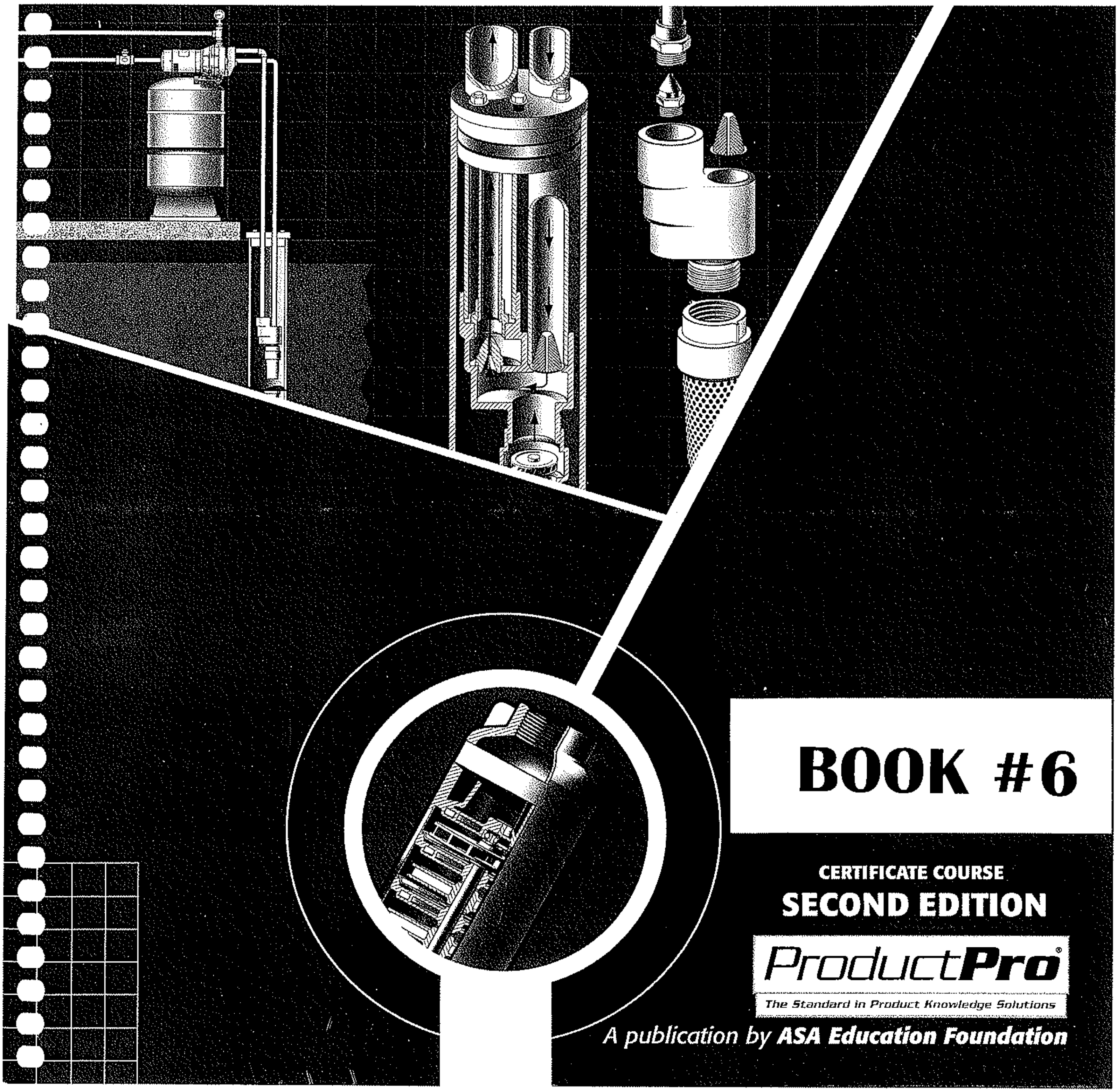
ASA UNIVERSITY

Specialty Products

Domestic Water Well Pumps©



BOOK #6

CERTIFICATE COURSE

SECOND EDITION

ProductPro®

The Standard in Product Knowledge Solutions

A publication by ***ASA Education Foundation***

Specialty Products

Domestic Water Well Pumps©

from the

American Supply Association Education Foundation

Domestic Water Well Pumps© provides new warehouse, counter, and sales personnel with an overview of the operation and components of domestic water wells. It is NOT intended to provide the kind of complex, technical data which would enable employees to plan or install water systems, wells, or pumps. This course includes definitions of common industry terms, descriptions of the components and functions of wells and pumps, and other information that will help employees serve their customers more effectively.

ProductPro®
The Standard in Product Knowledge Solutions

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HEADQUARTERS

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ASA Education Foundation

Welcome to the *ProductPro® Product Knowledge Training* series!

The Plumbing-Heating-Cooling-Piping (PHCP) and Industrial PVF industry is an important business channel. The products we see keep people healthy, comfortable and productive. In the United States, there are hundreds of domestic water well wholesaler-distributor locations; they generate billions of dollars in wholesale sales. It is an exciting and very competitive industry, and running a successful company requires cooperative efforts from educated and motivated employees.

To sell products in such a competitive atmosphere, it is crucial that all employees understand the products we sell. All of us need to be knowledgeable enough to provide our customers with the products they need to keep their operations running smoothly and their employees productive.

What you will learn from this training
This ProductPro® course is designed as basic training for newcomers to the water systems business, as well as a refresher course for the experienced professional. The course will give you an overview of domestic water well pumps. You will learn to correctly use basic terminology common used in the industry. You will pick up the vocabulary needed to talk intelligently about the products so you can help your customers and communicate effectively with your colleagues.

You will be able to describe the basic operation of water wells, basic principles of pump operation, and major types of pumps. You will learn how to size a pump in terms of lift, capacity, and discharge pressure requirements. You will learn how to order or specify each type of product. You will learn to help your customers choose the appropriate pump to meet their particular needs. Because your customer may request them, you will also learn about some products that your own company does not carry. In those cases, you need to be able to offer an alternative product or find the product from another source.

How the course is organized

The ProductPro® course is designed as basic training for newcomers to the water systems business, as well as a refresher course for the experienced professional. The course will give you an overview of domestic water well pumps. You will learn to correctly use basic terminology commonly used in the industry. You will pick up the vocabulary needed to talk intelligently about the products so you can help your customers and communicate effectively with your colleagues.

At the end of each self-correcting quiz, you will find *Applying What You've Learned* exercises so you can use the new information that you have learned within your own company.

Once you understand the basic concepts presented, know the important facts, and can confidently answer the questions correctly on all the quizzes, you are ready to take the final course exam.

THIS COURSE INCLUDES AN ONLINE FINAL EXAM

This course is limited to a single user. When you are ready to take the final exam to earn Certificate of Completion, please contact ASA at info@asa.net. You will be contacted about how to register for the exam.

Some hints for successful course completion

Read the learning objectives

Read the learning objectives at the beginning of each chapter. They will tell you what you should know when you complete the chapter. Go back after you read the chapter material and ask yourself whether you are confident in your command of the material. If you are not, reread anything that you did not understand. Ask your supervisor or colleagues questions to help clarify the material you did not "get" the first time.

Search for the important ideas

Use a highlighter marker or a pen to highlight or underline the most important points as you read. Think about how each idea relates to the rest of the chapter. Write notes in the margins about points you don't understand or about how the material you read applies to your own company.

Ask lots of questions

Ask your supervisor or mentor about any points you do not understand. Particular questions you'll want to ask include whether the products you are studying are carried by your company, how well they sell, and how important they are in the overall inventory.

Apply what you are learning to your job

Always think about what you have just read or learned. Compare your company's products to the products you have read about in the book. Do the *Applying What You've Learned* exercises using the real setting of your job.

Pace yourself in your studying

Don't try to complete the course all at once. You will remember what you learn more effectively if you make sure you understand each chapter thoroughly before you move on to the next. Take some time to "plug in" what you have just studied before acquiring more new information.

Be proud of what you have accomplished

When you successfully complete the course, be sure to proudly displace your course certificate. You earned it. Then consider moving on to the other courses in this series:

- *Domestic Water Heaters©*
- *Sump, Sewage and Effluent Pumps©*
- *Residential Hydronic Heating Systems©*
- *Residential Water Processing©*

Commit to learning something new every day

This course is just one step in developing your professional knowledge and your career skills. Read industry trade journals, study the manufacturers' literature, and attend any training the manufacturers offer. Listen to what company and industry experts says. Continue to enthusiastically take any additional training your company offers.

Visit the ASA Education Foundation website at www.asa.net regularly to find out about other learning opportunities to advance your career.

Acknowledgements

Developing new editions of the ProductPro® product knowledge training courses is an ambitious undertaking. During the creation and revision of this course, many individuals shared their expertise, input, and resources to significantly improve the interest and energy in the program.

Of special value were reviewers, such as Marty Riback of Riback Supply Company and Michael A. Babrowski of Zoller Pump Company, who thoroughly and diligently reviewed the course text, quizzes, illustrations, and final exam to ensure accurate and highly readable instructions. Their expertise and experience ensure that the content demonstrates a high level of real world application that immediately can be put to work in employees' day-to-day duties.

The Foundation expresses its very special gratitude to the visionaries who established and led the charge to develop the Karl E. Neupert Endowment Fund. Contributions that established the Fund were provided by hundreds of manufacturers, wholesalers, and individuals who recognized the need for a permanent endowment fund that would endure the ASA Education Foundation's ability to provide programs needed by the industry in perpetuity. Their generous contributions continue to make a major impact on the education and training opportunities available to the industry.
We are deeply grateful for their commitment.

– The ASA Education Foundation

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1 TYPES OF WATER WELLS

LEARNING OBJECTIVES

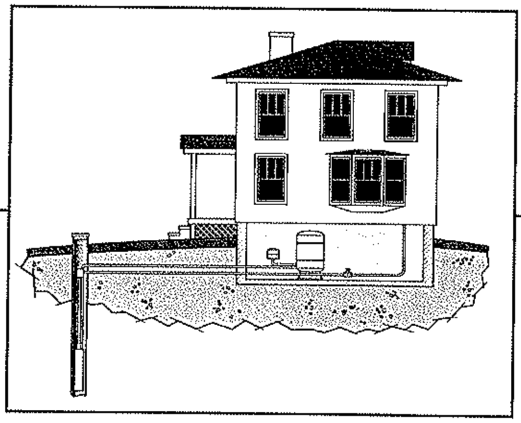
When you finish this Chapter, you will be able to:

1. Identify the sources people commonly use to obtain their primary drinking water.

2. Compare natural wells with the most common types of constructed wells.

3. Discuss the uses of the different kinds of constructed water wells used for families and farms.

4. Describe the three basic elements of a typical home water system.



WATER WELLS

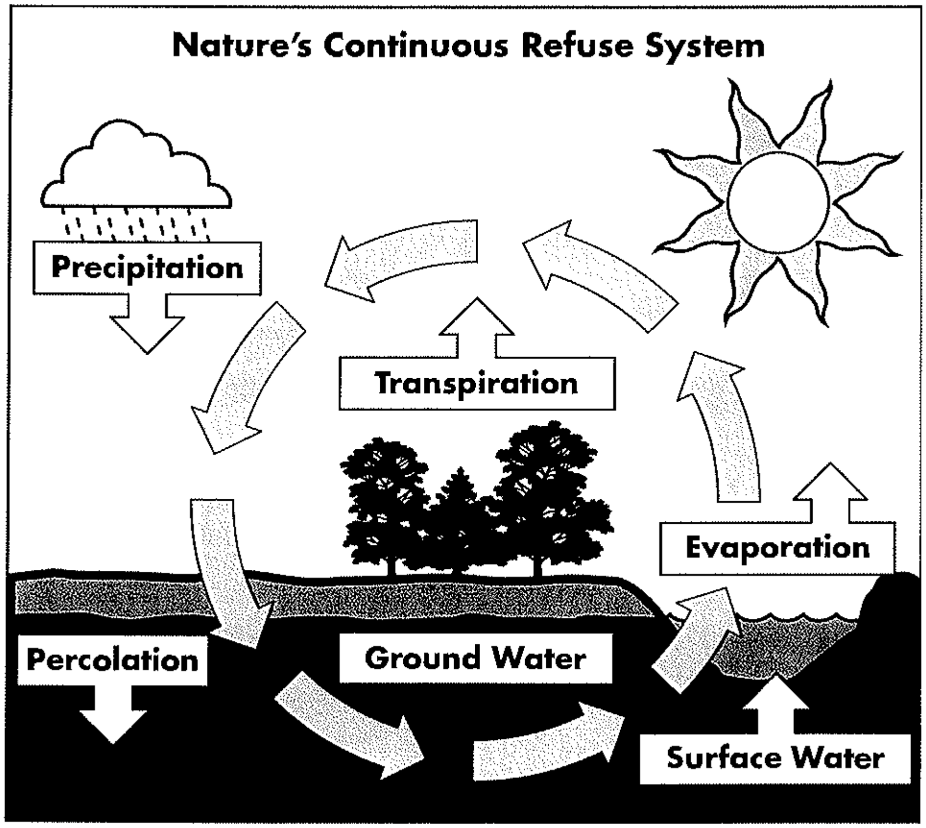
Where Water Comes From

All of the water on this planet comes from rain, snow, or other precipitation that falls to Earth. Water on Earth is either **SALT WATER**, such as found in the oceans, or **FRESH WATER** (non-salt water), which is found in **SURFACE WATER** such as lakes, rivers, streams, and springs.

The rest of the water seeps into the earth to become **GROUND WATER**—which flows underground until it finally makes its way into lakes, rivers, and oceans. Then ground water, too, becomes surface water.

The surface water eventually evaporates to form clouds which then produce precipitation. Water moves from gas to liquid to solid from the Earth to the atmosphere and back to Earth. This **WATER CYCLE** of precipitation and evaporation is called the **HYDROLOGIC CYCLE**.

HYDROLOGIC CYCLE



SP 5.1.02

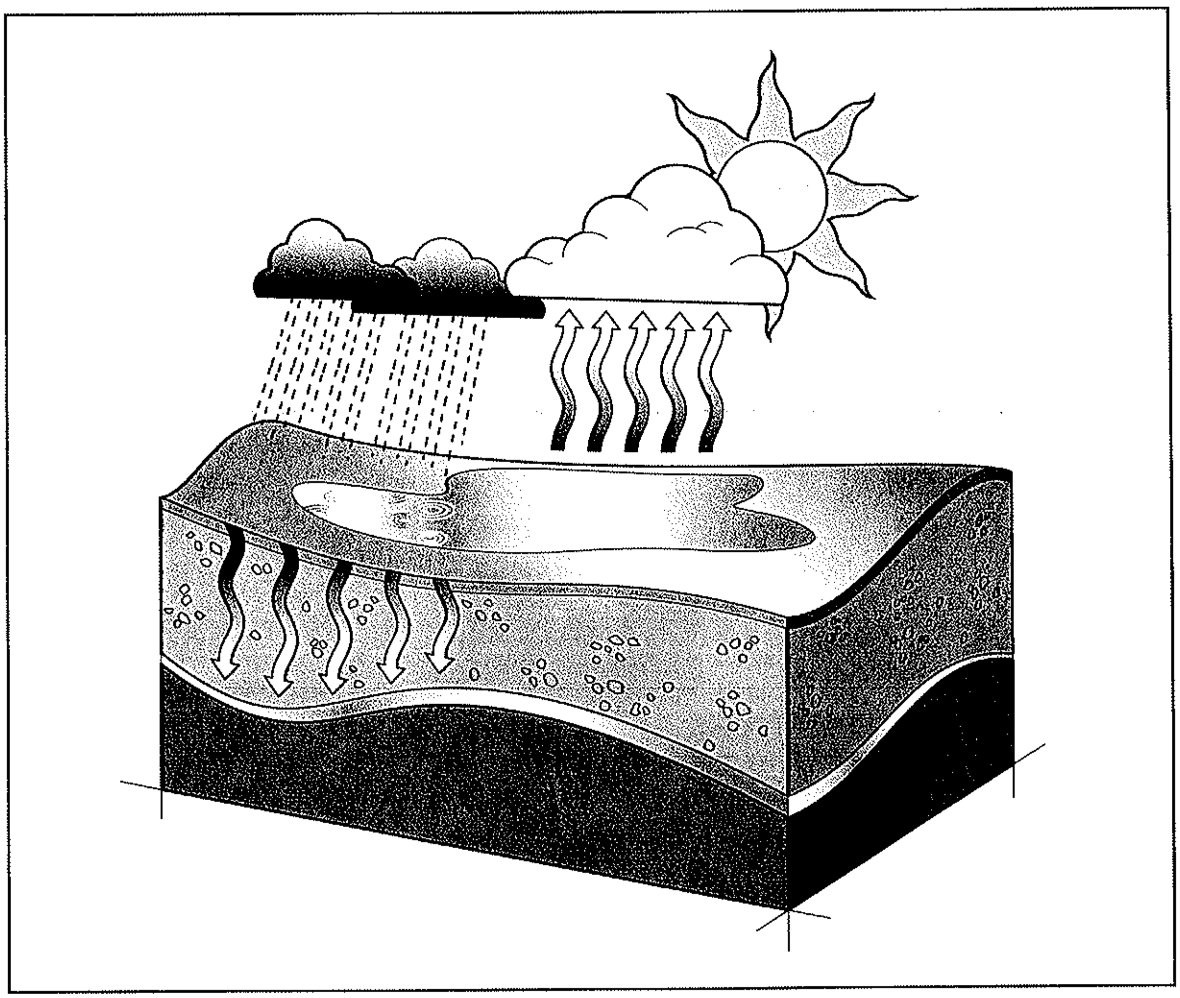
Ground Water

Ground water falls as rain then it is slowly filtered down through the crust of the earth. The water gathers in huge underground chambers called *aquifers.* Ground water provides fresh, non-salt drinking water. It is tapped by pumps in water wells.

All living creatures need water. History records many battles and wars over water rights and access to wells.

When you're in the water well business, you have one of the most important jobs in the world: providing people the water they need to live. It's important that you do this job right. This course will help you do just that!

NATURAL AQUIFIER



SP 2.1.02

Only three percent of the fresh water is surface water, and surface water is usually contaminated. Therefore, water for home use generally is ground water.

Because most Americans live in cities and towns, most families depend upon municipal (city-owned) **WATER SYSTEMS**. However, one out of five American families (20 percent) has private water systems that require use of natural or constructed wells tapping into ground water.

Springs, lakes, and other surface waters are **NATURAL WELLS**. Natural wells serve as water sources for thousands of people. Many other people need constructed wells. **CONSTRUCTED WELLS** are made by men and machines and access ground water.

The **WATER TABLE** is the more-or-less continuous top surface of the ground water. The water table may be only a few feet below the ground surface, or it may be hundreds of feet below ground.

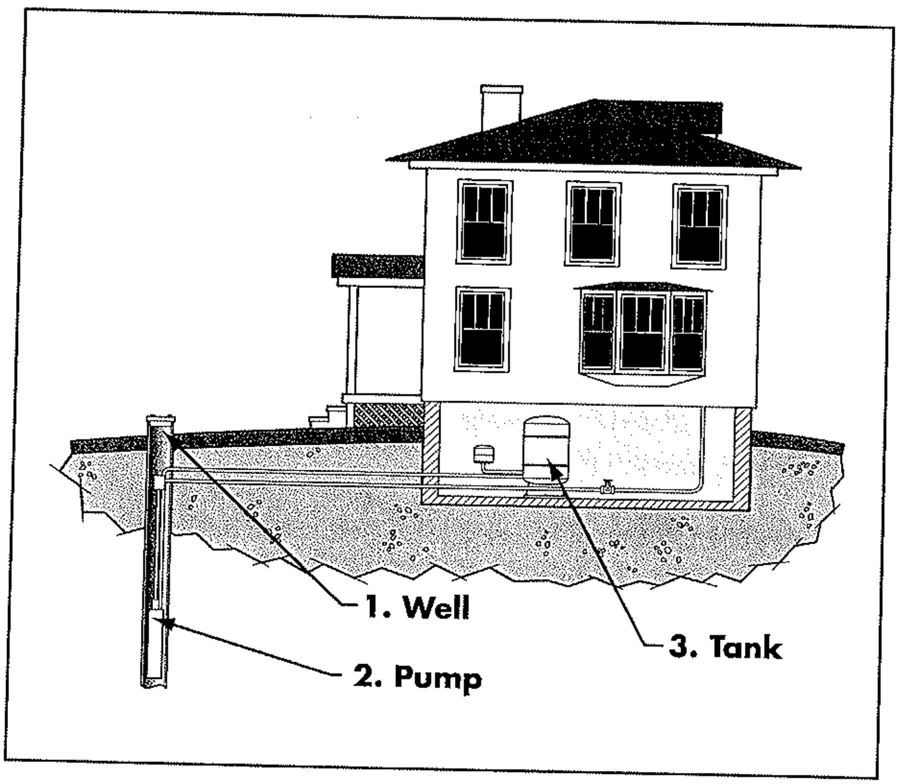
Any constructed well must be deep enough to be below the water table.

Home Water System

The typical home water system contains three basic elements:

1. A well, or other water source;
2. A pump, to move the water from the well into the home;
3. A pressure storage tank, to provide automatic operation of the home water system.

HOUSE WITH HOME WATER SYSTEM



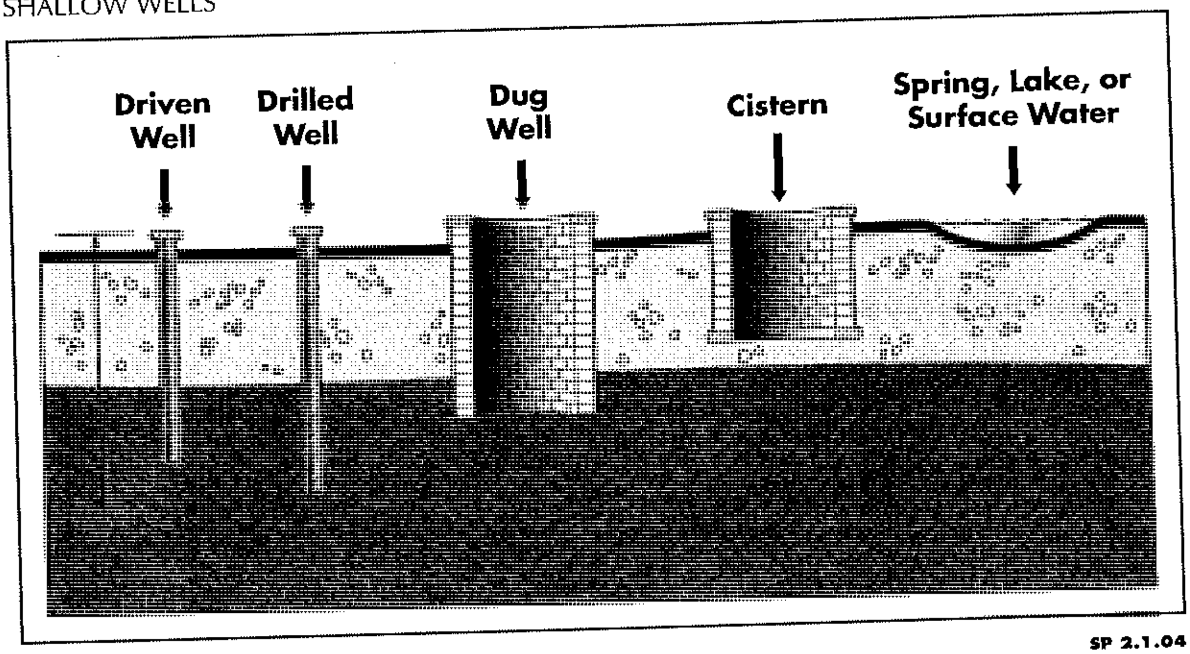
SP 2.1.03

Water Wells

In this first chapter we will look at types of water wells. The next four chapters discuss **PUMPS** and pump operations. Finally, in the last chapter of this course, pressure storage tanks are covered.

The term **WELL** is simply defined as a deep hole or shaft sunk into the earth to obtain water, oil, gas, or brine. Wells can be driven, drilled, or dug. They can be shallow (less than 25 feet) or deep (more than 25 feet). Driven and dug wells are rarely more than 50 feet deep. Wells generally are cased with steel pipe, plastic pipe, tile, or other strong casing material.

