9H SmartRanch™

Geothermal Stock Tank

DIY Ranch Guide

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Overseen and implemented by Cody Humphrey of the 9H Ranch and C&A Pet & Livestock Supply in Laramie, WY

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Motivation

Stock tanks are exposed to the elements in some of the coldest places in the county. This results in a common problem ranchers face: freezing stock tank water. From having to chop ice out to allow livestock to drink, to pipes and valves freezing, frozen stock tanks create an endless headache for ranchers. The 9H Ranch outside of Laramie, Wyoming has had to “fight with our tanks all winter long”, according to Ranch Manager and co-owner Cody Humphrey. One particularly elegant solution to this problem is the geothermal stock tank. A geothermal stock tank not only keeps the water on the surface from freezing, but also protects the plumbing from freezing – all without needing any electrical or mechanical power. Properly installed, these geothermal stock tanks require little-to-no maintenance.

How it works

The geothermal stock tank works through geothermal heat transfer, using the heat in the earth to keep the water from freezing. Using the same concept as a root cellar, the geothermal stock tank keeps water deep enough in the ground such that it always stays at a constant temperature, about 52 degrees Fahrenheit. The temperature difference between the insulated water (below the ground) and the cold water (at the surface in the tank) causes the water to circulate. This happens because the cold water at the top sinks (its density increases as it cools), and the relatively warm water below rises (its density decreases as it warms).

In short, a Geothermal Stock Tank (GST) is a 3-foot diameter culvert, about 10-feet long, capped on one end, and buried vertically.

Design notes

The three main challenges encountered when building a GSK are getting a durable seal, implementing low maintenance plumbing, and ensuring livestock couldn’t fall into the culvert once filled with water. The durable seal challenge was solved by pouring the culvert into a concrete slab and sealing it with flex seal. The slab at the bottom creates a watertight seal, and further, by placing the inlet and drainpipes into the concrete, it was no longer needed to drill into the side of the culvert (like other designs opt to do). This has the additional benefit of putting the drain plumbing at the bottom, creating an effortless way to drain the entire tank if necessary.

Once the water line enters the tank, a 1” Rainbird quick coupler was used to attach the float valve. This means that if the valve ever needed to be repaired, a simple twist is all that is needed for the entire fitting to pop out and shut off the water.

The last issue, which is protecting animals from falling into the culvert, was solved by pressing pipe into the seam between the culvert and tire and welding continuous fence. Essentially, a cage was built around the top of the culvert.

Parts list / Price list

quantity	description	unit price	total	notes	section
5	1" brass coupling	8.46	42.3		Concrete plumbing and float valve parts
4	1"x6" brass nipple	13.53	54.12		
1	1" brass elbow	10.2	10.2		
1	rainbird 1" quick coupler & key	210	210		
1	xtraflow 1" flow valve	42.98	42.98		
1	1"x 3.5 ft Galvanized pipe (threaded)	3.55	3.55		
1	1" brass Tee	16.72	16.72		
10	36" plastic culvert	77	770	/ft	
1	1.5" brass Coupler	18.99	18.99	For Drain	
1	1.5" PVC elbow	2.59	2.59		
1	1.5" PVC Pipe	1.28	1.28		
2	1" barbed fittings	14.06	28.12	For Pex pipe	
2	3/8"x1/4 fpt connector	4.49	8.98		Continuous Flow
2	1/4" Close BRS STD Nipple	3.49	6.98		
1	1/4" x 72" fridge line	13.49	13.49		
1	1/4" THRD ball valve	11.99	11.99		
1	1/4" Brass Compression fitting	7.99	7.99		
1	1"stop & waste valve	130.95	130.95		Stop and waste and components
1	6' valve key	45	45		
10	1.5" PVC pipe	1.28	12.8	/ft	
1	1.5" threaded coupler	0.98	0.98		
1	1.5" PVC cap	0.82	0.82		Overflow
20	2" PVC pipe	1.77	35.4	/ft	
1	2" elbow	3.99	3.99		
1	2" threaded coupler	4.59	4.59		
2	infiltrator	50	100		Miscellaneous
27	80lb quikcrete	7.86	212.22		
1	1 gal flex seal	114	114		
15	1" pex pipe	1.29	19.35		
		total	$1,930.38		

Additional Supplies & Equipment:

~1.5’ chain, large tractor tire, 2X8 boards & plywood for concrete form, rebar & spacers, forklift/loader

Step by Step Instructions

1) Collect Material

Decide what aspects of the stock tank are desired, including a continuous flow and overflow, a drain, or a metal culvert instead of a plastic one.

