New Hampshire Homeowner's Guide to Stormwater Management

DO-IT-YOURSELF STORMWATER SOLUTIONS FOR YOUR HOME

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do-it-yourself stormwater solutions for your home

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NEW HAMPSHIRE HOMEOWNER'S GUIDE TO STORMWATER MANAGEMENT

DO-IT-YOURSELF STORMWATER SOLUTIONS FOR YOUR HOME

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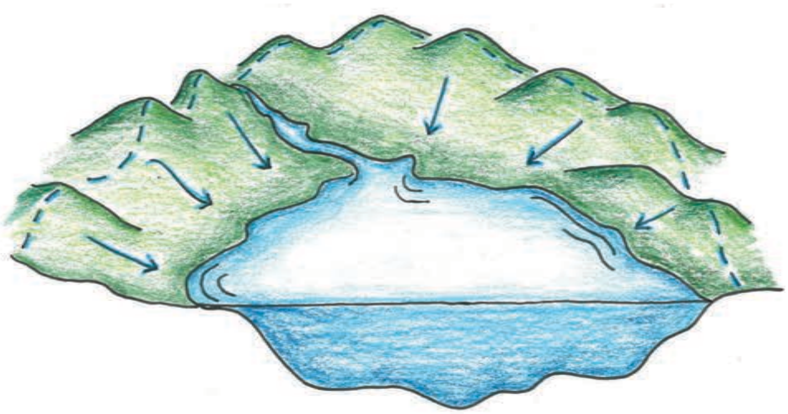
Introduction

WHAT IS STORMWATER RUNOFF?

Stormwater is water from precipitation events, like rain or melting snow. In a forest, meadow, or other natural environment, most stormwater soaks into the ground while a small portion flows over land to create brooks, streams, and rivers. When natural areas are developed into places like residential neighborhoods, commercial areas, and shopping centers, impervious surfaces such as rooftops, roads, parking lots, and compacted turf grass areas are created. During precipitation events, impervious surfaces act to prevent stormwater from soaking into the ground, thereby increasing overland flow and creating stormwater runoff.

Excess stormwater runoff becomes a problem when streams have to accommodate more flow than nature designed, resulting in flooding, stream bank erosion, and reduced groundwater recharge. Runoff can also carry pollution into waterbodies, making them unsafe for swimming and creating an unsafe habitat for fish and other animals. In fact, stormwater runoff contributes to over 90% of the water quality problems in New Hampshire.

WHAT IS A WATERSHED?

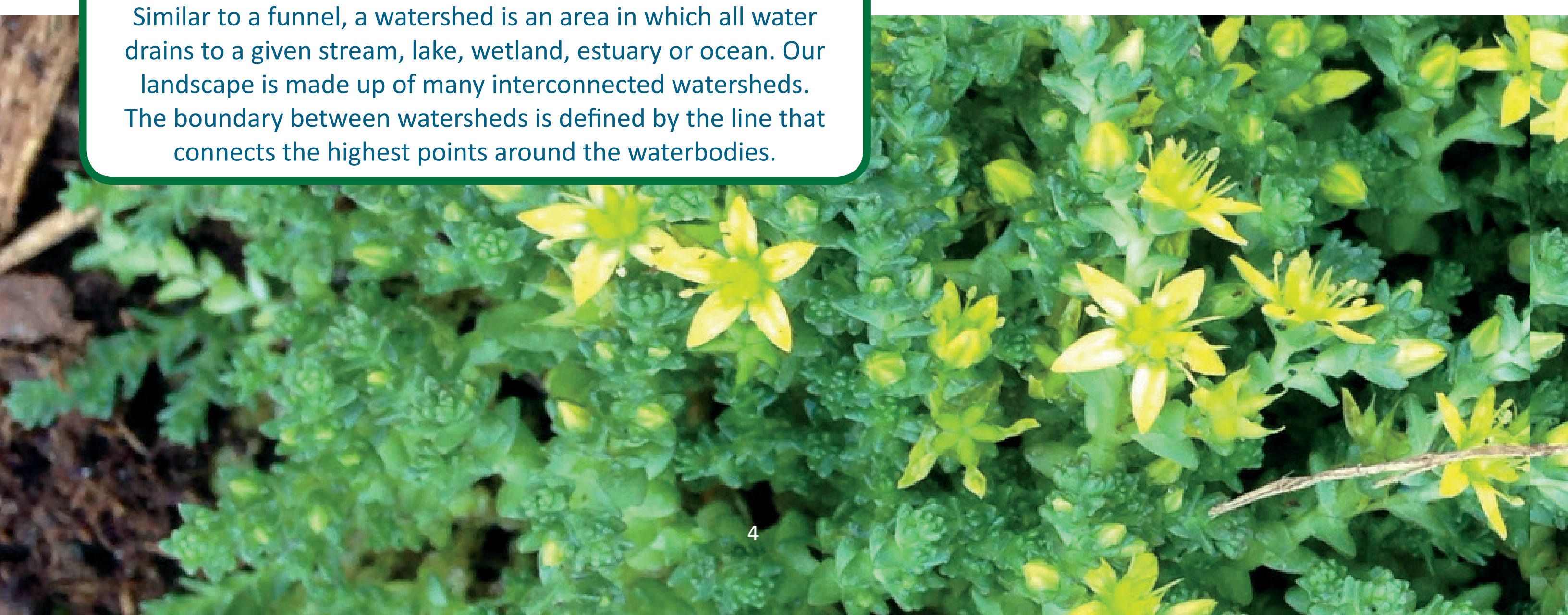


Similar to a funnel, a watershed is an area in which all water drains to a given stream, lake, wetland, estuary or ocean. Our landscape is made up of many interconnected watersheds. The boundary between watersheds is defined by the line that connects the highest points around the waterbodies.

STORMWATER RUNOFF IN YOUR OWN BACK YARD

That's right, you may have stormwater running off of your own yard. Roofs, driveways and other hard surfaces create stormwater runoff. The way you manage and care for your property, and the runoff it creates, can have an impact on the entire watershed.

Actions that seem harmless, such as directing your gutter downspout into



your driveway instead of a vegetated area or using an entire bag of fertilizer on your lawn instead of only the amount it needs, can increase stormwater runoff and wash excess pollutants into nearby streams and ponds.

Small, simple changes in the way we manage our properties can have a big impact and help protect the waterbodies that we play in and depend on.

PURPOSE OF THIS GUIDE

This guide is designed to help residential and small commercial property owners to better manage stormwater runoff and potential pollutants on their properties.

This guide:

1. Describes the sources of stormwater pollution, how stormwater pollution harms the quality of our waterbodies, and how good stormwater management can be used to reduce runoff.
2. Provides instructions for completing a project plan for your property, including how to estimate the amount of impervious surfaces and other land covers on your property, and how to select an appropriate location and stormwater treatment practice to install.
3. Provides do-it-yourself fact sheets to install stormwater treatment practices, such as dry wells and rain gardens, on your property. Each fact sheet includes a list of materials, illustrations and step-by-step instructions for construction.
4. Provides Good Housekeeping tips (see pages 52-54) for reducing runoff and preventing runoff from coming into contact with pollutants.
5. Is linked to the *Soak Up the Rain New Hampshire* (SOAK NH) program. To learn more, print this guide or the fact sheets starting on page 16, see stories and photos and more, visit the SOAK NH website.

This guide can be used along with the New Hampshire Residential Loading Model (see Appendix B) to estimate the amount of stormwater pollutants that come from your property (your "stormwater footprint") and to determine how adding stormwater treatment practices on your property can reduce your stormwater footprint.

Stonecrop sedum in a residential rain garden.

Eroding soils cloud this stream with sediment after a rain storm.

Excess nutrients increased plant and algae growth in this small pond.

Picking up after pets, like Cody, protects waterbodies from harmful bacteria potentially found in their waste.

A parking lot heavily treated with road salt may contaminate nearby surface waters with chloride.

COMMON STORMWATER POLLUTION PROBLEMS AND IMPACTS

Poorly managed stormwater can create many different problems including flooding, erosion, and water pollution. Common stormwater problems and pollutants include the following:

CHANGES IN WATER MOVEMENT over and through the land are a result of impervious surfaces like roofs, driveways, decks, patios and parking lots. These hard surfaces prevent rain and snow from soaking into the ground, prohibiting groundwater recharge and creating excess stormwater runoff. Excess runoff carries pollutants to waterbodies, as described in the following paragraphs. Further, excess runoff causes problems when streams receive more flow than nature intended, resulting in flooding and stream bank erosion.

ERODING SOILS from streams with unstable banks, dirt driveways or other activities that disturb the land, such as construction, can cause sediment to enter our lakes and ponds. This makes the water cloudy and reduces clarity. Fine sediment can clog the gills of fish and smother aquatic habitat. Over time, sediment can fill in a lake or stream, making it easier for plants, including invasive plants like purple loosestrife and exotic milfoil, to take root. Sediment tends to carry other pollutants with it, including nutrients and metals.

FERTILIZER, PET WASTE AND SEPTIC SYSTEMS can contribute excess nutrients that speed up plant and algae growth, including cyanobacteria, which can harm humans and animals and be a nuisance for swimming and boating. As bacteria consume the dead plant matter, they use large amounts of oxygen, leaving less available for fish and other organisms, which can result in fish kills. Nutrients can also increase bacteria that can make swimmers sick and lead to beach closures. Bacteria not only pose a public health risk, but can also cause an economic hardship for communities that rely on bathing beaches for tourism revenue.

ROAD SALT AND DEICING MATERIALS applied to roads, highways, parking lots and driveways include chloride, which increases the salinity of lakes, rivers and streams. This stresses aquatic organisms that depend on freshwater habitats. As salinity increases, freshwater plants die off and salt-tolerant plants take over. Chloride can contaminate drinking water supplies, including private wells. Unlike other pollutants, there is no treatment for chloride pollution except for reducing the amount applied.

LAWN CHEMICALS AND AUTO CHEMICALS contain contaminants that are potentially fatal to aquatic organisms, humans and other animals.

INCREASES IN WATER TEMPERATURE can occur when stormwater runs over hot pavement or other surfaces with very little shade. This heats the runoff, which can increase the temperature of streams and ponds when the runoff enters them. Many fish and other aquatic species depend on the higher oxygen concentrations that cool water provides. Warmer water has less oxygen and makes it more difficult for fish to breathe.


Leaking vehicle fluid on a parking lot can be carried into a nearby stream with the next storm.

STORMWATER ON SHORELAND PROPERTIES

While every property in a watershed has the potential to impact water quality, shoreland properties are in the unique position of having a direct impact on the health of the waterbodies on which they are located. Well-managed shoreland properties provide a natural woodland buffer with trees and other vegetation that intercept surface runoff. Shoreland buffers reduce the effects of nutrients, sediment, and other pollutants, moderate temperature, prevent erosion, and provide critical habitat and food sources to native wildlife.

The critical importance of shoreland buffers to waterbody and ecological health means that shoreland property owners have a unique responsibility and opportunity to protect New Hampshire's waterbodies. The practices in this guide are done on a small scale using hand tools, which typically classifies them as activities that do not require a Shoreland Permit. However, before beginning any project in the protected shoreland, property owners should consult with the NHDES Shoreland Program and their municipal planning department to determine whether or not a state or local permit is needed.

STORMWATER MANAGEMENT STRATEGIES

The primary goal in managing stormwater on any property is to try to mimic the natural hydrology, meaning that we try to match the way that the rain and melting snow behaved on a property before it was developed. This can be done in a number of ways, and on any scale of development, from large commercial sites to individual residential properties.

Larger sites tend to require larger solutions and often include a mix of conventional (pipes and catch basins) and innovative (green infrastructure) strategies. Green infrastructure strategies attempt to


Reducing runoff from shorefront properties helps keep waterbodies healthy.

A rain barrel collects roof runoff from this seacoast home.

infiltrate, or soak up, as much water as possible to get it back into the ground where it can be absorbed and pollutants can be filtered by soils and plants.

On residential and small-scale properties, we encourage the use of small-scale, low-impact development strategies like those included in this guide. These practices are often referred to as low-impact development or site-scale stormwater management strategies.

WHAT ARE GREEN INFRASTRUCTURE AND LOW-IMPACT DEVELOPMENT?

Green infrastructure (GI) and low-impact development (LID) are often used interchangeably. The primary difference is that green infrastructure generally refers to a broader, big picture view of a community or watershed, whereas low-impact development refers to designing and implementing practices at the individual site level.

Regardless of what term is used, they both focus on developing or redeveloping the landscape by working with nature to manage and treat stormwater as close to its source as possible. The overall goal of these strategies is to reduce the impact of built areas by mimicking the way water naturally flows over the land and through the soil.

Green infrastructure and low-impact development approaches often include reducing and disconnecting impervious surfaces, like roofs, roads and parking lots, to minimize the amount of stormwater runoff created as well as to preserve important natural features such as vegetated buffers and good soils. Stormwater management practices on individual lots, like infiltration trenches, also provide treatment to remove pollutants found in stormwater runoff and prevent them from entering nearby waterbodies.

GI AND LID PRACTICES:

- Reduce the volume of stormwater runoff created. This can reduce flooding and flooding-related damages and costs.
- Remove pollutants from stormwater runoff. This can reduce the impact of development on the environment and keep lakes and rivers healthy and clean for swimming, fishing, and playing.

- Often focus on maintaining the natural landscape or creating vegetated practices, such as rain gardens, with function and beauty in mind. This increases curb appeal, improves wildlife habitat, and reduces erosion potential.
- Can be water conservation practices, such as rain barrels and larger cisterns, that capture rain from roofs to be used during dry weather periods to water plants or provide for other non-potable water needs.
- Often work by slowing down stormwater runoff and creating places for it to soak into the ground. Eventually, water that soaks into the ground replenishes the groundwater that supplies private wells and public water supplies. This helps reduce the effects of drought and keeps streams flowing during dry weather.
- Focus on infiltrating and treating water close to the source. This can increase the lifespan of municipal storm drainage systems by reducing the volume of stormwater being directed to those systems.
- Give property owners the satisfaction of being a watershed steward. By carefully managing your property, you are taking care of the environment and reducing your stormwater footprint. For more ideas, see "Good Housekeeping" on pages 52-54.

Do-It-Yourself Stormwater Management

Whether you want to dig right in or create a comprehensive project plan, this section provides you with all you need to start managing stormwater on your property.

DIG RIGHT IN

If you have a specific problem area or the perfect spot for a rain garden in your yard, you may want to dig right in to your project. This section gives you suggestions to get started and includes do-it-yourself fact sheets with instructions to build your project.

CREATE A PROJECT PLAN

If you're more of a planner, you may want to develop a comprehensive project plan before getting started. Detailed instructions can be found in Appendix B.

GETTING STARTED

Before digging in, it is important to first take some time to observe where and how water flows over your property, to verify that the practice you have selected and location you have chosen are appropriate, and to make sure that the soil is able to soak up the rain.

STEP 1 – OBSERVE

Answer the following questions about your property:

1. Where is most of the stormwater runoff coming from?
   Often the roof and driveway are the largest sources of stormwater runoff.
2. Is the runoff creating any problems as it flows across the property?
   Bare soil, rills, gullies or sediment deposits can be an indicator of erosion issues.
3. Where does most of the runoff end up?
   Follow low spots and swales or look for signs such as grass lying flat, or leaves and debris pushed aside, to determine where stormwater ends up on your property. Storm drains, catch basins or drainage swales can indicate that stormwater runoff is directed to the road and into municipal storm drain systems.

Runoff erodes a small rill and carries sediment to a nearby lake.

Roof runoff directed onto this driveway flows into the street and may be sending pollutants to a nearby waterbody.

STEP 2 – SELECT A LOCATION

Consider the following factors when selecting a location to install your practice.

1. What stormwater runoff do you want to capture?
   Knowing whether you want to capture runoff from your roof, driveway or another part of your property will help you decide the type of practice to install and if you have enough space for it.
2. Are there any features on your property that might limit where a practice can go? Such as:
   - Underground utilities – must be confirmed by DigSafe prior to installation.
   - Drinking water wells, septic tanks or leach fields – should be at least 15 feet away.
   - Tree roots, large rocks or steep slopes.
   - Buildings with foundations – some practices need to be at least 10 feet away to prevent seepage into basement.
   - Property boundaries or required local setbacks.
   - Fences or other structures.

STEP 3 – TEST THE SOIL

A simple infiltration test will help to determine how well the soils in a particular location will absorb stormwater runoff. This will help to select the type of practice to install.

Infiltration practices such as rain gardens and dry wells should only be installed where soils drain within 24 hours. Water that takes longer to infiltrate may create mosquito breeding opportunities. For these areas, storage and conveyance practices such as rain barrels or water bars may be more appropriate.

NOTE: Rain gardens should never be placed in areas where water ponds and stays wet for periods of time. This indicates that the soil will not allow infiltration. See Figure 1. Instead consult with your local nursery to explore the idea of planting water-loving plants in the area.

INFILTRATION TEST

To conduct an infiltration test, use the following steps. Ideally, a 12-inch deep hole will drain completely within 24 hours.

1. Using a shovel or post hole digger, dig a 12-inch deep hole.
2. Fill the hole with water and allow it to drain completely (NOTE: if the hole fills with water on its own or if water is still in the hole after 24 hours, choose a new location).
3. Fill the hole with water a second time and do one of the following:
   - Place a ruler or yard stick in the hole. Note the water level and time. After 15 minutes, check the water level again and note the new water level. Multiply the change in water level by four to get the number of inches of infiltration per hour. A rate of at least $^1/_2$-inch per hour indicates that the soil is appropriate for an infiltration practice. See Figure 2.

     OR

   - Cover the hole for safety and check back 24 hours later. If the water has completely drained, this indicates the soil is appropriate for an infiltration practice.

