MANAGING STORMWATER RUNOFF FOR RURAL LANDOWNERS

Options for Managing Surface Water Drainage

Introduction

In rural areas you may not have city services like storm drains that conveniently carry stormwater away. This fact sheet describes ways you can manage drainage issues on your property, including removing standing water in your yard, preventing erosion, dealing with minor flooding, and redirecting water from your building foundation. In addition, you will be protecting groundwater and water quality in nearby lakes, streams, and marine waters.

Stormwater Basics

When the amount of rainfall and snowmelt exceeds the land's ability to absorb it, stormwater runoff results. Stormwater runoff is generated from rain and snowmelt that flow over land or impervious surfaces—such as streets, parking lots, compacted lawns, and rooftops—where the water cannot soak into the ground. Large volumes of stormwater runoff can cause erosion and flooding—even a little runoff can do damage if not effectively managed.

The amount of runoff and the rate at which it flows off the land varies with the intensity and duration of the rainfall and the type of land surface upon which it falls. Thus, moderate rainfall on permeable soils in a forested area might produce little to no runoff. However, that same rainfall on a paved or compacted gravel parking area can produce a substantial amount of runoff. If that water is not managed correctly, it may transport contaminants such as trash, chemicals, animal waste, oils, heavy metals, and dirt (sediment), that degrade water quality in our rivers, streams, lakes, and coastal waters.

Figure 1. Runoff in rural areas can impact water quality. Credit. D. McNamara

Options for Rural Stormwater Management

In this fact sheet, you will learn the advantages, disadvantages, and limitations of various stormwater "best management practices" (BMPs). While these techniques sometimes have varying names and specifications in different regions, this fact sheet was developed for Western Washington. You may be able to design and construct some of these techniques yourself, while others may require the help of a planner, engineer, or other professional.

The techniques covered in this fact sheet are grouped by how they manage drainage and include:

Options for detaining and infiltrating water
- Rain garden
- Bioretention system
- Gravel trenches: French drain/curtain drain
- Drywell

Options for conveying water
- Bioinfiltration swale
- Drainage ditch

Options for dispersing water
- Downspout dispersion
- Sheet flow dispersion
- Concentrated flow dispersion

Options for infiltrating water in areas with traffic
- Permeable pavers
- Gravel grid
- Porous asphalt
- Pervious concrete

Once you decide on an approach, be sure to check with your local planning department for permit requirements and regulations, and call before you dig by calling 8-1-1 or online at **http://www.callbeforeyoudig.org/washington/**.

Before attempting to identify drainage solutions for your property, you may want to review the fact sheet **Understanding Your Site Conditions**. That fact sheet includes tips on creating a site map to better understand how water moves on your property and what constraints you may have.

Options for detaining and infiltrating water

Unlike water conveyance systems that transport water across the landscape, retention systems capture, detain, and allow stormwater infiltration from the surface into the native soils below or to an underdrain. This reduces potential flooding and erosion as well as facilitates contaminant removal. Detaining and infiltrating water, where possible, is preferred since it alleviates downstream problems that additional water can create. There are several ways to design infiltration systems, but in every case, the bottom of the system is designed to be as flat as possible to allow for uniform infiltration.

Bioretention system

Bioretention is the process that captures and detains stormwater and allows for slow infiltration to remove contaminants and sediment using soil, plants, microbes, and other components of a healthy soil ecosystem. "Bioretention system" is a term used to refer to engineered systems using a specified Bioretention Soil Mix (BSM) designed to accommodate large volumes of stormwater runoff, often in commercial areas. The size, shape, and other characteristics of the bioretention systems depend on the contributing area, precipitation characteristics, the infiltration rate of the native soil, and site constraints such as steep slopes.

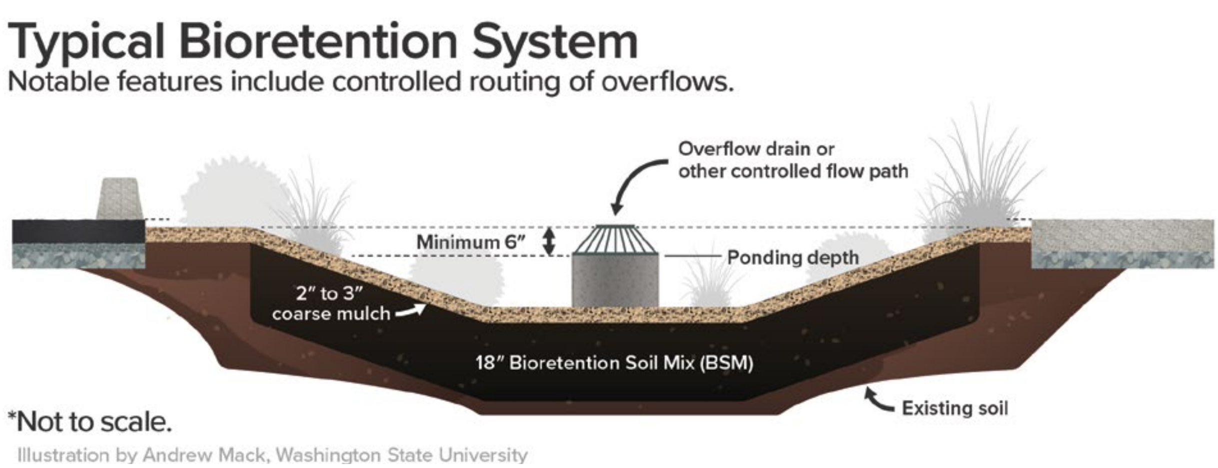


Figure 2. Cross-section of a typical bioretention system[1]

Rain garden

A rain garden is a bioretention system that usually does not need an engineer to design and is suitable for homeowners to install with a basic level of training. It is a shallow, flat bottomed, bowl-shaped feature designed to collect, filter, and infiltrate stormwater runoff from roofs and pavements. Rain gardens require a special soil mix or amendment of the existing soils with compost, plants that can withstand inundation and drought, and several inches of mulch to retain moisture and reduce maintenance. These components work together to remove contaminants, infiltrate water and provide other ecosystem and aesthetic benefits. Detailed information about rain gardens can be found in the "**Rain Garden Manual for Western Washington**."

