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Nebraska Cooperative Extension EC 96-821-B

Water Development Costs for Livestock

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When considering placing livestock at a new pasture without an existing source of water, ranchers/farmers have two alternatives: 1) develop a new water source, or 2) pipe or transport water from another source.

A well with a submersible pump or windmill is a common new source. Water can also be piped (usually in pipe buried below the frost line) from a source (new or existing) to one or more pastures located miles away. The cost of a complete water system (e.g., well, pump, storage, and distribution system) can vary substantially due to many factors including depth of the well, size of the pasture, number and kind of livestock and types of energy sources available.

Well drillers and suppliers across Nebraska were surveyed concerning the costs of materials and labor for developing a livestock water supply. Fourteen drillers and suppliers responded. Information was gathered about material and labor costs for well construction, windmills, submersible pumps, trenching, and stock tanks. The range of respondents' answers is given in summary tables in this publication to show the variability of estimates obtained. In addition to summarizing the survey results, the average costs of several water system examples are presented.

Livestock Water Requirements

Two important considerations when planning a new water system are the quantity and quality of water. The gallons per minute (g.p.m.) that a well can produce depends on the hydro-geologic conditions of the proposed well site. The needed g.p.m. for a particular pasture primarily depends on the number and type of livestock to be watered. An animal's water consumption depends on several physiological and environmental conditions such as kind of animal and size, whether or not it is lactating, type of diet, and weather conditions.[1] Daily water needs for planning a water supply are as follows: 15-20 gallons/head for beef cattle and horses; 20-25 gallons for a cow-calf pair; 25 gallons/head for dairy cattle; and 3-4 gallons/head for sheep and goats.[2] These amounts are higher than average consumption rates but they allow for maximum water needs and evaporation during the summer. If the pasture will be used exclusively in the winter then smaller quantities of water are sufficient.

Poor water quality can adversely effect the health of livestock resulting in poor performance or even death. Examples of problems are excessive salinity or nitrate content of the water and high alkalinity. For more information on livestock water quality, see NebGuide G79-467, *Livestock Water Quality*.

Well Drilling Costs

The cost of drilling and casing a well averages $8.40/ft among the well drillers surveyed for this study (see *Table I*). A 4-inch PVC casing is used for most wells less than 350 feet deep.[3] At greater depths a heavier duty (higher pressure rating) and sometimes larger casing adds at least $1.00/ft to this cost. Wells are usually gravel packed up to 10 feet from the surface and then sealed with an approved grout. Nebraska State Health Department regulations require a cement pad on top of the well seal.[4] The cost of the gravel, grout seal, and cement pad averages $155 per well. The required state registration of a livestock well costs $60.

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[1]Paul Q. Guyer, "Livestock Water Quality, *NebGuide*, No. G79-467, Univ. of Nebraska, 1980.

[2]Based on the following sources: Paul Q. Guyer, (see footnote 1); and personal communications (October 1995) with Jeff Nichols, Range Management Specialist, NRCS, USDA; and Steve Melvin, Extension Educator, University of Nebraska.

[3]The bottom section of casing is slotted (called well screen) to allow the water to pass through. Most well drillers averaged the cost of the casing and well screen together in their estimates.

[4]There are other ways to satisfy this regulation, but this was the most common for livestock wells.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

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Table I. Costs for Well Drilling

Water Development Component	*Range of Cost ($)*	*Average or Typical Cost ($)*
Wells:		
Drilling and 4-inch casing[1]	7 - 10 / ft	8.40 ft
Grouting[2]	8 - 10 / sack 20 - 150 / job[2]	50 / job
Gravel	8 - 10 / cubic yd	50 / job
Cement pad[3] - materials and labor	25 - 100	55
Registration (state)	——	60

[1]At the higher drilling and casing costs (i.e., $10/ft), gravel and/or grouting are usually included in the price.
[2]Range of job costs reflects a grout seal at just the top of a well to pressurized grouting much deeper into the well; this depends on the hydro-geologic conditions of the well.
[3]One common method of satisfying state health regulation for a sanitary seal of livestock wells.

