

Tile Drainage Pump Stations for Farm Fields



(NDSU photos)

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Installing perforated pipe below the surface of a field to remove excess water is referred to as subsurface drainage, commonly called tile drainage.

A typical tile drainage system has a number of small laterals, 3, 4 or 5 inches in diameter, that drain water to larger-diameter submains and mains. All the collected water from the tile laterals and mains flow to an outlet point on the edge of the field to discharge to an open ditch or other surface water body.

The outlet is at the lowest elevation of the tile system and may end up lower than the elevation of the bottom of the discharge channel. This situation requires a pump to lift the water to the discharge channel, where it will flow to a river or stream. Sometimes using a pump station will be necessary to lift the water over a hill or rise that is between the field and the discharge channel.

Need for Field-size Pump Stations

A pump station increases the investment in a tile drainage system significantly, but often it is the only option for moving the tile drainage water to the outlet. Common conditions requiring a pump station are:

- **The outlet ditch is shallow** — Often in flat topography such as the Red River and Souris River valleys, the only available outlet is a road ditch. The bottom of many road ditches is about 2 to 3 feet below field elevation, but the tile main at the outlet can be 6 to 7 feet below field elevation; thus, the water from the main must be lifted into the outlet ditch.
- **The downstream water elevation is controlled by a culvert or road** — Changing the outlet elevation by lowering the culvert or digging through the road may be possible so that a pump station is not needed; however, local governance and adjacent landowners may object.
- **The outlet ditch fills with water after a large rain and stays that way for more than three days** — If the outlet ditch is full, it will not let the tile drainage system drain at the design rate and the lower part of the field may stay saturated for a long time.
- **You need to control the amount of water that leaves the field** — During the growing season, lift pumps can be turned off to hold subsurface water in the field. Likewise, they should be turned off during snowmelt flooding situations.
- **You need grade control of laterals in the field** — Often the outlet elevation is in that gray area of design where it is *almost* deep enough to use as a gravity outlet. However, it may require shallower drains with very shallow grades on the laterals in the field, thus affecting the drainage intensity. A lift station will allow for deeper drains and increase the grade of the laterals, which may change the lateral spacing enough to pay for the lift station.

Locating the Pump Station

Most pump drainage stations are sized for farm fields of 240 acres or less. Most pump stations operate automatically based on flow from the tile system. When tile flow begins, the pump may run continuously for a few hours and then intermittently for three to 14 days, assuming no additional rain is received.

The preferred power source is electricity from the grid because it is reliable and consistent (Figure 1). Selecting a good location for the lift station is important. Some items to consider:

- **Identify the location of the nearest power line —** Electric lift pumps can be specified to use single or three-phase power, but the most common is single-phase power (220 volts alternating current). Placing the lift station near power lines can alter the design of the tile system. For instance, on flat fields, the slope of the main can be altered so that the pump station is near the power line, whereas in other fields, changing the location of the lift station may not be possible, and the discharge pipe may need to extend several hundred feet.
- **Many rural electric suppliers charge for extending power lines more than a certain distance —** The cost to extend power can add substantially to the total cost of the tile project. In these cases, engine-powered

generators that automatically start based on the water level in the sump can be used. One drawback to using engines is that they require periodic maintenance, such as changing the oil every 100 to 150 hours of operation.

- **Flow from the pump discharge pipe should not drop directly into a road ditch —** Federal, state and county transportation officials worry about ditch bank erosion and prefer that the water be directed into a channel before it enters a road ditch. Rock and other structures often are used to absorb the energy of the discharge water to reduce ditch erosion.
- **The pump station needs to be located where it is accessible at all times, including right after a large precipitation event —** It should be on high ground and accessible by pickup or an ATV. It should not be near a surface runoff ditch to prevent the lift station site from being flooded. A lift pump may malfunction during or after a large storm event, and working on it is difficult when it is surrounded by water.
- **Consider the impact of the pump station discharge on downstream neighbors —** Pump stations can run intermittently for a long time after a rain event. The receiving ditch stays wet for extended periods, thus providing a place to nurture mosquitos and cattails.



Figure 1. A tile drainage pump station is near power lines. (NDSU photo)

Basic Pump Station

A pump station for tile drainage is very similar to basement sump pumps in many houses and businesses. It has a sump with some type of casing material and an inlet for the tile main, a pump with water level controls, a power panel, a discharge pipe and a cover with an access door.