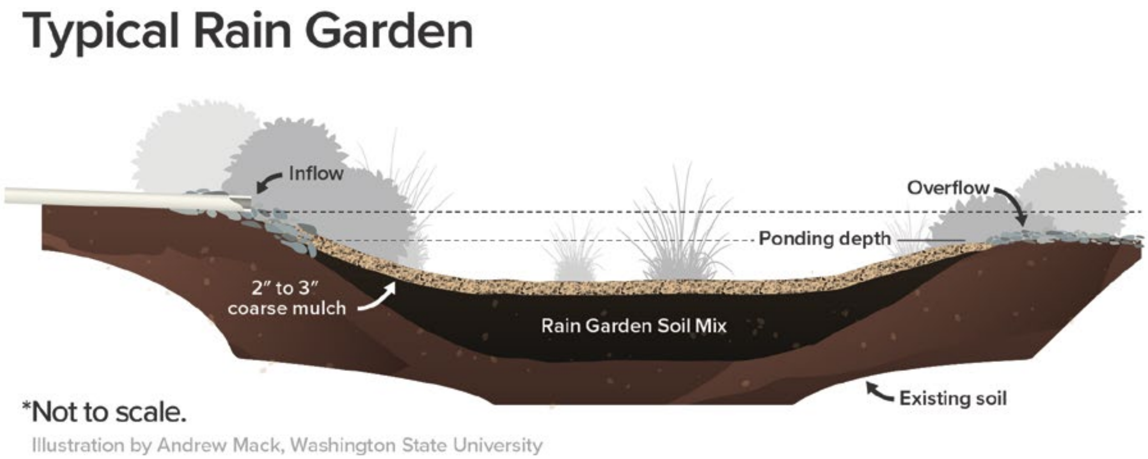


Figure 3. Cross-section of a typical rain garden[2]

Gravel trenches (French/curtain drains, and drywells)

Gravel trenches are narrow, stone-filled channels situated over well-draining soil and utilize the empty spaces between stones to act as a temporary reservoir for stormwater as it soaks into the surrounding soil.

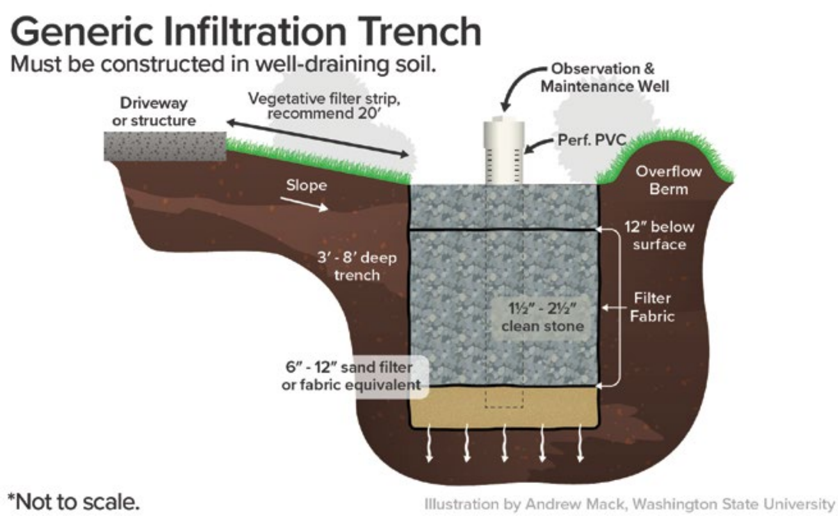


Figure 4. Generic infiltration system[1]

There are two general types of trenches—open and closed. Open infiltration trenches collect storm-water that flows from the surface of impervious areas such as a driveway through a vegetated filter strip and into the top of the trench.[3] A closed or subsurface infiltration trench handles stormwater that comes through a pipe into a sedimentation basin and eventually into the subsurface of the trench through a perforated pipe.[3] Trenches are typically designed with an overflow berm where excess water can flow out to a vegetated area. French drains and curtain drains are examples of gravel trench systems. Some French and curtain drains are designed to intercept shallow groundwater and move it away from features such as foundations and septic drain fields, these are different, and are not discussed in this publication.

Drywell

Drywells are similar to gravel trenches, but function vertically rather than horizontally. They are small underground chambers or pits that are filled with stone and allow runoff to infiltrate into the surrounding soils. They are sized according to the amount of water that needs to be managed, as well as the permeability of the soils. Runoff moves into the drywell through underground piping. Most drywells are buried and have an observation pipe. They are commonly used for runoff from sources that are low in contaminants, such as roofs.