Windmills, Submersible Pumps, Tanks and Trenching

The costs of used windmill towers and rebuilt mills (purchased from a supplier) are given in *Table II*. Several well drillers rebuild mills themselves at lower costs ($500-$1,000), but these costs were not averaged into *Table II*. New towers and mills are also available, but are much more expensive. For example, complete rebuilt windmills (with anchors) have a range of average costs of $2,270 (27 ft tower and 8 ft mill) to $3,630 (33 ft tower and 10 ft mill). However, the costs (delivered) from one manufacturer for these same windmills (new) are $4,135 and $5,670, respectively. Labor for installing a windmill adds another $465 to the average cost. The mill requires very little maintenance and if oiled yearly can easily last 30 or more years. The tower will last considerably longer. Both can be damaged in a storm, but insurance is available for approximately $4-5 per $100 of coverage.

The average cost of submersible pumps is $515 to $840 for .5 hp to 1.5 hp motors. Labor charges for installing a pump varied greatly among the survey respondents; reasons for the differences were difficult to determine. Costs of energy alternatives to power a submersible pump are discussed in a later section. Estimates on the longevity of properly installed submersible pumps averaged 7-12 years, but several well drillers said it was not unusual for pumps to last 20-25 years. Although lightning is a common reason for pump failure, insurance coverage (as an add-on to an existing farm policy) only costs about $6 or less a year.

Steel tanks are available in a variety of sizes (diameters), three of which are shown in *Table III*. The 21-ft to 30-ft bottomless tanks are commonly used with a windmill and other situations where water storage is important. The labor and materials (e.g., bentonite and plastic) for installation are a significant addition to the cost of bottomless tanks. Smaller 10-ft or 11-ft steel bottom tanks can be used with the submersible pump. Steel bottom tanks are easily moved and have a useful life of 10-20 years. Bottomless tanks are usually made of heavier gauge steel and last 30-40 years.

The size of the tank(s) needed for watering cattle is influenced by the number of cattle, the distance they travel to water, and the type of energy source used to pump the water. Cattle will drink 3-5 gallons each time they come to water (maybe more if they only water a couple of times a day) and can drink at a rate of 5 gallons/minute. The tank capacity and the rate at which the water is pumped should be able to supply adequate water to the cattle in a reasonable amount of time, especially if they have traveled a long distance to get to the water. If the energy source is wind or solar, a 3-5 day storage capacity of water is recommended.[5] The approximate gallon capacity of a tank is calculated as follows (diameter and height in feet):

$$\text{Gallons} = (3.14) \times (.5 \times \text{diameter})^2 \times \text{height} \times (7.484).$$

For example, the capacities of 10-ft, 20-ft, and 30-ft diameter tanks (each 2 ft. deep) are 1,175, 4,700, and 10,575 gallons, respectively.

Buried pipe (5-6 feet deep for year round use) can be a cost efficient way to distribute water from one well source to tanks in one or more different pastures. There are several types of pipe available including rigid PVC (typically white) and flexible polyethylene (usually black). PVC pipe is the cheapest of the alternatives but the flexible polyethylene pipe, which is sold in coils, is preferred by some people. Trenching charges for both types were similar among surveyed respondents. The volume of water and distance the water is piped are primary determinants of pipe size. Several installers have had trouble with gophers chewing holes in the polyethylene pipe, usually when the pipe diameter was less than 2 inches and/or when the pipe was empty. Disadvantages with using PVC pipe are that it can break if it freezes (when full of water) and the 20-ft to 40-ft sections of pipe must be glued together. The average cost of PVC pipe (1-2 inch diameter) and trenching is approximately $1.00/ft. The buried pipe system is usually connected to a well that has a submersible pump and buried pressure tank. If the well is located at a higher elevation than the watering points, then a pipeline also can be used as part of a gravity flow system (with windmill or pump) and the pressure tank is not needed.

[5]From unpublished handout and personal communication, Steve Melvin, Extension Educator, University of Nebraska, October 1995.

