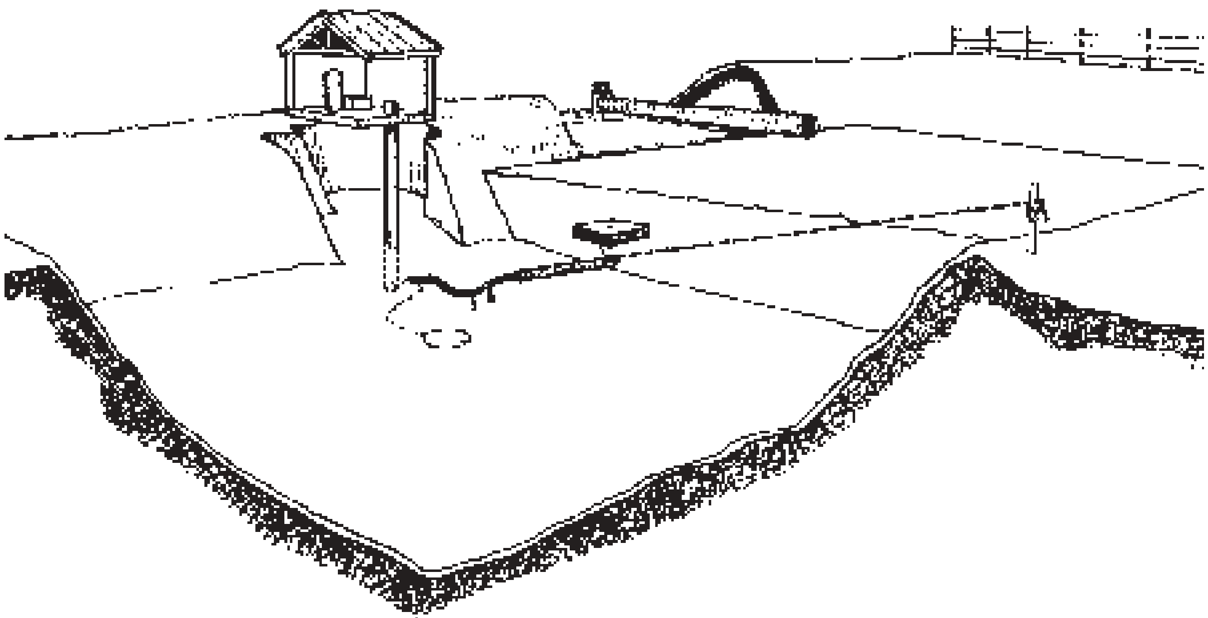
Operating Systems



Equipment Systems

A well-designed and efficient water system is a very important part of a farming operation. Dugouts are large reservoirs of water that can be pumped at a much faster rate than most wells on the Prairies. This is only an advantage if the water intake, pump, and water distribution lines are sized to meet the peak demands of the farm. Dugout aeration systems can make a dynamic improvement in dugout water quality. Remote watering systems that pump out of pasture dugouts, help protect livestock from illness and injury as well as improve water quality and livestock production.

Intake Systems

Research has shown that water in the top four to five feet of a dugout is of higher quality than water at the bottom and edges of the dugout. It has also shown that many farm dugouts become depleted of dissolved oxygen resulting in black smelly water. For these reasons, floating, water intake systems are recommended for all farm dugouts.

Floating Intake Systems

For the past 20 years, floating, water intake systems have been used in dugouts. The floating intake draws the better quality water from near the dugout water surface. These systems are usually installed with a wet well beside the dugout which contains a submersible pump. However with jet pumps, the intake assembly hooks directly to the suction line, and a check-valve is installed next to the pump. This eliminates the need for a wet well. Whatever the chosen system, it is recommended that intakes be planned and installed at the time of dugout construction. Floating intake systems include the components shown in Figure 23.

Figure 24 shows a submersible pump and intake system. Install the intake pipe inside another larger pipe where it enters the dugout. This will protect the intake line from possible damage or collapse during back filling of the intake pipe trench. The perforated intake pipe supplies water to a wet well located beside the dugout. The water flows by gravity as water is pumped from the well. Since plastic pipe is lighter than water, small concrete weights must be secured along the intake pipe. Generally, medium density 75 psi CSA rated pipe is recommended for the intake line. Install the dugout air line in the same trench as the intake line. This installation will protect the air line from freezing.