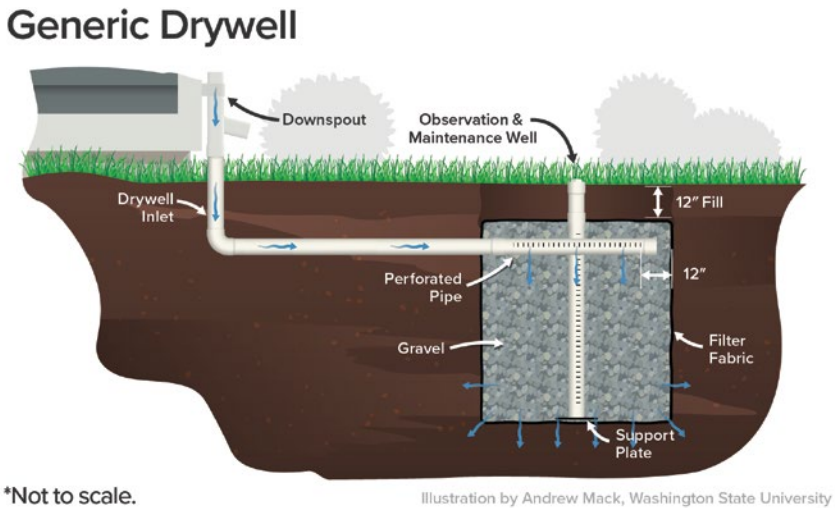


Figure 5. Generic drywell[4]

Table 1. Main differences between retention options.

Features	Bioretention System	Rain Garden	Gravel Trench/Drywell
Scale and suitability	Engineered bioretention system primarily used in larger applications. Size depends on infiltration rates and size of contributing area; engineered to meet water quality and quantity performance goals. Requires specific soil mix to ensure that it will adequately handle the flow and treat pollutants.	A type of bioretention system. Suitable for many locations but typically designed for homeowners and residential areas. Size is dependent on soil-drainage rates, but typically less than 15% of the size of the contributing area. Shape often depends on site constraints, landowner aesthetics and can range from long-skinny, kidney bean shaped, square or round.	Suitable for managing low contaminant runoff from sites. A good choice in locations where other methods won't fit. Gravel trench: Linear detention and infiltration system perpendicular to flow. Drywell: A buried chamber or pit filled with gravel.
Water quantity and quality benefits	Provides known level of contaminant and sediment treatment. Reduces peak flows and total runoff volumes.	Provides contaminant and sediment treatment but treatment levels are variable. Reduces peak flows and total runoff volumes.	Reduces peak flows and total runoff volumes. Provides some level of contaminant and sediment treatment.
Soils and mulch	▸ Uses an engineered mix of sand and compost—the sand and compost must meet a specific gradation. ▸ Often topped with mulch.	▸ Uses a "rain garden soil mix" of onsite soils or sand, plus yard-waste compost. ▸ Topped with mulch.	▸ Gravel or drain rock. ▸ No mulch.
Vegetation	Can be beautifully planted to fit any landscape. Need to select plants that can survive periods of saturation and ideally summer drought (to limit watering).	Can be beautifully planted to fit any landscape. Need to select plants that can survive periods of saturation and ideally summer drought (to limit watering).	Gravel trench usually not vegetated. Closed infiltration trenches and drywells can be covered with grass.
Maintenance	▸ Weeding, inflow and overflow cleaning. ▸ May need irrigation for plant establishment. ▸ Underdrain (if used) requires maintenance. ▸ Add mulch as needed.	▸ Weeding, inflow & overflow cleaning as needed. ▸ May need irrigation especially during first 2 years for plant establishment. ▸ Add mulch as needed.	▸ Remove debris. ▸ Weeding. ▸ Mow vegetative filter strip (bag grass clippings).

Options for conveying water

The following options control the flow of stormwater runoff or move water to other locations. Things to consider include the volume of water to move, peak flow rate, types of contaminants that might be present in the stormwater, adjacent land uses, soil types, slopes, and where the water is discharging to. Water movement occurs via a channel with a gentle downhill grade causing water to move by gravity. One presented technique removes contaminants and improves water quality, while the other only moves water.

Bioinfiltration swale

A bioinfiltration swale is a heavily vegetated open channel that moves water slowly. It is specially engineered to primarily convey stormwater and secondarily to achieve some infiltration and pollutant removal. The grass-like plants used in a bioswale help filter out the oils and sediment transported to them from impervious surfaces such as roads, driveways, and parking lots. Water is moved along the swale more slowly than a conventional drainage ditch, allowing water to filter through the plants and infiltrate into compost-amended soils below.

