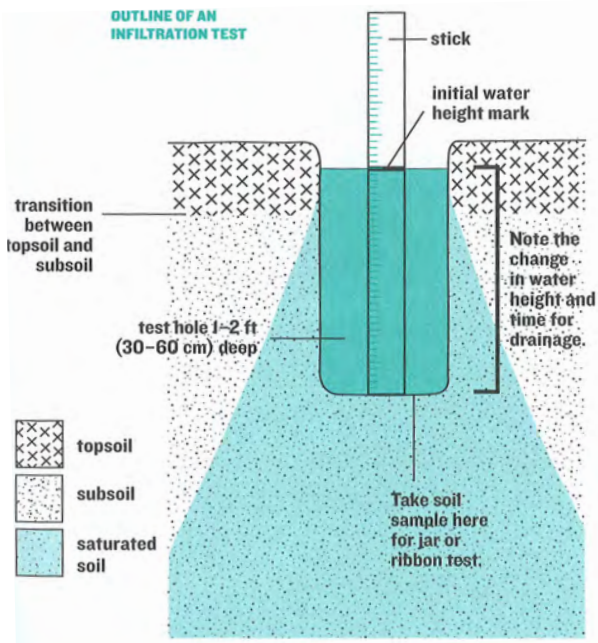
engineering your rain garden

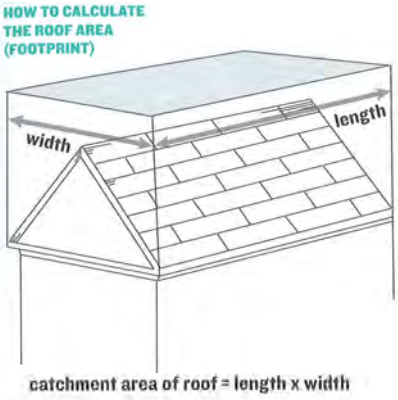
step 1: test your drainage rate



1. Dig a 1-foot (30-cm) test hole in well-draining soil or a 2-foot (60-cm) hole in slowly draining soil. If you're doing the infiltration test when the soil is dry, fill the test hole with water, let it drain, then repeat three times.
2. Jab the stake or stick into the middle of the test hole.
3. Fill the hole with water.
4. Mark the filled water level on the stake with the marker.
5. Note the time.
6. Wait for the hole to drain completely, then note the time again.
7. Measure the distance from the mark on the stick to the bottom of the hole (in inches or cm). This is the water depth.
8. Calculate how long (in hours) the water took to drain. This is the drainage time.
9. Divide the water depth by the drainage time. The result is the drainage rate (inches /hour or cm/hour).

source: Creating Rain Gardens
authored by Cleo Woelfle-Erskine & Apryl Uncapher

step 2: determine your catchment area



step 3: account for runoff coefficient

EXAMPLES OF RUNOFF COEFFICIENTS

SURFACE	TYPICAL RANGE	RECOMMENDED VALUE
Concrete	0.80–0.95	0.90
Brick	0.70–0.85	0.80
Roofs	0.75–0.90	0.85
Paving stones	0.10–0.70	0.40
Grass pavers/turf blocks	0.15–0.60	0.35
Lawns and grass on sandy soil	0.05–0.20	0.12 for a gentle (5%) slope, with values increasing as slope increases
Lawns and grass on heavy soil	0.13–0.35	0.22 for a gentle (5%) slope, with values increasing as slope increases
Landscaped beds	0.15–0.30	0.20
Crushed aggregate	0.15–0.30	0.20

Adapted from LEED-NC version 2.1

1. CALCULATE THE EFFECTIVE RUNOFF AREA OF THE ROOF AND THE DRIVEWAY.

- Effective runoff area = length × width × percent directed to rain garden × runoff coefficient
- Area 1 (roof) = 25 feet (7.5 m) × 40 feet (12 m) × 0.50 × 0.85 = 425 square feet (38.3 square meters)
- Area 2 (driveway) = 10 feet (3 m) × 16 feet (4.8 m) × 1.00 × 0.90 = 144 square feet (13 square meters)

2. ADD THE TWO AREAS TOGETHER TO GET THE TOTAL EFFECTIVE RUNOFF AREA.

- Area 1 + Area 2 = 425 square feet (38.3 square meters) + 144 square feet (13 square meters) = 569 square feet (51.3 square meters)

step 4: calculate runoff volume

To determine dimensions for your rain garden, first you need to calculate the runoff volume. Let's assume you have 1000 square feet (93 square meters) of catchment area directed to your rain garden and your local public works department tells you they use a rainfall intensity of 1 inch (25 mm) per hour as average design storm intensity. From experience, you know that heavy rainfall in your area usually lasts around 1 hour. Use the following equation to convert the catchment area to a volume of water draining off during a 1-hour storm:

Runoff volume (cubic feet) = total drainage area (square feet) × [rainfall intensity (inches/hour) × (1 foot/12 inches)] × duration of heavy rainfall (hours)

$$\text{Runoff volume} = 1000 \text{ square feet} \times \left[\frac{1 \text{ inch}}{1 \text{ hour}} \times \frac{1 \text{ foot}}{12 \text{ inches}}\right] \times 1 \text{ hour} = 83.3 \text{ cubic feet}$$

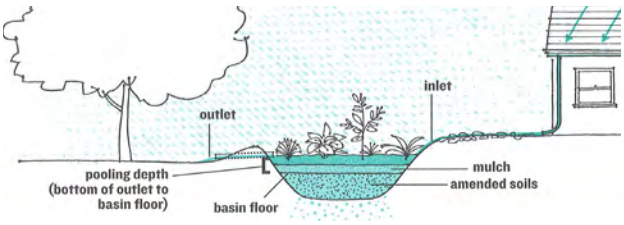
In this calculation, first do the multiplication within the brackets and then multiply that value by the square footage.

step 5: determine the depth of your rain garden

$$\text{Maximum pooling depth} = \left[\frac{1 \text{ inch}}{6 \text{ hours}} \times \frac{24 \text{ hours}}{1 \text{ day}}\right] = 4 \text{ inches/day}$$

Maximum pooling depth (inches or cm) =
soil drainage rate (inches/hour or cm/hour) x 24 hours/day

step 6: determine the surface area of your rain garden



Because volume is the product of area and depth, it's easy to calculate your rain garden's surface area once you've determined its ideal volume and depth. The pooling depth you calculated in the previous equation was in inches or centimeters, so here you need to convert to feet or meters.

$$\text{Rain garden area (square feet)} = \frac{\text{rain garden storage volume (cubic feet)}}{\left[\text{rain garden pooling depth (inches)} \times \left(\frac{1 \text{ foot}}{12 \text{ inches}}\right)\right]}$$

$$\text{Rain garden area} = \frac{83.3 \text{ cubic feet}}{\left[4 \text{ inches} \times \frac{1 \text{ foot}}{12 \text{ inches}}\right]} = 250 \text{ square feet}$$

$$\text{Rain garden area (square meters)} = \frac{\text{rain garden storage volume (cubic meters)}}{\left[\text{rain garden pooling depth (cm)} \times \left(\frac{1 \text{ m}}{100 \text{ cm}}\right)\right]}$$

$$\text{Rain garden area} = \frac{2.3 \text{ cubic meters}}{\left[10 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}}\right]} = 23 \text{ square meters}$$

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