SHALLOW WELLS



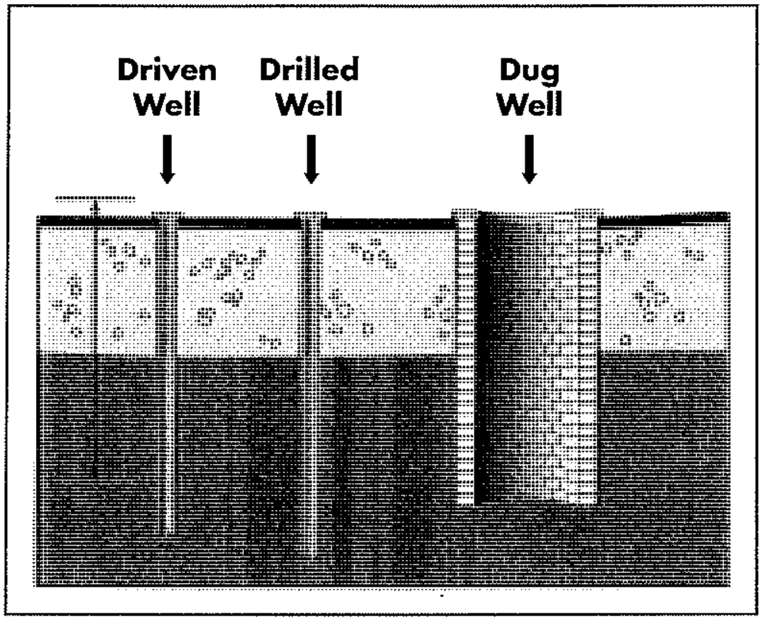
SP 2.1.04

A **DUG WELL** is a shallow hole (limited to 25–30 feet deep) dug several feet in diameter. Because of the shallowness, dug wells are easily contaminated. Some states prohibit dug wells in certain areas.

The **DRIVEN WELL** can be used if the soil is soft and sandy. A well point with a strainer screen is attached to a pipe and then driven through the soil down to the water table. Driven wells often provide only a limited supply of water. These wells are usually less than 50 feet deep. Where practical, however, they are relatively inexpensive.

A **DRILLED WELL** is used when greater depth, a larger **VOLUME** of water, or a larger well diameter is needed. Drilling, which is done by machine, may also be necessary if the ground is too hard for a well point to be driven through it. Drilled wells may be

DEEP WELLS



SP 2.1.05

hundreds of feet deep; they are the most common type of constructed well.

A **BORED WELL** is generally constructed at locations where aquifers (water bearing geologic formations) are both shallow and low-yielding. An aquifer that yields only 1 gallon per minute will provide 1,440 gallons per day. Bored wells range in depth from 30 to 100 feet. A bored well with a diameter of 3 feet, a total depth of 50 feet and a water depth of 30 feet, contains approximately 1,600 gallons of water.

Once the well is completed, the well driller should provide the well owner with a well log. The **WELL LOG** is a record showing the well's location, depth, and the various kinds of rock and soil which were found in drilling. The log should give the depth at which water was found and test pumping information needed to install a permanent pump.

Pumps that move the water from the well have an operating life of about 10 years. Your sales will thus come from the replacement market as well as from new installations.

The **WATER SYSTEMS COUNCIL** states that about one million water well pumps are sold each year.

REVIEW QUIZ – TYPES OF WATER WELLS

Answers appear on page 12

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. What is the hydrologic water cycle?
   a. The cycle of rivers
   b. The cycle of precipitation and evaporation
   c. The cycle of water pumps
   d. The cycle of salt water

2. What is an aquifer?
   a. A lake
   b. Any chamber above ground that contains ground water
   c. An underground chamber that contains ground water
   d. A water well

3. What percentage of fresh water is located underground?
   a. 10% c. 97%
   b. 55% d. 100%

4. What percentage of American families has private water systems?
   a. 20% c. 60%
   b. 40% d. 70%

5. A spring is an example of what kind of a well?
   a. Natural c. Artificial
   b. Constructed d. Drilled

6. How deep must a constructed well be?
   a. 10 feet
   b. 25 feet
   c. 100 feet
   d. Deep enough to be below the water table

REVIEW QUIZ – TYPES OF WATER WELLS *Answers appear on page 12*

7. What are the three elements of the typical home water system?
   a. Well, pump, and casing
   b. Well, pump, and pressure storage tank
   c. Pump, pressure storage tank, and aquifer
   d. Pump, piping, and well

8. The three kinds of constructed wells are driven, drilled, and
   a. natural.
   b. pumped.
   c. shallow.
   d. dug.

9. A major disadvantage of dug wells is that they are
   a. hundreds of feet deep.
   b. too expensive.
   c. easily contaminated.
   d. too shallow.

10. The major advantage of driven well is that they
    a. can be used in any type of soil.
    b. are the most common type of well.
    c. provide an unlimited amount of water.
    d. are relatively inexpensive.

11. What is the most common type of constructed well?
    a. Dug
    b. Drilled
    c. Driven
    d. Shallow

12. What is the record the well driller gives the well owner called?
    a. Well log
    b. Well book
    c. Well record
    d. Well chart

REVIEW QUIZ – TYPES OF WATER WELLS *Answers appear on page 12*

13. For greater depth and volume of water, select a
    a. dug well.
    b. driven well.
    c. replacement well.
    d. drilled well.

14. A well log provides test pumping information about the well's
    a. aquifer.
    b. temporary pump.
    c. permanent pump.
    d. strainer screen.

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Does your company sell more pumps for replacement or for new installations? Why?

____

____

____

B. What is the approximate volume of sales for water well pumps in your company in a year?

____

____

____

C. Who manufacturers the pumps your company sells?

____

____

____

ANSWERS TO REVIEW QUIZ

CHAPTER 1

TYPES OF WATER WELLS

Answers to REVIEW OF TYPES OF WATER WELLS (pages 8 – 10)

1. b. The cycle of precipitation and evaporation
2. c. An underground chamber that contains ground water
3. c. 97%
4. a. 20%
5. a. Natural
6. d. Deep enough to be below the water table
7. b. Well, pump, and pressure storage tank
8. d. dug
9. c. easily contaminated.
10. d. relatively inexpensive.
11. b. Drilled
12. a. Well log
13. d. drilled well.
14. c. permanent pump.

Applying what you have learned:

A. Depends on the company

B. Depends on the company

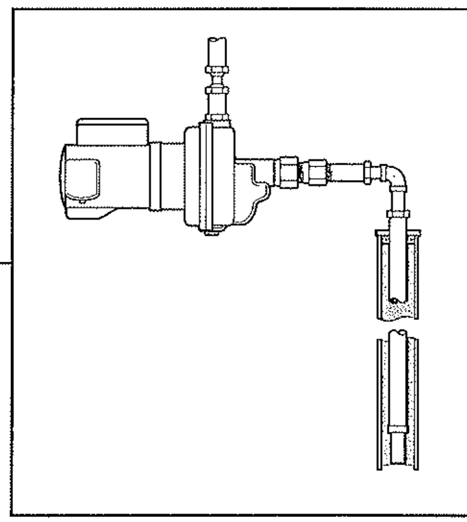
C. Depends on the company

2 BASIC PRINCIPLES OF PUMP OPERATION

LEARNING OBJECTIVES

When you finish this Chapter, you will be able to:

1. Explain the basic operation and parts of a pump.
2. Identify the scientific principles that affect a pump's ability to lift water and operate.
3. Describe barriers to a vacuum's efficiency.
4. Explain how pump design is used to control flow rate.



PUMP OPERATION

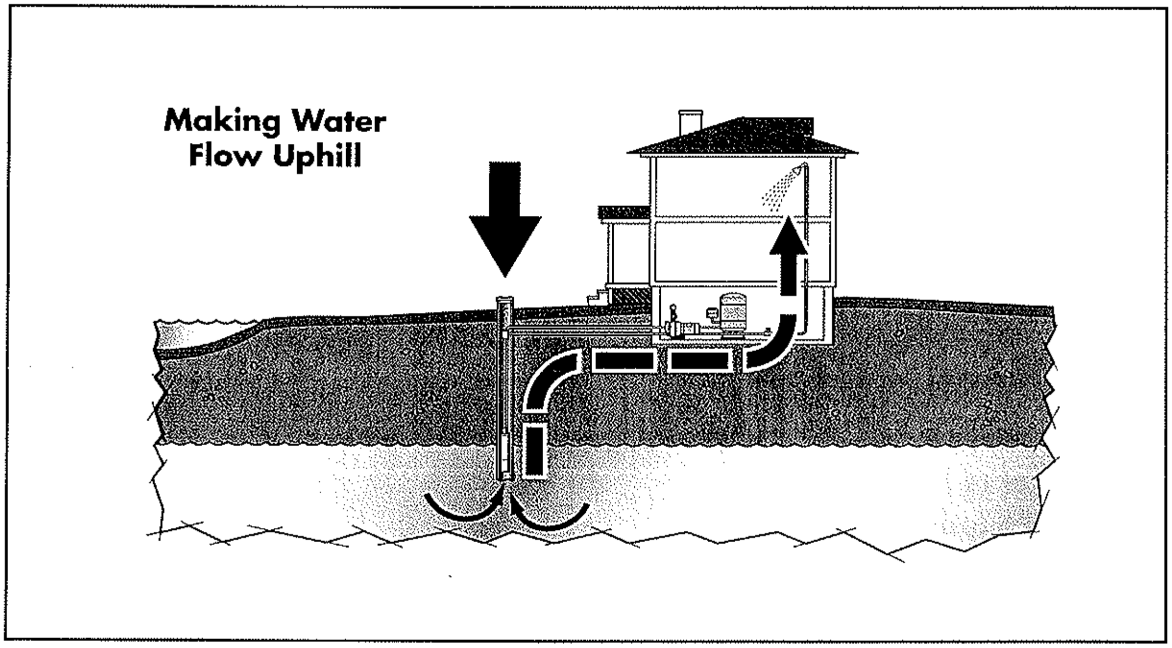
Why Pumps are Necessary

You have just learned about types of wells; now you will learn about pumps. Pumps work by "making water flow uphill."

If all domestic water supplies were delivered by gravity, we wouldn't need pumps. However, the level of the water is almost always below the ground, as well as below the level of the home we need to serve.

It may be just a few feet away, in a spring, lake or pond, or in a shallow well. Just as often it may be hundreds of feet beneath the surface, in an underground chamber or aquifer. In order to make this water flow uphill, we use a pump.

MAKING WATER FLOW UPHILL



SP 2.2.01

How Suction is Created

If the pump is immersed in the water supply, our problem is somewhat simplified. But what if the pump is above the ground? How do we get water up into the pump?

We use a force called **SUCTION**. Suction occurs when a vacuum exists. First, let's define a vacuum. The textbook definition of a **VACUUM** is a space where there is no matter—no air, no molecules, nothing! But this is a "perfect" vacuum, rarely found except in outer space or the laboratory.

A more practical definition of a vacuum is: a space where the pressure is significantly below atmospheric pressure.

The weight of atmospheric pressure can force a liquid or gas into the "open space" of the vacuum. The area of low pressure in the vacuum acts as a magnet to heavier (higher) atmospheric pressure, and draws in the liquid or gas. This drawing response is called suction.

Therefore, suction is created when pressure forces something into a vacuum. Suction is very important to pump operation.

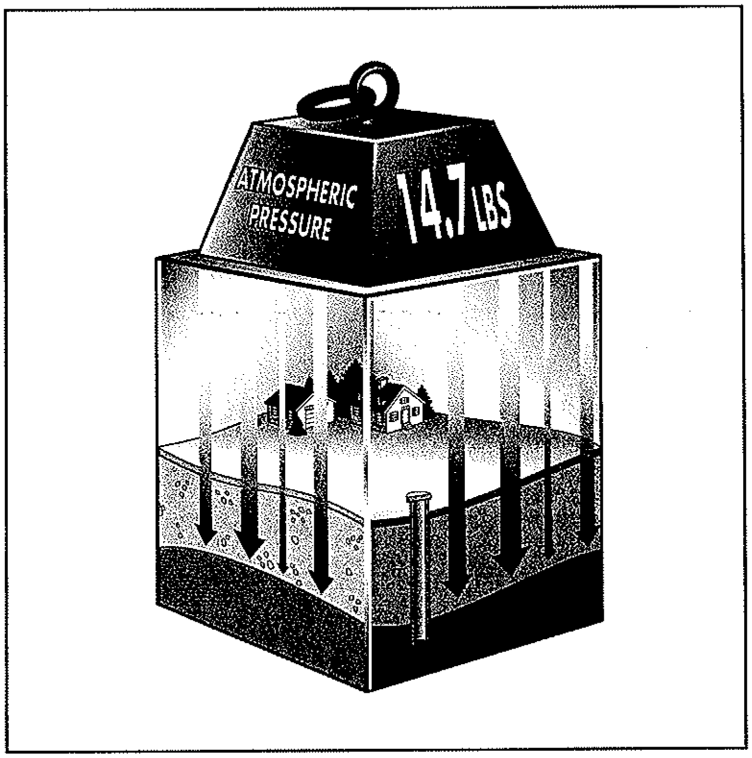
Atmosphere Exerts Pressure

The atmosphere all around us has weight. Now that we know **ATMOSPHERIC PRESSURE** is necessary for suction to occur, let's look at how much weight it exerts.

At sea level it exerts a pressure of 14.7 pound per square inch (psi). Atmospheric pressure decreases as we rise above sea level.

Try to suck soda pop from a bottle by closing your mouth over the entire mouth of the bottle. You can't.

ATMOSPHERIC PRESSURE WEIGHT

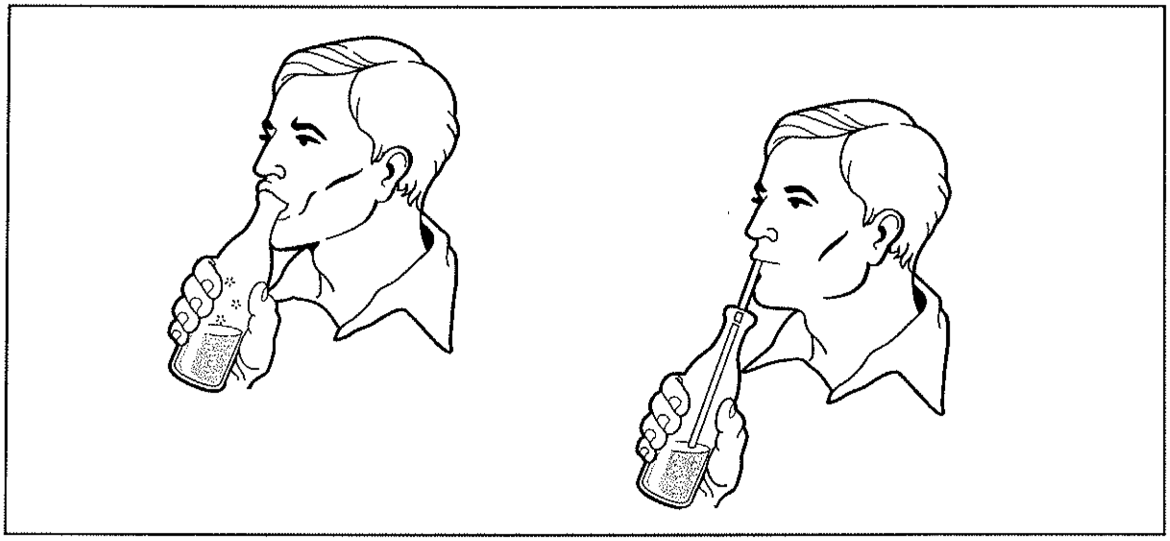


SP 2.2.02

You have created a partial vacuum in your mouth (by sucking) but you have not allowed an opportunity for the outside atmospheric pressure to reach the liquid and push it up the bottle.

Now use a straw. It is easy. Again, you've created a **PARTIAL VACUUM** in your mouth, but this time you've allowed the atmospheric pressure on the surface of the soda inside the bottle to reach the liquid and push it up the straw and into your mouth.

MAN SIPPING A SODA



SP 2.2.03

Vacuums are Partially Effective

What is the function of suction in a pump? Suction can raise the water from the water source. It can "make water flow uphill."

We know that, under ideal conditions, one pound per square inch (1 psi) of pressure will raise water 2.31 feet in a pipe. At sea level, atmospheric pressure (14.7 psi) should create enough force to raise water almost 34 feet.

This would be true if vacuums were 100 percent efficient. However, vacuums are not 100 percent efficient for three reasons.

1. A real-world "perfect vacuum" cannot be created.
2. Friction loss must be considered.
3. The elevation above sea level affects pressure's ability to raise a liquid.

Therefore, atmospheric pressure's effect will vary depending on certain conditions.

Friction Loss Affects Pressure

In real life, water passing through a pipe rubs against the inside of the pipe. This rubbing interferes with the free flow of the water and creates friction. The friction holds the water back; it keeps the water from going as far in the pipe.

The amount of distance lost (and therefore pressure lost) because of friction is called **FRICTION LOSS**. You will learn how to determine friction loss later in this book.

Elevation Affects Pressure

For all practical purposes, at sea level, atmospheric pressure will raise water 25 feet.

But another condition affecting pressure is elevation above sea level. At 5000 feet **ELEVATION**, water can only be raised 20 feet in a pipe.

As elevation above sea level increases, the lower air pressure will not raise the water as far. For every 1000 feet above sea level, the height of the water is reduced by one foot.

Many pumps work by creating a vacuum to create and manipulate pressure. They force water from a larger chamber into a smaller chamber by decreasing the pressure in the smaller chamber.

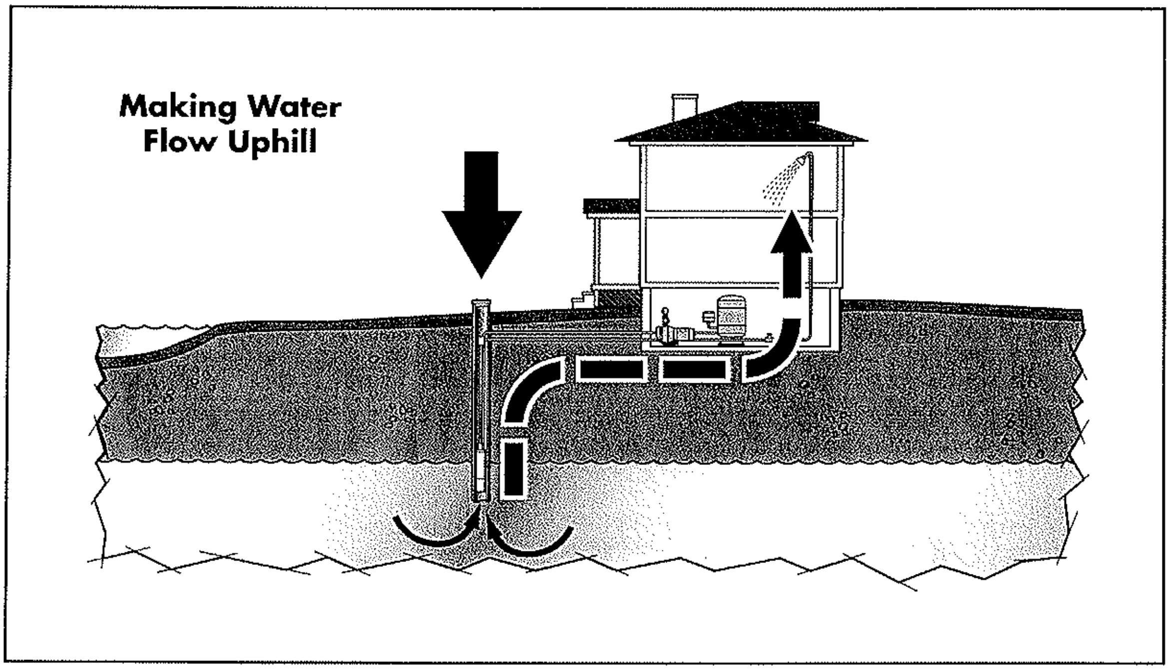
How Water Flows Uphill

Here's how a pump at ground level can raise (lift) water from a source beneath it.

1. The vacuum chamber (or suction chamber) of the pump is piped down into the water source.
2. Atmospheric pressure is removed from this chamber, creating a partial vacuum.
3. As a result, the water rises up the pipe.

The atmospheric pressure on the surface of the water source forces the water up the pipe and into the low pressure area created by the vacuum chamber of the pump. And that's how we use suction to make water flow uphill.

MAKING WATER FLOW UPHILL



SP 2.2.04

Other Physical Properties Used in Pump Design and Operation

We've just described how pumps operate using the principles of vacuums, suction, and atmospheric pressure to create the pressure changes that cause water to rise in pipes. We've learned that pumps are designed to have vacuum chambers.

Pump manufacturers recognize the previously cited barriers to the efficiency of vacuums (friction loss and elevation) and take into consideration these factors in their pump design.

Bernoulli's Law

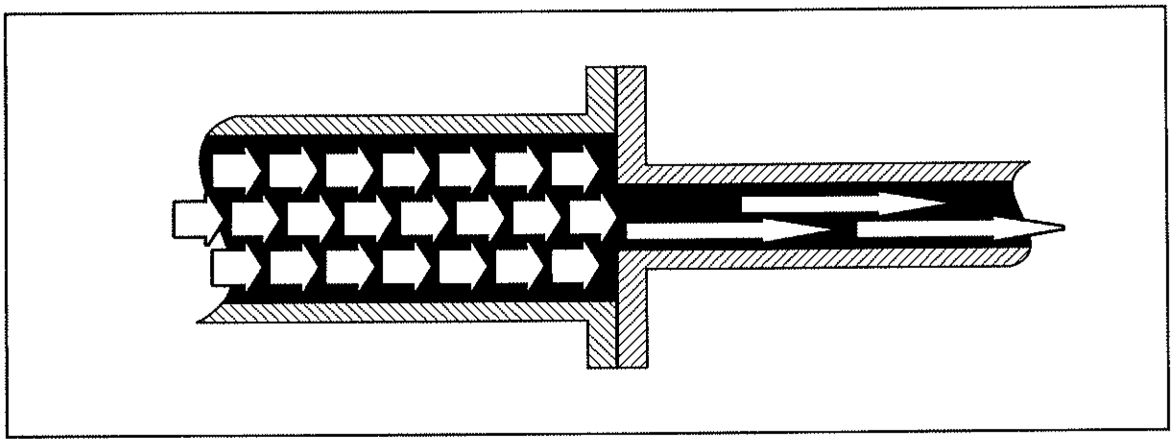
Pumps are also designed to use another principle of physics. They can alter the rate of flow to result in a change in pressure and a change in the pump's ability to lift the water. This method of operation uses the principle of physics known as **BERNOULLI'S LAW**. This Law states that pressure increases as flow rate decreases, and pressure decreases as flow rate increases. That is, pressure is inversely related to rate of flow (or **VOLUME**).

It is known that liquid flowing horizontally will flow faster through a narrow area (canyon, pipe, river, etc.) than through a larger area, and that liquid will flow more slowly when it passes into an area with a larger diameter.

The smaller the opening or chamber, the faster the rate of flow of the fluid through the pipe and the lower the pressure in the area.

Pumps are therefore designed with *different size openings between chambers.* Pumps can control the speed and (due to the inverse relationship of speed to pressure) the pressure, by adjusting the size of the opening.

SPEED FLOW



SP 2.2.05

Centrifugal Force

Another principle by which pumps operate to create the pressure that causes water to lift is **CENTRIFUGAL FORCE**.

A pump adds energy to the water by centrifugal force. Centrifugal force can increase the flow rate and decrease the pressure. Centrifugal force is the same force that pulls a ball on a string outward as you swing it around your head. Pumps can create a vacuum by using centrifugal force to increase the flow rate and decrease the pressure.

Centrifugal pumps are the basic pump type. Later in this unit you will learn that other pumps are modifications of centrifugal pumps.

Thus, we find that pumps control flow rate and pressure in two main ways:

1. by forcing water through different sized openings, the smaller openings speeding the flow rate and decreasing pressure.
2. by using centrifugal force to speed the flow rate and decrease pressure.

How Pumps Work

Now that we know what scientific principles are involved in pump design and operation, let's look at what causes the pump to do the job it is designed to do.

