Using the “Virginia Livestock Watering Systems” Worksheet

Designing Pressurized Livestock Watering Systems

Prince George Training

January 31, 2017

Raleigh Coleman, DCR

Virginia LWS Worksheet

- Can be used to design…
  - Pressure Systems
  - Public Water Connection Systems
  - Gravity Systems
- Select appropriate tab in Excel file
- VA NRCS Design Note 614 (DN-614) provides comprehensive guidance as well as 8 examples

VA Watering System Worksheets - Sept_2010.xlsm - Microsoft Excel

Home | Insert | Page Layout | Formulas | Data | Review | View

Paste | Cut | Copy | Format Painter | Clipboard | Arial | 10 | Font | Wrap Text | Merge & Center | Alignment | Number | Conditional Formatting | Format as Table | Cell Styles | Styles | Insert | Delete | Format | Cells | AutoSum | Fill | Clear | Sort & Filter | Find & Select | Editing

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Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

Print Page | Clear Data

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):
Design flow rate: gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure: psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure: psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft: ft./100 ft.
Velocity check (<5 fps): fps

If velocity is greater than 5 fps, consider a larger diameter pipe.

Pipe length to farthest watering point: feet
Add 10% for slope and fittings: feet
Total friction loss: ft. OR
Total friction loss: psi

If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi

Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet

Low point to pump "from":
Ground elev. of low point: feet

Elevation difference: feet
OR psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
feet
feet
feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of: gpm x
Minimum pumping time of: 1 minute =
Minimum pressure tank volume of: gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch

Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Select Appropriate Tab

Pressure System | Public Water Connection | Gravity System

Ready | 75%

Pressure System Design

Virginia Livestock Watering Systems - Pressure System Worksheet

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Total friction loss: ft. OR
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Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi — Compare with result in Step 5b.

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High point to pump "to":
Ground elev. of high point: feet

Low point to pump "from":
Ground elev. of low point: feet

Elevation difference: feet
OR psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:	psi	OR		feet
Friction loss:	psi	OR		feet
Minimum float valve pressure:	psi	OR		feet
Other:	psi	OR		feet
TOTAL REQUIREMENTS:	psi	OR		feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

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d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of gpm x
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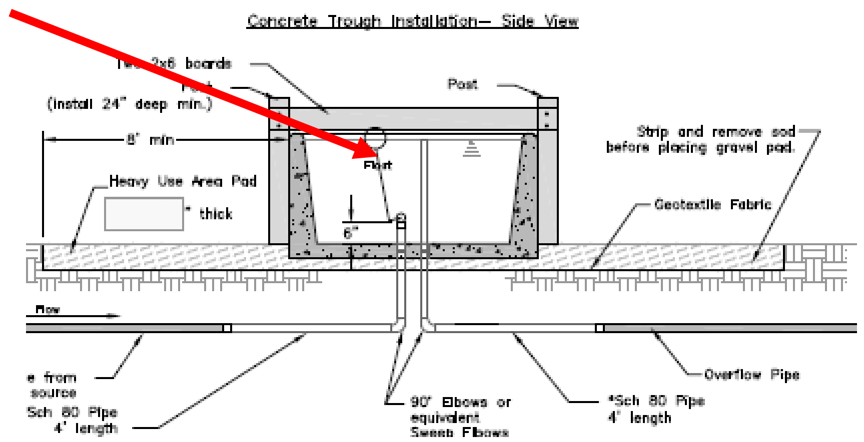
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

What is a “Pressure System”?

- Water supplied via a *pumping plant*
  - Pump: moves water through the system
  - Pressure Tank: maintains pressure when the pump is not running
  - Pump Switch: tells the pump when to run
- Troughs on Float Valves to contain pressure (and water)



What is the purpose of the worksheet?

TRUE or FALSE: The purpose of the "Pressure System Worksheet" is to size the pipeline.

The worksheet has ***many*** purposes, not just sizing the pipeline.

Virginia Department of Conservation & Recreation

What is the purpose of the worksheet?

- Evaluate the “Water Budget”: Is the water source adequate?
- Determine an appropriate *design flow rate* (pumping rate)
- Determine appropriate minimum pipeline diameter(s)
- Determine the energy requirements for the system
  - → Size the pump
  - → Determine the pressure switch settings
- Determine a minimum volume for the pressure tank
- Check for excessive static pressure at the pressure switch and at the trough float valves (*and in the pipeline*)
- Indirectly: Determine if components may need to be positioned differently on the landscape (or if an alternative system should be used) if energy requirements are excessive

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Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/da
Time desired to water herd:
Average peak demand:
Alternate peak demand:

See Design Note for considerat
peak demand.

3) Design Parameters

a) Trough Information

Trough type(s):
Design flow rate: gpm

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Maximum float valve pressure: psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure: psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter:
Pipe cross-sectional area:
Friction loss/100 ft
Velocity check (<5 fps):
If velocity is greater than 5 fps,

Pipe length to farthest watering
Add 10% for slope and fittings:
Total friction loss:
Total friction loss:

Pipe pressure rating:
72% of rating (See VA CPS 516

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system

Elevation head:		psi	OR		feet
Friction loss:		psi	OR		feet
Minimum float valve pressure:		psi	OR		feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:		psi	OR		feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b)

d)

Minimum pressure tank volume of gallons

A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:

Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Chec

Energy Requirements for the System =
Elevation Head (+ or -)
+
Friction Loss
+
Minimum Float Valve Pressure
+
"Other:" (other analyses for elevation and friction loss)

This total energy requirement will determine the pressure switch settings (energy requirement = low switch setting).

The high pressure switch setting will determine the dynamic head added to the pump.

Dynamic Head

- Pressure when water is *flowing* in the system
- Depends on the initial pressure (determined by the pressure switch), differences in elevation, and friction loss from the movement of water through the system
- **Importance:** We need to determine how much dynamic head will be needed to make the system work properly (i.e. What is the minimum amount of pressure energy that will allow the system to deliver water to the troughs?).
  - The energy requirements will determine the pressure switch settings and the dynamic head added to the pump.

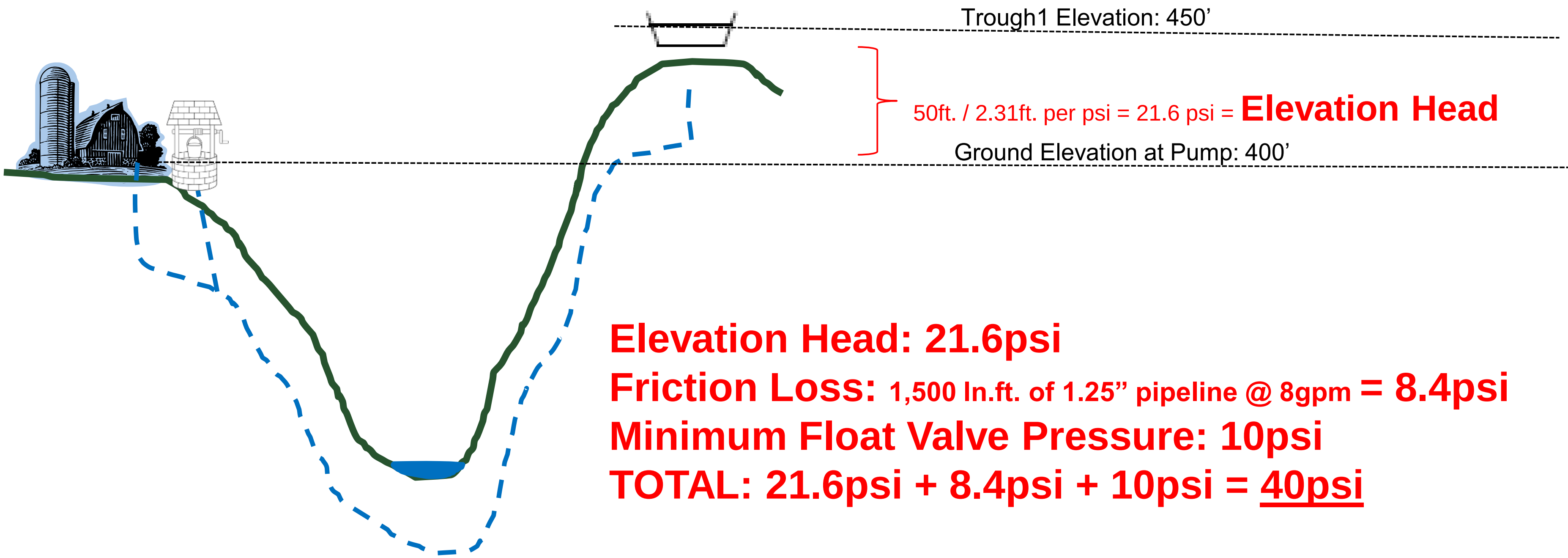
c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of 40 psi x 2.31 = 92 feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