Figure 25 shows a plan view of a dugout and the intake installation. The intake pipe should enter the dugout on a 45 degree angle to reduce the chances of kinking when the intake is pulled to shore for maintenance

Figure 23 Floating Intake

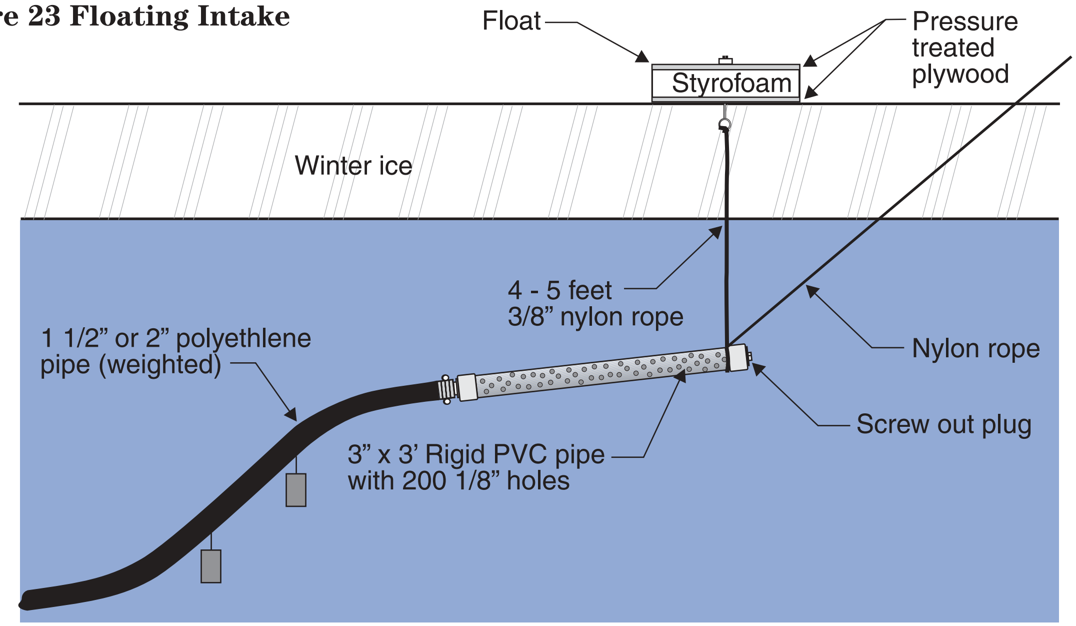


Figure 24 Submersible Pump and Intake System

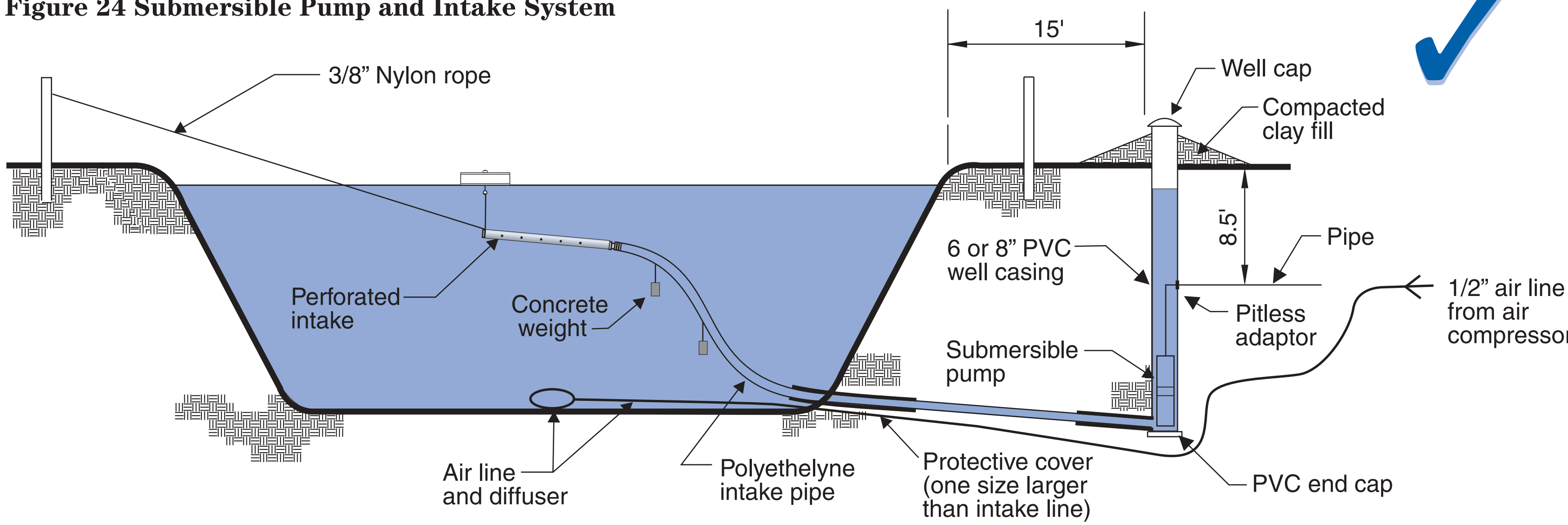
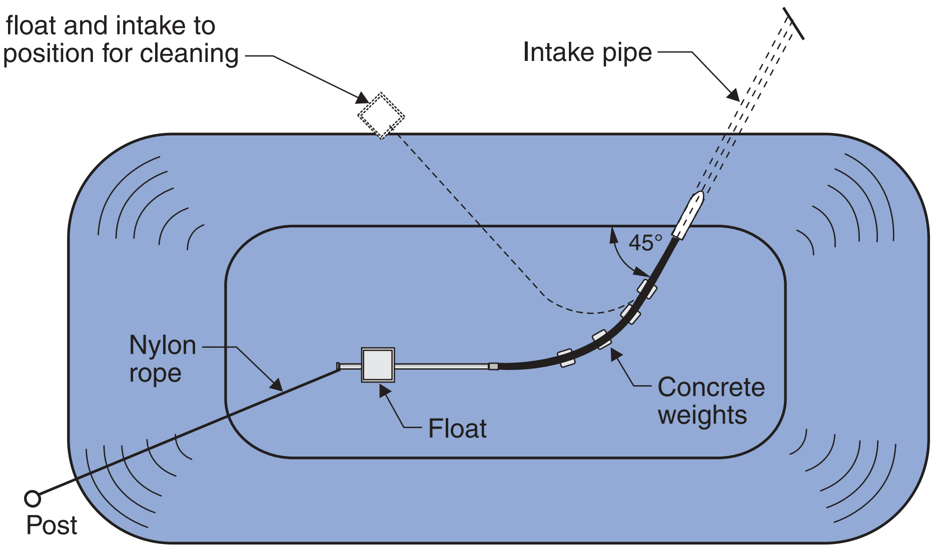


Figure 25 Plan View of Intake System



Other Intake Systems

Over the years, other types of water intake systems have been tried for dugouts. They are not recommended. Two common but unsatisfactory systems are:

Gravel infiltration trenches

Gravel-filled trenches between the dugout and a wet well beside the dugout have been unsuccessfully tried in the past. **They are not recommended.** The trenches can be effective filters for several years but will eventually fail due to plugging of the spaces in the gravel with soil, plant material, microorganisms, and biofilms. Flows to the wet well are inevitably reduced. Due to high levels of biological activity in the trench, oxygen levels fall which leads to the release of hydrogen sulphide gas. These conditions produce black smelly water in the wet well. It is also common to see a ten-fold increase in total dissolved solids, and greatly increased problems with iron, manganese, and hardness due to leaching of dissolved minerals from the gravel material. The only solutions are re-excavation and replacement of the gravel every few years, or replacement with an intake pipe.

Dugout bottom intakes

Large 4 to 12 inch (10 to 30 cm) horizontal piping has been used to convey water from the bottom of the dugout to a wet well. Although these systems do not plug, poor water quality is a problem. Unless the dugout is continuously aerated, the poorest water quality is always near the dugout bottom. Large open-ended pipes often result in water bugs entering the wet well, pumps and distribution system. In some cases, bugs can plug impellers on pumps and screens. Avoiding this problem requires installation of screens around the dugout intake or the pump intake in the wet well.

Wet Wells

A wet well is usually required beside the dugout to permit easy access to the pump. The water flows by gravity into the wet well as water is pumped from the well. For many years, two to three foot diameter, steel culverts were used for wet wells. Large diameter wells allow for some settling of solids to take place. However, recent monitoring of these installations has shown that dissolved oxygen levels are much lower in the wet wells than in the dugout water. The reasons for this include the large water storage capacity of wet wells and slow replenishment with fresh dugout water. Conditions in these wells can be similar to those that develop in gravel trenches: hydrogen sulfide gas formation, lower pH, and a high concentration of nutrients at the bottom of the wet well.

