Watering Systems for Grazing Livestock

Great Lakes Basin Grazing Network
and
Michigan State University Extension

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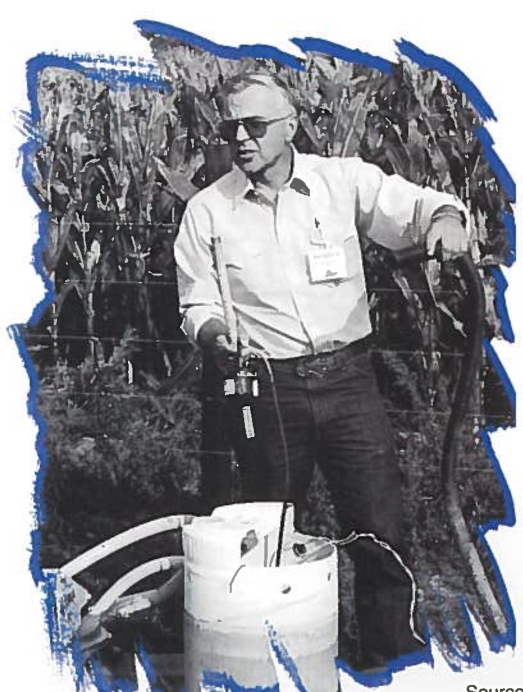
Purpose

This booklet will help you

1. Provide "how to's" for setting up water systems that will serve your livestock, your grazing systems and the environment.
2. Explain the role water systems can play in livestock production, pasture production, and the impact livestock can have on wetlands, riparian areas and the environment.
3. Determine requirements for water sources, livestock and various delivery systems.
4. Identify other information sources about various watering systems.

Credits

The Great Lakes Basin Grazing Network funded the major portion of this booklet and much of the on-farm information. The Great Lakes Basin Grazing Network was funded by the Great Lakes Protection Fund and is organized by the Wisconsin Rural Development Center, Mount Horeb, Wisconsin.



Source: Michigan Hay and Grazing Council.

Author

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Publication design and layout, Steve Deming, Hickory Graphix and Associates.

How to put a water system together

Rules of thumb

Intensively grazed pastures

Where animals drink individually and there is less than 600 to 900 feet from water to far corner of paddock, provide a flow rate that supplies water in four to eight hours and use a small tank that allows two to four percent of herd to drink at once.

Continuously grazed pastures

Where animals drink as a herd and can graze more than 900 foot from water, provide a water tank that holds a minimum of one-quarter of total daily needs and accommodates five to ten percent of herd. The tank refill time should be one hour or less.

Daily animal water requirements

Animal	Gallons water	Range
Dairy cow	20	(15-25)
Beef cow pair	15	(12-20)
Yearling bovine	10	(6-14)
Horse	10	(8-14)
Sheep	2	(2-3)

Source: Michigan Hay and Grazing Council.

Plastic pipe sizing chart

Gallons per minute

Pipe diameter	Pipe length 100'	200'	350'	500'	750'	1000'	1500'	2000'	3500'	1 mile
1/2"	4	3	–	2	–	–	1	–	–	–
3/4"	8	8	6	5	4	3		2	–	1
1"	13	13	10	8	7	6	5	4	3	2
1-1/4"	23	23	21	19	15	12	9	8	6	4
1-1/2"	30	30	30	26	22	19	15	12	9	7
2"	50	50	50	50	43	37	29	25	18	15

Information from Kentucky Grazers Supply

Source: Michigan Hay and Grazing Council.

Examples

Number one

System: Intensively grazed
Animals: 60 dairy cows
Distance to water in paddock: less than 600 feet
Distance to water source: 1,500 feet from water source to most distant paddock
Daily water consumption: 60 cows x 25 gallons water = 1,500 gallons per day
Tank refill time: Four-hour = 240 minutes
1,500 gallons divided by 240 minutes = 6.25 gallons water per minute
Pipe size: (from chart page 2) = All 1-1/4-inch or the first 750 feet of 1-1/4 inch and the last 750 feet is 1-inch pipe.
Tank size: 25-gallon minimum

Number two

System: Continuously grazed
Animals: 40 beef cows
Distance to water in paddock: over 1,000 feet
Daily water consumption: 40 head x 20 gallons water per day = 800 gallons per day
Tank refill rate: 200 gallons divided by 60 minutes = 3.3 gallons per minute
Pipe size: (from chart page 2) = 3/4 inch
Tank size: 10 percent of cows to drink = four head. Four head at two feet per head = eight feet of tank circumference. 200 gallon tank is 2-1/2-feet by 7 feet = adequate spacing or 19 feet of drinking space

Number three

System: Intensively grazed
Animals: 200 dairy cows
Distance to water in paddock: less than 800 feet
Distance to water source: nearly one mile to well (4,000 feet)
Daily water consumption: 200 cows x 25 gallons per day = 5,000 gallons per day
Tank refill rate: Four-hour = 240 minutes. Refill = 5,000 divided by 240 = 20.8 gallons per minute
STOP! Maximum well output is 10 gallons per minute!
Well capacity is limiting

Options

Use bigger tanks in each paddock to allow extended refill (eight hours = 10.4 gallons per minute). Pipe size = first 2,000 feet use two-inch and the last 2,000 feet use 1-1/2-inch pipe **OR** use larger capacity stock tanks to allow for slower refill rates, especially in paddocks farthest away (compare the cost of bigger tanks vs. the cost of bigger pipe as a decision aid).

Number four

Source: Michigan Hay and Grazing Council.

System: Intensively grazed
Animals: 400 ewes and lambs
Distance to water in paddock: 660 feet or less
Distance to water source: 2,640 feet
Daily water consumption: 400 x 2 gallons water = 800 gallons per day
(**NOTE:** Daily water intake for sheep is highly variable depending on temperature and moisture content of grazed forage)
Tank refill rate: 800 gallons per day supplied in four-hour period or 240 minutes = flow rate of 3.3 gal/min.
Pipe size: (from chart, page 2) one inch for entire distance or one inch for 1,600 feet and 3/4 inch for last 1,000 feet.

Important: If sheep run out of water for whatever reason, even for a short time period, it is CRITICAL to have adequate drinking space or to be at the tank maintaining orderly animal access until the rush to get a drink is satisfied.

Number five

System: Intensively grazed
Animals: 70 stocker cattle (one semi-truck load)
Distance to water in paddock: Less than 900 feet
Distance to water source: 5,280 feet (one mile)
Daily water consumption: 70 head x 10 gallon/day = 700 gallons per day
Tank refill rate: 700 gallons divided by 240 minutes requires a flow rate of three gallons per minute – If this was a case where the one-mile away paddocks are only used for a limited period each grazing season i.e. 30-acre hay field grazed just once for 30 days in late August/September.

Cost comparison of four alternatives

1-1/4 inch pipe will provide four gallons/minute at one mile and one-inch pipe will provide two gallons/minute at one mile.

5,280 feet of 1-1/4 inch @ $.20/ft plus 10 percent for fittings plus a small tank = $1,250.
5,280 feet of one inch @ $.15/ft plus 10 percent for fittings plus a large tank = $1,050.
1,100 gal tank ($425) on your hay wagon plus fittings plus small tank = $550.
Pay neighbor $100 to pump water to paddocks for a month plus fittings plus small tank = $225.

It's important to remember that everyone's situation is a little different and it's necessary to pencil out the options. The key point is that the cost to supply water when pasture is available is almost always cheaper than not using the pasture and feeding mechanically harvested feed.

Source: Michigan Hay and Grazing Council.

Water's impact on the environment, grazing, livestock and pasture productivity

Environmental considerations

In most grazing situations, what is good for the environment will be good for the grazing livestock. When cattle damage creek banks and foul water with manure and urine, not only does wildlife suffer, but in many cases, livestock accessing the water will also suffer. In the past, the only alternative was fencing livestock away from the waterways, but recent research shows that in many cases, pumping water or improving water access combined with a managed rotational grazing plan optimizes animal performance, pasture use and wildlife in riparian areas.

