Green Infrastructure Application Best Management Practices

A Guideline for Stormwater Management

Farmington Quaker Crossroads Historic District

FINGER LAKES INSTITUTE

HOBART AND WILLIAM SMITH COLLEGES

Acknowledgements

Support for this project was provided by Hobart & William Smith Colleges, the Isabel Foundation, and the Finger Lakes Institute. This project is a partnership with the Genesee/Finger Lakes Regional Planning Council (G/FLRPC) and the Ontario County Water Resources Council's 2013 Special Projects Fund.

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About the FLI-Community Design Center (FLI-CDC)

The Finger Lakes Institute, in partnership with Hobart & William Smith Colleges has created a community design center that strives to provide Finger Lakes communities with innovative, creative, and sustainable design solutions that improve the built environment and quality of life, while protecting the natural environment.

Communities throughout the Finger Lakes region share similar economic, environmental, and social characteristics mainly as a result of the natural assets and history of the region. The current and future state of communities relies on improving quality of life for all citizens, being good stewards of natural resources, and fostering the responsible growth of the built environment. To support these efforts, we offer comprehensive sustainable community development planning and design services to communities throughout the Finger Lakes region.

It is our mission to:

- Raise awareness of the benefits and potential of sustainable community development and design for small towns, villages, cities and other entities;
- Encourage preservation and protection of natural resources and the built environment;
- Facilitate regional planning and collaboration among communities, businesses, non-profits, higher education institutions, and other entities;
- Foster community resilience by providing an active resource center for holistic community planning and design and disseminating our expertise nationally.

About this Project

Genesee/Finger Lakes Regional Planning Council (G/FLRPC) has received partial funding through the Ontario County Water Resources Council's 2013 Special Projects Fund to work on a project entitled, Green Infrastructure for Historic Districts. G/FLRPC, in cooperation with the Ontario County Soil and Water Conservation District (OC SWCD), will identify sites suitable for green infrastructure practices and techniques in the seven National Register Historic Districts in Ontario County. These districts have been identified using New York State Department of Parks, Recreation and Historic Preservation data. Soil maps prepared by the Ontario County GIS Program will assist in these recommendations. Students from the Finger Lakes Institute – Community Design Center (FLI-CDC) will then create visual representations of the recommended green infrastructure practices and techniques.

Green infrastructure uses vegetation and soil to manage rainwater where it falls instead of using pipes to dispose of it in New York State waters. As a watershed develops, more impervious cover is created. Roads, buildings, parking, sidewalks, and driveways all increase runoff from rain events and snow melt. Stormwater runoff contains pollutants such as nutrients, pathogens, sediment, toxic contaminants, and oil and grease. Water quality problems generated by these pollutants have resulted with water bodies such as lakes and streams having impaired or stressed uses. Green infrastructure reduces stormwater discharges and lowers pollutant loads.

Green and sustainable design has become increasingly popular in both the preservation and new construction industries due to public interest in energy conservation, water efficiency, and source reduction and waste management. Preservation and green goals overlap, and reconciling their differences is possible—provided that both sides strive to be as creative and flexible as possible. Preservation of natural features; permeable paving materials for parking lots, walkways, and driveways; driveway reduction; vegetated swales; rain gardens; green roofs; stormwater planters; rain barrels and cisterns; native vegetation; and downspout disconnection or extensions have been identified as green infrastructure practices and techniques that could easily be incorporated into historic districts with some guidance.

The primary goal of Green Infrastructure for Historic Districts is to provide assistance to municipalities and residents who wish to incorporate the concepts and practices of green infrastructure into their structures while maintaining the historic integrity of the individual buildings and the overall character of their community.

Introduction

Due to its close proximately to multiple bodies of freshwater, the Finger Lakes region reaps the visual aesthetic and the environmental diversity benefits of the lake ecosystem. However, like many other water bodies, there are assorted threats to the health and vitality of the Finger Lakes. One of the main sources of pollution that contributes to the Finger Lakes is stormwater run-off. Stormwater is the water from rain and melted snow that runs off into nearby water bodies, instead of soaking into the ground. The runoff collects pollutions, such as chemicals, sediments, debris, and other pollutants that flow over impervious surfaces.

One of the ways to prevent the stormwater from reaching the water bodies is through green infrastructure. In the context of stormwater management, the term green infrastructure includes a wide array of practices at multiple scales to manage and treat stormwater, maintain and restore natural hydrology and ecological function by infiltration, evapotranspiration, capture and reuse of stormwater, and establishment of natural vegetative features. Unlike traditional grey infrastructure, green infrastructure is a practice that mimics the system of the natural environment to have a sustainable method of controlling pollution. Green infrastructure can be used to treat the polluted runoff to mitigate those pollutants from running into water bodies, like the Finger Lakes.

Green Infrastructure in Historic Districts

Ontario County is made up of many different towns and villages all with their own unique histories and cultures. Within the county, there are currently six National Historic Districts, soon to be seven as Downtown Geneva is in the process of applying for designation.

1. Farmington Quaker Crossroad Historic District
2. East Bloomfield Historic District
3. Canandaigua Historic District
4. South Main Street Historic District (Geneva)
5. Genesee Park Historic District (Geneva)
6. Clifton Springs Sanitarium Historic District
7. Downtown Geneva Historic District (TBD)

Historic research conducted as part of this project found that green infrastructure practices actually existed within each of these districts in the past, as it wasn't until 20th century industrialization that modern stormwater infrastructure practices were introduced and impervious paving became commonplace. Thus, it is hoped that by re-introducing green infrastructure into each of these historic districts, not only can their historic accuracy and integrity be improved, but also protection of existing structures, regional water bodies and local habitats can be improved as well as decrease the need for traditional water management infrastructure practices.

A historic photograph of Geneva's South Main Street shoes permeable pavers, street trees and a bio-swale.

Methods

On May 8, 2013, Jayme Breschard Thomann, Senior Planner at the Genesee/Finger Lakes Regional Planning Council and P.J. Emerick, Sr., District Manager for the Ontario County Soil and Water Conservation District visited each of the seven historic districts, evaluated soils and made recommendations about appropriate green infrastructure techniques for each district.

From those findings, for each district, the green infrastructure application guidelines were created. Recommendations are based off the research from the New York State Stormwater Management Design Manual – Chapter 5. The research that was conducted also utilized historical background from the various Ontario County historical societies and online research.

EPA National Stormwater Calculator

The EPA's National Stormwater Calculator can also be used to help enhance planning and application of green infrastructure techniques. The calculator is a desktop application that estimates the annual amount of rainwater and frequency of runoff from a specific site anywhere in the United States. Estimates are based on local soil conditions, land cover, and historic rainfall records. It is designed to be used by anyone interested in reducing runoff from a property, including:

- Site developers
- Landscape architects
- Urban planners
- Homeowners

The Calculator accesses several national databases that provide soil, topography, rainfall, and evaporation information for the chosen site. The user supplies information about the site's land cover and selects the types of low impact development (LID) controls they would like to use, such as:

- Rain harvesting (cisterns, rain barrels)
- Rain gardens
- Green roofs
- Stormwater planters
- Porous pavement
- Infiltration basins (planters, swales, filter strips, rain gardens, porous pavement are all various forms of green infrastructure techniques that utilize an infiltration basin)

To better inform decisions, it is recommended that the user develop a range of results with various assumptions about model inputs such as percent of impervious surface, soil type, and sizing of green infrastructure.

Clean water is essential to keeping our families and the environment healthy. The Calculator helps protect and restore the environmental integrity of our waterways. The link to calculator can be found below.
http://www.epa.gov/nrmrl/wswrd/wq/models/swc/

About this Document

This document serves as a guide to the application of green infrastructure practices and techniques for each of the seven historic districts in Ontario County. Application details include descriptions of typical preferred locations of each practice, recommendations of the appropriate sizes and/or models of each practice, relevant products and costs, as well as any necessary site preparation and maintenance necessary.

Farmington Quaker Crossroads Historic District was a community built off the ideals from Quaker farmers, where farmland was the main land use. The Quakers of this region came to form the Earth Quaker Action Team, who advocated for environmental protection. In the past, residents of the area had extensive gardens that functioned as rain gardens, and used rain barrels to collect stormwater for irrigation. Additionally, historically there are no signs of impervious surfaces, which are a large contributor to stormwater runoff. Thus, there is a great opportunity to implement green infrastructure practices in the Historic District and increase the historic character of the area.

Green infrastructure practices recommended for Farmington Quaker Crossroad Historic District are:

1. Bio-swales
2. Rain Gardens
3. Porous Pavement
4. Filter Strips

The predominately rural/agricultural town of Farmington is concentrated with the development of mostly residential areas. Farmington has a total of 2,668 acres of New York State designated freshwater wetlands, which take up 11% of the total area of the town. Permeable activity and construction is every increasing and not regulated. Activities such as, filling, grading, excavating, drainage, modification of existing structure and more have the potential to cause pollution in stormwater runoff and negatively influence the water bodies that make up an important part of the town. The most dominant water body in this area is Mud Creek, which flows from Canandaigua Lake, which runs along to East Bloomfield.

It is anticipated that this information will be utilized by property owners or municipal officials to incorporate the green infrastructure practices into each district, as appropriate.

Green Innovation Grant Program (GIGP)

A grant for various entities in New York State looking to incorporate green infrastructure exists, and could be applied for. The Green Innovation Grant Program (GIGP) provides grants on a competitive basis to projects that improve water quality and demonstrate green stormwater infrastructure in New York. GIGP is administered by NYS Environmental Facilities Corporation (EFC) through the Clean Water State Revolving Fund (CWSRF) and is funded through a grant from the US Environmental Protection Agency (EPA).

Projects selected for funding go beyond providing a greener solution, they maximize opportunities to leverage the multiple benefits of green infrastructure, which include restoring habitat, protecting against flooding, providing cleaner air, and spurring economic development and community revitalization. At a time when so much of our infrastructure is in need of replacement or repair and communities are struggling to meet competing needs, we need resilient and affordable solutions like green infrastructure that can meet many objectives at once.

EFC seeks highly visible demonstration projects which:

- Create and maintain green, wet-weather infrastructure
- Spur innovation in the field of stormwater management
- Build capacity locally and beyond, to construct and maintain green infrastructure
- Facilitate the transfer of new technologies and practices to other areas of the

State

GIGP 5 applicants are strongly encouraged to work with their Regional Council to align their project with regional goals and priorities. EFC reserves the right to fund all, or a portion of, an eligible proposed project. Funding will be provided to selected projects to the extent that funds are available.

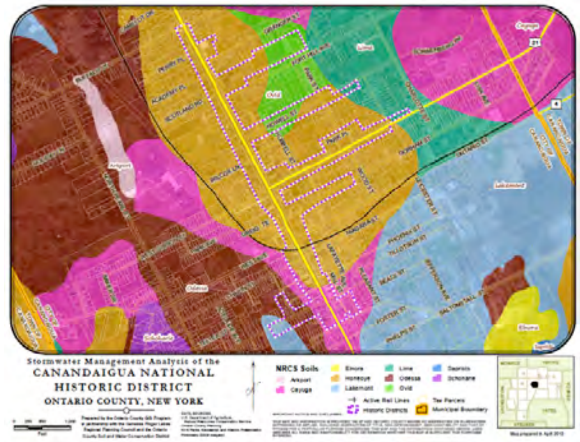
ELIGIBLE TYPES OF APPLICANTS:

- Municipalities
- State Agencies
- Public Benefit Corporations
- Public Authorities
- Not-for-profit Corporations
- For-profit Corporations
- Individuals
- Firms
- Partnerships
- Associations
- Soil and Water Conservation Districts

For more information about this funding opportunity, please see:

http://regionalcouncils.ny.gov/sites/default/files/documents/2013/resources_available_2013.pdf.

Soil Maps

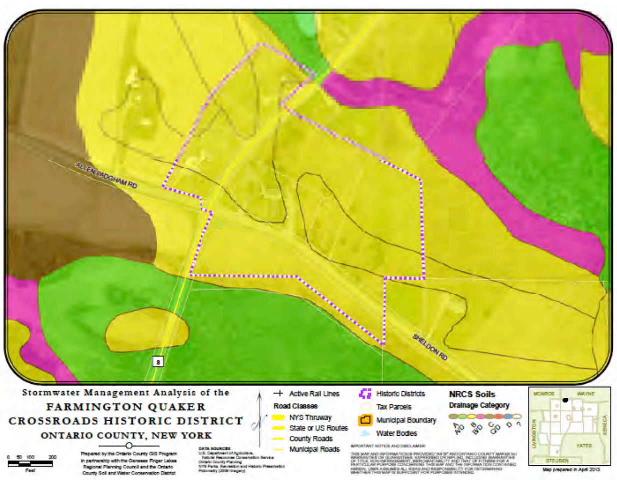


There are two types of soil maps provided within this report. The first illustrates the specific soil type present in the Historic Districts and the second shows its drainage classification. Data from these two maps was used in developing the following best management practices and if relevant, specific recommendations for dealing with the relevant soil type and drainage category for each Historic District are described for each stormwater management technique.

These maps were created by the Ontario County GIS Program in partnership with the Genesee/Finger Lakes Regional Planning Council and the Ontario County Soil and Water Conservation District.

Drainage Categories

The key provided on the Drainage Classification maps provides information about the drainage capabilities of the underlying soils in each Historic District. Definitions and descriptions of each drainage group are provided below.



Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

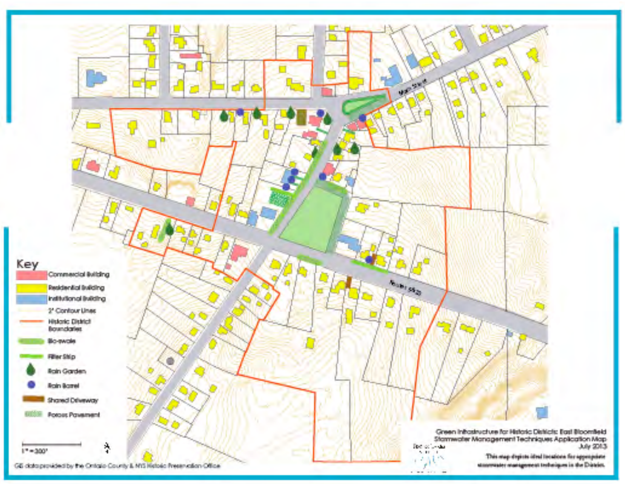
Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group D—Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.

Dual hydrologic soil groups—Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

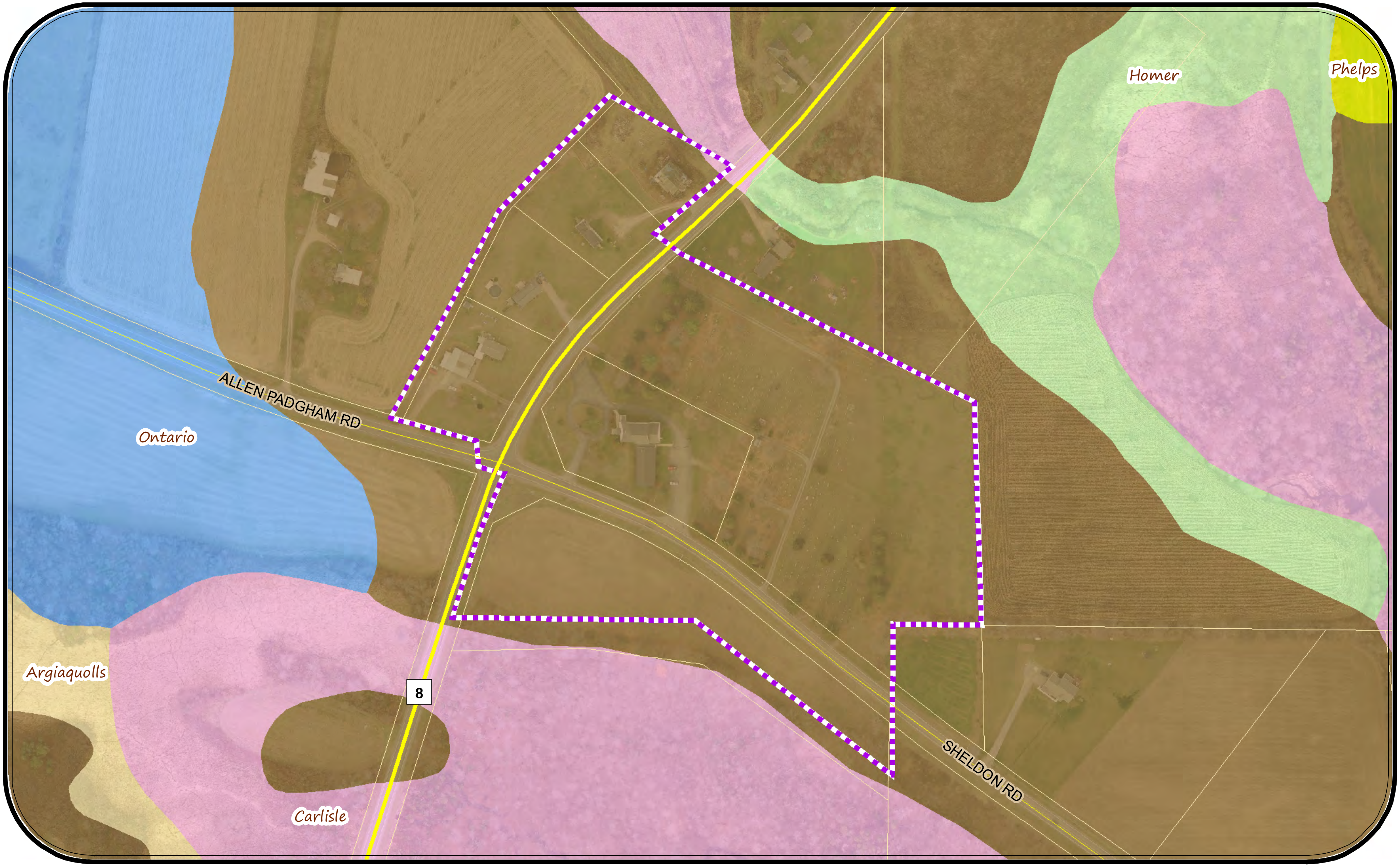
For more information about soil classification, see Part 630: Hydrology, Chapter 7 of the *National Engineering Handbook* by the United States Department of Agriculture.



Stormwater Management Techniques Map

Also included in the following pages is a map which details the ideal locations for the application of relevant stormwater management techniques for the Historic District. It is anticipated that these maps can be used by property owners and municipal officials to guide decisions regarding the location and need of green infrastructure techniques and methods within the Historic District. For further details regarding the installation of each technique, please see the following report.

These maps were created by the Finger Lakes Institute – Community Design Center using GIS data provided by Ontario County and the New York State Historic Preservation Office. Each Historic District was visited and appropriate places for green infrastructure were identified and recorded using physical observation and recommendations made by the Genesee/Finger Lakes Regional Planning Council. It should be noted that in most instances, all possible applications of the green infrastructure techniques were recorded, but each property owner should be careful to consider the specific needs and conditions of their property.



Stormwater Management Analysis of the

FARMINGTON QUAKER CROSSROADS HISTORIC DISTRICT

ONTARIO COUNTY, NEW YORK

0 50 100 200

Feet

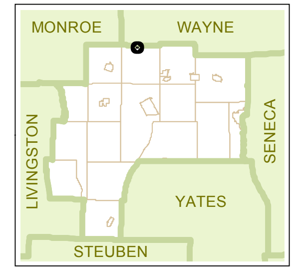
Prepared by the Ontario County GIS Program in partnership with the Genesse Finger Lakes Regional Planning Council and the Ontario County Soil and Water Conservation District

DATA SOURCES:
U.S. Department of Agriculture, Natural Resources Conservation Service
Ontario County Planning
NYS Parks, Recreation and Historic Preservation
Pictometry (2009 Imagery)

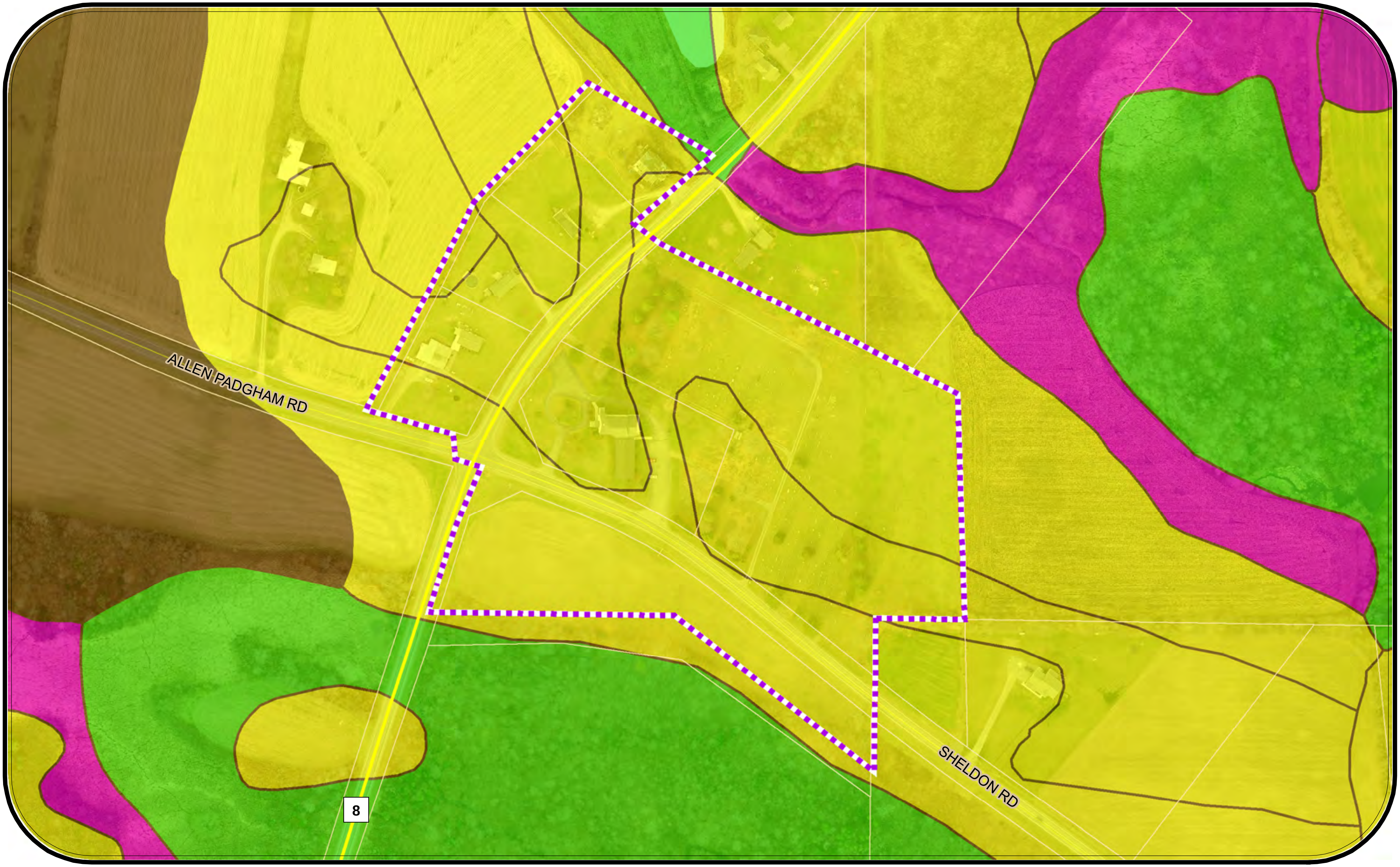
NRCS Soils

- Argiaquolls
- Carlisle
- Homer
- Ontario
- Palms
- Palmyra
- Phelps

- Active Rail Lines
- Historic Districts
- Tax Parcels
- Municipal Boundary



Map prepared in April 2013



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DATA SOURCES:
U.S. Department of Agriculture, Natural Resources Conservation Service
Ontario County Planning
NYS Parks, Recreation and Historic Preservation
Pictometry (2009 Imagery)

Active Rail Lines

Road Classes

NYS Thruway
State or US Routes
County Roads
Municipal Roads

Historic Districts
Tax Parcels
Municipal Boundary
Water Bodies

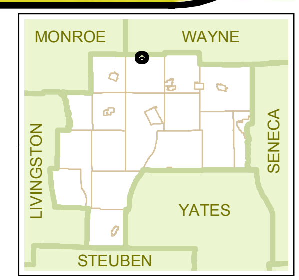
NRCS Soils

Drainage Category

A, A/D, B, B/D, C, C/D, D, ?

IMPORTANT NOTICE AND DISCLAIMER:

THIS MAP AND INFORMATION IS PROVIDED "AS IS" AND ONTARIO COUNTY MAKES NO WARRANTIES OR GUARANTEES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF TITLE, NON-INFRINGEMENT, MERCHANTABILITY AND THAT OF FITNESS FOR A PARTICULAR PURPOSE CONCERNING THIS MAP AND THE INFORMATION CONTAINED HEREIN. USER ASSUMES ALL RISKS AND RESPONSIBILITY FOR DETERMINING WHETHER THIS MAP IS SUFFICIENT FOR PURPOSES INTENDED.



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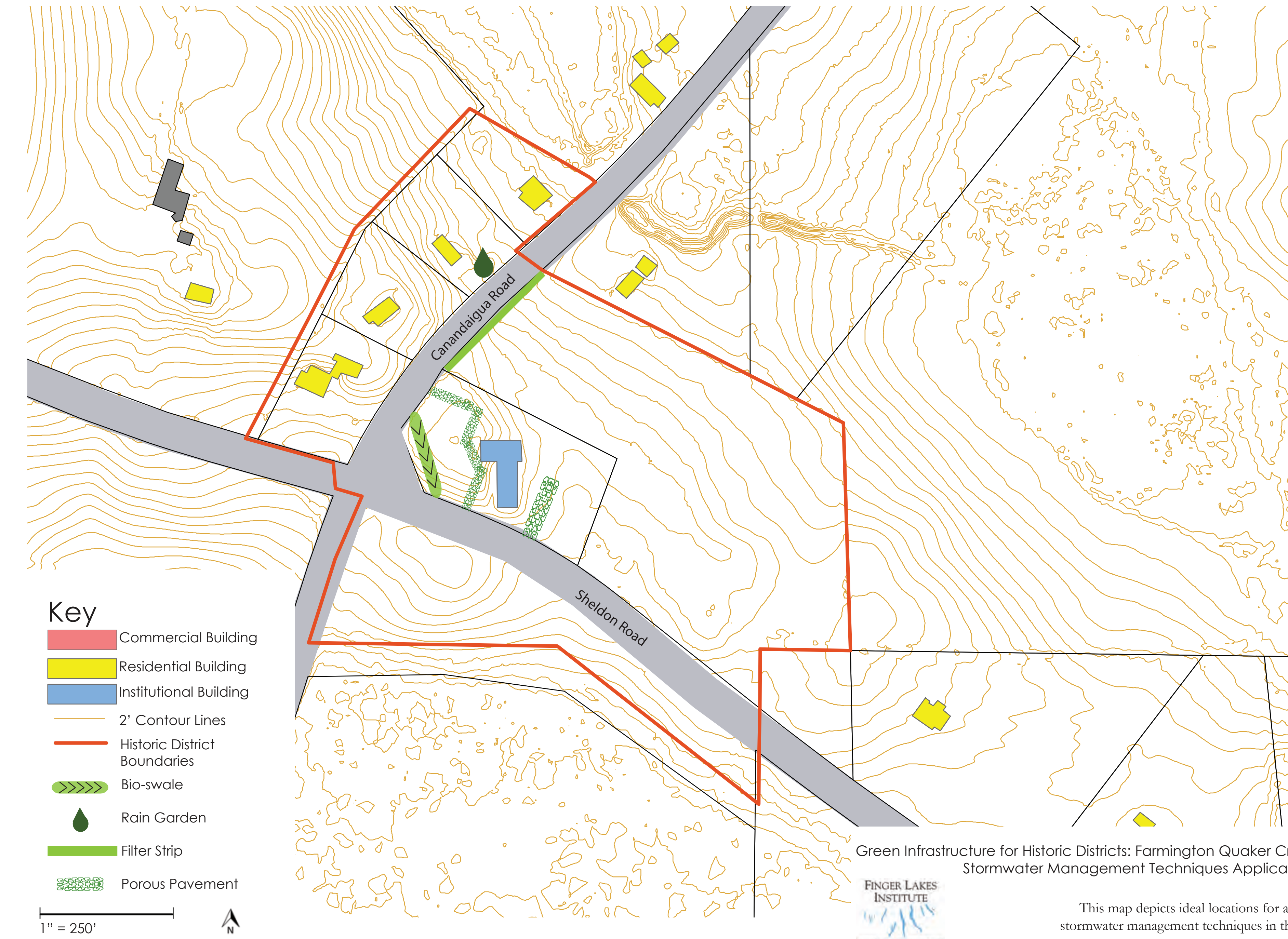


GIS data provided by Ontario County & NYS Historic Preservation Office

Green Infrastructure for Historic Districts: Farmington Quaker Crossroads
Stormwater Management Techniques Application Map
July 2013

This map depicts ideal locations for appropriate stormwater management techniques in the District.