Table II. Costs for Windmills and Submersible Pumps

Water Development Component			*Range of Cost ($)*	*Average or Typical Cost ($)*
Windmills:				
Towers (used) -	27 ft	(for 8 ft mill)	600 - 925	775
		(for 10 ft mill)	1,100 - 1,160	1,130
	33 ft	(for 8 ft mill)	790 - 1,145	970
		(for 10 ft mill)	1,280 - 1,315	1,300
Mills (rebuilt)[1] -	8 ft		1,290 - 1,355	1,335
	10 ft		2,080 - 2,215	2,170
Anchors (4) to hold tower			150 - 170	160
Drop (hanging) pipe - 1 1/4 inch galvanized			2.10 - 3.35 / ft	2.75 / ft
Sucker (pump) rod - 7/16 inch			0.90 - 1.30 / ft	1.10 / ft
Cylinder - 1 11/16 to 2 inch			150 - 200	165
Labor for installing tower			300 - 600	465
Submersible Pump:				
Pump -	.5 hp		430 - 550	515
	1.0 hp		520 - 750	680
	1.5 hp		750 - 1000	840
Pump electrical wire			——	.95 / ft
Drop (hanging) pipe[2]	- 1 1/4 inch galvanized		2.10 - 3.35 / ft	2.75 / ft
	- 1 1/4 inch PVC		1.00 - 1.40 / ft	1.10 / ft
Labor for installing pump			75 - 300	200
Other:				
Base flange (well plate)[3]			——	30

[1]Several contractors rebuild mills (instead of buying rebuilt ones from a supplier) at a cost of $500-$1,000.
[2]A preference for galvanized or PVC drop pipe for a submersible pump differed among the well contractors in this survey.
[3]Holds drop pipe to keep it from falling down the well.

Table III. Costs for Tanks, Trenching, and Other Items

Water Development Component	*Range of Cost ($)*	*Average or Typical Cost ($)*
Tanks:		
10 - 11 ft diameter steel bottom	270 - 400	325
21 ft diameter bottomless steel	525 - 600	565
30 ft diameter bottomless steel	900 - 1,100	985
Labor and materials[1] for installing bottomless tanks	500 - 900	600
Trenching:		
Trench digging (approx. 5 ft deep)	.50 - .75 / ft	.55 / ft
PVC pipe - 1 to 2 inch	.20 - .60 / ft	.40 / ft
Polyethylene pipe - 1 to 2 inch	.35 - .95 /ft	.80 /ft
Other:		
Hydrants - 3/4 to 1 1/4 inch	60 - 80	70
Float and valve for tanks	——	45

[1]Materials include bentonite and plastic, but not cement which is another type of bottom sometimes used for these tanks.

Table IV. Cost Examples for Water Well with Windmill or Submersible Pump

Water System Component	*Amount X Cost ($)*	*Windmill System Cost*	*Pump System Cost*
Drilling & 4 inch casing	150 feet @ 8.40/ft	$1,260	$1,260
Grouting & gravel		100	100
Well plate and cement pad		85	85
State registration		60	60
Windmill tower (27 ft)	1 @ 775	775	—
Rebuilt mill (8 ft)	1 @ 1,335	1,335	—
Anchors to hold tower		160	—
Labor for installing windmill		465	—
Galvanized drop pipe (1 1/4 inch)	100 feet @ 2.75/ft	275	—
Pump rod (7/16 inch)	127 feet @ 1.10/ft	140	—
Cylinder (2 inch)	1 @ 165	165	—
Submersible pump (1 hp)	1 @ 680	—	680
PVC drop pipe (1 1/4 inch)	100 feet @ 1.10/ft	—	110
Pump wire	110 feet @ .95/ft	—	105
Labor for installing pump		—	200
Total Cost (without tanks and energy source)		**$4,820**	**$2,600**

A well-planned water system design is important for optimal pasture utilization and economic efficiency. The next section illustrates three simple examples of alternative water systems. This information is presented only as a guide for determining the cost of other systems.