2) Cut Culvert

Depending on the type of culvert purchased, it may need to be cut to length. In the 9H Ranch GST project, the 36” culvert only came in 20’ lengths, so it was cut in half using a reciprocating saw and made into two tanks, with 10’ long culverts each. Ensure the cut culvert edge is smoothed out, cleaned, and clear of all cut marks/cutting so that the culvert can sit flat in the concrete form.

3) Build Concrete Form

The concrete form for the stock tank measured 4 ½ feet square, and 7 ½ inches tall. To do this, 2x8 boards were cut to length and screwed together, ensuring the inside dimensions were still 4 ½ ’ x 4 ½ ’. Then, a sheet of plywood was screwed to the bottom. In the 9H Ranch project, old sections of 4’x4’ that come with large mineral tubs were used. Remember to put two notches in the middle of two of the 2x8 boards for the plumbing to stick through.

4) Concrete Support, Spacers, and Chain

As shown in Figure 1, it's best to place the culvert on a grate with spacers long enough to fit the brass plumbing underneath, but short enough to fit the first corrugation of culvert into the slab. This project used 2 ¼” spacers and a piece of old cattle panel as the grate. It's also important to place a chain in the center of the form to allow the culvert and slab to be lifted once the concrete is poured. It is recommended to slide the chain through a piece of rebar, so the concrete has something to bind to.

5) In-Concrete Plumbing

Assemble the brass and PVC plumbing as shown in step 6 Figure 1. Place the plumbing underneath the grate. As shown, the water inlet will be three 6” nipples long and one nipple high. The drain will be roughly 10” long and needs to sit ~8 inches high from the bottom of the form.

6) Zip Ties

Use zip ties to anchor the brass inlets so they are square to the bottom of the form. Also, zip tie the spacers to the cattle panel so they don't move around.