Source: Michigan Hay and Grazing Council.

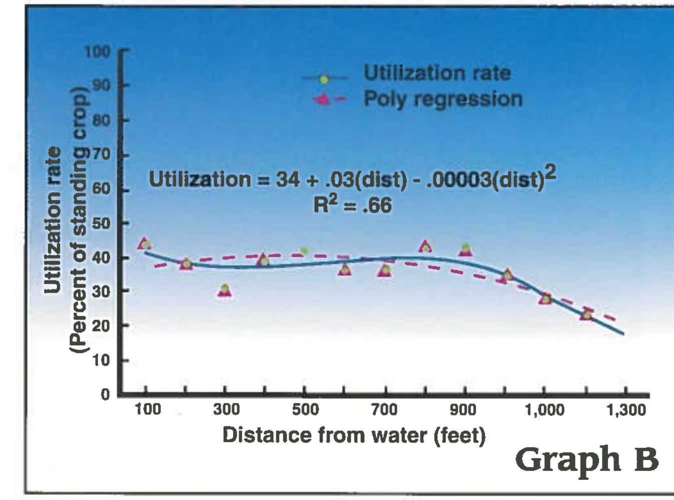
Research has shown that given a choice, cattle drink from a spring-fed water trough 92 percent of the time and only eight percent of the time from a stream. Luring cattle away from a stream reduces fecal streptococci bacteria in the water by 77 percent, nitrogen by 54 percent, phosphorous by 81 percent and total suspended solids by 90 percent.

Although electric fencing is the best way to keep cattle away from a stream, research underscores the usefulness of an alternative water source. In some situations fencing out livestock is the only option, for instance, trout streams can be very sensitive. Grazing may become a tool to harvest riparian areas and enhance wildlife habitat for woodcock or nesting waterfowl.

Livestock can often damage a water source, as in silting up ponds, or dugouts, requiring frequent maintenance and spring flows. If cattle go into a stream or pond to drink, it may be necessary to provide access sites, especially when the ground is saturated. Data from an Oregon trial demonstrates that providing watering sites and salt away from a stream decreases animal drinking and can increase performance. Recent research in Ontario has shown that cattle frequently drink from only a few limited access points. If stream bank degradation occurs, it may be due to lack of feed/pasture in the upland areas or the draw of shade.

Animal behavior and grazing efficiencies

One of the most exciting considerations when evaluating water systems is the impact that watering access can have on grazing behavior. While improved watering systems can have variable effects on individual animal performance, they frequently increase the amount of harvested forage and the output of milk or meat per acre. Missouri research has shown that when the distance to water approaches 900 to 1,000 feet, utilization of standing forage decreases (see Graph B). Research on Wyoming rangeland on a pasture of more than 2,000 acres, found that 77 percent of grazing occurred within 1,200 feet of the water source (a circle of 1,200 feet radius is less than 105 acres). More than 65 percent of the pasture was at least 2,400 feet from the water, but only supported 12 percent of the grazing.



Graph B

Source: Page 78, 1995 Missouri Grazing Manual, University of Missouri.

In another Missouri study, a 160-acre pasture only produced the equivalent of 130 acres of grazing when the cattle had to travel 1,320 feet or one-quarter mile to water. Providing water access that would have improved utilization in this example would increase the "pasture yield" by almost 19 percent.

Another factor regarding distance to water is ease of travel. In mountainous Oregon, cattle preferred grazing within 656 feet of water and mostly avoided grazing areas beyond 2,000 feet. In past water availability considerations, the most common criteria was whether the animal could reach water without using excess energy or hurting performance. Long distances to water can cause uneven grazing, with overgrazing near water and under-grazing (under-harvesting) in paddock far corners. This uneven forage harvest could potentially cost more on productive land that has seed and fertilizer improvements.

Additionally, when livestock travel more than 900 feet to drink, they travel as a herd. This whole-herd watering greatly increases the demand on the water tank and system's recharge capacity. Just as the forage usage depends on ease of travel, the desire to water as a herd is affected by the group's "flockingness," pasture visibility, level vs. hilly and other considerations. It's important to remember that watering access that is 900 feet or less from the farthest point in a paddock, increases forage use and reduces tank size and the water system's recharge capacity requirements.

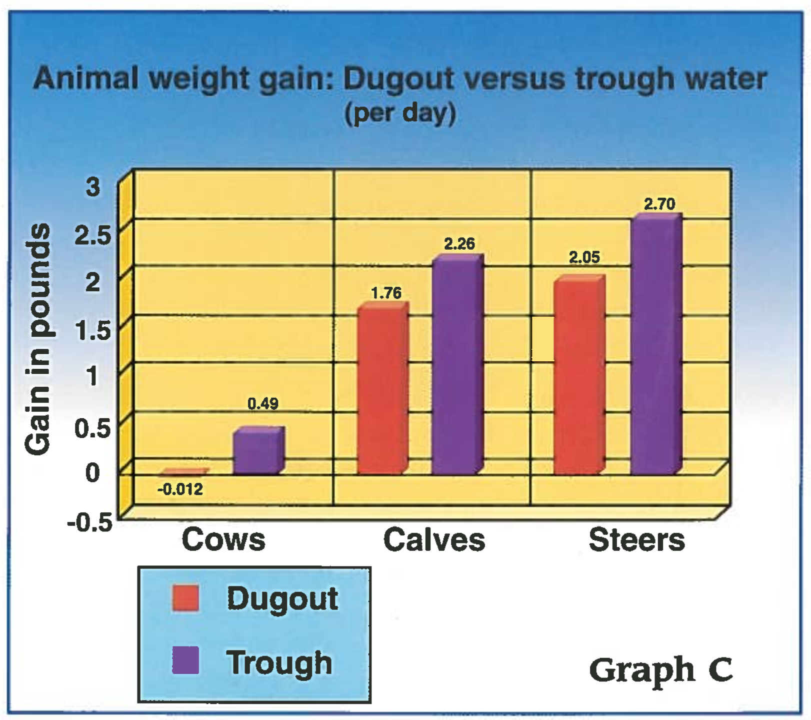
Source: Michigan Hay and Grazing Council.

Does water access and quality affect animal performance? It's hard to find research data that demonstrates a clear-cut performance advantage for water in each paddock. With high performance dairy cows, many farmers report increased milk output, two to five pounds per cow, when water is available.

Source: Ben Bartlett.

Lower producing animals, like dry beef cows, would be less likely to show the water access advantage. Nearby water access provides grazing animals the opportunity to reach their maximum output, barring any other limiting factors, such as forage quality and quantity, weather, etc.

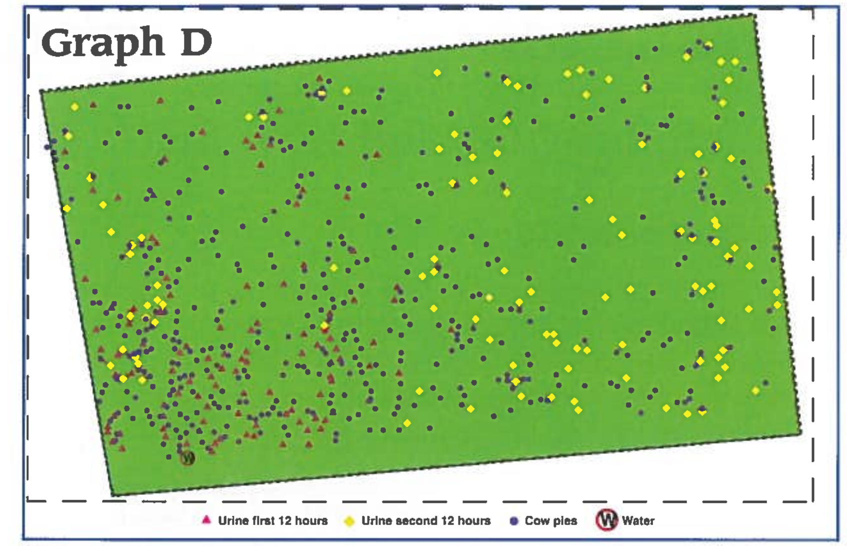
It's important to remember that water access also means adequate room at the tank to drink without undue peer pressure. When a herd of graziers travel to drink, the dominate animals take their fill and leave to graze or rest in the shade. Often the subordinate animals follow without adequate drinking or sometimes not drinking at all.