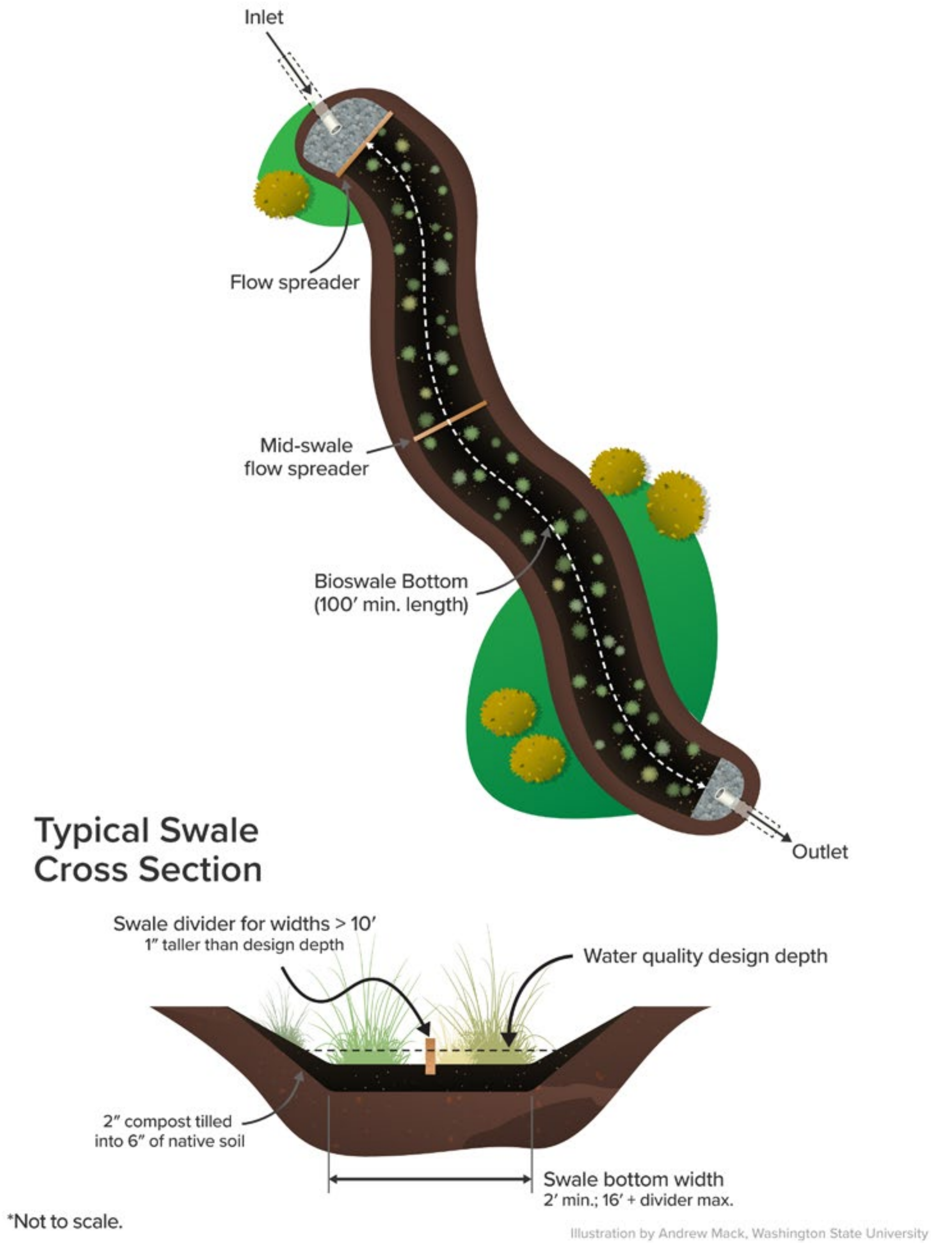


Figure 6. Anatomy of a bioinfiltration swale[5]

Drainage ditch

A drainage ditch is an open channel that moves water quickly from one place to another. It provides little to no water quality treatment; however, it can be helpful in moving water to or from an area where treatment occurs.

Figure 7. Drainage ditch with erosion control matting and rock check dams to slow water conveyance. Credit C. Thompson

Table 2. Main differences between options for conveying water.

Features	Bioinfiltration Swale	Drainage Ditch
Purpose	Moving water slowly from one area to another, treating it along the way, improving water quality and reducing flooding.	Removing water quickly from one area to another to reduce flooding.
Design	▸ Flat bottom sloping at a slight gradient to allow slow water conveyance. ▸ Dense plantings slow water to allow for infiltration, removing contaminants. ▸ May require engineering. ▸ May have check dams.	▸ Typically, U or V shaped bottom with varying downhill slope conveys large volumes of water from the area. ▸ Homeowner can design. ▸ May have check dams.
Soils	Typically amended with compost.	Native soils. No amendment.
Water Quality and Treatment	Effective for trapping sediment and associated pollutants.	Little to no water quality treatment.
Vegetation	Yes. 70% coverage minimum; hardy native grasses, sedges, and rushes in treatment area.	Not planted, however, turfgrass and other vegetation commonly grow in them. Could be lined with gravel to reduce the potential for erosion.
Maintenance	Mowing (only when just grasses are planted), leaf and sediment removal.	Cleaning ditch of plants (grasses can be left and mowed), leaves, and sediment as needed.

Options for dispersing water

Surface dispersion systems primarily utilize the existing landscape to slow and process stormwater. The stormwater is forced to flow as a sheet ("sheet flow") across the surface vegetation—the combination of spreading out the flow and slowing it down enhances infiltration of the stormwater into the native soils. This method is most suitable for properties with vegetated landscapes that contain enough room for stormwater to "naturally" disperse and infiltrate onsite. However, there is a potential to adversely impact adjacent properties and waterways if the property is too small and water runs off the property.

All surface dispersion systems have specific design requirements, which vary by jurisdiction. However, broadly, all dispersion BMPs have the following three components:

- Contributing areas—where the stormwater comes from, such as a driveway or roof.
- A "flow path"—the route water takes as it flows from contributing area to the dispersion area.
- The dispersion area—the area or piece of land where the stormwater will be directed to for dispersion.