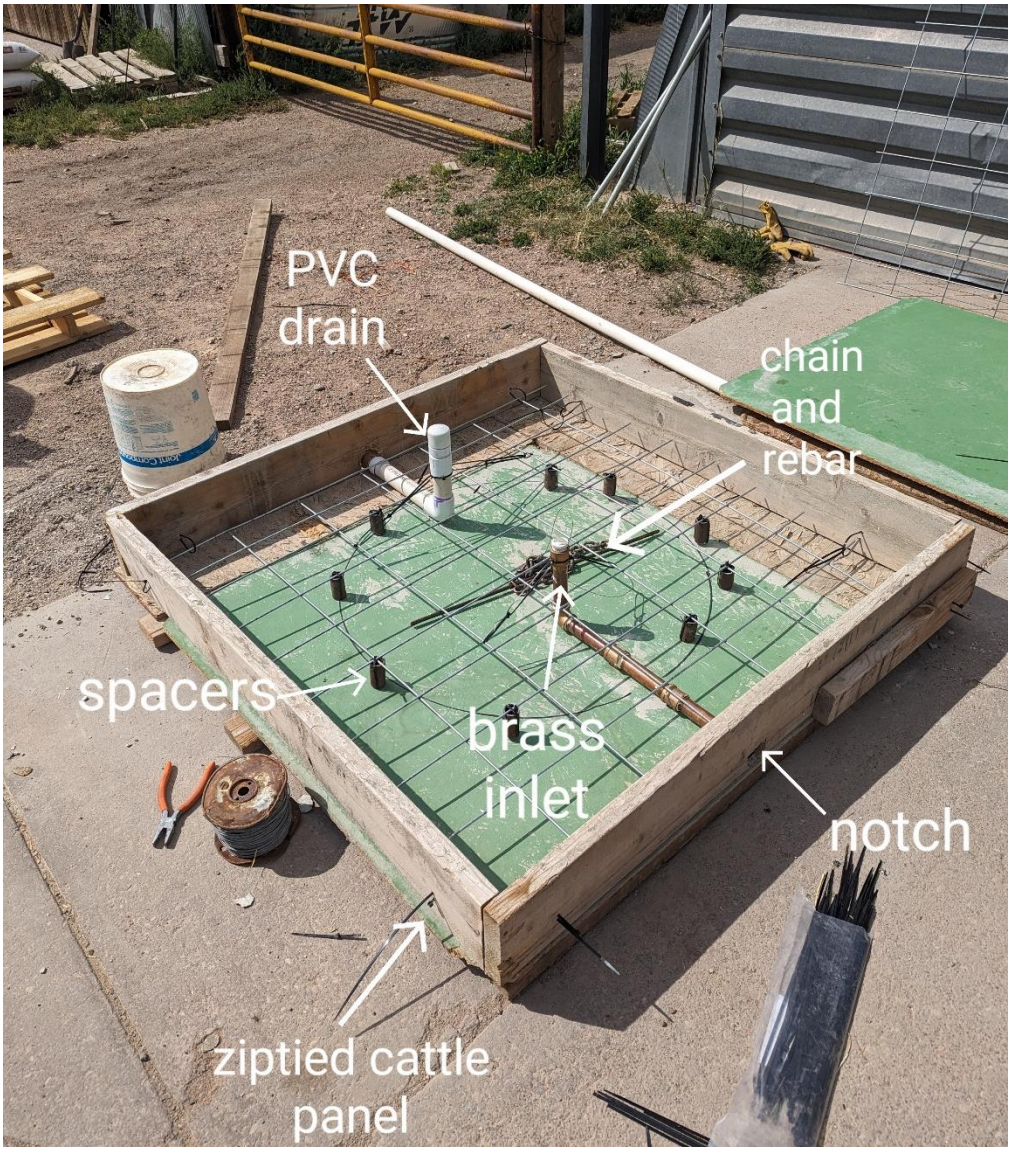

Figure 1

7) Place Culvert in Concrete Form

Place the culvert in the form on top of the grate. The culvert can be lifted with a chain on a forklift. Ensure the water inlet has at least 7" of space from the side of the culvert to guarantee there is enough free space for the quick coupler to spin freely.

Figure 2

8) Pour Concrete

Roughly 22 bags of 80lb Quikrete sacks are needed to completely fill the form. Start with the outside of the form. After the outside is filled, concrete will then need to be poured through the top of the culvert. The easiest way to do this is with a forklift and a pallet. Raise a few buckets of concrete and pour them in through the top of the culvert until it's almost level with the drainpipe. Make sure that the chain is suspended securely out of the concrete. Also ensure the pipes are plugged to keep concrete out of the threads.

Figure 3

9) Remove Form

Wait 48 hours for the concrete to cure. Raise the culvert using the chain and remove the form from the slab.

10) Flex Seal

To ensure that the culvert is sealed, paint flex seal on the inside of the culvert making sure to get plenty on the seam between the concrete and culvert. This was accomplished by climbing into the culvert via ladder and spreading as much as possible. Then climb out, remove the ladder, and pour flex

seal on the uncovered spots. Spread using a brush attached to a ten-foot 2x4. Wait 48 hours for flex seal to cure.

Figure 4

11) Assemble Float Valve

At this point in the process, it's time to build the quick-connect for the float valve. Be sure to add plenty of pipe dope and tighten to confirm there are no leaks. It is also a good time to crawl into the culvert and attach the galvanized riser pipe along with the male end of the quick coupler. Also, since a tee fitting is used, the top part can be used for a continuous flow in case it is ever needed.

Figure 5

Figure 6

12) Dig and Lower

Dig 10-11 feet deep plus an area wide enough to fit the culvert and an infiltrator, if applicable. This stock tank was located in the water table, so the drain couldn't be used. Using an excavator/loader, lower the culvert into the hole with a chain attached to the chain imbedded in the concrete slab. Be sure to position the inlet towards the water supply.

Figure 7

13) Connect Waterline and Stop & Waste valve

Attach the stop and waste valve to the water supply, making sure that the direction of flow is correct. From here, cut and attach pipe from the stop and waste to the inlet of the culvert. If located within the water table (like this project, shown in Figure 7), the inlet to the tank must first be attached before it is lowered into the water. Be sure to attach the riser pipe and key to the stop and waste valve so that it can be turned once its buried.