To avoid the problems associated with a large diameter wet well there are several options:

- Hire a vacuum-truck to come in every few years and suck out the black decayed plant material and sediment at the bottom of the wet well.
- It is very important that vacuum equipment be clean. A dirty hose can contaminate the well.
- For jet pump installations, elimination of the wet well is desirable with the intake assembly installed directly below the float in the dugout.
- For new submersible pump installations, a smaller diameter, 6 to 8 inch (15 – 20 cm) PVC well casing and pitless adapter are the best option. The smaller diameter PVC casing can also be installed inside an existing larger wet well. A smaller well has a steady supply of fresh dugout water and thus eliminates the poor water quality associated with larger wet wells. The PVC casing will last much longer than steel culverts, which eventually corrode.

Pumps

There are many types and sizes of pumps for dugout water systems. Some are designed for drawing from the water source only. Others draw the water and force it through the rest of the distribution system. Some pumps are used for special purposes such as boosting pressure or supplying a special outlet. Therefore, it is important to select the proper type and size of pump for the application.

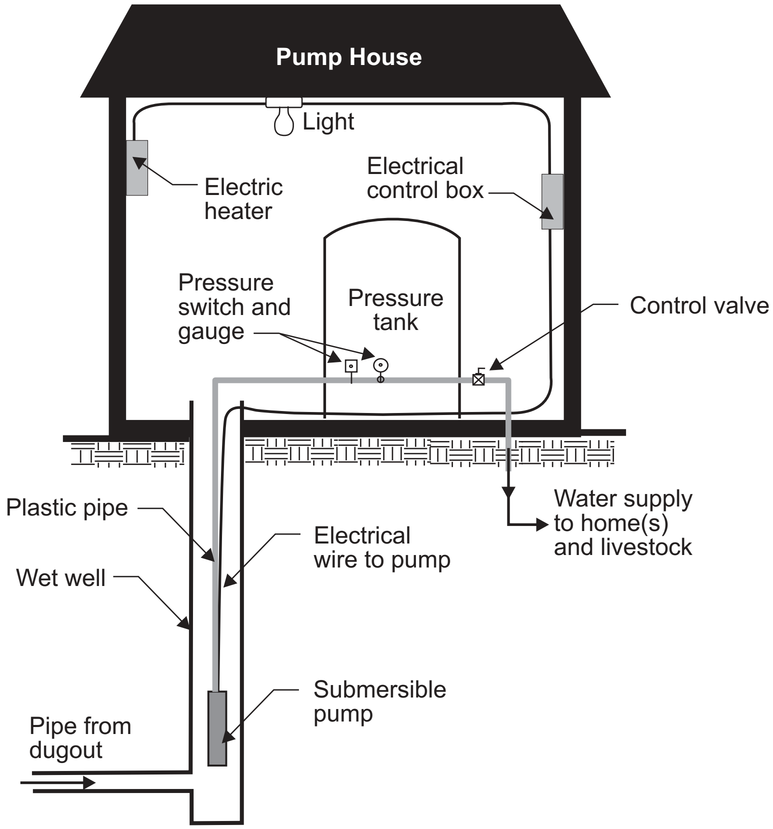
The most common pumps used for dugout applications systems are shallow well jet and submersible pumps. Shallow well jet pumps have a suction lift of approximately 20 vertical feet (7 meters), including friction losses. Once water has been lifted to the pump, it can be pushed to higher elevations. Jet pumps can be installed away from the dugout in the basement of a house, heated shop, or pump house. Ensure that the suction line is adequately sized. Jet pumps require a larger intake pipe than submersible pumps but save the cost of running electrical power to the dugout. Jet pumps are not as efficient as submersible pumps and are more suited for supplying smaller volumes of water for rural residences.

A submersible pump can lift water hundreds of vertical feet. It operates like a shallow well pump but has a number of impellers or stages mounted close together on a shaft. Generally, because of the low lift required for dugout applications, a pump with six to ten stages or impellers will supply all the pressure required. The most common size of submersible pump is 4 inches (10 cm) in diameter. These pumps are available in 1/2, 3/4, 1 horsepower and larger.

The pumps are placed in a wet well beside the dugout. Generally a small heated pump house is set over or beside the wet well to house the pressure tank, pressure switch, electrical controls and any other dugout pumping or aeration equipment. See Figure 26.