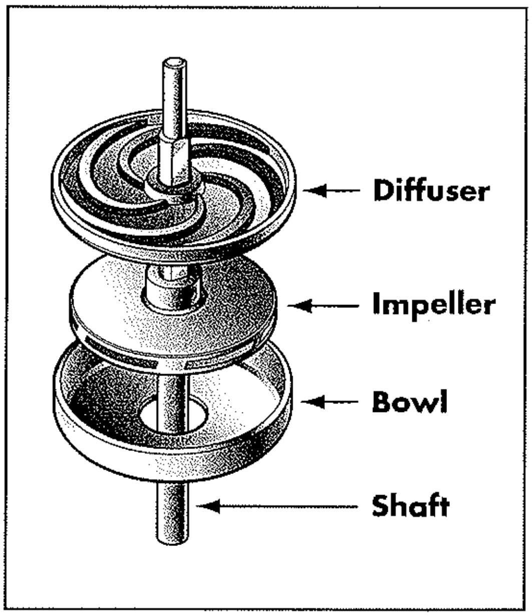
Water well pumps are modified centrifugal pumps. Let's look at the parts of straight centrifugal pumps to find out how they operate. A centrifugal pump has three basic parts:

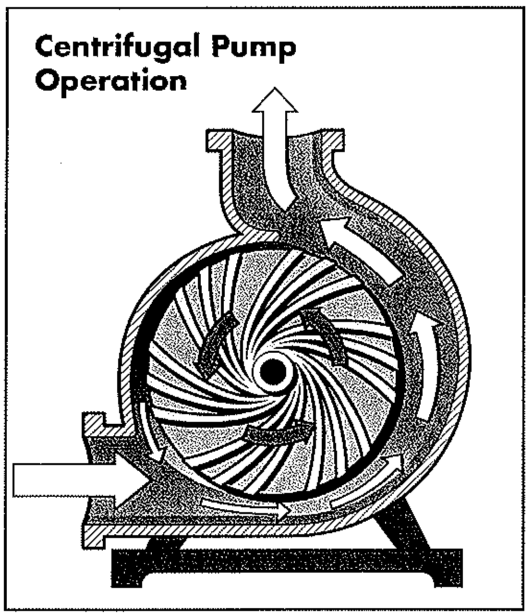
1. the impeller;
2. the diffuser or venturi tube; and
3. the discharge pipe.

To start the pump, water must be injected into the pump. This water is called the **PRIME**.

An **IMPELLER**, rotating on a motor shaft, forces water across its vanes (or blades). As the impeller spins, water enters through the opening in the center of the impeller and is thrown to the outside edge by centrifugal force. The water picks up speed, lowering the pressure in the center of the impeller. This creates a partial vacuum, sucking in more water.

BASIC PARTS OF A PUMP





SP 2.2.06

Meanwhile, a **DIFFUSER** receives the water that has been forced (impelled) to the outside of the impeller, and slows it down, thus increasing the water pressure.

The water is then passed into a discharge pipe. Some of the water must be sent back into the impeller to continue pump operation, but the rest of the water is discharged for use in the home.

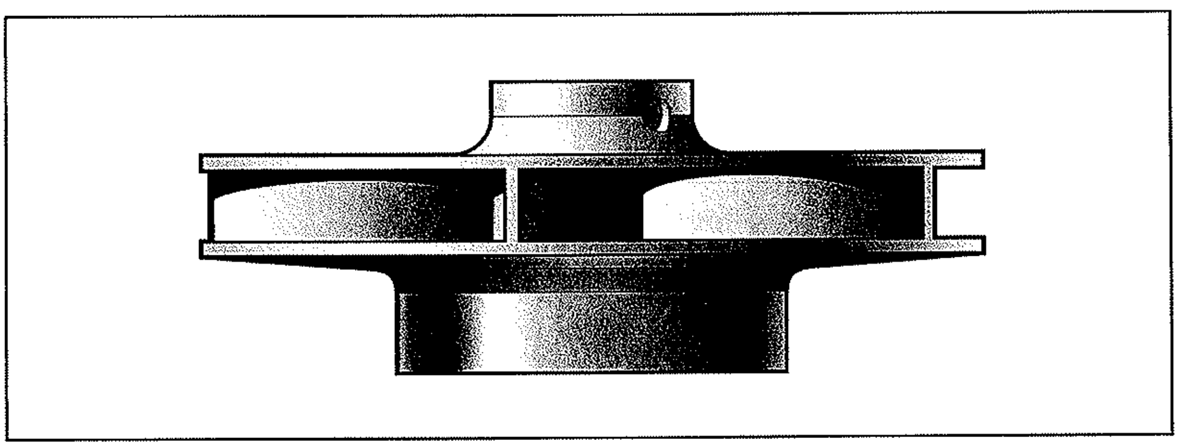
Increase Volume or Rate of Flow

Water well pumps operate by adding energy to water to provide either an increase in pressure or in rate of flow. [Rate of flow is sometimes referred to as **VOLUME**. A unit of measure of volume is **GALLONS PER MINUTE (GPM)**.]

As we've seen, with any given amount of energy we can have more volume or more pressure but not both. For one to increase, the other must be reduced by the same proportion.

Volume and pressure for any given pump are determined by impeller geometry. Each impeller requires a certain horsepower to perform as designed. Adding a larger motor does not change the performance characteristics of a pump unless the impeller geometry (or speed) is also changed.

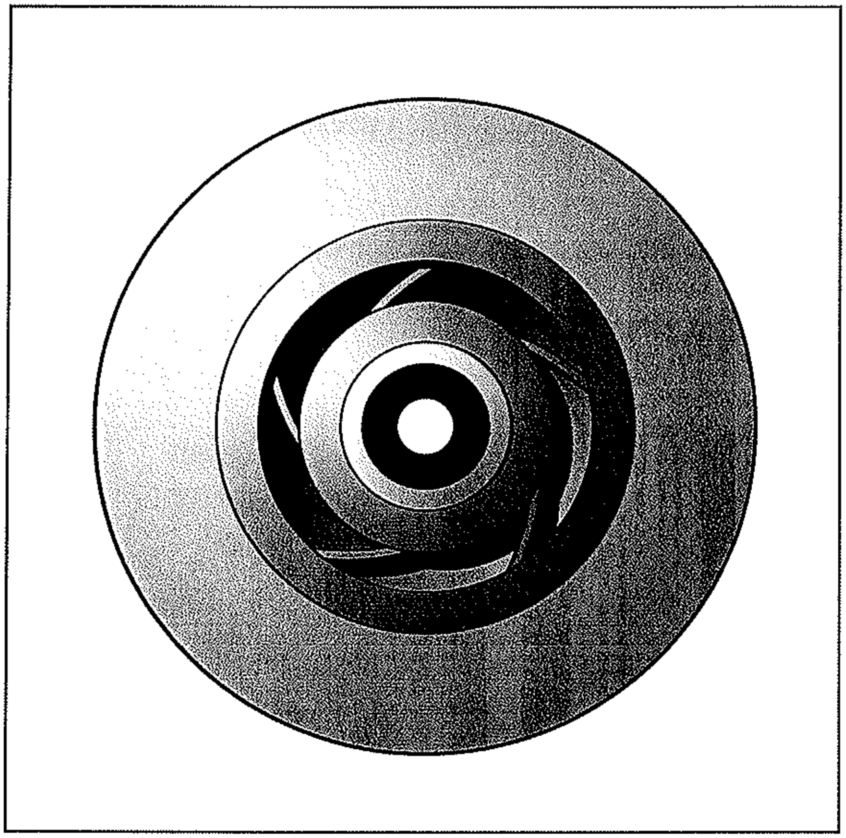
SIDE VIEW OF AN IMPELLER



SP 2.2.07

To increase the pump's volume, increase the thickness of the impeller. When you double the impeller thickness, you can double the **CAPACITY** (or volume/rate of flow) of the pump.

TOP VIEW OF AN IMPELLER



SP 2.2.08

When the impeller's diameter is doubled, you can double the pressure (**HEAD** pressure) of the pump.

The thicker the impeller, the greater volume the pump can handle. The greater the diameter of the impeller, the greater the pressure the pump creates.

REVIEW QUIZ – BASIC PRINCIPLES OF PUMP OPERATION

Answers appear on page 28

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. What is created when atmospheric pressure forces something into a vacuum?
   a. Weight
   b. Suction
   c. Friction
   d. Centrifugal force

2. What pressure does the atmosphere exert (at sea level)?
   a. 14.7 psi
   b. 2.31 psi
   c. 25 psi
   d. 147 psi

3. As we rise above sea level, atmospheric pressure
   a. disappears.
   b. increases.
   c. remains the same.
   d. decreases.

4. To force water up a pipe, atmospheric pressure is
   a. added to a chamber to create suction.
   b. removed from a chamber to create suction.
   c. added to a liquid.
   d. unchanged.

5. Pressure increases as flow rate
   a. increases.
   b. decreases.
   c. stays the same.
   d. speeds up.

6. How far could atmospheric pressure raise water if we had a perfect vacuum and perfect conditions?
   a. 2.31 feet
   b. 14.7 feet
   c. 15 feet
   d. 33.957 feet

REVIEW QUIZ –
BASIC PRINCIPLES OF PUMP OPERATION

Answers appear on page 28

7. At sea level, how far will a shallow well jet pump raise water in a pipe in a real-life situation?
   - a. 5 feet
   - b. 15 feet
   - c. 25 feet
   - d. 35 feet

8. The amount of water pressure lost because of the friction of liquid against a pipe is called
   - a. friction loss.
   - b. suction.
   - c. pressure loss.
   - d. elevation.

9. What law provides an operating principle for pump operation pointing out the inverse relationship between rate of flow and pressure?
   - a. Atmospheric pressure law
   - b. Bernoulli's Law
   - c. Law of gravity
   - d. Friction loss

10. Two ways pumps control flow rate are size of the openings or chambers and
    - a. friction loss.
    - b. elevation above sea level.
    - c. creation of a vacuum.
    - d. use of centrifugal force.

11. The three basic parts of a pump are the impeller, the diffuser, and the
    - a. discharge pipe.
    - b. vacuum chamber.
    - c. pipe.
    - d. shaft.

12. What determines a pump's volume and pressure?
    - a. Diffuser
    - b. Impeller geometry
    - c. Rate of flow
    - d. Atmospheric pressure

REVIEW QUIZ – BASIC PRINCIPLES OF PUMP OPERATION

Answers appear on page 28

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. What types of submersible electric pumps does your company sell?

____

____

____

B. With normal water pressure of 50 PSI and very cold water (approximately 40 degrees), the working pressure of the system may need to be boosted. If a customer reports low household pressure, you may suggest a booster pump. You may also consider a booster pump if the customer has very cold water. Does your company sell booster pumps and, if so, what company manufactures them?

____

____

____

ANSWERS TO REVIEW QUIZ

CHAPTER 2

BASIC PRINCIPLES OF PUMP OPERATION

Answers to REVIEW OF BASIC PRINCIPLES OF PUMP OPERATION (pages 24 – 26)

1. b. Friction
2. a. 14.7 psi
3. d. decreases.
4. b. removed from a chamber to create suction.
5. b. decreases.
6. c. 15 feet
7. c. 25 feet
8. a. friction loss.
9. b. Bernoulli's Law
10. d. use of centrifugal force.
11. a. discharge pipe.
12. b. Impeller geometry

Applying what you have learned:

A. Depends on the company

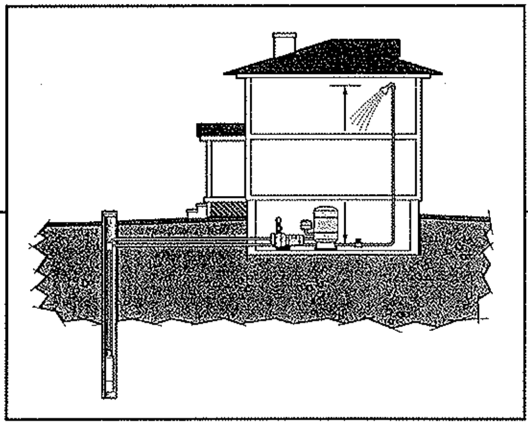
B. Depends on the company

3 CONDITIONS FOR PUMP INSTALLATION

LEARNING OBJECTIVES

When you finish this Chapter, you will be able to:

1. Explain the effects of the natural obstacles to pump performance—friction loss, vertical lift, and elevation.
2. Identify discharge conditions and the requirements for capacity and pressure.
3. Describe the methods used to measure capacity.
4. Define overpumping and explain how it can be avoided.



PUMP INSTALLATION

Friction Loss

The previous chapter cited friction loss and elevation as barriers to the efficiency of vacuums. They are also obstacles to pump performance in terms of allowing pumps to provide a satisfactory water supply. They must be overcome by every pump.

Let's start with friction loss. What does it do to a pump?

As water flows through a pipe on the way from the well to the home, the inside of the pipe resists the free flow of the water.

This resistance, called friction, means extra work for the pump because it has to work harder to move the same volume of water. Friction loss works against the pump performance, so you want to keep it as low as possible.

Friction loss is affected by three factors:

1. pipe length;
2. flow rate; and
3. inside diameter of the pipe.

In what ways do these factors affect friction loss?

- Friction loss *increases* as pipe length increases. The longer the pipe, the more the friction loss.
- Friction loss increases as flow rate increases. The greater the flow rate, the more the friction loss.
- Friction loss *decreases* as inside pipe diameter increases. The larger the inside diameter (i.d.) of the pipe, the less the friction loss. Therefore, you can reduce friction loss by using a larger i.d. pipe.

Friction loss can be expressed in either pressure (*pounds per square inch or psi*) or feet. It takes a certain amount of pressure to raise water to a height in feet. There is a relationship between pressure and feet (sometimes expressed as "feet head"). One pound of air pressure can raise water 2.31 feet in a vertical pipe.

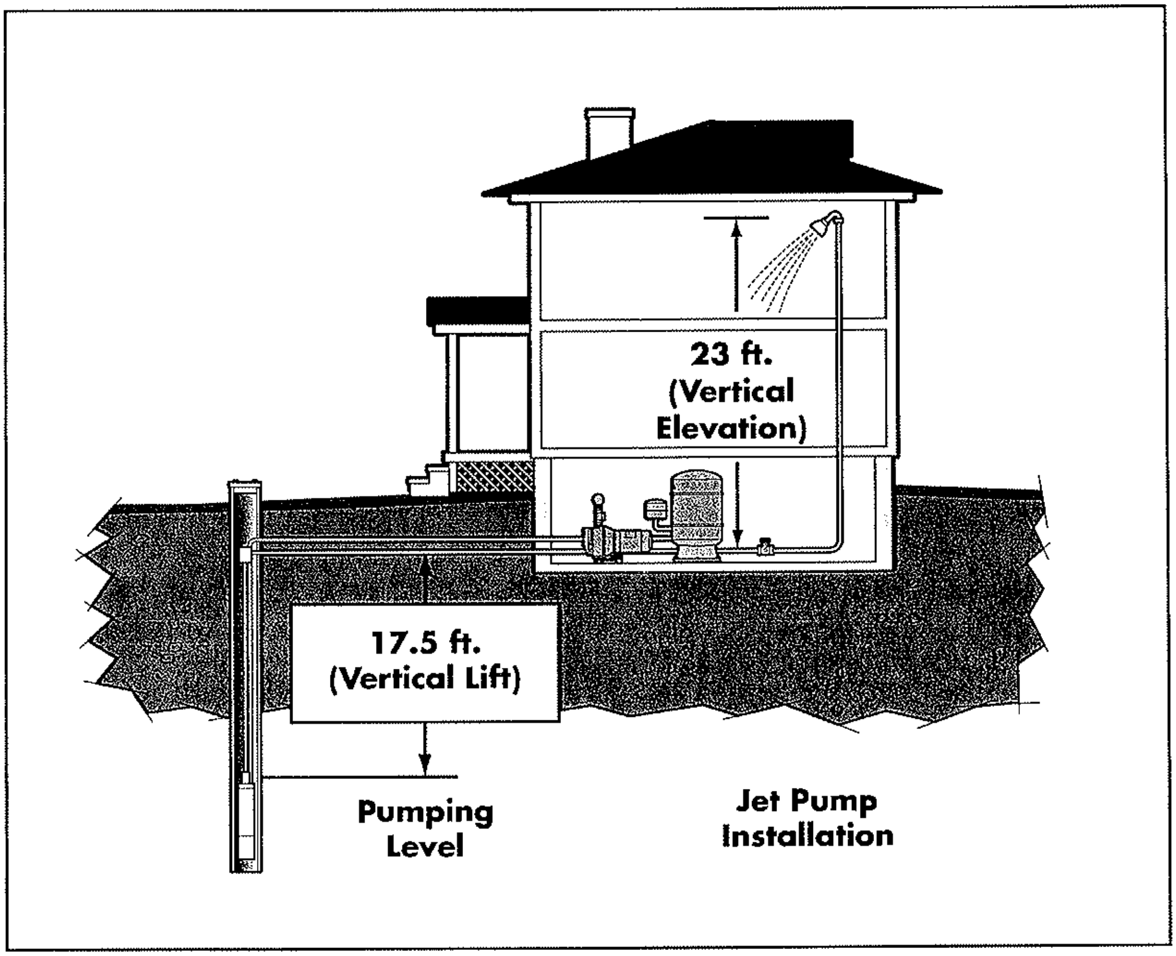
- To convert pressure to feet, multiply by 2.31.
- To convert feet to pressure, divide by 2.31.

In addition to overcoming friction loss, the pump must raise the water vertically from the water source to the highest outlet in the home.

Vertical Lift

We use the terms **VERTICAL LIFT** (or **SUCTION LIFT**) and vertical elevation to describe this process. When the pump is located above the ground, vertical lift is the distance from the pumping level in the well to the tank. The height of the pump has to pull water. Vertical elevation is the distance from the pump to the highest outlet in the home. The height of the pump has to push water.

JET PUMP INSTALLATION



SP 2.3.01

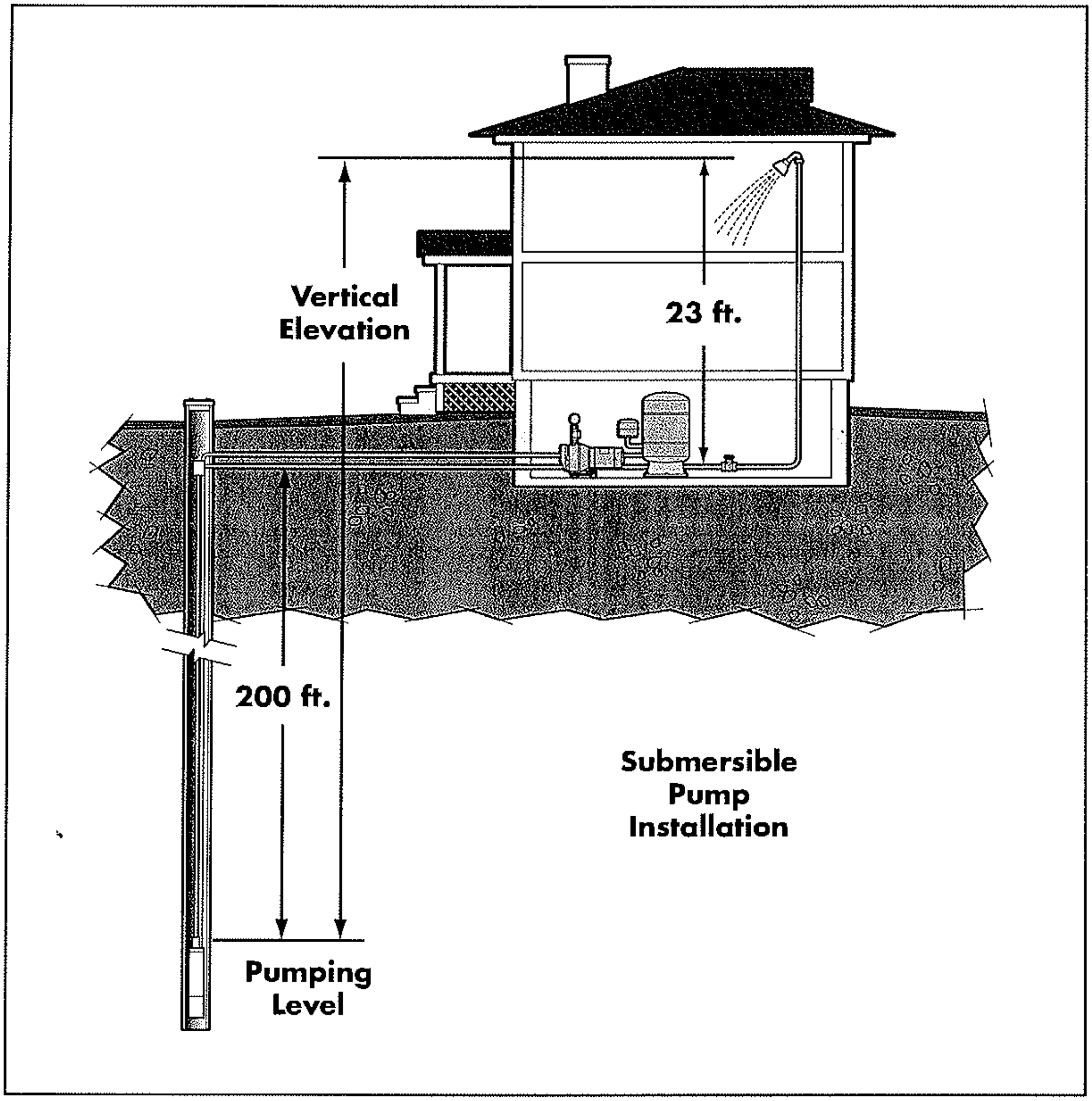
Jet Pumps and Submersible Pumps

There are two types of pumps in use today: jet pumps and submersible pumps. Pumps with a jet assembly are located above the ground and are known as jet pumps. Pumps submerged in the water source are known as submersible pumps. Both types can be used on shallow and deep wells. For details on these two types of pumps, see Chapter 5.

Notice that for above-ground pumps (jet pumps), vertical lift (suction lift) is on the suction side of the system, or between the pumping level and the pump. Vertical elevation is on the discharge side of the system, or between the pump and the home.

When the pump is submerged in the water source (submersible pump), there is no suction side in the system, only a discharge side. We simply total the distance from the pumping level in the well to the highest outlet in the home and call it vertical elevation.

SUBMERSIBLE PUMP INSTALLATION



SP 2.3.02

Discharge Conditions: Capacity and Pressure

To make sure you're providing a satisfactory water supply to the home, you need to also determine "discharge conditions," or what you need on the discharge side of the pump.

A satisfactory home water supply must satisfy two sets of requirements:

1. **Capacity requirements**: the capacity of the system, expressed in gallons per minute, or **GPM**.
2. **Pressure requirements**: the **SERVICE PRESSURE** at the outlets, expressed in pounds per square inch, or **PSI**.

In other words, the system should have enough **CAPACITY** to satisfy the maximum number of outlets which are liable to be used at the same time. And enough **PRESSURE** to overcome friction loss and vertical lift and/or vertical elevation, and still provide adequate operating pressure at each outlet. Capacity and pressure are inversely related. When one goes up, the other goes down. Capacity may be measured in gallons per minute (gpm) or gallons per hour (**GPH**). Be sure that you are speaking in the same terms as the customer!

You must know how to convert one measurement to the other.

- To change gpm to gph, multiply 60 x gpm

  EXAMPLE: 5 gpm x 60 = 300 gph

- To change gph to gpm, divide gph by 60 (minutes)

  EXAMPLE: 300 ÷ 60 minutes = 5 gpm

The water system should have enough capacity to satisfy the family's needs, particularly during the periods of heaviest demand. The amount of water needed by a family depends on three factors:

1. Number of people
2. Number of fixtures in the home
3. Peak demand periods

In figuring the water usage requirements for the average home, the following practical rules can be used:

- Pump capacity in gpm should at least equal the number of fixtures installed in the house.
- It should be 10 percent greater than the actual need.
- Do not oversize.

The term "fixtures" means outlets from which water will flow: lavatories, water closets, showers, dishwashers, outside hose bibs, etc.

Fixture Method

The Fixture Method can be summarized as: Adequate discharge capacity is 1 gpm for every fixture in the home.

FIXTURE & PEAK DEMAND CHECKLIST

CAPACITY NEEDED

FIXTURES:

Bathtub/shower	______
Toilet	______
Lavatory	______
Kitchen sink	______
Dishwater	______
Washing machine	______
Hose bib	______
Other	______
Total outlets	______
x 1 gpm =	______ gpm

PEAK DEMAND

No. of outlets being used at the same time	______
x 3 gpm =	______ gpm

SP 2.3.1g

Peak Demand Method

PEAK DEMAND PERIODS usually occur during morning and evening hours when most or all of the family is at home and the demand for water is the heaviest. These are the times when the most outlets are being used at the same time. Peak demand periods usually involve 7 to 10 minutes of maximum water usage (showers, dishwasher, etc.).

