Sustainable Building Program

Rainwater Calculations

There are a few numbers you need to calculate in order to implement a successful rainwater harvesting system. First, you need to know how much water you can potentially capture from your roof and other surfaces. You can find your **monthly and annual precipitation averages** for Coconino County at:

http://www.wrcc.dri.edu/summary/Climsmaz.html

Other areas of Arizona are also available at this site. If your location is not available, average the data from two or three locations that are near you or have similar climate/elevation.

Bright Angel	25.41
Flagstaff	22.91
Fredonia	9.73
Grand Canyon	13.71
Happy Jack	26.19
Leupp	6.50
Page	6.48
Sedona	17.85
Supai	8.59
Tuba City	6.42
Valle	9.39
Williams	21.65

Remember that these are *averages* – some years will be drier or wetter than others. You can calculate a more "normal" year by multiplying the average rate by 0.80 (80% of the average):

Flagstaff: 22.91 inches (average) x 0.80 = 18.33 inches ("normal")

From: http://www.ose.state.nm.us/water-info/conservation/pdf-manuals/Roof-Reliant-Landscaping/RRL-Chapter-3.pdf

You will also need to know the **total square footage** of the areas from which you will be harvesting water your "catchment" area). Once you have your precipitation amounts and catchment area calculated, use this site to find your rainwater harvesting potential:

http://www.harvestingrainwater.com/wp-content/uploads/2006/05/catchment-area-to-runoff-yield-2.xls

You can use this as a dynamic computer spreadsheet or print out a hard copy to use as a quick reference guide for estimating runoff from variously sized catchments. Change the first italicized number to your total annual precipitation (numbers in other columns show the catchment potential for 1, 2, 3, or 4 inches of precipitation, which may be useful for more general calculations, such as a single rain event).

Note that the **spreadsheet default is a 90% *runoff coefficient;*** this means that 90% of the rain falling on the catchment surface will run off and be available for capture, while the other 10% will be lost to evaporation, wind, leaks, infiltration into the catchment surface, etc. The 90% is typical for an asphalt or concrete roof or hardscape such as a patio, road, or driveway. You can **change the runoff coefficient** in Excel for different catchment surfaces if needed:

Metal: 95% **Tar Roof:** 85% **Concrete/Asphalt:** 80-95%

Above information from: http://www.harvestingrainwater.com/rainwater-harvesting-inforesources/water-harvesting-calculations/

If you cannot access the above links, you can calculate your rainwater harvest using this equation:

1" of rain falling on 1 square foot of surface = 0.52 gallons of water

from: http://www.rainwaterconnection.com/rainwater_harvesting/how_much.htm

For example, if your annual precipitation is 12.5" and your catchment surface is 2,000 sq.ft.:

(12.5 x 2,000) x 0.52 = 13,000 gallons

To account for the appropriate runoff coefficient (as seen above), include it in the equation (we used 90%):

(12.5 x 2,000) x 0.90 x 0.52 = 11,700 gallons

Although you have the ability harvest a particular amount of water over the course of the year (such as 11,700 gallons), you will not need to *store* all of that water at one time. Your water is being used every day and will draw down your storage tank before the next rain event occurs to replenish it. It is, however, important to understand how much water you will need to have stored during drier weather conditions. To estimate storage capacity (*i.e.* size/number of cisterns), calculate your **daily household water consumption**. Estimate the daily use for *each* person in the home (showers, sink use, toilet flushes) as well as appliances such as dish and clothes washers. If it's easier, you can calculate weekly estimates and then divide those by 7. If you have seasonal guests, irrigate gardens, or have other situations which may increase/decrease water use, average those numbers in to an annual usage and divide by 365 to get your daily use. Next, find the approximate number of days that your location could be in a "drought" condition (not receiving enough precipitation to sufficiently replenish your supply). In Flagstaff, a drought period is common in the spring before the monsoons arrive, where we may have 90+ days without significant precipitation. With these numbers, use the following equation to calculate your storage size:

Number of gallons used per day X longest drought period (days) = cistern size (gallons)

(from Brad Lancaster's *Rainwater Harvesting For Drylands and Beyond, Vol. 1, 2009 ed.*)

This number will show you how much water you will need to have stored in order to use your *normal* amounts of water during dry weather periods. If the number seems large, remember that you can always reduce your daily water consumption during dry periods. By sizing your cisterns correctly, you can have enough water stored from previous rainfalls to get through the dry time comfortably.

Another way to understand your water availability and necessary storage capacity is by calculating your monthly consumption (multiply your daily rate by 30), then refer to your local weather data to determine your monthly precipitation rates. By comparing your monthly water input (rainwater) *versus* your water consumption, you will be able to determine the times of year where rainwater may be insufficient for your use, and you will have a better understanding of how much water could be stored at one time.

A third (and very simple!) way to decide on your cistern size is called the "one-third rule". Multiply your potential rainwater capture amount by 0.333 to find the storage size which will hold approximately one-third of your total harvest:**12,000 gallons captured X 0.333 = approximately 4,000 gallons of storage**

***See also*: http://rainwaterharvesting.tamu.edu/**