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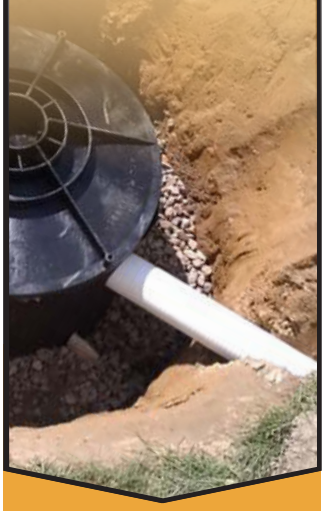


Downspout Full Infiltration Guidance

ELIGIBILITY

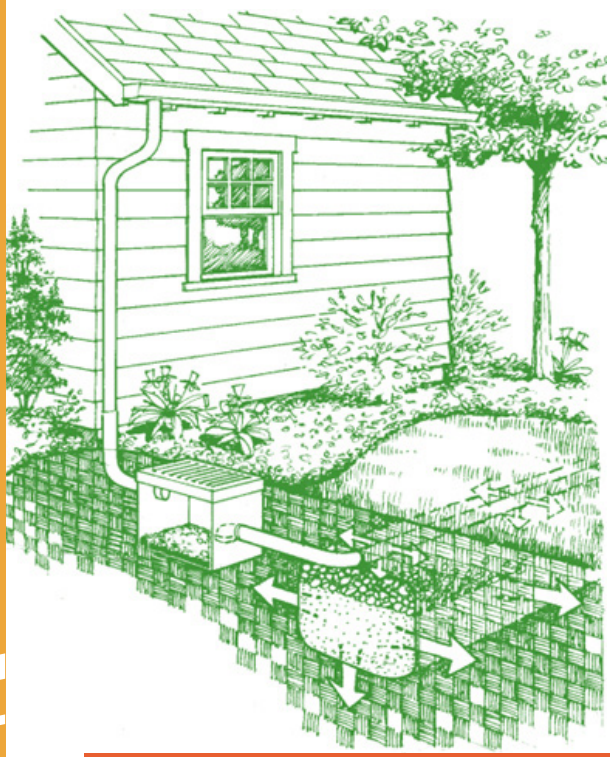
This handout is intended to aid applicants using the Stormwater Permit Application for Small Projects who have determined that Downspout Full Infiltration is the best method for managing stormwater from their project. This handout may also be used by owners of existing homes and other small structures to retrofit their property.

This design guidance may be used for residential roofs only. If any of the following is true, the system must be designed by a licensed Professional Engineer:

- If the system is placed under pavement.
- If the system handles runoff from more than 4,999 square feet of surface.
- If the system is placed in fill material.

If the infiltration system will receive runoff from any surface other than a roof or from any surface associated with a multi-family or commercial site, it may be regulated under the State of Washington's Underground Injection Control (UIC) program and may not be designed using this handout.

This guidance is intended for use by property owners and is not a substitute for Washougal Municipal Code. We have substituted some technical language with plainer terms. In case of conflict, the meaning and intent adopted in the Washougal Municipal Code and the Washougal Engineering Standards for Public Works Construction shall prevail.



WHAT IS DOWNSPOUT FULL INFILTRATION?

A downspout full infiltration system is either a cylindrical drywell or a trench designed to infiltrate runoff only from roofs. These are located underground and are filled with gravel which allows the runoff to collect and slowly soak into the ground.

Illustration from City of Portland Bureau of Environmental Services

WHERE SHOULD I BUILD MY INFILTRATION SYSTEM?

Once you have determined if downspout full infiltration is feasible for your roof, you can decide where to place the infiltration system. You should locate your infiltration system close to the roof downspout(s) you want to drain to it. If you have a large or complex roof, you may need more than one infiltration system. Water should flow into the system by gravity.