A rural water system requires a pressure tank. Pressure tanks store water and maintain water pressure between specified limits. As the water in the tank rises, air is compressed until the upper limit or cut out point is reached and pumping stops. When a valve is opened, the compressed air in the tank acts like a spring and forces water to flow into the system. Demands on the water supply cause the tank pressure to fall until the lower limit or cut in point is reached and the pump restarts. Without this buffer, the pump will start each time a small amount of water is drawn. Constant starting and stopping causes unnecessary wear on a pump. A 30 to 50 psi pressure switch is most common for farming operations.

Figure 26 Submersible Pump, Wet Well, and Pressure Tank

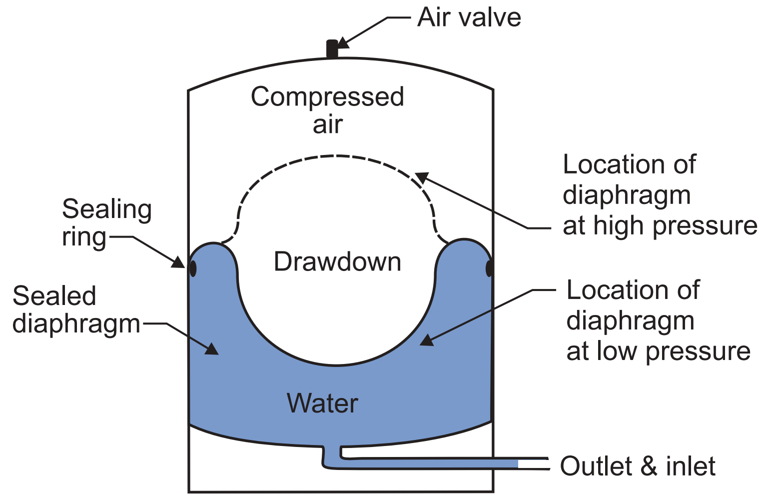


There are four types of pressure tanks as follows:

- Plain galvanized steel tank
- Plain galvanized steel tank with floating wafer or disk
- Diaphragm tank, pre-charged with air
- Bladder tank, pre-charged with air.

For dugout applications, it is best to have a sealed air diaphragm or bladder tank for submersible pumps as shown in Figure 27.

Figure 27 Sealed Air Diaphragm Pressure Tank



Dugout water has little dissolved gas and can absorb the air in a plain galvanized steel tank. When most of the air is gone from the tank, it said to be waterlogged. This is like not having a pressure tank and causes premature wear of the pump motor. If a tank has no bladder or diaphragm, waterlogging can be avoided with regular addition of air to the tank. An air volume control can be added to jet pumps to add air to less expensive steel or floating wafer tanks.

The size of the pressure tank is also important. Select a pressure tank that has at least one gallon of drawdown between low and high pressure, for each gallon per minute (**gpm**) of pump capacity. For example, a ten gpm pump requires a pressure tank with ten gallons of drawdown.