The Sump

The sump is the cased hole in which the pump resides (Figure 2). The hole is held open by a casing material that can be plastic, concrete or metal (Figure 3). Metal casings require a water- and soil-proof coating to prevent corrosion.

The sump is often 3 or 4 feet in diameter, but it can be much larger for float-controlled pumps. The minimum diameter is 3 feet, but that just barely allows space for the pump, riser pipe and water-level controls.

Plastic sumps (sometimes called ag catch basins) with built-in stubs or connectors for 15- to 24-inch-diameter pipe are available from tile manufacturers. The sump depth is typically 10 to 15 feet, but some can be deeper.

The bottom 3 feet of the sump accommodates the pump, and about 3 feet above the pump is for storage. Most tile mains are about 7 feet below the ground's surface, and the casing extends at least 2 feet above the ground's surface. The average sump casing length is about 13 feet.

To provide stability for the pump, about 6 inches of crushed rock can be placed at the bottom of the sump. In some cases, the clay soil at the bottom of the sump is solid and no rock is added. Manufactured sumps often include a base plate of metal or plastic. The sump has a cover of wood or metal with an access door (Figure 4).

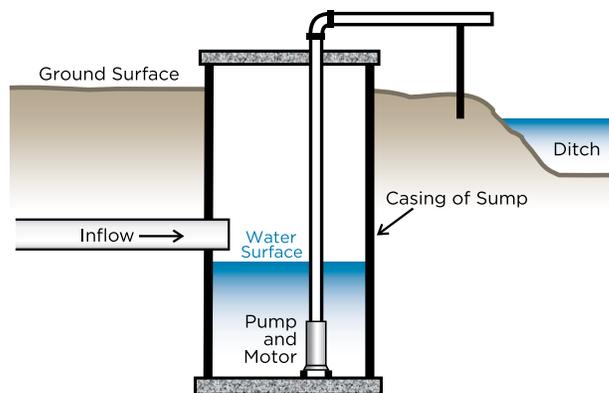
Figure 2. This is a typical field-sized subsurface drainage pump station. This installation has a submersible pump. Plastic, concrete or metal commonly are used for the casing material. The pump can be turned on manually but automatic operation is more common. (NDSU illustration)



Figure 3. This drainage lift station uses a manufactured plastic sump casing with a metal cover containing a submersible pump. This photo was taken in mid-November when the temperature was below freezing. (NDSU photo)



Figure 4. A concrete casing with metal cross beams supports the weight of the pump in this drainage lift station. This lift station also has a wooden cover with an access door. (NDSU photo)



Pumps

Low-head pumps with axial or mixed-flow impellers are used in drainage lift stations. The pumps can be submersible or shaft-driven (Figure 5). Pumps need about 3 feet of water above the inlet for anti-vortex protection and, for submersible pumps, cooling for the motor.

The weight of a submersible pump will rest on the bottom of the sump; however, the weight of a shaft-driven pump rests on the sump cover. Plastic sumps have been known to slump due to the weight of the pump; thus, additional support may be needed (Figure 6).

Ditch fires are common in the country and plastic sump casings are susceptible to burning; thus, a metal cap can provide protection.

Pump Sizing

To select the proper size pump, the maximum flow rate into the sump and the total “head” of lift must be estimated or determined. A “drainage coefficient” value was selected to design the tile drainage system for the field. This same drainage coefficient value is used to determine the maximum flow rate of the pump.

The drainage coefficient is defined as the depth of water to remove from the soil in 24 hours. In the Red River Valley, selecting a $\frac{3}{8}$ -inch drainage coefficient is common, but some have used a $\frac{1}{4}$ -inch drainage coefficient for their tile systems with no detrimental effects.

The maximum pump flow rate for a given field area can be estimated with the following formula:

$$\text{Maximum pump flow rate (gpm)} = 18.9 * Dc * \text{Area} \quad (1)$$

where: **Dc** is the design drainage coefficient (fraction of an inch per day)

Area is the number of acres draining into the sump

Table 1 shows the maximum flow rate per acre that will flow into the sump for selected drainage coefficient values.