The Peak Demand Method states that the maximum number of fixtures normally in use at the same time during peak demand periods x 3 gpm will determine adequate discharge capacity.

PEAK DEMAND = NUMBER OF FIXTURES IN USE X 3 GPM

Sizing a Pump for Residential Use

EXAMPLE #1

The Joneses have three teenage children and live in a four-bedroom home with the following fixtures:

- upstairs bath: sink, shower, and toilet
- downstairs bath: sink, shower, and toilet
- kitchen sink
- washing machine
- laundry tub
- two outside fixtures

Based on the Fixture Method, the adequate discharge capacity for the Jones' home would be 11 gpm, since there are 11 fixtures in the home.

The chart on page 37 is the peak demand chart for the house in Example 1. According to this chart, the minimum size pump required to meet the peak demand is 14 gpm.

TABLE 1: SEVEN MINUTE PEAK DEMAND PERIOD USAGE

Outlets	Flow Rate gpm	Total Usage Gallons	1	Bathrooms 1-1/2	In Home 2 – 2-1/2	3 – 4
Shower or Bath Tub	5	35	35	35	53	70
Lavatory	4	2	2	4	6	8
Toilet	4	5	5	10	15	20
Kitchen Sink	5	3	3	3	3	3
Automatic Water	5	35	–	18	18	18
Dishwasher	2	14	–	–	3	3
Normal seven minute *peak demand (gallons)			45	70	96	122
Minimum sized pump required to meet peak demand without supplemental supply			7 gpm (420 gpm)	10 gpm (600 gpm)	14 gpm (840 gpm)	17 gpm (1020 gpm)

SP 2.3.2g

Note: Values given are average and do not include higher or lower extremes.
*Peak demand can occur several times during morning and evening hours.

EXAMPLE #2

The Smiths have one child and live in a three-bedroom home with the following fixtures:

- upstairs bath: sink, shower, and toilet
- downstairs half-bath: sink and toilet
- kitchen sink
- washing machine
- laundry tub
- one outside fixture

Assume that the maximum number of fixtures normally in use during peak demand periods is three. Based on the Peak Demand Method, the adequate discharge capacity for the Smith home would be 9 gpm (3 fixtures x 3 gpm = 9 gpm).

EXAMPLE #3

The Brown house has one full bath, a kitchen sink, a washing machine, a laundry tub, and one outside faucet. Using the Fixture Method, a 7 gpm (420 gph) pump is needed for this house, as there are 7 fixtures.

The peak demand chart uses the total number of gallons required by all outlets to give you the 14 gpm figure. The Fixture Method showed a required capacity of 10 gpm for the house in Example 1.

It seems unlikely that all of the outlets really would be open at the same time. And water storage in the pressure storage tank may help meet the peak period demand.

Judgment, and knowledge of the homeowner's needs, may determine the minimum pump capacity needed. Keep in mind that a larger pump gives better service. Size the pump to the house's needs and flow needs—or the recovery of the well.

Based upon the peak demand chart, a 7 gpm capacity pump would be needed for the house in Example 2, which is the same capacity found by using the Fixture Method.

In general, 75 gallons per day per person will assure adequate service for a home if pump capacity and discharge pressure are adequate for peak demand periods.

Sizing a Pump for Farm Use

When sizing a pump for farm use, extra provisions must be made for watering livestock, cleaning farm outbuildings, and fighting fire. A pump capacity of 20 to 60 gpm is needed to assure reasonable ability to fight a fire.

The chart to the right shows the water requirements for various kinds of livestock. The pump capacity should be such that the daily requirements for all livestock can be pumped in one two-hour period.

EXAMPLE:

Assume that a farmer has 50 milking cows. The amount of water required for these cows is 1,750 gallons per day.

If the amount of water for peak demand periods is grater than the well and the pump provide, the difference may be made up in the storage capacity of the pressure storage tank. This is covered in more detail later in the course.

Livestock	Gallons per Day
Horse, mule, steer	12
Dry cow	15
Milking cow	35
Hog	4
Sheep	2
Chickens (per 100)	6
Turkey (per 100)	20

SP 2.3.1t

Highest Discharge Capacity

It is important that the user be able to continuously obtain water at the flow rate and under the pressure needed.

Remember that no two families are the same. No two families will have the same water usage needs. So you may have to adjust these formulas to provide adequate discharge capacity during peak demand periods.

When in doubt, use the formula that calls for the highest discharge capacity. Always provide more capacity, rather than less. Remember, no one ever complains about having too much water.

The amount of water a certain pump will actually produce depends not only upon the capacity of the pump, but upon the amount of water the well source can provide—the natural capacity of the well.

Capacity Requirements

The amount of water a certain pump will actually produce depends not only upon the capacity of the pump, but upon the amount of water the well source can provide—the natural capacity of the well.

A "weak" well may produce only a small number of gallons per minute. Use of a storage tank may make it possible for the weak well to provide a satisfactory water supply for the home, but the well must not be "overpumped." To **OVERPUMP** a well means to pump the water level so low that air gets into the pump and water system. Overpumping can damage the pump and disrupt water service to the home. To prevent overpumping the well, make sure that storage capacity is 1-1/2 times the peak demand period.

Most wells have enough discharge capacity to meet most family water usage needs. For example, a 2 gpm well can satisfy a peak demand capacity of 10 gpm if there is enough storage capacity.

The chart below gives you some examples of well capacity for a 10-minute peak demand period.

STORAGE CAPACITY = 1-1/2 X PEAK DEMAND REQUIREMENTS

CALCULATING DEMAND

PEAK DEMAND REQUIREMENTS X	PEAK DEMAND PERIOD	X 1-1/2	= STORAGE CAPACITY REQUIRED
7 gpm	10 minutes	X 1-1/2	105 gallons
8 gpm	10 minutes	X 1-1/2	120 gallons
9 gpm	10 minutes	X 1-1/2	135 gallons
10 gpm	10 minutes	X 1-1/2	150 gallons
12 gpm	10 minutes	X 1-1/2	180 gallons

SP 2.3.3g

If total well capacity isn't at least 1-1/2 times peak demand, you may be in danger of overpumping the well. You should consider alternatives such as:

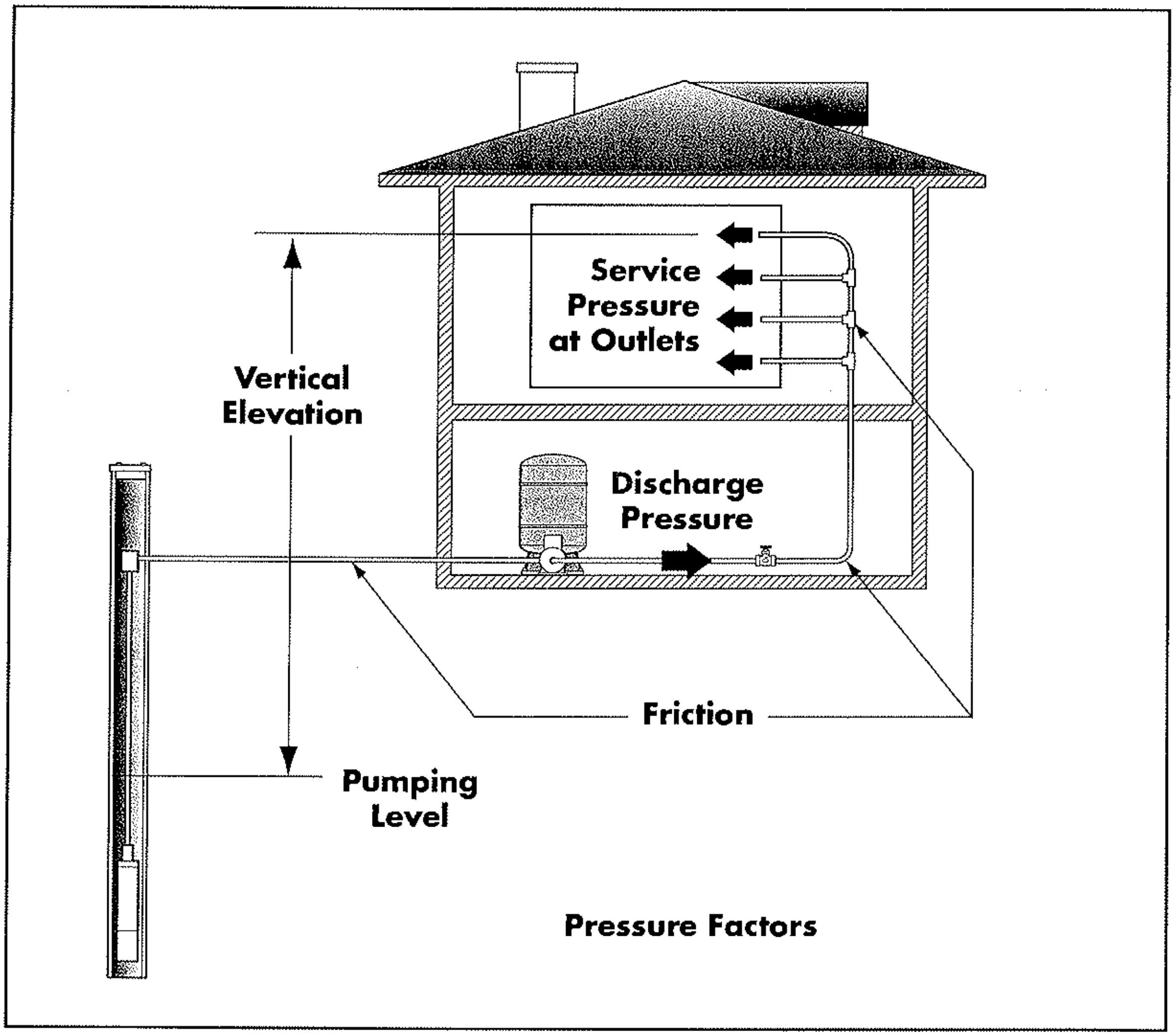
- a low water shutoff device
- increased storage in the home
- technical advice from distributors

Pressure Requirements

In addition to enough capacity, there must also be enough pressure to properly service the home. **DISCHARGE PRESSURE** (stated in psi) or **DISCHARGE HEAD** (state in feet head) is made up of:

- **Vertical elevation**: the pressure needed to raise the water vertically from the pressure tank to the highest outlet in the home (measure in feet, convert to psi), *plus*
- **Friction loss**: the friction loss in all pipe and fittings between the tank and the outlets (expressed in psi), *plus*
- **Service pressure**: the pressure required at the outlets (expressed in psi).

PRESSURE FACTORS DIAGRAM



SP 2.3.03

Discharge pressure is measured in **PSI** (pounds per square inch), and head is measured in feet. You must know how to change one to the other. One pound per square inch of pressure will raise water 2.31 feet.

- To change psi to feet of head, multiply psi x 2.31.
  (psi x 2.31 = feet of head)
- To change feet of head to psi, divide feet of head by 2.31.
  (Feet of head ÷ 2.31 = psi)

The most commonly used discharge pressure is 30/50 psi. This means that the pump will cut in when the pressure in the system falls to 30 psi and cut out when the pressure reaches 50 psi.

This provides enough pressure to service most homes adequately. When selecting a pump, always use the lower or "cut-in" pressure, because that represents peak demand conditions. Be sure peak demand conditions are covered by the lower pressure.

Preset discharge pressures can be changed manually. But most pumps have a maximum shutoff pressure limit due to design and hydraulics. Pressure switches can be adjusted manually in the field to accommodate unusual conditions.

If the home has old and corroded pipes and fittings or rusty faucets and shower heads, extra discharge pressure may be required to overcome the additional friction loss caused by these conditions.

Increased discharge pressure may also be required if vertical elevation is greater than normal; for example, a three-story home or a home located a great distance from the pump.

REMEMBER: To ensure adequate pressure throughout the home, make sure there's enough discharge pressure at the highest or furthest outlet.

REVIEW QUIZ –
CONDITIONS FOR PUMP INSTALLATION

Answers appear on page 50

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. What does friction loss do to a pump?
   a. It makes the pump more efficient.
   b. It causes the pump to work harder.
   c. It helps water flow more freely.
   d. It makes the pump last longer.

2. If flow rate and pipe length must stay the same, what is one possible way to decrease friction loss?
   a. Increase the pipe length
   b. Increase the flow rate
   c. Increase the pipe diameter
   d. Decrease the pipe diameter

3. Friction loss to an upstairs outlet is 21 psi. How many feet of friction loss is this?
   a. 2.31
   b. 4.62
   c. 9.1
   d. 48.5

4. To raise the water vertically, what two variables must be considered?
   a. Vertical lift and vertical elevation
   b. Friction loss and capacity
   c. Capacity and vertical elevation
   d. Vertical lift and pressure

5. Discharge conditions include what two sets of requirements?
   a. Capacity and pressure
   b. Vertical life and vertical elevation
   c. Friction loss and suction lift
   d. Friction loss and pressure

REVIEW QUIZ –
CONDITIONS FOR PUMP INSTALLATION

Answers appear on page 50

6. In what way are capacity and pressure related?
   a. They are always the same.
   b. They are inversely related.
   c. When one increases, the other increases.
   d. When one decreases, the other increases.

7. A pump produces 20 gpm. How many gph is that?
   a. 120 gph
   b. 200 gph
   c. 1200 gph
   d. 2600 gph

8. A customer needs 3600 gph. How many gpm is that?
   a. 6 gpm
   b. 60 gpm
   c. 600 gpm
   d. 1200 gpm

9. Which of the following does not affect the capacity of water needed by a family?
   a. Number of people
   b. Number of fixtures in the house
   c. Peak demand periods
   d. Number of floors in the house

10. What is the Fixture Method for determining adequate discharge capacity?
    a. 1 gpm per fixture
    b. 3 gpm per fixture
    c. Divide gph by 60
    d. Multiply 60 by gpm

11. What is the Peak Demand Method for determining adequate discharge capacity?
    a. Multiply 60 by gpm
    b. Divide gph by 60
    c. Number of fixtures in use x 3 gpm
    d. Number of fixtures in use x 1 gpm

**REVIEW QUIZ –
CONDITIONS FOR PUMP INSTALLATION**

Answers appear on page 50

12. How much water per day will provide adequate service in a home?
    a. 10 gallons per day per person
    b. 25 gallons per day per person
    c. 75 gallons per day per person
    d. 115 gallons per day per person

13. What is the minimum capacity pump needed for fire fighting on a farm?
    a. 1 to 3 gpm
    b. 5 to 10 gpm
    c. 10 to 15 gpm
    d. 20 to 60 gpm

14. To provide adequate discharge capacity for a family, always use
    a. the formula that calls for the lowest discharge capacity.
    b. the formula that calls for the highest discharge capacity.
    c. the Peak Demand Method.
    d. the Fixture Method.

15. Pumping the water level so low that air gets into the pump and water system is called
    a. overpumping.
    b. underpumping.
    c. friction loss.
    d. peak pumping.

16. In terms of the peak demand period, storage capacity is
    a. 1-1/2 times the peak demand period.
    b. 3-1/2 times the peak demand period.
    c. 5-1/2 times the peak demand period.
    d. 10 times the peak demand period.

17. If the total well capacity is not 1-1/2 times the peak demand, you may be in danger of
    a. friction loss.
    b. overpumping the well.
    c. underpumping the well.
    d. increasing water storage.

REVIEW QUIZ – CONDITIONS FOR PUMP INSTALLATION

Answers appear on page 50

18. The three elements that make up discharge pressure are vertical elevation, friction loss, and
    a. vertical lift.
    b. atmospheric pressure.
    c. service pressure.
    d. capacity.

19. 20 psi equals how many feet of head?
    a. 2.31 feet
    b. 8.66 feet
    c. 14.7 feet
    d. 46.2 feet

20. What does a pressure setting of 30/50 mean?
    a. The pump will kick on after 30 minutes and kick off after 50 minutes.
    b. The pump will kick on at 30 psi and kick off at 50 psi.
    c. The pump will kick on when pressure rises to 50 psi and kick off when pressure drops to 30 psi.
    d. The pump will kick on when pressure drops to 30 psi and kick off when pressure reaches 50 psi.

21. Which of the following conditions might require extra pressure above the preset discharge pressure?
    a. A very short distance between pump and outlets
    b. A small elevation between pump and outlets
    c. New outlets
    b. Old corroded pipes

REVIEW QUIZ –
CONDITIONS FOR PUMP INSTALLATION

Answers appear on page 50

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. Explain how you would determine an adequate discharge capacity for a customer who has a four bathroom house with other standard fixtures. What additional information might you need?

____

____

____

B. Does your company primarily provide sizing for residential customers? Does it ever provide sizing for farm use?

____

____

____

ANSWERS TO REVIEW QUIZ

CHAPTER 3

CONDITIONS FOR PUMP INSTALLATION

Answers to REVIEW OF CONDITIONS FOR PUMP INSTALLATION (pages 43 – 47)

1. b. It causes the pump to work harder.
2. c. Increase the pipe diameter
3. d. 48.5
4. a. Vertical lift and vertical elevation
5. a. Capacity and pressure
6. b. They are inversely related.
7. c. 1200 gph
8. b. 60 gpm
9. d. Number of floors in the house
10. a. 1 gpm per fixture
11. c. Number of fixtures in use x 3 gpm
12. c. 75 gallons per day per person
13. d. 20 to 60 gpm
14. b. the formula that calls for the highest discharge capacity.
15. a. overpumping.
16. a. 1-1/2 times the peak demand period.
17. b. overpumping the well.
18. c. service pressure.
19. d. 46.2 feet.
20. d. The pump will kick on when pressure drops to 30 psi and kick off when pressure reaches 50 psi.
21. b. A small elevation between pump and outlets

Applying what you have learned:

A. Adequate discharge capacity is based on the number of people in the household, number of fixtures in the home, and the peak demand periods.
To determine the water usage requirements for this customer, you will need to know all these factors.

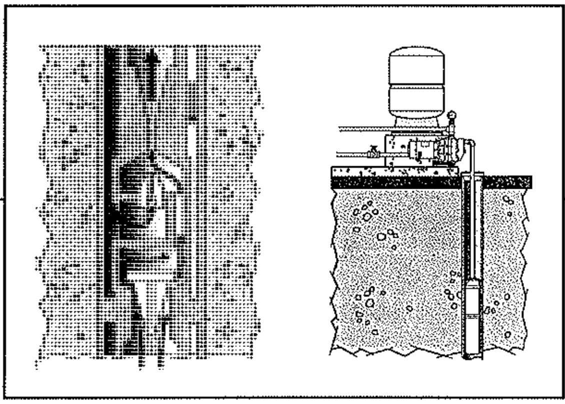
B. Depends on the company

4 DOMESTIC WATER WELL PUMPS

LEARNING OBJECTIVES

When you finish this Chapter, you will be able to:

1. Identify the types of jet pumps and how they operate.
2. Compare and contrast shallow well jet pumps, deep well jet pumps, and submersible pumps.
3. Describe the conditions that might dictate the selection of one type of pump over another.



WATER WELL PUMPS

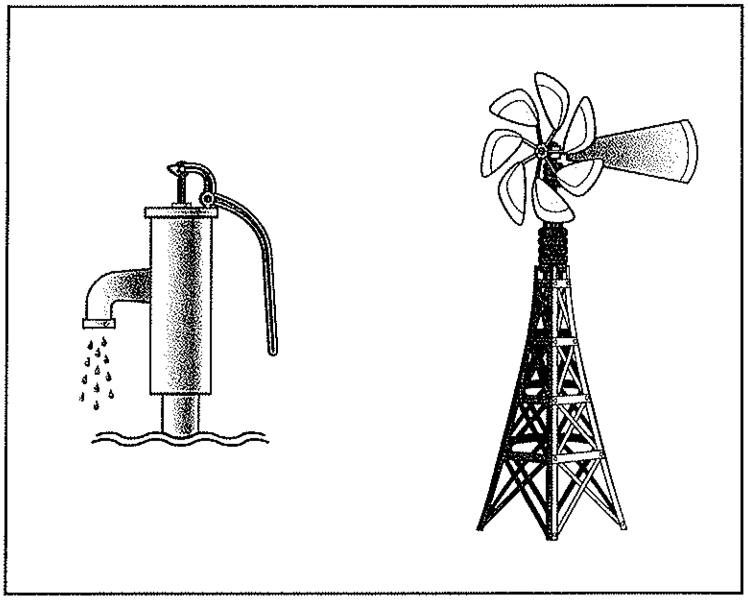
Types of Water Well Pumps

Now that you know about the basic principles and conditions for pump operation, you are ready to learn about the pumps themselves. A water well pump delivers water from a well or other water source to a tank, where the water is held under pressure until needed in the system.

In earlier times, pumps were hand operated or, perhaps, windmill powered. Windmill powered pumps may still be used in rural areas, especially for providing water for livestock.

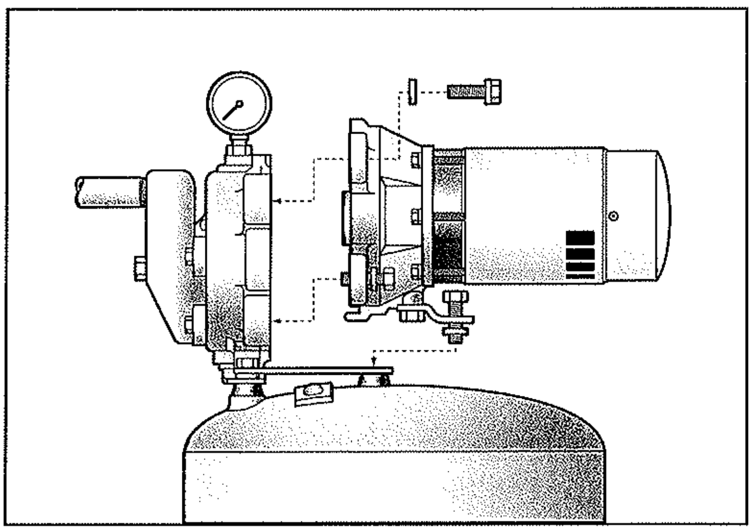
Today's water well pumps are generally powered by electric motors. The motor, as shown here, may be detachable for servicing.

HAND PUMP / WINDMILL



SP 2.4.01

ELECTRIC MOTOR



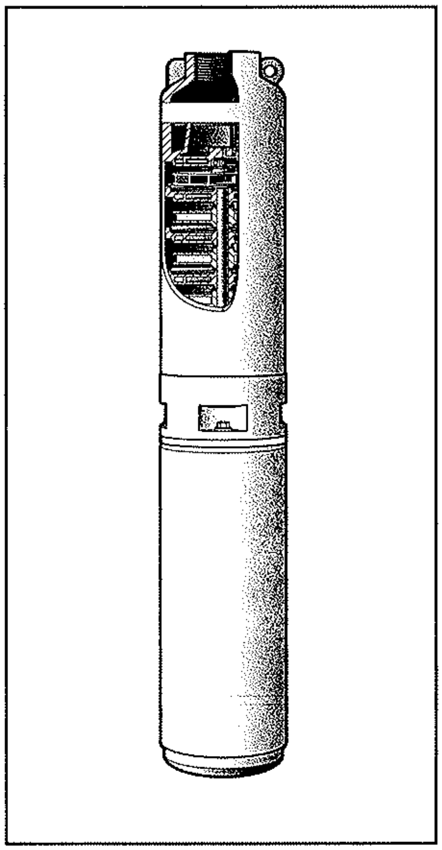
SP 2.4.02

Modifying Pumps for Residential Use

Residential water usage requires higher pressure and lower volume than a straight centrifugal pump provides. Therefore, the pump needs to be modified for water well use. There are two common ways to do so:

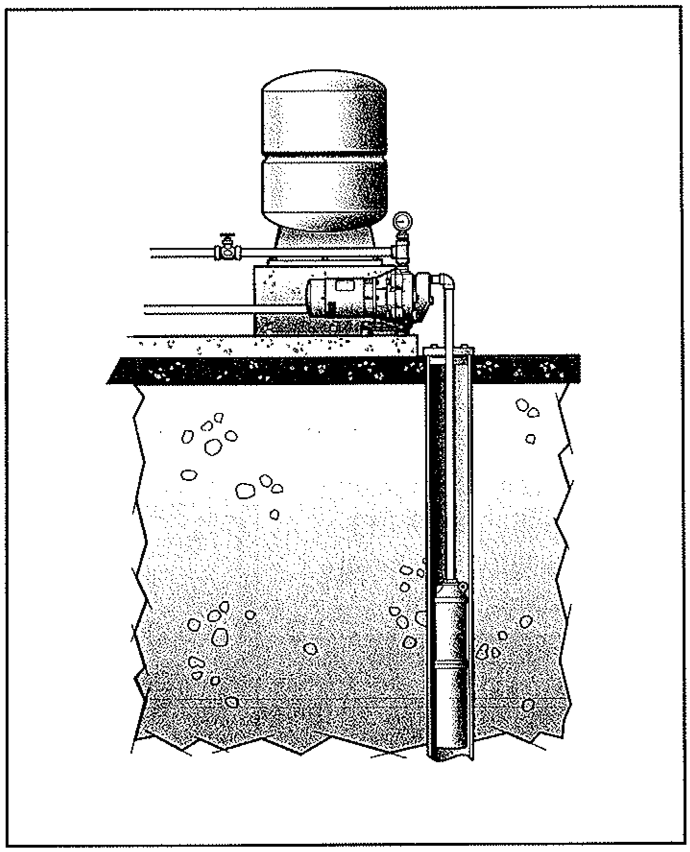
1. If the pump is located above the well, a jet assembly is used to convert some of the pump's volume to additional suction and discharge pressure (jet pump).
2. The pump can be designed with multiple stages and be submerged in the well (submersible pump).