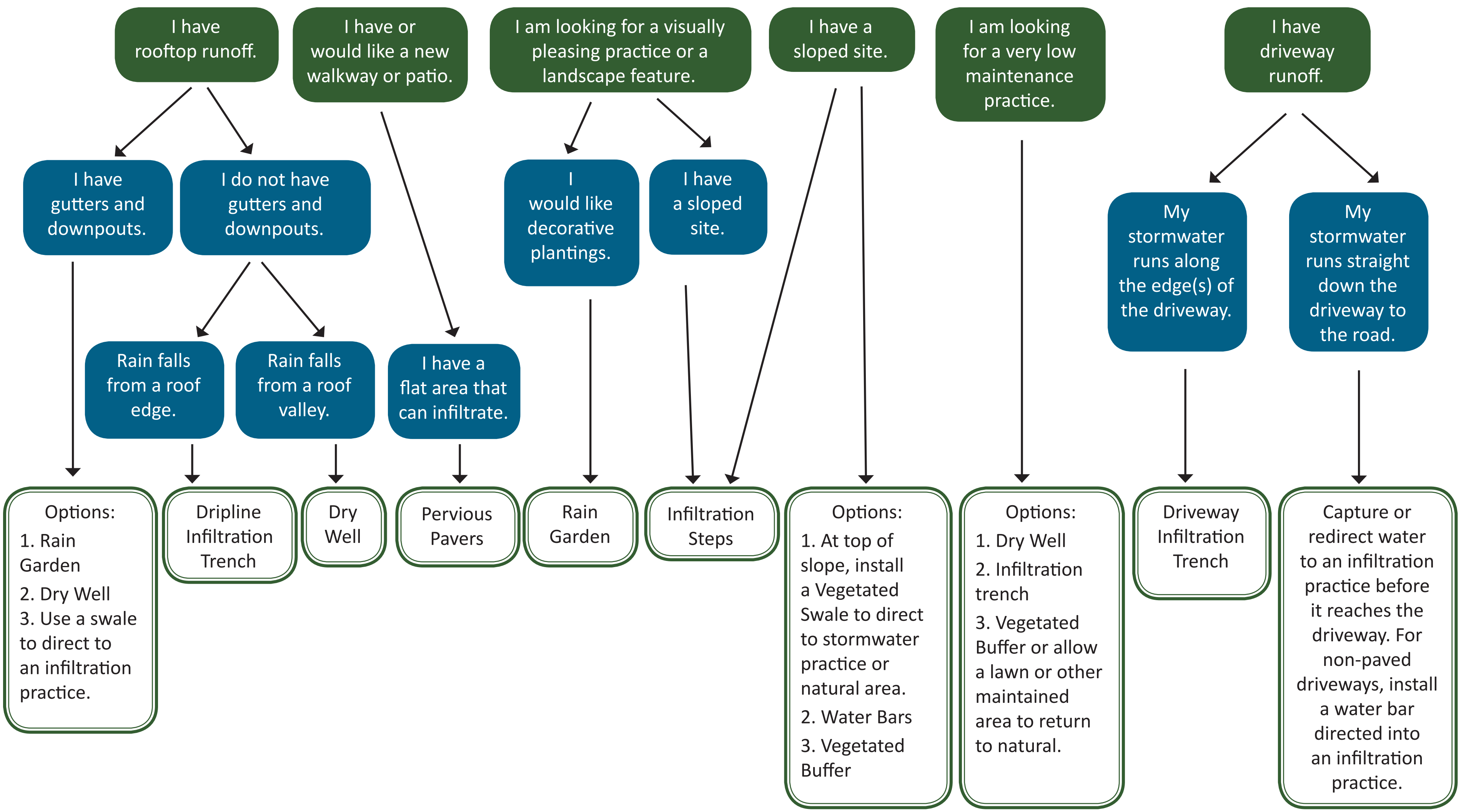
Figure 1 – Rain gardens must be planted where there is good infiltration – where water readily soaks into the ground – and NOT where water tends to puddle and persist.

Figure 2 – An infiltration test is performed to determine how well the soil will absorb and infiltrate runoff.

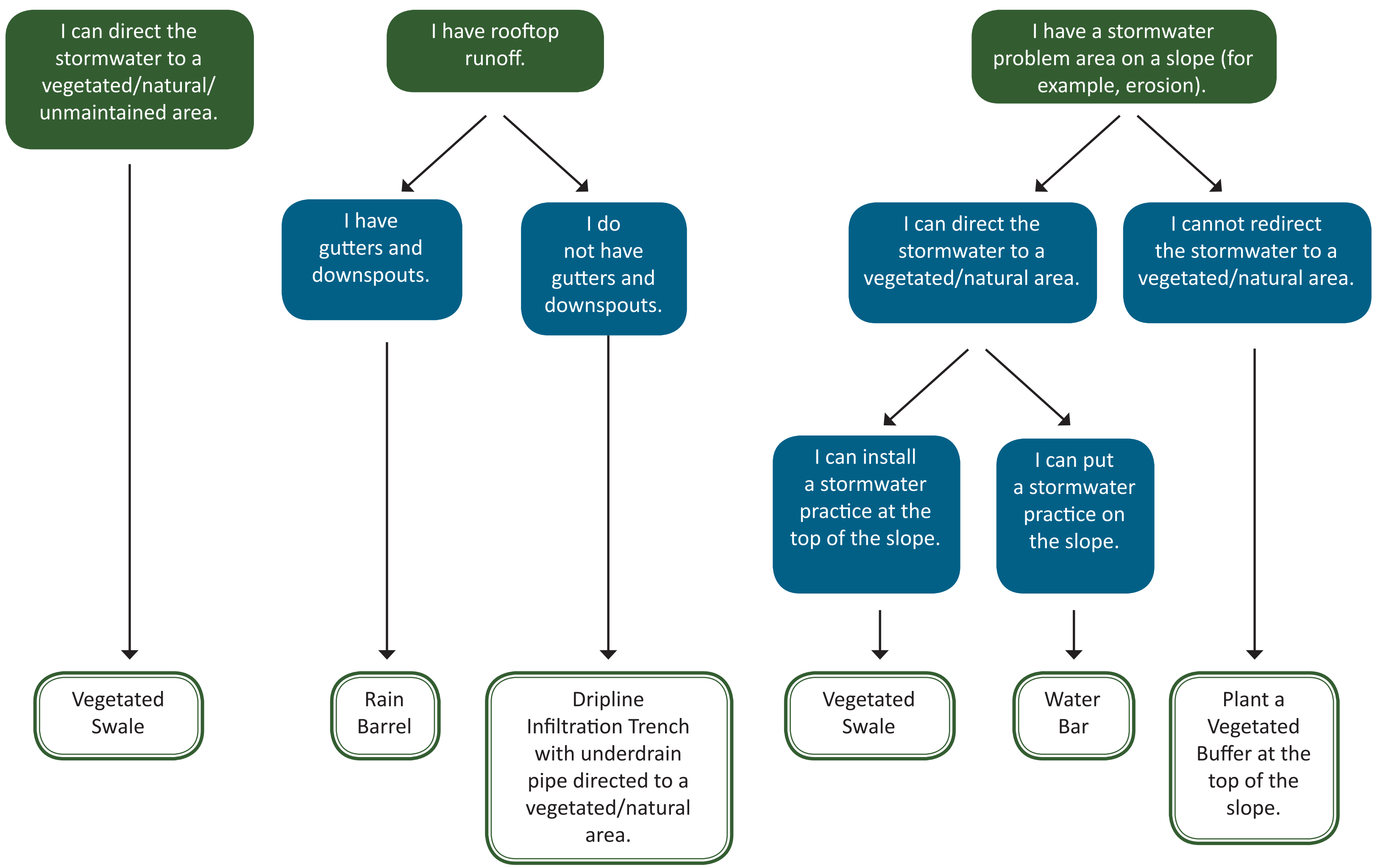
STEP 4 – SELECT A STORMWATER PRACTICE

Use your observations, location and soil information to help select a stormwater practice. The Flow Charts on the following pages, and the descriptions on page 16, can help get you started. Verify your selection by reviewing the included do-it-yourself fact sheet for the selected practice. Practice-specific fact sheets begin on page 17.

Stormwater Practice Selection Flow Chart for INFILTRATION PRACTICES



Stormwater Practice Selection Flow Chart for STORAGE AND CONVEYANCE



STEP 5 – DETERMINE THE SIZE OF THE PRACTICE

The size of the drainage area and the volume of runoff that you want to treat will help you determine how big your stormwater practice needs to be. Properly sizing a practice is most critical for rain barrels, dry wells, and rain gardens. Specific sizing for each practice is included in the fact sheets beginning on page 17 of this guide.

STEP 6 – DETERMINE MATERIALS NEEDED

The type, size and quantity of materials are specified in each stormwater practice fact sheet to help you determine the amount of materials that you'll need for your project.

STEP 7 – CONSIDER MAINTENANCE

As with any stormwater system, regular maintenance is essential to maximize the performance and water quality benefits of the practices. Maintenance recommendations are included in each stormwater practice fact sheet.

STEP 8 – CONSIDER ADDITIONAL ECOSYSTEM BENEFITS

While the primary purpose of the practices in this guide is to address stormwater runoff and pollution, there is an opportunity to provide additional benefits to the ecosystem and greater community through thoughtful design. For example, incorporating native plants provides the added benefit of providing a food source for native pollinators. Using locally grown plants or locally sourced wood and stone products supports local businesses and reduces energy required for transportation. This concept of "stacking functions" is discussed in more detail in the box on the following page. Examples of incorporating additional ecosystem benefits to stormwater practice designs are shown in Figure 1 below and Figure 2 on the next page.

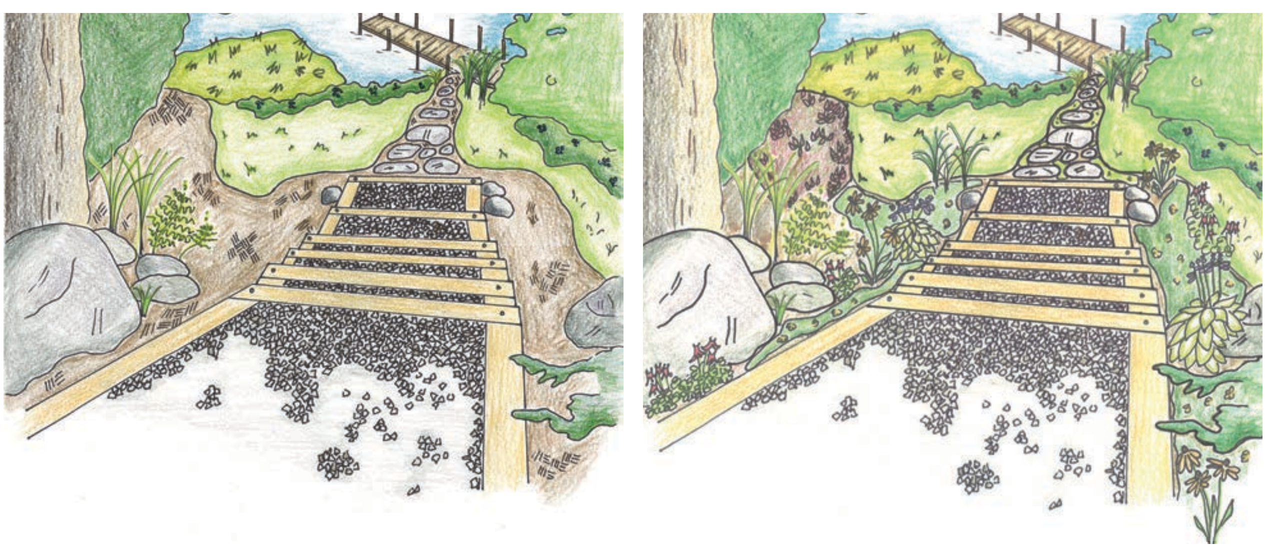


Figure 1 – The addition of native shrubs, perennials, grasses and groundcover enhance the function of the infiltration steps illustrated on the right to provide multiple ecological benefits compared to the mulch surrounding the steps in the drawing to the left.

PERMACULTURE: THE PRINCIPLE OF MULTI-FUNCTIONS

Permaculture is a design technology where guiding principles, derived from natural systems and ecology, are used to help design multi-functional solutions for simple to complex problems.

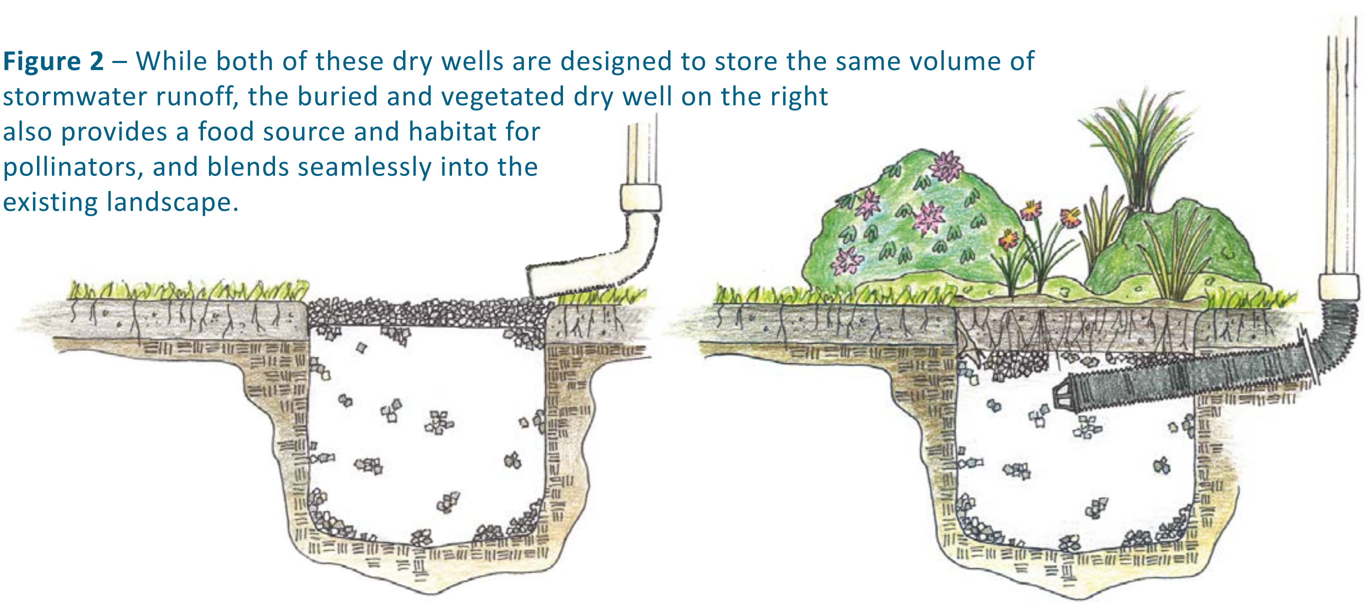
In permaculture, the 'Principle of Multi-Functions' suggests that in good design, every function is supported by many elements and every element serves or supports multiple functions. This is referred to as "stacking functions." The beauty and resourcefulness in this principle is that each element provides several different 'ecological services' or values, and if one service fails, there are others to provide similar or the same work. Thus, not all is at a loss if there is a failure in the system.

When we intentionally design an element that performs several functions, and those functional services support many other elements, a mimicked but natural system (like a garden) has better chances of remaining robust. For example, an ornamental plant may be beautiful when it flowers, but it also may be chosen because it is native, fragrant, attracts pollinators by providing pollen and nectar, and its plant parts may be edible, medicinal or used for craft. Its root system may be very fibrous and adept at holding the soil together on an embankment. The plant may fix nitrogen or its deep rooting structure may bring subsoil minerals to the surface through the later decomposition of its leaves and stems. It may provide a nesting site, or shade a sun-intolerant neighboring plant. After the flowers fade, seeds are produced and serve as a food source, or propagate more plants for the future.

If we steer away from linear, single purpose elements, a design can become more purposeful by intentionally providing multiple functions through the careful choices we make. The beneficial connections between these components help bring about stability and resilience, too.

– Lauren Chase-Rowell
Outdoor Rooms Permaculture Landscape Design Services
Dalton's Pasture, Nottingham, NH

Figure 2 – While both of these dry wells are designed to store the same volume of stormwater runoff, the buried and vegetated dry well on the right also provides a food source and habitat for pollinators, and blends seamlessly into the existing landscape.



DO-IT-YOURSELF FACT SHEETS*

The fact sheets contained in this section describe everything you need to build these practices at home. They can be broken into two categories as follows:

INFILTRATION

The following six practices are designed to capture and infiltrate stormwater, allowing it to soak into the ground, potentially reducing runoff and associated pollutants, decreasing erosion and recharging groundwater supplies.

DRIPLINE INFILTRATION TRENCH – PAGE 17

A stone-filled trench located under a roof dripline to collect water from the roof.

DRIVEWAY INFILTRTION TRENCH – PAGE 19

A stone-filled trench on the edge of a driveway to reduce runoff from the driveway.

DRY WELL – PAGE 21

A stone-filled hole in the ground designed to collect water from gutter downspouts, roof valleys and other areas where water concentrates and flows.

INFILTRATION STEPS – PAGE 25

Boxed-out, stone-filled steps designed to reduce erosion on moderate slopes.

PERVIOUS WALKWAYS & PATIOS – PAGE 29

Walkways and patio systems with a stone-filled reservoir underneath.

RAIN GARDEN – PAGE 32

A sunken, flat-bottomed garden that uses plants and soil to absorb and treat stormwater.

INTERVENTION

These four practices store, convey, intercept or otherwise handle stormwater to help reduce the harmful effects of runoff.

RAIN BARREL – PAGE 39

A container to temporarily store water for use later in dry weather.

VEGETATED BUFFER – PAGE 42

A vegetated area along a waterbody shore to slow runoff and provide bank stabilization.

VEGETATED SWALE – PAGE 46

A shallow vegetated channel used to reduce erosion and slow down runoff.

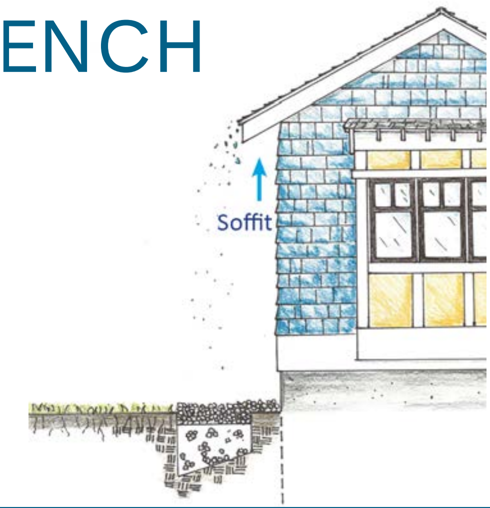
WATER BAR – PAGE 50

A device used along paths, driveways and roads to divert runoff into vegetated areas.

*Fact sheets are available individually on the SOAK NH website.

DRIPLINE INFILTRATION TRENCH

A stone-filled trench under the roof dripline to collect water from a roof allowing it to soak into the ground. It helps reduce stormwater runoff.



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SIZING AND DESIGN

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- $^1/_2$" to $1^1/_2$" washed stone
- Non-woven geotextile or landscape fabric

OPTIONAL

- Perforated plastic pipe
- String or spray paint

STEP 1 – **Soffit depth**. A soffit is the underside of a roof overhang. Measure the depth of the soffit by aligning your body under the edge of your roof and measuring the distance from your body to the house. This is the reference line.