The total head is the sum of the vertical lift distance, measured from the water surface in the sump to the point of discharge, and the friction loss through the pipes, elbows and connectors (Figure 5). The vertical lift will vary with each

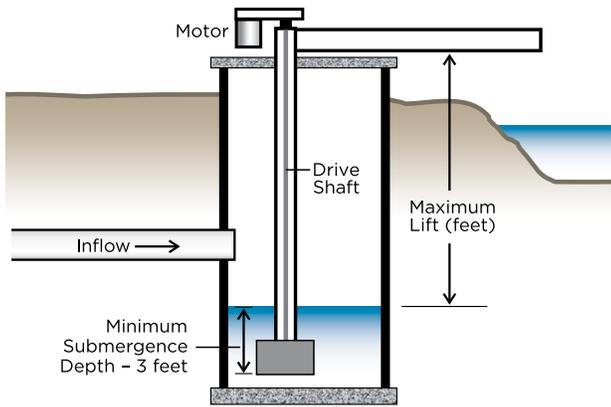


Figure 5. The motor is above ground in this shaft-driven lift station pump. (NDSU illustration)



Figure 6. A metal frame is used to support the weight of a shaft-driven pump on a plastic sump casing.

(Photo courtesy of Ranger Pump Co., Vesta, Minn.)

Table 1. The 24-hour volume and flow rate produced per acre for a design drainage coefficient.

Drainage coefficient (acre-inches per day)	Gallons of water from one acre of land	Average gallons per minute of flow per acre in 24 hours (1,440 minutes)
$\frac{1}{4}$	6,800	4.7
$\frac{3}{8}$	10,210	7.1
$\frac{1}{2}$	13,610	9.5
$\frac{3}{4}$	20,420	14.2

drainage pump station, but a common distance is about 12 feet.

Friction loss always occurs when water flows through pipe. The amount of friction loss depends on the flow rate and the inside diameter of the pipe. Polyvinyl chloride (PVC) and dual-wall polyethylene (PE) pipe have similar friction loss characteristics. Table 2 shows the friction loss in plastic pipelines per 100 feet of length:

In addition to the friction loss of water passing through the pipe, additional head loss always occurs when water changes direction or is constricted, such as through elbows, tees or flow meters. Smooth elbows and connectors commonly are used in lift stations, and the friction loss for these are typically about one-fourth of the values shown in Table 6.

For a typical lift station, if the flow rate is 700 gallons per minute (gpm) going through 20 feet of 8-inch-diameter PVC pipe with an elbow at the surface (Figure 5), the friction loss would be 0.76 plus 0.19 feet ($0.76 \times \frac{1}{4}$), or 0.95, for 100 feet of pipe, but for 20 feet of pipe, it would be one-fifth this value, which equals 0.19 feet.

Example: You need to select a pump for a tile project that will drain 100 acres at a $\frac{3}{8}$ -inch drainage coefficient. The invert of the tile inlet to the sump will be 7 feet below the surface, and the sump extends 2 feet above the ground surface. The average pumped water level will be about 1.5 feet below the tile invert. The discharge pipe will extend 15 inches (1.25 feet) above the sump cover and 12 feet from the sump. The discharge pipe diameter will be 8 inches.

Solution: a $\frac{3}{8}$ -inch drainage coefficient will produce a maximum of 7.1 gallons per minute per acre (Table 1). For 100 acres, the required pump flow rate will be 710 gallons per minute ($7.1 \text{ gpm/acre} \times 100 \text{ acres}$). The maximum head will be 12 feet of vertical head (1.5 feet below invert plus 7 feet below ground level plus 3.25 feet to pipe discharge level) plus about 0.25 feet of pipe and fittings friction loss. Call a pump supplier or find a pump that can move about 710 gpm at about 12 feet of head.

Power Requirements

The pump power requirements are dependent on the lift and flow rate. For most lift stations, the electric motor size can be 3, 5, 7.5, 10, 15 and 20 horsepower. The motors can be selected to run on single-phase or three-phase power, whichever is available. Assuming a 30 percent efficient pump (typical for low-head pumps), Table 3 provides an estimate of the required electric motor size.

Table 2. The friction loss in plastic pipelines given in feet of loss per 100 feet of pipe. The friction loss is not shown for pipe diameters and flow rates that are impractical to use.

Friction Loss in Plastic Pipelines per 100 feet of Length (feet of head)					
Flow Rate (gpm)	Pipe Diameter (inches)				
	6	8	10	12	15
300	0.6	0.16	0.06		
500	1.6	0.40	0.14		
700		0.76	0.25	0.10	
800		0.92	0.32	0.13	
900			0.40	0.16	
1,000			0.48	0.20	0.07
1,500				0.42	0.14

Table 3. Pump motor size in horsepower required based on total pumping head and peak flow rate, assuming a pump efficiency of 30 percent.