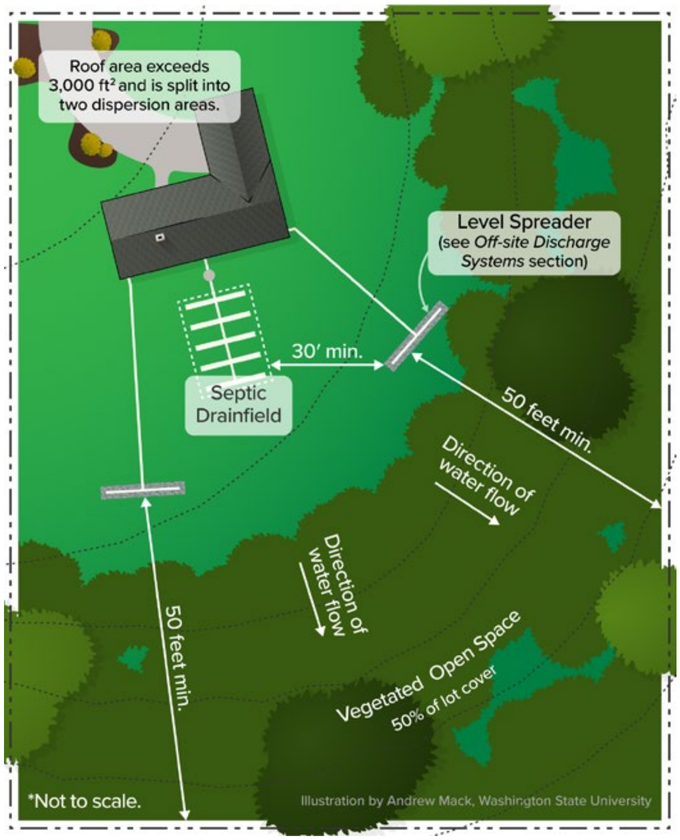


Figure 8. An example of a dispersion plan[6]

The simplest dispersion systems use unaltered native vegetated areas to accept stormwater runoff generated from impervious or compacted surfaces (roofs, roads, driveways, and paved areas). However, forested or heavily vegetated landscapes with soils uncompacted by heavy equipment are also often well suited to process stormwater runoff. Other dispersion systems include additional components to gently direct and spread stormwater flow onto landscape areas designated for stormwater accumulation and infiltration.

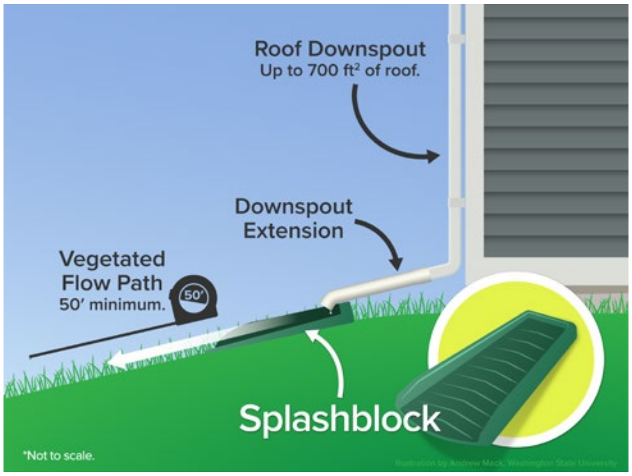
Below are some example design requirements for each surface dispersion BMP. Creating a dispersion plan is a good way to determine which design is right for your property. The best way to start is with a site plan, which can be developed following the guidance in the fact sheet **Understanding Your Site Conditions**.

Downspout dispersion

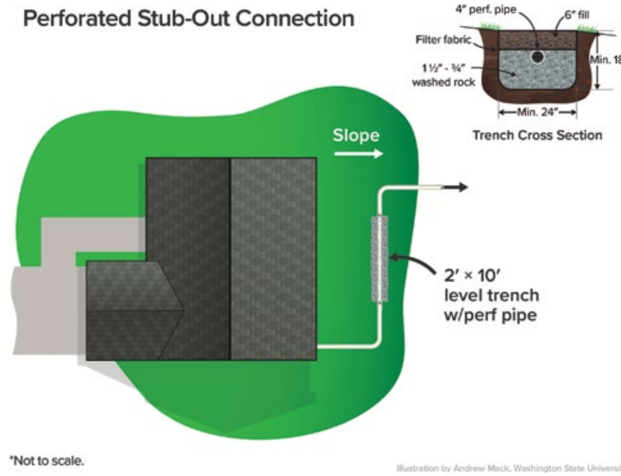
There are three different roof downspout dispersion methods: downspout splashblock, downspout dispersion trench, and dispersion trench with notched grade board.

Downspout dispersion using a splashblock is the simplest to implement of the three options listed above. Splashblocks require adequate vegetation, well-draining soils, proper flow paths, room for effective dispersion, and ground that slopes gently away from the foundation.[1]

Splashblock dispersion requires a vegetated flow path that infiltrates the water before reaching a structure, waterway, or property line. The distance is dependent on the volume of water anticipated from a significant rainfall event and the permeability of the soil. If this ideal distance is not attainable, a dispersion trench can be added. Depending on the site, the trench may also require a notched board to spread out the concentrated flow across the face of the vegetated flow path. Finally, if the vegetated flow path is shorter than 25 feet, a perforated stub-out connection may be necessary.[1]



▌ *Figure 9. Downspout dispersion*[1]



