Land&Water

Conserving Natural Resources in Illinois

University of Illinois Extension • College of Agricultural, Consumer and Environmental Sciences

Sizing Up a Sump Pump

Water World

It's every homeowner's nightmare—a basement under water. Carpeting ruined. Belongings water-logged.

In the ongoing battle for dry basements, sump pumps play a pivotal role. A pump typically has to be replaced every few years. But if you size it correctly, you can extend the life of your pump. What's more, you can ensure that you have the right pump for the job.

When you're selecting the size of a sump pump, you need two pieces of information:
- System Capacity
- Total Dynamic Head (Static Head plus Friction Head)

Determine System Capacity

It's important that your pump can draw water out of the basin (or "sump pit") faster than water flows into it. Therefore, the first thing you need to measure is the amount of water that drains into the basin during a high-flow period.

During a heavy rain, stick a ruler in the basin and measure how many inches of water flow into the basin in 60 seconds. This will tell you how many gallons flow into the basin per minute, which is the System Capacity.

If you have an 18-inch-diameter basin, 1 inch of water is equal to 1 gallon. If you have a 24-inch-diameter basin, 1 inch of water is roughly equal to 2 gallons.

If you find out that more than 30 gallons of rainwater flow into the basin per minute, you're better off with a 24-inch-diameter basin. Also, the water level should never be allowed to go higher than the bottom of the inlet pipe of the foundation drain tile.

But what if you're building a new home and don't have a system installed yet? In that case, there are some general guidelines.

If you're building on sandy soil, plan for a system capacity of 14 gallons per minute for every 1,000 square feet of home.

If you're building on clay soil, plan for a system capacity of 8 gallons per minute for every 1,000 square feet of home.

Example: Using a ruler, you find that 18 inches of water flow into your sump pump basin in 60 seconds. Because you have the smaller diameter basin, each inch equals 1 gallon. Therefore, your System Capacity is 18 gallons per minute.

Determine Static Head

Total Dynamic Head is equal to Static Head (or "vertical lift") plus Friction Head.

Static Head is the vertical height that the water rises through the discharge pipe. Begin measuring from the point where water enters the sump pump. Then measure up vertically to where the pipe becomes horizontal (see Figure 1).

Example: Assume that the height from the sump pump to the point where the discharge pipe becomes horizontal is 13 feet. This is the Static Head.
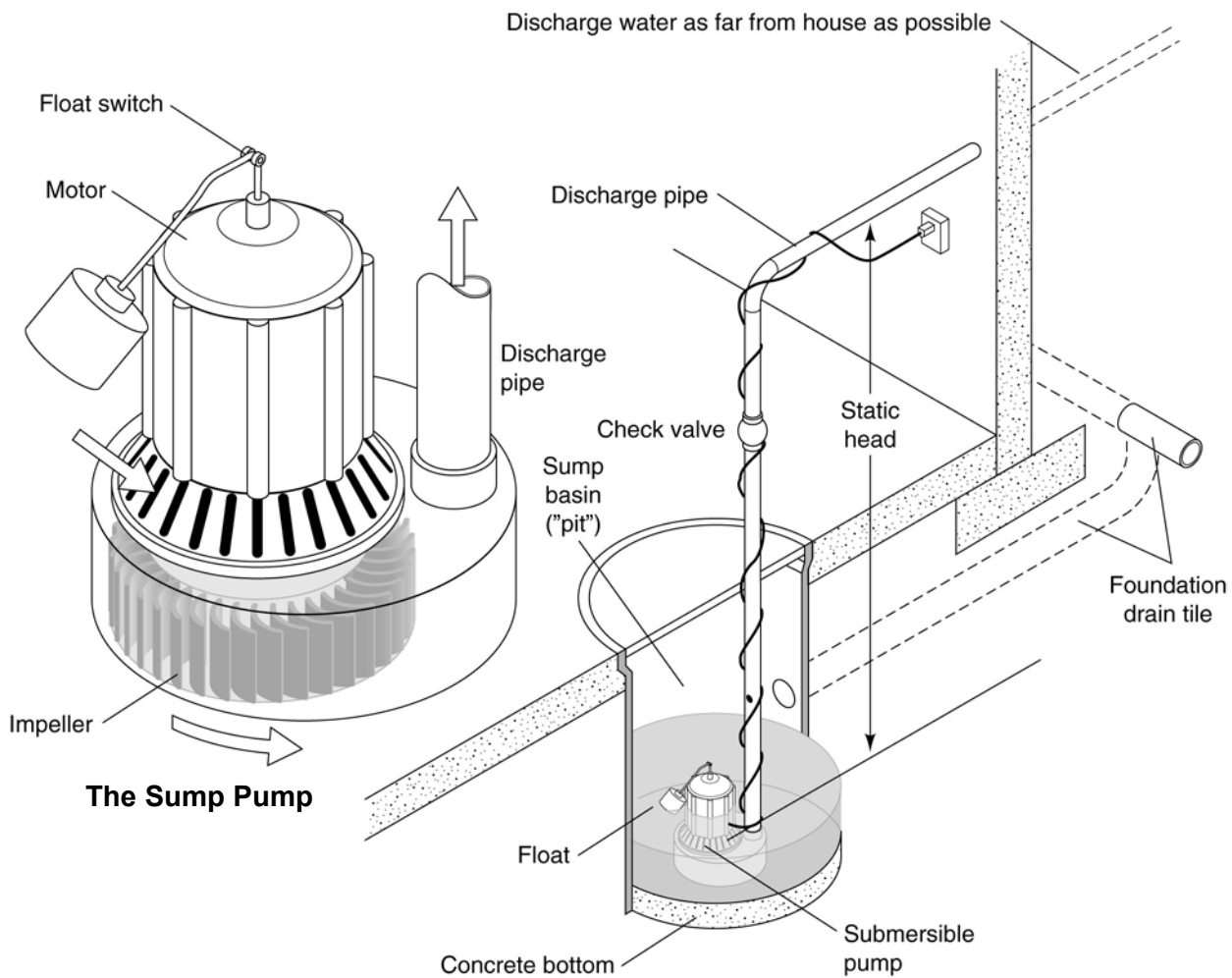
Figure 1. A Sump Pump System