INFILTRATION SYSTEMS SHOULD NOT BE LOCATED:

1. **Within 15 feet of a building foundation.**
2. **Over utilities –** Make sure to have all utilities located and marked before digging. Contact utility locate services by calling 811.
3. **Near the edge of steep slopes or bluffs –** The additional water soaking into the ground on steep slopes can cause landslides or unwanted settling. Do not build a downspout infiltration system on a slope greater than 15%. Do not build a downspout infiltration system with 200 feet of a slope greater than 40%.
4. **Near a septic tank, septic drainfield, or reserve drainfield area –** Provide at least 10 feet between the infiltration system and an existing or planned septic system.
5. **In low spots that do not drain well.**
6. **In areas that would require disturbing healthy native soils, trees and other vegetation –** These areas already do a good job of filtering and storing stormwater.
7. **Where there is high groundwater during the winter –** If groundwater rises to within one foot of the bottom (excavated soil surface) of your downspout infiltration system during winter (highest level), you should consider a different location. In areas with high groundwater downspout infiltration system will not drain or function properly.
8. **Near wells –** Your downspout infiltration system must be set back a minimum of 100 feet from drinking water wells.

HOW DO I DESIGN MY INFILTRATION SYSTEM?

1. **CALCULATE RUNOFF AREA:** Calculate the area of your roof. You do not have to worry about the pitch of the roof. Use the roof area and not the floor area. They will be different on a multi-story house. Be sure to include the roof overhang in your calculations.

   Runoff area * = _____ **square feet**

   (length x width = area in square feet)

   You will use this runoff area in later design steps.

   ** Maximum allowable roof area for applicants using this form is 4,999 square feet.*

2. **FIND INFORMATION FROM THE SOILS REPORT:** In Section B of the Stormwater Permit Application for Small Projects, a Soils Report prepared by a qualified professional is required. Use information from the Soils Report to guide selection and design of the infiltration system.

   a. Find the soil type and write it here: _____

   _____

   b. Calculate the maximum depth following the instructions on the following page

The depth of the facility is the distance between the ground surface and the bottom excavated soil surface of the infiltration system. The maximum depth is limited by properties of the soil and groundwater. The bottom of the facility must be 1 foot above the seasonal high groundwater, impermeable layer, or bottom of soils log.

Review the Soils Report and fill in the following table to find the maximum depth.

From the ground surface, write either the Depth of Soils Log or the Depth of Groundwater or the Depth of Impermeable Layer (feet), whichever one is smallest	feet
Subtract 1 foot	- 1 foot
MAXIMUM DEPTH BELOW GROUND SURFACE (FEET)	feet

c. Select the type of infiltration system

There are two types of infiltration systems: drywells and infiltration trenches. Drywells are tall and can have a smaller foot print, and they must be built on very well drained soils. Infiltration trenches are shallower with a larger footprint, and they have two design options, typical and alternative. The typical infiltration trench has a perforated pipe and can be built in most soil types. The alternative infiltration trench does not have a perforated pipe and must be built on very well drained soils.

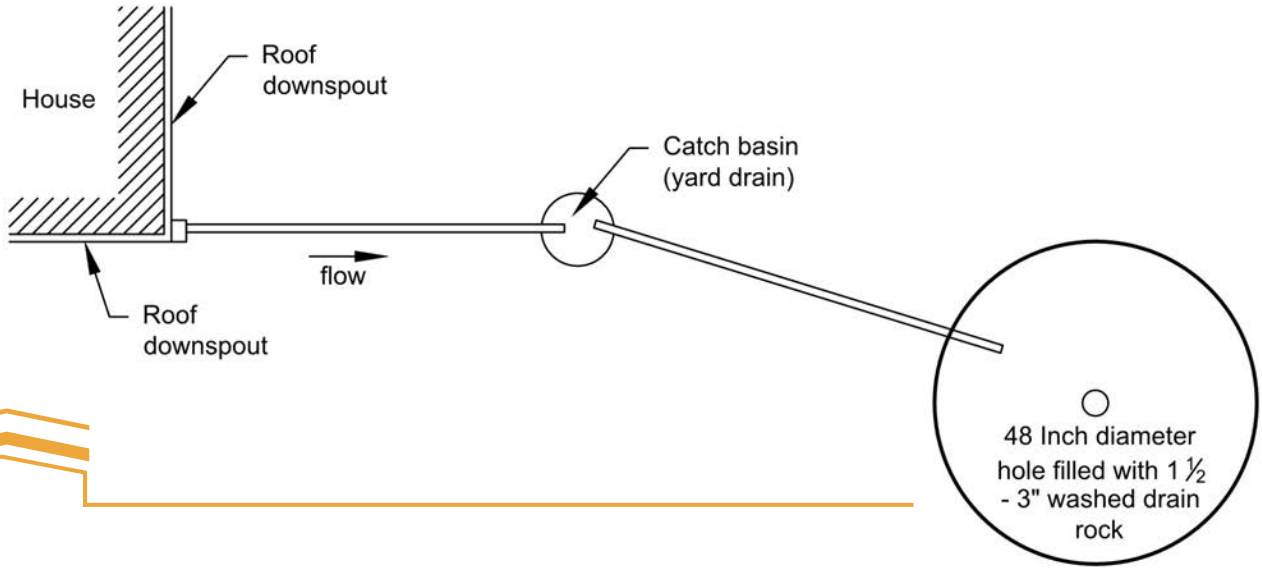
Use the matrix below to select a type of downspout infiltration system that will work with your soil type (Step 2a) and the maximum depth (Step 2b). When you have selected the type of system, choose the instructions below for designing that type.

