Small-Scale Residential Stormwater Best Management Practices

1.0 Overview

1.1 Purpose

This manual is designed to provide guidance for landscapers, landscape architects, homeowners and small business owners in selecting, designing and installing stormwater Best Management Practices (BMPs) to reduce stormwater runoff on small-scale sites. It focuses on smaller, more frequently occurring precipitation events, which have the greatest overall impact on the quality of local waterways.

The purpose of this manual is to provide criteria for utilizing small-scale Stormwater BMPs to prevent and manage stormwater pollution and to diminish adverse impacts to our streams and lakes, as well as the health and safety of Lincoln residents.

1.2 Introduction

The physical and chemical characteristics of stormwater runoff change as urbanization occurs, requiring comprehensive planning and management to reduce adverse effects on receiving waters. As stormwater flows across roads, rooftops, and other hard surfaces, pollutants are picked up and carried to streams and lakes. Additionally, the increased frequency and volume of stormwater discharges due to urbanization can result in the scouring of rivers and streams, degrading the physical integrity of aquatic habitats, stream function, and overall water quality (EPA 2009). This manual provides information fundamental to effective stormwater quality management and planning, including:

- An overview of the potential adverse impacts of stormwater runoff.
- A summary of small-scale residential BMPs and how they can help reduce these adverse impacts and improve the quality of our streams and lakes.
- Design guidelines for these small-scale residential BMPs.

1.3 Urban Stormwater Characteristics

Numerous studies conducted since the late 1970s show stormwater runoff from urban and industrial areas can be a significant source of pollution. Stormwater impacts can occur during both the construction and post-construction phases of development. As a result, federal, state, and local regulations have been declared to address stormwater quality. Although historical focus of stormwater management was either flooding or chemical water quality, more recently, the hydrologic and hydraulic (physical) changes in watersheds associated with urbanization are recognized as significant contributors to receiving water degradation. Whereas only a few runoff events per year may occur prior to development, many runoff events per year may occur after urbanization. In the absence of controls, runoff peaks and volumes increase due to urbanization. This increased runoff is environmentally harmful, causing erosion in receiving streams and generating greater pollutant loading downstream. Urban characteristics (e.g. imperviousness, BMPs, drainage infrastructure, time of concentration) and watershed characteristics (e.g. drainage network, geology, slope, soils, climate) are some of the physical factors associated with stormwater runoff and the subsequent response of receiving waters (e.g. pollutant loads, channel morphology changes, riparian and aquatic conditions, connectivity, flooding).

With regard to chemical water quality, Table 8.1 identifies a variety of pollutant types and sources often found in urban setting such as solids, nutrients, pathogens, dissolved oxygen demands, metals, and oils. Several national data sources are available characterizing the chemical quality of urban runoff.

		Pollutants						
Pollution Source	Source Explanation	Solids	Nutrients	Pathogens	Dissolved Oxygen Demands	Metals	Oils	Synthetic Organic Chemicals
Pet Waste	Pet waste (typically from dogs and cats) may contribute significantly if waste is not properly disposed of. Other animal wastes, such as birds and wildlife, may also contribute.	X	X	X	X			
Fertilizers	Improper storage and disposal of fertilizers, over-application, or incidental application to impervious surfaces (e.g. driveways and sidewalks) can lead to excess nutrients in stormwater runoff. Excess nutrients often contribute to algal blooms.		X	X	X			
Soil Erosion	Sediment entering a stream through natural processes or erosion of construction sites can decrease the biological function of the water and be detrimental to aquatic habitat. In addition, sediment can "pick up" nutrients such as nitrogen and phosphorus, and carry them downstream. This can create an incubation zone for algae and bacteria growth.	X	X		X	X		
Gravel and Sand	Gravel and sand, primarily applied in the winter to provide better traction on urban streets, typically gets flushed off paved surfaces after rain events if it is not removed manually by a sweeper truck or other method.	X						
Vehicle Fuel and Fluids	Pollution from vehicles includes oil, grease, metals and fuel. Maintenance facilities, streets, driveways and parking lots typically drain directly to an urban storm drain system where water and pollutants are piped directly to streams.	X			X	X	X	X
Household Chemicals	Household chemicals, including paint, cleaners and preservatives, can contribute to the degradation of water quality if they enter the storm drain system.	X	X		X	X	X	X

2.0 STORMWATER BEST MANAGEMENT PRACTICES

2.1 Background

In the past, conventional wisdom for stormwater management held that water was a problem to solve rather than a valuable resource to conserve. Historically, the primary objective of conventional stormwater engineering methods has been to convey stormwater away from our developed areas, seeking to quickly export water away from where it falls instead of beneficially storing and using the resource. In nature, by contrast, stormwater is dispersed across the landscape, reducing water runoff volumes and release rates while simultaneously cleaning the water through natural filtration processes.