Example: What are the energy requirements to deliver water to Trough 1?

Total Energy Requirement = Elevation Head + Friction Loss + Float Valve Minimum Pressure



Elevation Head: 21.6psi

Friction Loss: 1,500 ln.ft. of 1.25” pipeline @ 8gpm = 8.4psi

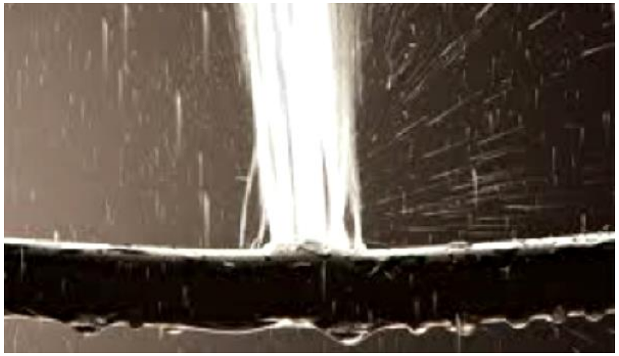
Minimum Float Valve Pressure: 10psi

TOTAL: 21.6psi + 8.4psi + 10psi = 40psi

Static Pressure

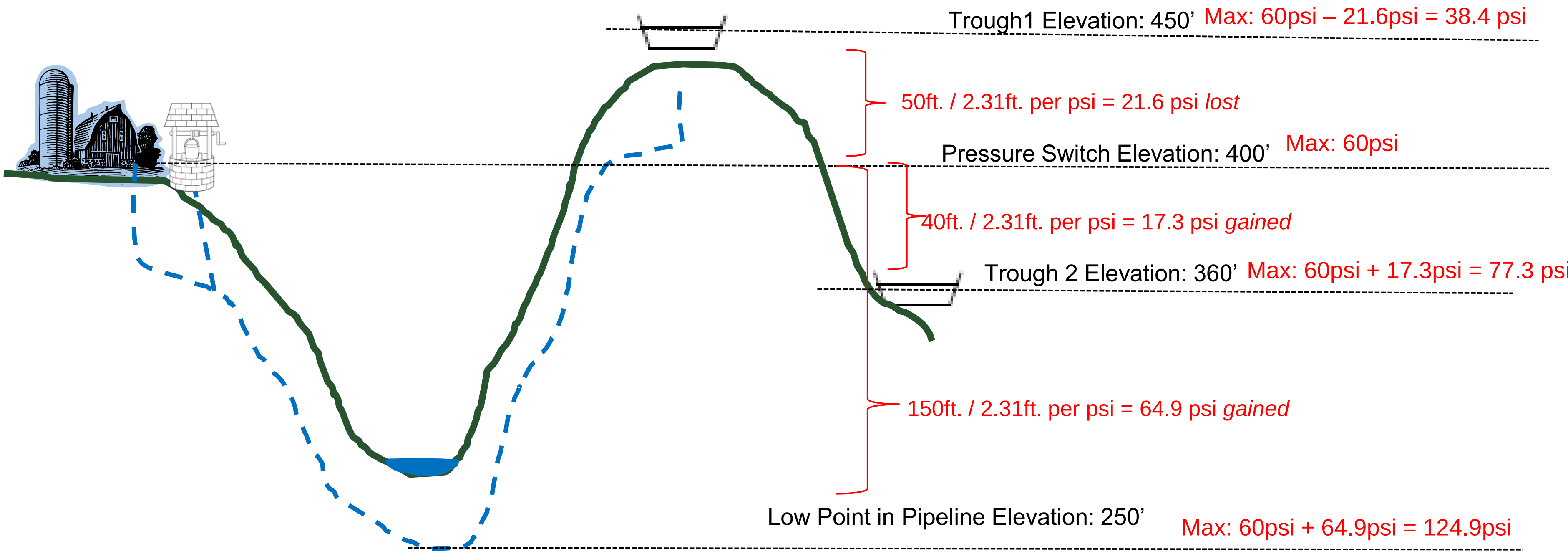
- Pressure when the system is at *rest*
- Friction loss is **not** a factor (water is not moving)
- Pressure will increase or decrease throughout the system based on elevation difference at each point from the pressure switch
- 1psi of pressure is gained for each 2.31 feet of elevation in a column of water
  - NOTE: The width of the column of water does not matter! Only the vertical elevation change affects pressure in the system.
- Importance: We need to check to make sure that static pressure is not *too high* at low points in the system.
  - Float Valves
  - Pipeline

Prevent this from happening:



Static Pressure Example

This system has a 40/60 pressure switch at elevation 400’. What is the maximum static pressure at each point of interest?



Completing the Pressure System Worksheet

Virginia Livestock Watering Systems - Pressure System Worksheet

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Customer:
County:
Date: 1/26/2016
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Project Notes:

2) Water Budget

a) Total Daily Water Demand

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Number of Animals:
Water demand/animal/day: gpd
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b) Daily Peak Water Demand

Number of times herd drinks/day: events
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Source flow rate: gpm
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Pipe material:
Pipe nominal diameter:
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Pipe cross-sectional area: sq. ft.
Friction loss/100 ft: ft./100 ft.
Velocity check (<5 fps): fps

If velocity is greater than 5 fps, consider a larger diameter pipe.