Water Distribution System

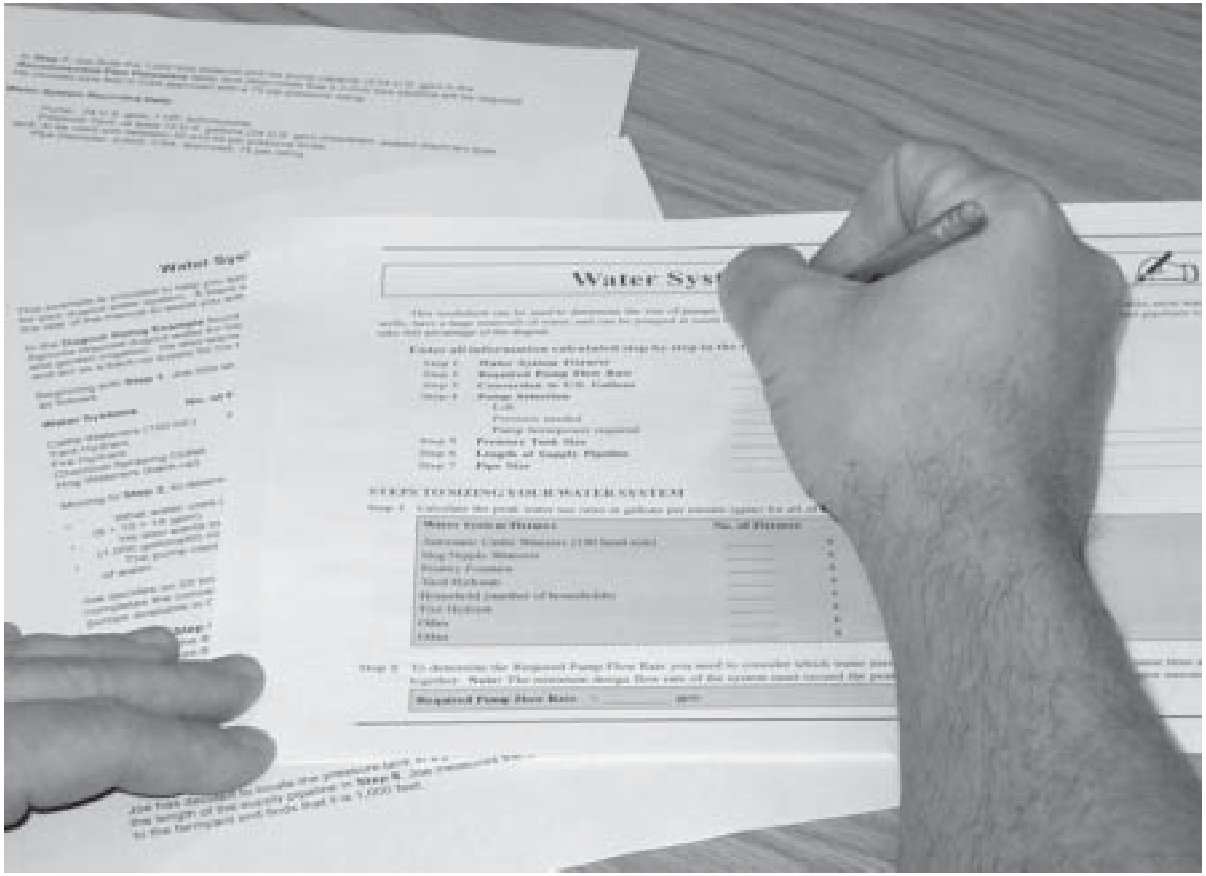
The water distribution line should be sized to effectively supply the required amounts of water and pressure throughout the system. As a rule of thumb, try to maintain no more than a five pound per square inch (**psi**) pressure loss due to friction, throughout the system.

For dugout applications generally 75 – 100 psi, CSA approved, polyethylene pipe is suitable for underground burial and general use in the water distribution system. Polyethylene pipe comes in low, medium, and high density. Low-density pipe is recommended because it is more resistant to damage, more flexible, and easier to join.

For pipe connections, it is best to use fittings that will not corrode from the water or contact with corrosive soil in an underground trench. Nylon, plastic or brass fittings are recommended. Use 100 percent stainless steel clamps for all connections and double clamp underground connections.

Figure 28 continues the example of the Joe Agricola farm to illustrate pump, pressure tank, and water pipe sizing for farm dugout, water distribution systems. Carefully work through the complete example contained in the pocket at the front of the manual. Blank worksheets for sizing the components of your water distribution system are contained in the pocket at the rear of the manual.

Figure 28 Water System Sizing Example



Dugout Aeration Systems

As previously outlined in the Understanding Prairie Dugouts Module, Biology of a Dugout section, an important part of maintaining water quality is ensuring that the level of dissolved oxygen in the water stays high all year round.

Under natural conditions in a dugout, oxygen exchange with the environment is not sufficient. In summer, a layer of warm water forms on the surface and floats on a layer of deeper, cooler water. The layer of cold water, having no contact with the atmosphere, becomes depleted of oxygen. Under low-oxygen conditions, plant nutrients, metals, and swamp gases are released from the dugout sediments and held by the cold water layer.

In fall, air temperature and the surface waters of the dugout cool rapidly. When the surface reaches the temperature of the cooler, bottom layer, the dugout 'turns over'. This means that the water in the dugout is no longer stratified and wind mixing of all the dugout water occurs. Nutrients and unwanted compounds become evenly distributed throughout the water.

During winter, ice cover prevents the transfer of oxygen from the atmosphere to the water. When oxygen is depleted, microbial activity in the sediments again begins to release unwanted compounds. One of these compounds, hydrogen sulfide, produces the rotten-egg smell that often develops in small water bodies in late winter.

The ice melts in spring, the surface warms, and the water mixes completely distributing the unwanted compounds throughout the water. Dissolved nutrients become readily available to plants and algae near the surface. As the air temperature increases, the cycle begins again.

In order to prevent this cycle of low-oxygen conditions from developing, supplementary aeration is required. This adds oxygen to the water and ensures complete mixing of the water so that contact with the atmosphere is maximized. Research has shown that dugouts should be aerated 24 hours per day, year round.