Examples of Alternative Systems

The first two examples (shown in *Table IV*) are the average costs of a well with either a windmill or submersible pump. These costs are based on the following assumptions: the *well is drilled 150 feet* and the *pumping level is 100 feet*. A bottomless 21-ft steel tank installed adds $1,165 to these costs and an 11-ft steel bottom tank adds $325. The pump system example does not include the electricity or alternative energy costs (hookup and usage) for the pump which vary by type and/or distance from power lines. Energy costs are discussed in the next section.

Grazing experts recommend placing water centrally to encourage cattle to graze evenly, and having at least one water source for every 320 acres. The last example is the cost of supplying water to a section of pasture (640 acres) divided into four equal and square paddocks. This example assumes that a well with submersible pump is located in the center of one paddock and that pipe is trenched to three tanks in the center of the other paddocks. To run water to the three tanks requires 1.5 miles (7,920 feet) of pipeline (.5 miles to each tank). To maintain the proper pumping pressure a buried pressure tank (includes pitless adaptor[6]) is installed underground at the well.[7] The cost of this system, using the same well specifications as before, is given in *Table V*.

In comparison, the cost of four separate wells, pumps, and tanks (with float and valve) is equal to $11,880. Although this may appear to be more economical, the pipeline system only requires one power source for one well. The four separate wells must have four separate sources of power or a portable generator or solar-powered system that is rotated among the wells. The costs of alternative energy sources for submersible pumps are discussed below.

Energy Source Alternatives

An AC power line, a generator (such as propane gas), and solar-power are the three main energy alternatives to power a submersible pump. Labeling one energy type as the least expensive is difficult because each situation may have unique factors that will affect cost. Five important factors are (1) pumping lift; (2) number of livestock to be watered; (3) length of pipeline in the water distribution system; (4) the power district in which the well is located, and (5) proximity of the well to existing electric power lines.

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[6]The pitless adaptor attaches directly to the well casing and provides a water-tight, sanitary subsurface connection for buried pump discharge below the frost line.

[7]Estimates on the longevity of the buried pressure tank varied from 10 to 25 years.

Table V. Cost Example for a Well, Pump and Pipeline System for Four Paddocks in One Section of Pasture

Well and submersible pump (from *Table IV*)		$ 2,600
Trench digging	7,920 feet @ .55/ft	4,356
PVC pipe (1.5 inch)	7,920 feet @ .40/ft	3,168
Buried pressure tank (with pitless adaptor)		1,100
Subtotal without tanks:		11,224
Steel tanks (11 ft)	4 @ 325	1,300
Tank float and valve[1]	4 @ 45	180
Total with tanks (excludes energy costs)[2]		$12,704

[1]Hydrants at each tank (if desired) would add another $280 (4 x 70) to this cost.
[2]There may be additional labor charges for connecting the pipe at each tank.

The power district and distance of the well to power lines are the major determinants of the cost of using AC power. Usually, if metered electric service is nearby (within 1/4 mile), then it likely will be the best alternative for wells in all power districts in Nebraska (i.e., for a range of kW-hr rate charges). However, when the well is located beyond 1/4 mile and a power line must be constructed (new service) then all power options should be considered. Electric line construction cost varies greatly among the power districts. Most power companies interviewed have a per foot charge for construction and a minimum monthly/yearly kW-hr usage charge. The per foot charges range from $.75 to $5.40, and this rate may increase, decrease or stay constant the longer the line, depending on the power district. Some companies have no charge for the first two to four hundred feet (one has no charge for up to 1/4 mile), but require a five to ten-year contract of minimum monthly/yearly payments for kW-hr usage. Monthly minimums range from $5 to $14. Line construction costs for 1/4 mile (among the power companies interviewed) range from $0 to about $3,000. For one mile the range of costs is $5,280 to $12,660. An important consideration when drilling a new well is whether it is feasible to place the well close to the power line. Since a buried pipeline has an average cost of $.95/ft, 1/4 mile of water line would cost $1,254 and may be less expensive than constructing an electric line. However, unlike the power line, which is maintained by the utility company, the water line maintenance falls upon the landowner or lessee.