Vegetated Bioswale

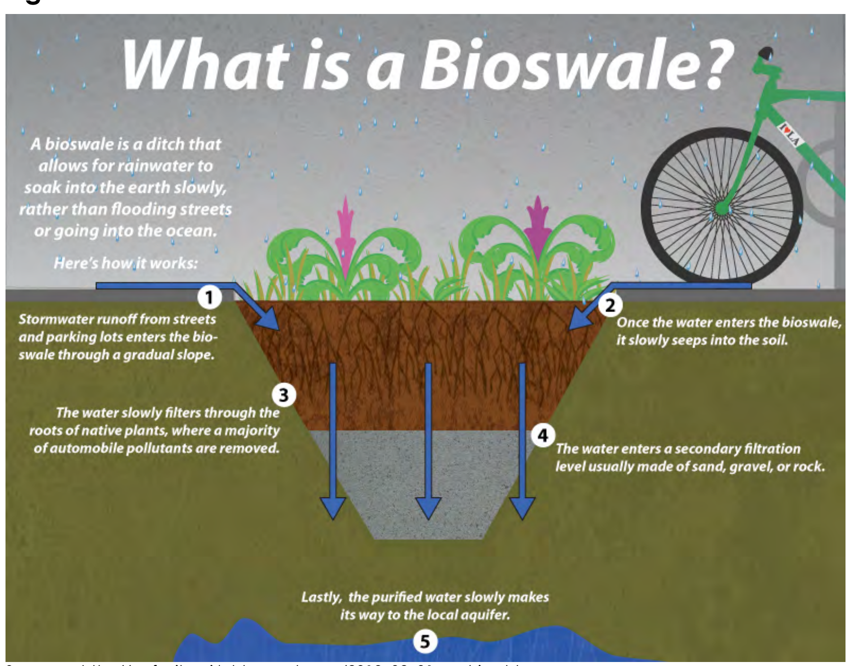
A vegetated swale is a drainage channel that is broad and shallow with a dense stand of vegetation covering the side slopes and bottom. The channel is known as a "swale". Swales have gently sloping sides and are used to convey the overland flow of stormwater down a subtle gradient. Vegetated bioswales slow and clean runoff, encouraging infiltration while also providing directed transport. This transport function is particularly important when managing concentrated flow during harsh storm events when stormwater needs to be directed to a destination, such as a wetland. Putting together the swale ditch and the vegetated strips create a vegetated bioswale.

Introduction

The vegetated bioswale is an urban landform used as mitigation for potential polluted and overflow of stormwater into watershed areas. It enhances infiltration and reduces surface runoff. This green infrastructure technique is normally integrated into urban designs because it enhances visual appeal. It can also be used in agricultural settings as a drain way to intercept runoff from silt, pesticides or nutrients (See Figure 1).

Swales should be designed with native species to filter stormwater pollutants to maximize the swales' effectiveness at managing stormwater. Vegetated bioswales are typically planted with native grass and forbs (a non woody plant other than grass), but can also use stone as part of the drainage way. The vegetated bioswale purpose is to filtrate, slow-down, cool and cleanse run-off water. It cleanses and slows run-off water directing the water to another location.

Figure 1: What is a Bioswale?



Source: http://surfwritergirls.blogspot.com/2013_02_01_archive.htm

Application in a Historic District

Bio-swales, often colloquially referred to as a vegetated ditch, were very common in the past as a way to collect and treat stormwater. Historic photographs from the South Main Historic District in Geneva show bio-swales running along the roadway, with wooden planks allowing pedestrians to cross over. The visual impact of incorporating a bio-swale into a historic district is minimal, they are below grade so they do not impact the view of any structures and vegetated bio-swales are planted with native and flowering plants, which can beautify a property or roadside, and contribute a rural character in districts such as Farmington Quaker Crossroads and East Bloomfield.

Figures 2 and 3 show natural and man-made swales that can be incorporated in a district.

Figure 2: Natural occurring vegetated bio-swale that has worked for GI

http://www.greenroofs.com/blog/tag/habitats/

Figure 3: Bio-swales for housing development. (Foreground is under construction and background is established)

Source: http://ben.biomimicry.net/tag/educational-activity/

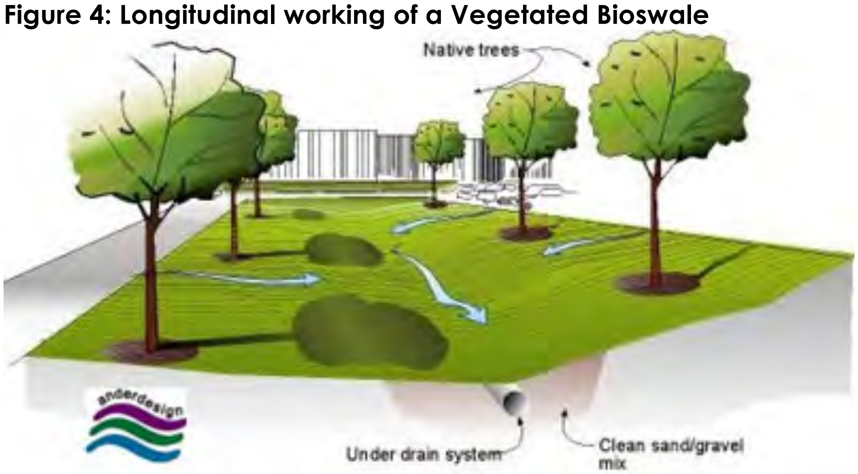
Types of Vegetated Bioswales

Grassed Channels

This type of bioswale is a conventional drainage ditch. The grassed channel bioswale has flatter side slopes that are longitudinal (See Figure 4). It is also made with a slower design velocity for water quality treatment. This type of bioswale is best in areas that experience small storm events. Grass channels are the least expensive option of bioswales. However, they also provide the least reliable pollutant removal technique.

The most ideal application of grassed channels is as a pre-treatment to other structural treatment practices. As an example, many grassed channel bioswales run along a rain garden in case of water overflow (See Figure 5). The grassed channel, unlike the other kinds of vegetated bioswales, is constructed based off of flow rate (i.e. a peak flow from the water quality storm; this varies from region to region but typically is the one in storm.). Grass channels should be designed with the plan that runoff should take 10 minuets to from top to bottom of the channel. The performance of grass channels will vary depending on the underlying soil permeability. Their runoff reduction performance

Figure 4: Longitudinal working of a Vegetated Bioswale



Source:
http://stormwater.horrycounty.org/Home/LowImpactDevelopment/EnhancedGrassSwale.aspx

can be boosted when compost amendments are added to the bottom of the swale. Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography and soils permit. Grass channels can also be used to treat runoff from the managed turf areas of turf-intensive land uses, such as sports fields and golf courses, and drainage areas with combined impervious and turf cover (e.g., roads and yards).

Figure 5: Water filled vegetated bioswale

Source:
http://inthewatershed.org/tag/rain-garden/

Wet Swales

These swales intersect with the groundwater and behave like a linear wetland cell (See Figure 6 & Figure 7). The design of the wet swale is unique because it incorporates a shallow permanent pool and implements wetland vegetation to provide for heavy stormwater treatment. Although wet swales are rarely used in residential areas because shallow standing water is not popular for many homeowners, wet swales work well to redirect stormwater runoff into filtration and then ground water. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. The depth of the channel is typically no less than 6 inches deep; this is more opportunity to create saturated soil or shallow standing water conditions. Wet swales do not provide runoff volume reduction, but provide moderate pollutant removal.

Figure 6: Dry Period

Source:
http://redac.eng.usm.my/html/projects/HydraResist/Index.html

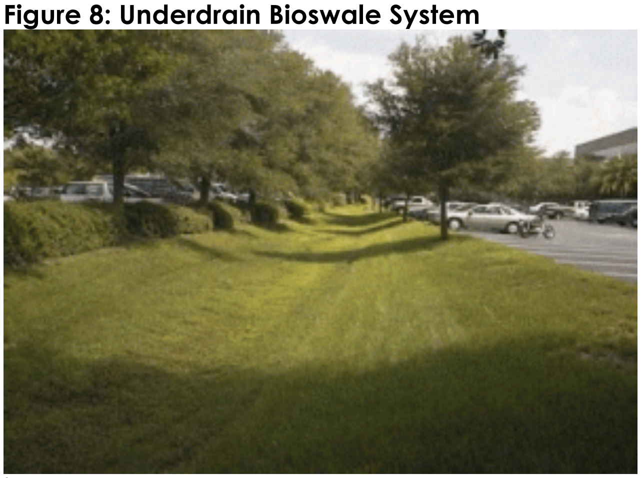
Figure 7: Wet Period

Source:
http://redac.eng.usm.my/html/projects/HydraResist/Index.html

Dry Swales

Dry swales, often known as "running bioretention", are a great way to reduce runoff and maximize pollutant removal within the existing stormwater conveyance system. Dry swales, unlike other vegetated bioswale techniques, incorporate a deep fabricated soil bed into the bottom of the channel. Dry swales replace existing soils with sand/soil mix that works to minimize permeability requirements. The underdrain system usually consists of a layer of gravel encasing a perforated pipe is replaced with a soil bed, which is placed over top the underdrain system. Stormwater treated by the soil bed flows into the underdrain, which conveys treated stormwater back to the storm drain system (See Figure 8) They can usually be applied in any open channel or road right of way (if it lacks curb and gutter).

Figure 8: Underdrain Bioswale System



Source: http://chesapeakestormwater.net/tag/bioswale/

Site Specific Consideration

Location

Vegetated bioswales can be applied in many different areas. They can be implemented residential areas, office complexes, rooftop runoff areas, parking and roadway runoff areas, parks and green spaces. Swales are well suited to treat highway or residential road runoff because of their linear nature and because they are designed to receive stormwater runoff via distributed sheet flow, which travels through a grassy filter area at the swale edges (See Figure 9). Vegetated bioswale designs can easily incorporate driveway crossings.

Figure 9: Residential Location

Source: http://www.crd.bc.ca/watersheds/lid/swales.htm

While some sources recommend that bioswales should be used on sites with relatively flat slopes (i.e., less than 4%), others note that the use of properly spaced weirs can allow siting on slopes up to 10%. When slopes become too steep, runoff velocities become fast enough to cause erosion, and prevent adequate infiltration or filtering in the channel.

Provision of underground overflow allows use of the technique in most soils, so it is very adaptable.

Design

Many different sources recommend a thick vegetative cover is necessary for a proper bioswale function. However water level fluctuation, long-term inundation, erosive flow, excessive shade, poor soils, and improper installation were found to be the most common causes of low vegetation survival. Therefore, it is important to be conscious of your own neighborhoods weather patterns and conditions.

In the Finger Lakes region, living in close proximity to lakes increases the chances of rain occurring in neighboring areas. The potential for storm rainfall is far greater than a neighborhood further away from water bodies.

Because of the linear nature of bioswales, stormwater should ideally enter via sheet flow (an overland flow or downslope movement of water taking a thin form); Pre-treatment (such as grassed boundaries) and erosion control must be part of the design in order to avoid sedimentation of the channel.