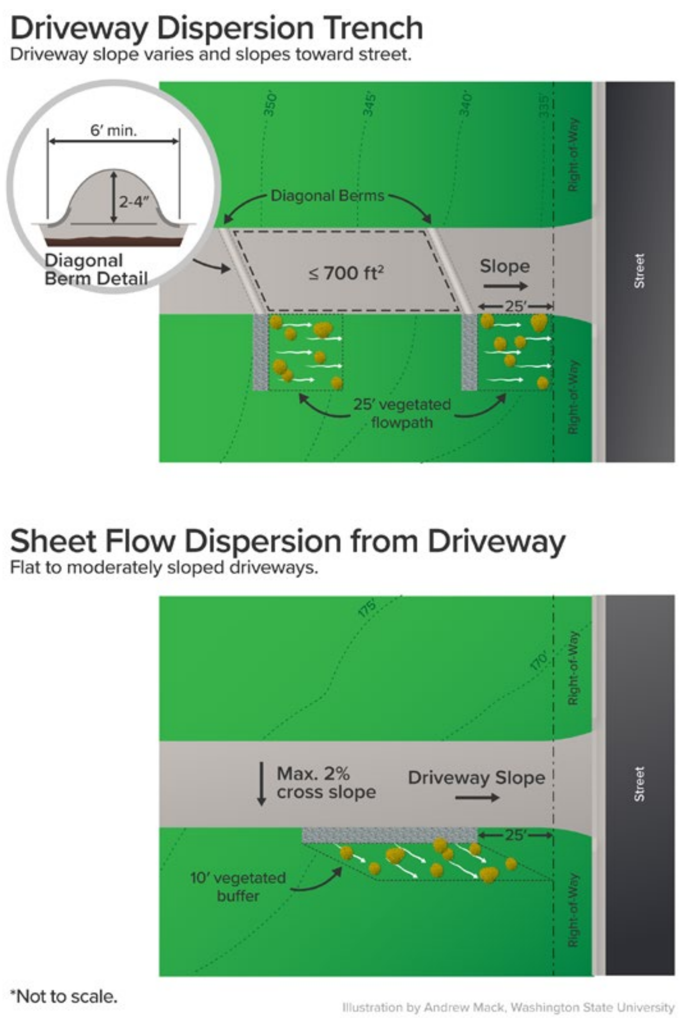
▌ *Figure 10. Perforated stub out connection*[1]

Sheet flow dispersion

Sheet flow dispersion systems have a transition zone and a vegetated buffer or dispersion area. The transition zone is primarily a two-foot-wide area of material such as drain rock, which is next to the impervious surface (e.g., driveway). The transition zone helps prevent erosion and channeling and aids the even flow to the designated vegetative buffer.[1] The vegetated buffer size is related to the size of the impervious surface and the permeability of the soils; the larger the driveway, the larger the vegetated buffer. With moderately well-drained soils, a driveway up to 20 feet wide requires a 10-foot vegetated buffer. An additional 10 feet of vegetated buffer width is needed for every additional 20 feet of impervious surface width or fraction thereof.[1] A 30-foot-wide driveway, for example, would require a vegetated buffer with a width of 20 feet.

Concentrated flow dispersion

Stormwater generated from impervious surfaces on sloped properties tends to flow along concentrated or channelized pathways. Therefore, specifically adapted concentrated flow dispersion BMPs include additional features like a rock pad or a dispersion trench to disperse concentrated flows. The rock pads or dispersion trenches are types of level spreaders—they slow down the water and spread it out over a wider area. The addition of a notched board, placed in a level manner across the slope, can also be added to ensure even distribution of the flow into the vegetated area. Downstream of the level spreader, there needs to be an unobstructed vegetated flow path of at least 25 feet free of rigid structures, steep slopes, water bodies, or other impervious surfaces to ensure proper dispersion. Additionally, "for sites with septic systems, the discharge point must be ten feet downgradient of the drain field and primary reserve areas."[1] The steepness of the property determines the length of the flow path and what type of level spreader is necessary.



▌ *Figure 11. Sheet flow dispersion for driveways*[1]

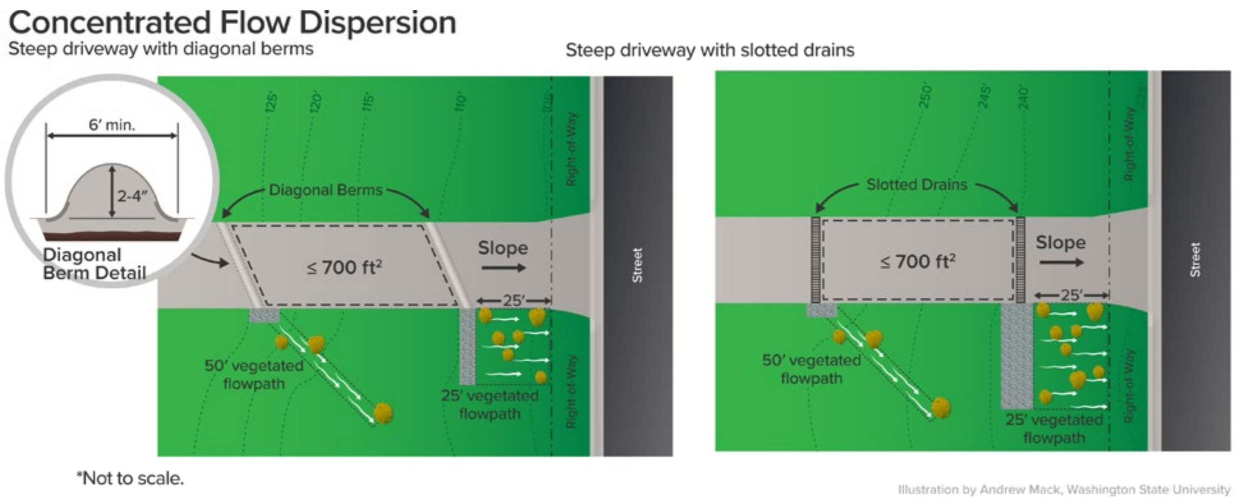


Figure 12. Concentrated flow dispersion for steep driveways[1]