Source: Willms, W. D., 1996. Agriculture and Agri-Food Canada and Alberta Agriculture, Stavely, Alberta.

Water quality impacts animal performance as shown in research by Dr. Walter Willms, Lethbridge Alberta. He compared animal weight gain on trough (clean) versus dugout/pond (dirty) water (Graph C). This research is continuing with a focus on animal performance. Other research does not show increased animal performance on pumped vs. pond water, but given that no one has shown an advantage for dirty water, it's still recommended to only offer livestock water that you would drink.

Cow pies and urine distribution during a 24-hour period in an intensively grazed system.



Source: Steven P. Washburn, 1997, Animal Science Dept. NCSU.

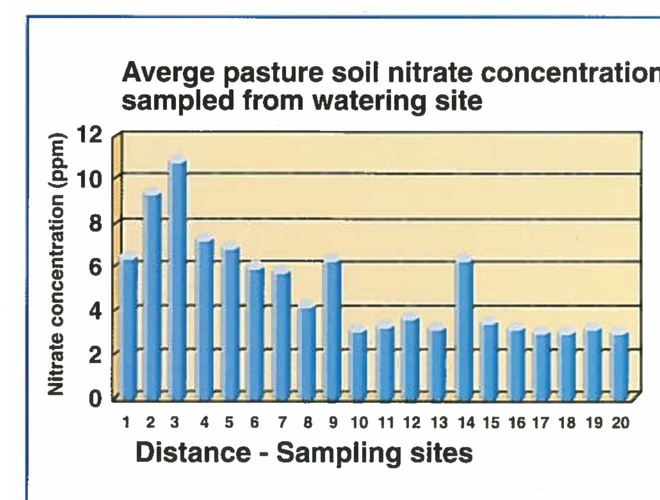
Pasture productivity

Nutrient distribution/management

A grazing cow returns 79 percent of the N, 66 percent of the P and 92 percent of the K she eats to the pasture. These nutrients don't always get recycled in the needed locations and in continuously grazed pastures, nutrients are often deposited near the shade, the water tank or the lane areas between the shade and water.

The livestock "mine" nutrients from around the pasture and redeposit them in concentrations that don't help pasture growth and may cause leaching around the water tank and shade. Missouri research has shown that using smaller paddocks and keeping water nearby promotes not only more uniform grazing, but also more random and uniform manure and urine distribution. In pastures where the water was less than 500 feet from the farthest point in the paddock, no relationship existed between soil test levels and distance from the water. When stock traveled as much as 1,100 feet to water, changes in soil test P and K levels were much greater nearer to the water. Graph D shows relatively uniform distribution of manure and urine across a paddock.

Michigan State University research shows pasture nitrate concentration pattern. Pastures were sampled along a line, every 10 ft. for the first 10 points starting at a watering site, then every 20 ft. thereafter. Sampling was done at Michigan farms and ag research stations.



Source: Richard Leep, 1995, Michigan State University.

Understanding water systems

How much, how far and how fast?

Water requirements

The values listed below show the daily minimums for a water system. Hot weather can more than double water requirements and combining this with less succulent forage can increase consumption four fold. The system should be able to handle double the intake, but the cost or practicality of a four-times system may be prohibitive. Be sure to have a back-up plan for hot weather situations.

You'll need to know livestock water needs to design the system and determine if your water source is adequate. If large mobs of livestock run together, the large amount of water required will not only tax the delivery system, but also might be greater than your well, spring or pond recharge capacity.

Animal	Gallons water	Range
Dairy Cow	20	(15-25)
Beef Cow Pair	15	(12-20)
Yearling	10	(6-14)
Horse	10	(8-14)
Sheep	2	(2-3)

Pipe and piping

Moving water up and out takes energy. There is friction in any pipe, though smaller diameter pipe has more friction or resistance to water flow than large-diameter pipe. New pipe with smooth insides has less friction than older pipe, so a system may lose pressure or flow over time, depending on the minerals in your water source. Increased flow rate also increases friction, so turning up the pressure to make the water flow faster will meet increasing resistance levels. Doubling the pressure doesn't double the flow–to double the water flow you must increase pressure four times. Therefore, if you try to increase flow rate by increasing pressure, you quickly reach your pipe's maximum working pressure.

Friction loss for 100 feet of plastic pipe

Delivery rate	Pipe diameter			
	3/4-inch	1-inch	1-1/4-inch	1-1/2-inch
8 gallons per minute	5.8 psi	1.3 psi	.4 psi	.2 psi
10 gallons per minute	8.4 psi	2.7 psi	.7 psi	.3 psi

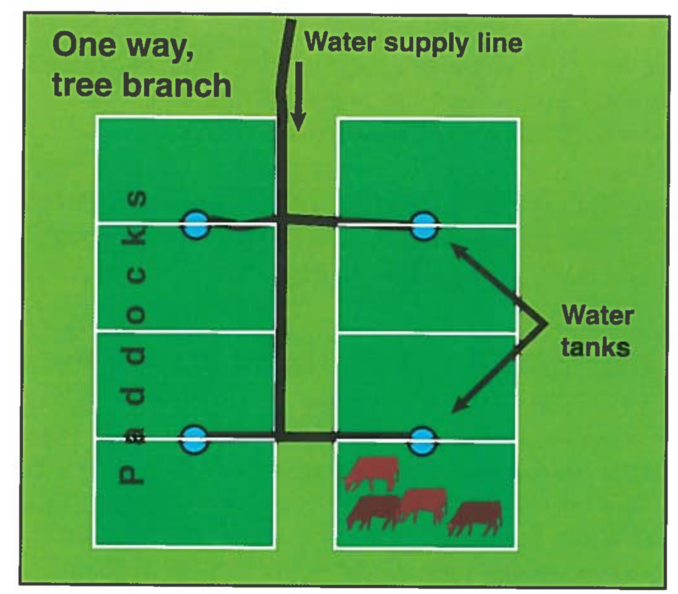
Each 2.3 foot in rise (or fall) decreases or increases water pressure by one psi. That means to pump water up a 200-foot well or up a 200-foot hill takes 86.9 psi (200 divided by 2.3 = 86.9). In addition to the pressure needed to move the water up the hill (87 psi for 200 feet in this case), also add the resistance in the pipe that travels up the hill (for example 7.6 psi in this case 1,000 feet, one-inch pipe and a flow of five gallons per minute), and the desired pressure of the water exiting the pipe to operate the float value, let's say 20 psi. This means you need a total of 87 + 8 + 20 = 115 psi.

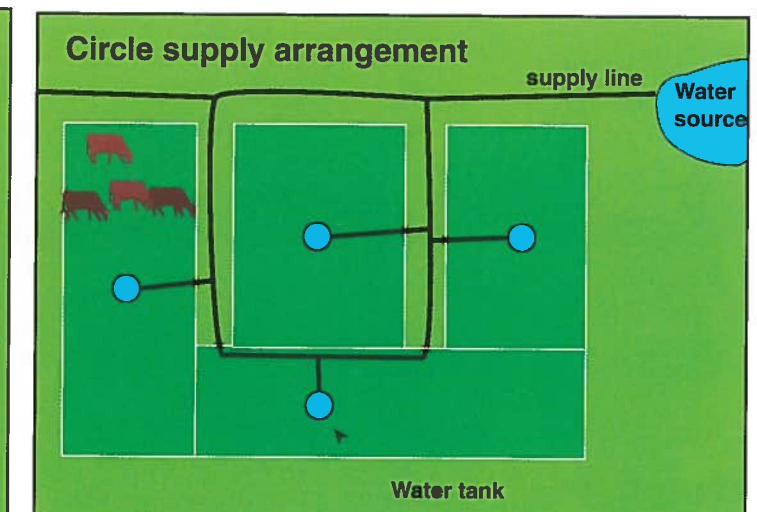
Going up hills, especially those more than 100 feet, takes special consideration and planning. Decreasing the required pressure to maintain flow means using full flow and low resistance valves to control the water level in the stock tanks, minimizing the number of elbows, corners and valves and using the larger size pipe. Larger pipe has less resistance since less of the water contacts the pipe sides.