As native vegetation is replaced by impervious surfaces created by conventional development, these natural stormwater management and treatment functions are lost, resulting in increased runoff, flooding, erosion, and pollution. With increased amounts of paved areas and impervious surfaces, as well as shallow-rooted vegetation (e.g. bluegrass lawns.), filtration and infiltration of stormwater is greatly reduced and traditional stormwater management quickly sends increased runoff volumes into our lakes and streams.

Alternatively, stormwater Best Management Practices (BMPs) emulate natural systems by capturing stormwater runoff and allowing more rain to soak in where it lands. These BMPs can be designed into new developments or retrofitted into developed areas. This manual focuses on four stormwater BMPs commonly used in small-scale, retrofit applications such as residential lots. Below are the minimum design guidelines for each of these BMPs, as defined by the City of Lincoln.

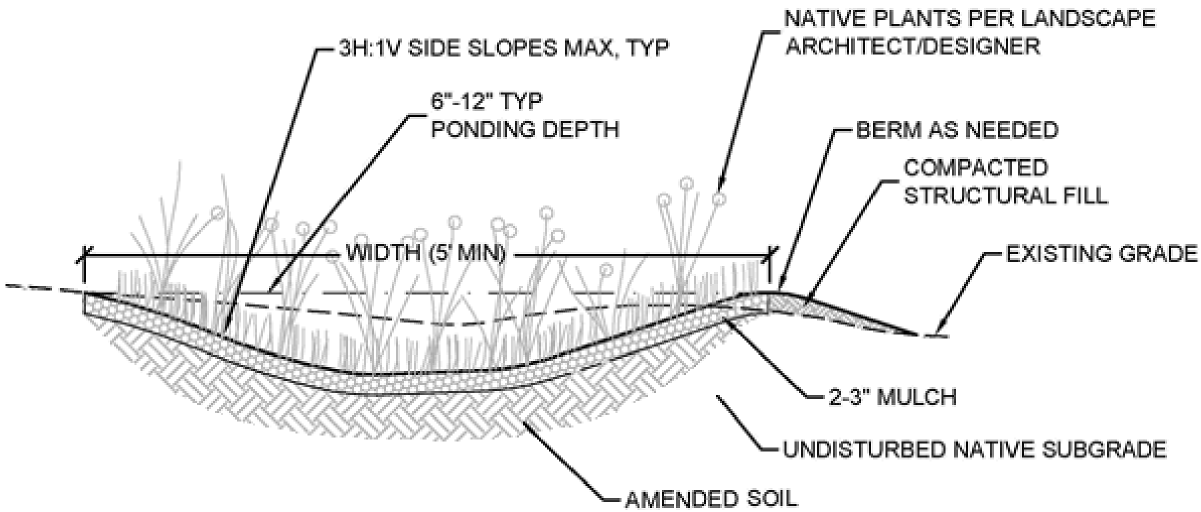
2.2 Rain Garden

2.2.1 Definition

A rain garden is a garden of native perennials, grasses and shrubs planted in a shallow depression. Rain gardens are designed and strategically placed on a gentle slope to capture stormwater runoff from a rooftop or other impervious surface. A berm is used to hold the water within the boundaries of the rain garden, allowing it time to soak into the ground below. Rain gardens are dry most of the time and typically do not hold captured stormwater for more than 24 hours following a rain event. If installed properly and under the right conditions, rain gardens can remove up to 90% of nutrients and chemicals from stormwater runoff (during a typical rain event).

2.2.2 Limitations

- Restrictions on where the facility may be successfully installed (e.g. cannot be installed uphill from a building foundation, etc.)
- Erosion-prone areas draining to the rain garden can clog the facility, pre-treatment is required for drainage areas with high sediment yields.
- Depending on the location of the rain garden, local ordinances may restrict plant height. Such restrictions may prohibit the use of certain species and/or varieties.