n/a	Downspout full infiltration may not be used
A	Alternative Infiltration Trench
B	Typical Infiltration Trench
C	Drywell

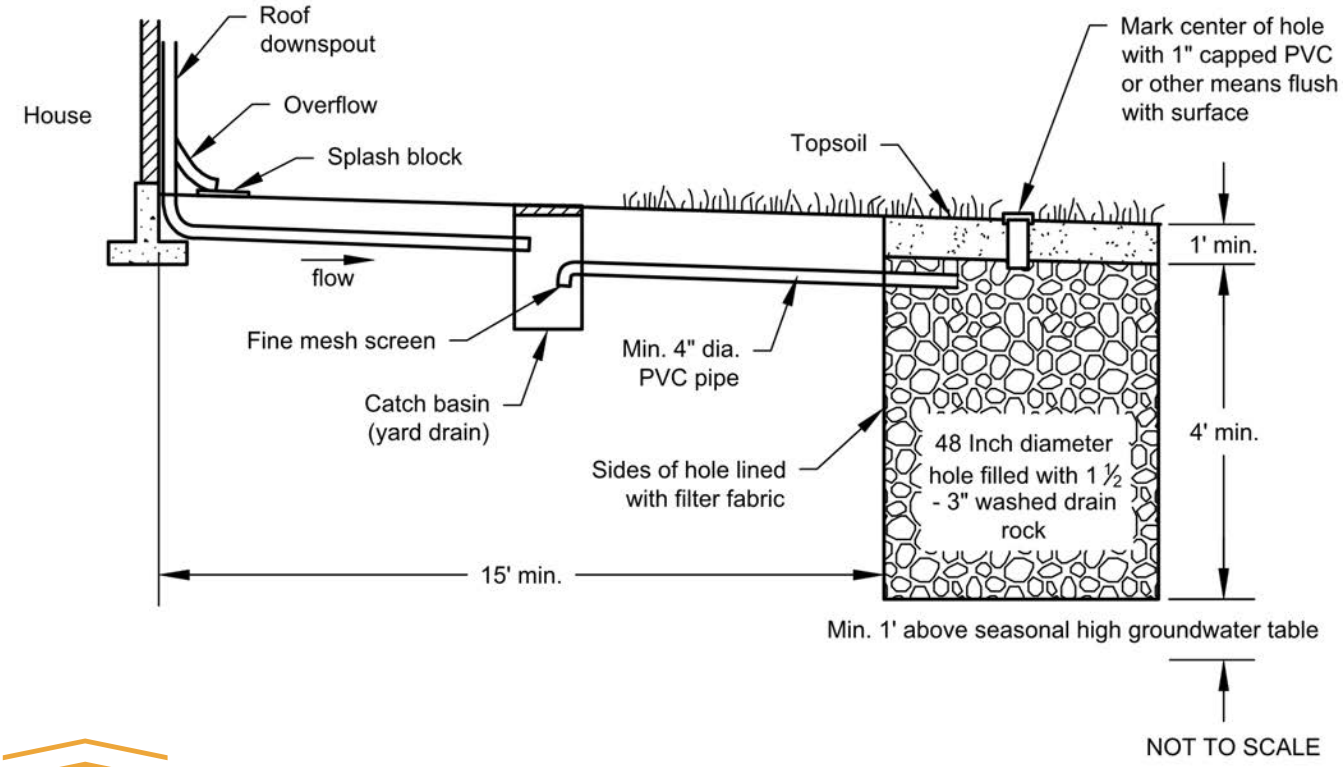
	Maximum Depth (feet)			
SOIL TYPE	**LESS THAN 3**	**3 TO 4**	**4 TO 5**	**5 OR MORE**
Coarse Sands and Cobbles	n/a	A, B	A, B	A, B, C
Medium Sand	n/a	B	B, C	B, C
Fine Sand, Loamy Sand	n/a	n/a	B	B
Sandy Loam	n/a	n/a	B	B
Loam	n/a	n/a	B	B

DESIGN A DRYWELL

To design a drywell, follow these instructions. To design an infiltration trench, skip to the next section.



