The Future of Stormwater Management: Bioswales and Environmentally Friendly Stormwater Control

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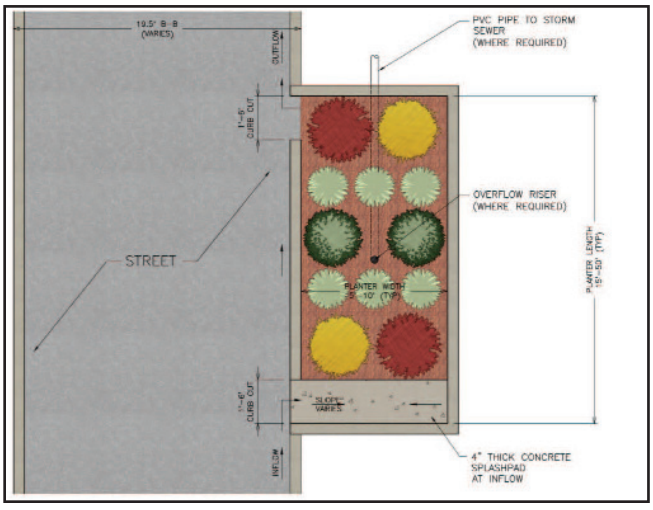
Stormwater management has long been regarded in municipal circles as a necessary evil; in order to permit development to occur, the impervious area and resultant stormwater runoff generated must be accommodated in some fashion. Without careful planning, poor stormwater control results in flooding, mosquito abatement issues and unhappy residents. Even with careful planning, managing stormwater requires expensive infrastructure and expansive detention basins to accommodate significant rain events. Over time, many municipalities have worked to beautify the stormwater management process by incorporating landscaping and other amenities into stormwater detention basins, and to attempt to turn such areas into passive recreation zones. Even when beautifying current designs, problems with controlling pollution resulting from street runoff, and accommodating peak stormwater flows can be very difficult.

In addition, while municipalities may have greater flexibility when designing from a blank slate with new development, there are many practical restrictions placed upon engineering and design principles when attempting to address stormwater control issues within existing, already developed areas. Historically, the best attempts typically involve attempting to install large diameter underground storm sewers to simply drain the problem away to somewhere else. However, with the advent of new technologies and new engineering design principles, municipalities now have options available to them to deal with stormwater management in an innovative, environmentally responsible fashion. The new tools described herein provide greater flexibility in addressing stormwater issues in existing areas, and provide ways to integrate, in an aesthetically pleasing fashion, stormwater control measures into new areas. In addition, wherever these new techniques are used, environmental benefits are certain to be reaped by the municipalities employing them.

Part One of this two-part article will describe the methodology and engineering principles behind the use of bioswales and related stormwater detention techniques. Part Two will address some of the practical issues which arise in attempting to utilize these new engineering principles, and will provide suggestions for making certain that municipal codes and ordinances adequately protect the investment in stormwater control infrastructure.

Part One: Engineering a Solution (the Pingree Grove case study):

Like many communities, the Village of Pingree Grove has worked in recent years to be an environmentally friendly community. It has undertaken projects such as recycling 100% of its wastewater effluent (through a spray-irrigation system) and constructing a LEED silver accredited police station. The Village incorporates substantial new development utilizing stormwater detention basins and similar infrastructure to accommodate 'new' stormwater control needs. The Village also includes a historical district, built before stormwater ordinances were in effect, which experiences occasional stormwater control issues. As part of an infrastructure improvement program, the Village sought to install upgraded streets with curb and gutters, and to implement a stormwater management program for the historical district. As different options for addressing the stormwater control issues were explored, Village leaders chose to evaluate some of the more environmentally friendly options available. At the forefront of those environmentally friendly options is the use of bioswales and related stormwater control mechanisms. After extensive investigation (both through research and through travel to other cities utilizing these stormwater management systems with success), the decision was made to include environmentally friendly stormwater controls into the renovation of the historical area of the Village.



In keeping with its conservation and green strategies, the Village implemented a "Green Street" strategy by the use of innovative bioswales to control stormwater runoff in its downtown area. A bioswale is a vegetated swale designed to intercept and convey stormwater runoff and is considered a Stormwater Best Management Practice (BMP). Stormwater from the area, if not managed properly, may contribute to pollution of rivers and

streams. Traditional stormwater management has been to convey runoff in storm sewers to detention basins and onto the natural drainage way. Sediment and pollutants can be carried along with the runoff and ultimately end up in rivers and streams. Bioswale improvements and other similar sustainable stormwater management (SSM) Programs, on the other hand, improve water quality by filtering pollutants and contaminants, reducing the rate of stormwater runoff, and decreasing erosion.