STEP 2 – **Reference line**. Mark the reference line on the ground along the perimeter of your house where you will be installing the dripline trench.

STEP 3 – **Outside boundary**. Measure and mark 12 inches from the reference line away from your house. This the outside boundary line for excavation.

STEP 4 – **Inside boundary**. Measure and mark six inches from the reference line toward your house. This is the inside boundary line for excavation.

STEP 5 – **Determine materials needed**.

Washed stone. Calculate the volume of the trench in cubic feet by using the calculation below. If needed, convert cubic feet to cubic yards by multiplying cubic feet by 0.037.

TRENCH LENGTH (ft) x TRENCH WIDTH (ft) x TRENCH DEPTH (ft) = TRENCH VOLUME (ft^3)

Landscape fabric. Purchase enough landscape fabric to extend twice the length of the trench.

Perforated pipe. Purchase enough perforated pipe to extend the length of the trench.

INSTALLATION

STEP 1 – **Dig a trench** at least eight inches deep between the outside and inside boundary lines marked along the perimeter of your house. Slope the bottom of the trench away from the house so that water will drain away from the foundation (Figure 1).

STEP 2 – **Line the sides** with a non-woven geotextile fabric to extend the life of the trench.

STEP 3 – **Fill with stone**.

For Well Drained Soils: Fill the trench with stone. Fill the trench with 1/2- to 1 1/2-inch washed stone until it is about three inches below the ground level. Place a piece of non-woven geotextile fabric over the stone layer and fill the remaining three inches with additional stone (Figure 1).

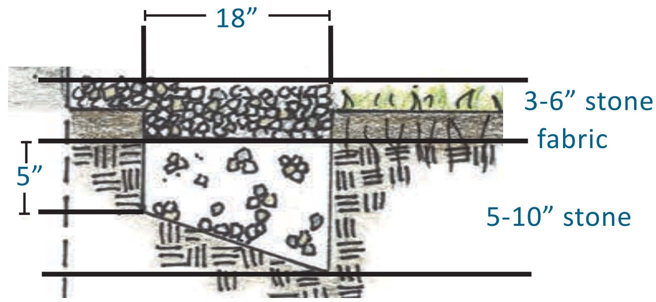


Figure 1 – Profile for well drained soils.

For Slowly Draining Soils: Fill the bottom one to two inches of the trench with washed stone. Lay a four-inch perforated pipe with the holes facing up along the trench. The end of the pipe should either outlet to a vegetated area with a splash guard to prevent erosion or to another treatment practice such as a dry well or a rain garden. The pipe should be sloped toward the outlet so the water easily flows out of the pipe. Consider screening or adding another type of rodent guard on the exposed end of the pipe to prevent animals from nesting and clogging the pipe. Fill the trench with 1/2- to 1 1/2-inch washed stone until it is about three inches below the ground level. Place a piece of non-woven geotextile fabric over the stone layer and fill the remaining three inches with additional stone (Figure 2).

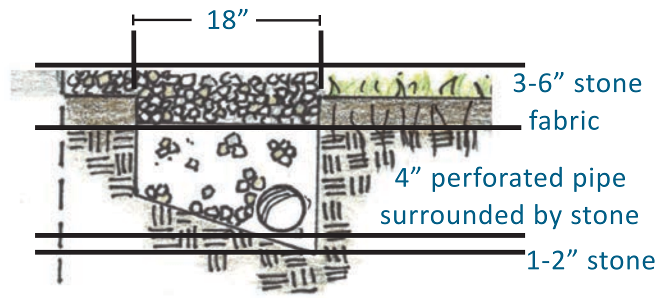


Figure 2 – Profile for slowly draining soils.

STEP 4 – OPTIONAL **Extend stone to foundation**. As material allows, spread a layer of stone all the way to the edge of your foundation. This creates a cleaner appearance and reduces the need for vegetation between the trench and your foundation.

MAINTENANCE

INSPECT: Periodically and after rain events, inspect the practice for any obvious signs of stress or potential failure. Remove accumulated debris and sediment as needed. Check for ponding or poorly draining water – this can be a sign of clogging.

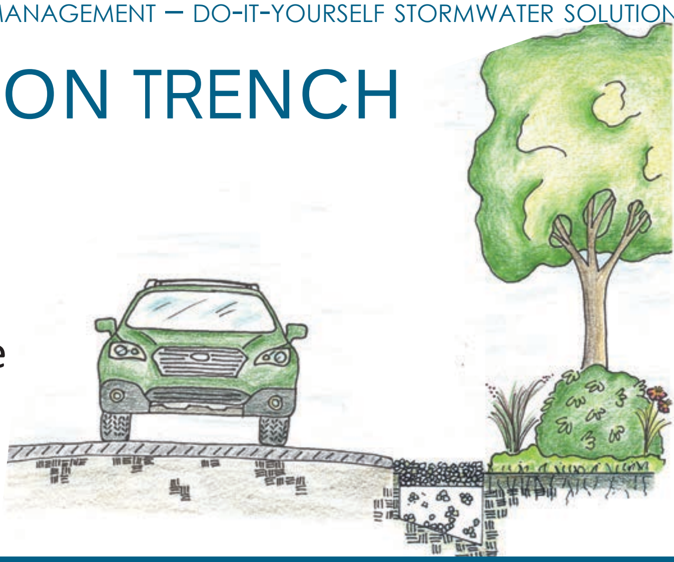
OTHER MATERIALS: Trenches lined with non-woven geotextile fabric will require less frequent maintenance, but will still clog over time. Ponding or slowly draining water can be a sign of clogging. The stone and fabric, if used, will need to be washed or replaced to remove the accumulated sediment and debris.

DESIGN REFERENCE

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

DRIVEWAY INFILTRATION TRENCH

A stone-filled trench on the edge of a driveway to collect water from the driveway, allowing it to soak into the ground. It helps reduce stormwater runoff.



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SIZING AND DESIGN

STEP 1 – **Observe Driveway.** Observe your driveway during a rain storm to determine how stormwater runoff flows across it. Depending on the volume of runoff and where it flows, you may only need an infiltration trench along one side or a portion of your driveway.

STEP 2 – **Determine Width.** Decide the width of the trench you want to install. It should be between 12 and 18 inches, as space allows. Mark the trench width along the edge of your driveway where you will be installing the trench. This is the boundary line for excavation.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- $^1/_2$" to $1^1/_2$" washed stone
- Non-woven geotextile or landscape fabric

OPTIONAL

- Perforated plastic pipe
- String or spray paint

STEP 3 – **Determine materials needed.**

Washed stone. Calculate the volume of the trench in cubic feet by using the calculation below. If needed, convert cubic feet to cubic yards by multiplying cubic feet by 0.037.

TRENCH LENGTH (ft) x TRENCH WIDTH (ft) x TRENCH DEPTH (ft) = TRENCH VOLUME (ft^3)

Landscape fabric. Purchase enough landscape fabric to extend twice the length of the trench.

Perforated pipe. Purchase enough perforated pipe to extend the length of the trench.

INSTALLATION

STEP 1 – **Dig a trench** at least eight inches deep between the edge of your driveway and the excavation boundary line marked along the perimeter of your driveway. Slope the bottom of the trench away from the driveway, if possible, so that water will drain away from the driveway.

STEP 2 – **Line the sides** with a non-woven geotextile fabric to extend the life of the trench.

STEP 3 – **Fill with stone**.

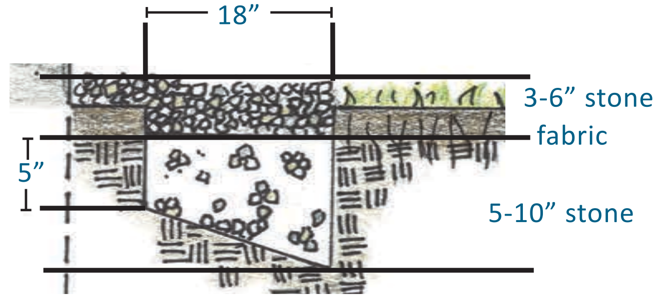


Figure 1 – Profile for well drained soils.

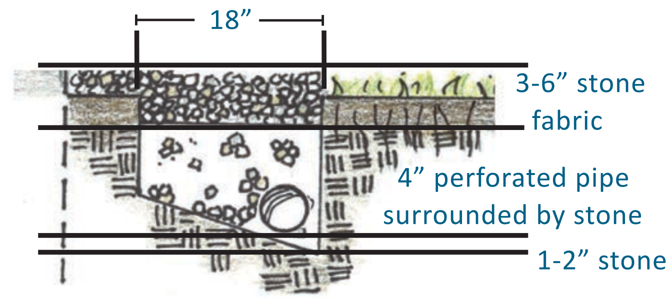


Figure 2 – Profile for slowly draining soils.

For Well Drained Soils: Fill the trench with stone. Fill the trench with 1/2- to 1 1/2-inch washed stone until it is about three inches below the ground level. Place a piece of non-woven geotextile fabric over the stone layer and fill the remaining three inches with additional stone (Figure 1).

For Slowly Draining Soils: Fill the bottom one to two inches of the trench with washed stone. Lay a four-inch perforated pipe with the holes facing up along the trench. The end of the pipe should either outlet to a vegetated area with a splash guard to prevent erosion or to another treatment practice such as a dry well or a rain garden. The pipe should be sloped toward the outlet so the water easily flows out of the pipe. Consider screening or adding another type of rodent guard on the exposed end of the pipe to prevent animals from nesting and clogging the pipe. Fill the trench with 1/2- to 1 1/2-inch washed stone until it is about three inches below the ground level. Place a piece of non-woven geotextile fabric over the stone layer and fill the remaining three inches with additional stone (Figure 2).

MAINTENANCE

INSPECT: Periodically and after rain events, inspect the practice for any obvious signs of stress or potential failure. Remove accumulated debris and sediment as needed. Check for ponding or poorly draining water – this can be a sign of clogging.

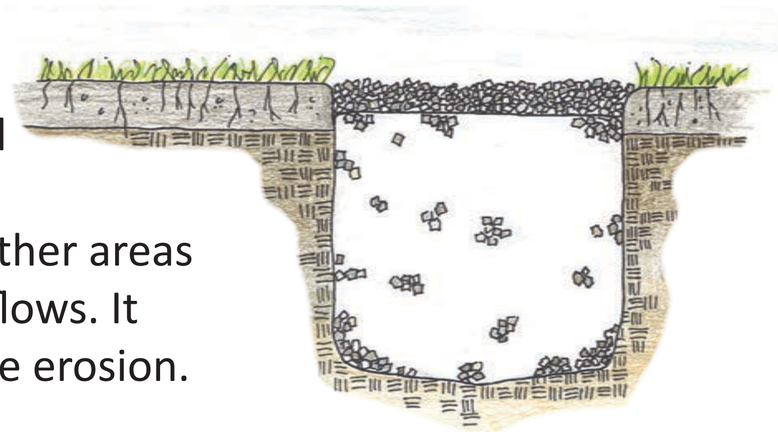
OTHER MATERIALS: Trenches lined with non-woven geotextile fabric will require less frequent maintenance, but will still clog over time. Ponding or slowly draining water can be a sign of clogging. The stone and fabric, if used, will need to be washed or replaced to remove the accumulated sediment and debris.

DESIGN REFERENCE

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

DRY WELL

A stone-filled hole in the ground that collects runoff from gutter downspouts, roof valleys, and other areas where water concentrates and flows. It helps infiltrate runoff and reduce erosion.



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SIZING AND DESIGN

STEP 1 – **Choose the location.** A good location for a dry well can receive and infiltrate large amounts of concentrated runoff, such as from a roof gutter downspout. The area should be away from basements and septic fields and must pass the infiltration test.

STEP 2 – **Perform an infiltration test.** Test the ability of the soil to infiltrate water (allow it to soak in and drain through the soil). Dry wells should only be built in areas where soils drain within 24 hours. Follow the steps below.

a. Using a shovel or a post hole digger, dig a 12-inch deep hole.

b. Fill the hole with water and allow it to drain completely (NOTE: if the hole fills with water on its own or if water is still in the hole after 24 hours, choose a new location).

c. Fill the hole with water a second time and do one of the following:

- Place a ruler or yard stick in the hole. Note the water level and time. After 15 minutes, check the water level again and note the new water level. Multiply the change in water level by four to get the number of inches of infiltration in an hour. A rate of at least $^1/_2$-inch of water per hour is appropriate for an infiltration practice.

  OR

- Cover the hole for safety and check back 24 hours later. If the water has completely drained, this indicates the soil is appropriate for an infiltration practice.

STEP 3 – **Calculate runoff volume.** To determine how large the dry well needs to be, you need to know the volume of water it will receive during a typical rain storm. Most storms in New Hampshire produce one inch or less of rain so designing for a one-inch storm will capture most runoff, as well as the dirtiest "first flush" of larger storms.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- $^1/_2$" to $1^1/_2$" washed stone
- Non-woven geotextile fabric or landscape weed fabric for smaller projects

OPTIONAL

- PVC or other plastic piping
- String or spray paint
- Splash guard
- Gutter downspout extension

TIP: One inch of rain will produce about 62 gallons of runoff for every 100 ft^2 of drainage area.

Complete steps a. through c. to calculate runoff volume.

a. Calculate the square footage of the drainage area:
DRAINAGE AREA LENGTH (ft) X DRAINAGE AREA WIDTH (ft) = DRAINAGE AREA (ft^2)

b. If multiple areas go to the dry well, calculate the square footage of each and add them together.

c. Find the volume of stormwater from the total drainage area for a one-inch storm by dividing the drainage area by 12. This shortcut, in effect, multiplies the drainage area by one inch while converting the inch to feet.

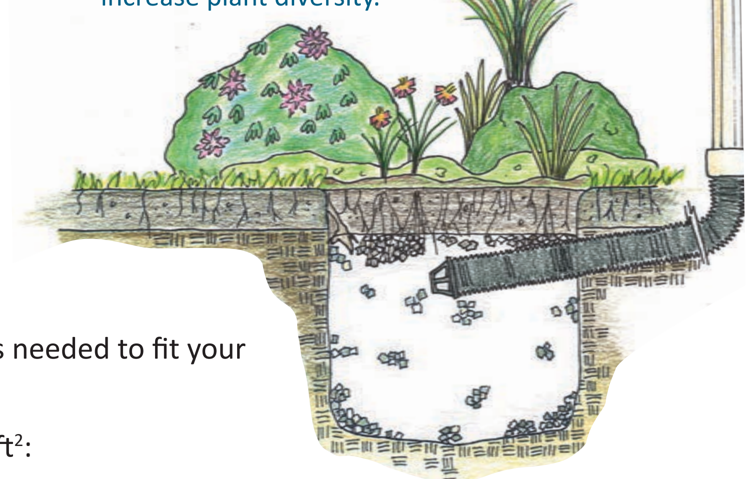
TOTAL DRAINAGE AREA (ft^2) ÷ 12 = STORMWATER VOLUME (ft^3)

STEP 4 – **Design how runoff will enter the dry well.**

For Open-Topped Dry Wells: Roof downspouts can direct runoff into the top of the dry well by simply directing and extending gutter downpouts. Shallow swales or trenches can also be used to direct runoff from the downspout into this type of dry well.

For Buried Dry Wells: Roof downspouts can be buried underground and extended through a flexible pipe/trench into the dry well. This allows the dry well to be buried and planted. Consider installing a flow diverter to allow you to easily disconnect the gutter from the dry well during winter months if you are concerned with freezing conditions.

Buried dry wells blend into the landscape, support pollinators and can increase plant diversity.



STEP 5 – **Determine the dimensions.** Dry wells are typically three feet deep and should be designed to accommodate the stormwater volume (determined in Step 3). Adjust the dimensions of your dry well as needed to fit your site.

a. Calculate the surface area of your dry well in ft^2:

STORMWATER VOLUME (ft^3) ÷ 3 ft (depth) = DRY WELL AREA (ft^2)

b. Identify any limitations on the length or width of the dry well in the chosen location, i.e., tree roots, large rocks or other structures that could be limiting factors. Use the most limiting dimension to help determine the shape.

For example, if the dry well area should be 12 ft^2 and it can only be two feet wide, it will need to be six feet long to accommodate the stormwater volume.

TIP: Washed stone takes up about 60% of the space in a dry well, leaving about 40% for water storage. A typical dry well is 3'x3'x3'. This will store about 11ft^3 of water, which is equal to the runoff from a 132ft^2 drainage area in a storm that produces one inch of rain.

STEP 6 – **Determine materials needed.**

Washed stone: To calculate the volume of stone needed, use the dimensions of the dry well, determined in Step 5. If burying the downspout, purchase extra stone to fill in the trench around the inlet pipe. Convert cubic feet to cubic yards by multiplying by 0.037.

Landscape fabric: To prevent migration of soil from the sides of the dry well into the stone reservoir, it is recommended to line all four sides of the dry well with landscape fabric. For ease of maintenance, or if your dry well will be buried, you may also want to line the top of the stone with landscape fabric. Variations on dry well design are discussed below.

Downspout adapter and flexible pipe: If you are trenching your downspout into the dry well underground, you will need to purchase a downspout adapter and flexible pipe, which can be purchased at most local hardware stores.

INSTALLATION

STEP 1 – **Mark the boundaries**. Once you have determined the location and dimensions, clearly mark the boundary of your dry well to identify where to dig. Landscape flags, string or spray paint work well.

STEP 2 – **Dig the dry well.** Excavate down three feet within the marked dry well boundary. Consider separating the good topsoil from the deeper soil layers to use as a planting bed if you are installing a buried dry well.

STEP 3 – **Dig the trench.** If your dry well will be buried, also dig a trench to bury your inlet pipe from the gutter downspout to the dry well. Carefully remove and set aside the sod growing over the trench to re-cover the trench once installation is complete. Be sure to pitch the trench toward the dry well so that the water easily drains from the gutter to the dry well and doesn't back up.

STEP 4 – **Shape the bottom.** Slope the bottom of the dry well away from your house or other buildings so that water drains away from the foundation.

STEP 5 – **Line with landscape fabric.** Extend the life of the dry well by lining the sides with non-woven landscape fabric.

For Open-Topped Dry Wells

STEP 6 – **Fill with stone.** Fill the excavated dry well with washed stone to within three inches of the ground surface.

STEP 7 – **Cover with landscape fabric.** Fold a flap of fabric over the top of the washed stone.

STEP 8 – **Topcoat with stone.** Fill to ground level with stone.