Total Head (feet)	Pump Motor Size (horsepower)				
	500 gpm	750 gpm	1,000 gpm	1,250 gpm	1,500 gpm
8	3	5	7.5	10	10
10	5	7.5	10	10	15
12	5	7.5	10	15	15
14	7.5	10	15	15	20
16	7.5	10	15	20	20

Most electric suppliers do not recommend single-phase motors greater than 10 horsepower; thus, where a pump requiring a 15-horsepower motor is needed, two pumps with 7.5-horsepower motors could be used instead. In this situation, the pump controls would be arranged so that the two do not turn on at the same time.

Pumping Costs

The annual per-acre cost to pump water will depend on the size of the motor, the number of pump starts, the number of pumping hours and local electric rates. These can be quite variable, but the following example may provide an estimate of the pumping costs.

In northwestern Minnesota, 2010 was a very wet year, and a farmer in the area had more than 25 lift stations to handle the flow from about 5,000 acres of tilled land. From April to November, he recorded almost 35 inches of rain. From 25 electric meters, the total electric bill for the year was \$30,000, or an average of \$6 per acre. However, the range was from \$3 to \$10.50 per acre, with the exception of two small fields (less than 70 acres), which were at \$12.50 and \$15 per acre.

Pump Flow Control

Some pumps are started and stopped manually, but the majority of pumps are designed for automatic start/stop operation. Two methods of automatic operation are in use: float control and water level control.

Float-controlled Pumps

Controlling a drainage pump with floats has been used for many years. It works like this: When the water in the sump rises to a set height, the float turns the pump on, and when the water drops to a certain level, the pump shuts off (Figure 7).

This is the same as the sump pump in the basement of many houses; the only difference is the volume of water and the size of the pump. Unlike a household sump pump, these pumps are not designed to run for very short periods of time (less than 30 seconds). To increase the pumping time, a storage volume must be included in the design.

Sump Storage Volume

The required storage volume is based on the number of times the pump turns on per hour. A pump cycle is the time in minutes when the pump turns on, shuts off and then turns on again. Most pump manufacturers do not recommend more than 10 cycles per hour, which means the pump turns on about every six minutes. The required volume of storage can be calculated with the following formula:

$$\text{Storage volume (cubic feet per acre)} = \frac{2 * \text{max flow rate of the pump (gpm)}}{(\text{Number of cycles per hour})} \quad (2)$$

Ideally, the maximum flow rate of the pump should equal the drainage coefficient selected for the tile drainage project (Table 1).

Example: Design a lift station for 100 acres where the tile system is designed for a $\frac{3}{8}$ -inch drainage coefficient and 10 is the maximum number of pump cycles per hour.

Solution: Table 4 shows that for 10 cycles per hour and a $\frac{3}{8}$ -inch drainage coefficient, 1.4 cubic feet of storage is required per acre; thus, the amount of pump storage from the pump-on water level to the pump-off water level must be 140 cubic feet (100 x 1.4).

Storage volume can be achieved in a vertical direction, with horizontal pipe or a combination of the two (Figure 8).

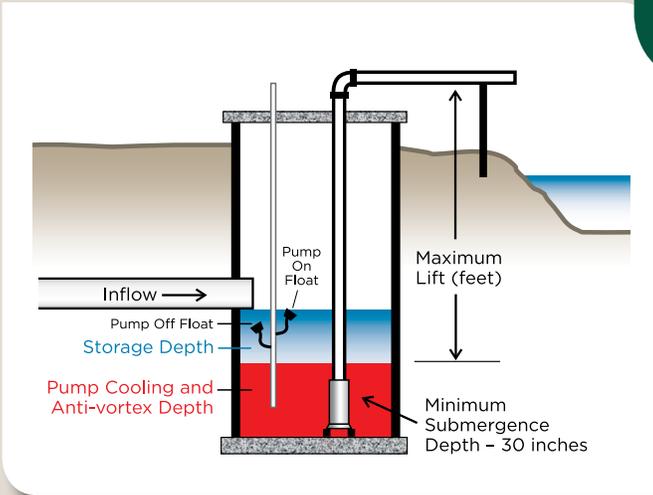


Figure 7. Float-controlled pumps allow for automatic operation. In this illustration, the water has risen to the level where the pump-on float will turn on the pump. As the pump removes water from the sump, the pump-off float will drop down 30 to 36 inches, at which time it will shut off the pump. (NDSU illustration)

