Opportunities to Strengthen Green Infrastructure in the Town of Franklin**

| Green Infrastructure Project/Program/Policy | Example Regulatory Barriers | Why should this be part of the Town's Green Infrastructure Strategy? |
|---|---|---|
| Pre-treatment, Treatment and Infiltration Practices (e.g., filter strips, bioretention cells, rain gardens, infiltration trenches) | Curbing, street design, landscaping, and parking standards | The requirements often include minimum standards that prohibit a hydrologic connection of the target impervious area to the practice, such as "a curb of at least four inches in height must surround all landscaped islands." |
| Rain Harvesting (e.g., rain barrels, cisterns) | Dimensional standards (yards, lot coverage), plumbing codes | Dimensional standards could prohibit rain barrels or cisterns from encroaching into required setback areas; plumbing codes could require downspouts to be connected to the stormwater collection system. |
| Alternatives to Impervious Cover (e.g., pavers, porous concrete) | Roadway and parking lot material specifications | The specifications can require that roadways and parking lots be constructed of impervious materials. |
| Advanced systems (e.g., green roofs) | Dimensional standards (building height) | Dimensional standards, such as maximum building height, can limit the height of green roofs. |
| Non-structural practices (e.g., impervious cover reduction, tree plantings, open space protection) | Dimensional standards (lot size, frontage, yards), parking standards, landscaping standards, street design requirements, open space requirements | All of these requirements relate to the amount of impervious cover required either directly or indirectly, or on the contrary, how many trees or how much open space protection is required. |

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# MEMORANDUM

TO: Brutus Cantoreggi, Franklin DPW

FROM: Rich Claytor and Michelle West, Horsley Witten Group

DATE: February 26, 2013

RE: Quantification of Benefits from Existing Green Infrastructure Projects – Town of Franklin, MA

This memorandum presents findings by the Horsley Witten Group (HW) from a review of six stormwater management projects within the Town of Franklin, MA. The purpose of the review is to quantify the benefits from these existing green infrastructure (GI) projects in order to help guide the development of a town-wide GI Implementation Strategy. The analysis specifically focused on phosphorus reduction to help the Town understand how best to address the Charles River TMDL requirements, but other benefits were evaluated as well.

This memorandum was developed under EPA contract no. EPA-C-11-009 as one of the 2012 EPA Green Infrastructure Community Partner Projects. HW developed the memorandum under subcontract to Tetra Tech, Inc.

## METHODS

Plans, calculations, and stormwater reports provided by the Town were used to gain an understanding of the projects. From this material, key information was compiled and/or determined, including type of practice used, land use, drainage area, impervious cover, and treatment volume provided (0 – 1 inch). Using this information and EPA Region 1 guidance developed for the draft Residual Determination Authority (RDA) General Permit (US EPA, 2010), phosphorus loading was established for each particular drainage area. Table 1 provides the phosphorus loading rates used for this project based upon land use and broken down by impervious and pervious area.

BMP Performance Curves (Tetra Tech, 2009) were used to calculate phosphorus removal rates based upon treatment storm, and where applicable, soil infiltration rate (practices such as bioretention and rain gardens are not categorized by soil infiltration rate). Where bioretention were used as pretreatment for infiltration practices, the infiltration phosphorus removal rate from the appropriate performance curve was assumed. For those projects that involved a reduction of impervious cover, the corresponding phosphorus loading reduction was determined as the difference between impervious and pervious loading values for the applicable land use (see Table 1).

The BMP Performance Curves were also used to calculate an estimate of the amount of annual runoff reduction provided by each practice. Runoff reduction occurs with infiltrating practices; the percentage of reduction is based upon design soil infiltration rates (Rawls et al., 1982) determined by soil texture/NRCS Hydrologic Group.