SUBMERSIBLE PUMP



SP 2.4.03

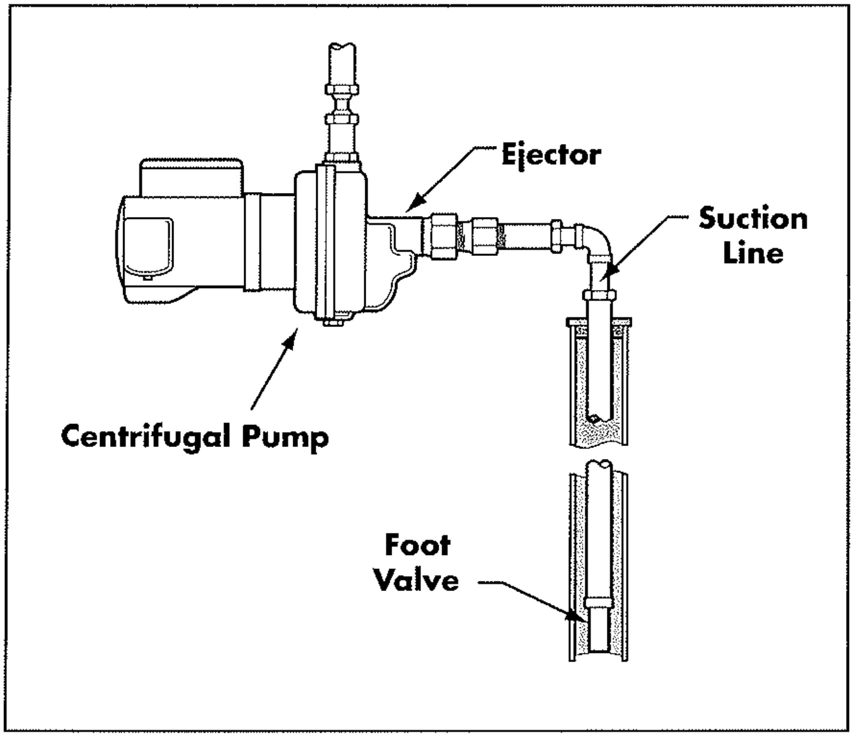
TYPICAL SHALLOW WELL JET



SP 2.4.04

Jet pumps operate by using an assembly, a **JET EJECTOR**, to increase the energy which a centrifugal pump can supply. When a centrifugal pump is combined with a jet ejector, both the pumping depth (lift) and the discharge pressure can be increased.

JET PUMP

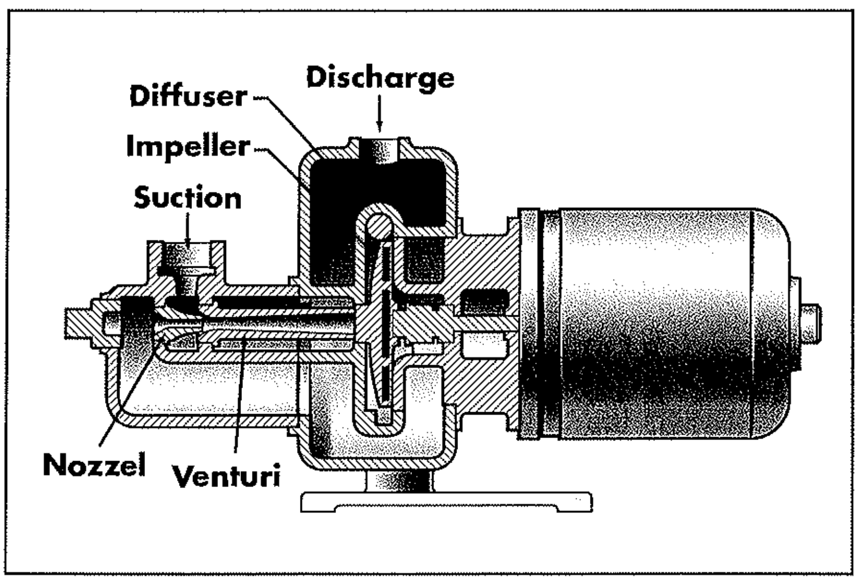


SP 2.4.05

Jet pumps alter the volume and pressure of the water inversely. They can force the speed of flow (volume) of water to increase and the pressure to decrease, or force the pressure to increase and the speed of flow to decrease.

You have already learned the basic parts of straight centrifugal pumps: the impeller, the diffuser or **VENTURI TUBE**, and the discharge pipe. A jet pump is a modified centrifugal pump. Now let's look at the three parts of a jet ejector: the outside body of the ejector, the **NOZZLE**, and the venturi tube (which could be a diffuser). None of these three parts is a moving part.

JET EJECTOR



SP 2.4.06

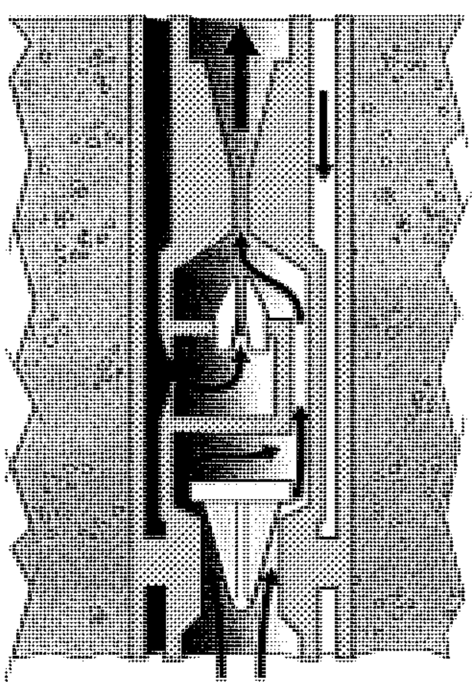
Some of the pressurized water from the impeller is sent back through the jet nozzle. This high velocity water creates an area of low pressure (vacuum) at the mouth of the diffuser, creating more suction to raise water from the well. The water is delivered to the center of the impeller along with this added pressure, thus giving jet pumps the added suction and pressure needed for residential water use.

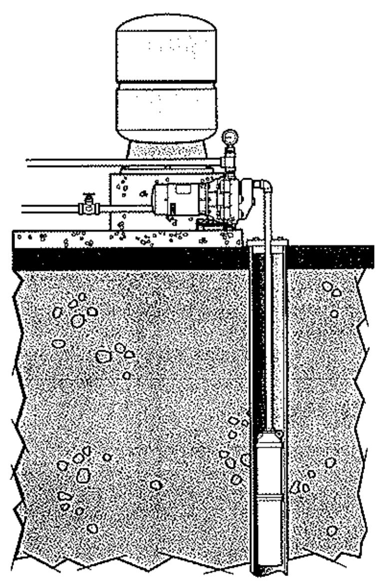
Shallow Well Jet Pumps

Let's look at the two kinds of pumps: **SHALLOW WELL JET PUMPS** and deep well jet pumps.

First, shallow well jet pumps are installed outside of and above the well and depend entirely upon atmospheric pressure to force water into the suction chamber of the pump.

JET PUMP OPERATION/TYPICAL SHALLOW WELL JET





SP 2.4.07

Shallow well jet pumps have a maximum pumping depth of 25 feet at sea level and are designed to operate on 1.25" or larger wells.

In a shallow well jet pump, the jet assembly is either fastened to the outside of the centrifugal pump or built into the pump casing along with the centrifugal pump. A **SUCTION PIPE** extends to below the water level in the well.

A shallow well jet pump is a centrifugal pump modified for higher suction and discharge pressure. This makes it a good choice for a pressure booster pump in residential applications. A pump, tank and pressure switch are put in the line and add the pump's pressure to the incoming pressure.

Deep Well Jet Pumps

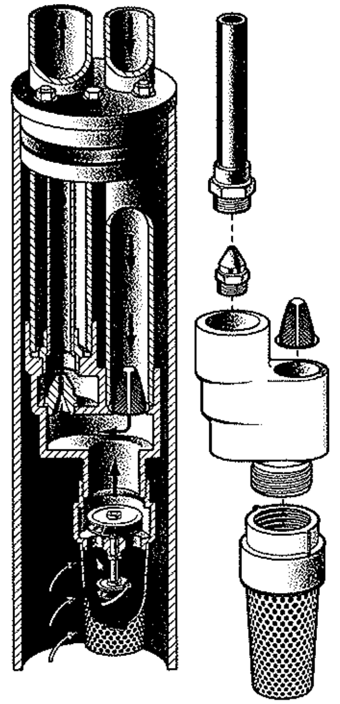
A **DEEP WELL JET PUMP** differs from the shallow well jet pump in that the jet assembly is placed below the water level in the well. This means the jet is pushing the water up the pipe and suction lift has been eliminated. Thus the 25-foot limitation of atmospheric pressure has also been eliminated.

A deep well jet is limited to a depth of about 200 feet. However, below 100 feet a submersible pump is usually suggested if the well casing is large enough for submersibles.

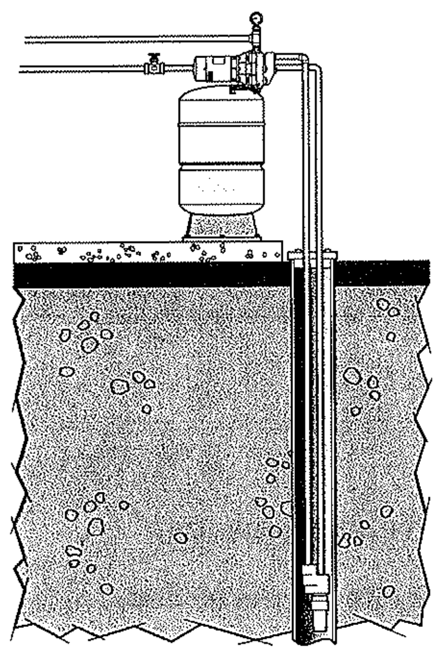
There are two types of deep well jet pumps: **TWIN PIPE** and **PACKER TYPE**.

A **TWIN PIPE DEEP WELL JET PUMP** has two pipes extending into the well. The **PRESSURE PIPE** carries the **DRIVE WATER** down to the jet assembly in the well. The suction pipe brings water up from the well. It delivers the upward pressure to the jet pump. Twin pipe deep well jet pumps require a well casing of 4" or larger.

TWIN PIPE ASSEMBLY/TWIN PIPE DEEP WELL JET



Typical Twin Pipe Assembly



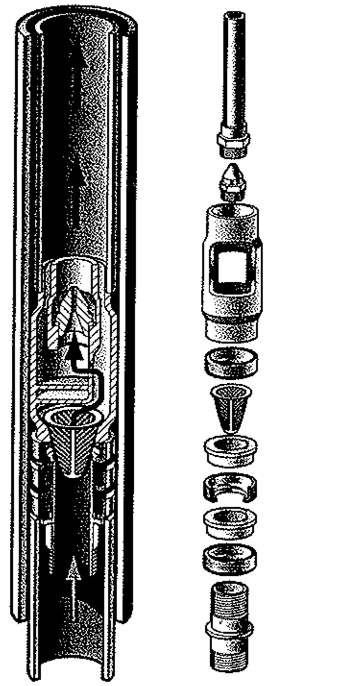
Typical Twin Pipe Deep Well Jet

SP 2.4.08

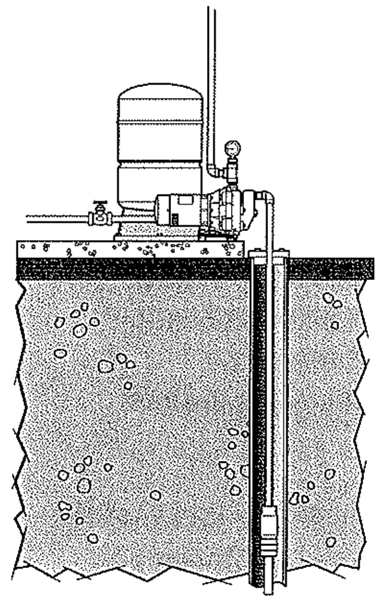
Deep well jet pumps have a pressure valve that is installed on the discharge pipe to adjust the amount of drive water returned to the jet. This is adjusted at the job site to maximize flow. This is often a separate item that you must remember to include in a deep well jet system.

A packer type deep well jet pump has only a single suction pipe extending down into the well. Pressure is created by water flowing down between the well casing and the suction pipe. A special well casing adapter is needed to connect the top pipes to the packer pipe. Packer systems are made to fit a 2″ to 3″ well casing. Make sure you supply the correct one.

PACKER TYPE DEEP WELL JET/PACKER ASSEMBLY



Typical Packer Assembly



Typical Packer-type Deep Well Jet

SP 2.4.09

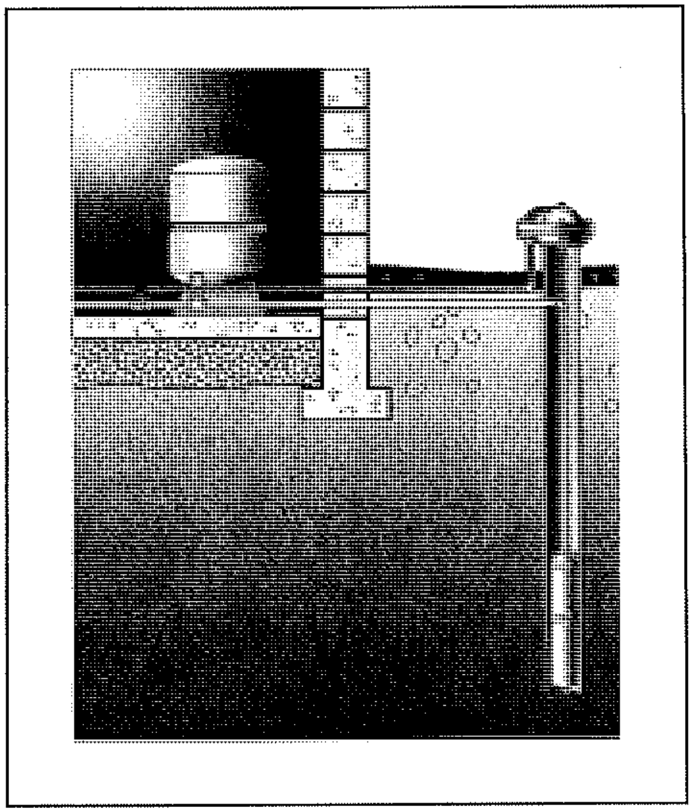
When a deep well jet is used in a low producing well, extending the foot valve 34 feet below the jet assembly will prevent the pump from running dry. The suction of the jet assembly will not draw water if it drops this low. This will not affect efficiency at normal **PUMPING LEVELS** but must be considered when figuring friction loss. A low water cutoff switch is another solution to a low producing well, but must be manually reset.

Submersible Pumps

Submersible pumps are the third kind of pump commonly sold for domestic water wells. **SUBMERSIBLE PUMPS** are designed in such a way that the entire unit—pump and motor—operates while submerged in the well.

The submersible pump is really a centrifugal pump with several stages. The impeller and diffuser of a submersible pump are positioned in a **BOWL**. The combination of impeller, diffuser, and bowl is called a stage.

TYPICAL SUBMERSIBLE PUMP INSTALLATION



SP 2.4.10

Each stage adds pressure. Submersible pumps use as many stages as necessary to satisfy the total head requirement. The capacity is determined by the impeller geometry.

The submersible pump works by passing water up through the series of stages.

Because the pump is submerged in the water, water flows naturally into the pump. Water passes through the impeller into the diffuser and then upward to the next impeller. Finally, the water passes into the discharge pipe, which is fitted with a check valve to make sure water does not run back into the well when the pump is not running.

At each stage the capacity stays the same and pressure is added. Therefore, in your catalog, pumps are grouped by capacity (gpm) and you choose the horsepower and number of stages to fit the job.

In essence, a submersible pump is several pumps in a series on a single motor shaft, each adding its energy to the previous ones.

Because it is submerged, a submersible pump is made from long-lasting corrosion-resistant products such as plastics and stainless steel.

A submersible pump can pump water from much greater depths than jet pumps. Submersible pumps are very efficient, high capacity pumps that can be used in wells 1100 or more feet deep.

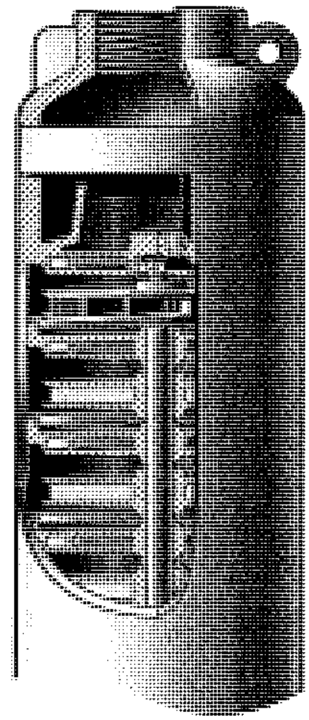
For instance, a 7 gpm pump with a 1/2 horsepower motor and 7 stages will pump 7 gpm at 140' **TOTAL DYNAMIC HEAD (TDH)**. A 7 gpm pump with a 3 horsepower motor and 34 stages will pump 7 gpm at 880' TDH.

The advantages of submersible pumps include:

- greater pumping depths
- higher capacities and pressures
- greater efficiency

Submersible pump motors today are water lubricated. In the past some were oil lubricated, but those are no longer manufactured in the United States.

STAGES WITHIN A SUBMERSIBLE PUMP



SP 2.4.11

Selecting a Pump

Some of the factors involved in selecting which type of pump to use include:

- the replacement situation (what kind of pump is being replaced?)
- maximum pumping depth
- well diameter
- well casing diameter

The diameter of the well casing may limit the size of the pump you can choose, and this may also limit the amount of water that can be produced. A small diameter casing will allow only small equipment to be installed. Limits on the physical size of the pump may also limit water output.

The Pump Selection Guide chart below will help you determine which types of pumps will work in which applications. This is only a guide. Judgment, experience, and customer preference will also play a part in final pump type selection. Other factors could be cost, future water usage projections, and cost and ease of service.

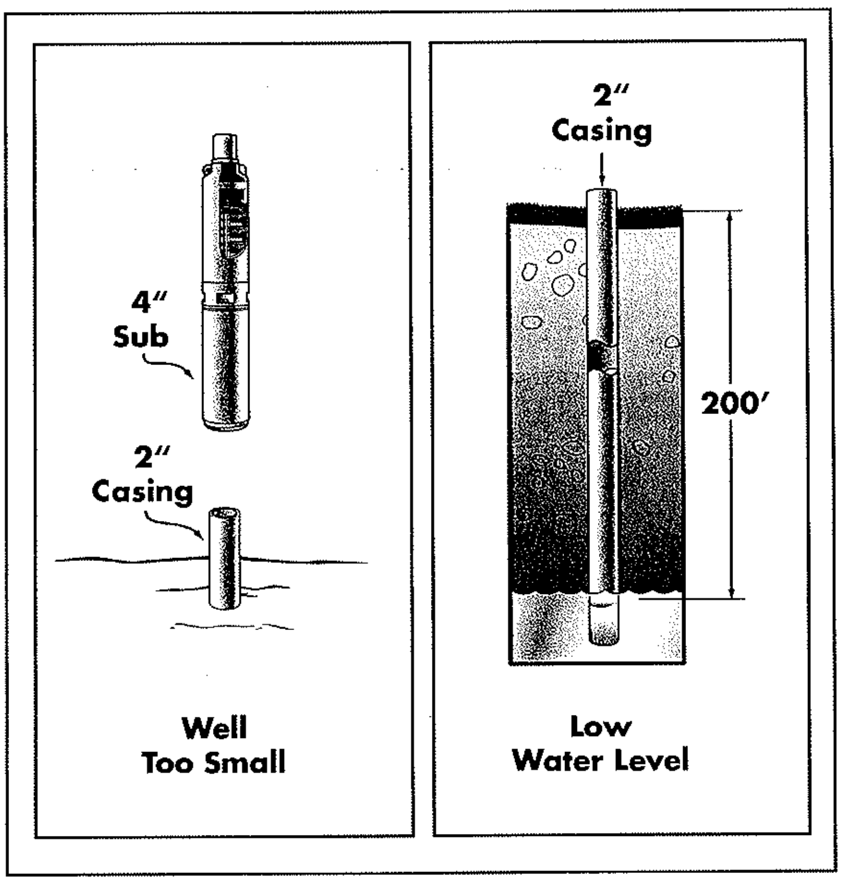
Type of Pump	Maximum Pumping Depth	Minimum Well Diameter
Shallow Well Jet	25 feet	1-1/4 inch Well Point
Deep Well Jet • Twin Pipe • Packer	 200 feet 230 feet	 4 inches 2 inches
Submersible	110 feet +	4 inches

SP 2.4.11

Well Casings

The well casings of most domestic wells range from 2"to 6" in diameter. In Michigan, and along the Gulf of Mexico and the Atlantic Ocean, it is not uncommon to find 2" or 3" wells. Most of the domestic wells in the United States are 4" to 6" in diameter.

PHYSICAL RESTRICTIONS



SP 2.4.12

To complete your knowledge of pump fundamentals, you also need to know about the condition of the well, the available electrical service, and the length and inside diameter of pipe and fittings. See the chart below.

Water Well Conditions	
What you need to know:	And Why:
Inside Diameter of Well Casing	• Determines the type and size pump that can be installed • A factor in determining well storage capacity
Well Depth	• Determines how deep you can place the pump or jet assembly • Helps determine vertical lift • A factor in determining well storage
Static Water Level (How high does the water rise in the well when system is not in use?)	• A factor in determining well storage capacity
Well Yield (Available from the well driller's log or by test pumping the well)	• Helps determine total well capacity • Helps determine discharge capacity under peak demand conditions
Pipe and Fittings	
What you need to know:	And Why:
Length and inside diameter of all pipe used in the system	• To calculate friction loss
Size and number of all fittings used in the system	• To calculate friction loss
Electric Services Available	
What you need to know:	And Why:
Available voltage, phase, frequency, etc.	• Pumps are powered by electric motors so you will have to determine the electric service available. • Pump motor and control must be the same voltage, phase, and frequency.

SP 2.4.2t

Some of the advantages of jet pumps and of submersibles are shown below.

Jets	Submersibles
Less expensive to repair Will fit into small well casings Limits to 200 feet (Not very efficient below 100 feet)	More efficient Used at greater depths Require 4" well casing

SP 2.4.3t

REVIEW QUIZ – DOMESTIC WATER WELL PUMPS

Answers appear on page 70

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Which of the following is an older type of water well pump?
   a. Jet pump
   b. Submersible pump
   c. Hand operated pump
   d. Electric pump

2. Modern water well pumps are powered by
   a. hand.
   b. solar energy.
   c. windmill.
   d. electric motor.

3. A pump with a jet assembly above ground is called a
   a. jet pump.
   b. submersible pump.
   c. hand operated pump.
   d. vacuum.

4. When a jet ejector is added to a centrifugal pump, both the lift and discharge pressure
   a. increase.
   b. decrease.
   c. remain the same.
   d. drop.