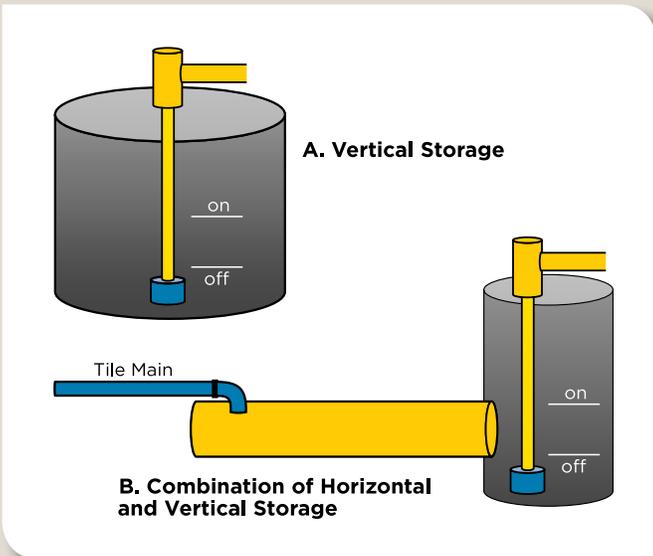


Figure 8. This illustrates common options for creating water storage in the sump. (NDSU illustration)

Table 4. Cubic feet of storage for each drained acre based on drainage coefficients and desired maximum pump cycles (equation 2).

Drainage Coefficient	Storage in Cubic Feet per Acre			
	Cycles per hour			
	6	8	10	15
$\frac{1}{4}$	1.6	1.2	0.9	0.6
$\frac{3}{8}$	2.4	1.8	1.4	1.0
$\frac{1}{2}$	3.2	2.4	1.9	1.3
$\frac{3}{4}$	4.7	3.6	2.8	1.9

Vertical Storage

Most sumps are circular, and storage in the sump will be the volume between the pump-on and pump-off levels. The diameter of the sump must be selected to achieve the desired storage volume.

A common distance between pump-on and pump-off is 30 to 36 inches. The required diameter for vertical storage is given in Table 5, assuming a maximum of 10 pump cycles per hour. For larger acreages, the diameter of the sump is so large that excavation and installation become a problem.

Combination Horizontal and Vertical Storage

To reduce the diameter of vertical storage, many tile installers and farmers use horizontal storage with a small diameter (3 to 4 feet) vertical sump (Figure 8).

Horizontal storage is much easier to install than large-diameter vertical storage. Horizontal storage is a length of buried 18- to 24-inch-diameter dual-wall corrugated plastic pipe connected to the vertical sump (Figure 9). The length is dependent on the number of acres draining into the pump station.

The tile main drains into the top of the horizontal storage pipe. The length of required horizontal storage can be calculated with the following formula:

Horizontal storage (feet of length) =

$$\frac{8 * q * A}{\pi * D_h^2 * N} - \left(\frac{D_v}{D_h} \right)^2 * d \quad (3)$$

Where:

- q - Drainage coefficient flow rate per acre (gpm/ac from Table 1)
- A - Area to be drained (acres)
- D_v - Diameter of the vertical sump (feet)
- $\pi = 3.14159$
- D_h - Diameter of the horizontal storage pipe (feet)
- N - Number of pump cycles per hour
- d - Distance between the pump on/off floats

For example, the required length of 2-foot-diameter horizontal storage connected to a 4-foot vertical sump is shown in Table 6, assuming a maximum of 10 pump cycles per hour.

Because the flow rate of most field lift pumps is more than 500 gallons per minute, the pump often will run for less than two minutes. In this short pumping time, when the required horizontal storage is more than 60 feet of linear length, all the water in the horizontal storage cannot get to the pump. Thus, for larger acreages requiring more than 60 feet of horizontal

storage, installers will make a tee or cross at the inlet to the vertical sump by placing 30 or more feet of horizontal storage in one direction and 30 or more feet in the other direction.

Table 5. Sump diameter required to provide the necessary storage so that the pump does not come on more than 10 times per hour at design flow rate.