Pipe length to farthest watering point: feet
Add 10% for slope and fittings: feet
Total friction loss: ft. OR
Total friction loss: psi — If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi — Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet

Low point to pump "from":
Ground elev. of low point: feet

Elevation difference: feet
OR psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

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Friction loss:		psi	OR		feet
Minimum float valve pressure:		psi	OR		feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:		psi	OR		feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

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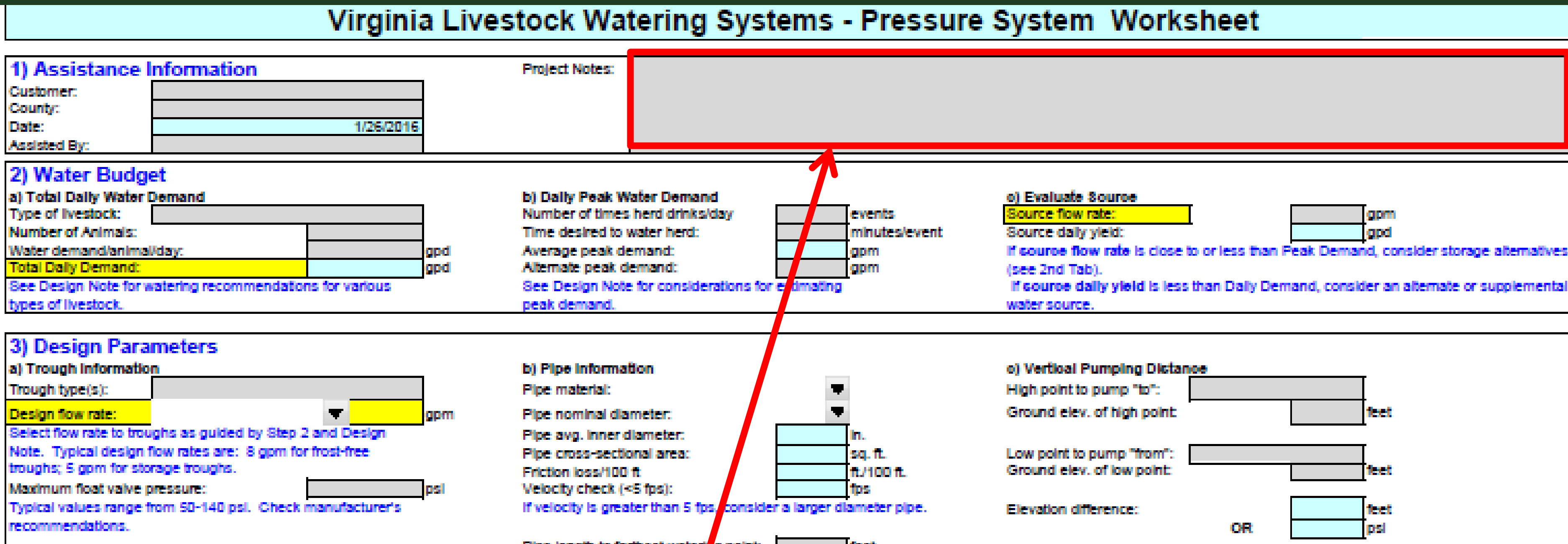
Project Notes

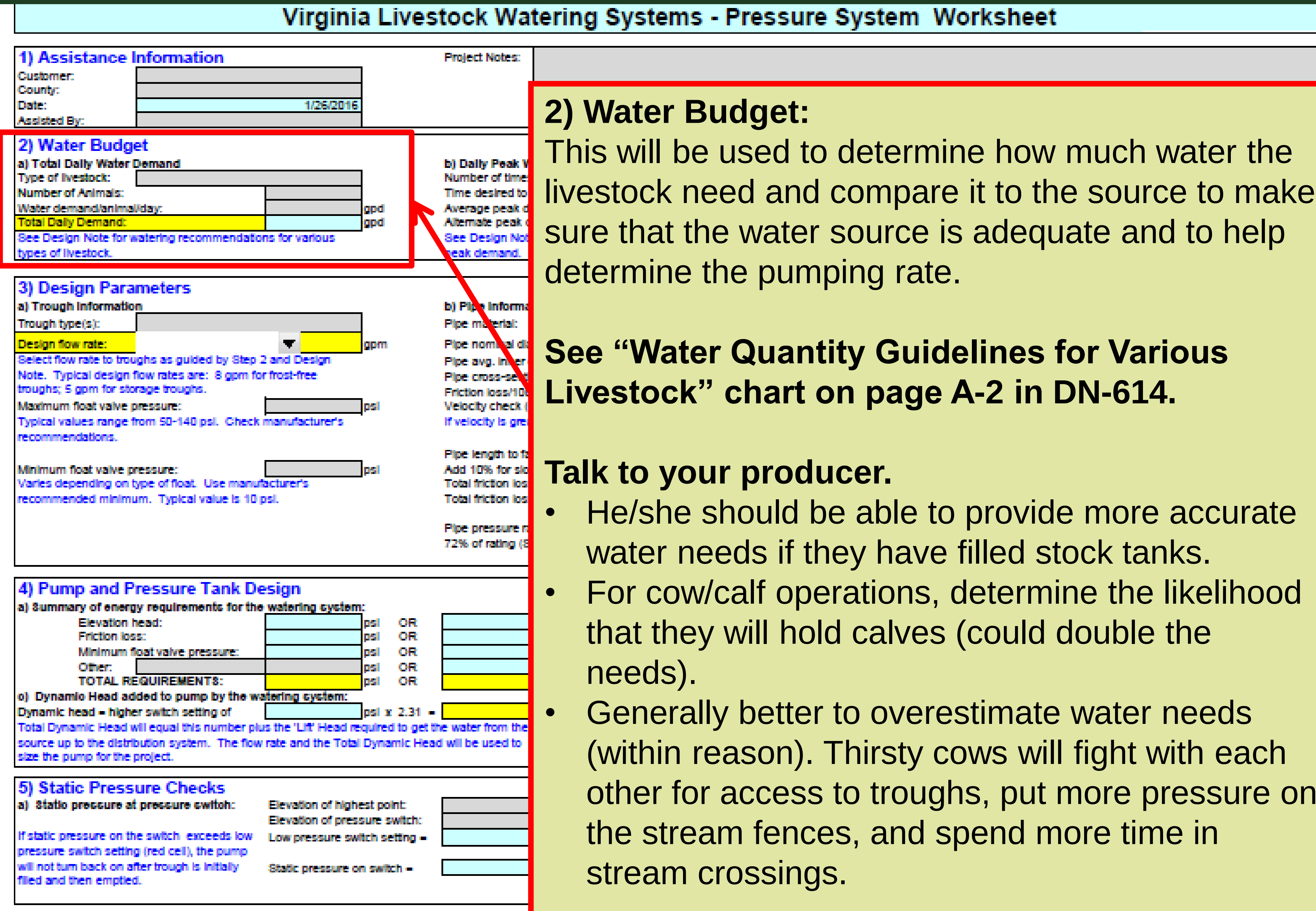


Project Notes: Include a brief description of the project, including any unique aspects (enough for your engineer, coworker, contractor to understand your inputs and your plans for the system).

Specifically:

- Is this a completely new system, or is it building off of an existing system?
- Will there be more than one analysis? (e.g., multiple pipeline sizes, remote pressure tank, adding to existing system, etc.) If so, describe the purpose of this analysis.
- Is there anything that you would like to highlight for the contractor/landowner? (e.g. which troughs have excessive pressure, notes on well yield, etc.)

Water Budget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TOTAL REQUIREMENTS: psi OR
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Low pressure switch setting =
Static pressure on switch =
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2) Water Budget:
This will be used to determine how much water the livestock need and compare it to the source to make sure that the water source is adequate and to help determine the pumping rate.

See "Water Quantity Guidelines for Various Livestock" chart on page A-2 in DN-614.

Talk to your producer.

- He/she should be able to provide more accurate water needs if they have filled stock tanks.
- For cow/calf operations, determine the likelihood that they will hold calves (could double the needs).
- Generally better to overestimate water needs (within reason). Thirsty cows will fight with each other for access to troughs, put more pressure on the stream fences, and spend more time in stream crossings.