2.2.3 Design Specifications

Location:

- Rain gardens must be at least 10 feet away from building foundations and 20 feet is recommended.
- Rain gardens should be located downhill from buildings and other structures.
- Rain gardens cannot be in the public right-of-way or directly above buried utilities.
- Rain gardens must be located at least 25 feet away from a septic system or wellhead.
- Rain gardens should not be located where water tends to pool or where the water table is high.
- Slope of the surrounding area should not exceed 12%.

Sizing:

- Rain garden size is dependent on the size of the area draining to it. Rain gardens must be designed to capture, at a minimum, 100% of runoff produced by the area draining to it during a 0.83 inch rain fall event.
- Slope should be used to determine the depth of the rain garden, with steeper slopes requiring larger berms on the downhill side. Rain garden depth should not exceed 8 inches.

Infiltration:

- Overall infiltration rate must be greater than 0.25 inches per hour.
- Rain gardens should drain within 24 hours, but up to 48 hours is allowable.
- If necessary, deep aeration and soil amendments (e.g. compost) may be used to increase infiltration rate.
- An underdrain system, complete with clean-out pipe(s), may also be used to increase infiltration rate. Underdrains should be encased in 8 to 12 inches of #2 (2 ½ inch) crushed stone, with a 2 inch layer of #8 (3/8 inch) crushed stone on top (see bioswale diagram). Filter socks or geotextile fabric should not be used.

Features:

- Overflow should consist of a notch in the berm lined with 6 to 8 inch flat cobblestones (a.k.a. river skippers) to prevent erosion.
- If a sediment trap is needed/desired, it should be constructed with a flat bottom and notched overflow. Metal or high density plastic "boxes" are recommended.