Drainage Coefficient	Sump Diameter for a Float-controlled Pump (36-inch on/off)(feet)					
	Area Drained (Acres)					
	40	80	120	160	240	320
1/4	4	6	7	8	10	11
3/8	5	7	8	10	12	14
1/2	6	8	10	11	14	16
3/4	7	10	12	14	17	19

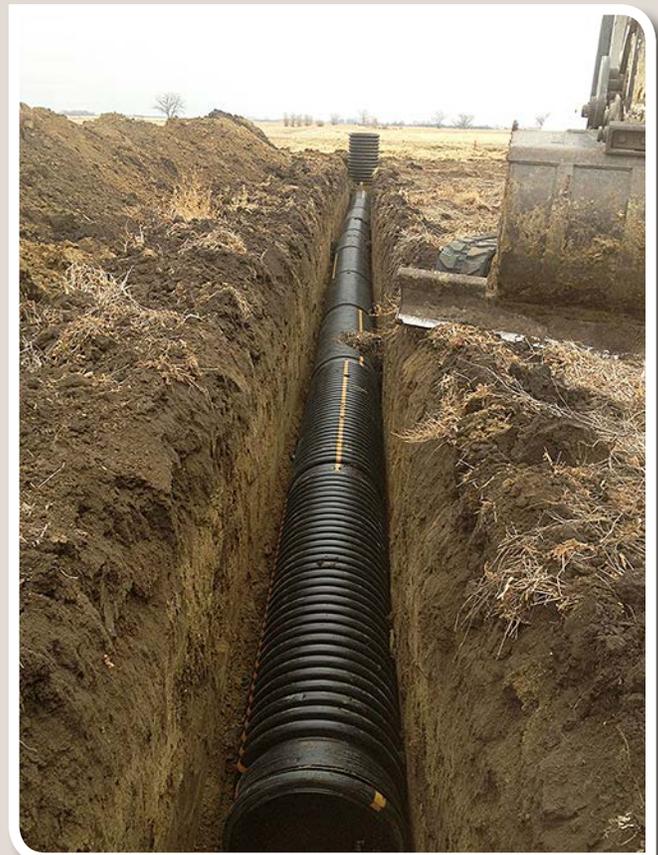


Figure 9. Two-foot-diameter corrugated plastic tile provides horizontal storage. (Photo courtesy of Ranger Pump Co., Vesta Minn.)

Table 6. Length in feet of 2-foot-diameter horizontal storage required to keep the maximum number of pump cycles per hour below 10.

2-foot-diameter Pipe for Horizontal Storage, Float-operated Pump (3-ft on/off) (feet)						
Drainage Coefficient	Area Drained (Acres)					
	40	80	120	160	240	320
¼	Not needed	11	22	34	57	80
⅜	6	24	41	59	95	131
½	12	36	61	85	133	182

Pump Controlled With a Variable-frequency Motor Drive (VFD)

A recent innovation is the use of variable-frequency motor controllers, commonly called VFDs, to control the lift pump motor. A VFD converts single or three-phase input electrical power to variable-frequency three-phase output power.

A pump driven with a three-phase motor provides several advantages vs. single-phase motors because three-phase motors are generally less expensive and physically smaller than single-phase motors. With three-phase power, soft-start options can be used to reduce the in-rush current and put less strain on the motor so it lasts longer.

With the ability to vary the frequency of the motor, the pump rotation speed (revolutions per minute, or rpms) will vary, thus changing the pump flow characteristics. A water level sensor provides feedback information from the sump to the VFD, which determines the pump rpm to maintain a set water level in the sump (Figure 10).

When the drainage flow is low, the pump's rpms are low, and when the drainage flow is high, the pump's rpms are high. Thus, the flow rate of the pump can be matched to the flow rate of the drainage water entering the sump.

A VFD-controlled pump runs continuously until very low drainage flow occurs. At this point, it acts like a float-operated pump and may turn on for short periods of time. This significantly reduces the required storage volume (Figure 11).