5. The three parts of a jet ejector are the outside body, the nozzle, and the
   a. valve.
   b. diffuser, or venturi tube.
   c. suction line.
   d. motor.

6. What is the maximum pumping depth of a shallow well jet pump at sea level?
   a. 10 feet
   b. 15 feet
   c. 20 feet
   d. 25 feet

REVIEW QUIZ – DOMESTIC WATER WELL PUMPS

Answers appear on page 70

7. In a shallow well jet pump, the jet assembly is either fastened to the outside of the centrifugal pump or
   a. built into the suction pipe.
   b. built into the pump casing.
   c. built into the diffuser.
   d. built into the motor.

8. What is the maximum effective pumping depth for a deep well jet pump?
   a. 25 feet
   b. 50 feet
   c. 100 feet
   d. 200 feet

9. What type of deep well jet pump has two pipes extending into the well?
   a. Packer type
   b. Shallow well
   c. Twin pipe
   d. Pressure pipe

10. What type of deep well jet pump has a single pipe extending into the well?
    a. Packer type
    b. Shallow well
    c. Twin pipe
    d. Pressure pipe

11. Where is a submersible pump placed?
    a. Next to the well at ground level
    b. Submerged in the well water
    c. Above the ground
    d. In shallow wells only

12. "Several pumps in a series on a single motor shaft" describes
    a. a jet pump.
    b. a submersible pump.
    c. both jet pumps and submersible pumps.
    d. neither jet pumps nor submersible pumps.

REVIEW QUIZ – DOMESTIC WATER WELL PUMPS

Answers appear on page 70

13. Which type of pump can be used at the deepest depths?
    a. Submersible pump
    b. Jet pump
    c. Both jet pumps and submersible pumps
    d. Neither jet pumps nor submersible pumps

14. In what areas will you generally find 2″ wells?
    a. Along the Pacific Ocean
    b. Along the Gulf of Mexico and the Atlantic Ocean
    c. Along the U.S. border with Mexico
    d. In Nevada

15. What is the diameter of most of the domestic wells in the United States?
    a. 1″
    b. 2″ to 3″
    c. 4″ to 6″
    d. 8 to 10″

16. If you know the length and inside diameter for all pipe used in the system, it will help you calculate
    a. friction loss.
    b. atmospheric pressure.
    c. suction.
    d. capacity.

17. What is one advantage of a jet pump?
    a. It is more efficient than a submersible pump.
    b. It can be used at greater depths than a submersible pump.
    c. It requires a 4″ well casing.
    d. It is less expensive to repair than a submersible pump.

18. What is one advantage of a submersible pump?
    a. It will fit into small well casings.
    b. It can be used at greater depths than a jet pump.
    c. It is used above ground only.
    d. It is less expensive to repair than a jet pump.

REVIEW QUIZ – DOMESTIC WATER WELL PUMPS

Answers appear on page 70

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. What types of jet pumps does your company sell?

____

____

____

B. What do you need to know about the electric service available for pumps and why?

____

____

____

ANSWERS TO REVIEW QUIZ

CHAPTER 4

DOMESTIC WATER WELL PUMPS

Answers to REVIEW OF DOMESTIC WATER WELL PUMPS (pages 64 – 67)

1. c. Hand operated pump
2. d. electric motor
3. a. jet pump.
4. a. increase.
5. b. diffuser, or venture tube.
6. d. 25 feet
7. b. built into the pump casing.
8. c. 100 feet
9. c. twin pipe
10. a. Packer type
11. b. Submerged in the well water
12. b. a submersible pump.
13. a. Submersible pump
14. b. Along the Gulf of Mexico and the Atlantic Ocean
15. c. 4″ to 6″
16. a. friction loss.
17. d. It is less expensive to repair than a submersible pump.
18. b. It can be used at greater depths than a jet pump.

Applying what you have learned:

A. Depends on the company

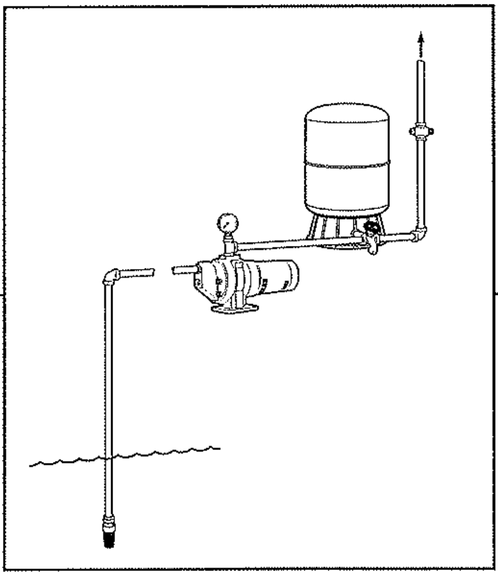
B. Pumps are powered by electric motors so you need to determine the electric service available. You will need to know the available voltage, phase, frequency, etc. because the pump motor and controls must be the same voltage, phase, frequency, etc.

5 SIZING PUMPS

LEARNING OBJECTIVES

When you finish this Chapter, you will be able to:

1. Describe the basic steps involved in sizing and selecting shallow well jet pumps, deep well jet pumps, and submersible pumps.
2. Explain the key determiners for each type of pump: total suction lift, depth to jet assembly, and total dynamic head.



SELECTING PUMPS

Choosing the Proper Pump

Selecting the proper pump for a particular well and water system begins with properly evaluating the need, then selecting an appropriate pump. The next step is a significant one—it is called "sizing the pump."

In Chapter 4, we actually began to learn how to size a pump when we discussed how to calculate capacity. This chapter contains background information, plus performance rating charts, selection charts and pump curves used in sizing and selecting pumps.

The charts and tables showing information about the lift capabilities are different for each of the three kinds of pumps. You will have to learn to read each kind of chart found in your manufacturers' catalogs.

Sizing Shallow Well Jet Pumps

The first decision to be made is about pump selection. Will the situation call for a pump suitable for shallow or deep wells? Or will it merit a submersible pump? Therefore, the first consideration must be how far the pump must lift the water, or the maximum pumping depth.

A shallow well jet pump can be used if the pumping level of the water is 25 feet or less. To determine this, calculate the total suction lift by using this formula:

TOTAL SUCTION LIFT = VERTICAL LIFT + FRICTION LOSS

Total suction lift is the distance in feet that water must be raised from beneath the ground by suction. For the purpose of this formula, vertical lift is the distance from the pumping level of the well to the pump level, expressed in feet.

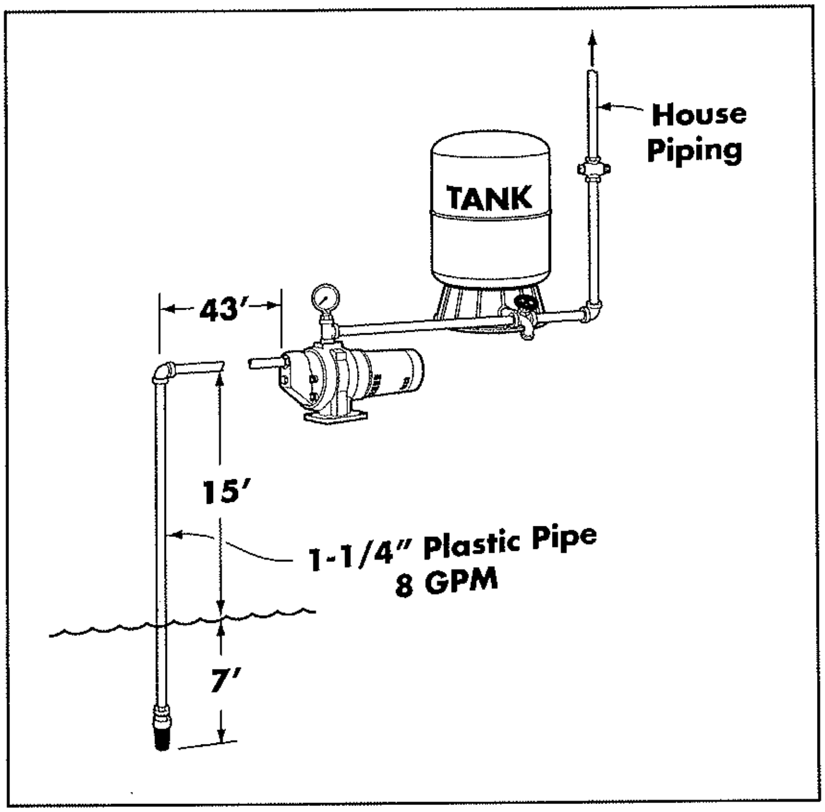
PROBLEM:

Using the illustration and given friction loss below, calculate the total suction lift. Is a Shallow Well Jet Pump the best choice? The answer appears on the following page.

ANSWER:

Yes. The vertical lift (15 feet) + friction loss (.77 feet) = 15.77 feet If the pumping level of the water is 25 feet or less a shallow well pump can be used.

TOTAL SUCTION LIFT



SP 2.5.01

Precalculated Friction Loss

Obviously, friction loss is an important variable in identifying and sizing the type of pump to be used. Precalculated friction loss tables provide friction loss rates that occur in various types of pipes at various flow rates. Look at the friction loss table on the following pages.

STEEL PIPE: FRICTION LOSS PER 100 FEET

gpm	gph	3/8″		1/2″		3/8″		1″		1-1/4″		1-1/2″		2″	
		ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.	ft.	lbs.
1	60	4.30	1.85	1.86	.80	.26	.11								
2	120	15.00	6.45	4.78	2.06	1.21	.52	.38	.16						
3	180	31.80	13.67	10.00	4.30	2.50	1.08	.77	.33						
4	240	54.90	23.61	17.10	7.35	4.21	1.81	1.30	.56	.34	.15				
5	300	83.50	35.91	25.80	11.09	6.32	2.72	1.93	.83	.51	.22	.24	.10		
6	360			36.50	15.70	8.87	3.81	2.68	1.15	.70	.30	.33	.14	.10	.04
7	420			48.70	10.94	11.80	5.07	3.56	1.53	.93	.40	.44	.19	.13	.06
8	480			62.70	26.96	15.00	6.45	4.54	1.95	1.18	.51	.56	.24	.17	.07
9	540					18.80	8.08	5.65	2.43	1.46	.63	.69	.30	.21	.09
10	600					23.00	9.89	6.86	2.95	1.77	.76	.83	.36	.25	.11
12	720					32.60	14.02	9.62	4.14	2.48	1.07	1.16	.50	.34	.15
15	900					49.70	21.37	14.70	6.32	3.74	1.61	1.75	.75	.52	.22
20	1,200					86.10	37.02	25.10	10.79	6.34	2.73	2.94	1.26	.87	.37
25	1,500							38.60	16.60	9.65	4.15	4.48	1.93	1.30	.56
30	1,800							54.60	23.48	13.60	5.85	6.26	2.69	1.82	.78
35	2,100							73.40	31.56	18.20	7.83	8.37	3.60	2.42	1.04
40	2,400							95.00	40.85	23.50	10.11	10.79	4.64	3.10	1.33
45	2,700									30.70	13.20	13.45	5.78	3.85	1.66
70	4.200									68.80	29.58	31.30	13.46	8.86	3.81
100	6.000											62.20	17.40	7.48	

SP 2.5.11

Friction loss tables always reflect 100-foot lengths. Because you may not need pipe in exactly 100-foot lengths, you need to know how to determine friction for odd lengths of pipe. Since figures are given in 100-foot lengths, a single foot is .01 of the 100-foot length:

- 12 feet are .12 of the 100-foot length.
- 106 feet would be 1.06 of the 100-foot length.
- 210 feet would be 2.10 of the 100-foot length.

To figure more or less than 100-foot lengths of pipe:

- First, write the number of feet as a whole number with a decimal point at the right end of the number (Example: 235.).
- Next, divide the number by 100 by moving the decimal two places to the left (Example: 2.35).
- Finally, multiply this decimal by the figure in the correct column of the friction loss chart. (Example: Friction loss for 235 feet of 1″ steel pipe at 25 gpm would be 2.35 x 38.60 = 90.71 of friction loss.)

REMEMBER: Friction loss is affected by the diameter of the pipe, the length of the pipe, and the flow rate of the water.

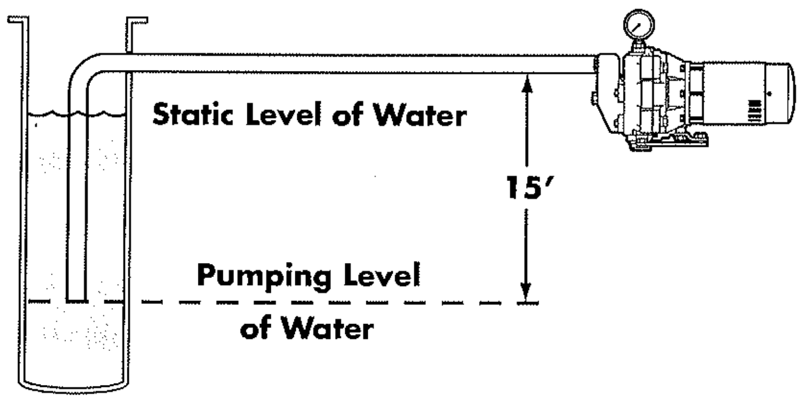
- Friction loss *increases* as pipe length increases.
- Friction loss *increases* as flow rate increases.
- Friction loss *decreases* as pipe diameter increases.

Using the Total Suction Lift Formula

We have just reviewed the components of the formula for determining total suction lift. Now look at the illustration below. Assume that you need to know the vertical lift, friction loss, and how much suction life is needed. Use the Friction Table from page 75 to find your answers. Check your answers on page 78.

1″ STEEL PIPE
TOTAL LENGTH = 65 FEET **PUMPING CAPACITY = 540 GPH**

STATIC LEVEL OF WATER/PUMPING LEVEL OF WATER



SP 2.5.02

PROBLEMS:

1. (a) What is the vertical lift?

   ______

   (b) What is the friction loss?

   ______

   (c) How much suction is needed?

   ______

2. If the suction lift figured in Question 1 were a real-life case, could you consider using a shallow well jet? Why or why not?

   ______

3. If the vertical life is 22 feet and the suction pipe is 35 feet of 3/4″ steel pipe with a flow of 600 GPH, could you consider using a shallow well pipe? Why or why not?

   ______

4. Using the information in Question 3, could you consider a shallow well jet if you used 1″ steel pipe? Why or why not?

   ______

ANSWERS:

1. (a) The vertical lift is 15 feet.
   (b) The friction loss is approximately 3.7 feet (.65 x 5.65 + 3.6725).
   (c) 18.7 feet of suction lift is needed: 15 + 3.7 = 18.7.

2. If the suction lift figured above was a real-life case, you could consider using a shal low well jet because the suction lift is less than 25 feet.

3. If the vertical lift is 22 feet and suction pipe is 35 feet of 3/4" steel pipe with a flow of 600 gph, you could not consider using a shallow well jet pump, because suction lift would be over 25 feet (it would be 30 feet).

4. In the above example, you could consider a shallow well jet if you used 1" pipe instead of 3/4". With 1" pipe, the suction lift would be less than 25 feet (24.4 feet).

Shallow Well Performance Ratings

Now let's look at the manufacturer's shallow well performance ratings chart below.

SHALLOW WELL PERFORMANCE RATINGS

HP/ Model	1/2 KP – J5					1/2 KP – J5H						3/4 HP – J7					
Shallow Well Package	FH5					FH5H						FH7					
Adapter												4K62					
Nozzle	ANO17					ANO19						ANO18					
Diffuser	AD3731					AD3528						AD3536					
	Discharge Pressure – PSI					Discharge Pressure – PSI						Discharge Pressure – PSI					
Total Suction Lift (feet)	20	30	40	50	Max. Shut Off (PSI)	20	30	40	50	60	Max. Shut Off (PSI)	30	40	50	60	Max. Shut Off (PSI)	30
	Gallons per Minute					Gallons per Minute						Gallons per Minute					
5′	17.5	16.5	10.2	5.0	63	11.5	11.3	11.0	7.7	4.8	83	21.3	18.3	12.5	6.6	70	24.8
10′	15.7	14.4	9.2	4.3	61	10.3	10.0	9.6	7.0	4.2	81	18.8	17.3	11.3	5.0	68	22.9
15′	13.7	12.5	8.0	3.6	59	8.8	8.6	8.3	6.3	3.7	79	16.4	15.5	9.6	3.7	66	19.0
20′	11.5	10.4	7.1	2.3	57	7.0	7.0	6.8	5.8	3.2	76	13.6	13.2	8.3	2.0	63	16.6
25′	8.7	8.6	6.2	1.3	54	5.3	5.2	5.2	5.0	2.8	73	10.0	9.9	6.4	1.0	59	12.5

SP 2.5.2g

As total suction lift (expressed in feet) *increases*, pump capacity, in the form of discharge volume (gpm or gph), *decreases. When pressure goes up, capacity goes down.* Suction lift and pump capacity are inversely related.

To use the portion of the selection chart above, first determine total suction lift. Let's assume it is 14.7 feet. Round up the total suction lift to the next highest number on the chart. Now, read across the chart to determine whether the pump meets capacity and cut-in pressure requirements.

In this case let's assume we need a capacity of 8 gpm and a discharge pressure of 40 psi. When we find a pump that will meet these requirements, we continue across the chart to the column headed "Max. Shut off (psi)." We make sure that the maximum shutoff exceeds the pump cut-out, which is preset at 50 psi on most shallow well jets.

Since it does exceed 50 psi, we return to our original selection and read up the chart for model number and jet assembly information. We have selected a 1/2 hp Model J5, with a FH5 Shallow Well Package.

REMEMBER: Pump cutoff pressure must always be less than maximum shutoff pressure.

Some performance ratings charts use gallons per hour instead of gallons per minute.

PERFORMANCE RATING CHART

Total Suction Lift (feet)	Discharge Pressure – PSI						Max. Shut Off (PSI)
	30	40	50	60	70	80	
	Gallons Per Hour						
5′	1690	1680	1630	1550	1270	970	105
10′	1490	1480	1450	1400	1120	820	103
15′	1280	1280	1250	1240	1120	820	101
20′	1080	1060	1050	1020	970	650	98
25′	740	720	715	700	630	–	95

SP 2.5.3g

Note again that the chart illustrates that suction lift and pump capacity are inversely related.
At 30 psi discharge pressure, the pump capacity is 1690 gph with suction lift of 5 feet.

Sizing Deep Well Jet Pumps

If a shallow well pump is not merited, a deep well jet pump may be required. The jet ejector of a deep well jet pump is usually placed about five feet below the pumping level of the water. Therefore, in sizing a deep well jet, the important lift factor is how far down into the well the jet assembly needs to be placed.

If the pumping depth is about 75 feet, you would want a deep well jet pump with the jet assembly 80 feet below the ground.

Deep well jets have greater lifting power than shallow well jets and may be used up to depths of 200 feet. However, as mentioned before, it is generally not very efficient to use deep well jets below a pumping depth of 100 feet. Below 100 feet, a submersible pump is more efficient and is preferable if the well casing is large enough.

As you recall, there are two types of deep well jet pumps: twin pipe and packer type.

Once you have determined that a twin pipe or packer type deep well jet is appropriate for the application, you still have to select the proper size and model.

Remember that twin pipe jet pumps require a minimum 4" well diameter, while packer type jet pumps are designed for 2" and 3" diameter wells.

To size a twin pipe deep well jet, let's use the portion of a manufacturer's performance

TWIN PIPE PERFORMANCE RATINGS*

HP Model		1/2 HP – J5				3/4 HP – J7				1 HP –			
Well Casing min. I.D.		4			4-1/2	4			4-1/2	4			
Pressure Pipe		1			1-1/4	1			1-1/4	1			
Suction Size (in.)		1-1/4			1-1/2	1-1/4			1-1/2	1-1/4			
Jet assembly Package		FT4-13	FT4-31	FT4-08	FT5-14	FT4-14	FT4-34	FT4-18	FT5-47	FT5-48	FT4-44	FT4-43	
Jet Body (only)		AT4			AT5	AT4			AT5	AT4			AT5
Nozzle		ANO17	ANO16	ANO15	ANO18	ANO17	ANO16	ANO16	ANO18	ANO17	ANO17	ANO17	
Diffuser (Venturi)		AD726	AD723	AD720	AD724	AD729	AD725	AD722	AD730	AD725	AD730	AD727	
Control Valve Setting (PSI)		20	20	20	20	28	29	30	28	30	31	33	35
Depth to Jet Assembly (based on submergence of 5 feet)	Feet	Gallons Per Minute (gpm) 30–50 PSI Pressure Switch Setting											
	30	13.7	11.5			15.8			16.6		17.0		
	40	12.4	9.5			15.7			16.0		16.6		
	50		8.0		7.3	13.2			15.0		14.4		
	60		7.4	5.5	6.7	10.2			13.0		11.5	11.2	
	70			4.9	5.9		8.2		11.0			9.2	
	80			4.0	5.0		6.5		8.6		7.3		
	90			3.3	4.3		5.0	5.0		7.3			6.5
	100							4.4		6.0			5.0
	110							3.5		5.0			4.0
	120												
	130												
	140												
	150												
	160												
	170												

SP 2.6.1g

chart below.

Friction loss is already included in the figures on the chart. Locate the appropriate Depth to Jet Assembly (how far down the jet assembly will be placed in the well) on the left-hand side of the chart.

Let's assume it is 58 feet. Round up to the next highest number on the chart, or 60 feet. Next, let's assume our capacity requirement is 10 gpm at a 30/50 psi pressure switch setting. Now, read across the chart until we find enough capacity—in this case, 10.2 gpm.

Then read up the chart for jet assembly and model number information. We have selected a 3/4 hp Model J7 with an FT-14 jet assembly package. Note that the chart gives the model, the jet assembly package, the jet body, nozzle and diffuser, as well as the psi setting.

Sizing Submersible Jet Pumps

There are normally two ways to size a submersible pump using a manufacturer's catalog. The first is by using tables that let you quickly select a pump from "depth to water" and "tank pressure." See the example on page 83. This is a quick method to size a submersible pump, but it is not as thorough or as accurate as sizing a pump using a pump curve. With experience, you will find that using a pump curve will be preferable.

To properly size a submersible pump, using either method, we need to know:

- **Capacity in gpm:** Submersible pumps are usually named by their capacity (for example, 7GS is a 7 gpm pump) so you can go directly to the correct curve or table.
- **Total dynamic head (TDH)**: Even when using tables, this should be calculated to determine accurate service pressure.
- **Type or style of pump:** There are many styles of pumps and specialty pumps that may do the job better.
- **The power source:** It is essential to know the voltage and the phase of the motor you specify, and you can calculate the wire size needed from the tables in your catalog.

Let's use the partial chart below to select a submersible pump for an application when the depth to water is 178 feet, the capacity requirement is 10 gpm, and service pressure

SELECTION CHART*

Horsepower Range 1/2 – 1, Recommended Range 1.5 – 10 gpm, 60 Hz, 3500 rpm																		
Pump Model	HP	PSI	Depth to Water in Feet / Ratings in gpm (gallons per minute)															
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
7GS05	1/2	0							9.8	9.2	8.5	7.8	7.0	5.9	4.5	2.8		
		20					9.7	9.0	8.3	7.5	6.6	5.7	4.1	2.0				
		30				9.5	8.9	8.2	7.3	6.4	5.4	4.0	1.5					
		40		10.0	9.4	8.8	8.1	7.3	6.1	5.1	3.9	1.5						
		50	10.0	9.3	8.6	8.0	7.1	6.0	4.8	3.3								
		60	9.2	8.5	7.8	7.0	5.9	4.5	2.8									
Shut-off PSI			121	113	104	95	87	78	69	61	52	43	35	26	17	9		
7GS07	3/4	0										9.8	9.4	8.8	8.4	7.9	7.4	5.8
		20								9.7	9.3	8.8	8.3	7.8	7.3	6.5	5.7	3.0
		30							9.6	9.3	8.7	8.2	7.7	7.0	6.3	5.5	4.5	
		40					10.1	9.5	9.1	8.7	8.2	7.7	6.9	6.2	5.4	4.5	2.7	
		50				10.0	9.4	9.0	8.5	8.0	7.6	6.8	6.0	5.2	4.0	2.5		
		60			9.8	9.4	8.8	8.4	7.9	7.4	6.7	5.8	5.0	3.8	1.5			
Shut-off PSI					148	140	131	114	123	105	97	88	79	71	62	53	45	25
7GS10	1	0													9.7	9.4	9.1	8.4
		20											9.7	9.3	8.9	8.5	8.1	7.3
		30									10.0	9.6	9.2	8.8	8.4	8.1	7.7	6.7
		40								9.9	9.5	9.2	8.7	8.4	8.0	7.7	7.2	6.1
		50							9.8	9.4	9.1	8.7	8.3	7.8	7.5	7.1	6.2	5.4
		60						9.7	9.4	9.1	8.6	8.2	7.8	7.4	7.0	6.5	5.8	4.4
Shut-off PSI								177	168	159	151	142	133	125	116	107	99	81

SP 2.6.2g

needed is 30 psi.