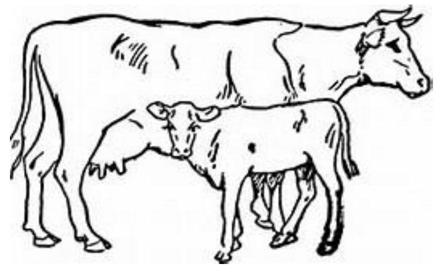
Water Quantity Guidelines for Various Livestock

DN-614, Page A-2

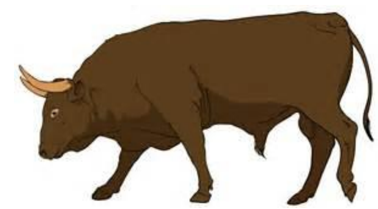
Type of Livestock		Estimated Daily Water Consumption per Animal (gallons per day)	References
Cattle	Beef adult	15	VA USDA-NRCS Introduction to Conservation Engineering
		8-12	Structures and Environment Handbook (MWPS, 1987)
	Calf	5	VA USDA-NRCS Introduction to Conservation Engineering
		1 to 1.5 gal/100 lb body weight	Structures and Environment Handbook (MWPS, 1987)
	Beef cow/calf pair	20	VA USDA-NRCS Introduction to Conservation Engineering
		6-18	National Range and Pasture Handbook (USDA-NRCS, 1997)
	Growing steers/ pregnant heifers	6-18	National Range and Pasture Handbook (USDA-NRCS, 1997)
	Heifer	10-15	Structures and Environment Handbook (MWPS, 1987)
	Milking cow	30	VA USDA-NRCS Introduction to Conservation Engineering
		10-30	National Range and Pasture Handbook (USDA-NRCS, 1997)
		35-45	Structures and Environment Handbook (MWPS, 1987)
	Dry cow	20	VA USDA-NRCS Introduction to Conservation Engineering
		20-30	Structures and Environment Handbook (MWPS, 1987)
Swine	Swine	4	VA USDA-NRCS Introduction to Conservation Engineering
	Finishing swine	3-5	Structures and Environment Handbook (MWPS, 1987)
	Nursery	1	Structures and Environment Handbook (MWPS, 1987)
	Gestating sow	6	Structures and Environment Handbook (MWPS, 1987)
	Sow and litter	8	Structures and Environment Handbook (MWPS, 1987)
Other Grazing Mammals	Horse	12	Structures and Environment Handbook (MWPS, 1987); VA USDA-NRCS Introduction to Conservation Engineering
		8-12	National Range and Pasture Handbook (USDA-NRCS, 1997)
	Llama	4	VA USDA-NRCS Introduction to Conservation Engineering
	Sheep, Goat	3	VA USDA-NRCS Introduction to Conservation Engineering
		2	Structures and Environment Handbook (MWPS, 1987)
		1-4	National Range and Pasture Handbook (USDA-NRCS, 1997)
Poultry	100 chicken layers	9	Structures and Environment Handbook (MWPS, 1987)
	100 turkeys	15	Structures and Environment Handbook (MWPS, 1987)
General	1000 lb live weight (AU)	30	Indiana USDA-NRCS IN-ENG-Pipeline-4-09.xls

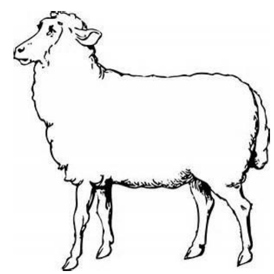
Total Daily Water Demand Example

A producer has:



- 20 cow/calf pairs
- 1 bull
- 12 sheep
- 2 horses





What is the “Total Daily Demand”?

“Pressure System Worksheet” only has room for one animal type. Quick calculations need to be done.

Total Daily Water Demand Example

We confirm that the producer will absolutely sell his calves every spring. Use "Water Quantity Guidelines for Various Livestock" to determine total demand.

• 20 cow/calf pairs	x 20 gal/day	=	400 gal/day
• 1 bull	x 15 gal/day	=	15 gal/day
• 12 sheep	x 3 gal/day	=	36 gal/day
• 2 horses	x 12 gal/day	=	24 gal/day

What is the "Total Daily Demand"? = 475 gallons/day

But the worksheet only allows you to enter number of animals and demand/animal/day…

475 gallons/day ÷ 35 animals = **13.57 gal/animal/day.** → 14 **gal/animal/day.**
=490gpd (conservative)

Enter into worksheet:

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	ef Cow/Calf Pairs, Bull, Horses, Sheep	
Number of Animals:	35	
Water demand/animal/day:	14	gpd
Total Daily Demand:	490	gpd

See Design Note for watering recommendations for various types of livestock.

Water Budget

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Project Notes:

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Type of livestock:
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Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day events
Time desired to water herd: minutes/event
Average peak demand: gpm
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See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information
Trough type(s):
Design flow rate: gpm
Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.
Maximum float valve pressure: psi
Typical values range from 50-140 psi. Check manufacturer's recommendations.
Minimum float valve pressure: psi
Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information
Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft ft./100 ft.
Velocity check (<5 fps): fps
If velocity is greater than 5 fps, consider a larger diameter pipe.
Pipe length to farthest watering point: feet
Add 10% for slope and fittings: feet
Total friction loss: ft. OR
Total friction loss: psi If friction loss is greater than 10 psi, consider using a larger diameter pipe.
Pipe pressure rating: psi

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point feet
Low point to pump "from":
Ground elev. of low point feet
Elevation difference: feet
OR psi

4) Pump and Pressure Tank D
a) Summary of energy requirements for th
Elevation head:
Friction loss:
Minimum float valve pressure:
Other:
TOTAL REQUIREMENTS:
c) Dynamic Head added to pump by the
Dynamic head = higher switch setting of
Total Dynamic Head will equal this number
source up to the distribution system. The flo
size the pump for the project.

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ate design or
minimum drawdown volume required to allow
o run for at least one minute before shutting off.
lume can be used.

5) Static Pressure Checks
a) Static pressure at pressure switch:
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

l: pressure exceeds max float valve pressure;
e pressure limit exceeded. Check troughs at
ations if pressure is excessive at lowest trough.
psi
psi
psi

2) Water Budget:

b. Daily Peak Water Demand

- This will calculate the livestock's peak demand for water. An "Alternate Peak Demand" can be entered based on the planner's experience.
- The following slides provide info for calculating "Average Peak Demand" and deciding on a possible "Alternate Peak Demand."

b) Daily Peak Water Demand

Number of times herd drinks/day		events
Time desired to water herd:		minutes/event
Average peak demand:		gpm
Alternate peak demand:		gpm