Figure 10. A pressure transducer box and pipe are part of this VFD-controlled pump. (NDSU photo)

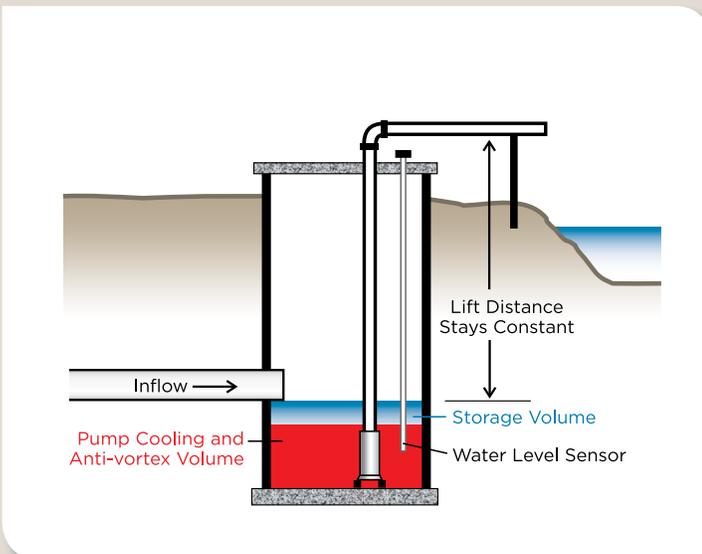


Figure 11. Variable-frequency drive (VFD)-controlled pumps still need some storage but not as much as a float-controlled pump. The water level commonly is sensed using a pressure transducer at the top of a 2-inch pipe. As the water level changes in the sump, the air pressure will change in the pipe. The pressure transducer senses this and provides a signal to the VFD to vary the rotation speed of the pump.

(NDSU illustration)

Pumping Long Distances

Two Pumps in a Sump

More than 95 percent of the time, the flow from the tile system into the sump is well below the design capacity. Thus, to reduce power requirements, two pumps, each about half the design capacity, can be installed in the sump.

For example, if the lift pump design requires around 1,400 gallons per minute, two 5-horsepower pumps could be installed instead of one 10-horsepower pump (Table 3). This adds investment cost but reduces the power usage.

Installing a pump station can be difficult and expensive. Often, after the initial tile installation project, additional land nearby is tilled. The sump from the first project is used as the outlet for the expansion and a second pump is added.

A second pump in the sump requires changes to the pump control system. When pumping is required, the control system can be set up in two ways. The controls can be programmed to alternate pumps between pump cycles or one pump can be designated as the primary, and if it cannot keep up with drainage inflow, the water will rise in the sump and the secondary pump will turn on.

In some installations, the water outlet may be some distance from the pumping station, requiring the use of a pipeline (Figure 12). Frequently, the pipeline has to go over the top of a rise to get to the outlet. In this situation, sizing a low-head pump requires the following information:

- **The maximum design flow rate from the tile drainage system** — Use equation 1 to calculate this quantity.
- **The total head (or lift) at the maximum flow rate** — The total head of the pump will be the sum of the vertical distance from the water level in the sump to the highest point of the pipeline, plus the friction loss in the pipeline and fittings.

Generally, PVC pipe will be used, but in some instances, dual-wall corrugated PE pipe may be an option. If dual-wall is used, check with the manufacturer concerning pressure rating of the pipe and, especially, the fittings and connectors.

When specifying a pump, manufacturers always want the desired flow rate and total pumping head at that flow rate.

Example: Specify the pump characteristics for a tile system designed with a drainage coefficient of $\frac{3}{8}$ inch for 100 acres of land where the water has to be lifted over a 10-foot rise between the low-water level in the sump and a discharge point that is 1,000 feet away.

Solution: From Table 1, the maximum flow rate will be about 710 gallons per minute ($7.1 \text{ gpm/ac} \times 100 \text{ ac}$). Assume a 9-foot lift from the water surface in the sump to the connection point of the pipeline. The total vertical lift will be 19 feet, but we need to determine the friction loss in the pipeline. The total head will depend on the diameter of pipe selected (assume PVC is used), and at 700 gpm, from Table 2, we can select 8-, 10- or 12-inch-diameter pipe. Multiply the values in Table 2