Plan View



Section View

Downspout Infiltration Drywell (Stormwater Management Manual for Western Washington revised 2019)

3. DRYWELL VOLUME: Calculate the minimum volume of gravel based on the **runoff area** (Step 1) and **soil type** (Step 2a):

If Soil Type = Coarse sand or cobble, then calculate 60 cubic feet per 1,000 square feet of runoff area.

Runoff area _____ square feet x 0.060 = _____ cubic feet of gravel (1 ½" - 3" clean drain rock)

If Soil Type = Medium sand, then calculate 90 cubic feet per 1,000 square feet of runoff area.

Runoff area _____ square feet x 0.090 = _____ cubic feet of gravel (1 ½" - 3" clean drain rock)

4. DIMENSIONS: Calculate dimensions of the drywell large enough to hold the minimum volume of gravel (Step 3).

a. Calculate the maximum height of the drywell.

- The bottom of the drywell must be located no deeper than the maximum depth (Step 2b)
- At least 1 foot of topsoil must cover the top of the drywell.

Maximum depth (from Step 2b) _____ (feet) - 1 (foot) = Maximum height: _____ (feet)

b. Calculate the minimum diameter of the drywell.

- The drywell must be a minimum of 4 feet in diameter.

Using the volume (Step 3) and the maximum height (Step 4a), find the minimum diameter using this equation[1]:

$$Diameter = \frac{2 \times \sqrt{volume}}{1.77 \times \sqrt{maximum\ height}}$$

DIAMETER = 2 multiplied by the square root of the volume then divide that by 1.77 multiplied by the square root of the maximum height.

$$Diameter = \frac{2 \times \sqrt{\quad} \text{ cubic feet}}{1.77 \times \sqrt{\quad} \text{ feet}} \Rightarrow \quad \text{feet}$$

The minimum diameter must be at least 4 feet. If the equation above results in a diameter less than 4 feet, then the minimum diameter = 4 feet.

Minimum diameter = _____ (feet)

[1] *The equation for diameter requires calculating the square root (√) of both the volume and the maximum height. If your calculator does not have a square root function, try using an Internet search for "square root calculator."*

Right: optional use of plastic drywell available at home improvement stores

c. Finalize Dimensions: Depending on the constraints of your site, the maximum height or the minimum diameter may be the most important size variable to you. Select either a diameter greater than the minimum or a height shorter than the maximum and calculate the other dimension using one of the equations below.

If you want to calculate the diameter, use the volume and the height in this equation:

$$\text{Diameter} = \frac{2 \times \sqrt{\text{volume}}}{1.77 \times \sqrt{\text{height}}}$$

$$\text{Diameter} = \frac{2 \times \sqrt{\quad\quad} \text{ cubic feet}}{1.77 \times \sqrt{\quad\quad} \text{ feet}} \quad \text{feet}$$

OR **If you want to calculate the height, use the volume and the diameter in this equation:**

$$\text{Height} = \frac{(4 \times \text{volume})}{3.14 \times (\text{diameter})^2}$$

$$\text{Height} = \frac{(4 \times \quad\quad \text{ cubic feet})}{3.14 \times (\quad\quad \text{ feet})^2} \quad \text{feet}$$

Write the final volume and dimensions of the drywell:

Height	Diameter	Gravel Volume
feet	feet	feet (1 ½"- 3" clean drain rock)

5. **DRYWELL BOTTOM DEPTH:** You will excavate to the bottom depth. The bottom depth is the drywell height plus the required topsoil cover. The bottom depth may not be lower (deeper) than the maximum depth (Step 2c).