Some Main Design Points:

- Individual swales should be designed to treat relatively small, flat drainage areas. If swales use slopes steeper than four percent, or if they treat areas larger than 5 acres, the flow velocity may be too great for effective treatment and erosion could occur.
- Unless existing soils are highly permeable, they are replaced with a sand/soil mix that meets minimum permeability requirements. An underdrain system may also be installed under the soil bed. Typically, the underdrain system is created by a gravel layer, which encases a perforated pipe.
- The bottom of the swale should be at least three feet above groundwater in order to prevent the swale bottom from remaining too wet.
- The swale should have trapezoidal or parabolic cross section with relatively flat side slopes (less than 3:1).
- The flat channel bottom should be between two and eight feet wide to ensure sufficient filtering surface for water quality treatment

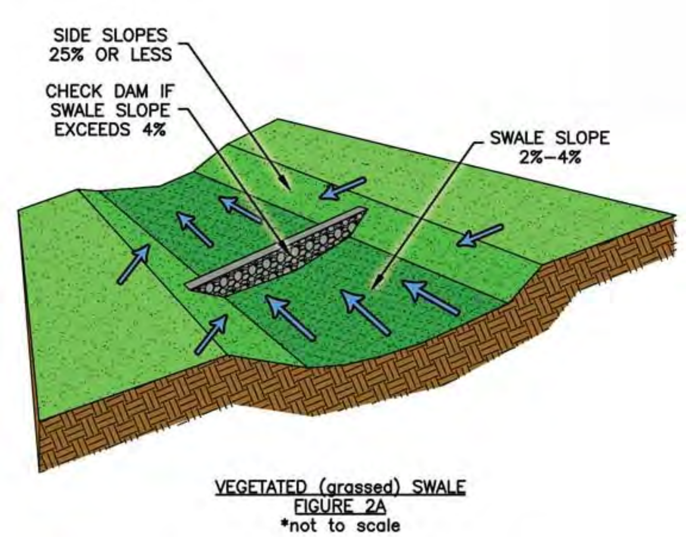
Implementation Considerations

- Since much of the population in your community may not be aware of the stormwater issues of the area, public outreach may be necessary to gain acceptance for implementation.
- Before constructing a bioswale it is important to check the extent of drainage area. This is to avoid interference with already installed drainage systems.
- Determine the necessary space and length to achieve stormwater management goals and water quality.

Retrofitting

One common retrofit opportunity is to use grassed swales to replace existing drainage ditches, which are typically hardscaped. Ditches are traditionally designed only to convey stormwater away from roads. In some cases, it may be possible to incorporate features to enhance their pollutant removal or infiltration using check dams (i.e., small dams along the ditch that trap sediment, slow runoff, and reduce the longitudinal slope) (See Figure 10).

Figure 10: Check Dams used in Vegetated Bioswale construction



Source:
http://chesapeakestormwater.net/tag/bioswale/

Size

Individual grassed channels are generally designed for drainage areas of less than 5 acres. If grass channels are used to treat larger areas, the flow velocity within the bioswale becomes too great to treat runoff or prevent erosion in the channel.

Soils

The soils that are in the Farmington Quaker Crossroads Historic District consist dominantly of Palmyra soil. Palmyra soil consists of very deep soil that have the ability to drain easily, so there is a lesser chance of run off potential in this soil area. They are steep soils that are made up of stratified gravel and clay. This soil is best used for intensive growing of gardens and plants. Therefor, this area is very amenable to bioswales.

Native Plants

Bioswales are seeded or planted with moisture tolerant plant species. The plants or grass should be adaptable to seasonal fluctuations in moisture levels. The structure of the plants is very important because it is what aids in reducing the flow rate of rainwater runoff. It also enhances the soils absorption of water even before it enters the rain garden retention area.

Specifically for the Finger Lakes some of the native plants that would work best in the vegetated bioswale are tree cushion moss, hobblebush, witch hazel, winterberry, woolgrass, switch grass, and red milkweed. For more native plants of the Finger Lakes region see figure 11.

Figure 11: Finger Lakes Region Ideal Native Plants

Shrubs	Herbaceous Plants
Witch Hazel *Hamemelis virginiana*	Cinnamon Fern *Osmunda cinnamomea*
Winterberry *Ilex verticillata*	Cutleaf Coneflower *Rudbeckia laciniata*
Arrowwood *Viburnum dentatum*	Woolgrass *Scirpus cyperinus*
Brook-side Alder *Alnus serrulata*	New England Aster *Aster novae-angliae*
Red-Osier Dogwood *Cornus stolonifera*	Fox Sedge *Carex vulpinoidea*
Sweet Pepperbush *Clethra alnifolia*	Spotted Joe-Pye Weed *Eupatorium maculatum*
	Switch Grass *Panicum virgatum*
	Great Blue Lobelia *Lobelia siphatica*
	Wild Bergamot *Monarda fistulosa*
	Red Milkweed *Asclepias incarnate*
Adapted from NYSDM Bioretention Specifications, Bannerman, Brooklyn Botanic Garden.	

Source:
http://www.dec.ny.gov/docs/water_pdf/swdm2010chptr5.pdf

Zoning

In the hopes of enhancing both the rural historical setting and agricultural spaces, implementing green infrastructure is acceptable. In zoning codes, there is no code enforcing that any green infrastructure cannot be placed on residential lots. However, if green infrastructure techniques is desired to installed in historic districts of public spaces, then it asked that before placing it in, that it be brought to the Town board and approved by The Chairman and Vice Chairman of the commission. However, according to the zoning laws, as long as the green infrastructure techniques that are desired for installation either possess special characteristic or historic or aesthetic interest or value, without disregarding the characteristics of the Farmington County, then it is fine.

Historic Overlay

Installing editions on the exterior of owners' structure is allowed as long as it represents a familiar visual aesthetic as the existing structure identifies with historic personage and protects and improves the intention of the site. Because bioswales often look much like gardens or wetlands, and were actually common in many historic districts in Ontario County pre-industrialization, it is anticipated that they can be implemented without conflict with the existing Historic Overlay.

Maintenance

Figure 12: Typical Maintenance

Activity	Schedule
• Inspect pea gravel diaphragm for clogging and correct the problem. • Inspect grass along side slopes for erosion and formation of rills or gullies and correct. • Remove trash and debris accumulated in the inflow forebay. • Inspect and correct erosion problems in the sand/soil bed of dry swales. • Based on inspection, plant an alternative grass species if the original grass cover has not been successfully established. • Replant wetland species (for wet swale) if not sufficiently established.	Annual (semi-annual the first year)
• Rototill or cultivate the surface of the sand/soil bed of dry swales if the swale does not draw down within 48 hours. • Remove sediment build-up within the bottom of the swale once it has accumulated to 25 percent of the original design volume.	As needed (infrequent)
• Mow grass to maintain a height of 3–4 inches	As needed (frequent seasonally)

Source:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=75

Maintenance requirements are similar to those for ditches: inspecting for bank slumping & erosion, replanting any bare patches where vegetation has been unsuccessful or removed, maintaining ideal vegetation heights by mowing, and removing garbage. Additionally, sediment build-up within the bottom of the swale should be removed once it has accumulated to 25% of the original design volume. Typical maintenance activities are included in Figure 12.

Cost

Little data are available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately $0.25 per ft. This price does not include design costs or contingencies. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately $0.50 per ft., which compares favorably with other stormwater management practices.

Costs to construct swales should be taken in context. With most development designs, some conveyance structure must be constructed as part of the development. The construction of grass swales is less expensive than concrete ditches or sewers. Hence, the use of grass swales is often a less expensive alternative than traditional design approaches.

"Roadside swales in residential settings achieve substantial documented cost savings over conventional curb and gutter and stormwater systems. In a suburban example in Chicago, a savings of about $800 per residence was estimated. Generally, costs may range from less than $0.10 to as much as $0.50 per cubic foot."

Conclusion

Vegetated bioswales are effective in managing water flow, slowing down stormwater and reducing significant amounts of runoff. According to the USEPA in 1999 the removal of sediment and pollutants is high, ranging from 20 to 40 perfect effective. However, there was more removal rates reported that year that exceeded 80 perfect.

With the increasing urbanized world, large parking lots systems and their connecting road networks, common in industrial complexes and office parks, shed large volumes of runoff because of impervious surfaces. A bioswale replaces the traditional concrete gutter with an earthen one. The vegetation reduces the water's velocity allowing for treatment and infiltration. Because they behave like a gutter, these trenches are best suited along roadsides or parking lots, but are less practical for dealing with stormwater that falls on rooftops. The usage of vegetated bioswales is beneficial for both the homeowner monetarily in the long run as well as the natural environment.

Vegetated bioswales have many benefits, however, there are some limitations that comes into creating one.

Limitations

- May require planning and stakeholder acceptance depending on location.
- Requires proper sloping.
- Not the fastest conveyance method—carefully design and place swales to minimize risk of flooding.
- Swales can only treat a limited area

Advantages

- Reduces runoff volume. It provides for effective stormwater control by slowing the runoff and storing water. The water infiltrates into the soils.
- Removes pollutants by filtration by vegetation and soils. Above ground plant parts (stems and leaves) retard flow and thereby encourage particulates and their associated pollutants to settle. The pollutants are then incorporated into the soil where they may be immobilized and/or decomposed. In particular, bacteria within healthy soils can help break down carbon-based pollutants like motor oil.
- There is ground water recharge by installing Grassed channels and dry swales.
- It is a system that can be used by itself or in cooperation with other GI techniques.
- Reduces soil erosion
- Flexible to incorporate into natural features
- Helps to preserve natural/native vegetation and provides habitat for wildlife.
- Protects adjacent properties
- Swale never need to be replaced, in contrast to conventional stormwater system

Rain Garden

A rain garden is a shallow depression in the landscape that is planted with deep-rooted native plants and grasses. It is a green infrastructure technique that allows rainwater and stormwater runoff from urban areas and impervious surfaces, such as roofs, driveways and sidewalks to be absorbed back into the ground and reduces the potential for runoff pollution.

Introduction

"A common problem for homeowners is what to do wet and soggy areas of their yard. Rain gardens help address both of these issues. A rain garden is a designated zone where water accumulates during storms and wet spells. Instead of grass, this area is planted with plants that are tolerant of standing water, and can also withstand the dry periods between storms." (See Figure 1) (http://ferncreekdesign.org/raingarden.html)

Figure 1: Residential Rain Garden

Source: http://articles.washingtonpost.com/2011-07-20/lifestyle/35238427_1_rain-garden-rain-forests-storm-water

Redirected stormwater is often warmer than the groundwater normally feeding a stream, which has resulted in some negative outcomes. The increase of warmer water flowing into waterways, where normally ground water flows in, can upset in some aquatic ecosystems primarily through the reduction of dissolved oxygen. Stormwater runoff is also a source where pollutants washed off hard or compacted surfaces during rain events. These pollutants can derive from both human and natural causes. Some examples of pollutants that can be carried by stormwater runoff are fertilizers, pesticides, and bacteria from pet waste, eroded soil, road salt, grass clippings and litter.

Figure 2: Rain water runoff

Source: http://www.uwgb.edu/facilities/stormwater/

The purpose of a rain garden is to improve water quality in nearby bodies of water. Rain gardens filter up to 99% of water pollutants through natural processes, making ground water safer and cleaner.

Rain gardens are a great technique to decrease the amount of stormwater that enters into sewer systems. Rain gardens are also a less costly alternative to traditional sewer treatment. Living in an ever-increasing urbanized society, the majority of land cover is made up of impervious surfaces. Some examples of impervious surfaces that contribute greatly to stormwater runoff are roofs, sidewalks, roads, and driveways. When it rains these surfaces cannot absorb the water, so the rainwater becomes run-off (See Figure 2). It is high-speed run-off and has high potential for infrastructure destruction. It can cause flooding, erode property and soils, and carry pollutants into streams, wetlands and lakes. The purpose of rain gardens is to recall nature's natural filtration and retention process, while improving the visual aesthetics of the community. They also mitigate the potential for costly infrastructure, like pipes, drains and treatment facilities.

Application in a Historic District

The first rain gardens were in our native ecosystems. Before humans settled and began constructing the built environment with impervious surfaces, rain was filtered naturally through soil, roots, and plants in nature. Stormwater specialists created the first conceived green infrastructure rain garden in Maryland in 1990. However, many conventional gardens were created not with stormwater runoff in mind, but worked as tool of filtration. In the Finger Lakes region, many of the historic districts before the twentieth century had gardens.

To the outside observer, rain gardens look much like any other garden. For this reason, they have a minimal impact on a historic district, and with any well-maintained garden, can actually contribute beauty and interest to the area. Gardens in general and rain gardens were very common in Ontario County, as the glacial soils here are very rich. Rain gardens, like other gardens, are entirely compatible with the aesthetics and character of a historic district.

Site Specific Consideration

Location

Although rain gardens look like a typical flower garden, they are designed specifically to capture and absorb rainwater from impervious surfaces. Since they have a distinct purpose, they need to be strategically placed. When constructing rain gardens, their location is very important to optimize the potential absorption of stormwater runoff. Therefore it is necessary for homeowners to observe their property and base the rain garden location on the specific characteristic of rain flow to determine the best location.

Figure 3: Rain Garden

Source: http://ferncreekdesign.org/raingarden.html

Figure 4: Rain Garden

Source: http://www.mychamplain.net/raingardens

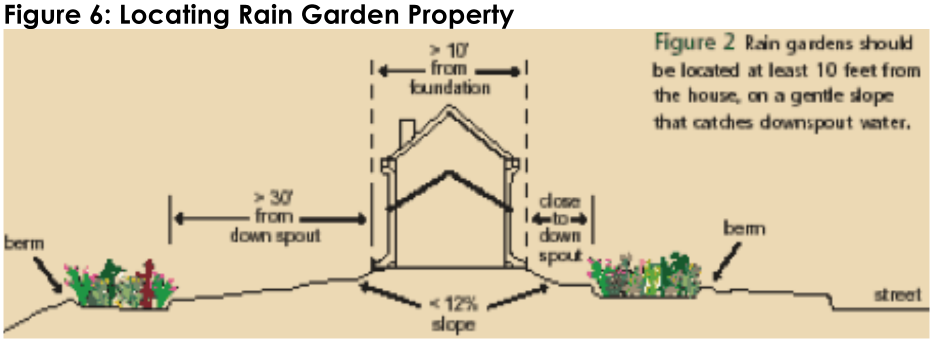
When it rains, a rain garden can fill a few inches of water and it allows water to slowly filter into the ground and soil. Compared to a patch of lawn, a rain garden allows up to 30% more water to soak into the ground. To successfully optimize the runoff absorption of a rain garden, it should be located between a water source (roof down spout, a paved surface, or a hill in your lawn) and where the water usually runs to, examples are a storm drain or a gutter, (See Figure 3 & Figure 4& Figure 5).