System layout

Which is better, a tree branch system with pipe that goes out like a tree to the paddocks, or a circle system with piping that makes a loop around the paddocks and returns to the source? It depends on the paddock layout and cost. The advantage of the loop system is that it sends two lines to each tank. If your paddocks are straight away from the water source, it may be less expensive to use a larger pipe for the first half of the distance to increase the flow. Generally, the pipe's water carrying capacity increases faster than its cost, so one big pipe is cheaper than two smaller pipes of equal capacity.

White pipe was considered for above ground use because designers believed it decreased solar heating of water in the pipe. Since grass can grow over the pipe, and the pipe water mixes with the tank water, overly warm water is rarely a concern.





It's important to decide whether the waterline is buried or left on top of the ground. For most operations, the water lines will not be used in the middle of winter, so making them freeze-proof is not necessary. Often, people want to "trench in" the line 12 to 18 inches to protect it and offer some frost protection. The trade-off is that lines above ground are cheaper to lay, easier to repair and portable. Protect or bury water lines that cross vehicle or animal lanes. Though all black plastic pipe looks alike, there can be significant differences. Most plumbing shop pipe was designed to be buried and is not highly UV stabilized for above-ground installation. The pipe that was designed for drip irrigation systems generally holds up better to both freezing and UV light and will be slightly higher in cost.

Source: Michigan Hay and Grazing Council.

How fast?

If you need 1,400 gallons of water per day and you can move one gallon per minute, then in one day you can move 1,440 gallons. (24 hours x 60 minutes x one gallon per minute = 1,440 gallons per day). Is this enough to support a system? Not really, ignoring that the system leaves no margin of error, there are other potential problems to consider. If your well pump can move one gallon per minute, that means it would have to run continuously, which is not a good idea. Pumps should run only about four hours per day, with a maximum of 12 hours to meet daily needs.

It's also important to think about the rate at which livestock drink water. In continuous grazing systems with large paddocks (back corner of paddock to water is more than 1,000 feet), the stock come to drink as a herd/flock. This means that either a rapid recharge rate, large stock tank or some combination are needed to handle the sudden draw down. When stock intensively graze or are less than 600 to 900 feet from water, the stock go to water individually, so lower flow rates and smaller water tanks are adequate. As a rule of thumb, you'll need a tank that allows two to four percent of the animals to drink at one time and a flow rate that provides total daily needs in four hours with the use of full flow values. When stock travel in groups to drink, the tank should hold a minimum of one-quarter of the daily requirement and allow five to ten percent of the animals to drink at one time. With sheep or other species that are trailing significant distances, more trough space is desirable. Thirsty sheep will need almost 100 percent trough availability to prevent trampling. If recharge cannot be accomplished in one hour, then increase the tank size.

Water systems options

Water sources

There are two main water sources: wells or underground sources and surface sources, such as ponds, lakes, streams, etc. In the upper Midwest, with regular winter feeding most operations depend on subsurface systems. Further south, with the increasing number of beef cattle comes an increased use of surface water. The most flexible and cost effective water source can be well water with electric pumps. If the pastureland is too far from a well, doesn't have a well or a potential well site, inadequate well water quality and quantity, then explore the surface water option.

Surface water can be obvious, such as ponds or streams, but can also be developed at seeps, wetland or marshy areas. In addition to development costs, the other main limitation to surface water is that it is usually found in the pasture's low spot, far from electrical access. This means the watering spot can only serve limited acreage to minimize traveling distance. Otherwise, the water system must be portable or constructed in many locations. These limitations are mentioned only because in many situations, plastic pipe from the homestead well is the least costly and most effective option. A stream running through the pasture may or may not be the best way to provide water and control stock movement as they harvest the forage.

Source: Michigan Hay and Grazing Council.

Since summer watering for large animal groups greatly increases water usage, work with a local well driller to test your well's water yield and draw down. Contact local governmental agencies to learn about potential cost-share programs for developing livestock watering systems. In many cases, the situation can be a win-win arrangement with improved wildlife habitat and an improved stock watering system.

If your pastures improve and you run more stock, have you built expansion potential into the system? While piping and electric wells may be the most common system, be prepared to tap various water sources to increase flexibility and provide an emergency backup system. When the submersible pump dies on July 4 and the temperature is 100 degrees, a pond or stream access can make the holiday much more enjoyable for you and the stock.

Always remember water is an invaluable resource and contamination errors, whether to ground water or surface water, never have quick and easy fixes.

Water delivery system

There are three ways to get water to the stock: let the stock go to the water via pond/stream access, gravity or pumps.

Surface access

Surface access can be simple and inexpensive, but it only provides water at one location, requires some investment and maintenance and opens the possibility for water source contamination. Access ramps are walkways with a slope of 6:1 (run to rise) and constructed with concrete or gravel that provide a firm, non-slip surface. Ramps constructed of pit run or crushed rock, should have fines on the surface to bind the gravel and provide a non-irritating walking surface. In some situations, a sub-surface of geotextile will add life to the ramp. Ramps should be at least 10 feet wide with an additional one foot of width per 10 head (i.e., 80 cows require an 18-foot wide ramp). Fencing may be needed if the ramp is part of an exclusion plan to keep the edges in good repair. A rough walking surface is important, especially during icing conditions. Check with the Natural Resources Conservation Service for cost-share information and technical construction support.

Source: Michigan Hay and Grazing Council.

Gravity

A spring or pond that lies above the paddocks can utilize gravity. Gravity is a free way to provide the energy to move water, though where you want the water may not always be downhill. Gravity systems are usually low pressure and so piping has to be bigger to maintain flow rates, but low-pressure pipe is usually lower cost. If using a reserve tank, monitor level and don't forget to take the cost of the reserve tank into account. Pumping water up into a reservoir has advantages if you have a high point relatively close to the water supply, and don't have access to public electricity to operate a pump. The reservoir can be filled with a high capacity gasoline pump and then gravity will "ration out" the water over a three to seven day period. Slower-moving gravity systems freeze up sooner unless you have an abundant water supply and can allow for overflow to keep the water moving. Gravity is free, but don't let the system's limitations cost more than a positive pressure system.

Source: Michigan Hay and Grazing Council.