Bottom depth = drywell height _____ feet + 1 foot = _____ feet

6. **DISTANCE FROM DOWNSPOUT:** Measure the distance from the downspout to roughly the center of the drywell location. You will need 4-inch or 6-inch PVC pipe of this length and fittings to connect this inlet pipe to the downspout. If you choose to use a catch basin (yard drain) with downturned elbow to prevent dirt from clogging your infiltration system (recommended), then obtain two lengths of 4-inch or 6-inch PVC pipe, elbow connection, mesh screen fitting, and residential catch basin/yard drain from a home improvement store. You may need a small amount of crushed gravel or crushed stone to evenly slope the pipe from the downspout to the infiltration trench (estimate 1 bag from a home improvement store).

PVC pipe length(s) = _____ and _____

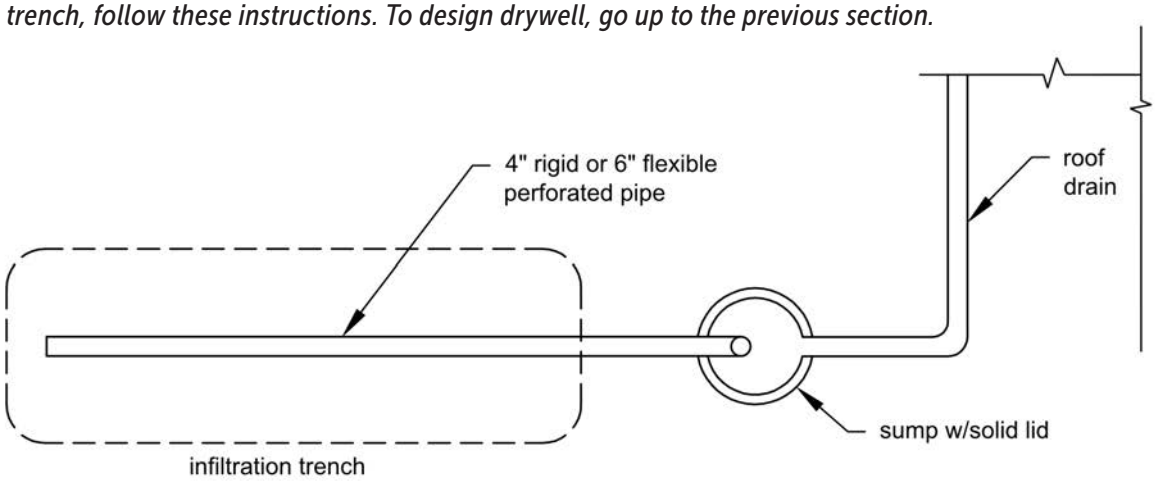
Listing other fittings and items needed: _____

_____

You are finished designing your drywell. Skip to the section on **How Do I Build My Infiltration System.**

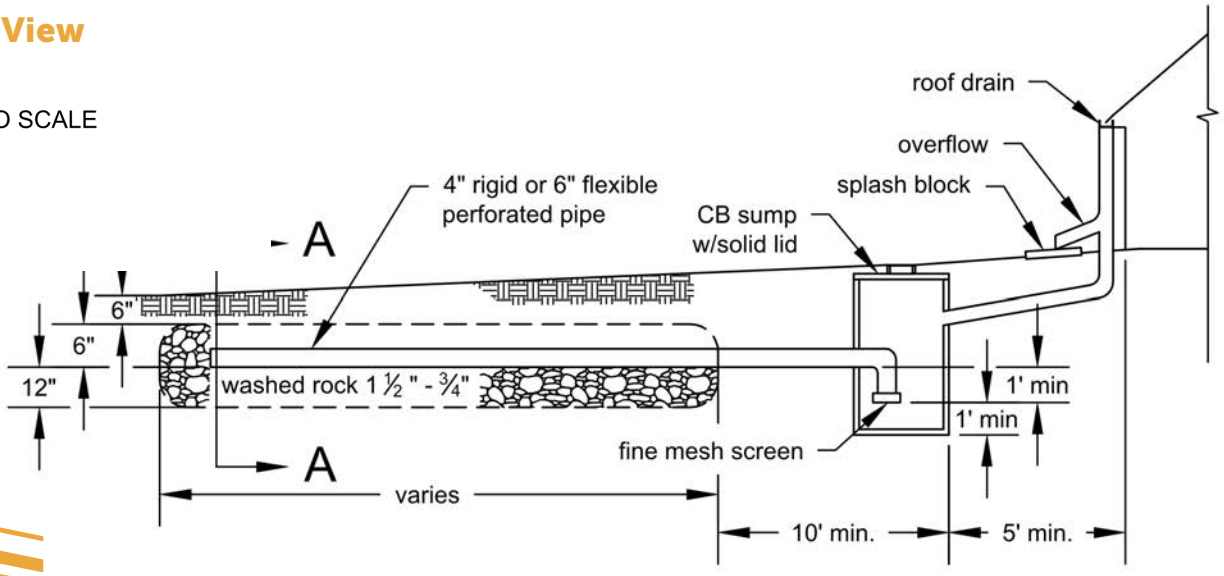
Design an Infiltration Trench using One of Two Options

To design an infiltration trench, follow these instructions. To design drywell, go up to the previous section.