Source: http://mtwatercourse.org/media/photos/LIDRainBarrel01.jpg

When locating where to place the rain garden on your property there are several different conditions that should be considered: (See Figure 6)

- Rain Gardens should be built at least 10 feet from a house or building.
- Think about the direction of flow from building downspouts/ sump pumps outlets, so that the rain garden is built on a low point in the lawn.
- Place the garden to take advantage of the natural drainage patterns that will direct garden overflow from the buildings.
- Locate the garden so it received full or partial sunlight.
- It should avoid areas over a septic system.

Figure 6: Locating Rain Garden Property



Source: (http://www.lakesuperiorstreams.org/stormwater/toolkit/raingarden.html)

Zoning & Historic Districts

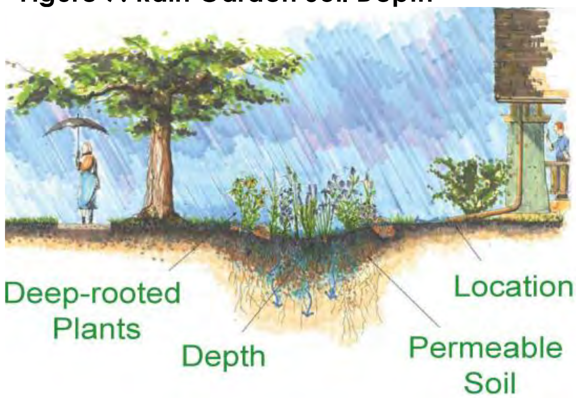
In the hopes of enhancing both the rural historical setting and agricultural spaces, implementing green infrastructure is acceptable in Farmington Quaker Crossroad Historic District. In zoning codes, there is no code enforcing that any green infrastructure cannot be placed on residential lots. However, if green infrastructure techniques is desired to installed in historic districts of public spaces, then it asked that before placing it in, that it be brought to the Town board and approved by The Chairman and Vice Chairman of the commission. However, according to the zoning laws, as long as the green infrastructure techniques that are desired either possess special characteristics or historic or aesthetic interest or value, without degrading the characteristics of the town, then it is fine.

Historic Overlay

Installing editions on the exterior of owners' structure is allowed as long as it represents a familiar visual aesthetic as the existing structure identifies with historic personage and protects and improves the intention of the site. It is anticipated that there should be no conflict with the installation of rain gardens.

Soil

Figure 7: Rain Garden Soil Depth



Source: http://www.thecoves.ca/projects/pollution-solutions

Whenever it rains, water-flow from impervious surfaces is diverted into the garden, where there is maximum potential for water to infiltrate the ground and nourish the plants in the garden. The size and depth of the rain garden are based off of different environmental factor of the landscape.

Some of the dependent factors are soil type, slope and the size of the area that will be drained into the garden. Rain gardens must have good drainage location so it can soak in water within 24 hours after rainfall.

When an area's soils are not permeable enough to allow water to drain and filter properly, the soil should be replaced and an under-drain installed, which is a concealed drain with an opening that water can enter when it reaches drainage levels. The depth of the soils should be about 4 inches below the bottom of the plants roots. This bio retention mixture should typically contain 60% sand, 20% compost, and 20% topsoil. Bio-retention is the process that contaminants and sedimentation are removed from stormwater runoff through natural means. Existing soil must be removed and replaced. Do not combine the sandy soil (bio-retention) mixture with a surrounding, existing soil that does not have high sand content. Otherwise, the clay particles will settle in between the sand particles and form a concrete-like substance. Since most of the soils used in urbanized areas are reliant on chemical materials such as fertilizers it has a lowered rate of absorption, therefore it is necessary to test out the condition of your rain garden soil and if necessary, take the measures to build around the conditions of your soil. Preferred soil mixtures are discussed in the Cost & Products section below.

The soils that are in the Farmington Quaker Crossroads Historic District consist dominantly of Palmyra soil. Palmyra soil consists of very deep soil that have the ability to drain easily, so there is a lesser chance of run off potential in this soil area. They are steep soils that are made up of stratified gravel and clay. This soil is best used for intensive growing of gardens and plants, so it is ideal for a rain garden.

To test for the condition of your soil, take a handful of soil from your future garden site and squeeze firmly. If your soil holds shape, poke it slightly. If it gently crumbles then it is in proper condition for being a rain garden. If after poking it the soil remains in the same shape then the soil has too much clay. If the soil immediately falls apart then it is too sandy. As described above, it is likely that the soils in Farmington are ideal for planting.

Soil Depth

For rain gardens, it is most beneficial to have the soil deep enough so that it can accept large roots, which initially should be about 24 inches deep. Deep plant roots also create additional channels for stormwater to filter into the ground (See Figure 7). Microbial populations feed off plant root secretions and break down carbon (such as in mulch or desiccated plant roots) to aggregate soil particles. This increases infiltration rates.

Slope and Depth

When you have determined what type of soil you have you can determine the size of the garden. This is based on of the soil type and the area you are going to drain, and example of this is by using the size of your roof. To generally measure the size of your rain garden you can multiply the drainage area by the appropriate value according to the slope of your property. The rain gardens surface is dependent on the storage volume of runoff water. The storage volume requirements but should not exceed a loading ratio of 5:1 (drainage area to infiltration area, where drainage area is assumed to be 100% impervious; to the extent that the drainage area is not 100% impervious, the loading ratio may be modified).

Another way to determine the slope of land where the garden is being built for the depth of the rain garden is by the rule of thumb:

- Less than 4% slope: Dig garden 3-5 inches deep
- Between 5-7% slope: Dig garden 6-7 inches deep
- Between 8-12% slope: Dig garden 8 inches deep

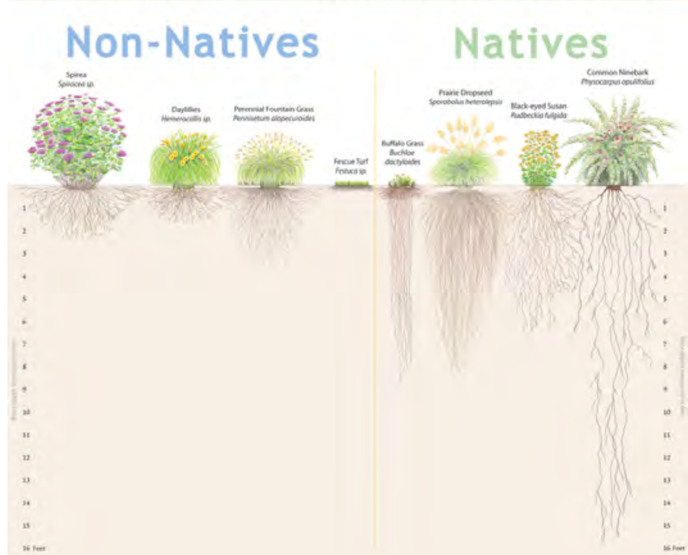
Native Plants

Unlike natural gardens, rain gardens are made with the purpose of reducing water runoff; therefore it is essential for rain gardens to be constructed with the environment in mind. The plants in the rain garden play an essential role in the functionality and performance of the garden. Therefore, builders need to be conscious of the plants that are placed into the rain gardens. Planters must be conscious of species of plants that are in the rain garden, so there are a variety of plants, be sure it is a native species to ensure durability and that the plant can survive in ranging weather conditions.

It is preferred when installing a rain garden that native plants should be used. Native plants are the plants that originated in the area; it is the vegetation that grow and thrive in the environment since it originated there and is best suited for the environmental conditions. This is because native plants are best adapted to soil and temperature conditions of your neighborhood, tolerable to both saturated and dry soil. Using native plants is ideal because they can have a greater survival rate when tolerating the soil conditions. The roots of the native plants are able to flourish with the native soil. (See Figure 8). Native plants also work as a positive contribution to urban habitats for native spices and insects.

environment

Native and non-native root comparison chart



Source: http://water-festival.org/2013/635/where-water-falls-rain-gardens-as-a-clean-solution-to-spring-stormwater-pollution/

Often, simply adjusting the landscape so that downspouts and paved surfaces drain into existing gardens may be all that is needed because the soil has been well loosened and plants are well established. However, many plants do not tolerate saturated roots for long and often more water runs off one's roof than people realize. Often the required location and storage capacity of the garden area must be determined first. Rain garden plants are then selected to match the situation, not the other way around.

Some native plants that are in the Finger Lakes region as advised in the NYS Stormwater Management Design Manual in Chapter 5, can be seen in Figure 9.

Trees

Well-planned plantings require minimal maintenance to survive, and are compatible with adjacent land use. Trees under power lines, or that up-heave sidewalk when soils become moist, or whose roots seek out and clog drainage tiles can cause expensive damage.

Trees generally contribute most to the functionality of rain gardens when located close enough to tap moisture in the rain garden depression, yet do not excessively shade the garden. Also, the shading open surface waters can reduce excessive heating of habitat. Plants tolerate inundation by warm water for less time because heat drives out dissolved oxygen, thus a plant tolerant of early spring flooding may not survive summer inundation.

Figure 9: Finger Lakes Region Ideal Native Plants

Table 5.11 Suggested Rain Garden Plant List	
Shrubs	**Herbaceous Plants**
Witch Hazel *Hamemelis virginiana*	Cinnamon Fern *Osmunda cinnamomea*
Winterberry *Ilex verticillata*	Cutleaf Coneflower *Rudbeckia laciniata*
Arrowwood *Viburnum dentatum*	Woolgrass *Scirpus cyperinus*
Brook-side Alder *Alnus serrulata*	New England Aster *Aster novae-angliae*
Red-Osier Dogwood *Cornus stolonifera*	Fox Sedge *Carex vulpinoidea*
Sweet Pepperbush *Clethra alnifolia*	Spotted Joe-Pye Weed *Eupatorium maculatum*
	Switch Grass *Panicum virgatum*
	Great Blue Lobelia *Lobelia siphatica*
	Wild Bergamot *Monarda fistulosa*
	Red Milkweed *Asclepias incarnate*
Adapted from NYSDM Bioretention Specifications, Bannerman, Brooklyn Botanic Garden.	

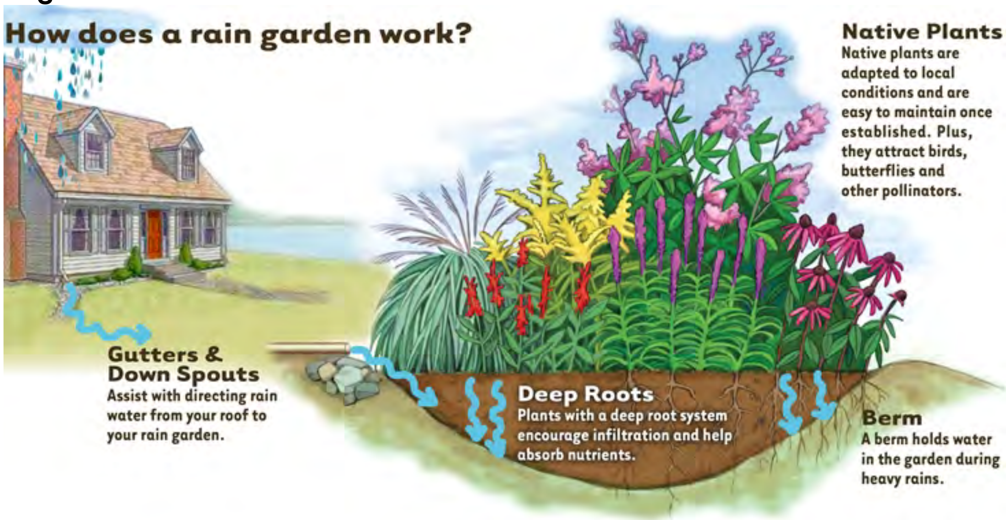
Source: http://www.dec.ny.gov/docs/water_pdf/swdm2010chptr5.pdf

Site Prep Design

Installation and Maintenance

1. Choose Garden Location: Walk your property while it's raining and find out where the water runoff lies (See Figure 10).
2. Check for underground pipes: Make sure before you dig to make the rain garden to have a utility mark the location of underground lines.
3. Select the Plants: Choose native plants that bloom at different times of the season and have a variety of heights, shapes and textures. Variety is Key!
4. Start Digging: A rain garden is usually one to two feet deep with a flat bottom and angled sides. Most are between 100 and 300 square feet in size.
5. Add the soil that is best for the environmental conditions.
6. Plant, water, and tend: After building the rain garden the job is not done. You need to water your rain garden, especially when it's first planted and during dry weather. Rain gardens also need to be regularly weeded and mulched.

Figure 10: Rain Garden Location



Source: http://www.watershedcouncil.org/learn/rain-gardens/

Cost

One of the most important factors involved with the rain garden project is the budget. According to the Watershed Activities to Encourage Restoration website, the cost associated with installation of the rain garden is about $3-$4 per square foot, depending on the soil conditions and the type of plants used. Although the cost is a little more than a typical landscaping job, it is because of the increased number of plants that are being used. However, it is also this initial expensive investment that will pay off in the near future, both environmentally and homeowner costs. Below is a chart from the Chesapeake Bay Foundation and their materials budget (See Figure 11).

As far as choosing which kind of soils to place in for your rain garden, the ideal soil mix to use is 50-60% sand, 20-30% topsoil (no clay) and 20-30% compost. The reason sandy soil is the most ideal is because unlike regular gardens, sand and loamy soil drains better than clay soil that can be waterlogged or compacted soil, which is normally found on developed land and sand will not mix well with it. Sand and loamy soils drain water well. Unfortunately most of the Finger Lakes region is filled with soil with high clay content so will be necessary to purchase soil that has a low clay level.