Determine Friction Head

Determining Friction Head is more involved than finding out the Static Head. Friction Head is "the equivalent length of pipe" plus the actual length of pipe multiplied by the "friction loss" divided by 100.

What follows are four steps in figuring out Friction Head.

Step 1. Determine Equivalent Length of Pipe

The equivalent length of pipe is determined by how many pipe fittings are required for your system. Table 1 shows the equivalent length of pipe for various fittings, based on pipe size.

Example: Assume you're using 1¼-inch pipe, with three 90-degree elbows and 1 check valve. According to Table 1, three elbows add 10.5 feet of equivalent pipe, while the check valve adds 11.5 feet. The total equivalent feet of pipe is 22 feet.

Step 2. Determine the Actual Pipe Length

The actual pipe length is the length of pipe running horizontally out of the house. You should be able to see where the pipe discharges outside of the house.

Example: In our example, the length of discharge pipe is 100 feet.

Step 3. Determine Friction Loss

Friction loss is how much friction slows the flow of water moving through the pipe. Table 2 shows what friction loss occurs for different pipe sizes, depending on how many gallons of water per minute move through the pipe.

With Table 2, use your System Capacity number as the "gallons per minute."

Example: If 18 gallons per minute flow through your 1¼-inch pipe, it would create a friction loss of 5.25 per 100 feet of pipe.

Table 1. Equivalent Length of Pipe Due to Fittings

Pipe size	90° elbow	45° elbow	Check valve (swing pipe)
	⟵————— (feet) —————⟶		
1-1/4 inch	3.5	1.8	11.5
1-1/2 inch	4.0	2.2	13.4
2 inch	5.2	2.8	17.2
2-1/2 inch	6.2	3.3	20.6
3 inch	7.7	4.1	25.5

Table 2. Friction Loss Per 100 Feet of Plastic Schedule 40 Pipe

Gallons per minute (GPM)	Size of pipe				
	3/4"	1"	1-1/4"	1-1/2"	2"
4	3.7	1.2	.34		
6	7.9	2.4	.71	.33	
8	13.4	4.1	1.19	.56	
10		6.3	1.78	.83	
12		8.8	2.48	1.16	.34
14		11.7	3.29	1.54	.45
16			4.21	1.97	.58
18			5.25	2.41	.72
20			6.42	2.96	.88
25			10.39	4.8	1.38
30			13.6	6.27	1.81
35			19.2	8.82	2.4

Step 4. Put it All Together

To figure out Friction Head, add the actual length of the discharge pipe to the equivalent length of pipe from fittings. Then multiply by the friction loss and divide by 100.