Table 3. Main differences between stormwater dispersion systems[1]

Features	Downspout Dispersion	Sheet Flow Dispersion	Concentrated Dispersion
Purpose	Disperse roof runoff water at bottom of roof gutter downspout.	Dispersion system designed to manage stormwater off gently sloped impervious surfaces.	Dispersion system designed to manage stormwater off steeper-sloped impervious surfaces where water concentrates and does not sheet flow.
Design	Water is directed away from structures to dispersion areas. Various dispersion techniques that can be used, depending on site conditions.	Transition zone next to impervious surface that leads to a dispersion area.	Concentrated flow from an impervious surface is spread out before entering a dispersion area.
Soils	Uncompacted, well-draining soil is essential.	Uncompacted, well-draining soil is essential.	Uncompacted, well-draining soil is essential.
Vegetation	Yes, specifically sized vegetated flow path requirements.	Yes, specifically sized vegetated buffer requirements.	Yes, specifically sized vegetated flow path requirements.
Maintenance	▸ Monitor flow path for erosion or sediment accumulation. ▸ Maintain healthy vegetation.	▸ Monitor transition zone and vegetated buffer for erosion or sediment accumulation. ▸ Maintain healthy vegetation.	▸ Monitor flow path for erosion or sediment accumulation. ▸ Maintain healthy vegetation.

Options for infiltrating water in areas with traffic

Permeable pavements help to sustainably manage polluted stormwater by filtering, slowing, and infiltrating stormwater as it flows across the landscape. Permeable pavements have an upper "wearing layer" that is rigid enough to support vehicles and permeable enough to allow water to pass through pores in the layer. This upper layer is commonly made with grids, pavers, pervious concrete, or porous asphalt. Below the wearing layer are base layers of different sizes of aggregate with various pore spaces where the water infiltrating from the surface is temporarily stored. Over time, the water in the storage layers slowly infiltrates into the native soils.

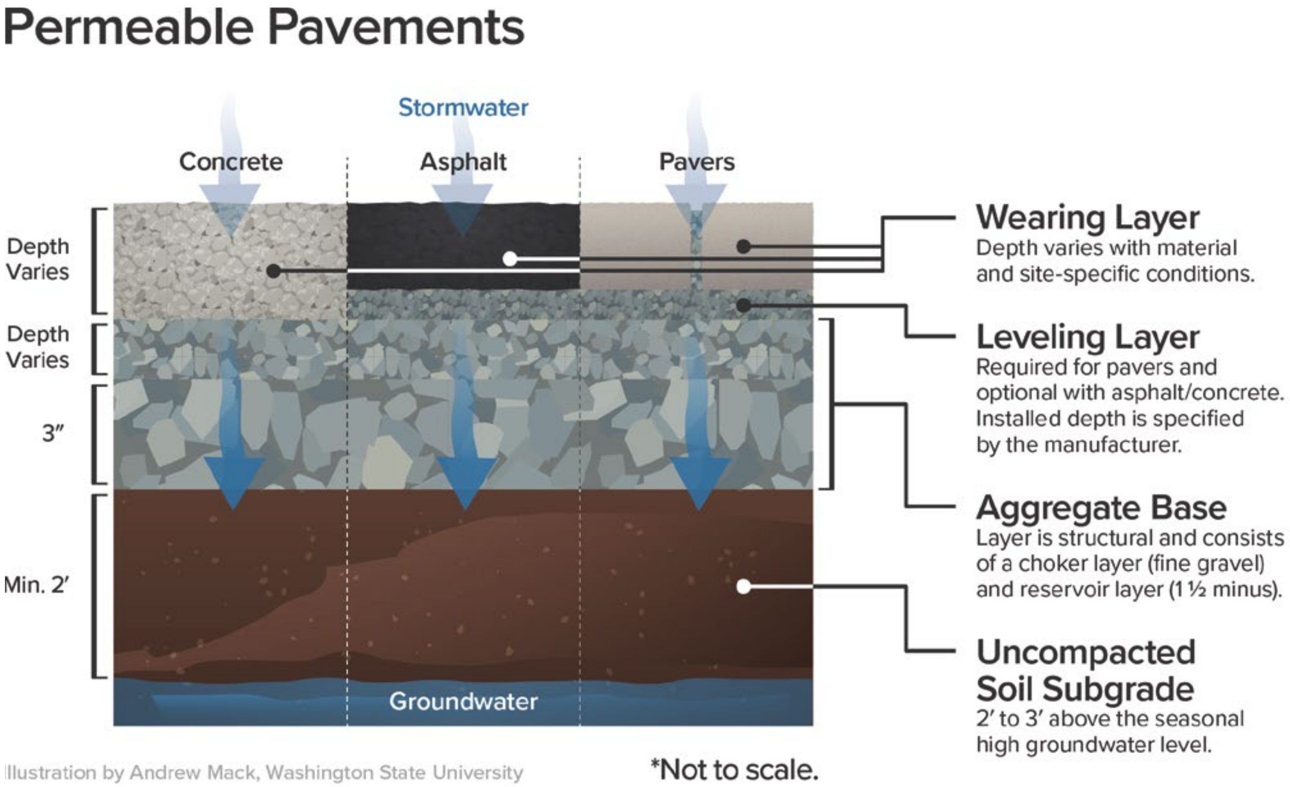


Figure 13. Cross-section of permeable pavements[7,8]

Permeable pavers

Figure 14. Two types of pavers, inset paver is permeable. Credit: C. Thompson

Like regular interlocking pavers, permeable pavers can be attractive in a home or commercial setting. However, unlike interlocking pavers, permeable paving blocks are spaced to allow water to flow between them into the subsurface. There are two types of permeable paver systems. The first type uses impermeable blocks that are spaced apart, with unsealed joints filled with specific grades of gravel aggregate so that water can flow between them into the subsurface storage layer. The second type uses permeable blocks that allow water to flow directly through them. In both systems, required grades of gravel aggregates or sand are typically used between blocks, and the subsurface is underlain with larger stones to facilitate drainage. There may also be engineered storage capacity or piping depending on the native soils and volume of water received. It's also important to consider the type and frequency of traffic the area will receive. Pavers are typically designed only to accommodate light traffic conditions—not heavy trucks.