STEP 9 – **Connect to dry well.** Extend gutter downspout to the dry well. A splash guard, flat paver or flat stone can be placed under the downspout to soften the force of the water entering the dry well. If using a shallow swale or trench, dig it out and stabilize the trench with washed stone, river rocks or plants, per your design.

For Buried Dry Wells

STEP 6 – **Fill with stone.** Fill the excavated dry well with washed stone to the depth where the pipe from the gutter will be laid. Be sure to place the pipe deep enough to allow for a six-inch planting bed or sod layer on top.

STEP 7 (OPTIONAL) – **Install the flow diverter.** Flow diverters allow you to easily direct flow from your gutter downspout into your dry well during warm seasons. They can be closed during winter months, which allows your gutter to operate normally. To install the diverter, cut the gutter with a hand saw and install per manufacturers instructions at a height that allows the water to flow from the diverter into the dry well.

STEP 8 – **Connect pipe to dry well.** Attach the pipe to the downspout or flow diverter, if using one. Lay the pipe in the trench with the outlet near the center of the well. Use washed stone and a level to make sure it is pitched toward the dry well so it will drain.

STEP 9 – **Continue to fill with stone.** Fill with stone to within six inches of the ground surface.

STEP 10 – **Cover with landscape fabric.** Fold a flap of fabric over the top of the washed stone.

STEP 11 – **Topcoat with soil.** Cover landscape fabric with six inches of good planting soil. Densely plant buried dry wells with native groundcover, grasses or other perennials. Fertilize sparingly and only as needed.

MAINTENANCE

INSPECT: Check seasonally and after large storms. Look for signs of clogging, such as ponding at the surface. If your downspout is buried, look for water backing up into gutter.

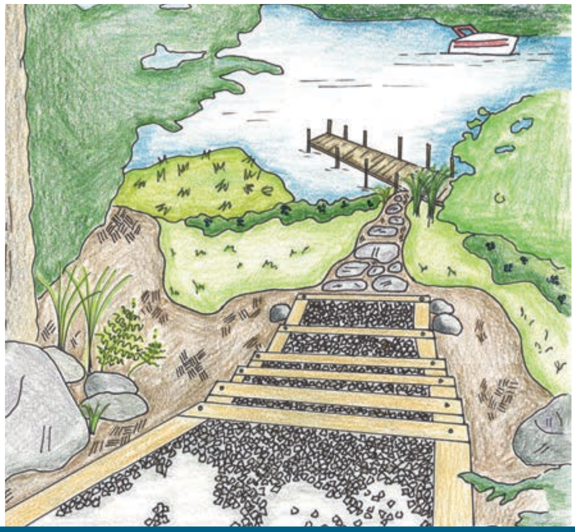
CLEAN OUT: The use of filter fabric will extend the life of dry wells, but will eventually clog over time. If clogging occurs, remove and wash or replace stone and fabric.

PLANT CARE: If your dry well is buried, inspect, prune, thin or replace plants as needed on the surface of the dry well.

DESIGN REFERENCE

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

INFILTRATION STEPS



Boxed-out, stone-filled steps designed to define pathways on moderate slopes. They help to reduce erosion, promote infiltration and are well suited for shorefront properties.

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SIZING AND DESIGN

STEP 1 – **Measure the slope**. Measure the overall rise and run of the area in inches (Figure 1).

STEP 2 – **Determine the number of steps needed**. Divide the rise of the slope (measured in Step 1) by the height of the timber (six inches unless you are using different sized timbers) and round to the nearest whole number. This is the number of steps you will need.

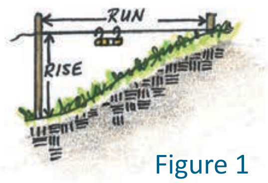


Figure 1

RISE ÷ TIMBER HEIGHT = NUMBER OF STEPS

STEP 3 – **Determine step depth (tread).** Divide the run of the slope by the number of steps (figured in Step 2). The depth of the step tread is flexible, but should be at least 15 inches to be comfortable to walk up and down.

RUN ÷ NUMBER OF STEPS = DEPTH OF STEP TREAD

STEP 4 – **Determine the width of the steps.** A comfortable width is usually four feet, but depending on the topography, trees or other site conditions, a wider or narrower step may be desired.

STEP 5 – **Determine materials needed.** Once you know the number of steps that you need, their width and tread depth, you can determine the length of timber and the amount of steel rebar that you will need.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Sledge hammer
- 4 Wooden stakes
- String or spray paint
- $^{3}/_{4}$” Washed stone or pea stone
- Non-woven geotextile fabric
- 6” x 6” Pressure treated timbers (or similar sized material such as granite or logs)
- 18” long pieces of $^{1}/_{2}$” diameter steel rebar
- Level
- Power drill with $^{1}/_{2}$” drill bit
- 12” Galvanized spikes

TIP: Side timbers may not be needed if the steps are in a pathway where the surrounding land is higher. If so, extend the timbers into the adjacent banks so water will not go around the steps.

Timbers: If you are using side timbers (see Figure 5, page 27), add the length of each side timber (the tread depth) to the step width to get the total length of timber you'll need per step. As a guide, use the following equations to estimate the length (in feet) of timber material you will need:

STEP WIDTH + (2 X TREAD DEPTH) = TIMBER LENGTH PER STEP

TIMBER LENGTH PER STEP X NUMBER OF STEPS = TOTAL TIMBER LENGTH

Rebar: If you piece any of the side timbers together, plan to install rebar at each end of the timber where the pieces join.

STEPS: Two 18-inch lengths of $^{1}/_{2}$-inch diameter steel rebar for each step.

SIDE TIMBERS (IF USING): Six 18-inch lengths of $^{1}/_{2}$-inch diameter steel rebar for each step.

Landscape Fabric: Multiply the number of steps by the square footage needed for each step to estimate the total square footage of fabric needed. Add several inches to your planned width and tread depth to allow for extending the fabric up the sides of the timbers.

For example: four steps X 4' width X 1.5' tread = 24 ft^2 of landscape fabric needed.

Stone: Multiply the number of steps to be back-filled by the volume of step. Calculate the volume for each step by multiplying the step's width, tread depth and timber height.

For example: four steps X 4' width X 1.5' tread X 0.5' high = 12 ft^3 of stone. You can convert cubic feet to cubic yards by multiplying by 0.037.

INSTALLATION

STEP 1 – **Stake perimeter**. Stake out the perimeter of the stairway by driving a stake into the ground at each corner of the stairway and stretching string between them (Figure 2).

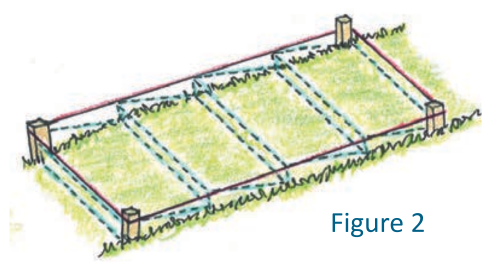


Figure 2

STEP 2 – **Mark areas to be excavated**. Determine the areas that need to be excavated for each step. Using a measuring tape and starting from the string at the bottom of the slope, measure and mark the depth of each step until you reach the string at the top of the slope. Use spray paint, sand or flour to mark the depth of each step (Figure 2).

STEP 3 – **Excavate first step**. Starting at the bottom, dig a trench for the first riser timber (this will be more like a shallow groove in the ground). Next, if using side timbers, dig trenches for the side timbers, which should be long enough to extend six inches past the next step's riser. Check to make sure the trenches are level (Figure 3).

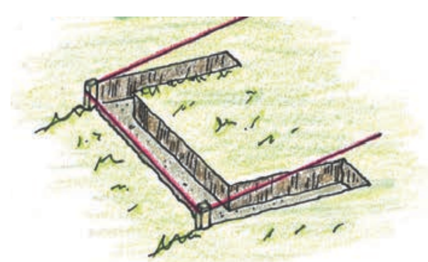


Figure 3

NOTE: Be careful not to excavate deeper than needed as this will create loose material under the timbers, which may cause washout during storms.

STEP 4 – **Prepare materials**. Cut the timbers to the appropriate length. For each step, cut one riser timber as long as the step width and two timbers as long as the step depth for the side timbers (remember that each step should extend six inches past the next step's riser.) Drill $^{1}/_{2}$-inch diameter holes approximately six inches from the ends of each timber (Figure 4).

TIP: Most lumber supply stores have a cutting station to cut timbers to the correct length if you do not have a saw.

STEP 5 – **Position timbers**. Position the timbers in the step and remove or add soil as needed to level them (Figure 4).

STEP 6 – **Anchor timbers**. Drive the steel rebar through the drilled holes on the end of each timber and into the ground. Make sure the rebar is level with the timber surface, or slightly recessed, since the edges may be sharp (Figure 4).

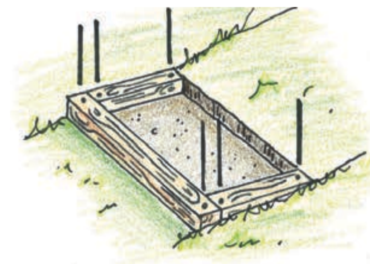


Figure 4

STEP 7 – **Dig and level inside step**. Shovel out the soil inside the step to create a surface roughly level with the bottom of the timbers. Additional soil can be removed to provide more area for infiltration if desired. Make sure to dispose of excavated soil in a place where it will not wash away (Figure 4).

STEP 8 – **Build second step**. To build the next step, measure from the front of the first riser timber and mark the tread depth on the side timbers with a pencil. Align the front of the second step riser timber with the pencil lines on the side timbers of the step below. Secure the riser timber to the side timbers using 12-inch galvanized spikes (Figure 5). To make it easier to drive the galvanized spikes into the timber, you can pre-drill holes to about five inches deep.

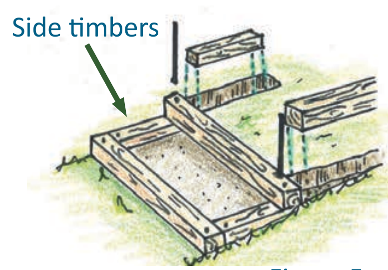


Figure 5

STEP 9 – **Excavate side timbers**. Set and anchor side timbers by driving the steel rebar through the drilled holes on the end of each timber into the ground (Figure 5).

TIP: Place the galvanized spikes where they will not interfere with the rebar.

STEP 10 – **Dig and level inside step**. Shovel out the soil inside the step to create a surface roughly level with the bottom of the timbers, the same as in Step 7.

STEP 11 – **Repeat**. Repeat Steps 8 through 10 for each remaining step. When installing the top step, cut the side timbers six inches shorter than the ones on the lower steps – these timbers do not need the extra length since no stairs will rest on them.

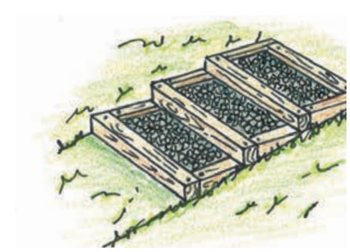


Figure 6

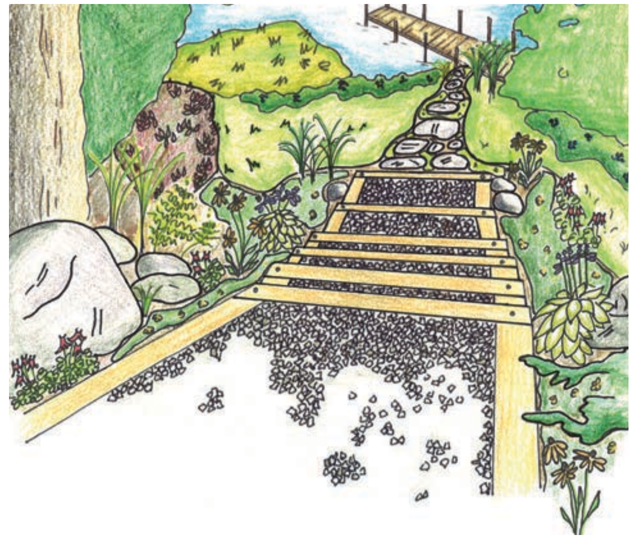
STEP 12 – **Fabric and backfill**. Lay down fabric and backfill with stone.

a. Line the area inside each set of timbers with non-woven geotextile fabric. Make sure the fabric is long enough to extend a few inches up the sides of the timbers.

b. Fill each step with stone until it is about one inch below the top of the timber (Figure 6). This will create a lip to encourage infiltration within each step.

c. Seed, mulch or vegetate bare soil adjacent to the steps.

TO RETROFIT EXISTING STEPS



Existing steps can be retrofit to improve infiltration by removing the existing material and filling in according to Step 12. TIP: If the timbers are not firmly secured, drill $^1/_2$-inch diameter holes six inches from the ends of each timber. Drive $^1/_2$-inch diameter, 18-inch long steel rebar through the holes with a sledge hammer. For gentle slopes, wooden stakes or large rocks can also secure the timbers.

MAINTENANCE

INSPECT: Seasonally and after large storms, look for signs of erosion or clogging such as ponding at the surface or accumulated sediment.

CLEAN OUT: If clogging occurs, remove and wash or replace stone and fabric. Remove any vegetation growing on the steps if not included in the design.

REPLACE: Replace timbers if damaged or rotted, as needed.

DESIGN REFERENCE

Maine Department of Environmental Protection. *Conservation Practices for Homeowners*. Fact Sheet Series. May 2006.

Figures adapted with permission from the Maine Department of Environmental Protection.

PERVIOUS WALKWAYS AND PATIOS

Walkway and patios areas that look like traditional pavers but have a stone-filled reservoir underneath designed to store and infiltrate water. They help to reduce runoff.

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SIZING AND DESIGN

STEP 1 – **Identify installation area**. Determine the areas where you will be installing pervious pavers.

Pervious pavers are best for areas with slopes of less than 2% (one foot of elevation change for 50 feet of length). There should be a minimum of two feet between the bottom of the stone base and bedrock or the water table.

STEP 2 – **Perform an infiltration test**. Test the ability of the soil to infiltrate water (allow it to soak in and drain through the soil). Pervious pavers should only be built in areas where soils drain within 24 hours. Follow the steps below.

a. Using a shovel or a post hole digger, dig a 12-inch deep hole.

b. Fill the hole with water and allow it to drain completely (NOTE: if the hole fills with water on its own or if water is still in the hole after 24 hours, choose a new location).

c. Fill the hole with water a second time and do one of the following:

- Place a ruler or yard stick in the hole. Note the water level and time. After 15 minutes, check the water level again and note the new water level. Multiply the change in water level by four to get the number of inches of infiltration in an hour. A rate of at least $^{1}/_{2}$-inch of water per hour is appropriate for an infiltration practice.

  OR

- Cover the hole for safety and check back 24 hours later. If the water has completely drained, this indicates the soil is appropriate for an infiltration practice.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovel
- Rake
- Broom
- $1^{1}/_{2}$" washed stone
- $^{3}/_{8}$" pea stone
- Non-woven geotextile fabric
- Tamper or roller
- Pervious pavers
- Level

TIP: Pervious pavers come with manufacturer instructions for the type and depth of sub-base material. If the information in this fact sheet differs from the manufacturer's instructions, follow the manufacturer's instructions.

STEP 3 – **Determine materials needed**.

a. Calculate the area of the new or existing walkway or patio that you will be installing with pervious pavers by multiplying the length (in feet) and width (in feet) of the area to be paved.

   If the area you are paving is not a simple square or rectangle, sketch the area where the pavers will be installed on a piece of paper, write down the corresponding measurements, and bring it to your local landscape supply yard or store where you will be purchasing the pavers. They will be able to help you determine how many pavers you need.

b. Sub-base materials (Figure 1) are the $1^1/_2$-inch stone and pea stone layers that go under the pavers. These materials provide a reservoir for stormwater before it soaks into the ground underneath. You should have a minimum depth of 12 inches of $1^1/_2$-inch diameter washed stone and six inches of $^3/_8$-inch pea stone for your sub-base. Use the following equations to determine the minimum amount of sub-base materials you will need (multiplying by 0.037 converts cubic feet to cubic yards):

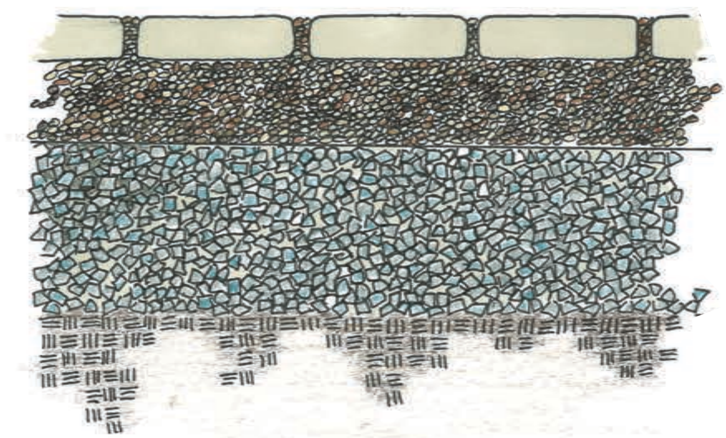


Figure 1 – Pervious walkway profile.

   WASHED STONE: PAVEMENT AREA (ft^2) x 1ft x 0.037 = YARDS

   PEA STONE: PAVEMENT AREA (ft^2) x 0.5ft x 0.037 = YARDS

STEP 4 – **Identify staging and material disposal area(s)**. Identify an area on the site where delivered materials, such as stone, compost and mulch, can be stored temporarily while the project is being built. Also identify an area to dispose of excess materials, like sod and soil that is excavated from the project area, where it will not wash away during storms.

INSTALLATION

STEP 1 – **Prepare the installation site**. If the project area is within 250' of a waterbody and requires use of equipment beyond hand tools, such as a jack hammer or backhoe, contact the NHDES Shoreland Program to see if a permit is required. Remove any existing walkway or patio material. Mark the location of the walkway or patio with either landscaping paint or a string line on either side.

STEP 2 – **Excavate**. Excavate the site approximately 20 inches deep, depending on the type of paver you're using. Smooth the area you've excavated with a rake.

STEP 3 – **Lay the sub-base materials and pavers**.

a. Spread the $1^1/_2$-inch stone over the excavated dirt to a depth of 12 inches, or per manufacturer's instructions. Compact with a roller or tamper.

b. Check paver manufacturers instructions for use of non-woven geotextile fabric over the $1^1/_2$-inch stone.

c. Spread the pea stone over the fabric, if using. The depth of the pea stone should be six inches, or per manufacturer's instructions. Compact with a roller or tamper. Level the surface to make the pavers easier to install.

d. Install the pavers on top of the pea stone and use a level to make sure they are installed uniformly. Most pervious pavers have tabs on the edges to create proper spacing between them.

e. Once the pavers are installed, spread more pea stone over the top and use a push broom to work the pea stone into the space between the pavers.

