Chapter 3: Sizing Your Cistern

One of the first steps in any roof-reliant landscaping project is estimating the appropriate size of your water storage tank. This estimate will be required as you begin to design your landscape, estimate its cost, create your water budget and schedule the installation of your project. Knowing the exact size of your system will, of course, be of critical importance when you actually design your cistern system.

You can determine the appropriate size of your cistern by taking the following simple steps:

- Calculate the catchment area of your roof
- Estimate your "normal" rainwater harvest
- Apply the One-Third Rule

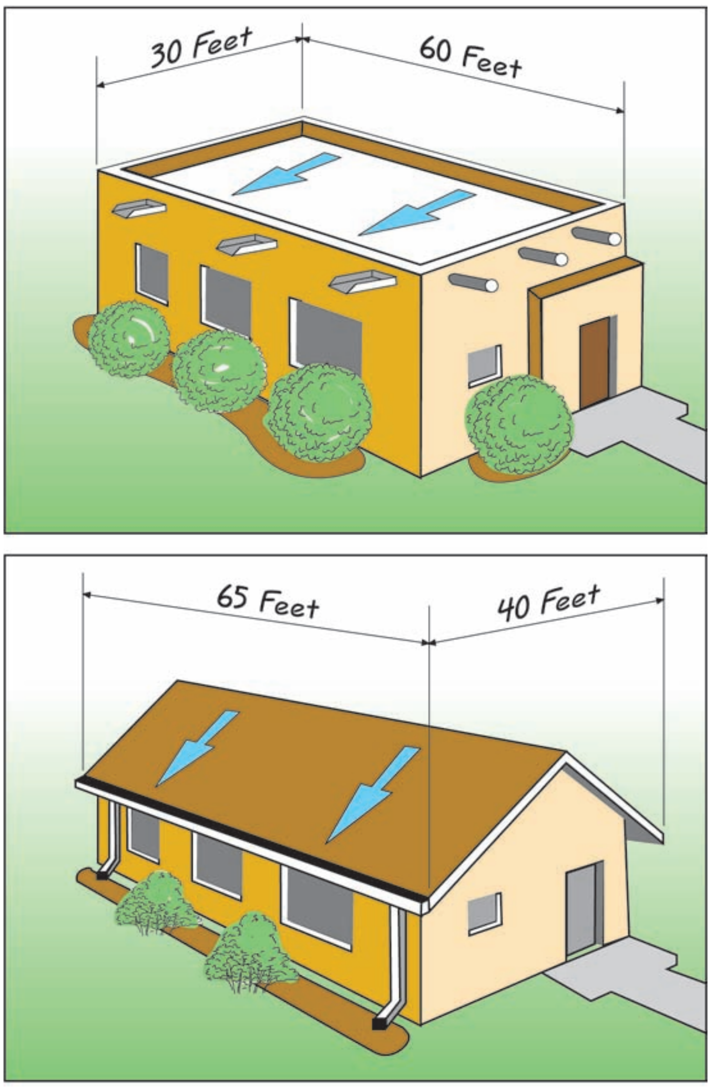


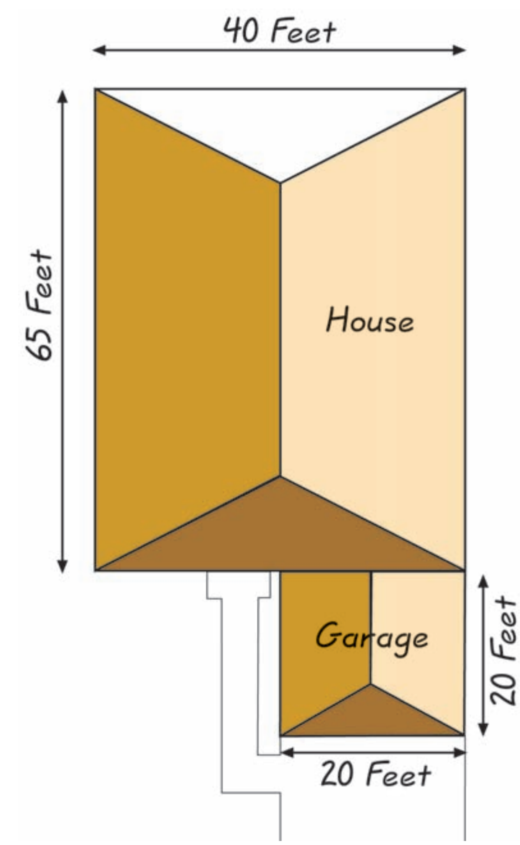
Figure 3-1: Calculating the square footage of roof or catchment area

Calculate the Catchment Area of Your Roof

The amount of water that can be harvested is determined by the size of the catchment area and the amount of rain that falls on that catchment area. Start by determining the size of your roof in square feet. Figure 3-1 shows that the square footage of a rectilinear roof can be easily calculated by multiplying the length of the roof by its width.