**Table 1. Phosphorus Loading as Function of Land Use (US EPA, 2010)**

| Land Use | Composite P Load Rate (CPLE) (lbs/ac/yr) | Land Surface Cover | P Load Export (PLE) Rate by cover (lbs/ac/yr) |
|---|---|---|---|
| **Agriculture** | 0.45 | Pervious | 0.45 |
| **Commercial** | 1.50 | Impervious | 2.23 |
| | | Pervious | 0.27 |
| **Forest** | 0.12 | Impervious | 0.89 |
| | | Pervious | 0.09 |
| **Freeway** | 0.80 | Impervious | 1.34 |
| | | Pervious | 0.27 |
| **High-density Residential** | 1.00 | Impervious | 2.23 |
| | | Pervious | 0.27 |
| **Industrial** | 1.30 | Impervious | 1.78 |
| | | Pervious | 0.27 |
| **Low-density Residential (rural)** | 0.27 | Impervious | 0.89 |
| | | Pervious | 0.13 |
| **Medium-density Residential** | 0.50 | Impervious | 1.34 |
| | | Pervious | 0.27 |
| **Open Space** | 0.27 | Impervious | 0.89 |
| | | Pervious | 0.22 |

## PROJECT DESCRIPTIONS

The Town of Franklin, with input from HW, selected six representative Town GI projects for assessment of benefits. The selected projects represent a variety of GI work currently being done within Franklin. A description of each project is included below, with a summary of key information provided in Table 2. A summary of each project's annual phosphorus and runoff reduction benefits can be found in Table 3.

**Table 2. Summary of Key Information for the 6 Reviewed Projects**

| Project Name | | Type of BMP(s) | Drainage Area (ac) | Impervious Cover (ac) | Treatment Storm (in) | Infil. Rate (in/hr) | Land Use |
|---|---|---|---|---|---|---|---|
| **Lockewood Drive** | | Bioretention, Infiltration Basin | 22.00 | 4.68 | 0.48 | 0.27 | Medium-density Residential |
| **Panther Way** | | Infiltration Basin | 27.61 | 10.22 | 0.60 | 1.02 | Medium-density Residential |
| **Wachusett Street** | Small Fletcher Lot | Bioretention | 5.80 | 1.90 | 0.09 | 1.02 | Medium-density Residential |
| | Parmenter School-1 | Bioretention | 1.05 | 0.57 | 0.25 | 0.27 | Commercial |
| | Parmenter School-2 | Bioretention, Infiltration Chambers | 1.05 | 0.57 | 1.00 | 0.27 | Commercial |
| **Wyllie Road/ Miller Street** | Miller at Green | Bioretention, Infiltration Chambers | 37.52 | 5.10 | 0.38 | 2.41 | Medium-density Residential |
| | Wyllie Rd | Infiltration Chambers | 9.68 | 1.70 | 1.00 | 2.41 | |
| **Greensfield Road** | | Rain Garden, Pavement Reduction | 0.10 | 0.10 | 0.60 | 2.41 | Medium-density Residential |
| **Town Property – P-free Fertilizer** | | Zero P Fertilizer | 120.00 | 0.00 | NA | NA | Open Space |

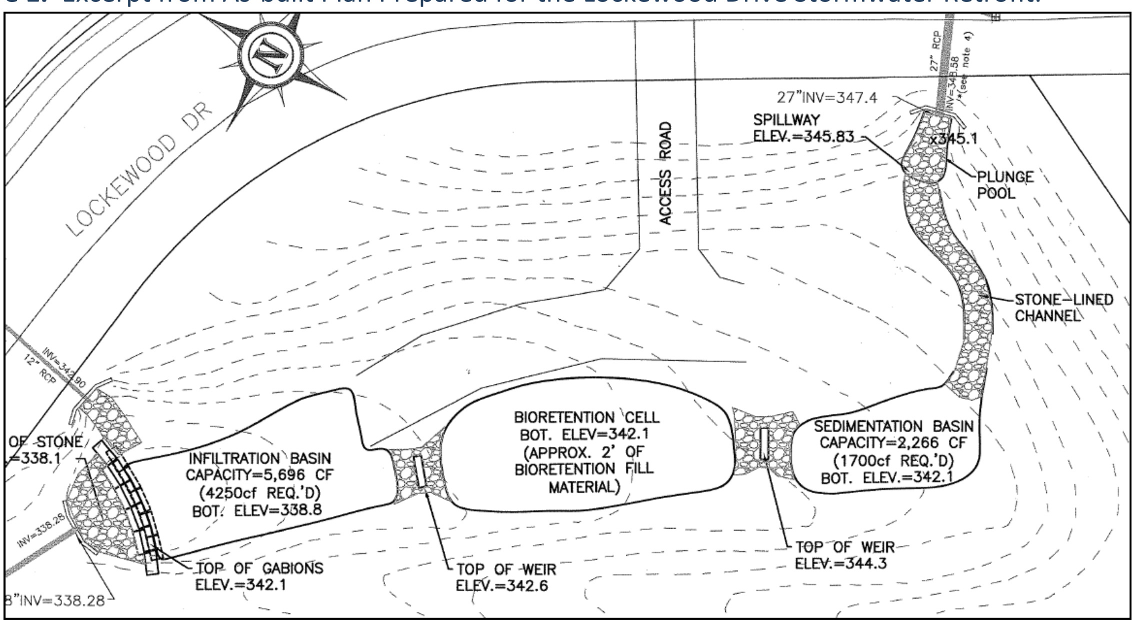
**Table 3. Annual Total Phosphorus (TP) and Runoff Reduction from the Reviewed Projects**