Figure 11: Example of Rain Garden Cost

Build Your Own Rain Garden
Sample Materials Budget

Material	Quantity	Price Each	Total Price	Source
2 x 12 #1 treated pine board	3	$15.00	$45.00	Hardware store
2 foot steel rebar	10	$ .96	$9.60	Hardware store
Stainless steel elbow brackets w/screws	2	$7.00	$14.00	Hardware store
40 lb. Bag topsoil	4	$3.00	$12.00	Donated by Nice Guy Landscaping Co.
20 lb. Bag sand	1	$5.00	$5.00	Donated by Nice Guy Landscaping
40 lb. Bag mulch	1	$3.00	$3.00	Donated by Nice Guy Landscaping
Straw bale	1	$5.00	$5.00	Donated by Sally's Dad
Screwdriver	1	$4.00	$4.00	Borrow from Janitor
Hammer	1	$12.00	$12.00	Borrow from Janitor
Shovels	3	$20.00	$60.00	Borrow from home
Rakes	2	$10.00	$20.00	Borrow from home
Total			**$189.60 + costs of plants and flowers**	

These prices are just estimates and will vary, depending on where you buy them. You may not need to **buy** everything on this list, and you may decide that you need items not included here. Your budget will also depend on the kinds of plants you decide to use, how many, and what size garden you design! And remember, if you are able to borrow materials, or have them donated, you can subtract them from the actual cost of the project. In other words, the total in this sample budget is $189.00, but the group only needs to raise $68.60 because many of the items have been donated or borrowed!

One more thing: don't forget to include the costs of your plants and flowers!

Source:
http://www.lowimpactdevelopment.org/raingarden_design/downloads/BaysaversRainGardenGuide.pdf

Conclusions

Environmental Benefits

There are many benefits of installing a rain garden. The first is the environmental benefits. Rain gardens improve water quality. Rain gardens filter contaminates from run-off, improving quality of water and recharging ground water.

Rain gardens also reduce stormwater pollution, by collecting and using rainwater that would otherwise be drained into the sewer system. Rain gardens divert this water and decrease the flow of pollution to sewers and instead flow to waste water treatment plants (See Figure 12).

Rain garden reduce sewer flooding and overflow. If adopted on a community or neighborhood scale, rain gardens can reduce combined sewer overflows and localized flooding. Most importantly, by creating a holding zone for water that would typically end up in the gutter, the total volume of runoff from a storm is reduced. Rain gardens ultimately protect rivers, streams and greater bodies of water, and in particular the Finger Lakes, which are treasured bodies of waters in this area. Polluted stormwater that enters rivers and creeks untreated can hurt both water quality and the wildlife that inhabit them. Excessive runoff can also erode banks and increase downstream flooding as well. Rain gardens can help minimize both.

This has an important positive benefit to rivers, streams, and lakes where high runoff volumes cause many devastating effects. Instead, water is able to slowly seep back into the ground and replenish the water table. In a related way, storm runoff also picks up phosphorous and nitrogen from lawn fertilizers and street debris, as well as pollutants like gas, oil, antifreeze, and other chemicals which can also cause major problems for the streams and lakes that it drains into.

When this water is allowed to slowly seep into the ground, most pollutants will become attached to the soil, and removed from the water (See Figure 13). As a benefit to the homeowner, rain gardens provide a solution to existing wet spots where water naturally accumulates, or a beautiful and environmentally friendly garden to replace an area of lawn.

Figure 12: Displaced rain water runoff

Source: http://www.watershedactivities.com/projects/fall/raingrdn.html

Benefits for Homeowners

Rain gardens reduce the potential for basement flooding. A rain garden gives runoff a beneficial, safe place to go, helping to keep it away from your home's foundation.

Rain gardens reduce garden maintenance. A rain garden essentially "waters itself," requiring little or no additional irrigation. In fact, rain gardens are more likely than other gardens to survive droughts. Periodic weeding, mulching and pruning are all the maintenance they need. Because you don't need to fertilize or spray them, they make your yard a healthier place for your children and pets as well.

Figure 13: Water Filtration

Source: http://www.watershedactivities.com/projects/fall/raingrdn.html

Rain gardens enhance curb appeal. Because are more tolerant of the local climate, soil, and water conditions, native plants are recommended for rain gardens. These plants also provide interesting planting opportunities, and are an attractive and creative alternative to traditional lawn landscapes

Rain gardens increase garden enjoyment. Rain gardens are not only pleasing to look it; they are an ideal habitat for birds, butterflies, and other wildlife.

Rain gardens reduce mosquitoes. In a properly designed rain garden, water will soak into the ground within a day or two, long before mosquitoes have the opportunity to breed. They can also be designed to attract the kinds of insects that eliminate pest insects.

With just a little effort, a rain garden can be a beautiful, low-maintenance addition to your lawn. Its contribution to our region's water quality may seem small. But if we all do our part, the total impact can be environment changing.

Figure 14: Rain Garden

Source:
http://www.watershedactivities.com/projects/fall/raingrdn.html

Porous Pavement

Porous, or permeable, pavement is material that allows stormwater to move through the surface and be absorbed rather than flow over the surface. Currently, most development uses impervious materials, such as asphalt and concrete. Rainwater cannot penetrate these materials and is directed into a storm drain off of impervious material, where it then continues to flow untreated into a waterway. Because of this during heavy rainfall sewer systems can also get overwhelmed and flood. Porous pavement is a development technique that can mutually reduce run-off and flooding, as well as minimize the spread of pollution.

Pervious pavement is widely available and can bear frequent traffic, as well as is universally accessible. Porous paving functions like a stormwater infiltration basin and allows the stormwater to infiltrate the soil over a large area, thus facilitating recharge of precious groundwater supplies locally.

Figure 1: Pebbled Path in Pulteney Park

Source: Geneva Historical Society.

Some examples of places that can utilize porous pavement include: roads, paths, lawns and lots that are subject to light vehicular traffic, such as car/parking lots, cycle-paths, service or emergency access lanes, road and airport shoulders, and residential sidewalks and driveways.

Application in a Historic District

Historic photos from Ontario County show pebble and gravel sidewalks, dirt roads and driveways, and then later cobblestone and brick pathways before being paved over with impervious materials. Many home exteriors in Historic districts had descriptions of pathways with spaced out stones framed by grass, where water could easily run off the surface and be absorbed by it's surrounding environment. Figures 1 and 2 are pictures from Geneva, Figure 1 is a pebbled pathway in Pulteney Park, and Figure 2 shows a dirt road and sidewalk in downtown Geneva. The first porous pavement to be widely used however after the industrial revolution was pervious concrete. Pervious concrete was first used in the 1800s in Europe as pavement surfacing. Cost efficiency was the main motivator due to a decreased amount of cement. Then during WWII pervious cement became popular again due to a decrease in availability of cement. Below are some further porous pavement options. By implementing porous paving in a historic district, it is likely that this will improve the historic character and integrity of the district, as well as mitigate stormwater run-off.

Figure 2: Dirt Road & Sidewalk in Downtown Geneva

Source: Geneva Historical Society

Types of Porous Pavement

Concrete & Brick Pervious Pavers

Concrete and brick pervious pavers are commonly used materials that qualify as low impact development and allow the absorption of water. Concrete or brick pavers are manufactured in many sizes and shapes and are laid with a drainage base and permeable joint material, allowing water to slowly seep into the ground. Homeowners can use them for parking areas, patios, sidewalks, and pool decks. Driveways can be paved with these; however, snow removal equipment may catch edges.

Plastic Grids

Plastic Grids allow for a 100% porous system using structural grid systems for containing and stabilizing either gravel or turf. These grids come in a variety of shapes and sizes depending on use; from pathways to commercial parking lots. These systems can be used to meet LEED requirements as well. The ideal design for this type of grid system is a closed cell system, which prevents gravel/sand/turf from migrating laterally.

Figure 3: Loose Gravel

Source: http://www.englishgardenco.co.uk/driveways.html

Porous asphalt

Porous asphalt is conventional asphalt with large, single-sized aggregate particles that leave open voids and give the material porosity and permeability. Under the porous asphalt surface is a base course of further single-sized aggregate that acts as a reservoir where water can be allowed to evaporate and/or be absorbed by underlying soils. Porous asphalt surfaces, called *open-graded friction courses* (OGFC), are being used on highways to improve driving safety by removing water from the surface. OGFCs are not full-depth porous pavements, but a porous surface course usually 3/4 to 1.5 inches thick that allows for the lateral flow of water through the pavement, improving the friction characteristics of the road and reducing road spray.

Loose Gravel

Loose gravel may be used or stone-chippings are another alternative. This form of porous paving should only be used in very low-speed, low-traffic settings like car parks and drives.

Permeable Interlocking Concrete Pavements

Permeable interlocking concrete pavements are concrete (or stone) units with open, permeable spaces between the units. They give an architectural appearance, and can bear light and heavy traffic, particularly interlocking concrete pavers, excepting high-volume or high-speed roads.

Figure 4: Porous Turf

Source: http://www.100khouse.com/2010/12/08/permeable-pavement-options-for-leed-projects/

Porous Turf

Porous turf, as seen in Figure 4, if properly constructed, can be used for occasional parking like that at churches and stadia. Plastic turf reinforcing grids can be used to support the increased load. Living turf transpires water, actively counteracting the "heat island" with what appears to be a green open lawn.

Figure 5: Permeable Clay Brick Pavements

Source: http://www.stixnstones.com/blog/bid/96524/Garden-Stone-Path-Ideas-and-Gallery

Permeable Clay Brick Pavements

Permeable clay brick pavements are fired clay brick units with open, permeable spaces between the units. Clay pavers provide a durable surface that allows stormwater runoff to permeate through the joints. These are ideal for incorporating porous pavement in historic districts.

Resin Bound Paving

Resin bound paving is a mixture of resin binder and aggregate. Enough resin is used to allow each particle to adhere to one another and to the base yet leave voids for water to permeate through. Resin bound paving provides a strong and durable surface that is suitable for pedestrian and vehicular traffic in applications such as pathways, driveways, car parks and access roads.

Elastomerically Bound Recycled Glass Porous Pavement

Elastomerically bound recycled glass porous pavement is made out of processed post consumer glass with a mixture of resins, pigments, and binding agents. The product trademarked as FilterPave provides a permeable paving material that also reuses materials that would otherwise be disposed in landfills. Approximately 75 % of glass in the U.S. is disposed in landfills, so increasing the use of this form of porous pavement helps reuse material and reduce waste.

Benefits

Although some porous paving materials appear nearly indistinguishable from non-porous materials; their environmental effects are qualitatively different. Whether pervious concrete, porous asphalt, paving stones or concrete or plastic-based pavers, all these pervious materials allow stormwater to percolate and infiltrate the surface areas that currently do not utilize the soil below. The goal is to control stormwater at the source, reduce runoff and improve water quality by filtering pollutants in the substrata layers.

Figure 6: An Example of Porous Paving

Source: http://www.wycokck.org/InternetDept.aspx?id=23020&menu_id=1444&banner=15284

Benefits of permeable paving include:

- Recharging ground water
- Run-off reduction
- Decrease in capacity restraints in stormwater networks
- Effective pollutant treatment for solids, metals, nutrients, and hydrocarbons, as well as aesthetic improvement to otherwise hard urban surfaces.

Controlling Pollutants

Perhaps one of the most important benefits of porous pavement is the reduction of pollutants. Impervious pavement amplifies and spreads non-point source pollution. Non-point source pollution is caused by rainfall or snowmelt moving over the ground. As run-off moves it picks up human made pollutants and deposits them into streams, creeks, and lakes. Common examples of pollutants that fall into this category and spoil our waterways are: fertilizers, herbicides, insecticides, oil, and grease.

Porous pavement slows the velocity and momentum in which water moves over the surface, allowing sediment to drop out of the water, resulting in less erosion; and this means the water picks up fewer pollutants and allows the pollutants to filter into the ground. Studies have shown that porous pavements capture the heavy metals that fall on them, preventing them from washing downstream and accumulating inadvertently in the environment. In the void spaces, naturally occurring microorganisms digest car oils, leaving little but carbon dioxide and water.

Examples

A study done in Rockville, MD reported high removal rates for zinc (99%), lead (98%), and chemical oxygen demand (82%). The University of New Hampshire Stormwater center found typical performance efficiencies for TSS, total zinc, and total phosphorous to exceed 95%, 97%, and 42% respectively. The EPA estimates that porous pavement has the ability to remove 65% of total phosphorous, 80-85% of nitrogen, and 82%-95% of suspended solids.

Site Specific Considerations

Soils

The soil should have a minimum infiltration rate of 0.5 inches per hour. Soil testing is required to maintain and ensure effective pollutant removal is taking place in the soils. The soils that are in the Farmington Quaker Crossroads Historic District consist dominantly of Palmyra soil. Palmyra soil consists of very deep soil that have the ability to drain easily, so there is a lesser chance of run off potential in this soil area. They are steep soils that are made up of stratified gravel and clay. This soil would be amenable to porous pavement because its ability to drain easily.

Siting

Permeable pavement cannot be used in areas where there are risks for foundation damage, basement flooding, interference with subsurface sewage disposal systems, or detrimental impacts to other underground structures. Permeable pavement, like any other stormwater infiltration practice, bears the possibility of groundwater contamination. Therefore, permeable paving infiltration systems should not be used to treat stormwater hot spots. Stormwater hot spots are areas where land uses or activities have the potential to generate highly contaminated run-off. Examples of this are commercial nurseries, auto recycling and
repair facilities, fleet washing, fueling stations, high use commercial parking lots, and marinas.