Remember to always select the smallest pump that will get the job done. This saves *power and operating costs.*

First we round up our depth to water to 180 feet and locate this Depth to Water column on the chart. Now move up and down this column until you find the capacity and pressure closest to our requirements—10 gpm at 30 psi.

Then move over to the left-hand side of the chart and see that Model 7GS10 would be selected.

Now use the same Selection Chart to select a pump for an application when the depth to water is 175 feet, the capacity requirement is 8 gpm, and service pressure needed is 30 psi.

Again round up the depth to water to 180 feet and locate this in the column on the chart. Then find the capacity and pressure closest to our requirements—8 gpm at 30 psi.

Note that either Model 7GS10 or Model 7GS07 would be good selections.

- Model 7GS10 is not be as efficient as a Model 7GS07. The Model 7GS07 would do the job with only 3/4 horsepower while the 7GS10 requires 1 horsepower.
- Model 7GS10 has 17 stages; 7GS07 has 10 stages.
- At 50 psi 7GS07 delivers 4.8 gpm while 7GS10 delivers 9.1 gpm.

Unless higher pressure is required, the 7GS07 might be the better choice. However, the decision about which pump to choose depends upon the customer and details about volume and pressure requirements.

Needed Information

To size a pump, you should know the pumping level of the well. This should be in the owner's well log.

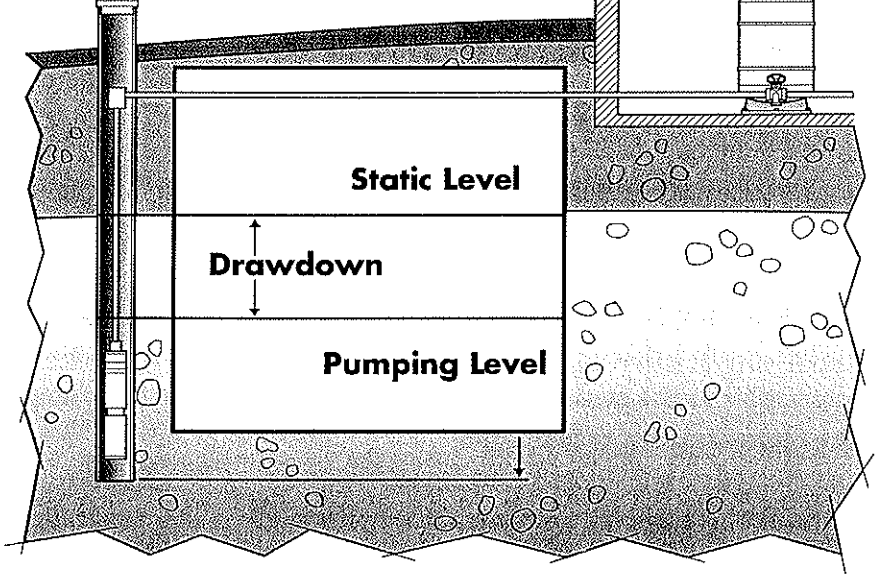
The pumping level is the lowest level that the water will reach with the pump operating. It is the point where the water entering the well equals the volume of the pump.

The highest level of the water when the pump is not operating is called the **STATIC LEVEL**, or the standing level. The difference between the static level and the pumping level is called **DRAWDOWN**.

As water is pumped from a well, surrounding water flows into the well. If the water is pumped out faster than water flows in, the water level in the well drops. The farther a well is drawn down, the faster the surrounding water flows in, until equilibrium is reached.

The lift component for **TOTAL HEAD (TH)** should be calculated from the pumping level. Errors in calculation can occur if you use the static water level or depth of the well. If you do not have information on the pumping level, then the depth of the pump is the next most reliable number to use. The others could be hundreds of feet off.

WELL PUMPING LEVEL DIAGRAM



SP 2.5.03

To size any pump accurately requires the calculation of total head, also known as **TOTAL DYNAMIC HEAD (TDH), TOTAL SYSTEM HEAD** or **TOTAL PUMPING HEAD**. This is the total amount of pressure the pump will have to build to deliver the flow and pressure desired. TDH is expressed in feet.

Total dynamic head (TDH) includes:

- Pressure need to lift the water from the pumping level to the top of the well, *plus*
- Pressure needed to move the water from the top of the well into the pressurized

storage tank, *plus*

- Service pressure, *plus*
- Friction loss throughout the whole system.

To calculate TDH you must know three things:

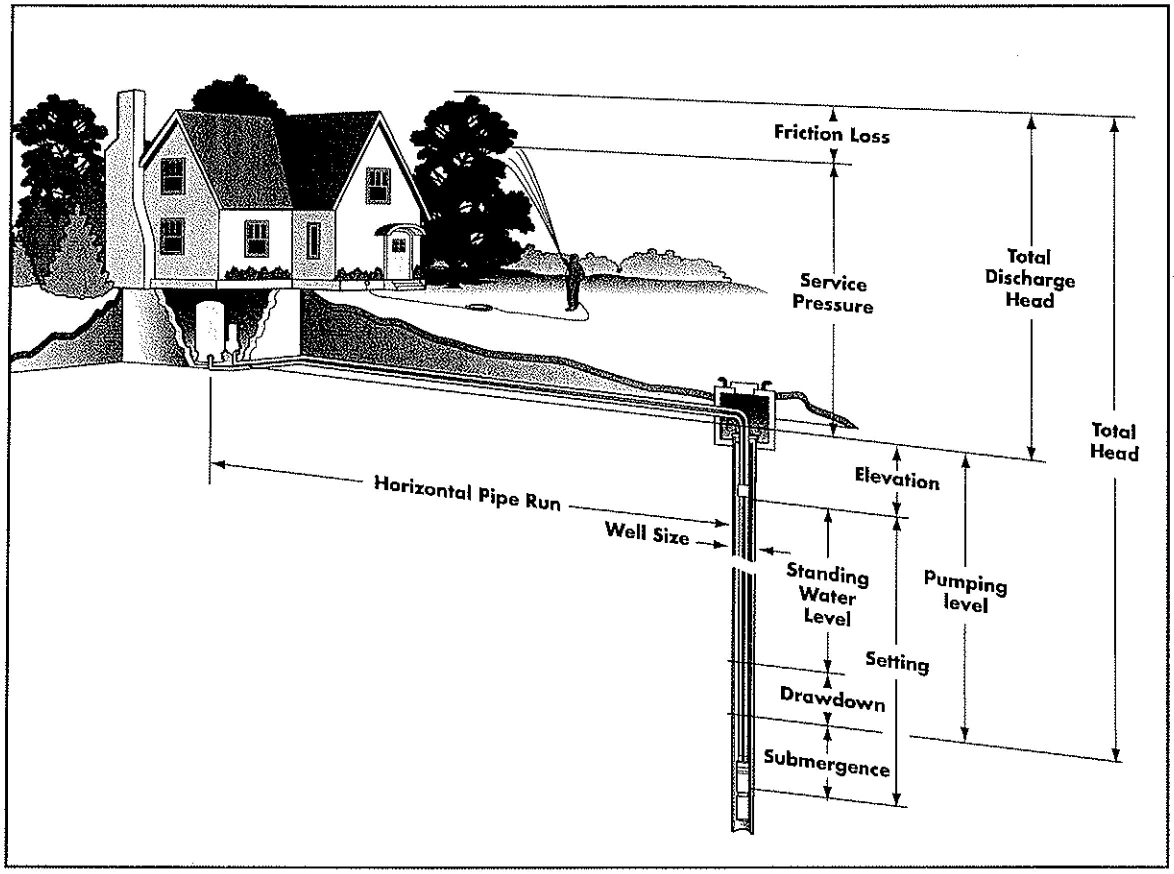
1. The vertical lift from the pumping level to the highest point of discharge expressed in feet;
2. The friction loss for the longest piping run in the system expressed in feet; and
3. The system pressure required expressed in feet.

We know that pressure and lift refer to the same forces, except lift is expressed in feet and pressure is measured in psi. To convert psi to feet, multiply by 2.31.

REMEMBER: When the pump is submerged in the water source, there is no suction side in the system, only a discharge side. Vertical lift and vertical elevation for submersible pumps refer to the same thing—the total distance from the pumping level in the well to the highest outlet in the home.

Using the illustration on page 87, notice what is included in TDH. It is called total dynamic head because the pumping conditions are always changing. The level in the well may drop as it is being pumped. The pressure increases as the pressure tank fills while the volume and friction loss decrease. When the pump shuts off, the pressure starts decreasing as the volume and friction again increase. You should size a pump

HOUSE DETAILING ELEVATION



SP 2.5.04

using the cut-in pressure (usually 70') but should be aware of performance along the entire dynamic curve.

ELEVATION is the vertical distance from the top of the well to the pump. If the pump is installed immediately above the well, or in the well, there is no elevation.

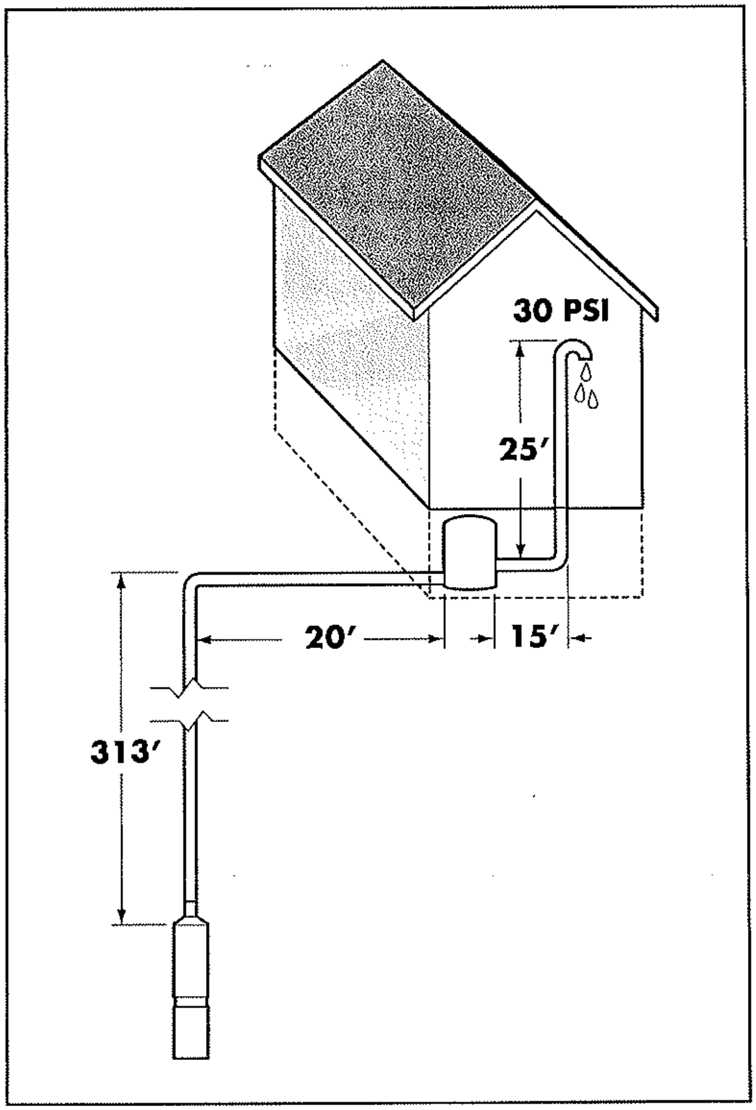
EXAMPLE:

Assume we are sizing a submersible pump:

- All pipe is 1" steel pipe
- Pump capacity needed is 7 gpm
- Friction loss is 3.56 feet per 100 feet pipe
- Pumping level is 313 feet
- Horizontal pipe run (well to tank) is 20 feet

- Shower stall is 25 feet above tank in the basement and is connected by 15 feet of horizontal pipe
- Desired service pressure is 30 psi

TOTAL HEAD DIAGRAM



SP 2.5.05

Now, let's determine the total dynamic head required. To lift water from pumping level, calculate:

- Friction loss on 313 feet
- Friction loss on 20 feet of horizontal pipe
- Friction loss on 15 feet of horizontal pipe

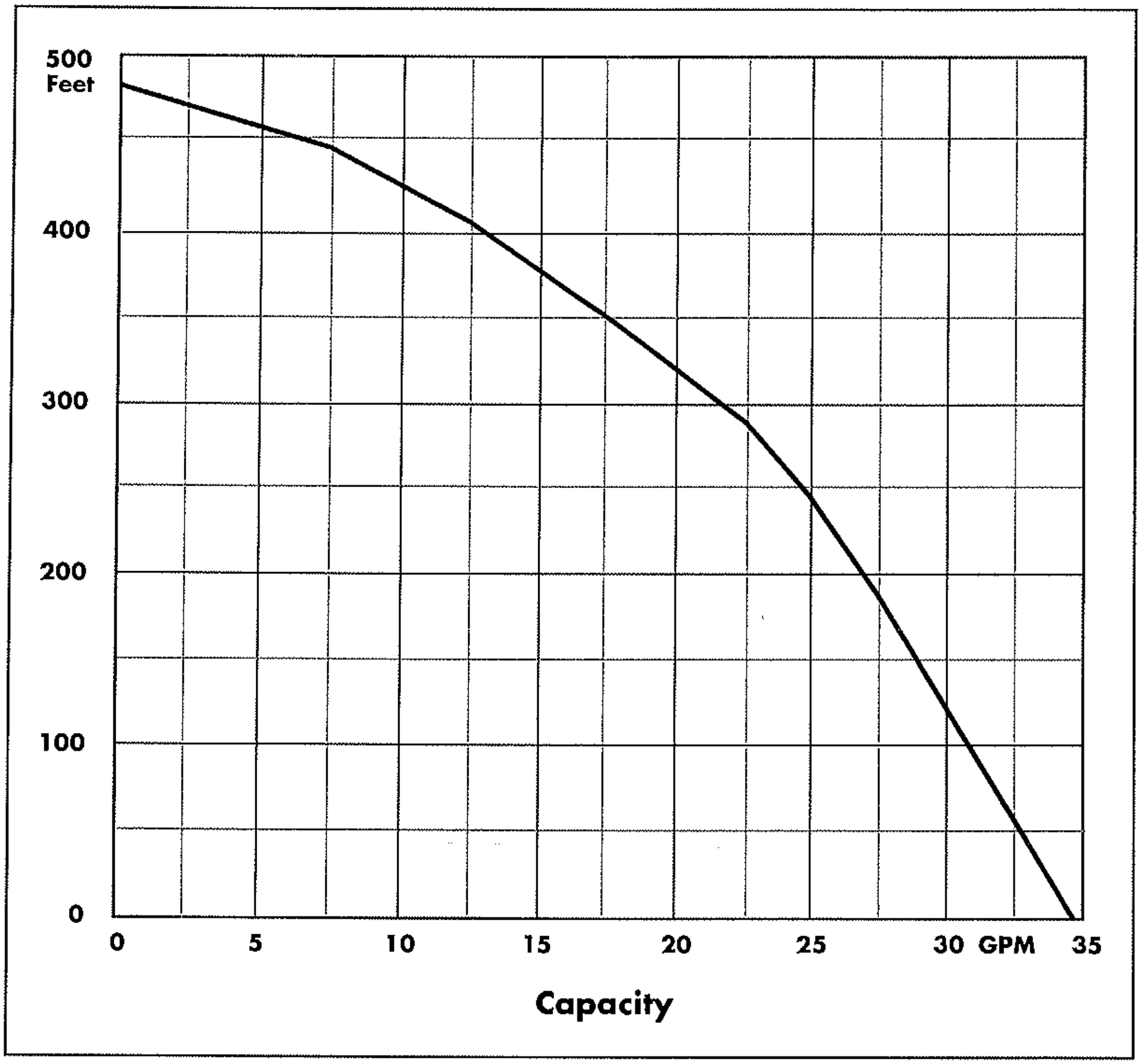
To lift water 25 feet from pump to shower, calculate:

- Friction loss on 25 feet pipe
- Service pressure in feet head (30 psi x 2.31)

The TDH required would be 420.57.

Using Pump Curve Charts

PUMP CURVE



SP 2.5.1g

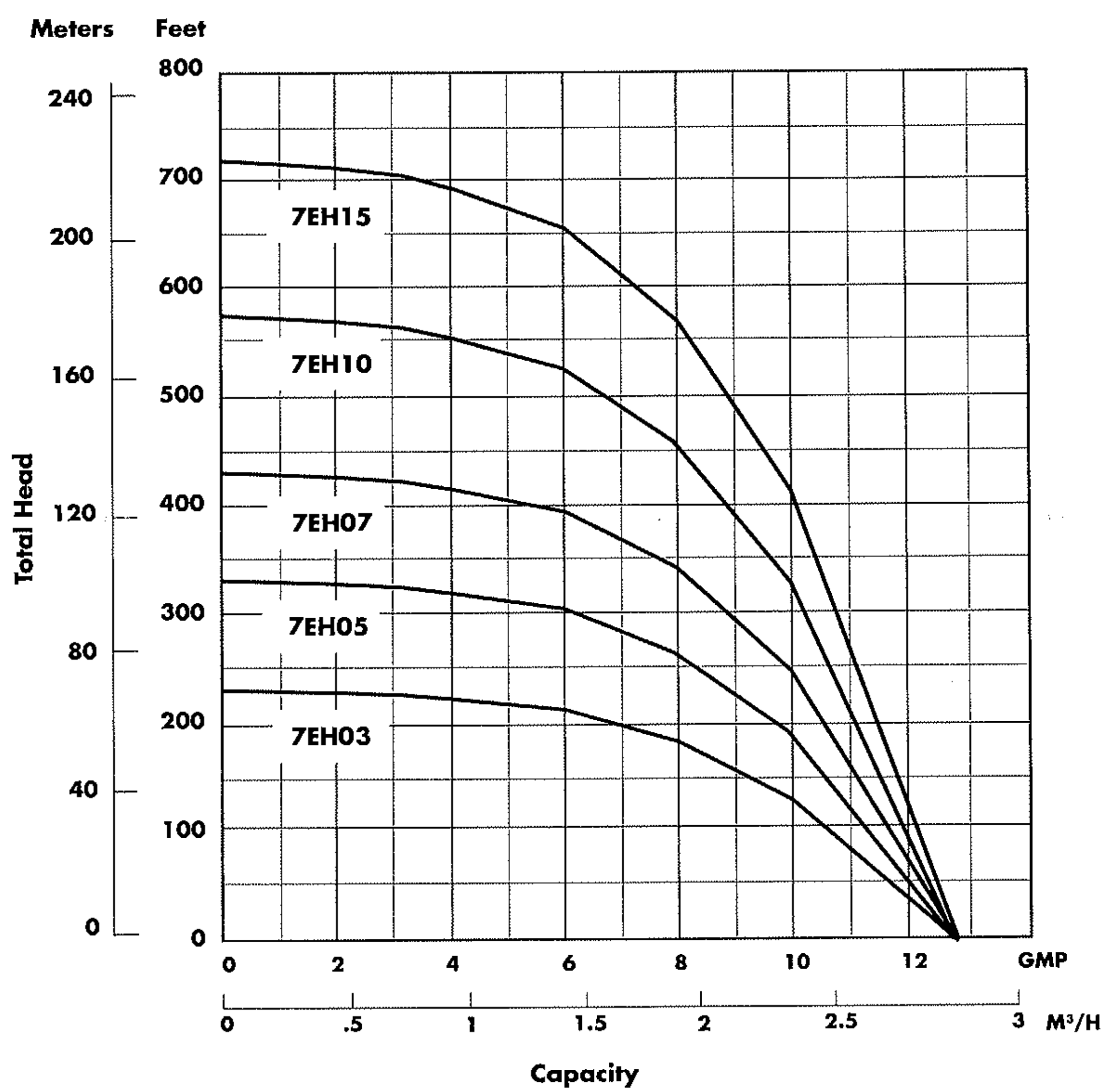
A more exact, but somewhat more complicated, way to size a submersible pump is to use the manufacturer's pump curve charts. Pump curves, like the one page 89, show the pump capacities (gpm) compared to the amount of pressure the pump can produce (feet of head).

To size a submersible pump, one must know how to read a pump curve. A pump adds energy to water, whether powered by an electric motor, wind, or a bucket and rope. As you add more energy you can have either more volume/capacity (gpm) or more force (lift or pressure—TDH). These two factors trade off.

If you plot the tradeoff on a graph with gpm (capacity) at the bottom (x-axis) and TDH (lift or pressure) on the side (y-axis), you get a pump curve. All pump curves show the tradeoff between volume and pressure at a given horsepower.

The pump will always perform at some point on the curve. This makes it easy to see how the service pressure change from 30 psi (69.27 feet) to 50 psi (115.45 feet) will affect volume, or how a change in pipe size (friction) will affect performance.

PUMP CURVE



SP 2.6.3g

Reading Pump Curves

When reading pump curves, the point of intersection between the TDH figure and the capacity figure must always be *on or below* the correct curve. If the two figures intersect above the curve, that particular pump is not powerful enough, and you must go up to a more powerful pump. The numbers on the grid itself are pump model numbers (7EH15, for example).

Most pump curves will show the performance of the pump from 0 gpm to well over the nominal volume. But each pump has an optimum range based on impeller geometry. On the pump curve below, note that the maximum efficiency (60%) is only a small portion of the curve, and the efficiency falls off quickly to each side of the optimum. Pumps will perform at any point on the curve, but you should always try to give the customer the most efficient system. This will lower operating cost and extend the life of the pump. By trying to stay near the center of the pump curve, you can pick the pump with maximum efficiency.

In addition to the mechanical requirements for the pump, other considerations need to be taken into account when sizing the pump. These include: possible future expanded water usage, efficiency of the pump, cost of the pump, cost of installation, cost of operating the pump, cost and ease of servicing the pump.

REVIEW QUIZ – SIZING PUMPS

Answers appear on page 98

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. Total suction lift equals
   a. vertical lift + friction loss.
   b. vertical distance from the top of the well to the top of the pump.
   c. flow rate + friction loss.
   d. vertical life + pump capacity.

2. What is the first consideration when sizing a pump?
   a. Capacity
   b. How far the pump must lift the water
   c. Diameter of the pipe
   d. How far down the jet assembly should be

3. If the flow and pipe length must stay the same, what is one possible way to decrease friction loss?
   a. Decrease the pipe diameter
   b. Increase the pipe diameter
   c. Decrease pressure storage tank capacity
   d. Increase pressure storage tank capacity

4. As flow rate increases, friction loss
   a. is not measured.
   b. decreases.
   c. increases.
   d. stays the same.

5. As total suction lift increases, discharge pressure/pump capacity
   a. is not measured.
   b. decreases.
   c. increases.
   d. stays the same.

REVIEW QUIZ – SIZING PUMPS

Answers appear on page 98

6. When pressure increases,
   a. suction lift increases.
   b. capacity stays the same.
   c. capacity increases.
   d. capacity decreases.

7. Pump cutoff pressure must always be
   a. less than maximum shutoff pressure.
   b. more than maximum shutoff pressure.
   c. the same as maximum shutoff pressure.
   d. steady.

8. Pump capacity is expressed as gpm and what else?
   a. Suction lift
   b. Pumping level
   c. Friction loss
   d. Discharge pressure

9. The two types of deep well jet pumps are twin pipe and
   a. packer type.
   b. electric.
   c. submersible.
   d. shallow.

10. Selection charts for submersible pumps are based on
    a. pump capacities.
    b. pressure.
    c. depth to water.
    d. vertical lift.