MAINTENANCE

INSPECT: Seasonally and after large storms, look for signs of clogging such as ponding at the surface or accumulated sediment.

CLEAN OUT: If clogging occurs, remove and wash or replace pea stone and fabric. Remove any vegetation growing on the steps if not included in the design. Refer to manufacturer's instructions for pressure washing or vacuuming.

DESIGN REFERENCE

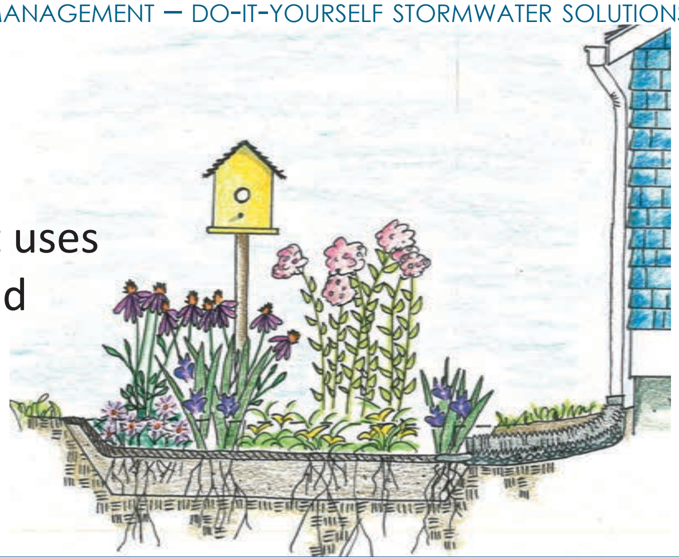
Low Impact Development Center. *Permeable Paver Specification*. 1995.

NHDES. *Permeable Pavement Demonstration Brochure*. 2010.

ADDITIONAL PRACTICES

Grass pavers or geo grids. These are general terms for a variety of open grid structures designed to stabilize erodible areas. They may be woven, interlocking or honeycomb structures constructed of plastic, natural fibers or concrete. They are installed for soil reinforcement and stabilization. Some types can be filled with stone or with soil to grow grass. Search online or ask at a hardware or home improvement store to find options suitable for your needs.

RAIN GARDEN



A sunken, flat-bottomed garden that uses soil and plants to capture, absorb and treat stormwater. It helps to reduce stormwater runoff and recharge groundwater.

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DESIGN CONSIDERATIONS

STEP 1 – **Site constraints**. Identify site constraints in the area where the rain garden will be located, such as:

- High water table – rain gardens should not be placed in persistently wet areas or areas where puddles regularly form.
- Underground obstructions such as gas or electrical lines, other utilities, structures or bedrock. Contact DigSafe 72 hours in advance of your project.
- Place rain gardens on slopes less than 12% (less than one foot of elevation change over 8.3 feet of length).

STEP 2 – **Setbacks**. Be sure to locate the rain garden:

- At least 10 feet away from buildings with basements to prevent seepage into the basement.
- At least 15 feet away from a septic tank or leach field.
- Away from tree roots and drinking water wells.

STEP 3 – **Perform an infiltration test**. Test the ability of the soil to infiltrate water (allow it to soak in and drain through the soil). Rain gardens should only be built in areas where soils drain within 24 hours. Follow the steps below.

a. Using a shovel or a post hole digger, dig a 12-inch deep hole.

b. Fill the hole with water and allow it to drain completely (NOTE: if the hole fills with water on its own or if water is still in the hole after 24 hours, choose a new location).

c. Fill the hole with water a second time and do one of the following:

EQUIPMENT & MATERIALS

- Calculator
- Measuring tape
- Spray paint
- Yard stick
- 6-12 Stakes
- 2-4 Long stakes (4')
- String
- Shovels
- Carpenter's level
- String level
- Rakes
- Compost/Woodchips
- Mulch
- Washed stone
- Flat stones or pavers
- Tarp(s)
- Wheel Barrow(s)
- Plants
- Inlet piping, if needed

- Place a ruler or yard stick in the hole. Note the water level and time. After 15 minutes, check the water level again and note the new water level. Multiply the change in water level by four to get the number of inches of infiltration in an hour. A rate of at least $^1/_2$-inch of water per hour is appropriate for an infiltration practice.

  OR

- Cover the hole for safety and check back 24 hours later. If the water has completely drained, this indicates the soil is appropriate for an infiltration practice.

SIZING

Use the following steps to determine the dimensions of the rain garden. Use Table 3 to organize the information.

STEP 1 – **Total drainage area**. Identify the surface(s) that will drain to the rain garden. Multiply the length by the width to get the drainage area in square feet.

LENGTH (ft) X WIDTH (ft) = DRAINAGE AREA (ft^2)

If more than one surface will contribute runoff to the rain garden, add them together. For example, if two roof areas are collected by a downspout that will drain to the rain garden, add the two roof areas together.

Table 1 – Soil type based on ribbon test.

Soil Type	Ribbon Length (inches)
Sand	No ribbon will form
Silt	Weak ribbon <1.5"
Clay	>1.5"

STEP 2 – **Soil type**. The size of the rain garden is dependent on the soil type. Estimate your soil type by performing a ribbon test using the following steps:

a. Grab a handful of moist soil and roll it into a ball in your hand.

b. Place the ball of soil between your thumb and the side of your forefinger and gently push the soil forward with your thumb, squeezing it upwards to form a ribbon about $^1/_4$-inch thick.

Figure 1 – Soil ribbon test.

c. Try to keep the ribbon uniform in thickness and width. Repeat the motion to lengthen the ribbon until it breaks under its own weight. Measure the ribbon and compare it to Table 1.

STEP 3 – **Slope**. Find the slope of the land where the rain garden will be located. Slopes should be less than 12%. Follow the steps below to determine slope.

a. Place one stake at the uphill end of the rain garden area and another at the downhill end as illustrated in Figure 2.

b. Tie a string to the uphill stake at ground level. Using a string level, level the string between the two stakes, tying it off to the downhill stake.

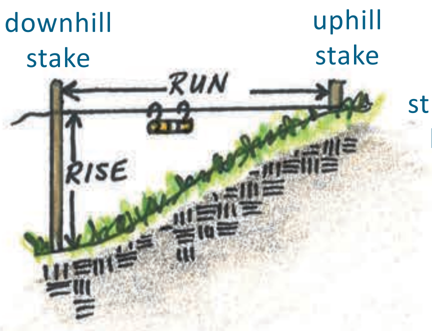


Figure 2 – Determine the slope of the landscape before digging.

c. Measure the length of the string between the stakes. This is the run or length.

d. On the downhill stake, measure the height from the ground to the string. This is the rise or height.

e. Divide the rise by the run and then multiply the result by 100. This is the slope.

SLOPE (%) = (RISE ÷ RUN) X 100

STEP 4 – **Ponding depth**. Use the slope to determine the corresponding rain garden ponding depth in Table 2. The ponding depth is the distance between the top of the mulch layer and the top of the rain garden outlet.

Table 2 – Ponding depth and size factor.

Slope		≤ 4%	5-7%	8-12%
Ponding Depth		3-5 inches	6-7 inches	8 inches
Soil Type	Sand	0.19	0.15	0.08
	Silt	0.34	0.25	0.16
	Clay	0.43	0.32	0.20

STEP 5 – **Size factor**. Match the ponding depth to the appropriate soil type in Table 2 to find the rain garden size factor. For example, if your slope is 6%, the corresponding ponding depth is 6-7 inches. If you have a silt soil, your corresponding size factor is 0.25.

STEP 6 – **Rain garden area**. Use the equation below to calculate the needed rain garden area in square feet. You can configure the shape and dimensions to best suit the site as long as it meets the total rain garden square footage.

RAIN GARDEN SIZE FACTOR x TOTAL DRAINAGE AREA (ft^2) = RAIN GARDEN AREA (ft^2)

STEP 7 – **Total depth to dig**.

a. A rain garden should have between six and 12 inches of planting bed material with 12 inches being ideal. The planting bed can include native soil, compost and other soil amendments. Choose the planting bed depth for your rain garden. A two-inch mulch layer is recommended to suppress weeds and prevent the soil from drying out in the first few years until the garden is established.

b. The total depth to dig your rain garden is the sum of the ponding depth from Step 4, the planting bed depth (anywhere between six and 12 inches), and the mulch layer depth.

PONDING DEPTH + PLANTING BED DEPTH + MULCH LAYER DEPTH = TOTAL DEPTH TO DIG

Table 3 – Rain garden sizing information.

START – Infiltration test (pass/fail)	
STEP 1 – Total drainage area (ft^2)	
STEP 2 – Soil test (type)	
STEP 3 – Slope (%)	
SETP 4 – Ponding depth (inches)	
STEP 5 – Size factor	
STEP 6 – Rain garden area (ft^2)	
STEP 7a – Planting deb depth (inches)	
STEP 7b – total depth to dig (inches)	

DESIGN

STEP 1 – **Identify staging and material disposal area(s)**. Identify an area on the site where delivered materials, such as stone, compost, and mulch, can be stored temporarily while the rain garden is being built. Also identify an area to dispose of excess materials, like sod and soil that is excavated from the rain garden, where they will not wash away during storms.

TIP: To maintain the ponding depth, it is best to design the berm to be a few inches higher than the outlet. If this makes the berm taller than 12", you can increase the "depth to dig" and decrease the berm height.

STEP 2 – **Design the berm**. If the rain garden is on a slope, a berm or low wall is needed on the downslope side of the rain garden to hold water in the garden. The berm should be the same height as the upslope edge of the garden to make the entire perimeter of the garden level. This creates the ponding area.

The berm should be no more than 12 inches high in order to blend with the surrounding landscape and to be easier to maintain. This can limit the length of the rain garden in the direction of the slope. Table 4 shows the recommended rain garden length based upon the slope of the ground where the rain garden will be located.

TIP: If the length of the rain garden cannot be adjusted, increase the "depth to dig" and decrease the berm height.

Table 4 – Suggested Rain Garden length for a 12-inch berm height.

Slope	12%	11%	10%	9%	8%	7%	6%	5%	4%	3%	2%	1%	0%
Rain Garden no longer than	8.5'	9'	10'	11'	12.5'	14.5'	16.5'	20'	25'	33.5'	50'	100'	N/A

STEP 3 – **Consider the rain garden shape**. Plan the shape of the rain garden to fit the situation. The rain garden can be any shape as long as it meets the square footage determined in Sizing Step 6. Restrictions include the length based on the berm height (as recommended above) and other potential site constraints that limit the length, width or depth of the garden.

STEP 4 – **Plan the inlet and outlet**.

a. **Inlet**. The location where runoff enters a rain garden is called the inlet. Whether stormwater runoff enters the rain garden through a gutter downspout, a swale or as sheet flow, the inlet is susceptible to erosion and scouring during rain storms so it should be reinforced with stone or gravel. A flat rock or paver can also be placed at the inlet, directly under where runoff enters the garden, to help spread out the flow. Four-inch diameter corrugated piping can be buried to extend a gutter downspout into the garden.

b. **Outlet**. The location where water exits, or overflows, from a rain garden is called the outlet. While the rain garden is designed to contain most rain storms, the outlet provides a safe and controlled place for water to overflow during storms that produce a lot of rain. Similar to the inlet, the outlet is susceptible to erosion and scour and needs to be reinforced with stone. For rain gardens with berms, an outlet is usually created along a portion of the berm on the downslope side of the rain garden. An outlet is created by lowering a one- to two-foot wide section of the berm by a couple of inches.

STEP 5 – **Select plants and create a planting plan**. Rain garden plants are not the same as water-loving plants. Rain gardens have fluctuating wet and dry conditions and can have extended periods of dry soils between storms. Similar to planning any perennial garden, soil, light, wind, climate and exposure to environmental stressors like road salt, need to be considered. Consider the following recommendations when selecting plants for your rain garden.

- Refer to Native Plants for New England Rain Gardens on the *Soak Up the Rain NH* program website.
- Choose New England native plant species to enhance the ecological function of the rain garden by supporting native wildlife species, including birds and pollinators.

- Avoid plants with lower basal leaves that may remain under water and become more susceptible to rot.
- Use sturdy plants, such as Blue Flag Iris, where runoff enters the garden at the inlet.
- Have the soil tested to determine pH, organic content and other soil conditions to plan for soil amendments you may need to encourage healthy plant growth.
- Review the spacing suggestions for each plant and design your plan accordingly to give plants the space they need to grow to full maturity.
- Create a bird's eye view drawing of your planting plan to guide you when you plant and to help remind you of their placement when you inspect and maintain the rain garden.

STEP 6 – **Determine materials needed**. Once you know the area and depth of your rain garden, follow the instructions below to approximate the amount of soil, compost, mulch and other materials you may need. If needed, convert cubic feet to cubic yards by multiplying cubic feet by 0.037.

a. Decide how thick each material (soil, compost, mulch, etc.) should be. Material thickness: ________ inches

b. Use Table 5 to match the material thickness to the area covered per cubic yard of material. Area covered per cubic yard of material: ________ ft^2

c. Determine the area (in ft^2) the material needs to cover based on your rain garden size. Use the equation below to divide the size of the area to be covered by the area covered per cubic yard. The result is the number of cubic yards you will need.

SIZE OF AREA TO BE COVERED ÷ AREA COVERED PER CUBIC YARD = CUBIC YARDS NEEDED

Table 5 – Material thickness and coverage.

Material Thickness (inches)	Area Covered (ft^2) per Cubic Yard (yd^3) of Material
1"	324 ft^2
2"	162 ft^2
3"	108 ft^2
4"	81 ft^2
5"	67 ft^2
6"	54 ft^2
7"	47 ft^2
8"	40 ft^2
9"	36 ft^2
10"	33 ft^2
11"	30 ft^2
12"	27 ft^2

SOIL AMENDMENTS The condition of the soil, organic content, pH and other factors will determine the type and amount of soil amendments for your rain garden. The University of New Hampshire Cooperative Extension offers soil testing and will provide soil recommendations for residential rain gardens. More information on soil testing can be found on the UNH Cooperative Extension Soil Testing Services webpage. Be sure to indicate on the form that the test is for a residential rain garden.

PLANTS The number and type of plants will be dictated by the size of the rain garden and localized sun or shade, soil and climate conditions, and should be specified in your planting plan.

STONE About a half of a yard of washed stone is useful for securing the inlet and outlet and achieving the pitch of the inlet pipe from the gutter. Two or more one-square-foot or larger flat stones or pavers are useful for placing at the inlet. The inlet and outlet can also be reinforced with stones that you find as you dig out the rain garden area.

INSTALLATION

STEP 1 – **Define borders**. Use string or spray paint to outline the shape of the rain garden. The berm, if needed, will be built outside of the outline.

STEP 2 – **Remove sod**. Remove the grass within the outlined area. You can either dig through the lawn or lay a tarp or sheet of black plastic within the rain garden area for several weeks to kill the grass. Herbicides are not recommended.

STEP 3 – **Start digging**. Remove the soil from within the rain garden area. Form a gentle slope along the edges as you dig. Lay out tarps to temporarily sort and store sod, top soil and lower soil layers to use later in building the berm and preparing the soil planting bed. Consider the following:

a. On a Slope: If the rain garden is on a slope, a berm will be needed. The sod and soil material excavated from digging the garden should be reserved to build the berm (Figure 2).

b. On Level Ground: If the rain garden is on level ground, no berm is necessary and the excavated soil and sod can be removed or used elsewhere on the property.

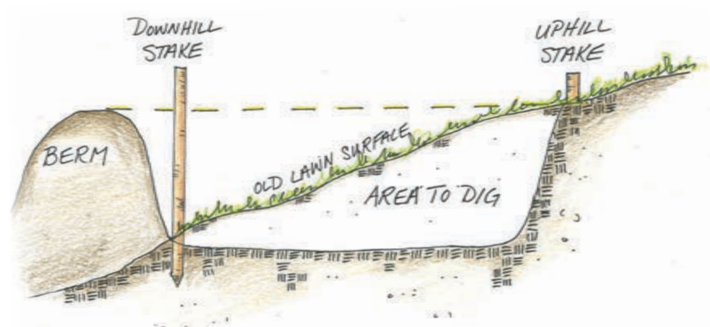


Figure 2. Where to dig and how to create the berm on a sloped site.

STEP 4 – **Set the berm height**. Once you are close to having the entire garden area dug down to the "total depth to dig," hammer stakes along the perimeter of the rain garden about three to four feet apart, starting with the highest edge and working around the garden. Attach a string to the base of the highest stake. Use a string level to mark that height on each stake around the perimeter of the garden. This will be your berm height. Tie a string from the stake to stake at that level to guide you while building the berm. See Figure 2.

STEP 5 – **Level the bottom**. The rain garden must have a level bottom to encourage the water to spread evenly throughout. Once all of your stakes are marked with the berm height, use a leveled string and a yard stick or measuring tape to measure the distance from the bottom of the rain garden to the string, crisscrossed throughout the rain garden. You may find that you need to dig out additional material or rake it out to get rid of high or low spots.

STEP 6 – **Prepare the soil**. Combine native soil, compost and other soil amendments to create a planting bed between six and 12 inches deep.

STEP 7 – **Prepare inlet**. If your rain garden is capturing roof runoff from a gutter, you can dig a trench to bury your inlet pipe from the gutter downspout to the garden. Carefully remove the sod growing over the trench and set it aside to replace it when the trench is complete. Be sure to pitch the trench toward the rain garden so that the water easily drains from the gutter to the garden and doesn't back up. You can use a carpenter's level to check the pitch.

Inside the rain garden, stabilize the inlet area with washed stone to prevent erosion and scour of the inlet. Place one or more flat stones or pavers directly under the inlet pipe to further reduce erosion and to prevent a channel from forming.

STEP 8 – **Build berm and outlet**. Using the marked stakes along the edge of the rain garden as a guide, use overturned sod and soil to build and shape the berm to the specified berm height. Designate a one- to two-foot section of the berm to be the outlet. The outlet should be one to two inches lower than the rest of the berm height. After shaping the berm and the outlet, compact the soil. Reinforce the outlet with stone.

STEP 9 – **Add planting bed materials**. Before adding the planting bed materials to the rain garden, hammer tall stakes into the bottom of the rain garden and mark them with the planting bed depth. Use this line as a guide as you evenly distribute a mix of native soil, compost and other amendments, as needed, to create a planting bed. Mix well and be sure to place some planting bed material up the sloped sides of the rain garden so that they may also be planted. Rake the bed level. To avoid compacting the planting bed, work from the center of the garden outward.