Figure 7:

Source: http://homeklondike.com/2010/09/29/garden-path-design-ideas/

The recommended applications of permeable paving are for low-traffic roads, single-family residential driveways, overflow parking areas, sidewalks, plazas, tennis and or basketball courts, and courtyard areas, as well as backyard patios. Many opportunities exist in larger parking lots, schools, municipal facilities, and urban hardscapes as well. Permeable paving is easily applicable to redevelopment areas as well as new development.

As mentioned, porous pavement is recommended for mostly light traffic areas, however, given the variability of products available the range of accepted applications is expanding. Some concrete paver companies have developed products specifically for industrial applications.

Zoning

In the hopes of enhancing both the rural historical setting and agricultural spaces, implementing green infrastructure is acceptable. In zoning codes, there is no code enforcing that any green infrastructure cannot be placed on residential lots. However, if green infrastructure techniques is desired to installed in historic districts of public spaces, then it asked that before placing it in, that it be brought to the Town board and approved by The Chairman and Vice Chairman of the commission. However, according to the zoning laws, as long as the green infrastructure techniques that are desired possess special characteristics or historic or aesthetic interest or value, without degrading the characteristics of the town, then it is fine.

Historic Overlay

Installing editions on the exterior of owners' structure is allowed as long as it represents a familiar visual aesthetic as the existing structure identifies with historic personage and protects and improves the intention of the site. Because the Farmington Quaker Crossroads Historic District in the past had no pavement, installing a porous paving system that mimics (in look) grass, while still maintaining functionality for parking and car traffic, would be ideal.

Slopes

Permeable paving can only be used on gentle slopes (<5%); ideal surfaces should be completely flat. For all permeable paving, base course is a reservoir layer of 1"-2" crushed stone; depth to be determined by storage required and frost penetration.

Figure 8: A Terraced Application of Porous Pavement

Source: http://realestate.msn.com/garden-paths-12-easy-to-imitate-stone-walkways-1

The introduction of dirt or sand onto the paving surface, whether transported by runoff from elsewhere or carried by vehicles, will contribute to premature clogging and failure of the paving. Consequently, permeable paving should be constructed as one of the last items to be built on a development site and flat or very minimal slope. A terraced system may be used on slopes and perforated pipes can be used to help distribute run-off through the reservoir evenly. An example of a terraced system can be seen in Figure 8 above.

Drainage

Not all water will be absorbed by porous pavement; therefore drainage must be taken into consideration. Run-off should flow through and exit permeable pavements in a safe and non-erosive manner. Systems should be designed to ensure that the water surface evaluations for the 10- year 24-hour design storm do not rise into the pavement to prevent freeze/thaw damage. As a back up measure to help mitigate clogging, permeable paving practices can be designed with a perimeter trench to provide some overflow treatment.

Climate

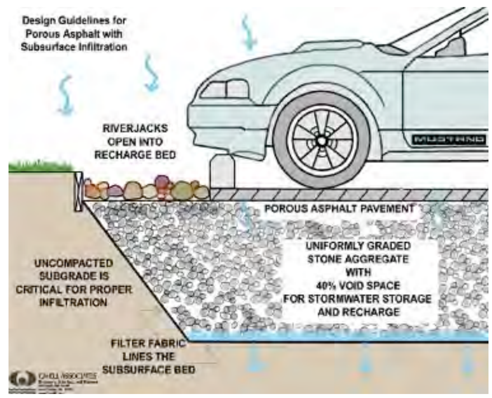
Concerns over the resistance to the freeze-thaw cycle have limited the use of pervious concrete in cold weather environments. The rate of freezing in most applications is dictated by the local climate. Avoiding saturation during the freeze cycle is the key to the longevity of the concrete. Having a well-prepared 8 to 24 inch (200 to 600 mm) sub-base and drainage will reduce the possibility of freeze-thaw damage. The use of salt or sand during the winter should be minimized. Road salt contains chlorides that could migrate through the porous pavement into groundwater. Snowplow blades could catch block edges and damage surfaces. Sand cannot be used for snow and ice control on pervious asphalt or concrete because it will plug the pores and reduce permeability.

These potential problems do not mean that porous pavement cannot be used here in the Finger Lakes though. Porous pavement designed to reduce frost heave and clogging has been used successfully in Norway. Furthermore, experience suggests that rapid drainage below porous surfaces increases the rate of snowmelt above. So, salting and plowing may become less necessary and severe. Sidewalks, patios, and tennis courts are a few examples of places that are not greatly affected by snow and could still easily be paved with a form of porous pavement.

Site Preparation & Design

Construction Guidelines

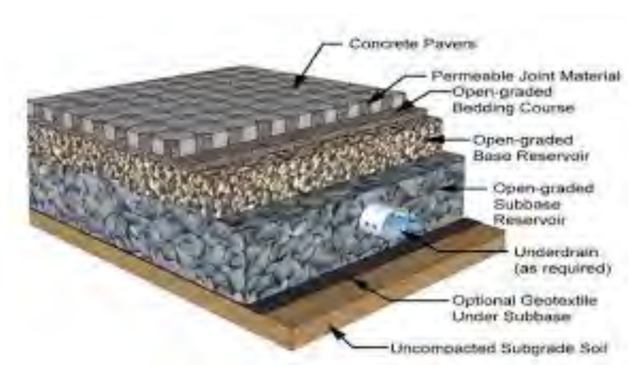
Figure 9: Layers of Porous Paving



Source: http://www.mapc.org/resources/low-impact-dev-toolkit/permeable-paving

When installing pervious pavement projects certain precautions should be taken. Prior to installation areas for the porous pavement should be clearly marked in order to avoid compaction or disturbance of the soil. Weather conditions at the time of installation can affect the final product, as well. Extremely low or high temperatures should be avoided during construction. The pervious pavement and other infiltration practices should be installed towards the end of construction-to ensure securement and stability of upstream construction. It is recommended that filter fabric overlap a minimum of 16 inches and should be secured at least 4 feet outside of the bed to help drainage. The strip of fabric should remain in place until all bare soils contiguous to the beds are stabilized and vegetated.

Figure 10: Layers of Porous Paving



Source: http://www.dot.ca.gov/hq/LandArch/ec/lid/lid-permeable-paving-new.htm

More specifically, there are a few layers that should be incorporated into porous paving to ensure proper and efficient absorption and filtration. There should be a "choker course"—a single ½ inch layer of crushed granules and functions as a stabilizer for the open-graded asphalt surface for paving. A drainage layer is used to separate the underlying native soils from the filter layer with a 3-inch layer or gravel over a reservoir course. An underdrain is required to meet storage/release criteria and overflow piping is necessary to minimize the chance of clogging. It is recommended that a 4"-6" perforated PVC pipe with 3/8 inch perforations at 6 inches on center, solid connectors should be used. Each pipe should have a minimum 0.5% slope and be placed 20 feet apart. An observation well is also required-in order to observe any changes in groundwater levels that may occur over a period of time. Examples of these layers can be more clearly demonstrated in Figures 9 and 10.

Maintenance

If maintenance is not carried out on a regular basis, the porous pavements can begin to function more like impervious surfaces due to clogging. However, with more advanced paving systems the levels of maintenance needed can be greatly decreased. An example of this is plastic grid systems. Plastic grid systems are becoming more and more popular with local government maintenance personnel because they result in reduced gravel migration and increased weed suppression in public park settings.

Some permeable paving products are prone to damage from misuse, such as drivers who tear up patches of plastic & gravel grid systems by "joy riding" on remote parking lots at night. The damage is not difficult to repair but can look unsightly in the meantime. Grass pavers require supplemental watering in the first year to establish the vegetation; otherwise they may need to be re-seeded.

A maintenance checklist for permeable paving would include:

- Posting signs that identify porous pavement areas
- Keeping landscape areas well-maintained to help prevent soil transportation and erosion onto the pavement
- Regular cleaning with a vacuum sweeping machine, or high pressure hosing
- Regular monitoring to ensure the surface is draining properly after storms
- It should not be resealed or repaved with impermeable materials
- An annual inspection for deterioration is recommended

Basic quick fixes for each type are available and fairly easy to do. Potholes and cracks can be filled with patching mixes, as long as less than ~10% of the surface needs repairing. Spot clogging can be fixed by drilling 0.5 holes through the pavement every few feet. Displaced gavel in open celled pavers can be refilled as needed.

Feasibility & Limitations

Major limitations to this practice are suitability of the site grades, subsoils, drainage characteristics, and groundwater conditions. Proper site selection is an important criterion in reducing the failure rate of using porous paving. Ownership and maintenance also heavily influence the success of a permeable pavement. Soil should be permeable and able to support adequate infiltration. Sandy and silty soils are critical to successful application of permeable pavements. Chlorides can easily migrate into ground water, so heavily salted pavement is not ideal. The surface material must be able to tolerate undulations from frost movements, and be able to bear frost. Since the Finger Lakes experience a colder climate porous material may require more in-depth consideration.

Cost

Some estimates put the cost of permeable paving at two to three times that of conventional asphalt paving. Using permeable paving, however, can reduce the cost of providing larger or more stormwater BMPs on site, and these savings should be factored into any cost analysis. In addition, the off-site environmental impact costs of not reducing on-site stormwater volumes and pollution have historically been ignored or assigned to other groups (local government parks, public works and environmental restoration budgets, fisheries losses, etc.) The City of Olympia, Washington is studying the use of pervious concrete quite closely and finding that new stormwater regulations are making it a viable alternative to stormwater ponds. The table below shows cost estimates below for various different kinds of porous pavement options.

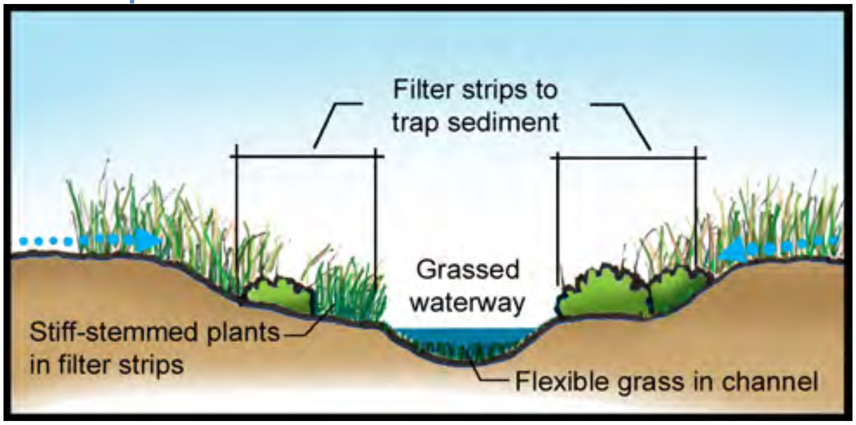
Table 1

(sq. ft.)	Paved Area	Quote ($) Highest	Quote ($) Lowest	Quote ($ sq. yd.) Highest	Quote ($ sq. yd.) Lowest
Hot Mix Asphalt	36,225	98,600	92,620	24.50	23.01
Porous Asphalt	5,328	28,650	18,352	48,40	31.00
Porous Pavers	5,328	67,960	61,755	114.80	104.32
Porous Concrete	7,988	63,200	53,919	71.21	60.75

Conclusion

The proper utilization of pervious paving is recognized by Best Management Practice by the U.S. Environmental Protection Agency (EPA) for providing first flush pollution control and stormwater management. As regulations further limit stormwater runoff, it is becoming more expensive for property owners to develop real estate, due to the size and expense of the necessary drainage systems. Pervious concrete reduces the runoff from paved areas, which reduces the need for separate stormwater retention ponds and allows the use of smaller capacity storm sewers. This allows property owners to develop a larger area of available property at a lower cost. Pervious concrete also naturally filters stormwater and can reduce pollutant loads entering into streams, ponds and rivers; protecting our ecosystems and unique glacially made region.

Filter Strips

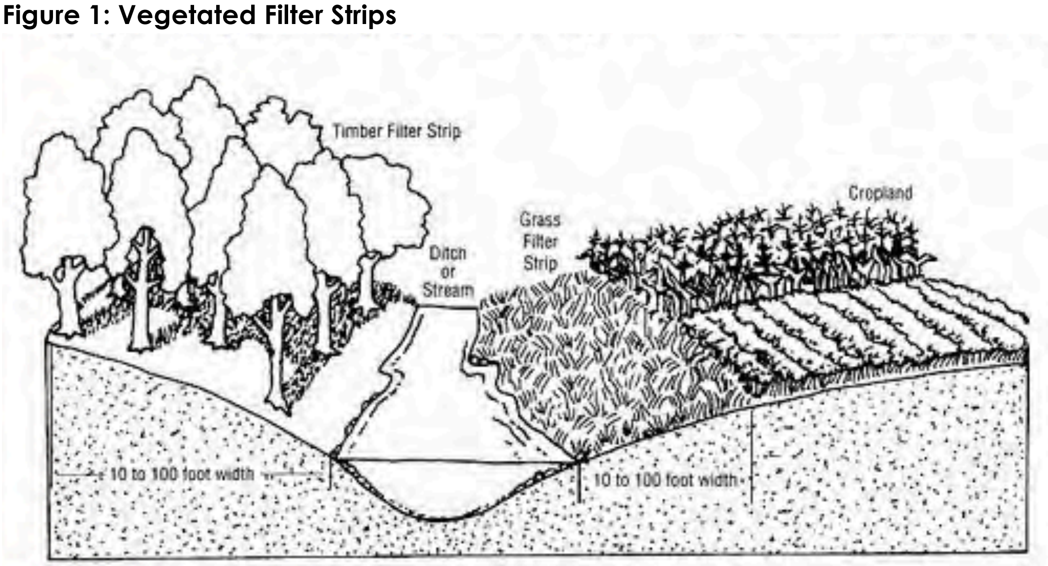


A filter strip is a type of buffer strip that is an area of vegetation, generally narrow and long, that slows the rate of runoff from stormwater. The strip of area of vegetation is used for removing sediment, organic matter, and other pollutants from runoff and wastewater.