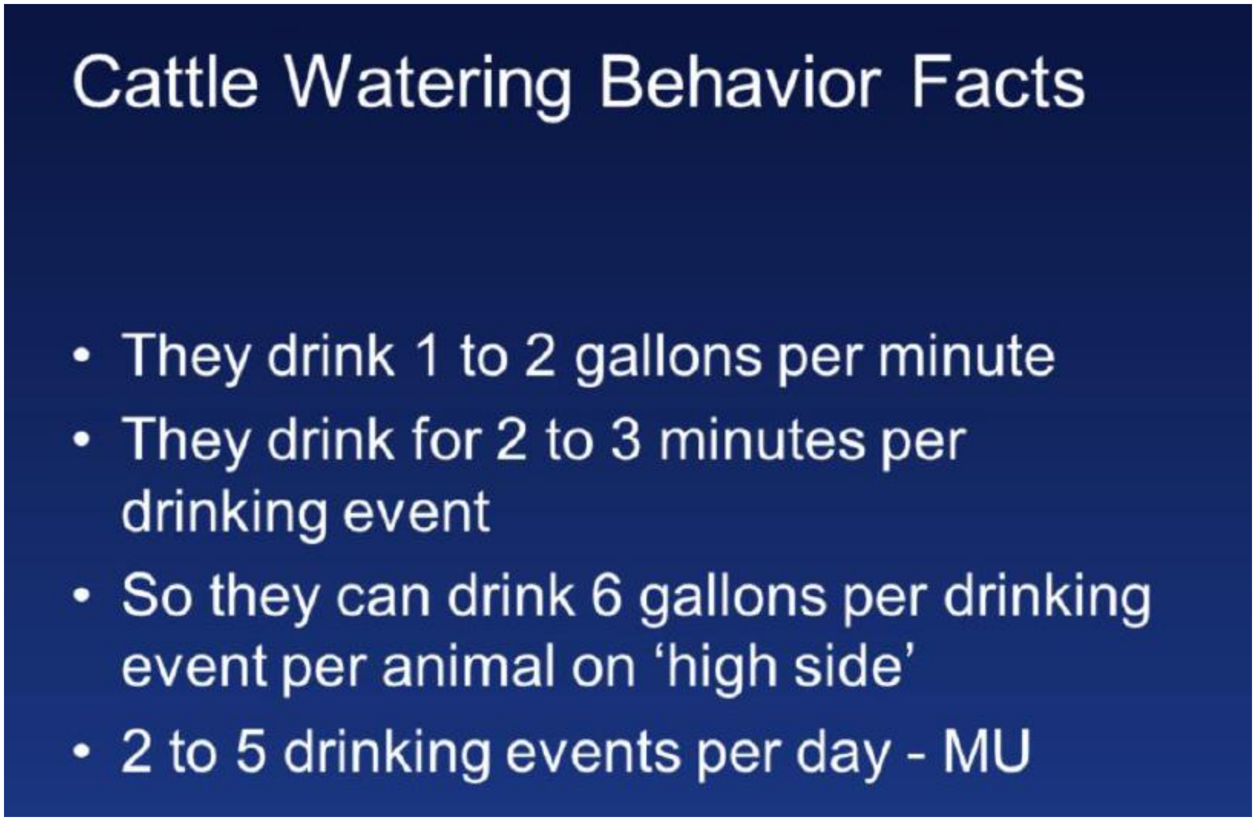
See Design Note for considerations for estimating peak demand.

Number of Times herd drinks/day:

This is typically 2 or 3, but for heavily subdivided, small pasture, this number may be as high as 5 or 6. Pasture size and shape factor in heavily.

From the *Missouri Livestock Watering Systems Handbook*:

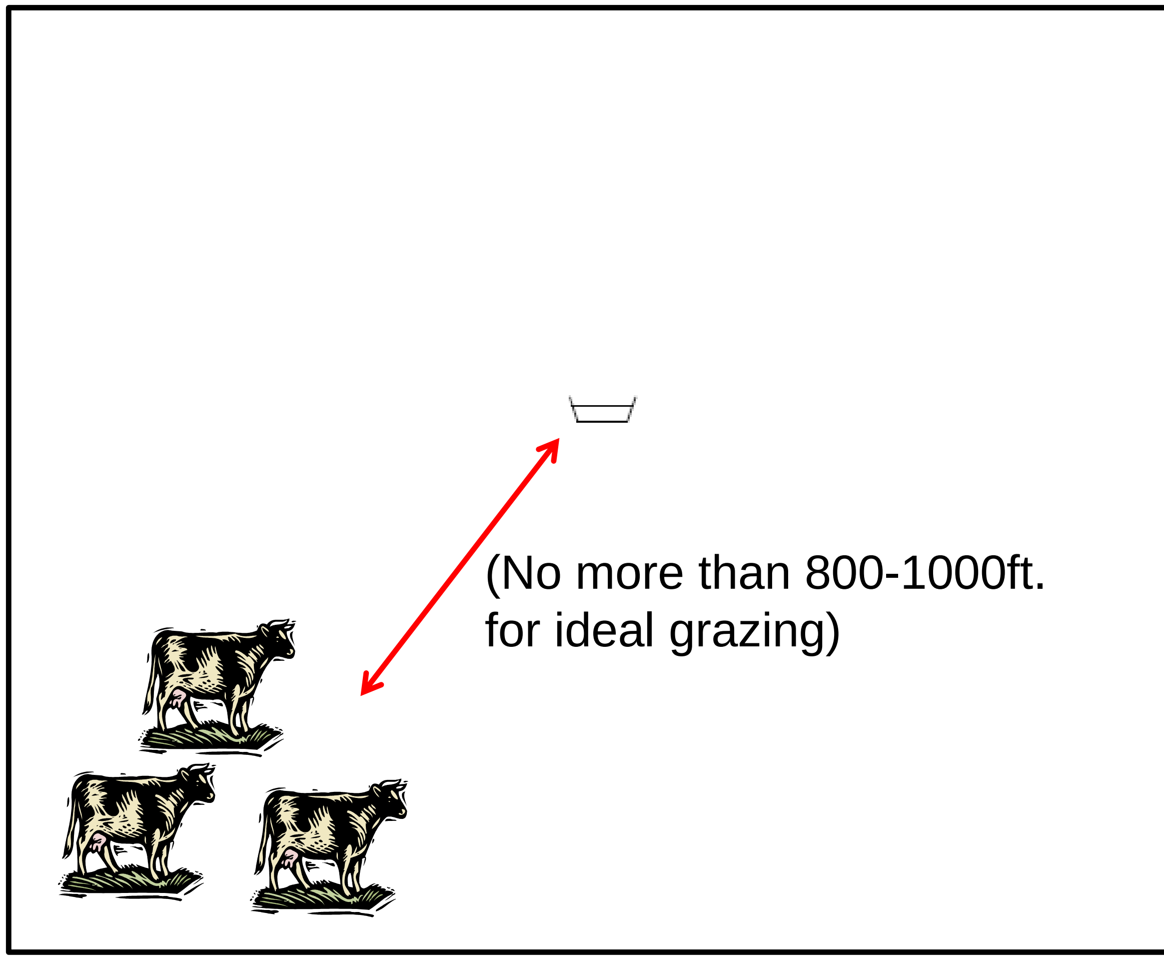
- Distance animals have to travel to get to water affects herd behavior as related to the social event of going to the water hole and the amount of water consumed.
- According to cow psychologists, cattle go to water less frequently and go as a herd or large grazing groups if water is farther than **800 feet** from the pasture.
- If water is closer animals tend to go to water more often and as singles, pairs, or small groups (especially in flat or gently rolling terrain where they can keep sight of their buddies).
- The design delivery rate should be the maximum available or maximum required whichever is less. The tank size should be made bigger for low delivery systems. History has shown that oversized tanks work well with few problems.



Slide borrowed from “Solar Powered Water Systems for Grazing Operations” webinar presentation by Kevin Ogles, Grazing Lands Specialist, USDA-NRCS

Fewer drinking events may be expected in:

- Large pastures (Distance to Troughs)