STEP 10 – **Plant**. Place plants while still in their pots into the garden according to the planting plan. Make adjustments for spacing as needed. When you are ready to plant, remove one plant at a time from its pot and loosen the rootball with your fingers to encourage root growth. Plant to the same depth that they were in the pot.

STEP 11 – **Apply mulch**. Apply a two-inch layer of mulch over the entire rain garden to help retain moisture in the soil and to prevent weeds. Keep mulch one to two inches away from plant stems.

STEP 12 – **Water thoroughly**. Water thoroughly (to about two inches deep) immediately after planting. Give the plants an inch of water every week for the first growing season. Once the plants have been established, water only as needed during extended dry weather.

MAINTENANCE

Rain garden maintenance is similar to the maintenance of any perennial garden, with a few extra tasks:

INSPECT: Check after storms to verify the inlet and outlet are stable, no channels have formed, that plants are healthy and that it is draining. Adjust and repair if needed.

PLANT CARE: Weed and water as needed. Replace dead plants as needed. Cut back, prune or divide plants when appropriate to encourage growth.

CLEAN: If the rain garden is receiving runoff that contains sand or debris, such as from a driveway or roadway, clean out accumulated materials as needed.

DESIGN REFERENCES

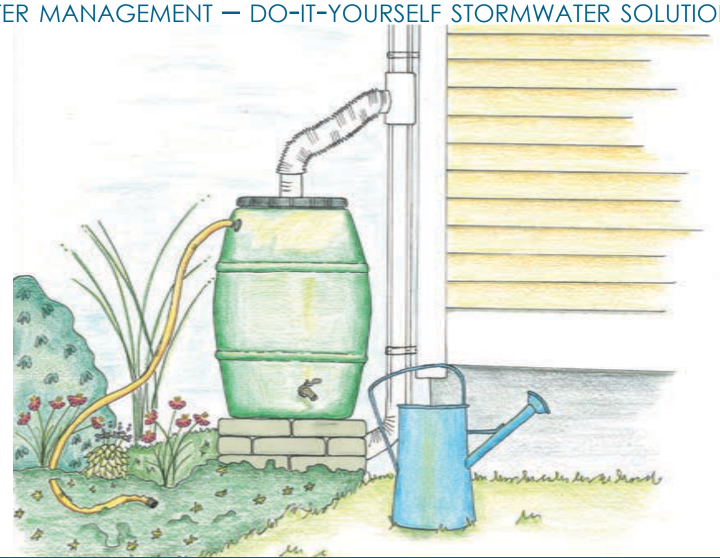
Winooski Natural Resources Conservation District. *The Vermont Rain Garden Manual "Gardening to Absorb the Storm"*. 2009

Wisconsin Department of Natural Resources. *Rain Gardens: A Guide for Homeowners and Landscapers*. 2018.

Figures adapted from Wisconsin Department of Natural Resources. *Rain Gardens: A How-to Manual for Homeowners*. 2003.

RAIN BARREL

A container that captures rainwater from your roof to temporarily store it for use later in dry conditions. It helps to reduce runoff.



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SIZING AND DESIGN

STEP 1 – **Observe your roof runoff**. Note where you have existing roof gutter downspouts, roof valleys or edges that drain large amounts of water.

STEP 2 – **Calculate the volume**. To determine how many rain barrels you need and whether you should designate an area to direct the rain barrel overflow, you need to know the volume of water the barrels will receive during a typical rain storm. Most storms in New Hampshire produce one inch or less of rain so designing for a one-inch storm will capture most of the volume, as long as the barrels are emptied between storms.

Complete steps a. through d. to calculate volume.

a. Calculate the square footage of the roof area:

   ROOF LENGTH (ft) X ROOF WIDTH (ft) = ROOF AREA (ft^2)

b. If multiple areas will be directed to the rain barrel, calculate the square footage of each and add them together.

c. Find the volume of runoff by multiplying the area(s) found in steps a and b by 0.083 (one inch equals approximately 0.083 feet):

   AREA (ft^2) x 0.083 (ft) = VOLUME (ft^3)

d. Most rain barrels give the holding capacity in gallons. Convert the cubic feet found in step c to gallons by multiplying by 7.48.

   VOLUME (ft^3) X 7.48 = VOLUME (gallons)

EQUIPMENT & MATERIALS

- Purchased or home-made rain barrel (food grade)
- Downspout diverter (purchased or made)
- Shovel
- Cinder block or other elevated base
- Level

OPTIONAL

- Soaker hose
- Washed stone
- Mulch
- Splash guard

STEP 3 – **Determine how many rain barrels are needed**. Attempt to capture the volume from a one-inch storm.

VOLUME (gallons) ÷ RAIN BARREL STORAGE CAPACITY (gallons) = NUMBER OF RAIN BARRELS NEEDED

STEP 4 – **Address the overflow**. Be sure to note where the overflow will go during large storms. Avoid directing the overflow next to building foundations. Plan to use a splash guard, install a soaker hose or build a slight swale to direct overflow away from your home and into an area where it can be absorbed, such as a naturally vegetated area, rain garden or dry well.

TIP: If more than one rain barrel will be needed to capture a one-inch storm:

- Rain barrels can be linked together so that the overflow from one goes into the next.
- You can plan to capture smaller storms and designate an area to receive overflow.

INSTALLATION

STEP 1 – **Level the area**. Once you have determined where you want your rain barrels to go, level the ground surface. You can use stone or mulch to stabilize the ground.

TIP: Your rain barrel must be secured on a firm, level surface. A full, 55-gallon rain barrel weighs over 400 pounds.

STEP 2 – **Install blocks or stand**. Elevating the rain barrel is necessary to allow room for a watering can, bucket or hose attachment under the spigot. Elevating the barrels will also create stronger water pressure. Place the blocks or other materials to create a stand on the leveled ground and recheck for level. Adjust as needed to achieve level.

STEP 3 – **Connect the downspout to the rain barrel**. Flow diverters allow you to easily direct flow from your gutter downspout into your rain barrel during warm seasons. They can be closed during winter months, which allows your gutter to operate normally. To install the diverter, temporarily place the rain barrel on the blocks to mark where the diverter needs to be installed. Cut the gutter with a hand saw and install the diverter per the instructions, at a height that allows the water to flow from the diverter into the barrel. If not using a flow diverter, the gutter downspout can be directed or connected directly to the barrel. However, in cold months, the rain barrel should be emptied and stored, and the downspout should be returned to normal function.

STEP 4 – **Install the rain barrel**.

a. Place the rain barrel on the blocks or stand.

b. Direct flow from gutter downspout or diverter into the barrel.

c. Cover the open top of the rain barrel with screen to prevent mosquitoes from breeding in the standing water and to reduce the amount of debris entering the barrel. Most rain barrels that you purchase pre-made will come with a screened cover.

d. Direct the overflow hose from the rain barrel to a vegetated area or another stormwater practice where it can soak into the ground.

MAINTENANCE

INSPECT: Check after storms to determine how soon you need to empty the barrel. Remember that a rain barrel only works if it has space to contain more water. Check seasonally that all parts are in good working condition.

EMPTY: Empty the rain barrel between storms or, at a minimum, when full. The water can be used on perennial gardens, house plants and other non-potable or non-drinking water needs. Carefully consider what you water with your rain barrel. This water has the potential to contain pollutants from your roof that you may not want to come in contact with vegetables or other edible crops.

CLEAN: Keep the screen clear of debris and clean with a soft brush as needed. Periodically clean out the inside of the barrel if debris has collected. Keep gutters and downspouts clean and clear to prevent debris, such as leaves and pine needles, from entering the rain barrel.

WINTER STORAGE: It is recommended in New Hampshire that you completely empty your rain barrel and store it indoors through freezing winter months. When the rain barrel is removed for the season, the gutters and downspouts should be returned to their normal function to drain the roof during winter storms. This can be done by closing or removing the diverter and extending the downspout back to the ground.

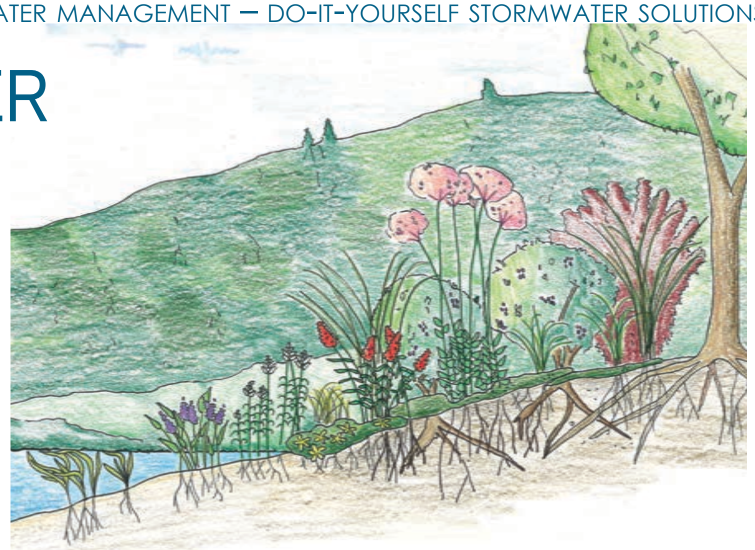
BUILD YOUR OWN RAIN BARREL

Pre-made rain barrels are available in many sizes and styles. They range in price from $50 to over $200. To save money, you can make your own rain barrel out of a food-grade drum and plumbing parts that you can find at most hardware stores. An internet search of "How do I make a rain barrel" will result in a long list of how-to sites and videos, such as the Rainwater Harvesting: Rain Barrel DIY video on Instructables.com. Whatever instructions you follow, we recommend using a food-grade drum and avoiding trash barrels, which may not be sturdy enough to stand up to the pressure of being full of water.

DESIGN REFERENCES

Vermont Department of Environmental Conservation. *Vermont Low Impact Development Guide for Residential and Small Sites*. December 2010.

VEGETATED BUFFER



A vegetated area along a waterbody that stabilizes the shoreline and provides wildlife habitat and shade. Buffers help slow down and clean stormwater runoff.

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DESIGN CONSIDERATIONS

STEP 1 – **Location**. Buffers are beneficial along all types of waterbodies from small streams to large rivers and bays. Vegetated buffers are located between the water and the built portions of a property, such as buildings, driveways, patios and lawns.

STEP 2 – **Check for local and state regulations**. Be sure to follow any local or state regulations regarding working along shorelines. Permits and other permissions are often needed before doing any work close to surface waters or wetlands. Contact your municipal office and NHDES Shoreland Program for more information.

STEP 3 – **Sizing**. The larger the buffer, the more beneficial it is to waterbody and ecosystem health. Even a thin strip of vegetation can help stabilize the shoreline. Consider the following when sizing your buffer:

Length. Where possible, extend the buffer along the entire shoreline – particularly in areas with steeper slopes. Consider the placement of walking paths through the buffer or installing additional practices such as water bars or infiltration steps to clearly define water access.

Width. The wider the buffer, the greater the benefits. Table 1 suggests minimum buffer widths for water quality protection based on slope, however, even a narrow buffer will help to stabilize the shoreline, slow down runoff and intercept falling rain. A buffer can vary in width, being wide where space allows and narrower where necessary. See Figure 1.

EQUIPMENT & MATERIALS

- Measuring tape
- Spray paint
- Stakes
- String
- Shovels
- Rakes
- Compost/Woodchips
- Mulch
- Wheel Barrow(s)
- Plants

Table 1 – Suggested buffer width by slope of land for water quality.

Percent Slope	Buffer Width (ft)
0 - 1%	25
2 - 5%	35
6 - 9%	50
10 - 12%	65
13 - 15%	75

Note: Assumes buffer is not in wetland soils or ledge, and that the area does not receive channelized flow. Modified by the University of New Hampshire from USDA NRCS.

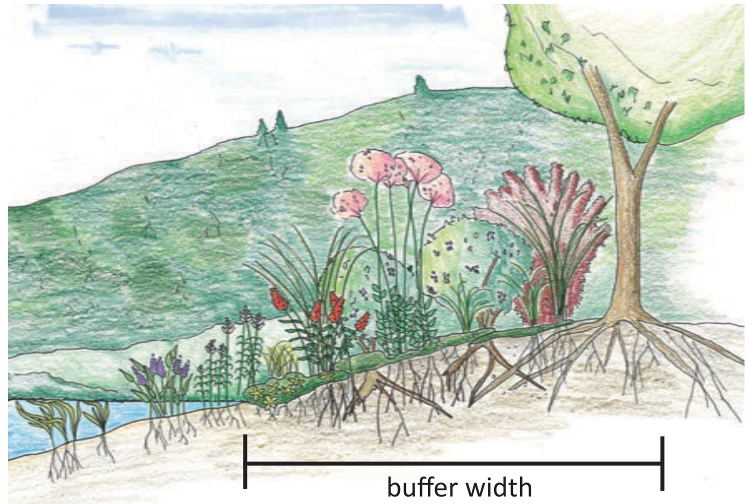


Figure 1. The wider the buffer, the greater the benefits to the waterbody.

Height. We often think that buffers on shorefront properties will block the view of the water, but a well-designed buffer can enhance the view by:

- Layering the buffer with plants of various heights. Thoughtful placement of high and low vegetation can provide a screen where you want it, such as to block a neighbor's house, and can frame views that you want to emphasize, like the open water or the location of sunrises or sunsets.
- Selective removal of a few low branches can provide openings or "windows" to enjoy views from a house to the water without sacrificing privacy or the water quality and wildlife benefit of the buffer. Check local and state regulations before removing branches to make sure it is allowed.

STEP 4 – **Plant selection**. If creating a landscaped or enhanced buffer (see Table 2), selecting plants is similar to planning a perennial garden. Soil, light, wind and climate need to be considered. Salt tolerance may also need to be considered if your buffer will be next to a tidal waterbody or treated roadway. Consider the following recommendations when selecting plants for your vegetated buffer:

- Select a variety of groundcover, herbaceous plants, shrubs and trees appropriate for each zone within the vegetated buffer.
- Refer to *Landscaping at the Water's Edge: An Ecological Approach* for plant suggestions in the different buffer zones, including salt-tolerant species that survive well in estuarine and coastal landscapes.
- Refer to *Native Plants for New England Rain Gardens* for plant suggestions. While this list was developed for rain gardens, many of the species would do well in buffer plantings.
- Choose New England native plant species to enhance the ecological function of the buffer by supporting native wildlife species, including birds and pollinators.
- Consider the type of soil – sand, loam, clay – and select plants that prefer that soil type. If you are uncertain, look at what is already growing in the buffer zone on your property or nearby. As long as they are not invasive, add plants of the same species and feel confident they will likely grow well.
- Review the spacing suggestions for each plant and design your plan accordingly to give plants the space they need to grow to full maturity.
- Consider how you want the buffer to look and how much time you have to maintain it. Table 2 gives different approaches to establishing buffers.

STEP 5 – **Paths and water access design**. Access to the water through the buffer will likely be needed. Consider the following when planning pathways and access:

- Avoid straight paths. Instead meander paths across the slope to prevent channels from forming.
- Use materials that can infiltrate runoff, such as pea stone with stepping stones, or consider materials that can be compacted and do not easily erode, such as stone dust. Incorporate water bars to shed water off of the path and into nearby vegetation.
- Consider installing infiltration steps on steep slopes.

Table 2 – Approaches to establishing buffers.

Natural Buffer	Landscaped Buffer	Enhanced Buffer
• Designate an area to stop mowing/maintaining and allow to grow. • Plants will slowly grow and fill in – must watch for invasives. • Takes the longest time. • Often the simplest and least expensive approach.	• Plant purchased or transplanted native and other non-invasive plants. • Quickest results – can be planted in phases. • Often the most labor intensive. • Often most expensive if plants need to be purchased.	• Combination of natural and landscaped – allow to grow in and add plants where desired. • Good middle ground for effort, cost, time and appearance.

INSTALLATION

STEP 1 – **Site preparation**. It may be useful to mark the perimeter of the buffer area with stakes and string. This is particularly helpful to identify no-mow areas if you are going to allow a natural buffer to grow. If you created a planting plan, identify where your plants will be placed, where your pathways will meander, and where your access points will be.

In New Hampshire, fertilizer use is prohibited within 25 feet of the reference line of a waterbody, which is usually the high water mark, and is restricted to slow-release nitrogen and low- or no-phosphorus fertilizer within the 250 feet of the reference line. Check your local rules, which may be stricter.

STEP 2 – **Planting landscaped or enhanced buffers**. Use good planting practices, such as those listed below. Place plants, while still in their pots, into the buffer according to the planting plan. Make adjustments for spacing as needed. When you are ready to plant, remove one plant at a time from its pot.

- Dig a hole twice as wide as the plant's rootball and no deeper than the rootball.
- Loosen and rough up the rootball before planting, especially those rootbound in the container, to encourage healthy root growth.
- Set plants as deep as they were in their pots.
- If staking trees, make sure the trunks are allowed to sway in the wind.
- Water: For landscaped or enhanced buffers, water thoroughly (to a depth of two inches) just after

planting and daily during the first week. During the second week, water every other day. Then, water twice a week through the first growing season.

STEP 3 – **Mulching**. Spread two to three inches of mulch over the root zone of plants to provide weed suppression, slow release of nutrients, and additional moisture retention. Be sure to keep mulch a few inches away from plant stems and trunks.

MAINTENANCE

WATER: Newly planted vegetation needs regular watering for the first two growing seasons. A good rule of thumb is give plants about an inch of water twice a week. Cut back to watering once a week in fall and in the next growing season.

INSPECT: Inspect plants frequently for stress – wilting, discolored leaves, etc. If one type of plant doesn't do well, consider replacing it with a species that is thriving.

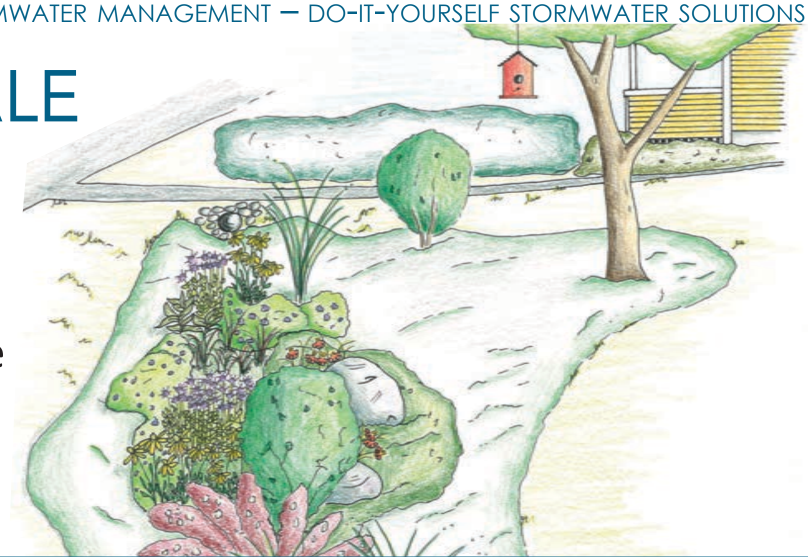
WEED: Weed as needed, or allow native and non-invasive "weeds" like goldenrod, Queen Anne's lace and yarrow to grow. Be on the look out for invasive plants, such as oriental bittersweet and purple loosestrife. Carefully remove invasives in a way that will not spread seeds and cause more to grow.