14) Fill and Level

Now it's time to back fill the hole with dirt. It's very important to make sure that the ground around the culvert is compacted and level so that the tire, in turn, will be level. Check with a long straight board and a bubble level. This project left ~1 ft of culvert sticking out of the ground, not counting the thin bell part.

Figure 8

15) Bury the Overflow

Cut a 2ft section of 2” PVC pipe and attach it to the 2” elbow. Attach the other 16ft to the other side of the elbow. Bury about 1ft underground as close to the culvert as possible and dig a trench to bury the rest of the pipe. Make sure the trench is angled so that water can flow away from the tank. It must be cut flush with the top of the culvert so that the tire can be placed over it.

Figure 9

16) Place Tire Over the Culvert

The outside diameter of the culvert is approximately 40” so it’s important to have the bottom inside diameter of the tire to be at least 46” to fit the pipe for the cage. Place the tire over the culvert.

17) Press Pipe

Press four 10’ long pieces of 1” 7/8 metal pipe on four sides of the culvert for the cage. Make sure they stand straight and level with each other and stick out of the ground around 5 to 6ft.

Figure 10

18) Fill with Concrete

Fill the area between the culvert and tire with Quikrete. This project required ~9 bags. At this point it is important to cut the overflow pipe to the correct height to where the coupler will sit in the concrete. Glue the coupler to the pipe.

Figure 11

19) Build the Cage

It’s possible to go about this step many ways; for this project, continuous fence pieces were cut and welded to the 4 vertical metal pipes. Ensure the welding does not leave burnout holes in the pipe to where water can leak through.

Figure 12

20) Seal with FlexSeal

After the concrete has cured, apply flex seal to the concrete and be sure to get plenty in the seams where the concrete meets the culvert and where it meets the tire.

21) Final Touches

Screw in the overflow pipe to the fitting in the concrete and build a handle for the quick coupler. For the handle on the Rainbird quick coupler, a 2” black steel nipple was screwed in,

followed by an elbow, followed by about 5’ of riser pipe, followed by another elbow and nipple. The joints were welded on the black steel pipe to make sure they would not come undone.

Issues Encountered

Although the design is relatively simple, no design is immune to unforeseen issues.

Firstly, be careful not to drop anything when pouring concrete into the top of the culvert. If an object (cellphone, sunglasses, hat, etc.) is dropped, the easiest way to get it out is to take a light aluminum ladder, shorter than the culvert, and hold it at the top, hovering above the wet concrete. Place two 2x4 boards through the top rung of the ladder to hold the ladder up, and CAREFULLY climb down, with someone holding the ladder, the boards, and the culvert steady. This will prevent the rancher from having to dump a ladder into the concrete, and from having to get covered in concrete themselves. Alternatively, a metal ladder could be permanently placed into the concrete. This would make it easier, later, to perform repairs or for cleaning.

Another issue encountered was the stock tank was located in a shallow water table zone, meaning that 8 feet was the maximum attainable depth. This forced the construction of a large dirt pad around the culvert so that most of it is still protected by earth, making it possible for it to still heat water geothermally.

Additional Considerations – Make it More Affordable

Some options that could be eliminated or replaced include:

- Different Culvert
    - A metal culvert would be more economical, costing ~$61 per foot instead of $77 per foot for the plastic culvert. However, a metal culvert includes the added risk of not having a watertight seal (easier to pierce) along with the possibility of rusting.
- Quick Coupler
    - When it comes to the quick coupler, the idea of being able to remove the valve and take it somewhere to fix anything that could be wrong is very appealing. However, if desired, a rancher could opt to not use the quick coupler so long as the valve is deep enough into the water. However, this means that if dirt ever needed to be cleaned from the valve, the tank would have to be drained. Another option is the Plasson quick coupler (plastic). It is a less expensive alternative to the rainbird quick coupler (brass) costing ~$25 and works on the same principle.
- Drain
    - If draining the tank for cleaning or maintenance purposes is not something the rancher requires, the drain pipe and drain infiltrator can be omitted. Then, if draining becomes necessary, a generator and a sump pump can be used.
- Continuous flow and overflow
    - The continuous flow and overflow pipe could be eliminated. This project opted to install these options as the efficiency of the geothermal aspect of the tank is still unknown.