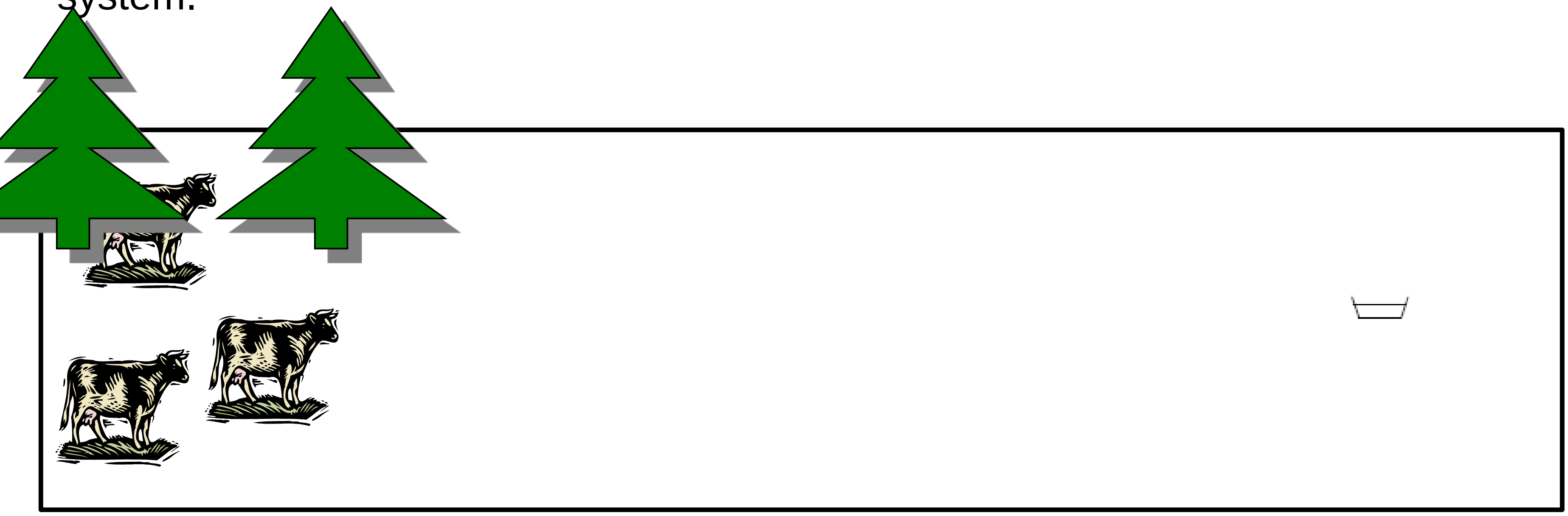
Fewer drinking events may be expected in:

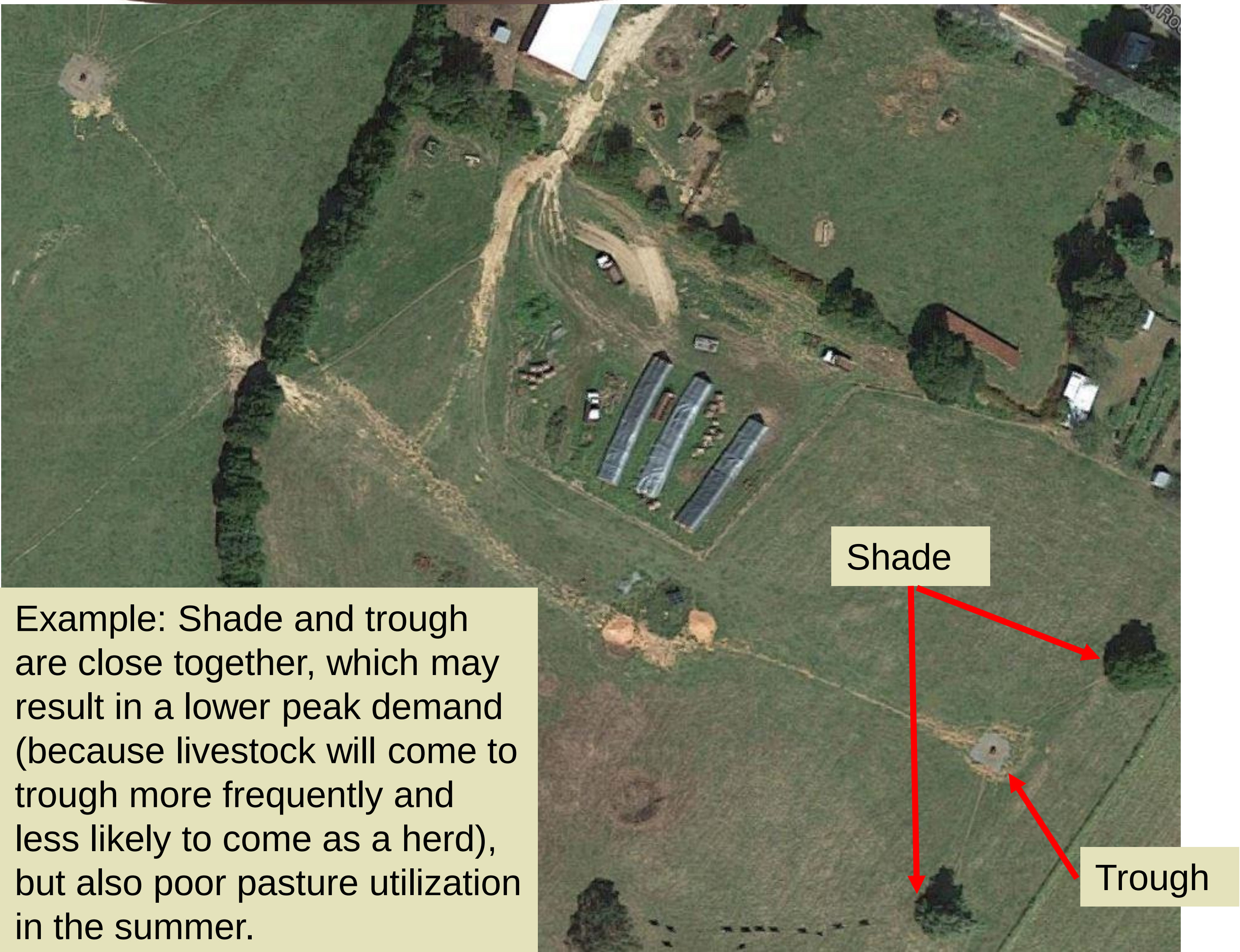
- Large pastures (Distance to Troughs)
- Odd-Shaped Pastures or Non-Centrally Located Troughs

Fewer drinking events may be expected in:

- Large pastures (Distance to Troughs)
- Odd-Shaped Pastures or Non-Centrally Located Troughs
- Pastures where the water source and shade are separated***

***Note that this is a good conservation planning technique to encourage full utilization of the pasture; it just means that you can expect cattle to need fewer, longer-duration drinking events (thus a higher peak demand) when designing the system.





Example: Shade and trough are close together, which may result in a lower peak demand (because livestock will come to trough more frequently and less likely to come as a herd), but also poor pasture utilization in the summer.

Fewer drinking events

- Longer Duration events
- Higher Peak Demand
- More water consumed per event

b) Daily Peak Water Demand

Number of times herd drinks/day		events
Time desired to water herd:		minutes/event
Average peak demand:		gpm
Alternate peak demand:		gpm

See Design Note for considerations for estimating peak demand.

Time desired to water herd:

Typical values are 30 to 60 minutes but is highly subjective.

Time is valuable when cattle cannot graze because they are waiting for water.

b) Daily Peak Water Demand

Number of times herd drinks/day		events
Time desired to water herd:		minutes/event
Average peak demand:		gpm
Alternate peak demand:		gpm

See Design Note for considerations for estimating peak demand.

Alternate peak demand:

This is where the planner can use their field experience to enter a peak demand that they think is reasonable.

Alternate Peak Demand

- One common "Rule of Thumb" is to design to supply 2 gallons per minute (gpm) per head (for cattle) that can drink at one time

  (Missouri University Extension, *Pumps and Watering Systems for Managed Beef Grazing*).

- **For example:**

  6-hole trough: 6 holes x 1 cow per hole x 2gpm per cow = **12gpm**

  4-hole trough: 4 holes x 1 cow per hole x 2gpm per cow = **8gpm**

  2-hole trough: 2 holes x 1 cow per hole x 2gpm per cow = **4gpm**

- This is based on the premise that one beef cow will only drink 2gpm, so there is no need to deliver more water than 8gpm to a 4-hole trough.