DESIGN REFERENCES

Hardesty and Kuhns. *The Buffer Handbook*. 1998.

University of New Hampshire Cooperative Extension. *Landscaping at the Water's Edge: An Ecological Approach*. 2007

VEGETATED SWALE



A shallow vegetated channel used to direct runoff. The plants stabilize the soil, reduce erosion, slow the flow and absorb runoff.

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SIZING AND DESIGN

STEP 1 – **Location**. Swales are often located close to roads or driveways. They are usually built in naturally sloping areas to convey runoff safely and slowly to a vegetated area where it can infiltrate. If a vegetated area doesn't exist, consider building a rain garden, dry well or other practice at the end of the swale to encourage the runoff to soak into the ground. A slope of one inch for every foot in length is enough to slowly move the runoff through the swale. When selecting the location of your swale, consider the source of the runoff, the slope of the land, and where you want the runoff to ultimately end up. Swales should not be used to direct water off of your property, or into a road or waterbody.

EQUIPMENT & MATERIALS

- Measuring tape
- Shovels
- Rakes
- Plants - native grasses, sedges, and seedlings
- Mulch
- Wheel Barrow(s)
- Stakes
- String & string level

STEP 2 – **Length and width**. Consider the natural contour of the land when deciding on the shape and dimension of the swale. A swale that meanders down a slope will convey runoff more slowly than a straight swale. The distance from the source of the runoff to the desired outlet location will dictate the length. A swale can be any width. Constraints on the site, such as buildings and property setbacks, can influence the width and how the swale fits into other landscaped features.

STEP 3 – **Berms or check dams**. If a swale needs to be oriented straight down a hill or on a steep slope, consider adding berms or check dams to the swale design. Berms or check dams are built across a swale, similar to speed bumps in a road. They are used to slow down the speed of runoff as it flows through the swale.

STEP 4 – **Plant selection**. Refer to Native Plants for New England Rain Gardens on the *Soak Up the Rain New Hampshire* program website for plant suggestions. While this list was developed for rain gardens, many of the species would do well in vegetated swales. Hardy ground covers and grasses that produce uniform, dense cover that can withstand flood and drought conditions are best. If the swale is to be located close to a road or in an area where snow will be stored, salt-tolerant plants should be considered.

STEP 5 – **Identify staging and material disposal area(s)**. Identify an area on the site where delivered materials, such as stone, compost and mulch, can be stored temporarily while the vegetated swale is being built. Also identify an area to dispose of excess materials, like sod and soil that is excavated from the swale, where it will not wash away.

INSTALLATION

STEP 1 – **Mark out location**. Using stakes and string or spray paint, mark out the boundary of the swale according to the design. Be sure to identify the placement of any berms or check dams. These are areas that you will likely not need to dig as deeply, if at all.

STEP 2 – **Dig**. Dig out the shape of the swale. The deepest part of the swale should be about three feet deep. The width of the swale will depend on how much space you have on your site. A swale can be any size or length, but most are shaped like a trapezoid with the sides being three times wider than the width of the base. The slope of the sides should be between 1% and 4% (Figure 1).

STEP 3 – **Check dams**. For swales on steep slopes (5% or steeper), berms or check dams can be used to slow down the flow of runoff and reduce the potential for erosion. These can be made of compacted earth and reinforced with plantings and stone, or can be made of larger stones. Be creative. Check dams made with large stones can become beautiful landscape features. See Figure 2.

STEP 4 – **Secure swale inlet**. Depending on how runoff enters the swale, consider stabilizing the inlet with a splash guard, washed stone, or hardy plants to reduce erosion from fast moving water.

STEP 5 – **Plant the swale**. Use good planting practices, such as those listed below. Place plants while still in their pots into the buffer according to the planting plan. Make adjustments for spacing as needed. When you are ready to plant, remove one plant at a time from its pot.

TIP: Be careful not to compact the soil when digging because it will reduce the ability of the swale to infiltrate runoff. For clay soils or other poorly infiltrating soils, you may want to dig down an additional $1^1/_2$-inch below the bottom of the swale and create a sandy loam by mixing sand in with the existing soil, then refill the hole. This will improve infiltration.

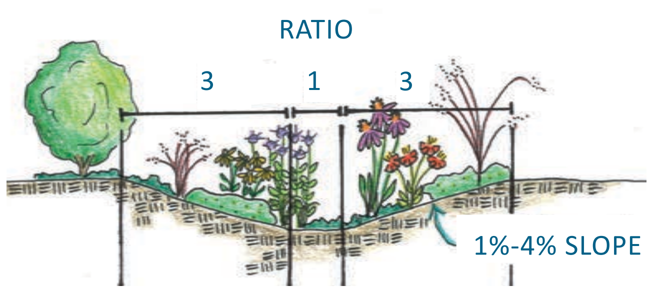


Figure 1. Profile of vegetated swale.

Figure 2. Check dams within a swale slow the flow, allowing sediments to settle out and some infiltration to occur.

- Dig a hole twice as wide as the plant's rootball and no deeper than the rootball.
- Loosen and rough up the rootball before planting, especially those rootbound in the container, to encourage healthy root growth.
- Set plants to the same depth as they were in the pot.

- If staking trees, make sure the trunks are allowed to sway in the wind.
- Water: For landscaped or enhanced buffers, water thoroughly (to a depth of two inches) just after planting and daily during the first week. During the second week, water every other day. Then, water twice a week through the first growing season.

STEP 6 – **Mulching**. Spread two to three inches of mulch over the root zone of plants to provide weed suppression, slow release of nutrients, and additional moisture retention. Be sure to keep mulch a few inches away from plant stems and trunks.

MAINTENANCE

INSPECT: Seasonally and after large storms, look for signs of erosion, accumulated sediment and plant stress, such as wilting, discolored leaves, etc.

WATER: Newly planted vegetation needs regular watering for the first two growing seasons. A good rule of thumb is for trees and shrubs to get about an inch of water twice a week each time you water. Cut back to watering once a week in fall and in the next growing season.

WEED: Weed as needed, or allow native and non-invasive "weeds" like goldenrod, Queen Anne's lace and yarrow to grow. Be on the look out for invasive plants, such as oriental bittersweet and purple loosestrife. Carefully remove invasives in a way that will not spread seeds and cause more to grow.

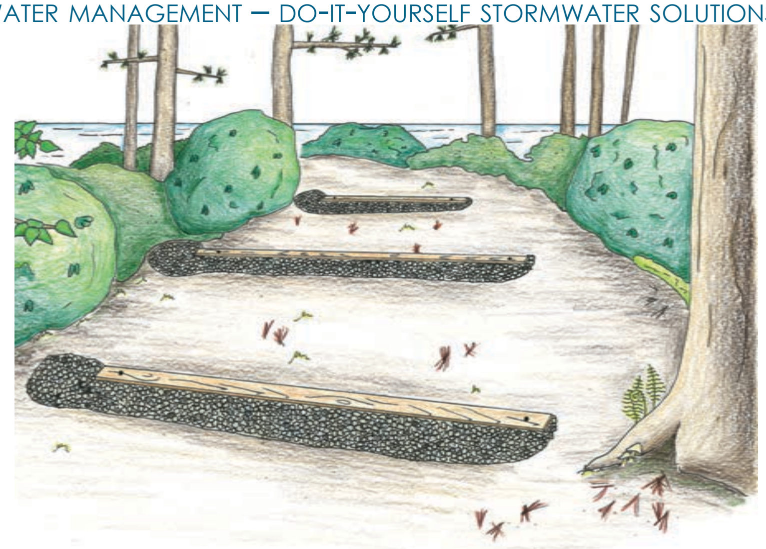
CLEAN: Remove accumulated sediment and replace vegetation as needed.

DESIGN REFERENCES

Vermont Department of Environmental Conservation. *Vermont Low Impact Development Guide for Residential and Small Sites*. December 2010.

WATER BAR

A device used on gentle slopes along paths, driveways and roads to divert runoff into vegetated areas. It helps to reduce erosion and runoff.



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SIZING AND DESIGN

STEP 1 – **Determine slope**. Find the slope of the land where the water bars will be located. Follow the steps below to determine slope. See Figure 1.

a. Place one stake at the uphill end of the slope and another at the downhill end (Figure 1).

b. Tie a string to the uphill stake at ground level. Use a string level to level the string between the two stakes and tie string to downhill stake.

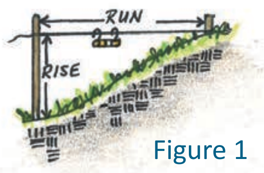

Figure 1

c. Measure the length of the string between the stakes. This is the run or length.

d. On the downhill stake, measure the height from the ground to the string. This is the rise or height.

e. Divide the rise by the run and then multiply the result by 100. This is the slope.

SLOPE (%) = (RISE ÷ RUN) X 100

STEP 2 – **Determine how many water bars are needed**.

a. Compare your percent slope to the waterbar spacing in Table 1 to determine how far apart the water bars should be.

b. Divide the length of your path by the spacing between water bars from Table 1 to get the number of water bars you will need. Round to the nearest whole number.

LENGTH OF PATH / WATER BAR SPACING = # WATER BARS

EQUIPMENT & MATERIALS

- Measuring tape
- Shovels
- Saw
- 6" x 6" Pressure treated or other rot-resistant timbers or logs
- Two 18" lengths of 1/2" steel rebar (per water bar)
- 3/4" Washed stone
- Mulch

Table 1 – Suggested water bar spacing

Percent Slope	Spacing between water bars (ft)
2%	250
5%	130
10%	80
15%	50
25% +	40

TIP: Alternatively, you can place the water bars to target erosion-prone areas.

STEP 3 – **Determine material needs**.

Timbers or Logs: Water bars should be installed at about a 30 degree angle to the path and should extend six inches off both sides of the path. Measure the width of your path at the angle you intend to install them. To determine the length of timbers or logs you will need, multiply the number of water bars by the width of the path plus one foot.

NUMBER OF WATER BARS x (PATH WIDTH + 1ft) = TIMBER LENGTH (ft)

Washed Stone: Each bar should have a trench about 12 inches wide and six inches deep along the entire uphill length and an apron, or small dry well, at the outlet end. Allow about one cubic foot for the apron for each bar. To determine the volume of washed stone needed, multiply the number of bars by the volume needed for each bar using the equation below (assumes a twelve-inch wide and six-inch deep trench). If needed, multiply the result by 0.037 to convert cubic feet to cubic yards.

$[1ft^3 + (0.5ft^2 \times \text{LENGTH (ft)})] \times \text{NUMBER OF BARS} = \text{WASHED STONE NEEDED } (ft^3)$

INSTALLATION

STEP 1 – **Dig**. Dig a trench for the wood timber or log that is at approximately a 30^o angle across the path. The trench should be deep enough so the top of the timber or log will be almost flush with the trail on its downhill side, once in place. Be careful to dig only as deep as needed to set the timber to make sure that the soil under the water bar is stable (Figures 1 and 2).

STEP 2 – **Prepare timbers**. Prepare materials by cutting the timbers or logs to the appropriate length according to the design. Many lumber suppliers will cut them to length for you. Remember that each timber should extend six inches on each side. Drill $^1/_2$-inch diameter holes approximately six inches from the ends of each timber.

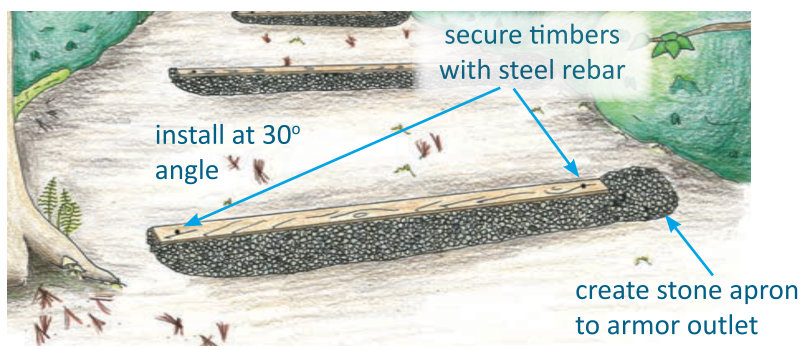

Figure 1. Top view of water bar.

STEP 3 – **Install timbers**. Install the timber or log by placing it snug against the downhill side of the trench. The timber should be level and have no high points or voids under it.

STEP 4 – **Secure timbers**. Secure the timber with rebar stakes, making sure that the rebar is pounded down flush or slightly recessed with the top of the timber to avoid any sharp edges.

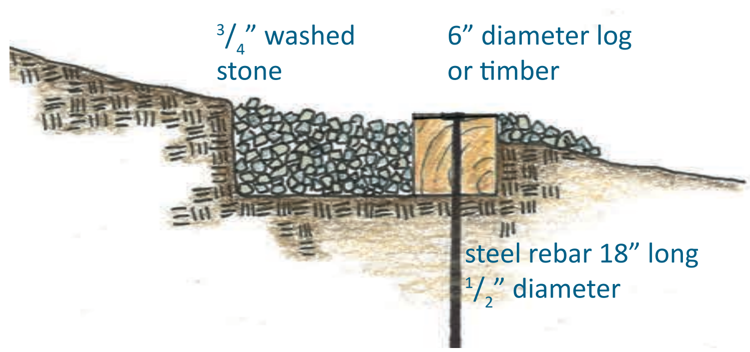

Figure 2. Side view of water bar.

STEP 5 – **Backfill the water bar**.

a. Dig a 12-inch wide and six-inch deep trench along the uphill side of the timber.

b. Fill the trench with washed stone, leaving a few inches of the timber exposed.

c. At the outlet of the waterbar, place an apron of washed stone to prevent erosion.

d. Pack soil and gravel up against the downhill side of the timber so that the top of it is flush with the path.

e. Cover all disturbed soil with seed and mulch or cover with leaf litter.

MAINTENANCE

INSPECT: Seasonally and after large storms, look for signs of erosion or accumulated sediment.

CLEAN: Remove accumulated sediment, leaves and debris as needed. The stone may need to be cleaned or replaced periodically if void spaces get filled with sediment. Remove and replace with clean stone or remove clogged stone, wash and reinstall.

DESIGN REFERENCE

Maine Department of Environmental Protection. Conservation Practices for Homeowners. Fact Sheet Series. May 2006.

Figure used with permission from the Maine Department of Environmental Protection.

ADDITIONAL PRACTICES

Rubber razors are a type of water bar constructed from heavy rubber material, such as conveyer belt material, sandwiched between lumber. See the Maine Department of Environmental Protection and Portland Water District joint fact sheet for design and installation information.

Good Housekeeping

The following good housekeeping practices help reduce the volume of runoff created and help prevent pollutants from coming in contact with runoff.

AUTOMOBILE MAINTENANCE

- Keep your vehicles (and any other motorized equipment) serviced regularly by a qualified mechanic.
- Clean up fluid leaks with cat litter and put an absorbent rag or carpet remnant under the leak to absorb the fluid until it is fixed.
- Handle and store gasoline and other vehicle fluids carefully to avoid spills. Clean up spills immediately with absorbent materials. For more information, see NHDES fact sheet CO-10 – *Consumer Tips for the Safe Management of Gasoline*.

CAR WASH

- Take your vehicle to a local car wash that recycles and reuses the wash water and uses non-toxic cleaners.
- When washing your vehicle at home, park your car on a grassy or pervious area, use a non-toxic soap, and minimize the amount of water that you use by running the hose only when needed.
- For more information, see NHDES fact sheet WMB-14 – *Car Washes and Water Quality*.

"GREEN" YARD CARE AND LANDSCAPING

- Reduce the square footage of your lawn area by planting low-maintenance ground-covers, trees, flowers and shrubs to help water infiltrate into the ground and prevent soil erosion.
- For new lawns, use six to 12 inches of topsoil to encourage deeper root growth.
- Choose native grasses and ground coverings as alternatives to conventional turf lawns on some or all of your property. Native plants have originated and evolved in your area and generally require less water, herbicides, pesticides, fertilizers and trimming.
- Test your soil to see what it really needs before you apply fertilizer or lime (contact your county UNH Cooperative Extension office for information on soil testing).
- When fertilizer is necessary, use a slow-release fertilizer to avoid excess nutrients running off your lawn. The New Hampshire Surface Water Quality Protection Act prohibits the use of fertilizer within 25 feet of public waters. For more information and great lawn care tips for all property owners, see NHDES fact sheet WD-SP-2 – *Proper Lawn Care within the Protected Shoreline*.
- If you have an automated irrigation system, make sure it has a rain gauge or soil moisture sensor to prevent watering when it isn't necessary – like when it is raining or immediately following a rain shower. For more information, see NHDES fact sheet WD-DWGB-26-22 – *Home Water Efficiency: In-Ground Irrigation Systems*.

- Aerate your lawn to help the soil breathe and promote stronger root systems.
- Raise and keep your lawn mower at a height of three inches.
- Leave mulched grass clippings on your lawn to naturally fertilize and prevent evaporation, reducing the amount you need to water. Typically, this will not cause thatching.
- Keep yard debris away from storm drains, waterbodies and wetlands. Dispose of yard waste at your local transfer station or compost in your backyard. For more information, see NHDES fact sheet WMB-SW-3 – *Municipal Composting of Yard Waste*.
- Maintain natural vegetation and buffers around your property. For more information, see NHDES fact sheet WD-SP-5 – *Vegetation Management for Water Quality*.
- To help prevent over-population of lawn and garden pests, consider using a variety of control tactics other than reaching for chemical pesticides. Lady bugs can be used to control aphids, for example. Pesticide use is restricted on and near public waters. For more information, see NHDES fact sheet WD-SP-3 – *Integrated Pest Management: An Alternative to Pesticides*.
- Find ways to reduce phosphorus sources from your property, such as planting native vegetation along shores, stabilizing eroded areas and maintaining your septic system. When phosphorus in runoff reaches waterbodies, it can cause problems like algae and cyanobacteria blooms. See NHDES fact sheet WD-BB-20 – *Phosphorus: too much of a good thing*.
- Rather than washing your driveway with a hose, which may deliver pollutants to a waterbody, sweep it or use a shop vacuum to collect yard waste and other materials.