11. In sizing a deep well jet for lift capability, what is the important factor to consider?
    a. The depth of the well
    b. How far down into the well the jet assembly should be
    c. The tank capacity
    d. The type of motor

12. What is the recommended maximum pumping depth for a deep well jet?
    a. 25 feet
    b. 50 feet
    c. 75 feet
    d. 100 feet

REVIEW QUIZ – SIZING PUMPS

Answers appear on page 98

13. If the well diameter is 3″ which type of deep well jet pump should you select?
    a. Twin pipe
    b. Packer type
    c. Submersible
    d. Shallow well

14. If vertical elevation is 200 feet and friction loss is 13.2 feet, what is the depth to water?
    a. 213.2 feet
    b. 186.8 feet
    c. 173.6 feet
    d. 2.31 feet

15. The lowest level of water when the pump is operating is called the
    a. capacity of the well.
    b. static level.
    c. pumping level of the well.
    d. drawdown.

16. Total dynamic head relates to
    a. friction.
    b. pressure.
    c. drawdown.
    d. flow.

17. The term "elevation" means the
    a. lowest level of water when the pump is operating.
    b. vertical distance from the top of the well to the pump.
    c. difference between the static level and the pumping level.
    d. total amount of pressure the pump will need.

18. What does a pump curve show?
    a. Pump capacities (gpm) compared to the amount of pressure the pump can produce
    b. Friction loss rates at various flow rates
    c. Total suction lift
    d. Performance ratings

REVIEW QUIZ – SIZING PUMPS *Answers appear on page 98*

19. What variable is on the x-axis of a pump curve?
    a. Total dynamic head
    b. Horsepower range
    c. Capacity
    d. Total suction lift

20. To save power and operating costs, always select
    a. the largest pump available.
    b. a deep well jet pump.
    c. the smallest pump that can get the job done.
    d. the pump with the highest pumping level.

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. What method does your company commonly use to size pumps and why?

____

____

____

B. What manufacturer's pump curve charts does your company commonly use?

____

____

____

ANSWERS TO REVIEW QUIZ

CHAPTER 5

SIZING PUMPS

Answers to REVIEW OF SIZING PUMPS (pages 92 – 95)

1. a. vertical lift + friction loss.
2. b. How far the pump must lift the water
3. b. increase the pipe diameter
4. c. increases.
5. c. increases.
6. d. capacity decreases.
7. a. less than maximum shutoff pressure.
8. d . discharge pressure
9. a. packer type
10. c. depth to water.
11. b. How far down into the well the jet assembly should be
12. d. 100 feet
13. b. Packer type
14. a. 213.2 feet
15. c. pumping level of the well.
16. b. pressure.
17. b. vertical distance from the top of the well to the pump
18. a. Pump capacities (gpm) compared to the amount of pressure the pump can produce
19. c. Capacity
20. d. the pump with the highest pumping level.

Applying what you have learned:

A. Depends on the company

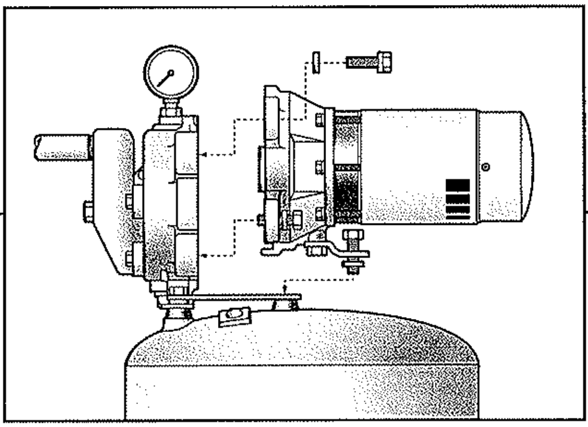
B. Depends on the company

6 PRESSURE STORAGE TANKS

LEARNING OBJECTIVES

When you finish this Chapter, you will be able to:

1. Describe how a pressure storage tank works.
2. Explain what the term "cycling" means.
3. Select a tank for maximum system life.
4. Evaluate and select an electric motor.
5. Recommend available pump accessories.



STORAGE TANKS AND PUMP ACCESSORIES

Pressure Storage Tanks

The water system consists of the pump, a pressure storage tank, and the controls to keep the system operating. In most cases a pump is part of a whole water system.

It is important to be aware of the other parts of the total system and to know what accessories might be needed.

Storage Tank Functions

The pressure storage tank's primary function is the automatic operation of the home water system. The pressure storage tank serves three purposes:

1. It creates an automatic system that provides water under pressure between pump cycles.
2. It provides additional water under pressure for heavy demand periods when the pump and/or well might not be able to provide enough water.
3. It prevents the pump from having to cycle (turn on and off) too often by providing stored water so that the pump does not have to turn on every time water is used.

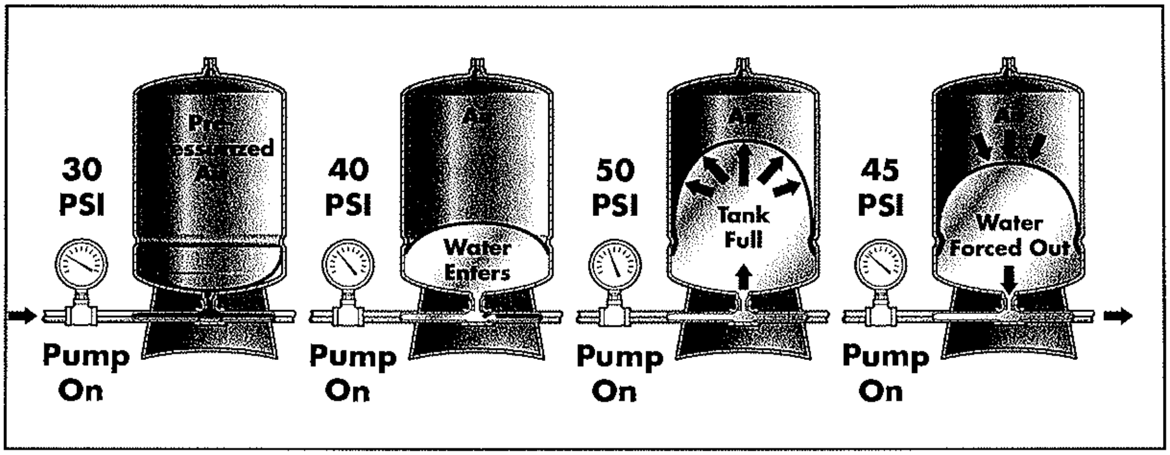
Water cannot be compressed, so to pressurize the system a storage tank with a cushion of air is used. This allows the system to work automatically and maintain pressure in the system when the pump is not running.

The proper amounts of pressurized air and water to produce the maximum pressure setting on the pressure gauge (50 psi on a 30/50 setting) are put into the tank. When a service outlet is opened, the stored pressurized air expands and pushes water out.

When enough water has run out that the startup pressure is reached and the tank is nearly empty, the pump switches on automatically to push water out when an outlet is opened again. The amount of water which can be drawn from the tank before the pump kicks back on is called **DRAWDOWN**.

If more than one tank is used, the system will sense all the tanks as if they were one big tank. Often multiple tanks are used because of space considerations.

PRESSURE STORAGE TANK OPERATION



SP 2.6.01

Problem: Waterlogging

The air in the tank will gradually be absorbed by the water unless methods are used to prevent this from happening.

When the air is almost all absorbed, the tank is waterlogged and does not work efficiently due to lack of pressure. A waterlogged tank causes the pump to turn on and off rapidly, which is called short cycling.

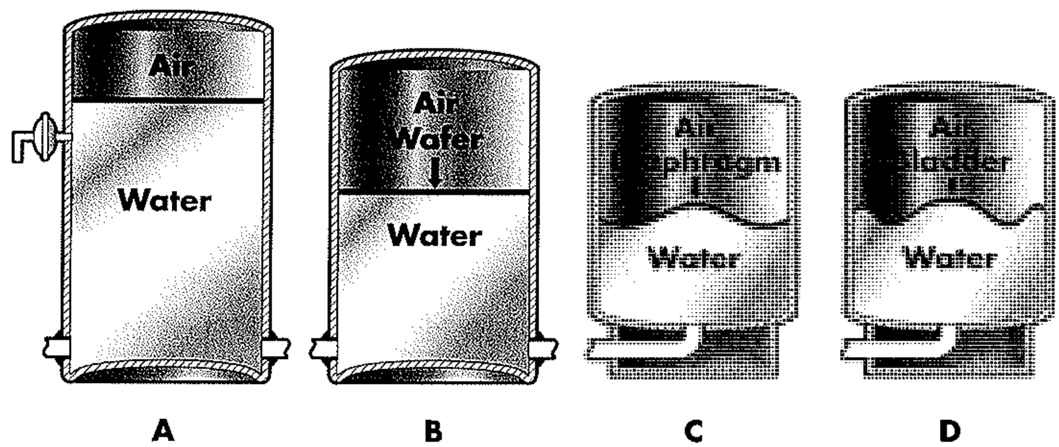
Different types of storage tanks have various methods to help control **WATERLOGGING**. We will look at the plain steel tank, floating wafer tank, air diaphragm tank and air bladder tank.

The **PLAIN STEEL STORAGE TANK** uses an "air changing system" that injects air into the tank every time the pump starts, and the "air volume control" releases the excess. If a plain steel tank is replaced by a captive air tank, the air charging system must be removed.

The **FLOATING WAFER TYPE TANK** uses a wafer on the water surface to slow down the absorption of air.

Both the **AIR DIAPHRAGM TANK** and the **AIR BLADDER TANK** use flexible separators to permanently seal the air away from the water. The air diaphragm and air bladder tanks can be precharged with air to the cut-in pressure of the pump. This makes them more efficient.

ABCD PRESSURE STORAGE TANKS



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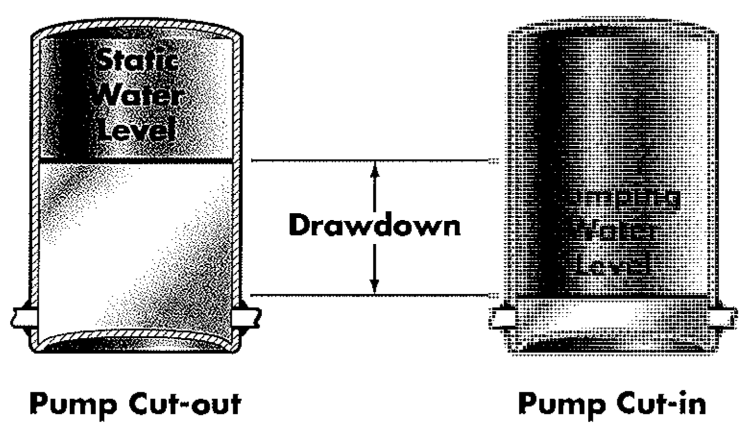
Problem: Pump Cycle Length

The **CYCLING**, or turning on and off, of the pump produces most of the wear and tear on the pump, and water systems should be planned so that the pump runs longer and cycles less often. These longer cycles also assure adequate cooling of the motor through heat dissipation.

A pump should not have a cycle shorter than 60 seconds. That is, once the pump starts running, it should run for at least one minute before shutting off again.

PUMP CUT-OUT/PUMP CUT-IN



SP 2.6.03

A minimum of a one-minute cycle means that the storage tank must have a drawdown at least equal to the capacity (gpm) of the pump.

Drawdown in a pressure tank is the amount of water that can be drawn from the tank before the pump kicks back on. For example, if pump capacity is 7 gpm, the storage tank should have a drawdown of at least 7 gpm so that the pump will run for a full minute before shutting down.

Sizing the Pressure Tank

To obtain maximum system life, select the properly sized tank. Use the tables in the tank catalog or pump catalog. As a rule of thumb for the plain steel tank or the floating wafer tank, the volume of the tank should be at least 10 times the pump capacity. For precharged tanks such as the air bladder or air diaphragm tank, the volume of the tank should be at least 5 times the pump capacity.

If the well flow rate or the pump capacity is too low to provide adequate water for peak demand periods, the storage tank should be larger than the above formulas in order to provide adequate water supply.

If the tank is too small, the pump will cycle too often, and put unnecessary wear and tear on the system. The larger the tank, the longer the pump will last. See the motor manufacturer's sizing guides for tanks.

Accessories: Electric Motors

Submersible pumps come in various sizes and with two styles of electric motors. Choice of a two-wire or a three-wire motor is usually up to the installer. A two-wire has 150 percent starting torque. A three-wire has a higher starting torque (250 percent), which is important when there is sand or algae in the water.

The three-wire is also more prone to lightning damage. Three-wire motors also have more parts, a box, capacitor and start relay. These parts are more prone to failure than the two-wire pump and require separate lightning protection.

It is essential that the cables and electrical wiring and controls you sell are correctly matched in terms of capacity and voltage.

Other Accessories

Other kinds of accessories may be needed when your customer buys a pump. For example, both the shallow and deep well jets will require foot valves on the tailpipes to prevent water from running back into the well when the pumps are off.

A submersible pump will probably need a check valve to be placed between the pump and the tank. A pressure control valve will be needed for a deep well jet.

A relief valve should be used if the pump is capable of producing more pressure than the suggested working pressure of the tank.

A well seal or pitless adapter is needed to keep the well clean and prevent debris from falling into the well. A well adapter will be needed if a packer style deep well jet is used. Lightning arrestors may be desirable, and torque controls are useful for submersible pumps.

Here is a list of possible accessories your customer may need. The best source for specifications and installation instructions is the manufacturer's specifications.

1. **Pump:** Stainless steel casing and bowls, bronze castings and lightning protected motor. Several models are available from most manufacturers.
2. **Certificate of Insurance:** Most manufacturers offer optional insurance (usually a five-year plan) covering up to 1-1/2 horsepower pumps and motors against failure due to wear or abrasion, corrosion or even lightning.
3. **Splice Kit:** Connector crimps and heat shrinks tubing. Seals wire lead connections to electrical units.
4. **Torque Arrestor:** Absorbs thrust of motor start-ups, keeps pump centered in well.
5. **Torque Stops:** Spaced at regular distances apart in the well to keep wire from rubbing against the side of the well.
6. **Electric Cable:** Either two-wire or three-wire.
7. **Safety Rope:** Sometimes used to support the weight of the pump.
8. **Pitless Adapter:** Provides a sanitary seal in underground connection of well pipe to horizontal pipe.
9. **Well Cap or Well Seal:** Keeps debris out of the well; allows entry into the well.
10. **Control Box:** Contains components of the motor required with all three-wire models.
11. **Lightning Arrestor:** Recommended for units over 1-1/2 horsepower. Models up to 1-1/2 horsepower usually have lightning protection built into the motor.

12. **Fittings:** Plumbing fittings that are usually included in a typical water system.
13. **Pressure Switch:** Senses system pressure at all times.
14. **Pressure Gauge:** Indicates system pressure at all times.
15. Storage Tank: Offers water storage for fewer pump cycles. Provides a cushion to operate against. Tank should be sized so that drawdown is equal to capacity of the pump.
16. **Pressure Relief Valve:** Offers protection against pressure buildup. Particularly vital where the pump is capable of producing more pressure than the working limits of the tank.

Of course, piping will also be needed. Unions should always be advised to allow ease of access in case repair is needed.

Always check the manufacturers' specifications and installation instructions to see what is needed or recommended.

REVIEW QUIZ – PRESSURE STORAGE TANKS *Answers appear on page 112*

DIRECTIONS: Carefully read each question and circle the correct answer. There is only one correct answer per question. When you have finished, check your answers.

1. What are the three parts of a water system?
   a. Pump, jet ejector, and controls
   b. Pump, storage tank, and check valve
   c. Pump, lightning arrestor, and controls
   d. Pump, storage tank, and controls

2. How does the storage tank prolong the life of the pump?
   a. It keeps the pump centered in the well.
   b. It supports the weight of the pump.
   c. It prevents rapid cycling of the pump.
   d. It senses system pressure.

3. What happens when the startup pressure is reached?
   a. The pump shuts off.
   b. The tank is waterlogged.
   c. The pump comes on to begin refilling the tank.
   d. The air in the tank is absorbed.

4. What causes a tank to be waterlogged?
   a. The air is absorbed by water so there is a lack of pressure.
   b. The startup pressure is reached.
   c. A service outlet is opened.
   d. The water in the tank evaporates.

5. The four common types of water storage tanks are plain steel, air bladder, air diaphragm and
   a. plastic.
   b. floating wafer.
   c. steel bladder.
   d. steel diaphragm.

REVIEW QUIZ – PRESSURE STORAGE TANKS *Answers appear on page 112*

6. What should be the minimum length of the pump cycle?
   a. 10 seconds
   b. 20 seconds
   c. 30 seconds
   d. one minute

7. If the pump capacity is 12 gpm, what is the minimum acceptable drawdown for the tank?
   a. 3 gpm
   b. 6 gpm
   c. 12 gpm
   d. 15 gpm

8. For precharged tanks, the volume of the tank should be at least
   a. 5 times the pump capacity
   b. 10 times the pump capacity
   c. 15 times the pump capacity
   d. 20 times the pump capacity

9. What is the torque difference between two-wire and three-wire pumps?
   a. There is no difference.
   b. Three-wire has a lower starting torque.
   c. Two-wire has a higher starting torque.
   d. Two-wire has a lower starting torque.

10. What is the starting torque of a three-wire motor?
   a. 100 percent
   b. 150 percent
   c. 250 percent
   d. 300 percent

11. What kind of valve should be used if the pump can produce more pressure than the suggested working pressure of the tank?
   a. Foot valve
   b. Relief valve
   c. Check valve
   d. Tailpipe valve

REVIEW QUIZ – PRESSURE STORAGE TANKS

Answers appear on page 112

APPLYING WHAT YOU HAVE LEARNED:

By observing and asking questions, fill in the blanks. If you are not sure of the answers, ask your supervisor.

A. What types of water storage tanks does your company sell?

____

____

____

B. What types of accessories does your company typically recommend?

____

____

____

ANSWERS TO REVIEW QUIZ

CHAPTER 6

PRESSURE STORAGE TANKS

Answers to REVIEW OF PRESSURE STORAGE TANKS (pages 107 – 109)

1. d. Pump, storage tanks, and controls
2. c. It present rapid cycling of the pump.
3. c. The pump comes on to begin refilling.
4. a. The air is absorbed by water so there is a lack of pressure.
5. b. floating wafer.
6. d. one minute
7. c. 12 gpm
8. a. 5 times the pump capacity
9. d. Two-wire has a lower starting torque.
10. c. 250 percent
11. b. Relief valve

Applying what you have learned:

A. Depends on the company

B. Depends on the company

THIS COURSE INCLUDES AN ONLINE FINAL EXAM

This course is limited to a single user. When you are ready to take the final exam to earn Certificate of Completion, please contact ASA at info@asa.net. You will be contacted about how to register for the exam.

GLOSSARY OF TERMS

Air bladder tank: A precharged pressure storage tank which uses a permanent flexible bladder to keep the air in the tank separated from the water.

Air diaphragm tank: A precharged pressure storage tank which uses a permanent flexible diaphragm to separate the air from the water.

Atmospheric pressure: The weight of the air or atmosphere.

Bernoulli's Law: The principle of physics that states that the flow rate and pressure of a liquid or gas are related in such a way that as one increases the other decreases.

Bored well: A well constructed by using an auger to bore a hole in the ground.

Capacity (pump): The number of gallons per minute (gpm) or per hour (gph) a pump can produce.

Constructed well: A man-made well, constructed by men and machines rather than by nature.

Cycling: A complete sequence of processes in a machine, or the time that this process takes.

Deep well jet pump: A jet pump that has the jet assembly inserted into the well itself.

Diffuser: The part of a centrifugal pump that slows down the water coming from the impeller and creates higher pressure.

Discharge head: *SEE* Discharge pressure.

Discharge pressure: The amount of pressure needed to raise the water from the pump to the outlets in the house, including the service pressure and the friction loss in the pipes and fittings between pump and outlets. Discharge pressure is stated in psi. If stated in feet of head, it is called discharge head.

Drawdown: The difference in feet between the static level and the pumping level of the well. That is, the amount of water (in gallons) that can be drawn from the pressure storage tank before lowered pressure makes the pump kick on the refill the tank.

Drilled well: A well drilled by a drilling machine. Drilled wells are the most common type of wells.

Drive water: The water used in a jet pump to create the vacuum by flowing at a high rate of speed through the nozzle of the jet assembly.

Driven well: A well constructed by driving a pointed instrument (called a well point) with a strainer screen into the ground.

Dug well: A shallow well (not more than 30 feet deep) dug several feet in diameter. Dug wells are easily contaminated.

Elevation: The vertical distance from the top of the well to the pump.

Floating wafer type tank: A pressure storage tank that uses a wafer floating on the top of the water to slow down the rate that the air is absorbed into the water in the tank.

Fresh water: Not salt water. Fresh water is found in streams, rivers and most lakes.

Friction loss: The amount of distance (in feet) or pressure (in psi) lost because of the friction of liquid rubbing against the pipe, fitting or tube through which it is flowing.

gph: Gallons per hour.

gpm: Gallons per minute. A measure of volume.

Ground water: Water from rain, snow, etc. which seeps into the ground and flows underground for some distance until it reaches a stream, river, lake or ocean.

Head: The total amount of pressure the pump will build for lift and discharge. Also called total dynamic head (TDH), total system head, total pumping head, or total head(TH).

Hydrologic cycle: The natural cycle by which the earth's water is recycled, including precipitation, movement of precipitated water through the earth into streams, rivers, lakes, and oceans, and evaporation of water from these bodies of water into clouds to produce more precipitation.

Impeller: The part of a centrifugal pump that rotates with the shaft and creates the centrifugal force to speed up the water and create the vacuum.

Jet assembly: *SEE* Jet ejector.

Jet ejector: Part of a jet pump that contains the nozzle, the venturi tube, and the ejector body. A jet ejector attached to a centrifugal pump creates a jet pump.

Jet pump: A combination of a centrifugal pump and a jet ejector.

Natural well: A body of surface water such as a lake, pond, stream or river that may serve as a natural source of water for humans or animals.

Nozzle: Part of a jet ejector through which drive water is passed.

Overpump: To pump the water level so low that air gets into the pump and water system.

Packer-type deep well jet pump: A deep well jet that has only one pipe extended into the well.

Peak demand period: The period of the day (or evening) when the most water is used.

Plain steel storage tank: A pressure storage tank that uses an air volume control to assure enough air in the tank to create the needed pressure and prevent waterlogging.

Pressure pipe: The pipe in a twin pipe deep well jet that carries the drive water down from the centrifugal pump to the jet ejector in the well.

Prime: The water that must be injected in some types of pumps (centrifugal and jet) in order to start the pump.

Pump: A device that adds energy to water to provide either pressure or volume.

Pumping level: The lowest level that the water will reach with the pump operating.

Salt water: Salt water is not fresh water. It is found mostly in oceans, though some lake and marshes are salt water.

Service pressure: The pressure (in psi) needed at the final outlets in the house.

Shallow well jet pump: A jet pump that is located entirely above the well (except for the suction pipe) and can only be used for well of 25 feet pumping depth or less.

Static level: The water level that the well naturally produces when the pump is not operating. Also called standing water level.

Submersible pump: A multistage centrifugal pump that operates submerged in the well itself.

Suction: The process of atmospheric pressure forcing something into a vacuum.

Suction lift: The distance in feet that water must be raised from beneath the ground by suction.

Suction pipe: The pipe that brings the water up from the well.

Surface water: Water from rain, snow, etc. that collects in ponds, streams, rivers and oceans.

Twin pipe deep well jet pump: A deep well jet pump that has two pipes going down into the well.

Total dynamic head: *SEE* Head.

Total head: *SEE* Head.

Total pumping head: *SEE* Head.

Total system head: *SEE* Head.

Vacuum: A space in which the pressure is far below the normal atmospheric pressure.

Venturi tube: Part of a jet ejector that slows down the water coming from the nozzle and creates pressure.

Vertical lift: The vertical distance between the pumping level of the water and the horizontal discharge pipe.

Volume: Rate of flow of water.

Water cycle: The cycle of precipitation (rain, snow, sleet, etc.) and evaporation that provides water for earth.

Waterlogging: A condition that occurs when most of the air in a pressure storage tank has been absorbed by the water. The reduction in pressure causes the pump to turn on and off very rapidly.

Water system: The pump, pressure storage tank, and the controls to keep the system operating.

Water Systems Council (WSC): A national non-profit organization, dedicated to promoting the wider use of wells as modern and affordable safe drinking water systems and to protect ground water resources. The only national organization solely focused on individual water wells and other private well-based water systems.

Water table: The more or less continuous top surface of the ground water.

Well log: The record the well driller gives the well owner that contains information about water depth and drilling operations.

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Specialty Products

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