Watering Systems for Grazing Livestock – Water systems options

Pumps

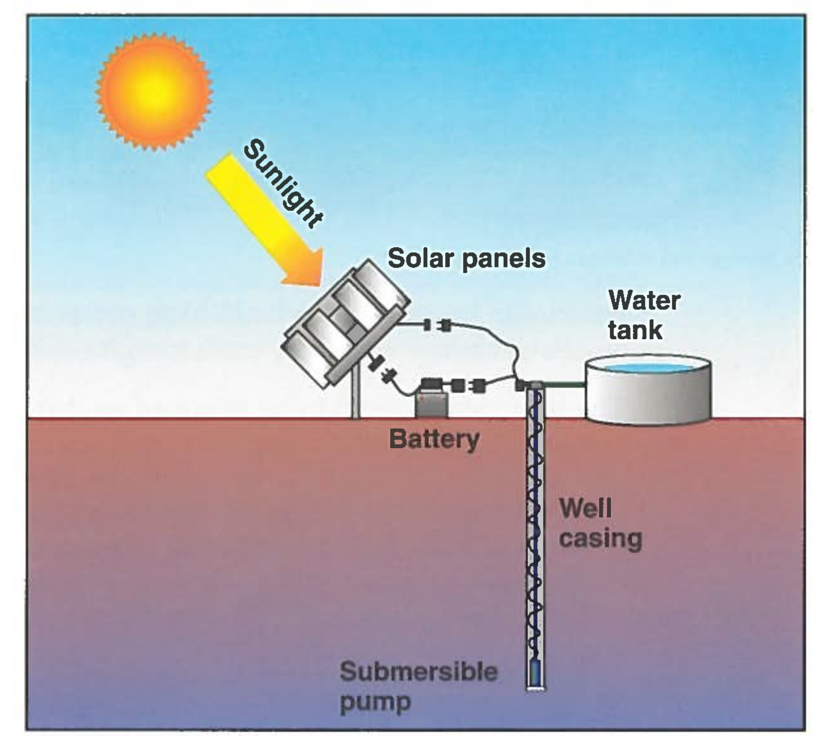
Pumps move water in two ways: 1) to **suck** water up shallow jet pumps, centrifugal pumps or diaphragm pumps or, 2) to **push** water, pistons, impellers or jets. Pumps that suck water up can only draw water up about 22 feet, surface to pump, because it is the atmospheric pressure that pushes the water into the vacuum that the pump creates. These pumps are generally lower cost and can often move large quantities of water at medium pressure levels. The most common push-type pump is the submersible pump, which is put down the well into the water source. The other type is the piston pump, which is often used with windmills or as a booster pump to increase pressure to go up hills.

Pump power options

It takes energy to move water, and the more water to move, the more energy is needed. A steady power supply that could run different kinds of pumps and operate at a low cost is preferred since stock drink daily. Public electric power is the closest thing to an ideal power source, except it is not available everywhere. In many cases it's necessary to look for alternative ways to pump water. Every producer and farm has different resources and goals, so each alternative should be judged on an individual basis.

Alternative pumping systems

Much of the producers' experience quoted below was generated by two years of on-farm trials supported by the Great Lakes Basin Network Research Project. This anecdotal information is added to give some sense of how the various systems may perform. Most were on-farm operations, with a few examples from MSU experiment station farms.

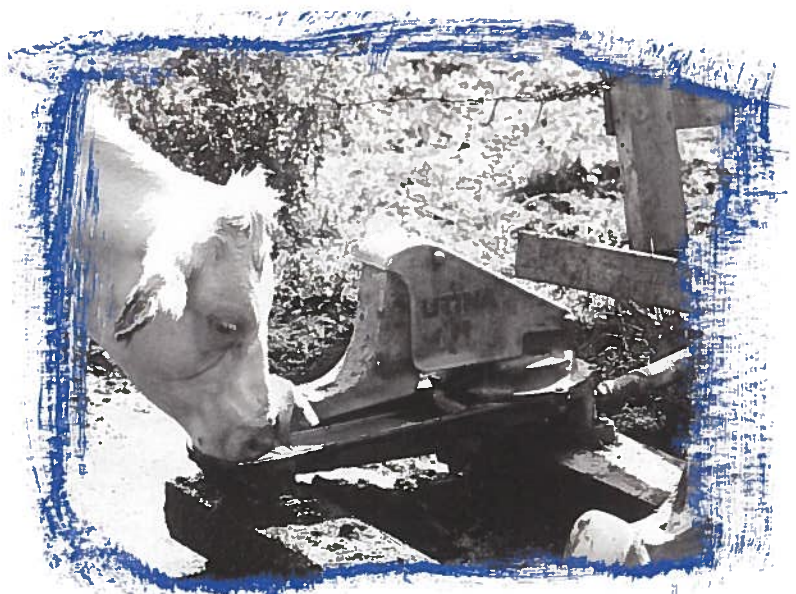


Source: Water Management Guide, 1996, Ontario Federation of Anglers & Hunters.

Solar pumps

Solar energy has a lot of appeal because it is new technology, environmentally friendly and once set up, is "free." In addition, it is relatively maintenance-free, can go anywhere and offers various pump options. Additionally, when the weather is hot and dry, water consumption increases and so does the solar unit's pumping ability. The biggest drawback is that it only works when the sun shines. In the upper Midwest, the solar powered pump will not work at night or on many cloudy days. The system has to "store" energy either in batteries or water storage for the down time, which adds to the system's cost. Other disadvantages are susceptibility to vandalism in remote locations, the technical nature of the panels and their operation and that the solar system is a relatively expensive investment.

A number of pumps are available that work off the DC current, from inexpensive bilge pumps (costing about $25 to $50), to submersible pumps that work in deep wells. A one- to two-panel system that pumps about 700 gallons in seven hours from a depth of 50 feet costs $1,500 to $2,000. Batteries or a water storage system for at least three days of non-pumping cost extra. Some solar experts recommend using water storage instead of batteries to avoid the cost of batteries and the energy loss (about 40 percent) from converting solar electricity to batteries and back to current to run the pumps. If your only water source is a well with the water table below 20 feet, solar and windmills are the best two options. Farmer experience was limited, but there seemed to be some hesitation to deal with the solar systems, due to their technical nature and high start-up costs.



Source: Michigan Hay and Grazing Council.

Animal-powered pumps

Nose pumps are diaphragm pumps that are operated as stock push a paddle out of the way to get the water in a sloped trough. After the stock drink the water, the paddle returns and pumps about one pint of water into the trough for the animal to drink again. Nose pumps are portable, animal powered, simple and ruggedly constructed. But the pump can only draw water up about 20 feet or over about 200 feet or some combination (i.e., setting the pump on a pond bank where the lift is 10 feet, staying as close as possible, without getting more than 100 feet away). Less lift and distance makes the paddle push easier. There should be no more than 25 head per pump, and small calves cannot operate the pump. A catch tray under the main trough could service small calves.

The nose pumps need to be mounted so that cattle pushing the paddle or fighting over the water don't move the pump. The suction hose with foot valve needs to be mounted in the water supply, creek, pond or spring hole to have an adequate supply of clean water. The livestock need a few days to learn to operate the system, before hot weather sets in and other water sources are removed. Our experience with dairy cows is that they are very adept with the nose pump. On one farm, four pumps were set up for 100 dairy cows on pasture. The farmer said, "They were using the pump before you got out of the yard."

A beef producer who had not fastened the pumps down, said his beef cows just pushed them under the fence and couldn't use them. The cows kept pushing at the end of the stroke and moved the whole pump. Since there is water left in the trough after the stock quit drinking, the pump does not work in freezing weather. The cost is $300 to $450 per pump and necessary hoses and connections. The mounting is often done on railroad ties and can be pinned down with re-rod in between moves. Most of our trial farms were impressed with the nose pump and would consider using it to access surface water with a potentially portable system.

Wind-powered pumps

Windmills once dotted almost every farmstead, but have not been used recently in the Midwest, except for the recent interest in wind generator farms. Windmills are low cost once established and can pump from surface or deep well situations. Their disadvantages are similar to solar, as a regular wind is needed (windmills don't work when the wind doesn't blow) and installation is relatively costly. Windmills also usually involve more permanent construction and the best location for the windmill, a windy area away from trees (20 times the height of the trees/windbreaks), may not be near the water supply. Newer, smaller windmills are available, that generate compressed air which is used to pump water. A storage tank is needed to hold a five- to seven-day water supply. The newer windmill pumps using compressed air cost about $1,500 and the bigger tower versions with deep-well capacity can cost $5,000 or more. Given their lack of portability, cost and frequency of tree-lined paddocks, our trial did not include any windmill systems.