LAKE-FRIENDLY LIVING

- Whether you live along a lake or miles from it, explore the NH LAKES "LakeSmart Program" to learn about lake-friendly living through this free, educational, evaluation, and certification program. Learn more at LakeSmart: A Lake-Friendly Living Program.

REDUCE IMPERVIOUS COVER

- Limit the amount of impervious surfaces, such as paved driveways, decks, patios and roofs created on your property.
- Replace impervious surfaces with natural, native ground cover or materials that allow rain water to seep into the ground, such as gravel, brick, stepping stones, wood chips or other porous surfaces.
- Direct runoff from impervious areas to pervious ones. For example, direct the downspout from your roof gutter away from your driveway and instead into a vegetated area, such as a swale or garden.

SEPTIC SYSTEM MAINTENANCE

- Know the location of your septic tank and leach field area. For more information, visit the Get Pumped! New Hampshire website.

- Have your septic tank inspected yearly. If the sludge and surface scum combined are as thick as $^{1}/_{3}$ the liquid depth of your tank, have it pumped out by a licensed septage hauler. You can find NHDES-licensed haulers in your area on the New Hampshire Association of Septage Haulers website.
- Keep bulky items like flushable wipes, diapers, sanitary pads, cigarettes and paper towels out of the system, as they will cause clogging.
- Keep toxic materials like paint thinners, pesticides and bleach out of your system. The chemicals could kill the good bacteria that live in your septic tank that keep it functioning.
- Do not use septic tank additives. They could be harmful to the beneficial bacteria.
- Repair leaking faucets and fixtures promptly to reduce the amount of water the system has to treat. For more information, see NHDES fact sheet WD-DWGB-26-23 – *Home Water Efficiency: Fixing Leaks Indoors and Out*.
- Avoid putting food waste and grease into the system or using a garbage disposal. Food waste in your system requires more frequent pumping and can increase nutrient-seepage into the soils surrounding your leach field.
- Keep deep-rooted trees and bushes away from the leach field.
- Keep vehicles, equipment and heavy foot traffic away from the leach field to avoid compacting the soils.
- Use alternative cleaning products, such as baking soda and borax, to avoid chlorine and strong acids that could kill the good bacteria in the septic system.

WINTER WALKWAY AND DRIVEWAY MAINTENANCE

- Reduce the amount of salt that you apply to your driveway and walkways. A thorough shoveling or possible sweeping of snow can reduce or avoid the need for salt.
- For business owners: hire a NH Certified Green SnowPro contractor for winter snow removal. These certified contractors are trained in the most up-to-date technology to ensure a high level of service and safety while using reduced-salt practices to protect our waterbodies from chloride pollution.
- Use only sand to provide traction.
- If you have multiple entrances to your home, designate one of them as the "winter entrance" and only maintain the walkway that serves that door.

PET WASTE

- Take the time to "scoop the poop" and dispose of it properly.
- Pick up pet waste. Flush it down the toilet, put it in the trash, or bury it in the yard at least five-inches deep and away from vegetable gardens, wells and waterways.
- Do not put pet waste into storm drains; it can introduce bacteria to the waterbody that the storm drains leads to.
- For more information, see the NHDES Scoop the Poop Campaign.

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Appendix A – State and Federal Regulations to Protect Water Quality

The State of New Hampshire uses the following programs and permits to protect water quality. Please also check in with your town or city for any applicable regulations.

ALTERATION OF TERRAIN LAWS protect surface waters, drinking water supplies and groundwater by controlling soil erosion and managing stormwater runoff from developed areas that propose to disturb more than 100,000 ft^2 of terrain (or 50,000 ft^2 if any portion of the project is within the protected shoreland) or an area having a grade of 25% or greater within 50 feet of any surface water. For smaller projects, the General Permit by Rule applies. For more information, visit the NHDES Alteration of Terrain Bureau webpage or call (603) 271-2147.

SHORELAND PROTECTION LAWS protect surface waters by managing the disturbance of shoreland areas to maintain naturally vegetated shoreland buffers. It applies to all fourth order and greater streams, designated rivers, tidal waters, and lakes, ponds and impoundments over 10 acres in size. For more information, visit the NHDES Shoreland Program webpage or call (603) 271-2147.

WETLANDS LAWS protect surface waters by requiring avoidance and minimization of potential impacts to state surface waters, banks of lakes, ponds or rivers, and tidal or non-tidal wetlands. For more information, visit the NHDES Wetlands Bureau webpage or call (603) 271-2147.

SECTION 401 WATER QUALITY CERTIFICATION protects water quality by making sure the State water quality standards are met in nearby lakes, ponds, streams, rivers and other surface waters during and after construction of large projects, such as the development of a large subdivision, shopping center, or for wastewater discharges. For more information, visit the NHDES Water Quality Certification webpage or call (603)-271-8872.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMITS EPA regulates stormwater under the Federal Clean Water Act, National Pollutant Discharge Elimination System Program (NPDES). For more information, see the EPA NPDES website or call NHDES at (603) 271-1352.

APPENDIX B – CREATE A PROJECT PLAN

Creating a project plan allows you to take a comprehensive look at your property. Through thoughtful observation, you can follow the path that stormwater flows through your property from its source to its ultimate endpoint. Once these details are identified, you can start planning where you might be able to install one or more of the stormwater practices described in this guide to intercept flow and *soak up the rain*. Finally, you can use the Residential Loading Model to calculate your property's stormwater footprint and the water quality benefit a stormwater practice would provide.

EQUIPMENT & MATERIALS

- Measuring tape
- Ruler
- Calculator
- Shovel
- Bucket or waterproof container
- Paper and Pen
- Graph paper
- Tax map or aerial photo of your property with lot lines

Illustrations in Appendix B by Braden Drypolcher

STEP 1 – MAP YOUR PROPERTY

Map your property using an aerial photo or by hand using graph paper. Using a grid will help you draw your house, driveway and other property features to scale. Other resources available to map your property include:

- Google Maps or other online imagery.
- Municipal offices or website – tax map, online GIS (if available).
- Approved septic system plan, if you have a septic system.

EXISTING CONDITIONS

Map or sketch your property the way it currently exists (Figure 1). It is useful to make copies of your existing conditions map to sketch different ideas for your planned future conditions.

PLANNED CONDITIONS

Sketch proposed changes and property improvements, such as building an addition, deck or storage shed, or installing a stormwater practice, like a rain garden or rain barrel.

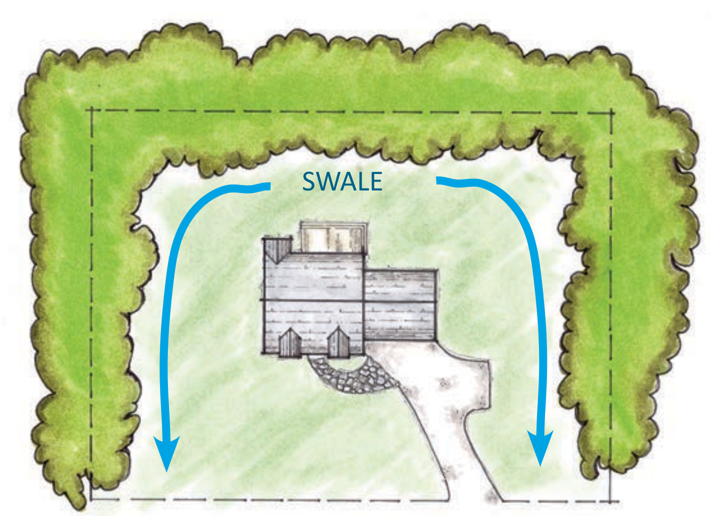

Figure 1. Example existing conditions map.

STEP 2 – IDENTIFY PROPERTY DETAILS

Identify and record the following features of your property:

LOT SIZE

The size of your lot should be on your property tax assessment, the deed to your house, the purchase and sales agreement for your home, on your town's website, or you can contact your town offices.

BREAK DOWN OF LAND COVER TYPES

Estimate the area of each land use type by doing the following.

Impervious Roof

Measure the length and width of your house, garage and any other structure that has a roof, and multiply to get the area (Figure 2).

Add the roof areas together to get the total impervious roof area for the property.

Other Hard Surfaces

Other hard surfaces include driveways, walkways, decks, patios or other surfaces that prevent water from soaking into the ground. Measure the average length and average width of these areas and multiply to get the area (Figure 3).

Add the areas together to get the total other hard surfaces area for the property.

Lawn and Landscaped Areas

Lawn and landscaped areas include any areas with grass or gardens that you regularly maintain. Measure the average length and average width of each of these areas and multiply to get the area (Figure 4). Note: older, compacted lawns that shed water may be counted under "Other Hard Surfaces."

Add the areas together to get the total lawn/landscaped area. If your property has no natural or forested areas on it, you can simply subtract the impervious roof and other hard surface areas from your total lot size to get the lawn/landscaped area.

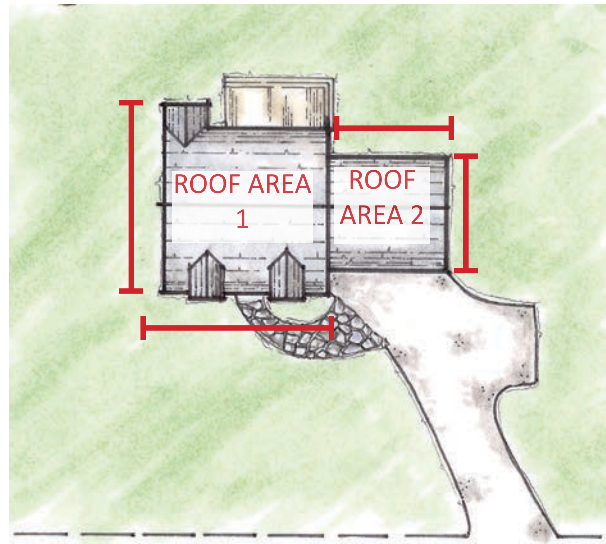

Figure 2. Measuring impervious roof areas.

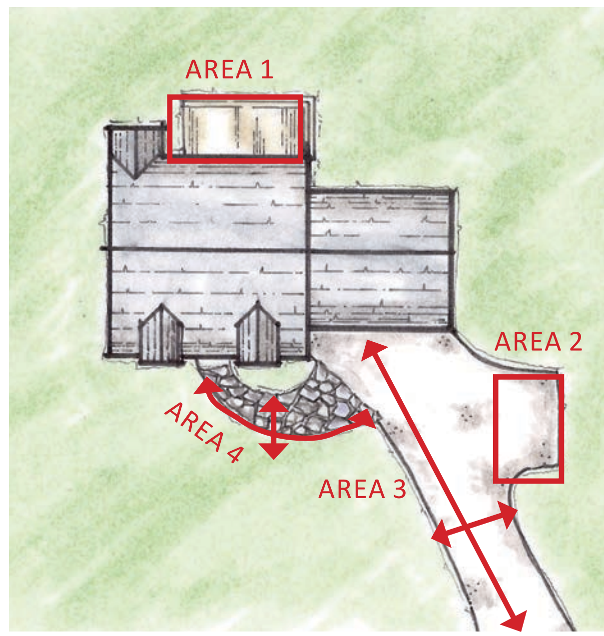

Figure 3. Measuring other hard surface areas.

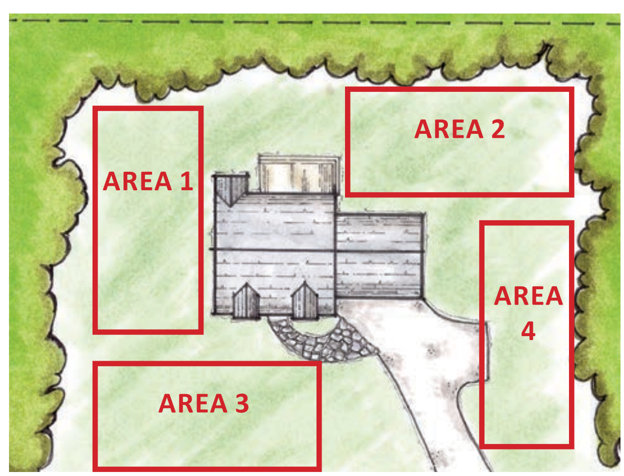

Figure 4. Measuring lawn areas.

Forested or Natural Areas

Forested and natural areas include any areas that are naturally vegetated and are not actively maintained. Measure the average length and width of these areas and multiply to get the area. Then add the areas together to get the total forested area.

Alternatively, subtract the impervious roof, other hard surfaces, and lawn/landscaped areas from the total lot size to get the forested/natural area of your property.

OTHER FEATURES

Roof Downspouts

If you have gutters on your house, follow them along the roof line to the downspouts. There may be more than one downspout on your house. Identify downspout locations and other areas, such as roof valleys, where rain collects and runs off of your roof. This will help you plan the best placement for stormwater treatment practices to capture roof runoff.

Vegetated Buffer Areas

Identify vegetated buffer areas such as trees and shrubs at the edge of your property, around waterbodies, and along steep slopes.

Steep Slopes and Other Vulnerable Areas

Identify any areas on your property with steep slopes and areas that regularly erode. Existing rills or gullies in the soil or exposed roots and rocks identify areas that may have erosion problems. Planting or allowing natural vegetation to grow along the top of the slope to create a buffer can protect against slope erosion.

Stormwater Treatment Practices

Identify any existing or planned stormwater treatment practices and their approximate location on your property.

Streams or Ponds

Identify any streams or ponds on or near your property. You can look up the water quality of those waterbodies to see if they have any existing pollution problems or impairments to consider in the NHDES Surface Water Quality Assessment webpage.

STEP 3 – IDENTIFY HOW AND WHERE STORMWATER FLOWS

When rain hits the ground, it flows over and through your yard. Some of it finds places to soak into the ground or low spots to puddle, and the rest of it may run off of your property. Using the property maps that you created, you can estimate how and where stormwater runoff flows on your property by following the steps below.

1. Imagine you're a raindrop (or better yet, watch a real rain storm). Identify high points in your lawn or driveway. Observe the directions that water flows and the places where the water ends up (the stormwater endpoints). These could be places where water puddles, where it enters a catch basin, or where it enters or could enter a stormwater practice that you install.

2. Draw a boundary line on your project map around the area that drains to each stormwater endpoint. The boundary line represents the "drainage area" for each stormwater endpoint. For example, if all of the runoff from the back of your garage roof drains to a single gutter downspout, the roof is the drainage area to the stormwater endpoint at the downspout. And if the right side of your yard all drains toward the road, that is a separate drainage area. You can identify these drainage areas on your property map by drawing a line around their perimeters (Figure 5).

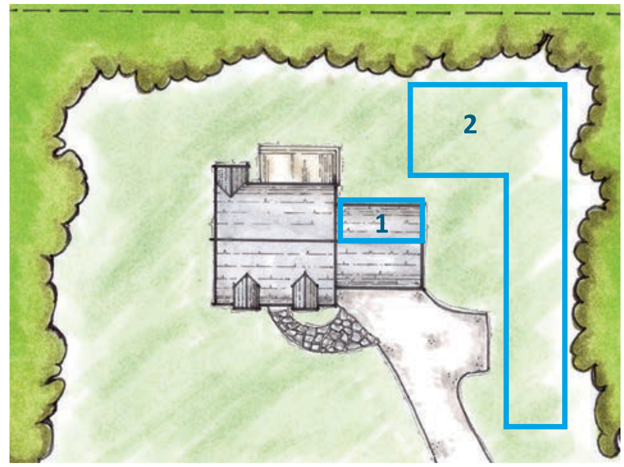

Figure 5. Draw the boundary lines (drainage areas) for stormwater endpoints.

3. To estimate the size of each drainage area, measure the approximate length and width and multiply to get the area or, if you used grid paper to scale your map, you can count the squares within each boundary line.

STEP 4 – ESTIMATE HOW MUCH STORMWATER RUNOFF YOUR PROPERTY CREATES

The roof and other hard surfaces on your property create the most stormwater runoff. While lawns and landscaped areas contribute to the stormwater problem, managing the runoff that comes from impervious surfaces is the best way to reduce stormwater runoff and pollution.

To estimate the amount of stormwater runoff that your property creates, complete the following steps:

1. Add up all the areas of impervious roof and other hard surfaces (ft^2) that you identified in Step 2.
2. Most storms in New Hampshire produce one inch of rain or less. To determine the volume of stormwater created during a storm that produces one inch of rain, multiply the total area of hard surfaces by 0.083 feet, which is approximately equal to one inch. Keep in mind that some storms produce greater than one inch of runoff. Stormwater treatment practices could be oversized to reduce overflow, or the practice could be designed to direct overflow to another treatment practice or designated pervious area.

   (IMPERVIOUS AREA$_{total}$ ft^2) X (0.083 ft) = STORMWATER VOLUME (ft^3)

STEP 5 – SELECT A LOCATION, TEST THE SOIL AND SELECT A STORMWATER PRACTICE

Refer to the Getting Started section of this guide for instructions on determining an appropriate location, testing the soils, and selecting a stormwater practice for your property.

STEP 6 – PREPARE A PROJECT PLAN

Using a copy of your existing conditions map, create your project plan by combining all of your property details (from Step 2), how and where water flows (from Step 3), and soil information and selection of location and stormwater practices (from Step 5) into one document. Include proposed changes and improvements to the property, such as building new structures like a deck or storage shed, clearing trees to expand your lawn or installing a stormwater practice, like a rain garden or rain barrel.

Chapter 4, The Landscape Design Process, from *Landscaping at the Water's Edge: An Ecological Approach* provides detailed instructions for preparing a project plan.

STEP 7 – ESTIMATE YOUR STORMWATER FOOTPRINT

Take your project one step further by using the New Hampshire Residential Loading Model to estimate your stormwater footprint.

The New Hampshire Residential Loading Model was developed by NHDES specifically for property owners to use to estimate the amount of sediment and nutrients, specifically phosphorus and nitrogen, running off of your property. This model can be used to:

- Calculate a property's "stormwater footprint," which is how much water volume and pollutants (sediment, phosphorus or nitrogen) run off of a property.
- Calculate the water quality benefit of installing stormwater treatment practices on your property.
- Compare the existing and planned future condition of your property with different stormwater treatment scenarios to see the difference in stormwater runoff volume and pollutant amounts.

The New Hampshire Residential Loading Model is available on the Winnipesaukee Gateway website.

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