Introduction

As the construction of permeable surfaces increases, so does stormwater runoff. The loss of sediment, plant nutrients and crop pesticides are only some of the few identified contributors to the significant environmental problem of stormwater pollutant runoff. Vegetated filter strips are one of the best management practices to alleviate the pollution.

Figure 1: Vegetated Filter Strips



Source: http://ohioline.osu.edu/aex-fact/0467.html

Filter strips are land areas of either planted or indigenous vegetation that is placed between a potential pollutant source area and a surface-water body that receives the water runoff (See Figure 1). They can also be planted around drainage tile inlets for the same purpose.

A vegetated filter strip is vegetated surface, usually grassed, that are designed to treat water runoff on impervious surfaces, specifically sheet flow (See Figure 2). Filter strips function by working as a tool to slow down runoff velocities and filtering the sediment and pollutants. Vegetated filter strips also provide a localized protection for erosion.

As an edge-of-the-field best management practice, filter strips help remove pollutants from runoff, serve as habitats for wildlife, provide an area for field turn rows and haymaking, and could be used as livestock management system. Grass filter strips can also help protect groundwater when planted around sinkholes or in wellhead protection areas. Ongoing management of grass filter strips is needed to maintain the health of the vegetation and to repair rills running through the strip or channels that may develop along the edges (See Figure 3.)

Figure 2: Sheet flow

Source: http://www.lakesuperiorstreams.org/understanding/impact_impervious.html

Figure 3: Filter strips in relation to area

Source http://www.mda.state.mn.us/protecting/conservation/practices/buffergrass.aspx

Filter strips originally were used as an agricultural treatment practice. Recently it has been adapted to be used in urban areas.

Application in a Historic District

The first vegetated was suggested as a stormwater management technique in the late 1980's. However, historically filter strips naturally occurred along side farms where parts of the land where cut utilized for cattle, many reoccurring American farms allocated strips of land solely for vegetation because it worked as a natural barrier so cattle would not go beyond parts of the farm land and they would be contained. However, these strips of land also worked as a stormwater runoff filtrating tool.

Filter strips also historically occurred in the Finger Lakes region. Filter strips are a very common green infrastructure technique in rural and agricultural areas, like the Farmington Quaker Crossroads Historic District area, and in these settings, are very low profile. Placed around the edge of a parking lot or along a roadway, filter strips would be unlikely to have any negative impact on the historic integrity or character of any district. Instead, they would add additional plants and green-space as well as slow and filter run-off.

Site Specific Consideration

Location

Filter strip and vegetated filter strips are applicable in most regions, however they may be restricted in some areas because filter strips take up a large amount of space that could be used for other practices. Since the purpose of filter strips is to treat runoff, the most ideal location would be one that can catch the most amount of runoff. Some ideal locations are the areas adjacent to roads, highways, roof downspouts, small parking lots, and pervious surfaces that are adjacent to impervious surfaces (See Figures 4, 5 & 6).

Filter strips can be applied in most of the country, but there are certain areas that are not ideal for installation:

- In highly dense urban areas there is little pervious surface. Filter strips need pervious areas. They also take up a significant amount of space, so it may not be suited to urban areas.
- In extreme arid climates, filter strips need to be irrigated. The practice of manually irrigated may be very expensive.
- It would not be ideal to install a filter strip in an area of stormwater hot spot. A stormwater hot spot is an area where the land or the activities on the land generate extremely contaminated runoff. An example being a gas station. Filter strips should not receive hot spot runoff because it would have a lot of harm toward the soils and discourages infiltration.

Figure 4: Filter strips near roads

Source http://ucanr.edu/sites/UCNFA/Past_Programs_2009/Managing_Runoff_with_Vegetated_Treatment_Systems__Seminar_and_Tour-_Santa_Paula/

Figure 5: Filter strips in parking lots

Source http://www.lakesuperiorstreams.org/stormwater/toolkit/filterstrips.html

Figure 6: Filter strips near roof downspouts

Source http://www.3riverswetweather.org/green/green-solution-disconnected-downspout

Drainage Area

Typically, filter strips are used to treat very small drainage areas. The limiting design factor, however, is not the drainage area the practice treats but the length of flow leading to it. As stormwater runoff flows over the ground's surface, it changes from sheet flow to concentrated flow. Rather than moving uniformly over the surface, the concentrated flow forms a small stream, which are slightly deeper and cover less area than the sheet flow. When flow concentrates, it moves too rapidly to be effectively treated by a grassed filter strip. This concentrated flow often leads to scouring. As a rule, flow concentrates within a maximum of 75 feet for impervious surfaces, and 150 feet for pervious surfaces. Using this rule, a filter strip can treat one acre of impervious surface per 580-foot length.

Slope

Filter strips should be designed on slopes between 2 and 6 percent. Greater slopes than this would encourage the formation of concentrated flow. Except in the case of very sandy or gravelly soil, runoff would pond on the surface on slopes flatter than 2 percent, creating potential mosquito breeding habitat.

Soils/Topography

Filter strips should not be used on soils with high clay content, because they require some infiltration for proper treatment. Very poor soils that cannot sustain a grass cover crop are also a limiting factor. The type of vegetated cover that is planted on the filter strip can also influence the amount of total suspended solid (TSS) removal rate (See Figure 7). The soils that are in the Farmington Quaker Crossroads Historic District consist dominantly of Palmyra soil. Palmyra soil consists of very deep soil that have the ability to drain easily, so there is a lesser chance of run off potential in this soil area. They are steep soils that are made up of stratified gravel and clay. This soil is best used for intensive growing of gardens and plants. Therefor, it is anticipated that filter strips will function well in the Historic District.

Figure 8: Simple Filter Strip Design

Vegetated Cover	Adopted TSS Removal Rate
Turf grass	60 %
Native Grasses, Meadow, and Planted Woods	70 %
Indigenous woods	80 %

http://www.njstormwater.org/bmp_manual/NJ_SWBMP_9.10.pdf

Ground Water

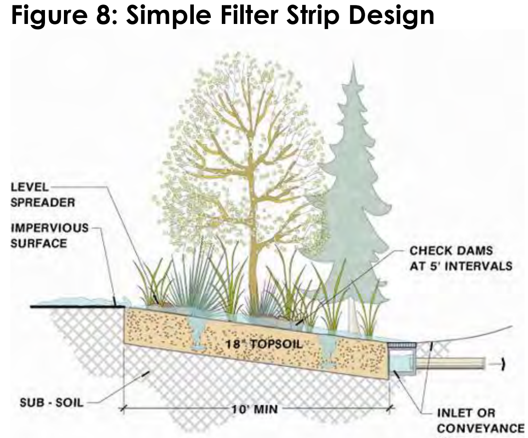
Filter strips should be separated from the ground water by between 2 and 4 ft. to prevent contamination and to ensure that the filter strip does not remain wet between storms.

Design Considerations

Filter strips appear to be a minimal design practice because they are basically no more than a grassed slope (See Figure 8.) However, some design features are critical to ensure that the filter strip provides some minimum amount of water quality treatment.

A pea gravel diaphragm should be used at the top of the slope. The pea gravel diaphragm (a small trench running along the top of the filter strip) serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip.

Figure 8: Simple Filter Strip Design



Source: http://www.land2plan.com/Stormwater.htm

The filter strip should be designed with a pervious berm of sand and gravel at the toe of the slope. This feature provides an area for shallow ponding at the bottom of the filter strip. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm. The volume ponded behind the berm should be equal to the water quality volume. The water quality volume is the amount of runoff that will be treated for pollutant removal in the practice. Typical water quality volumes are the runoff from a 1-inch storm or ½-inch of runoff over the entire drainage area to the practice.

The filter strip should be at least 25 feet long to provide water quality treatment.

Designers should choose a grass that can withstand relatively high velocity flows and both wet and dry periods. For the Finger Lakes region turf grass would be an ideal grass used. For the Finger Lakes Region, turf grass would be an ideal type to use. (See figure 9) Both the top and toe of the slope should be as flat as possible to encourage sheet flow and prevent erosion.

Regional Variation

In cold climates such as the Finger Lakes region, filter strips provide a convenient area for snow storage and treatment. If used for this purpose, vegetation in the filter strip should be salt-tolerant, (e.g., creeping bentgrass), and a maintenance schedule should include the removal of sand built up at the bottom of the slope. In arid or semi-arid climates, designers should specify drought-tolerant grasses (e.g., buffalo grass) to minimize irrigation requirements.

Maintenance

Filter strips require similar maintenance to other vegetative practices. These maintenance needs are outlined below. Maintenance is very important for filter strips, particularly in terms of ensuring that flow does not short circuit the practice.

Figure 9: The two Deign Variations of the Filter Strips and Vegetation Buffer according to the grass used.

Design Issue	Sheetflow to Riparian Buffer	Sheetflow to Grass Filter Strip
Soil and Ground Cover	Undisturbed Soils and Native Vegetation	Amended Soils and Dense Turf Cover
Construction Stage	Located Outside the Limits of Disturbance and Protected by ESC controls	Prevent Soil Compaction by Heavy Equipment
Typical Application	Adjacent Drainage to Stream Buffer or Forest Conservation Area	Treat small areas of impervious cover (e.g., 5,000 sf) close to source
Compost Amendments	No	Yes
Boundary Spreader	GD at top of filter	GD at top of filter PB at toe of filter
Boundary Zone	10 feet of level grass	At 25 feet of level grass
Concentrated Flow	ELS with 40 to 65 feet long level spreader* per one cfs of low, depending on width of conservation area	ELS with 1ength of level spreader per one cfs of flow
Maximum Slope, First Ten Feet of Filter	Less than 4%	Less than 2%
Maximum Overall Slope	6%	8%

Source: NYS Storm Management Design manual

An annual inspection for the first year should inspect for clogging, check if removal of build up of sediment is needed, inspect vegetation for rills and gullies, and inspect to ensure the grass has established. If it is not flourishing then replace with alternative species.

For regular but less frequent maintenance checks, it is to remove sediment build up within the bottom of the filter strip.

Zoning

In the hopes of enhancing both the rural historical setting and agricultural spaces, implementing green infrastructure is acceptable. In zoning codes, there is no code enforcing that any green infrastructure cannot be placed on residential lots. However, if green infrastructure techniques is desired to installed in historic districts of public spaces, then it asked that before placing it in, that it be brought to the Town board and approved by The Chairman and Vice Chairman of the commission. However, according to the zoning laws, as long as the green infrastructure techniques that are desired possess special characteristics or historic or aesthetic interest or value, without degrading the characteristics of the town, then it is fine.

Historic Overlay

Installing editions on the exterior of owners' structure is allowed as long as it represents a familiar visual aesthetic as the existing structure identifies with historic personage and protects and improves the intention of the site.

Cost

According to the EPA little data is available on the actual construction costs of filter strips. An estimate can be the cost of seed or sod, which is approximately 30¢ per ft^2 for seed or 70¢ per ft^2 for sod. This amounts to between $13,000 and $30,000 per acre for a filter strip, or the same amount per impervious acre treated. This cost is relatively high compared with other treatment practices. However, the grassed area used as a filter strip may have been seeded or sodded even if it were not used for treatment. In these cases, the only additional costs are the design, which is minimal, and the installation of a berm and gravel diaphragm. Typical maintenance costs are about $350/acre/year. This cost is relatively inexpensive and, again, might overlap with regular landscape maintenance costs.

Figure 10: Filter Strip

Source: NYS Storm Management Design manual Chap 5

The true cost of filter strips is the land they consume, which is higher than for any other treatment practice. In some situations this land is available as wasted space beyond back yards or adjacent to roadsides, but this practice is cost-prohibitive when land prices are high and land could be used for other purposes.

Conclusions

Limitations

Filter strips have several limitations related to their performance and space consumption:

- The practice has not been shown to achieve high pollutant removal.

- Filter strips require a large amount of space; typically equal to the impervious area they treat, making them often infeasible in urban environments where land prices are high.
- If improperly designed, filter strips can allow mosquitos to breed.
- Proper design requires a great deal of finesse, and slight problems in the design, such as improper grading, can render the practice ineffective in terms of pollutant removal.

Effectiveness

Structural stormwater management practices can be used to achieve four broad resource protection goals. These include flood control, channel protection, ground water recharge, and pollutant removal. The first two goals, flood control and channel protection, require that a stormwater practice be able to reduce the peak flows of relatively large storm events (at least 1- to 2-year storms for channel protection and at least 10- to 50-year storms for flood control). Filter strips do not have the capacity to detain these events, but can be designed with a bypass system that routes these flows around the practice entirely. Filter strips can provide a small amount of ground water recharge as runoff flows over the vegetated surface and ponds at the toe of the slope. In addition, it is believed that filter strips can provide modest pollutant removal. (See figure 10)

Environmental Benefits

- Helps protect surface water quality by trapping and filtering sediment, nutrients, pesticides and pathogens in agricultural runoff
- Helps protect groundwater quality by preventing contaminants from leaching into the water table
- Creates food and cover for wildlife and may connect existing fragmented habitat for small birds and animals. (Wider strips are recommended to prevent entrapment by predators in narrow corridors.)
- May help stabilize eroding banks
- May reduce downstream flooding

Practical Benefits

- Provides an alternative for marginal, flood-prone cropland along creeks and streams
- Straightens irregular fields, keeps farm machinery away from steep banks and avoids the need to plant end-rows where crop yields are often lower due to soil compaction
- Serves as a turning and parking area, facilitating season-long access to fields (especially remote fields), which custom applicators appreciate
- May reduce flood damage on adjacent cropland