| Project Name | | TP Loading to Facility (lbs/yr) | TP Removed By Impervious Reduction (lbs/yr) | TP Removed By BMP (lbs/yr) | Annual Runoff Reduction |
|---|---|---|---|---|---|
| **Lockewood Drive** | | 10.95 | NA | 7.90 | 56% |
| **Panther Way** | | 18.39 | NA | 15.45 | 77% |
| **Wachusett Street** | Small Fletcher Lot | 3.60 | NA | 0.65 | 21% |
| | Parmenter School-1 | 1.40 | NA | 0.53 | 34% |
| | Parmenter School-2 | 1.40 | NA | 1.40 | 82% |
| **Wyllie Road/ Miller Street** | Miller at Green | 15.59 | 0.08 | 11.64 | 70% |
| | Wyllie Rd | 4.44 | NA | 4.26 | 94% |
| **Greensfield Road** | | 0.13 | 0.21 | 0.08 | 84% |
| **Town Property –P-free Fertilizer** | | 34 | NA | 34 | 0% |
| | **Totals:** | 91.5 | 0.29 | 75.92 | |

**Lockewood Drive:**
Lockewood Drive is located in a medium-density residential neighborhood off King Street, southeast of downtown. Stormwater from this neighborhood (22 acres, 21% impervious) was originally directed into a dry "detention pond" with an at-grade outlet pipe, which resulted in modest detention at best and little treatment of the runoff. In 2011, this existing basin was modified to increase treatment, recharge, and storage. Franklin Engineering staff designed the retrofit, a contractor was hired with grant funds for the initial excavation, and then the project was finished by DPW and Engineering staff. The retrofit included a plunge pool, sediment forebay, bioretention cell, and infiltration basin constructed in HSG C soils.

No BMP details or design plans were created for this project, but the Town provided an as-built plan and the design calculations. To analyze the benefits of the retrofit, HW interpolated the volume of the bioretention cell based on the given media depth and the volumes of the adjacent infiltration basin and sediment forebay (see Figure 1). The bioretention cell was assumed to have no underdrain, with any overflows going into the infiltration basin; thus, the volumes were added together, treating it as a large infiltration basin. The treatment storm provided was calculated at 0.48 inches.