Plan View

NOT TO SCALE



Profile View

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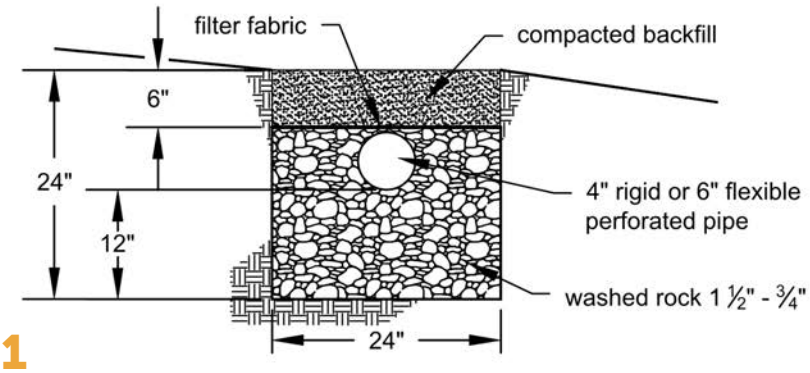
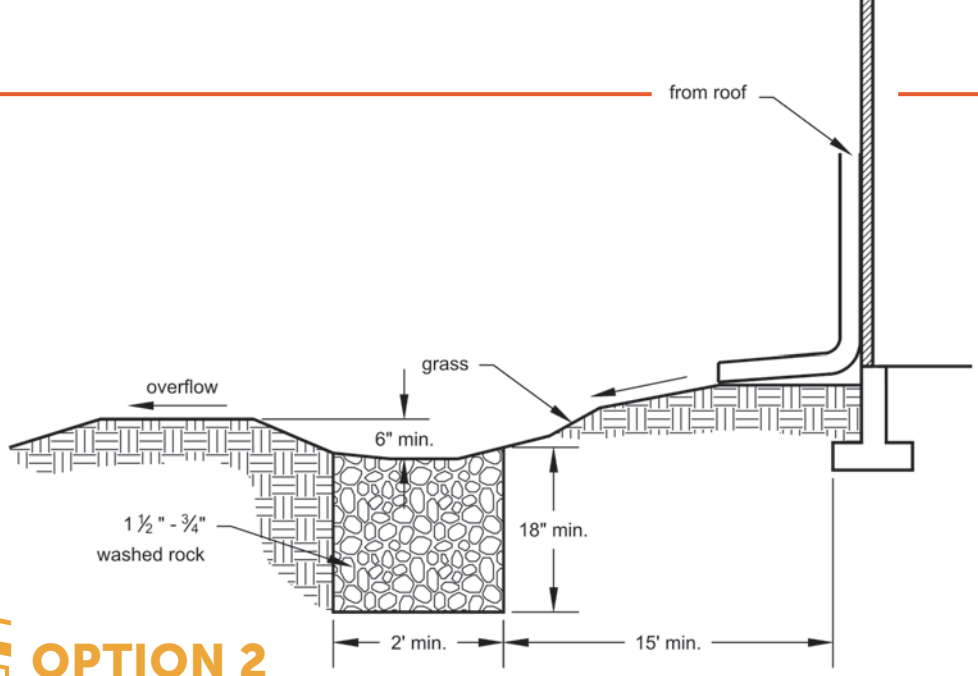


OPTION 1

Section View

Typical Downspout Infiltration Trench with Perforated Pipe
(Stormwater Management Manual for Western Washington, revised 2019)



OPTION 2

Section View

Alternative Downspout Infiltration Trench for Coarse Sand & Cobbles (without perforated pipe)
(Stormwater Management Manual for Western Washington, revised 2019)

3. TRENCH DIMENSIONS:

a. **Length:** Trench length is calculated by multiplying the runoff area (Step 1) by a multiplier from the table below. The multiplier depends on your soil type (Step 2a). In the table below, circle the multiplier that corresponds to your soil type (Step 2a).