Length (in feet) x width (in feet) = square feet

However, it is not uncommon for a roof to be affected by other factors that can slightly complicate this simple calculation. The most common of these factors occurs when two roof surfaces need to be added together, as in Figure 3-2. The house shown below has a garage, which should be included in the total roof square footage. Buildings such as portals, sheds, shade structures and other roof surfaces that can serve as collection areas also need to be included in your calculations.



(65 ft. x 40 ft.) + (20 ft. x 20 ft.) = Total square feet

Figure 3-2: How to calculate the square footage of a complex roof to determine the catchment area.

Note that the increased angle of a pitched roof does not increase your catchment area. While it is true that more materials are needed to cover a house with a pitched roof than a flat roof, a pitched roof still covers the same amount of ground surface as a flat roof (of the same length and width measured at the given buildings' ceilings).

One advantage that pitched-roof structures do have over flat-roof structures is that pitched roofs often have large overhangs. Given the same building footprint, a pitched-roof house will typically have larger roof dimensions than a flat-roof house. In Figure 3-3, we see how a two-foot overhang can significantly increase a roof's catchment area.

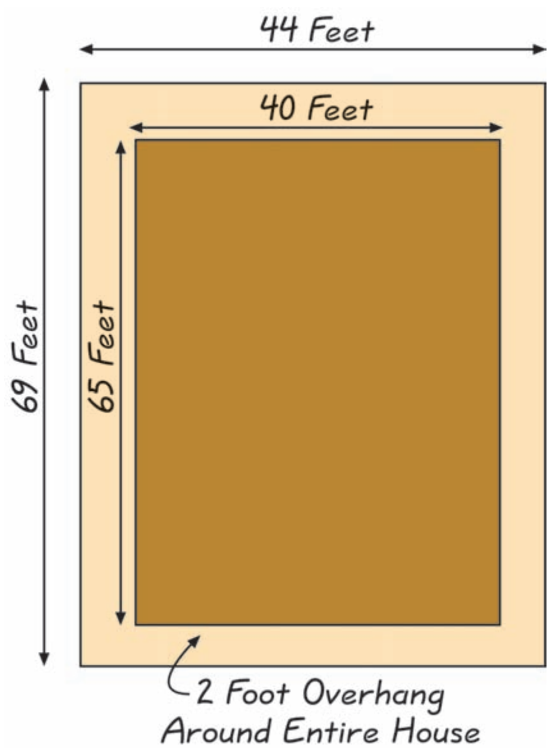


Figure 3-3: Calculating the catchment area including roof overhang

Other minor mathematical complications occur when roof lines are not rectilinear. Typically, such roofs can be reduced to either triangular or curvilinear shapes. In the case of triangular shapes in which one of the angles is 90 degrees, simply multiply the length of the roof by the width of the roof, then divide this product by two:

Length x width / 2 = area of a triangle

Curvilinear shapes are rare, but most of them can be reduced to circular shapes, the areas of which are determined by multiplying the square of the radius of the circle by pi (3.14).

Radius x radius x 3.14 = area of a circle

It is imperative that your square-footage calculation is accurate. The proper sizing of your cistern, the total cost of your project and perhaps even the success of your project will depend on your precision here.

Estimate Your "Normal" Harvest

Now that you have determined the square footage of your collection area, the next step in sizing your cistern is to estimate the amount of precipitation that you might collect in a given time period. It is important to note that there is a significant distinction between "average" and "normal" when discussing the amount of precipitation your location receives in a year.

Although average annual precipitation data is easy to find for most municipalities and counties throughout the state[5], the concept of average precipitation is misleading in New Mexico. It is actually normal for a location to get 20 percent less precipitation than the average annual precipitation figure. This is because occasional wet years skew the average.

Take the example of Albuquerque from 1996 through 2005. Table 3-1 on the following page shows that Albuquerque received an average of 9.09 inches of precipitation during this 10-year period (which is 0.43 inches more than its historic average of 8.66 inches). Albuquerque received less than the average annual rainfall during five years of this period, and during three of those years it received only about 70 percent of the 10-year average.

[5] See Appendix 1, which contains average monthly and annual precipitation figures for municipalities in New Mexico.

TABLE 3-1: Precipitation in Albuquerque from 1996-2005

YEAR	PRECIPITATION
1996	9.75"
1997	12.36"
1998	9.83"
1999	8.29"
2000	8.24"
2001	6.50"
2002	6.39"
2003	6.35"
2004	11.80"
2005	11.42"
Total inches for 10 year period =	90.93"
Average (90.93/10) =	9.09" per year

TABLE 3-2: Approximate Annual Supply from Roof Catchment

Inches of Rainfall	Gallons/Square Foot
0	0.00
1	0.62
2	1.24
3	1.86
4	2.48
5	3.10
6	3.72
7	4.34
8	4.96
9	5.58
10	6.20
11	6.82
12	7.44
13	8.06
14	8.68
15	9.30
16	9.92
17	10.54
18	11.16

Historical weather data shows that a normal year receives about 80% of the precipitation that an average year receives. The equation below describes this concept in simple arithmetic terms. Here, average precipitation is multiplied by 80% in order to determine the most likely amount of precipitation for a location in a given year.