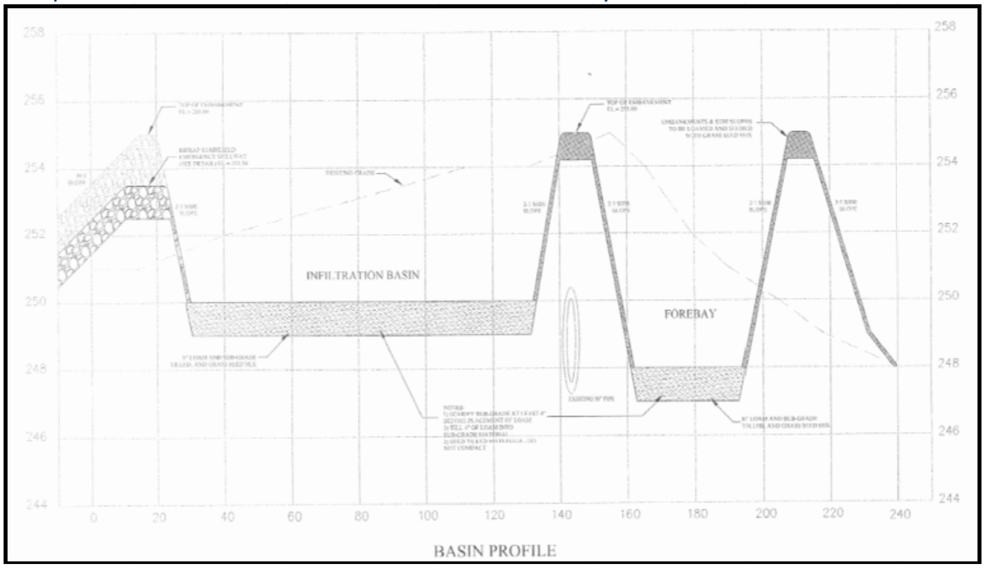
**Figure 1.** Excerpt from As-built Plan Prepared for the Lockewood Drive Stormwater Retrofit.




**Panther Way:**
Panther Way is located off West Central Street, which is to the northwest of downtown, and provides access to the high school. The surrounding land use in this area is medium-density residential. A new stormwater BMP was installed near the police station to manage runoff from its parking lot and from the existing storm sewer system on Highwood Drive (condominium development with no prior stormwater management). A diversion manhole, sediment forebay, and infiltration basin were constructed to relieve existing flooding issues and to provide water quality treatment and recharge before discharging into an unnamed stream

that feeds Mine Brook, a tributary of the Charles River. Over 27 acres (37% impervious) drain to this new infiltration basin, which was sized to treat the 0.6-inch storm in HSG B soils.

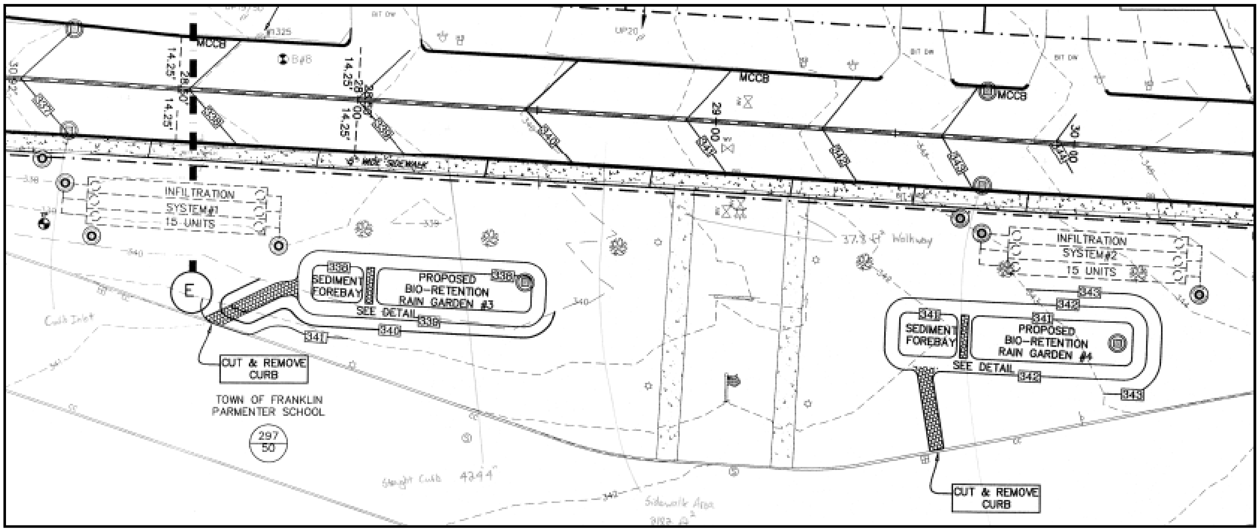
**Figure 2.** Excerpt from the Scanned Plans for the Panther Way Infiltration Basin.