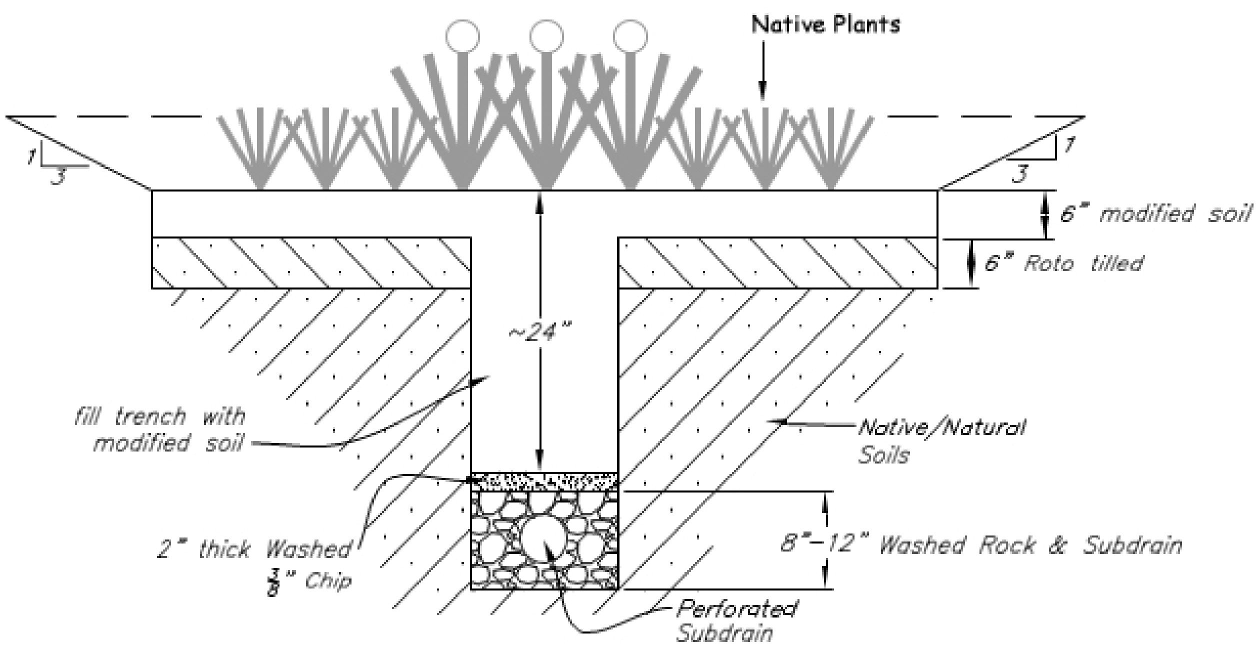
2.3 Bioswale

2.3.1 Definition

A bioswale is a garden of native perennials, grasses and shrubs planted in a long, shallow channel. Bioswales are designed and strategically placed to capture stormwater runoff from a rooftop or other impervious surface. Stormwater filters through the plants and soaks in as it makes its way along the channel. Some bioswales also utilize an underdrain system to speed infiltration. Bioswales are dry most of the time and they only hold water during a rainfall event. If installed properly and under the right conditions, bioswales can remove up to 70% of nutrients and chemicals from stormwater runoff (during a typical rain event).

2.3.2 Limitations

- Restrictions on where the facility may be successfully installed (e.g. cannot be installed uphill from a building foundation, etc.).
- Installations on steeper slopes are more prone to soil erosion.
- Depending on the location of the bioswale, local ordinances may restrict plant height. Such restrictions may prohibit the use of certain species and/or varieties.



Bioswale Cross Section

2.3.3 Design Specifications

Location:

- Bioswales must be at least 10 feet away from building foundations and 20 feet is recommended.
- Bioswales should be located downhill from buildings and other structures.
- Bioswales cannot be in the public right-of-way or directly above buried utilities.
- Bioswales must be located at least 25 feet away from a septic system or wellhead.
- Bioswales should not be located where water tends to pool or where the water table is high.
- Slope of the surrounding area should not exceed 5%.
- If slope of the surrounding area exceeds 5%, check dams should be used to slow velocity and control flow.

Sizing:

- Bioswale size is dependent on the size of the area draining to it. Bioswales must be designed to contain within its banks, at a minimum, 100% of runoff produced by the area draining to it during a 0.83 inch rain fall event.

Infiltration:

- Overall infiltration rate must be greater than 0.5 inches per hour.
- If necessary, deep aeration and soil amendments (e.g. compost) may be used to increase infiltration rate.
- An underdrain system, complete with clean-out pipe(s), may also be used to increase infiltration rate. Underdrains should be encased in 8 to 12 inches of #2 (2 ½ inch) crushed stone, with a 2 inch layer of #8 (3/8 inch) crushed stone on top (see diagram). Filter socks or geotextile fabric should not be used.

Features:

- If check dams are needed/desired, they should be designed to resist washout and scouring.

2.4 Waterwise Lawn

2.4.1 Definition

A Waterwise lawn is a lawn consisting of native turfgrasses planted on amended soil. Native turfgrasses such as buffalograss and blue grama are typically used, but cool-season grasses such as fine fescues are also acceptable. Not only are these grasses drought-tolerant, they also have extensive root systems that help more water infiltrate the soil and reach the deeper layers below. Waterwise lawns are planted on soil that has been amended with compost. The organic matter found in compost helps more stormwater soak in where it lands, instead of running off. Once established, Waterwise lawns require less maintenance (mowing, watering, fertilizing, etc.) than a traditional lawn. When installed properly, a Waterwise lawn generates significantly less stormwater runoff than a conventional lawn.

2.4.2 Limitations

- Maintenance requirements for these grasses differs greatly from conventional lawn care practices. Avoid using too much fertilizer (if any at all) and over watering. Herbicides may be used, but care should be taken to select a product appropriate for the type of lawn to which it will be applied.
- Most grasses recommended for Waterwise lawns do not tolerate heavy foot traffic well. However, the level of wear tolerance varies depending on species and variety.

2.4.3 Design Specifications

Soil:

- Organic matter content of the soil should be 5-10%.
- Soil amendments (e.g. compost) may be used to increase organic matter content. For heavy clay soils, the general recommendation is to till 2 inches of compost into 6 to 8 inches of soil. However, soil amendment requirements will vary depending on current soil conditions.

Grass:

- Waterwise lawns should consist of native or deep rooting grasses such as buffalograss, blue grama, or fine fescues.
- Lawns should be established via seeding, hydroseeding or plugs.