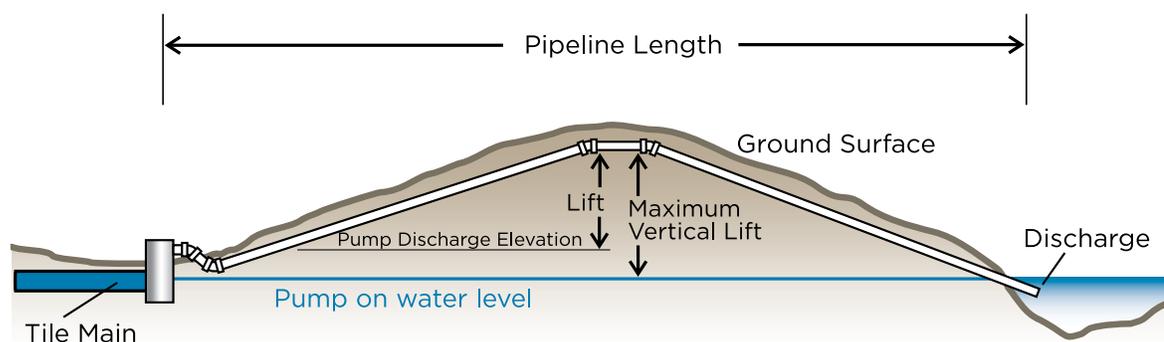


Figure 12. A drainage pump station is used to lift water over a hill to the outlet. (NDSU illustration)

by 10 to get the friction loss for a 1,000-foot pipeline. The friction loss for these three diameters will be 7.6, 2.5 and 1 feet, respectively. The total head will be 19 feet plus these values. With 8-inch pipe, the total head will be about 27 feet (assume 0.5 feet of loss for fittings), 10-inch pipe will have about 22 feet and 12-inch pipe will have 20.5 feet.

As you can see, the pipe diameter is a tradeoff, with low friction loss for large-diameter pipe, but large-diameter pipe is much more expensive than smaller-diameter pipe. In addition, the total head will affect the horsepower requirements for the pump. A pump's efficiency drops off when the head becomes too great.

However, we have calculated the pipe friction loss for the **maximum flow rate** of the tile system. Measurements have shown that more than 95 percent of the time, the flow rate is less than half the maximum. Thus, the flow rate for this system often will be less than 350 gpm, so the 8-inch pipeline should be selected. You may be tempted to save money and try 6-inch pipe, but even at 350 gpm, the friction loss would be too great.

Long discharge pipelines, especially those that rise away from the pump, will require a check valve; otherwise, you will have water hammer problems. Also, the pipeline will have to be drained for winter conditions. In some situations, air release valves may be needed at the highest elevation of the pipeline.

Alternative Power Sources

If the nearest power line is too far away from the pump station site, an alternative is to use an engine-driven generator to power the pump or drive the pump directly with an engine (Figure 13). These installations will require a fuel storage tank at the site. When tile flow occurs, an engine can be operated manually or wired to turn on automatically in response to high water levels in the sump (Figure 14).

Solar cells and wind turbines have been mentioned as alternative power sources, but both would require an energy storage system such as a large bank of batteries. Tile pumps can run intermittently for long periods of time (often seven to 14 days after a rain event); thus, a consistent source of power is required. No drainage lift stations are using either of these technologies.



Figure 13. A generator is used to power the VFD-controlled submersible pump in this drainage lift station.

(NDSU photo)

Management and Maintenance

Pump stations are water-control structures, which means they can be shut off to retain water in the field and turned on to remove excess water. During a normal growing season, fields often have excess water at planting and during harvest, and the pump will have to be turned on. However, after planting and early spraying (around the middle of June), the pump can be turned off to hold water in the soil for use by the growing crop.

Generally, with the pump turned off, the water level in the sump will rise to the average water level in the field. In some installations, turning off the pump is not practical because water will rise in the sump and spill out the top.

Pump stations require supervision and maintenance, especially in early spring and late fall. Pumps discharging water when the air temperature is below freezing can expect large ice formations at the outlet (Figure 3). During and at the end of winter, ice accumulating in the sump and on control wires, floats and riser pipes can cause damage. Often, the weight of the ice will pull wires from connections and dislodge floats.

Not all lift stations have a freezing problem, but for those that do, many farmers put a stock tank water heater in the sump to prevent ice formation. Above-ground pumps usually require periodic oil or grease.

After a heavy rain or during flooding conditions, making sure the pump is operating is common. In the past, a site visit was required, but now remote monitoring systems are available that notify the owner via smartphones and other digital devices when problems occur at the pump station. In addition, the water level in the sump can be monitored, thus allowing better water table management in the field.

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Figure 14. This engine powered drainage lift pump is controlled by water level sensors in the sump.

(Photo courtesy of Ranger Pump Co., Vesta Minn.)

A pump station increases the investment in a tile drainage system significantly, but often it is the only option for moving the tile drainage water to the outlet.