**Wachusett Street:**
Wachusett Street is located south of downtown, connects King and Cottage Streets, and has significant traffic volumes during certain times of day for both Parmenter School and Fletcher Field. The surrounding land use is a mix of medium-density residential and commercial. Stormwater management work was done as a part of the recent Wachusett Street Improvements project, including installation of facilities in two sub-watersheds. At the small Fletcher Field Lot, catch basins were installed to redirect flow from Arlington and Wachusett Streets into a bioretention area with a sediment forebay. At Parmenter School, four bioretention areas and two sets of underground infiltration chambers were installed to provide treatment to runoff associated with the school, its parking lots, and a portion of Wachusett Street. These locations and practices were chosen for their high visibility, which makes them excellent demonstration projects for educating the public about stormwater.

The designs of these features were based on concepts developed by the Charles River Watershed Association (CRWA, 2009), but no final sizing calculations or details were created by the Town; the size of the systems was based on the space available. Plans provided by the Town of Franklin and the CRWA report were used to determine approximate drainage areas and treatment volumes, using static calculation methods for the infiltration chambers. The analysis divided the BMPs into two main categories: Fletcher Lot Bioretention (drainage area of 5.8 acres, 33% impervious) and Parmenter School Bioretentions/Infiltration Chambers (drainage area of 2.1 acres, 54% impervious). For the Parmenter School bioretention practices, it was assumed that half the drainage area was flowing to the two locations in the parking lot (with no infiltration chambers), and the remaining half flowed into the two bioretentions that discharged to infiltration chambers.

**Figure 3.** Excerpt from the scanned plans for the Wachusett Street Improvement Project, showing two bioretention areas and underground infiltration.




**Wyllie-Miller:**

Wyllie Road and Miller and Green Streets are located in medium-density residential areas in the northeast portion of Franklin. Stormwater management projects were designed in this area as a part of a grant project. The first portion of the project, completed in 2012, involved retrofitting the storm sewer system on Wyllie Road to discharge to underground infiltration chambers at the cul-de-sac (see Figure 4). The drainage area to the infiltration chambers is 9.7 acres with over 17% impervious cover, and the treatment storm depth is one inch. The second portion of the project, scheduled to be completed in 2013, will involve replacing pavement with grass cover, a rain garden, and underground infiltration chambers at the intersection of Miller and Green Streets. This project will be able to treat 0.38 inches of runoff over a 37.5-acre drainage area with 14% impervious cover, and has the added benefit of less pavement to maintain in the long run.

**Figure 4.** Photos taken during the construction of underground infiltration chambers on Wyllie Road.

**Greensfield Road:**

Greensfield Road is a relatively short, dead-end road off Lincoln Street in the northeastern portion of Franklin. The road provides access to a medium-density residential neighborhood. Over time, a spur road was added to the original cul-de-sac, leaving unnecessary pavement. In 2012, the Franklin DPW removed the excessive pavement (0.21 acres), replacing the impervious cover with grass (see Figure 5). In addition, a small rain garden was installed to treat runoff from the contributing roadway area (0.1 acres).

**Figure 5.** Excess pavement from an unnecessary cul-de-sac was removed (left); DPW staff installed a rain garden to manage some of the remaining road runoff (right).

**Town Property – Phosphorus-free Fertilizer:**

In 2008, the Town of Franklin began using zero phosphorus fertilizer on all Town-owned property, which includes turf that is both active (e.g., sports fields) and passive (e.g., lawn around buildings and in parks). Prior to 2008, Franklin spread fertilizer with 5% phosphate (or roughly 2% phosphorus) on these areas multiple times a year (see breakdown attached to this memo). To determine the annual reduction of phosphorus discharged to Franklin's surface waters that resulted from this change in fertilizer use, it was necessary to calculate how much of the phosphorus from the fertilizer was lost to runoff versus being taken up by the grass and bound in the soil. This value is highly variable based on type of vegetation and site-specific soil characteristics. However, an empirical relationship for average annual phosphorus loss to runoff from fertilizer was developed by Vadas et al., 2009. This equation is based upon the amount of annual runoff vs. precipitation expected (based on runoff coefficient), total quantity of fertilizer used (unincorporated into the ground), and an empirical factor. Using this equation, it was determined that roughly 2% of the phosphorus applied as fertilizer in this area will run off to nearby storm sewers and surface waters. This was used as the phosphorus reduction estimate.