Gravel grid pavers

Gravel grid pavers work with an engineered form of rigid plastic or concrete that has open cells that are filled with gravel. The form is placed below grade, and then the required grade of gravel is inserted in the openings. If heavier traffic is anticipated, an additional subsurface of gravel may be needed depending on the underlying soils. Other grid systems rely on the open cells being filled with soil and planted with grass if traffic is light. Vehicles can drive or park on the grid, and water can flow through.

Figure 15. Gravel grid pavers Credit: C. Thompson

Permeable pavement: Pervious concrete and porous asphalt

Permeable paving options are usually found in urban and suburban areas, but rural areas can benefit too. Like all the methods discussed in this fact sheet, proper design and construction are essential for function and long-term maintenance, including ensuring that the site's underlying soils and subsurface water levels are appropriate for installing these systems.

Newly installed permeable pavements may have very high infiltration rates initially, however the infiltration rates decline somewhat over time. However, as long as the system receives regular maintenance (at least annually) to keep the pore spaces from clogging with sediment and debris, small decreases in infiltration are unlikely to affect overall performance.

Figure 16. Pervious concrete (left) and porous asphalt (right). Credit: C. Thompson

Watching where the water goes during heavy rain events is an excellent way to ensure permeable pavements are functioning correctly. For example, noticing a significant amount of water flowing across the top of the pavement instead of soaking in indicates that the pavement is likely clogged with sediment. Traditional asphalt and concrete mixes contain a wide range of particle sizes that interlock and create an impermeable surface. Pervious concrete and porous asphalt mixes, however, use only larger particles, resulting in the creation of pores (or voids) in the pavement. These pores allow water to infiltrate through them, from the surface to the underlying layers. Porous asphalt void space ranges from 16 to 25 percent, and the asphalt has some flexibility to it. Pervious concrete void space typically ranges from 15 to 35 percent and is considered a rigid pavement. These pavements offer other benefits, including avoiding the need for seal coats and allowing water and snowmelt to penetrate, avoiding wear due to the freeze-thaw cycle.

Table 4. Main differences between permeable surface options[1]

Features	Permeable Pavers	Gravel Grid	Porous Asphalt	Previous Concrete
Appropriate for	Residential and light commercial use, trails, pedestrian paths, driveways.	Trails, paths, access roads, driveways, patios, residential use.	Parking lots and streets with low-weight axle loads, and light traffic volumes.	Heavier traffic loads. Also commonly used for sidewalks and parking lots.
Construction (min. layer requirements)	Pavers on top of an aggregate base that is installed above infiltrating soils.	Concrete or rigid plastic grids filled with topsoil/grass or gravel over an aggregate base that is installed over infiltrating soils.	4-inch minimum porous asphalt wearing layer on top of 6-inch sand layer, with an aggregate base that is installed over infiltrating soils.	6-inch minimum pervious concrete wearing layer on top of 6-inch sand layer, with an aggregate base that is installed over infiltrating soils.
Maintenance	▸ Sweep or vacuum when surface and debris are dry 1-2 times annually. ▸ Occasional pressure washing, as prescribed by manufacturer. ▸ Replace joint aggregate as necessary.	▸ May need to replace or replenish gravel if clogged or depleted.	▸ Prevent sediment from collecting on pavement ▸ Clean surface twice a year with a combination of suction and sweeping.	▸ Prevent sediment from collecting on pavement ▸ Clean surface annually with a combination of suction and sweeping.

What's Next?

How do you know which drainage solution is right for you? Try making a site map of your property. See the fact sheet Understanding Your Site Conditions. A map will outline more clearly what your options are. The resources below link to more information about the strategies described above.

A word of caution

Clearing native vegetation, interrupting the flow of water, compacting soils, or adding additional impervious surfaces—such as a driveway—changes the way water flows on your property. Altering the water flow can have unintended consequences downstream such as flooded basements, overwhelmed culverts, washed-out roads, and loss of salmon habitat. Please consult with someone knowledgeable at your local Extension office or conservation district first.

Determining which management practice is most appropriate to manage stormwater on your site may require consultation with an expert or participation in some basic training offered by the local county, Extension, or conservation district. This document seeks to outline some options but is not written as a substitute for professional advice. Please consult with your local planning department and be familiar with the stormwater ordinances in place in your area.

Resources

For more information, visit Rural Stormwater Solutions (**https://ruralstormwater.wsu.edu/resources/**).

References

For links to these references, visit Rural Stormwater Solutions (**https://ruralstormwater.wsu.edu/references/**).

1. Washington Department of Ecology. *2019 Stormwater Management Manual for Western Washington.*
2. Washington State University Extension. *Rain Garden Handbook for Western Washington: A Guide for Design, Maintenance, and Installation (2013).*
3. Michigan Department of Environmental Quality. *Infiltration Trench*. (1992).
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