Box 2.4. Calculating Runoff Volumes

You can get a ballpark estimate of runoff volume from any sloped surface by multiplying the volume of rain that falls on that surface by its "runoff coefficient"—the average percentage of rainwater that runs off that type of surface. For example, a rooftop with a runoff coefficient of 0.95 estimates that 95% of the rain falling on that roof will run off.

The runoff coefficient for any given surface depends on what the surface is composed of. Rainfall intensity also affects the coefficient: the higher the rainfall intensity, the higher the runoff coefficient. Ranges and averages of various runoff coefficients I use in the southwest U.S. are as follows:

• A roof or impervious paving (such as an asphalt street): 0.80–0.95
• Sonoran Desert uplands (healthy indigenous landscape): range 0.20–0.70, average 0.30–0.50
• Bare earth: range 0.20–0.75, average 0.35–0.55
• Grass/lawn: range 0.05–0.35, average 0.10–0.25
• For gravel use the coefficient of the ground below the gravel.

The runoff coefficient for earthen surfaces is greatly influenced by soil type and vegetation density. Large-grained porous sandy soils tend to have lower runoff coefficients while fine-grained clayey soils allow less water to infiltrate and therefore have higher runoff coefficients. Whatever your soil type, the more vegetation the better, since plants enable more water to infiltrate the soil.

CALCULATING ROOF RUNOFF: AN EXAMPLE IN METRIC UNITS

Determine the size of a roof catchment by measuring only the outside dimensions—or "footprint"—of the roof's edge (if your house has a roof with overhangs the roof's footprint will be larger than the building's footprint). Ignore the roof slope; no more rain falls on a peaked roof than falls on a flat roof with the same footprint. (See figure 2.5).

To calculate the runoff in liters from a metal roof's 9 meter × 10 meter "footprint" (90 square meters) in a climate averaging 304 millimeters of rain a year:

90 square meter roof × 304 millimeters of average annual rainfall = 27,360 liters of rain falling on the roof in an average year.

90 m^2 × 304 mm = 27,360 liters/average year

Multiply the above figure by the roof surface's runoff coefficient 0.95*:
27,360 liters × 0.95 = 25,992 liters running off the roof in an average year.

Note*: 5 to 20% of runoff from impervious catchment surfaces such as roof can be lost due to evaporation, wind, overflow of gutters, and minor infiltration into the surface itself. In volume 3, the chapter on cistern components includes a table for runoff coefficients specific to roof type.

CALCULATING YARD RUNOFF: AN EXAMPLE IN ENGLISH UNITS

Let's say we are on a site receiving 18 inches of rain in an average year, and the neighbor has about a 25 foot by 12 foot bare section of his yard that drains onto our example property. The soil is clayey and compacted.

Determine the available rainwater running off that section of the neighbor's yard onto our land by multiplying its catchment area (300 square feet) by the average annual rainfall in feet (1.5) by 7.48 (to convert the answer to gallons):

CATCHMENT AREA (ft^2) × RAINFALL (ft) × 7.48 gal/ft^3 = TOTAL RAINWATER (gal)

300 × 1.5 × 7.48 = 3,366 gallons of rain falling on that section of the neighbor's yard in an average year.

Multiply that figure by the soil surface's runoff coefficient of 0.60:

3,366 × 0.60 = 2,019 gallons annually running off the neighbor's compacted yard into ours. Add that to our site's annual rainwater budget.