## RESULTS

Costs received from the Town were used to quantify the cost of phosphorus removal by giving a dollar amount to the pounds of phosphorus removed annually. When stormwater practices were a part of a larger construction project, only the estimated cost for the stormwater portion was used for this analysis. The costs are summarized below in Table 4. These results will be used to help the Town develop the most cost-effective GI implementation strategy.

**Table 4. Cost of Phosphorus Removal for the Reviewed Projects**

| Project Name | | Type of BMP(s) | TP Reduction (lb/yr) | Project Cost | Cost of TP Reduction ($/lb/yr) |
|---|---|---|---|---|---|
| **Lockewood Drive** | | Bioretention, Infiltration Basin | 7.90 | $13,000 | $1,645 |
| **Panther Way** | | Infiltration Basin | 15.45 | $75,388 | $4,880 |
| **Wachusett Street** | Small Fletcher Lot | Bioretention | 0.65 | $71,612 | $27,768 |
| | Parmenter School-1 | Bioretention | 0.53 | | |
| | Parmenter School-2 | Bioretention, Infiltration Chambers | 1.40 | | |
| **Wyllie Road/ Miller Street** | Miller at Green | Bioretention, Infiltration Chambers | 11.72 | $122,000 | $10,409 |
| | Wyllie Rd | Infiltration Chambers | 4.26 | $112,289 | $26,363 |
| **Greensfield Road** | | Rain Garden, Pavement Reduction | 0.29 | -$10,000 | -$34,634 |
| **Town Property – P-free Fertilizer** | | Phosphorus-free Fertilizer | 34 | -$5,978 | -$173 |
| **Total:** | | NA | 76.2 | $378,311 | $4,964.71 |

From Table 4, the total TP reduction for all six BMP projects is 76.2 pounds, with an average cost per pound of $4,964.71. After removing the non-structural project (the phosphorus-free fertilizer), the average cost per pound of TP reduction is $9,106.37 for structural stormwater projects. The Town may be able to use this average cost for future planning-level estimation purposes. In addition, it is important to note that the five structural stormwater projects result in a 75.5% reduction in phosphorus loading from their drainage areas. As a reference, the General Permit (US EPA, 2010) calls for a 52.1% phosphorus load reduction town-wide to meet the total maximum daily load (TMDL), which is the equivalent of 2,828 lbs/year for the Town of Franklin. However, in a recent evaluation that looked at TMDL costs in Franklin (HW et al., 2011), it was assumed that 15% of the load reduction could be met by non-structural practices. This leaves 37.1% (2,013.80 lbs/yr) to be removed by structural practices. Using the average cost per pound from Table 4, the cost estimate for implementing the total necessary structural controls is around $18.3 million vs. $74.6 million from the recent study. The average cost presented here is from a limited review of projects and likely represents the extreme low-end estimate of the total cost of structural controls for meeting the phosphorus TMDL. These are projects that were likely done first due to their lower costs and easy implementation (e.g., open space available, easy retrofits, town-owned property, etc.). However, the Town can use these examples to formulate a cost-effective plan for reducing phosphorus loading per the TMDL. A discussion of the notable trends that emerged from the review of the six projects is included below.

The most conspicuous results shown in Table 4 are the negative costs per pound of annual TP removed for the Greensfield Road and the phosphorus-free fertilizer projects. The Greensfield Road project shows a negative cost due to the net savings incurred by the DPW because they did not need to repave the former cul-de-sac. This will continue to be a savings every time the rest of the road needs to be repaved. The cost per pound of TP reduction for the phosphorus-free fertilizer initiative is also a negative number because the fertilizer without phosphorus is less expensive. It should be noted that the greatest total phosphorus reduction of all six projects was achieved by the Town changing the fertilizer it uses; the statewide ban on using phosphorus-containing fertilizers will expand these benefits to non-municipal properties starting January 1, 2014. GI Projects that save money as well as remove phosphorus should be the highest priority projects that the Town would want to pursue in their long-term strategy. In particular, the Town should consider pavement reduction whenever feasible for future repaving projects for the most cost-effective phosphorus removal.