Average precipitation x 0.80 = "Normal" precipitation

For Albuquerque, using the historic average of 8.66 inches of average precipitation results in this equation:

8.66 inches x 0.80 = 6.93 inches

Table 3-2 shows how to convert inches of rainfall into gallons per square foot. For every inch of rainfall, 0.62 gallons of water can be harvested from every square foot of roof surface. Rounding the "normal" year in Albuquerque to 7.0 inches reveals that every square foot of roof catchment surface will predictably result in 4.34 gallons of collected rainwater.

Finally, in order to finally estimate the amount of precipitation that can potentially be collected from a roof in a normal year, multiply the total square footage by the number of gallons per square foot. For a 1,800-square-foot roof in Albuquerque, this translates into less than 8,000 gallons of water. The calculation looks like this:

1,800 (square feet of catchment area) x 4.34 gallons = 7,812 gallons

In summary, your catchment area multiplied by the number of gallons per square foot in a normal year equals the total number of gallons you can expect to collect off of your roof during a normal year.

Catchment Area

x Gallons per square foot

= Total Gallons

Apply the One-Third Rule*

Precipitation can come at any time of year in New Mexico, and you can expect to distribute some portion of your rainwater harvest in between storm events. Therefore, it is unnecessary to have a cistern large enough to store an entire year's worth of precipitation.

For this reason, the recommended cistern size is approximately one-third of the amount that can be collected in a normal year. Therefore, the owners of the 1,800-square-foot roof in the Albuquerque example on the previous page should consider a cistern in the 2,000 to 3,000 gallon range.

If cost is a major factor, it may be wise to consider a storage tank on the smaller side of the containment spectrum. If finances allow, consider a tank on the larger side of the spectrum. Please note that the "One-Third Rule" is meant only as a helpful tool for getting you started. While developing your plans and designs, you can always modify this calculation depending on your needs, desires and finances.

The last step in sizing your cistern is simply to convert gallons into cubic feet so that you can get a sense of what size tank you will need. One way to determine the approximate dimensions of your storage tank is to ask potential cistern suppliers what size tanks are available in the number of gallons you require. Or, to manually calculate the volume of your tank, use this simple conversion equation:

1 cu. ft. water = 7.48 gallons of water

A 1,000-gallon cistern, then, equals 133.69 cubic feet of volume, which is about the size of a compact car. A 2,000-gallon cistern is approximately the size of a minivan, and the volume of 5,000-gallon tank is the equivalent of a large van or small school bus. A 10,000-gallon cistern can fit snugly on a large flatbed trailer.

Detailed information on different types of cisterns and on cistern-system components appears in Chapter 9, Water Storage.

*The Case for the "One-Half Rule" (or even more)

Some landscape professionals have been known to say that the only cistern that is too large is the one you cannot afford. That's because in New Mexico, we tend to get infrequent rainfall events. A typical "good" monsoon season consists of a handful of rainfall events that deliver quite a lot of rain (1/2 to 2 inches of rain) at a time. For example, it is not uncommon for areas in New Mexico to receive 1.5 inches of rain within a 24-hour period every two or three years. This would produce almost 1,700 gallons of water from a 1,800 square foot roof. If your water storage tank holds 2,000 gallons and you've already "banked" 500 gallons, then almost 200 gallons of water would overflow out of your cistern.

So, if the budget allows for a larger tank—and there is space on the property for a larger tank—consider applying the One-Half Rule (or even more) if you want to minimize the rainfall events that produce more water than your cistern can hold.

Use Worksheet 1 on the next page to perform the calculations described in this chapter.

Figure 3-4: A 10,000 gallon tank like the one shown above must be delivered to the site on a flatbed trailer.

WORKSHEET 1

Use this worksheet to perform the calculations described in this chapter.

1. Determine the square footage of your rectilinear areas by multiplying the length by the width

Main House

Length of catchment area (linear feet)	
Width of catchment area (linear feet)	
Multiply the two numbers above	x
Total square footage =	

Garage

Length of catchment area (linear feet)	
Width of catchment area (linear feet)	
Multiply the two numbers above	x
Total square footage =	

Other

Length of catchment area (linear feet)	
Width of catchment area (linear feet)	
Multiply the two numbers above	x
Total square footage =	

2. Add up your various catchment areas

Square footage of main house	
Square footage of garage	
Square footage of storage shed(s)	
Square footage of portals and covered porches	
Square footage of all other roof surfaces	
Add up all of the numbers above	+
Total square footage of catchment area =	

3. Estimate your "normal" harvest

Total square footage of catchment area	
Average annual rainfall x .80 x value in Table 3-2	
Multiply the two numbers above	x
Total normal annual precipitation in gallons =	

4. Apply the One-Third Rule

Total normal annual precipitation in gallons	
One third	0.333
Multiply the two numbers above	x
An appropriate size of cistern in gallons	