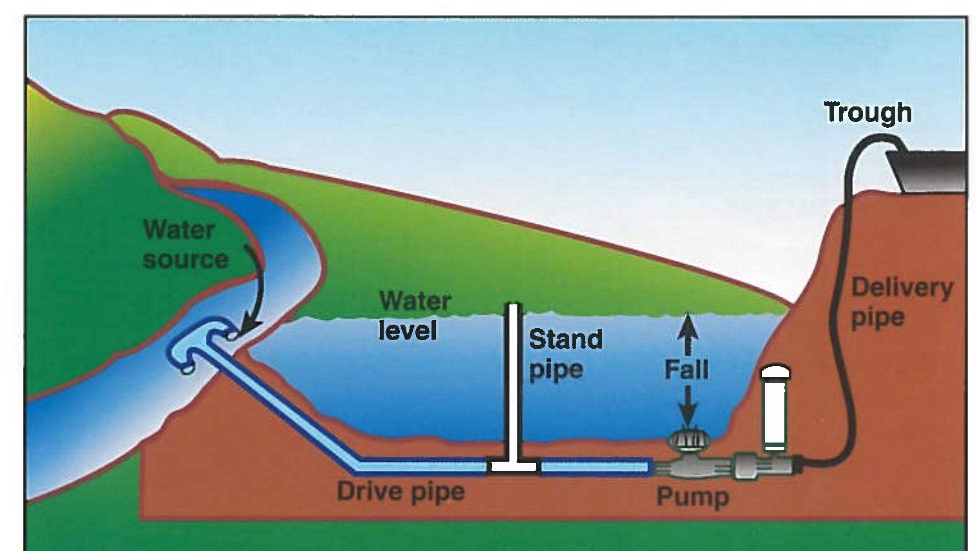
Water-powered pumps

Two very different pumps use falling or moving water as a power source, the ram pump and the sling pump.

Ram pump

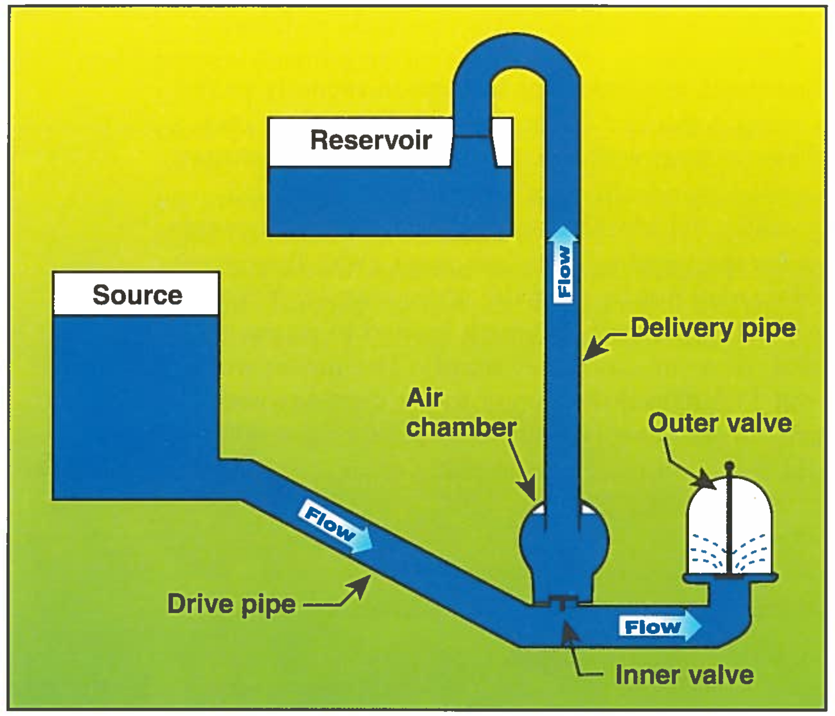
The hydraulic ram pump was invented in the late 1700s and uses the energy of falling water to pump a small percentage (two to 25 percent) of falling water higher than its original height. At least two feet of fall and a flow of one to three gallons per minute are required to drive the system. This two-foot fall can pump the water up to 20 feet (8:1 to 10:1). Ram pumps are not very expensive, have low operating costs and come in varying sizes. A source of falling water is necessary, most often a stream, a pond up a hill or an artesian well. The system eventually freezes up, but moving water takes some frosts.

Setting the pump up takes some time and periodic adjustments may be required. One farmer used an artesian well that discharged water 12 feet in the air to power two 1.5-inch pumps. Water was pumped just over one mile at five gallons per minute to serve a large stock tank. In his case, he had to manage the run-over at both the pump and the stock tank. While the farmer is satisfied with the system, he did spend considerable time getting the system working properly.



Typical ram pump set-up.

Source: Water Management Guide, 1996, Ontario Federation of Anglers & Hunters.



Source: The Stockmans' Guide to Range Livestock Watering from Surface Water Sources, Praire Agricultural Machinery Institute (PAMI), Manitoba, Canada. (www.pami.ca)

Ram pump operation

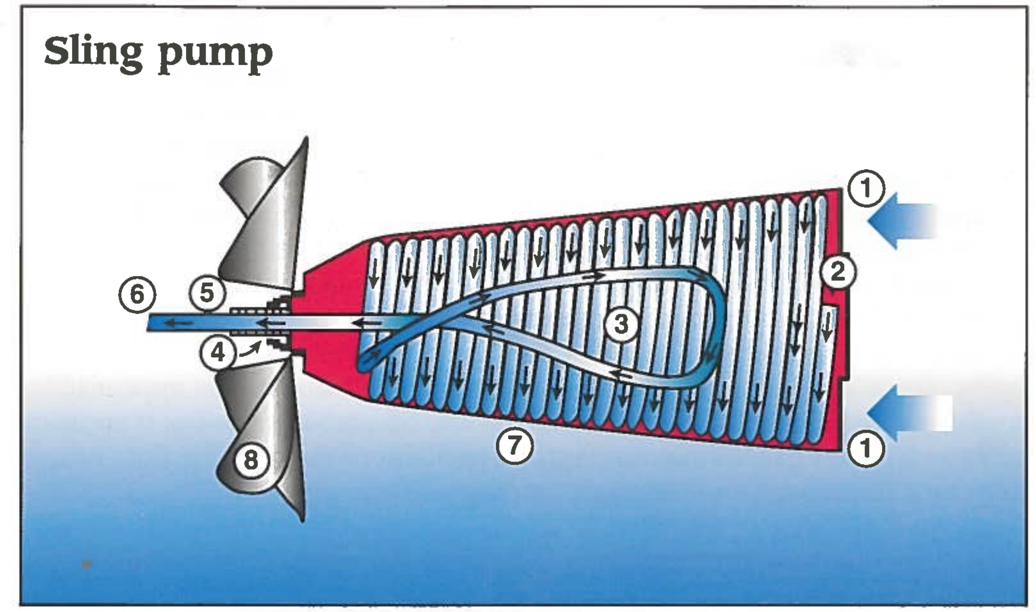
Water from the source flows downhill through the **drive pipe**, and out at the **outer valve**, which stays open as long as the water velocity remains low. The speed of water passing through the outer valve increases until it overcomes the tension on the **outer valve spring** (not shown). The outer valve suddenly closes, reducing the water velocity to zero. This creates a considerable pressure peak in the **drive pipe** and causes the **inner valve** to open, pushing water up into the **air chamber**, up the **delivery pipe**, and into the reservoir at the higher elevation. When the water in the drive pipe comes to a complete stop, the outer valve opens again and the cycle is repeated. (Water from the outer valve is returned to the source.) Once in motion, the two valves will rhythmically open and close, continuously pumping water to the higher elevation.

Twin ram pumps.

Source: Ben Bartlett.

Sling pumps

Sling pumps use a plastic drum with internally coiled piping. The drum is open to water at the rear and has a propeller on its front. It is tethered in a flowing stream and floats half in and half out of the water. As the propeller turns the drum, water then air is taken into the coiled piping. As the drum turns, the air rises and pushes the water along in the piping and eventually out of the sling pump to the stock tank (see diagram below). A wind-powered version of this system uses a windmill-like fan and belt to spin the drum in standing water. The sling pump requires a moderate initial investment, no operating cost and is simple to set up and operate. The sling comes in various sizes, from the small one, which in a stream flow of two feet per second, pumps more than 800 gallons per day with a 26-foot head, to the large size that pumps 1,500 gallons with a 49-foot head. Slower flows have the same head, but less volume. Pumps cost from $700 and $1,000 each.