Another pattern is related to the type of labor. Projects done “in-house” by DPW, such as Lockewood Drive, tend to have a lower dollar amount per pound of TP removed; those done by outside contractors, such as Wachusett Street, have a higher cost. It should be noted that salary, benefits, and overhead were not included in this review, which would raise the cost. Even so, the Town should design and construct projects in-house when feasible for the most return on their investment. In-house projects have the additional benefits of on-the-job training for staff about GI and creating a sense of ownership for the GI projects, which can lead to better maintenance.

In addition, the type of stormwater practice installed has a large impact on cost effectiveness. Table 4 clearly shows that infiltration basins cost much less per pound of phosphorus removed than their underground counterparts, infiltration chambers. This is due to the need for more associated infrastructure and materials required for the underground systems. Thus, the Town should try to install surface practices to the extent possible, depending on the surrounding land use and when the space is available.

Finally, the size of the stormwater practice can affect the cost of phosphorus removal. As a rule of thumb, a stormwater BMP may not be worth installing if it treats less than 0.25 inches. This is supported by the fact that the Wachusett Street project has the highest cost of phosphorus removal; the majority of the drainage area (almost 90%) is treated by the small Fletcher lot and Parmenter School(1) bioretention areas, which treat the 0.09-inch and 0.25-inch storms, respectively. This reduced cost effectiveness may have to do with the fact that much of the cost of stormwater practices involves conveyance into and out of the BMP. These costs remain basically the same regardless of the size. While the Wachusett Street project had the added benefit of public education, in general, the Town should focus efforts on the retrofits that can treat at least 0.25-inches of runoff from the contributing drainage area.

### Other Associated Benefits

GI projects offer many significant benefits in Franklin besides the reduction of phosphorus loading to the Charles River. While not specifically analyzed in this review, these projects also reduce a suite of other pollutants such as sediment, nitrogen, hydrocarbons, metals, and bacteria. Phosphorus is a nutrient that adsorbs easily to particulates; thus, one would expect a close correlation between the phosphorus load reduction of a given project and the removal of other particulate-based pollutants (e.g., sediment, hydrocarbons, and metals). Bacteria removal does not follow the same pollutant removal pathways; however, infiltrating practices are known to have the best bacteria removal capability. GI projects tend to incorporate runoff reduction through infiltration, so bacteria load reduction would be another important benefit.

Through review of the selected projects, annual runoff reduction rates were also calculated where applicable. By reducing the annual runoff, infiltrating GI practices help lessen the load on storm sewer systems and downstream water resources, which reduces maintenance costs and streambank erosion issues. Practices not specifically designed for infiltration still help to decrease runoff through evapotranspiration. In some cases, such as on Panther Way, the GI practice also helps address existing flooding issues, adding the benefit of public safety and reduction of property damages.

In general, maintenance costs tend to be lower with above-ground stormwater management systems, such as bioretention facilities, due to easier access and the mostly landscape-related activities. The very nature of being visible also helps to ensure that routine inspections occur; thus, improving the overall maintenance and effectiveness of the practice. As mentioned above, the Town also saves money on the future maintenance for those GI projects where pavement was reduced. This is a recurring savings every life cycle of the remaining pavement.

There are a number of other benefits that are not easily quantified but important to the Town of Franklin. GI seeks to mimic natural hydrology and incorporate native vegetation as the primary means of managing stormwater. Because of this, many typical GI-influenced stormwater systems also provide increased habitat and a greater wildlife biodiversity compared to traditional stormwater practices. This tends to reduce nuisance species, such as mosquitoes, by providing habitat for natural predators. In addition, since many GI practices incorporate vegetation, such facilities can provide green spaces for the public to enjoy. This leads to unique opportunities for education and outreach features, helping to increase the awareness of stormwater and its impacts. These benefits can be hard to find in many suburban environments. Finally, property values typically increase when they abut landscaped, open areas versus abutting uninterrupted paved areas such as parking lots and streets. This can also help attract new home and business owners to the town, improving the economy.

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