Types of Aeration Systems

Many types of aeration systems have been tried over the years including electrical, wind-powered, and solar-powered systems. Where possible, electrical systems are always preferred, but for remote locations, other power sources are required. All systems have advantages and disadvantages.

Wind-powered systems can be effective in low-sunlight winter conditions but only in areas where winds are relatively constant. Solar systems are very portable and work best in hot sunny conditions coinciding well with peak demand for water. Producers should try to find options that suit their operations and their geographic area.

Some floating systems are available but research indicates that these systems are not very practical or effective for prairie dugouts.

Components of an Aeration System

There are four components to an aeration system:

- power supply
- air compressor
- aeration line
- diffuser.

Power supply

As with pumping systems, aeration can be powered by electricity, solar power, or wind. For dugouts stocked with fish, use an electrical type compressor, as it will provide a continuous supply of dissolved oxygen. This is crucial for fish survival in a dugout. Windmill type systems may not pump sufficient dissolved oxygen for fish survival during low wind conditions at night or during hot calm periods in summer.

Air compressors

Bank-mounted windmills use a diaphragm-type pump that pushes air into an aeration hose that extends to the bottom of the dugout. Windmills are suitable for areas with good wind conditions and for remote sites where electrical power is too costly to install. However, they perform poorly on sites where winds are obstructed by hills or trees, water is deep (over 20 feet), or there are high concentrations of organic matter in the water.

The most common types of electrical compressors are the oil-less diaphragms or piston pumps. These compressors are quiet, relatively inexpensive to purchase and operate, and require little maintenance. When choosing a pump, make sure it is rated for continuous use. As a rule, a diaphragm-type compressor that pumps approximately one cubic foot per minute (**cfm**), for every million gallons of dugout water is adequate. For best results, locate the compressor in a heated building or enclosed box to protect the motor, diaphragm, and electrical supply.

Aeration Lines

Aeration lines convey air from the pump to the dugout. For new dugouts, the aeration line should be buried with the water intake line. This will prevent damage from frost, ultraviolet light, ice, and animals.

Diffusers

A diffuser is a device to release air into the water. Research has shown that the type of diffuser is very important. Diffusers that create fine to medium-sized bubbles are more efficient at circulating and aerating water than open-ended hoses that produce large bubbles. An open-ended hose requires three times the volume of air to saturate water with dissolved oxygen compared to an air stone or perforated hose. Proper location of the diffuser maintains oxygen levels from top to bottom, as shown in Figure 29. Recommended types of diffusers are:

- Air stone
- Linear, fine bubble diffuser
- Membrane diffuser.