The stormwater runoff from the downtown Pingree Grove area is tributary to Tyler Creek, a high quality tributary stream to the Fox River. The Tyler Creek watershed itself has been undergoing extensive study due to the rapid pace of development and its threat to degrading water quality. The construction of the bioswale improvements will improve the runoff water quality from downtown area and ultimately be a key improvement in the watershed. The bioswale improvements were based on the Green Street designs from Portland, Oregon (one of the cities visited by the development team from Pingree Grove).

Layout and Configuration

A total of 13 infiltration bioswales were designed as part of a SSM and paving improvement project to convey and infiltrate a portion of the runoff from the existing downtown streets. The location of the bioswales was chosen at low points in the streets where a portion of the runoff from is allowed to infiltrate into the ground through the landscaped planter box. The other portion of the runoff not infiltrated through the bioswales is conveyed through storm sewers and connected to an existing storm sewer and outlet for the downtown area. The new bioswale and paving improvements replace an existing ditch and culvert section along the existing roadways. A typical plan view of the bioswale and street is shown below.

The planting box is designed with curb inlets to allow water to enter and exit the structure. Most of the runoff is allowed to infiltrate into the soil with some ponding in the structure. During heavy rain of extensive wet periods, the runoff will be carried through an overflow pipe back into the street and into a storm drain. Table 1 lists the physical details and configuration of the bioswales that were designed for this particular project.

One design criteria of great significance when retrofitting similar stormwater management techniques and infrastructure into existing areas of a municipality is the design flexibility inherent in bioswale use. As shown in the depiction above, bioswales and SSM programs can be incorporated into curbed areas of the right of way without having a significant impact on adjoining property owners. None of the bioswales utilized in Pingree Grove extend onto private property or require significant open areas of detention as would customarily be utilized. For example, a bioswale of 15'x8' generates sixty cubic feet of stormwater detention volume, without need for a pond or other structure. In effect, a single lost parking space is converted into valuable stormwater detention in an aesthetically pleasing fashion (and unlike traditional detention basins, bioswales permit water infiltration and aquifer recharge, instead of simply storing and discharging water to alternate locations). In lieu of wet or dry bottom grassed detention basins, bioswales can be attractively landscaped planter boxes, as described below.

Planter Box Design

The planter boxes utilized in Pingree Grove were designed to filter runoff and thereby improve water quality. The planter boxes are filled with an engineered soil medium consisting of a mix of topsoil, coarse sand, and compost to filter stormwater as it infiltrates into the ground through the planters. The coarse sand maximizes infiltration and mechanical filtering, while the compost provides organic matter to help aid biological and chemical filtering within the soil. Perennial herbaceous plants and shrubs were included based upon their ability to survive in both wet conditions such as during or after a rain storm, and between rain events when the soil dries out. Additionally, the most salt tolerant plants that met design requirements (height, appearance, etc.) were selected. Lastly, a dark-colored volcanic rock mulch has been specified in the planters. A wood mulch would have floated during rain events and therefore would not be practical, and a larger or heavier stone mulch could have created issues related to public safety and vandalism (i.e. the rock becoming projectiles). Within the first year or two, the planter boxes should appear lush and green, contributing to the overall aesthetic appeal of the new streetscape while providing "unseen" water quality benefits. The typical planter section is shown below, and the following table lists the variety of plants used in the planter box design.

The mulched surface of the bioswale in question is nearly sixteen inches below the adjacent top-of-curb, but with attractive plantings, it blends into the surroundings and discourages pedestrian cut-through traffic. (The base of the bioswale is several feet below grade, to provide a filtration and permeation area).

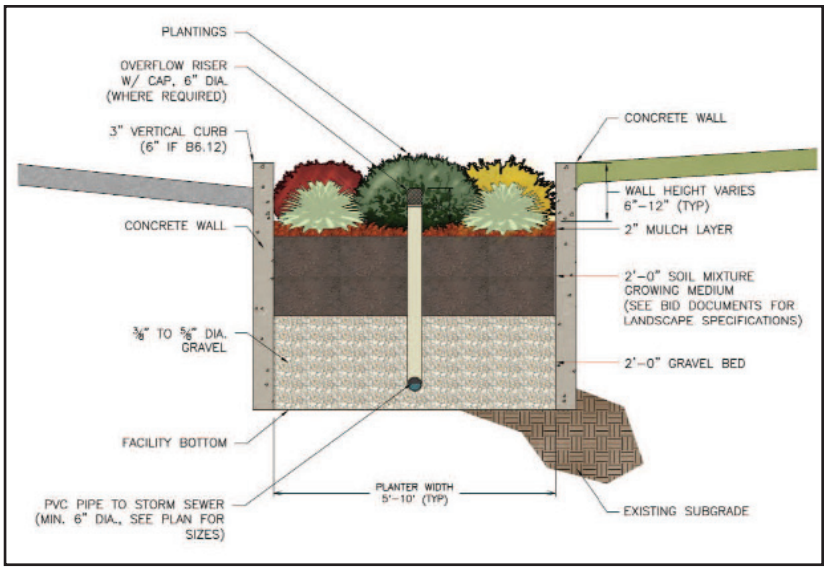
Protection and Maintenance

It is expected that periodic maintenance will be required until the plants in the bioswales are fully established. Standard landscape maintenance practices such as weeding to control/eradicate unwanted species, irrigation