SOIL TYPE	TRENCH LENGTH MULTIPLIER
Coarse sands and cobbles	0.020
Medium Sand	0.030
Fine sand, loamy sand	0.075
Sandy Loam	0.125
Loam	0.190

Runoff area _____ square feet x Trench length multiplier _____ = Length of trench _____ linear feet

Notes:

- The maximum length of a trench is 100 linear feet. If the calculated length of trench is greater than 100 linear feet, build multiple parallel trenches.
- Minimum spacing between parallel trench centerlines is 6 feet.
- The trench length is also the length of 6-inch perforated pipe that you will need for the typical trench.

b. **Height:** 1.5 feet high (required height) (or 18 inches)

c. **Width**: 2 feet wide

4. **TRENCH GRAVEL VOLUME:** Multiply the trench length by height by width to determine the volume of gravel required.

Trench length _____ feet x 1.5 feet x 2 feet = _____ cubic feet of gravel (1 ½" - 3" clean drain rock)

a. ***If you are designing Option 2, an Alternative Infiltration Trench,*** you may choose to modify the length, height, or width of the trench as long as all of the following are true: the trench can accommodate the required minimum volume of gravel calculated above, is at least 18 inches high, is at least 2 feet wide, and the bottom depth is at least 1 foot above the maximum depth (Step 2b). This handout does not provide equations for this calculation. If you are using this design, please show your calculations in the box on the right.

5. **TRENCH BOTTOM DEPTH:** Calculate the depth of the bottom of the trench. You will excavate to the bottom depth. The bottom depth may not be lower (deeper) than the maximum depth (Step 2c).

Trench bottom depth = height (18 inches) + minimum 6 inches (of topsoil or overflow height) = Trench depth _____ (feet)

6. **DISTANCE FROM DOWNSPOUT:** Measure the distance from the downspout to end of the drywell trench. You will need 4-inch or 6-inch PVC pipe of this length and fittings to connect this inlet pipe to the downspout. If you choose to use a catch basin (yard drain) with downturned elbow to prevent dirt from clogging your infiltration system (recommended), then obtain two lengths of 4-inch or 6-inch PVC pipe, elbow connection, mesh screen fitting, and residential catch basin/yard drain from a home improvement store. You may need a small amount of crushed gravel or crushed stone to evenly slope the pipe from the downspout to the infiltration trench (estimate 1 bag from a home improvement store).

PVC pipe length(s) = _____ and _____

Listing other fittings and items needed: _____

_____

You are finished designing your infiltration trench. Go to the next section on **How Do I Build My Infiltration System.**

HOW DO I BUILD MY INFILTRATION SYSTEM?

Once you've selected the location for and planned the size of the infiltration system, you're ready to build.

7. **MARK THE BOUNDARIES:** Once you have determined the location and dimensions, clearly mark the boundary of your infiltration system to identify where to dig. Landscape flags, string, or spray paint work well.

8. **DIG THE INFILTRATION SYSTEM:** Excavate down to the bottom depth of the drywell or trench (Step 5) within the marked boundary. Consider saving the good topsoil near the surface to use in a planting bed later. Call 811 before you dig. If you are using an excavator, be careful not to drive or park the excavator over where you intend to dig the infiltration system because it may reduce the system's ability to drain.

9. **SHAPE THE BOTTOM:** The bottom of the infiltration system should be level to ensure even infiltration.

10. **DIG AN INLET CHANNEL:** For a drywell or typical infiltration trench, dig a narrow channel from the gutter downspout to the infiltration system. The channel should be wide enough and deep enough to hold a 4-inch or 6-inch pipe. Carefully remove and set aside the sod growing over the channel to use later to re-cover once it is complete. Be sure to slope the inlet channel toward the infiltration system so that the water easily drains from the gutter to the infiltration system and doesn't back up. **If you selected the alternative trench design,** simply slope the ground from the downspout to the infiltration system.

11. **DIG A HOLE FOR THE CATCH BASIN/YARD DRAIN.** If you are using a catch basin/yard drain between the downspout and the infiltration system (recommended), dig a hole in the inlet channel at least 5 feet away from the downspout. Dig it deep enough and wide enough to accommodate the residential catch basin/yard drain you purchased.