2.5 Permeable Paver System (Pavement Removal)

2.5.1 Definition

A permeable paver system is a type of paving that captures stormwater and allows it to percolate into the surrounding soil. The system typically consists of concrete blocks or clay bricks specially designed to maintain gaps along the abutting sides. These gaps are filled with rock chips, which are pervious and allow water to pass through to a special layer of crushed rock below. This layer, called the reservoir, contains voids that hold the water until it has time to soak into the soil below. When installed properly, permeable paver systems can reduce stormwater runoff up to 100% (during a typical rain event), with deeper reservoirs having greater storage potential, and remove pollutants such as nutrients and chemicals.

2.5.2 Limitations

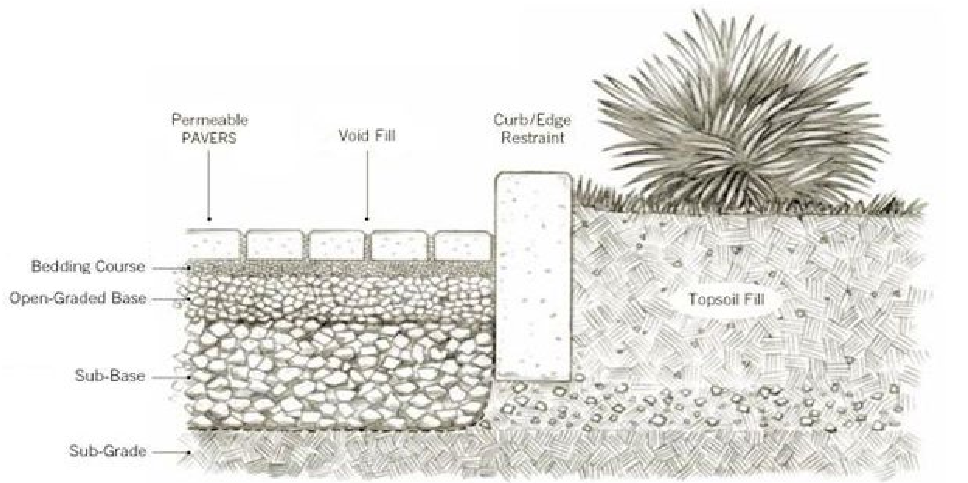
- Restrictions on where the facility may be successfully installed (e.g. cannot be installed uphill from a building foundation, etc.).
- Erosion-prone areas draining to the permeable paver system can clog the facility.
- Permeable paver systems require special maintenance, including vacuuming the pavers to remove sediment and buildup.

2.5.3 Design Specifications

Location:

- Permeable pavers should be at least 10 feet away from house or building foundations.

- If permeable pavers are within 10 feet of a house or building foundation, a waterproof liner must be used on the affected side to prevent seepage. An underdrain system is recommended.
- Permeable pavers should be located downhill and/or slope away from buildings and other structures.
- Permeable pavers cannot be located in right of way or directly above buried utilities.
- Permeable pavers must be located at least 25 feet away from a septic system or wellhead.
- Permeable pavers should not be located where water tends to pool or where the water table is high.
- Slope of surrounding area should not exceed 5%.
- Slope of permeable pavers should not exceed 3%.



Infiltration:

- Overall infiltration rate of subgrade soil must be greater than 0.5 inches per hour.
- If the infiltration rate of the subgrade soil is insufficient, an underdrain system should be used.

Sizing:

- Permeable paver system size is dependent on the size of the area draining to it. Permeable paver systems must be designed to capture, at a minimum, 100% of runoff produced by the area draining to it during a 0.83 inch rain fall event.
- Reservoir depth should be a minimum of 10 inches. Reservoirs are typically made up of two layers. The bottom layer should consist of at least 6 inches of #2 (2 ½ inch) crushed stone and the top layer should consist of at least 4 inches of #57 (3/4 inch) crushed stone. Note: the reservoir depth does not include the pavers or bedding material.

Features:

- Bedding layer should consist of 2 inches of #8 (3/8 inch) crushed stone. Gaps between pavers should be filled with #8 (3/8 inch) or #9 (1/4 inch) crushed stone.
- If a waterproof liner is needed, it must extend to the bottom of excavation and then 5 feet away from the house or building foundation.
- Bottom of excavation must slope away from house or building foundation at 1 to 2%.