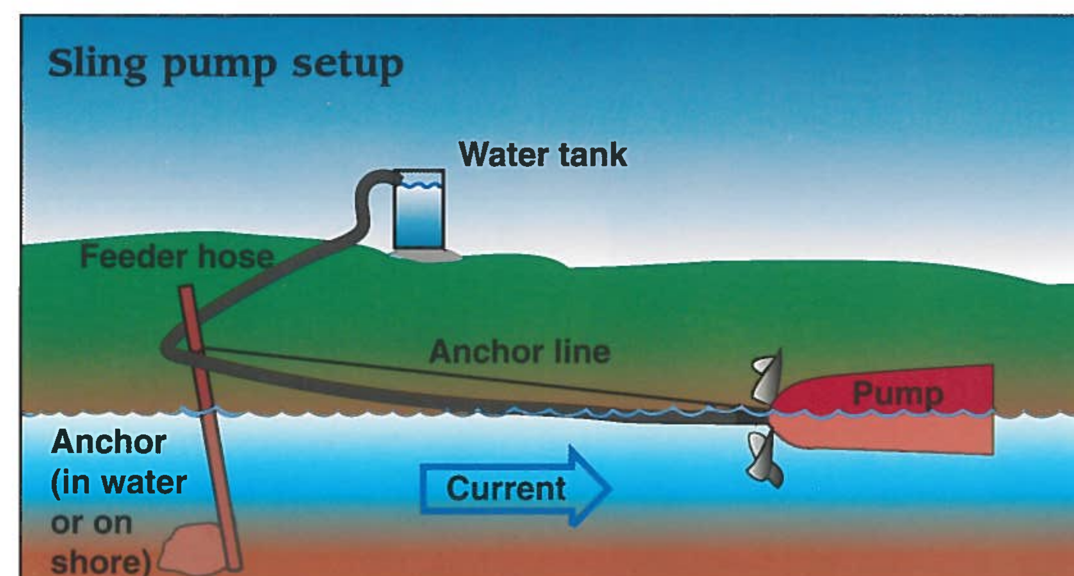


Source: Water Management Guide, 1996, Ontario Federation of Anglers & Hunters.

Typical parts of a sling pump

1. Bottom plate with sieve-shaped openings
2. Rear hose end/water inlet
3. Spiral-wound pump hose
4. Swivel coupling
5. Connecting piece for feeder hose and bracket for anchor wire
6. Feeder hose for outgoing water
7. Floating substance
8. Propeller blades

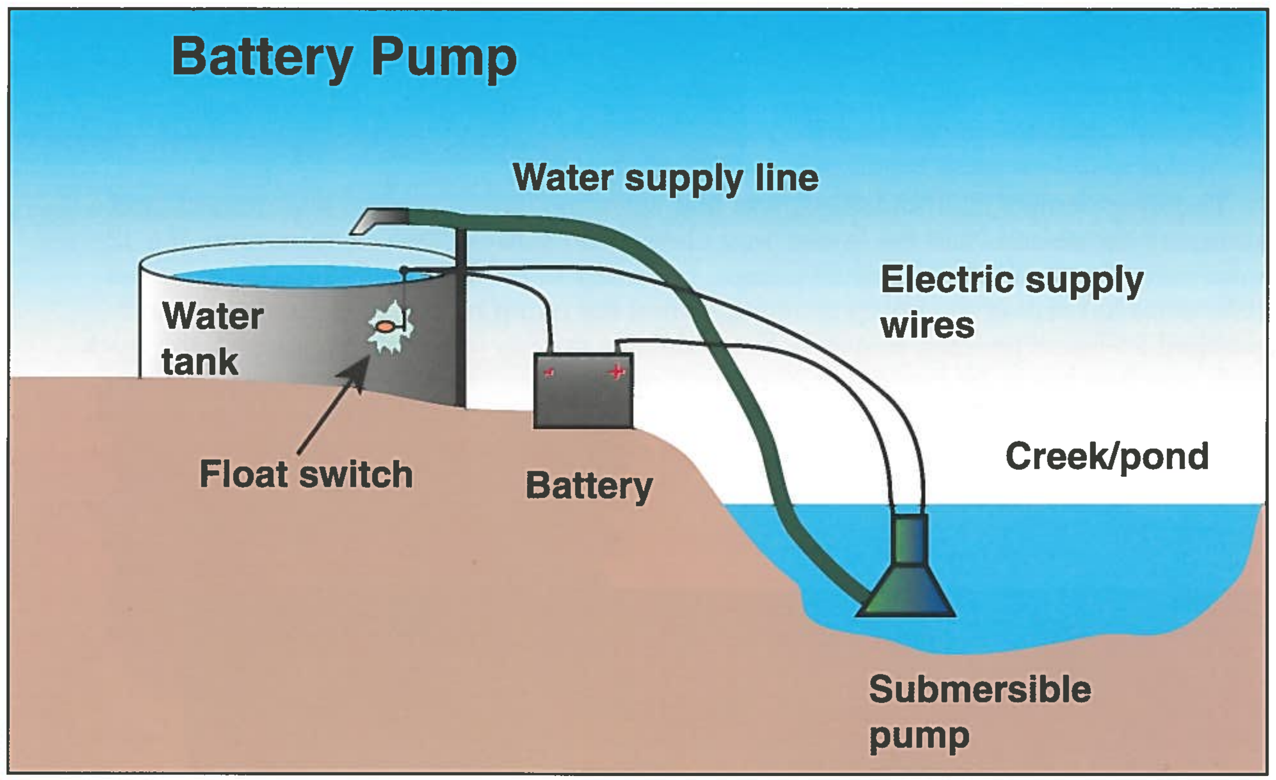
The sling pump's main drawback was that when the largest volume was desired (mid summer), the streams had the lowest water levels and slowest flows. A minimum of a 12-inch water depth is listed for small pumps, but many of our trial operations experienced difficulties in keeping the pump spinning. When the pump turned, it worked great and pumped 24-hours per day, non-stop. Since there is no way to turn the pump off, the stock tank overflow has to be controlled to prevent mud around the tank. Floating debris has been mentioned as a problem, but that was not our experience. One concern expressed by one of our trial farms was the sling pump's potential to impeded canoers or be vandalized by canoers or rafters.



Source: Water Management Guide, 1996, Ontario Federation of Anglers & Hunters.

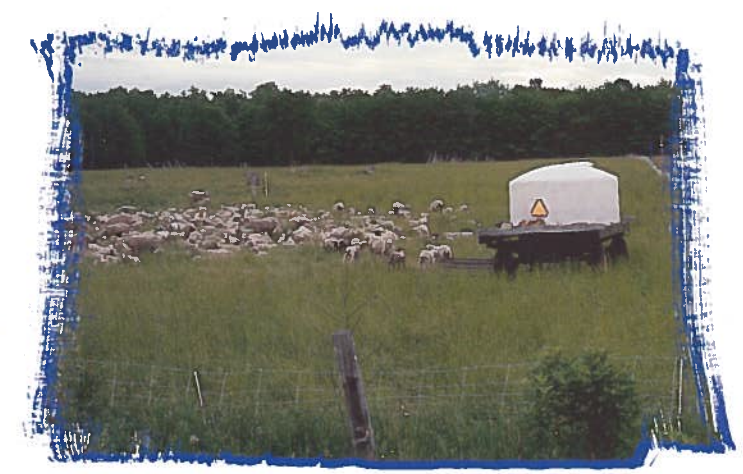
Battery pumps

With the availability of sump pumps that work off 12-volt batteries and the need to move water from a stream or pond just up the bank to prevent stock access, an Ontario farmer developed an inexpensive livestock watering system. This battery system is portable, economical, uses locally available parts and can move large volumes quickly if with minimal pumping height. The system costs about $300–$150 for the pump, $100 for a good rechargeable marine battery and $50 for an on/off tank fill switch and miscellaneous wiring. The switch is like a sump pump mercury switch, except it works opposite, in this case up is off and down is on. The figure below shows how the unit is set up. If large volumes of water are required, or more pumping height is needed, the battery life between recharging can be as short as one day. New pumps are available that appear to be more energy efficient and this should extend battery life. Situations vary, but it appears that between 3,000 and 15,000 gallons can be pumped per battery charge. The float must be protected from stock to prevent unnecessary pumping and damage.