The cost of a licensed electrician to hook up a submersible pump is around $75-125. Electric utility charges per month depend on the horsepower of the pump, the rate of pumping (g.p.m.), the number of hours pumped (i.e., total number of gallons needed per day), and the charge for kW-hr. Estimates on kW usage for a one hp pump were .75 - 1.5 kW. As an example, assume the following: 1 hp pump uses 1.5 kW and averages 7 g.p.m., 100 cow/calf pairs consume 1,700 gallons of water per day, and the cost is $.06/kW-hr. The pump would have to run approximately 4 hours (1,700 / (7 x 60)) and would use 6 kW-hr/day; therefore, the cost is $.36/day or $10.80/month.

Gas-powered generators and solar units have one advantage over AC power lines. Both systems can be installed on a trailer and moved among different well locations. In general, the gas-powered generator may become a cost efficient alternative when water is needed 1/4 mile or more from existing electrical power. The average generator, including the automatic on-off float switch for the tank, costs around $2,400 installed (the trailer is extra). This generator can handle up to a 1.5 hp submersible pump (prices of pumps in *Table II*). If propane gas is used, 250 gallons of propane may last up to three seasons. The propane tank and installation are provided by the propane company at no charge to the customer.

A solar-powered system is often more expensive, but solar power is quiet and does not involve maintenance of a generator. A system designed to pump 3,000 gallons per day (with an 80-100 ft lift) needs six 75-watt solar panels at $450 each. Most solar systems use a DC motor-powered submersible pump which costs about $2,200 (variable power up to 1.5 hp). Mounting brackets for the solar panels cost $200. The total cost of this 3,000 gal/day system is about $5,100 (or around $5,300 installed).[8] However, there may be ways to make solar power less expensive. For example, at least one public power company leases 75-watt solar panels at $50/year/panel.

USDA Cost Sharing

Cost sharing may be available for water development for livestock, subject to availability of funds. Producers may qualify for cost-share payments from programs operated by the USDA Farm Service Agency, the USDA Natural Resource Conservation Service, or the Nebraska Natural Resource Districts (NRDs). For most counties the 1995 cost-share rate was 65 percent of an average of approved application costs from the previous year. Types of subsidized costs (they vary by county) include costs of well drilling, well casing, extended pipelines (including trenching), steel tanks, and construction of earthen dams (not included in this cost survey). There are specific requirements concerning size and type of materials and installation. Contact your local USDA or NRD office for more information. Your application must be approved before you start developing the water source.

[8]Smaller solar systems (e.g., for shallow wells) may be less expensive than a generator system.

Worksheet for Determining Your Water System Investment Costs

Fill in this worksheet (where applicable), by using information from *Table I - Table V*, to get a rough cost estimate of a water system you are considering. To determine your specific needs and costs, gathering the following information for your operation will be helpful: size of pasture, number of livestock to be watered, number of gallons of water/day needed, depth of well, and distance to AC power line.

Water System Component	*Amount X Cost ($)*	*Windmill System Cost*	*Pump System Cost*
Drilling & casing	feet @ /ft		
Grouting & gravel			
Well plate and cement pad			
State registration		60	60
Windmill tower	@		----
Rebuilt mill	@		----
Anchors to hold tower			----
Labor for installing windmill			----
Galvanized drop pipe	feet @ /ft		----
Pump rod	feet @ /ft		----
Cylinder	@		----
Submersible pump (hp)	@		----
PVC drop pipe	feet @ /ft		----
Pump wire	feet @ /ft		----
Labor for installing pump	____		
	Subtotal	$_____	$_____
Tanks (incl. labor)		_____ @ _____	_____
Hydrants		_____ @ _____	_____
Float & valves		_____ @ _____	_____
Cost of trenching and pipe		_____feet @ _____/ft	_____
Buried pressure tank			_____
Energy Alternatives:			
a. Power line construction		_____feet @ _____/ft	a._____
Hookup charges			_____
b. Generator system			b._____
c. Solar system			c._____
Total System Cost			$