Alternate Peak Demand

- If you calculate an "Average Peak Demand" of 20gpm but understand that only 8gpm will be consumed from the trough, do not design the system with pumping rate of 20gpm (resulting in a bigger pump, larger pipeline, and more cycling of the pump if cows are really only drinking 8gpm).
- Concerned about the time it will take to water a herd with a 4-hole trough at 8gpm?→ Consider a 6-hole trough at 12gpm OR troughs with more storage (concrete or HETT with float valves) if the peak demand (gpm) cannot be met.
  - Do not install a 6-hole trough simply for more "storage" than a 4-hole trough (6-hole troughs typically only store 15-30 more gallons than 4-hole troughs)


Okay girls, we need to drink a little slower – this drinking event is supposed to last one hour.

Recommended Approach:

b) Daily Peak Water Demand

Number of times herd drinks/day		events
Time desired to water herd:		minutes/event
Average peak demand:		gpm
Alternate peak demand:		gpm

See Design Note for considerations for estimating peak demand.

- Calculate an “Average Peak Demand” using 30-60 minutes per event and 3 events.
- Compare this result to the “Alternate Peak Demand” using the “2gpm-per-hole” approach
- If the “Average Peak Demand” >> “Alternate Peak Demand,” then:
  - Work backwards to determine how long it will take to water the herd at the “Alternate Peak Demand”
  - If the Alternate Peak Demand is too low, upgrade to a trough with more holes or a storage trough
- If the “Average Peak Demand” << “Alternate Peak Demand,” then:
  - Use the “Alternate Peak Demand” as the “Design Flow Rate”
  - Consider a trough with fewer holes as the “least cost, technically feasible alternative”
- If the “Average Peak Demand” ≈ “Alternate Peak Demand, then: GREAT!
- **In this way, the “*Average Peak Demand”* can be thought of as more of a planning tool and will rarely be used as the actual pumping rate.**

Summary: Alternate Peak Demand

- 8gpm for 4-hole troughs
- 4gpm for 2-hole troughs
- 12gpm for 6-hole troughs
- 5gpm for concrete or HET troughs
- Compare to “Average peak demand” to determine if trough size is appropriate

In case you forget…

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd

If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):
Design flow rate: gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

b) Pipe Information

Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
sq. ft.
ft./100 ft.
fps

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet
Elevation difference: feet OR psi

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

4) Pump and Pressure Ta

a) Summary of energy requirements fo

Elevation head:
Friction loss:
Minimum float valve pressure:
Other: psi OR feet
TOTAL REQUIREMENTS: psi OR feet

high pressure-rated tank.

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:

Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

A Related Aside…

- Manufacturer's recommendations for the number of cattle served by frost-free troughs may be higher than reality in pastures
  - Manufacturers' numbers appear to be based on feed lot/loafing lot scenarios (not pasture) where cattle do not come to drink as a herd

Manufacturer's Recommendations for # Beef Cattle Served by Troughs:

Trough Size	Ritchie	MiraFount
1-hole	30 (CT1-2000)	70 (#3345)
2-hole	100 (CT2-2000)	150 (#3390)
4-hole	200 (CT4-2000)	200 (#3354-S)
6-hole	300 (CT6)	250 (#3370-S)

This information is provided for informational purposes ONLY and is not a recommendation of any product or manufacturer.

For example, if a 2-hole trough is installed to serve 100 cows, the last cows in line would have to wait through 49 other pairs of cows to drink. Each drinking event could take several hours.

Trough Size Selection Example

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	Cow/Calf Pairs	
Number of Animals:	120	
Water demand/animal/day:	20	gpd
Total Daily Demand:	2400	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day	3	events
Time desired to water herd:	60	minutes/event
Average peak demand:	13.3	gpm
Alternate peak demand:	8	gpm

See Design Note for considerations for estimating peak demand.

- This is a large herd of 120 cow/calf pairs.
- If we plan for a 4-hole trough at 8gpm with 3 drinking events, how long will it take to water the herd?

  2400gpd/3 events = 800gallons per event

  800gallons/8gpm = 100 minutes → This is a long time!
- What if we planned to upgrade to a 6-hole trough with an “Alternate Peak Demand”/”Design Flow Rate” of 12gpm

  800gallons/12gpm = 67 minutes --> This is reasonable.

Water Budget

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd

b) Daily Peak Water Demand
Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet
Elevation difference: feet
OR psi

...ss is greater than 10 psi, consider using a larger diameter pipe.

...with result in Step 5b.

...n System Load:
psi (Minimum is 20 psi.)
psi (Max. is usually 80 psi.)
...ting of 80 psi or more is required, consider alternate design or

Pressure Tank:
gpm x
1 minute =
...ume of gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

...rough:
feet
feet
feet OR psi
psi
psi
...etting:
Total pressure at lowest trough:
filled and then emptied.

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

2) Water Budget:

c. Evaluate Source

- This will check to make sure that the source produces enough water in a 24-hour period to meet the "Total Daily Water Demand" of the livestock.
- **"If daily yield is less than daily demand, then an alternative or a supplemental source of water will need to be used or the number of animals served will need to be reduced."**
    - A reservoir may help meet peak demand in some cases, but if the source doesn't produce enough for the daily demand, the system will run dry
- If the well is used for other purposes aside from the watering system, be sure to account for this – especially when it comes to dairies!

Design Parameters

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times
Time desired to
Average peak d
Alternate peak d
See Design Not
peak demand.

c) Evaluate Source

3) Design Parameters

a) Trough Information
Trough type(s):
Design flow rate: gpm
Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.
Maximum float valve pressure: psi
Typical values range from 50-140 psi. Check manufacturer's recommendations.
Minimum float valve pressure: psi
Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Informa
Pipe material:
Pipe nominal dia
Pipe avg. inner diameter: in.
Pipe cross-secti
Friction loss/100
Velocity check (
If velocity is grea
Pipe length to
Add 10% for slo
Total friction loss
Total friction loss
Pipe pressure ra
72% of rating (S

Trough type: Enter a brief description
e.g.: "4-hole frost-free"
"HETT on float valve"
"Concrete trough on float valve"

Design Flow Rate: Select "Average Peak Demand," "Alternate Peak Demand," or "Source Flow Rate"
Design Flow Rate = Design Pumping Rate

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:
Elevation head: psi OR
Friction loss: psi OR
Minimum float valve pressure: psi OR
Other: psi OR
TOTAL REQUIREMENTS: psi OR

c) Dynamic Head added to pump by the watering system:
Dynamic head = higher switch setting of psi x 2.31 =
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Lo

Compare the selected "Design Flow Rate" to "Source Flow Rate". If the "Design Flow Rate" *exceeds* the "Source Flow Rate", you risk pumping the source dry. Use "Source Flow Rate" for Design Flow Rate in that case, OR:
-consider storage alternatives (reservoirs)
-calculate storage in the well to see if it would be pumped dry in a drinking event.

5) Static Pressure Checks

a) Static pressure at pressure switch:
Elevation of highest point:
Elevation of pressure switch:
Low pressure switch setting =
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Design Flow Rate – Feasible?