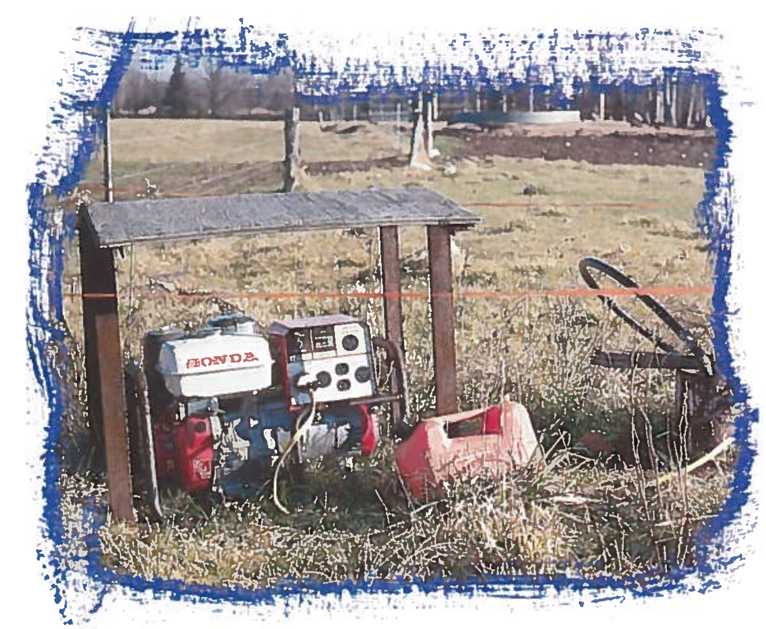
Gasoline/diesel pump or generator and hauling water

This is a different power source. Gas-powered centrifugal pumps that can move large volumes of water very fast can be used to charge storage systems. Generators can be used to provide electricity in remote locations to run regular electric pumps. One operator learned that half a tank of gas operates a submersible pump to deliver 1,000 gallons to a large stock tank. He adds the gas, starts the pump and leaves. The generator and pump cost about $1,000–less than a solar system–and uses off-the-shelf equipment. Hauling water is an additional option that is very flexible but can be time consuming. How much water you can haul on one trip that will last for at least one day determines how much stock can be supplied hauled water. Most pickups, tractors and regular farm wagons can pull or carry about 1,000 gallons, or four tons of water. One thousand gallons serve 66 cows at 15 gallons per day, or 100 yearlings at 10 gallons per head, per day. The crunch occurs during hot weather, when consumption triples and more trips are necessary.



Source: Ben Bartlett.

These alternative systems can serve as the main water supply system, but in many cases are used for the out-of-the-way, underutilized paddocks or as a backup to the homestead well system. They also may be a watering system that allows stock regrouping for increased performance or better forage use. These systems allow you to give your stock the option to not water in the creek or pond and improve wildlife habitat without extensive fencing.



Source: Ben Bartlett.

For more information

Well capacities, electric pump sizing
Your local well drillers, local plumbing shops

Ponds, construction, sizing, utilization; stream access construction
Your local NRCS office

Nose pumps

Blue Skies West (Aquamat Nose Pumps)
110 Michigan Hill Road
Centralia, WA 98531
1-888-NOSEPUMP

Rife Company
P.O. Box 95
Nanticoke, PA 18634
570-740-1100

Farm'Trol Equipment (Utina)
409 Mayville Street
Theresa, WI 53091
414-488-3221

Sling pumps

Rife Company
P.O. Box 95
Nanticoke, PA 18634
570-740-1100

Ram pumps

The Ram Co. (Fleming Hydro Ram)
HCR 61, Box 16
Lowesville, VA 22951

Rife Company
P.O. Box 95
Nanticoke, PA 18634
570-740-1100

Wind-powered

Dutch Industries Ltd.
P.O. Box 4497
Regina, Saskatchewan
Canada S4P 3W7
306-781-4820

Koenders
David Wilson
Tensegrity Systems Limited
RR 1 Metcalfe, Ontario
Canada KOA 2PO
613-821-4420

Cumberland General Store
#1 Highway 68
Crossville, TN 38555
1-800-334-4640

Aermotor Windmill Corp.
Box 5110
San Angelo, TX 76902
915-651-4951

Dempster Industries, Inc.
Beatrice, NE 68310
402-223-4026

Verdun Co. (Monitor Windmills)
Box 1481
Hutchison, KS 67504-1481
316-662-8502

Battery pumps

Local building supply stores can supply 12-volt sump pumps and "fill" mercury switches, but usually a special order.

Solar pumps

Numerous companies advertising in dairy and livestock publications.
Local/regional solar energy companies.

References

This section will provide information about people and places that have served as resources for this publication.

Water systems

(Pamphlet) *Private Water Systems Handbook*, Midwest Plan Service – 14. Agricultural Engineering Department, Michigan State University, E. Lansing, MI 48824.

(Pamphlet) *Ponds–Planning, Design, Construction*, by USDA Natural Resource Conservation Service (contact local office).

(Handbook) *Facilities for Watering Livestock and Wildlife* by USDA Forest Service Technology Development Center. Fort Missoula, Bldg. 1, Missoula, MT 59801.

(Magazine Article) *Farm Water Supply Factors: Dairy Exporter,* January 1994, pg. 22-23, by Professor Gavin Wall, Agricultural Engineering Department, Massey University.

1995 Missouri Grazing Manual, Chapter 9, Water Requirements and Availability, pg. 75-81, by James Gerrish and Maurice Davis, University of Missouri, Forage Systems Research Center, Dept. of Agronomy, Columbia, MO 65211.

Environmental impact

(Pamphlet) *Grazingland Hydrology Issues: Perspectives for the 21st Century,* by K. E. Spaeth, F. B. Pierson, M. A. Weltz and R. G. Hendricks. Society for Range Management, 1839 York Street, Denver, CO 80206.

(Literature Review) *Alternative Livestock Watering Systems* by Dr. E. Ann Clark, Crop Science, University of Guelph, Guelph, Ontario NIG 2W1.

(Research Project) *Offstream Water and Salting as Management Strategies for Improved Cattle Distribution and Subsequent Riparian Health* by Marni L. Dickard and others, Dept. of Animal Science, Eastern Oregon Agricultural Research Center, Oregon State University, Onion, OR 97883, 541-562-5129.

(Research Project) *The Economic Feasibility of Off-stream Water and Salt to Reduce Grazing Pressure on Riparian Areas* by Amy Stillings and John Tanaka, Dept. of Ag and Res. Economics, Oregon State University, Ballard Extension Hall, Corvallis, OR 97331-3601.

(Research Project) *Regional Center of Sustainable Dairy Farming, Southern Region* SARE Project by Steven P. Washburn, Animal Science Dept., NCSU, Box 7621, 105 Polk Hall, Raleigh, NC 27695-7621, 919-515-7726.

Grazing behavior and animal performance

(Book) *Grazing Management* by John F. Vallentine, Professor of Range Science, Brigham Young University, Provo, UT.

(Book) *Ethology of free-ranging domestic animals* by G. W. Arnold and M. L. Dudzinski, CSIRO Division of Land Resources Management, Western Australian Labs, Wembly, WA, Australia.

(Research Project) *Effect of Water Source and Quality of Water Intake and Performance of Steers Grazing Tall Fescue* by Richard Crawford and others, College of Agriculture, Food and Natural Resources, Missouri Agricultural Experiment Station, University of MO–Columbia, Rt. 3 Box 88, Mount Vernon, MO 65712-9523, 417-466-2148.

(Research Project) *The Water Source as a Factor Affective Livestock Production* by Walter Willms and others, Agriculture and Agri-Food Canada, P.O. Box 3000, Lethbridge, ABTIJ4B1, Canada.