Bioswale	Location	Dimensions	Internal Storage Volume (ft3)
No. 1	Reinking Rd.	30' x 7'	105
No. 2	Reinking Rd.	35' x 8'	140
No. 3	Railroad St.	(2) @ 20' x 7'	140
No. 4	Public St.	20' x 10'	100
No. 5	Prairie St.	20' x 6'	60
No. 6	Prairie St.	30' x 6'	90
No. 7	Grove St.	15' x 8'	60
No. 8	Grove St.	15' x 10'	75
No. 9	Jackson St.	20' x 10'	100
No. 10	Jackson St.	20' x 10'	100
No. 11	Railroad	10' x 5'	25
No. 12	Traffic Circle	57' diameter	1,275

during periods of drought, replacing plants that die or become damaged, and/or thinning/trimming overgrown plants may be required. The stone mulch will need to be maintained in conjunction with the plantings. Sediment accumulation is also expected with removal approximately twice a year. As can be seen in the photograph, leaves, dirt and other debris accumulates near the curbside cutouts that permit water to enter the bioswale.

This area is intentionally left clear of plantings, to permit an area for debris to collect and be easily removed as a component of the maintenance process.



Construction Cost

The construction cost of the bioswale improvements in Pingree Grove is projected to be $143,000, including plantings and planter box construction. The combination of road paving and the addition of curbs on many of the streets allowed for the bioswale construction to be a seamless integration into the roadway profile. If the Village decides to construct additional bioswale improvements in the future, the cost of the construction is likely to decrease as a result of design and construction experience from this project. As the improvements are all located within public right of way, no additional land acquisition costs were necessary (i.e. the Village did not need to locate a site for a traditional stormwater detention basin to accommodate the stormwater flows).

	Botanical Name	Common Name
Grasses		
	Deschampsia Cespitosa	Tufted Hair Grass
	Chasmanthium Latifolium	Northern Sea Oats
	Sporobolus Heterolepis	Prairie Dropseed
	Panicum Virgatum 'SheNandoah'	Switch Grass
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Shrubs		
	Hypericum Kalmianum	Kalm St. John's Wort
	Viburnum Prunifolium	Black Haw
	Diervilla Lonicera	Dwarf Honeysuckle
	Spiraea Alba	Meadow Sweet
	Amorphia Fruticosa	Indigo Bush
	Spiraea Tomentosa	Steeple Bush
Perennials/Flowers		
	Limonium Latifolium	Sea Lavender
	Physostegia Virginiana 'Pink Bouquet'	Obedient Plant
	Asclepias Incarnata	Swamp Milkweed
	Echinacea Purpurea 'Magnus'	Purple Coneflower
	Eupatorium Perfoliatum	Boneset
	Juncus Torreyi	Torrey's Rush
	Liatris Aspera	Rough Blazing Star
	Liatris Spicata 'Kobold'	Blazing Star
	Zizia Aurea	Golden Alexanders
	Solidago Speciosa	Showy Goldenrod

Engineering Benefits

There are many major benefits as an outcome of the bioswale project. It is expected that the water quality of the overall runoff from the area will be enhanced through infiltration of the captured stormwater. A portion of the

Example of a mature bioswale utilized as a planter box, in Portland, Oregon.

runoff is managed onsite instead of direct conveyance through the storm sewer system; therefore, the peak runoff events should be reduced by some margin. Runoff will be allowed to infiltrate thereby recharging the groundwater table. The bioswales can also reduce sediment and nutrient runoff.

The addition of the bioswales reduced the amount and size of storm sewers that would have been necessary to manage the runoff and the addition of landscaping improves the streetscape in the existing downtown. As part of the downtown revitalization and development the improvements bring the downtown area up to today's model for stormwater management in an attractive, aesthetically pleasing fashion. Furthermore, it brings attention to the public on conservation of stormwater runoff and fits into the Village's environmentally friendly practices. In addition, the incorporation of the stormwater control into the public right of way leaves more area available for any potential future redevelopment of historical areas, and ensures that adequate infrastructure will be available to service those areas. ■