Figure 29 Aeration System

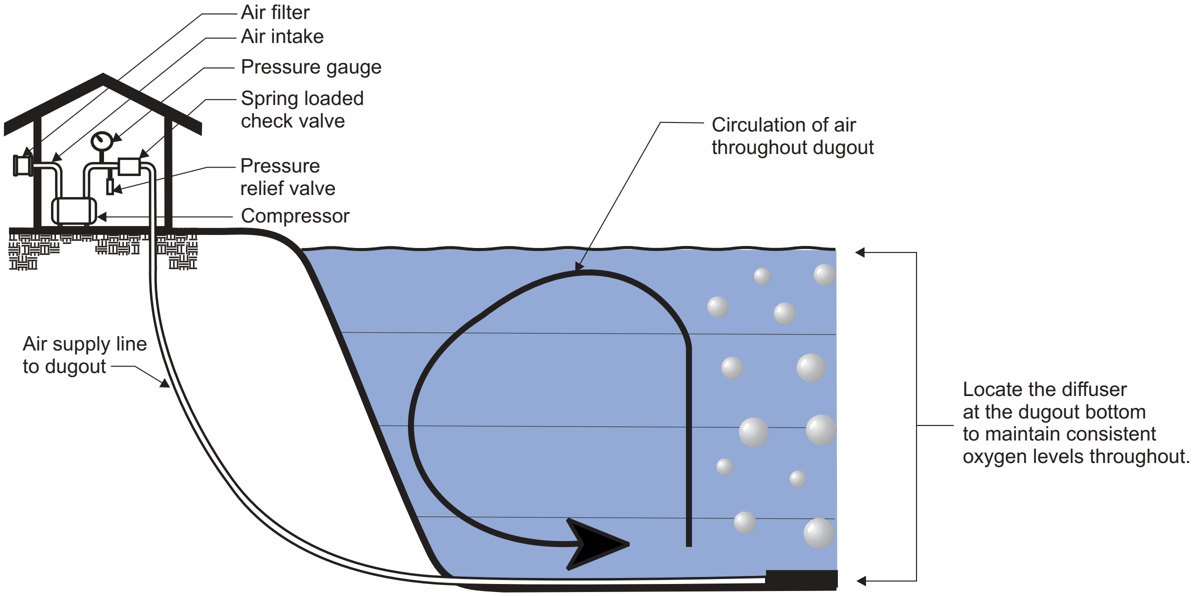


Figure 30 Airstone Diffuser

Figure 31 Linear Diffuser

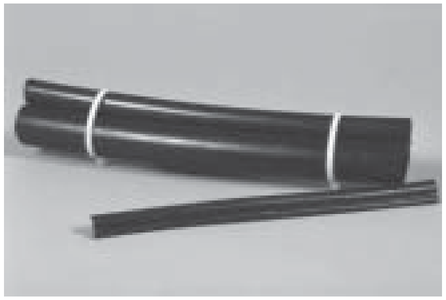
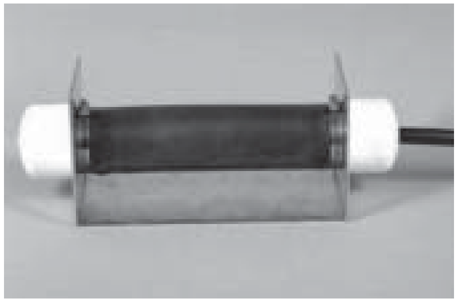


Figure 32 Membrane Diffuser



Safety

During winter, dugout aeration systems can result in open or weak areas in the dugout ice. These conditions can be very dangerous for young children, pets, and people snowmobiling at night. It is essential to educate your children about these hazards and post the area with highly visible warning signs and fluorescent snow fence around open water areas.

Pasture Water Systems for Livestock

Today, livestock producers want to provide a safe, reliable supply of good quality water for their livestock. They also want to better utilize their pasture dugouts. Direct watering of livestock from dugouts causes a number of environmental, herd health, and pasture utilization problems:

Problems with Direct Watering

Direct access watering has a negative effect on water quality, herd health, and the lifespan of the farm dugout:

- Fecal pathogens are directly added to the water allowing for rapid spread throughout the herd. Problems may also arise due to pathogens causing footrot.
- Nutrient loading from excrement will lead to proliferation of algae populations and in some cases the production of toxins from cyanobacteria.
- Oxygen depletion results from the biological breakdown of excrement.
- Destruction of side-slopes from hoof action speeds sedimentation and shortens the life of a dugout.
- Cattle are sensitive to taste and odour in water supplies, and may limit their intake of less palatable water, possibly leading to reduced feed conversion and productivity.

There is enough dissolved phosphorus in the manure from one cow in one day to cause an algae bloom in 265,000 gallons (over 1,000,000 liters) of water.

The amount of oxygen needed to decompose the manure from one cow for one day will deplete all the dissolved oxygen in 8,000 gallons (over 30,000 liters) of water.

Options to Direct Watering

Some of the most common livestock watering alternatives involve complete exclusion of animals from the water source:

- Water hauling
- Gravity-fed reservoirs
- Pumped gravity flow reservoirs
- Animal-operated pasture pumps
- Pipelines from nearby water sources
- Gas powered pumping and generator systems
- Solar-powered pumping systems
- Wind-powered pumping systems
- Flowing water driven pumps including sling pumps, paddle pumps, and hydraulic ram pumps
- Air compressor pumps.

Many producers are also looking at winterizing their pasture water systems so that the pasture season can be extended and winter feeding done on pasture.

Remote Watering Equipment

Essentially, a watering system requires a water source, a pump, storage of either water or power, and a watering device. Today there is a variety of livestock watering methods available to suit any type of pasture and location. The power options to move water to livestock include solar, wind, fuel, stream flow, main line electricity, and gravity flow. Selecting the most appropriate one can be a challenge. Establish a list of priorities and try to use some of the natural advantages of the site and equipment. Figure 33 illustrates an example of a solar powered watering system.

An effective and well-planned pasture water system is a very important part of all livestock grazing plans. Planning for remote watering of livestock, at the same time as planning for dugout construction and operation, is recommended.

Figure 33 Solar Watering System