12. **LINE WITH LANDSCAPE FABRIC:** Extend the life of the drywell or trench by lining the sides with non-woven landscape fabric. Leave extra fabric extending from the top to later fold over the gravel (Step 17). **Do not place landscape fabric on the bottom of the infiltration system because it will prevent drainage.**

BEFORE YOU BUILD, MAKE A SUPPLIES LIST:

1. Clean drain rock (clean gravel) sized 1 ½-inch to 3-inch _____ cubic feet (Step 3 or 4)
2. 4-inch or 6-inch PVC perforated pipe length _____ feet (Step 3 for typical infiltration trench, not needed for drywell or alternative infiltration trench)
3. 4-inch or 6-inch solid PVC pipe length(s) _____ feet and _____ feet (Step 6 for drywell or typical infiltration trench, not needed for alternative infiltration trench)
4. Crushed stone estimated quantity: _____
5. Landscape flags or string or spray paint
6. Level
7. Shovel
8. Residential catch basin/yard drain (if using)
9. 4-inch or 6-inch PVC elbow and mesh screen (if using)
10. For drywell, consider renting a small excavator.

13. **FILL PARTIALLY WITH GRAVEL:** Begin filling the drywell or infiltration trench with 1 ½" - 3" clean drain rock (clean gravel). For typical infiltration trench, fill with 1 foot of gravel, then go to Step 14. For drywell, fill the excavation with gravel up to where the inlet pipe from the gutter will come in. Be sure to place the inlet pipe deep enough to allow additional gravel to cover it and for the required topsoil cover on top of the drywell. **If you selected the alternative trench design,** fill the trench with the full volume of gravel and stop here.

14. **LAY PERFORATED PIPE:** For the typical infiltration trench, lay perforated pipe lengthwise in the trench with 1 foot of gravel under the pipe. Carefully cover the perforated pipe with gravel to avoid crushing the pipe. For a drywell, skip this step.

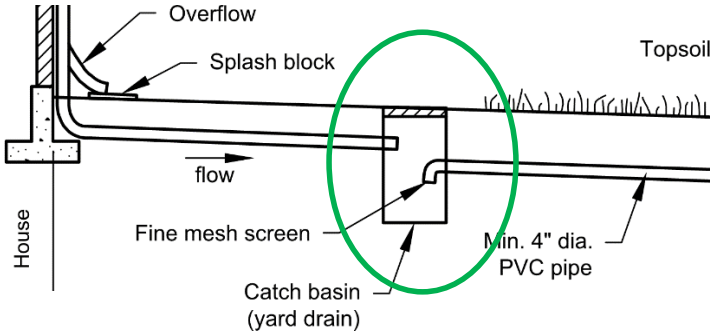
15. **CONNECT AN INLET PIPE FROM THE DOWNSPOUT TO INFILTRATION SYSTEM:** Attach the inlet pipe to the downspout and lay it in the inlet channel. Use crushed stone and a level to make sure it is sloped toward the infiltration system so it will drain. If using a residential catch basin/yard drain (recommended), connect the first section of inlet pipe from the downspout to the catch basin, connect the second section of inlet pipe from the catch basin to the infiltration system, and connect a downturned elbow with wire mesh fitting to the second section of inlet pipe inside the catch basin. See illustration below. In this example, flow is traveling left to right from the downspout to the infiltration system.

    For drywells, extend the inlet pipe to near the center of the well. For infiltration trenches, connect the inlet pipe to the perforated pipe in the trench.

16. **CONTINUE TO FILL WITH GRAVEL:** Fill with remainder of the infiltration system with gravel to within 1 foot of the ground surface (drywell) or within 6 inches of the ground surface (infiltration trench).

17. **COVER WITH LANDSCAPE FABRIC:** Fold a flap of filter fabric over the top of the gravel.

18. **COVER TOP WITH SOIL:** Cover the landscape fabric with a 1-foot (drywell) or 6-inch (typical infiltration trench) deep planting bed of soil. Densely plant the buried infiltration system with native groundcover, grasses, or other perennials. Fertilize sparingly and only as needed.



Inlet Pipe Connection

HOW DO I MAINTAIN MY INFILTRATION SYSTEM?

INSPECT: Seasonally and after large storms. Look for signs of clogging such as ponding at the surface or water backing up into gutter if your downspout is buried.

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

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