Example: Add the actual length of the discharge pipe (100 feet) with the equivalent length of pipe from fittings (22 feet) to get 122 feet. Then multiply this by the friction loss per 100 feet of pipe (5.25) and divide by 100.

$$122 \times 5.25 \div 100 = 6.40 \text{ feet}$$

6.40 is the Friction Head

Determining Total Dynamic Head

Now that we've determined Static Head and Friction Head, we simply add the numbers to get Total Dynamic Head.

Example: Add the Static Head (13 feet) to the Friction Head (6.40) to get a Total Dynamic Head of 19.40. Round up to 20 feet.

Selecting the Pump

You now know your System Capacity (18 gallons per minute) and you know the Total Dynamic Head (20 feet). So you're ready to select a pump.

Most sump pumps have charts or curves that show how many gallons per minute they can pump for different lengths of head (See Figure 2). You've already determined how many gallons per minute must be pumped out. So look at these charts and make sure that the pump can handle that many gallons per minute.

You don't want a pump that is either too small or too powerful. If the pump is too small, it won't be able to keep up with water flowing
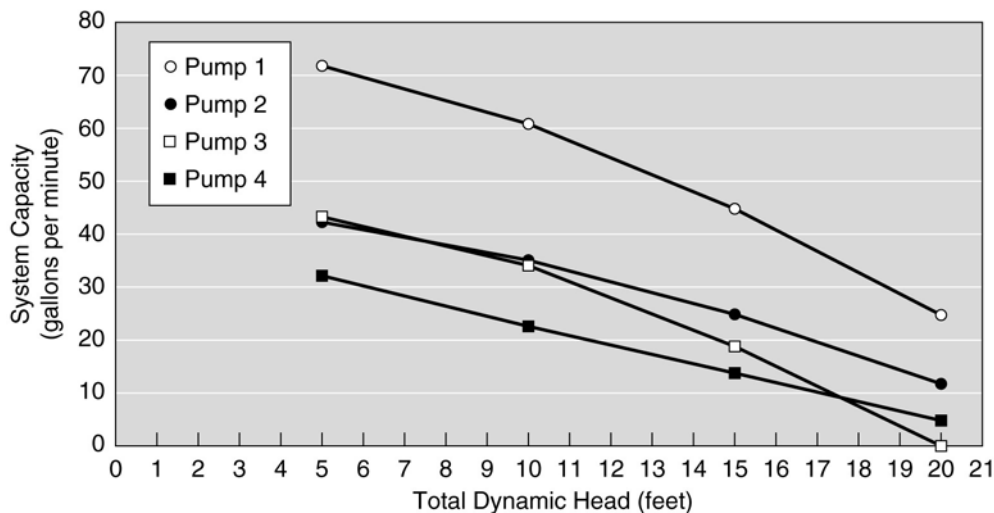
Figure 2. Sample Sump Pump Performance Curves

into the basin. If the pump is too powerful, it will "short cycle." This means the pump will start and stop frequently, which can cause premature pump failure.

Example: If the Total Dynamic Head is 20 feet, you have only one choice among the four pumps shown in Figure 2. Only Pump 1 will be able to handle 18 gallons per minute. The other three pumps can't handle any more than 12 gallons per minute.

Note that changing to a larger size of pipe in this case might lower the friction head enough to enable you to use a different pump (Pump 2 on the chart).

Maintaining the Pump

Periodically maintain your pump by doing the following:
• Check the operation of the float to make sure that its up-and-down movement is not restricted.
• Check the outside pipe when the pump is running to make sure it is discharging water. Several things can cause water not to be discharged, including a stuck check valve, the impeller loose on its shaft, or a plugged water pipe.
• If the pump has not had to run for several months, put enough water in the sump pump basin to trigger the float switch. That way, you ensure that the pump is still operating properly.

Other Considerations

Basin Size. Most residences have an 18-inch diameter basin—or sump pit. Basin size plays a part in how long the pump runs and how long it takes to fill up. If your existing basin is undersized and fills too quickly between pumping cycles, it may be worth installing a wider basin to accommodate the flow.

A cheaper option may be installing an adjustable float switch that allows the water to rise to a higher level before turning the pump on. Most pumps depend on having water in the pump at all times to lubricate and cool pump seals. So make sure the float switch is positioned to prevent the pump from running dry. Pedestal-type pumps have floats that can be adjusted to different lengths for operation.

Check valve. Select a swing-type check valve of the same size as the discharge pipe. Install it just above the sump pump. The check valve keeps the water in the discharge pipe from flowing back into the basin between pump cycles.

Electrical Circuit. The sump pump must be supplied with its own dedicated motor control circuit and breaker. Be sure to observe all applicable local electrical codes and ordinances when installing electrical circuits.