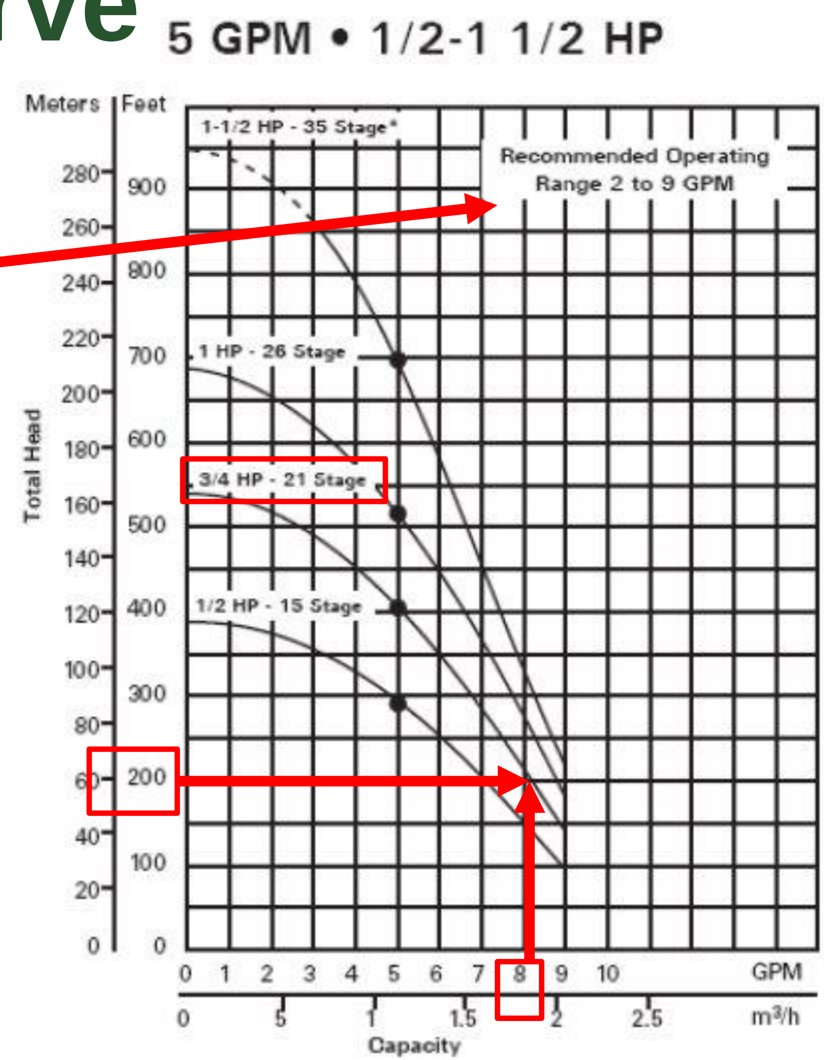
- Don't fall into "trap" of contractors saying pumps only come in 5gpm, 10gpm, etc. so you can't plan for pumping rates of 8gpm, 12gpm, etc.
- A pump's advertised flow rate is only the average of its advertised pumping range!

Example Pump Curve

- These 5gpm pumps of varying horsepower operate at pumping rates of 2gpm – 9gpm depending on the total head on the pump.

- Example: The pump for our system will have a "Total Head" of 200ft. Will any of these 5gpm pumps pump at 8gpm?
  - YES: the ¾ HP pump will work

NOTE: This is beyond the scope of our engineering responsibilities. We rely on the plumber to size & select the pumps.



Multiple size troughs in system?

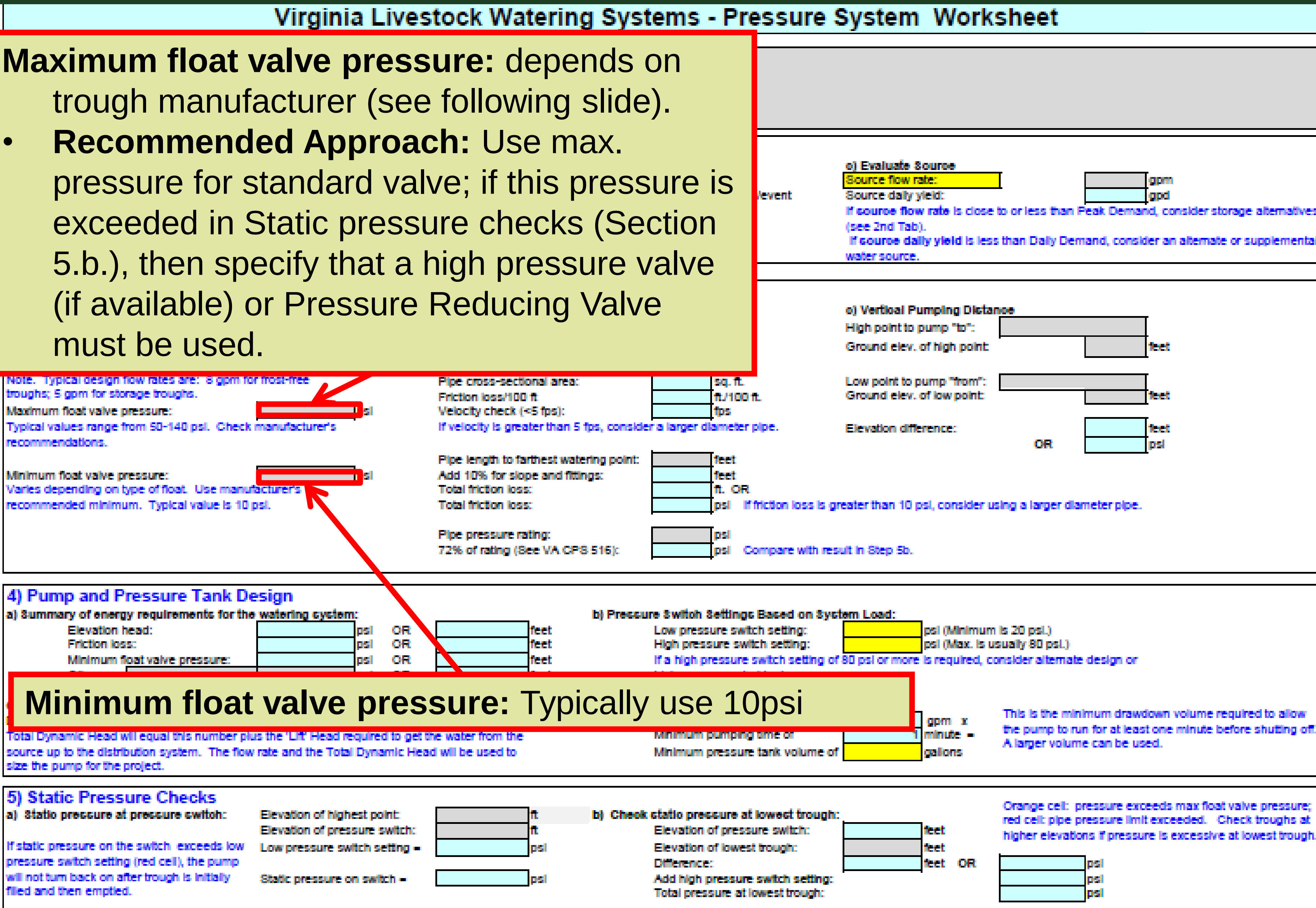
- Decide on one design flow rate (there will only be one pump for the system)

Design Parameters

Maximum float valve pressure: depends on trough manufacturer (see following slide).

- **Recommended Approach:** Use max. pressure for standard valve; if this pressure is exceeded in Static pressure checks (Section 5.b.), then specify that a high pressure valve (if available) or Pressure Reducing Valve must be used.

Minimum float valve pressure: Typically use 10psi


Virginia Livestock Watering Systems - Pressure System Worksheet

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet
Elevation difference: feet OR psi

Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.
Maximum float valve pressure: psi
Typical values range from 50-140 psi. Check manufacturer's recommendations.
Minimum float valve pressure: psi
Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

Pipe cross-sectional area: sq. ft.
Friction loss/100 ft: ft./100 ft.
Velocity check (<5 fps): fps
If velocity is greater than 5 fps, consider a larger diameter pipe.
Pipe length to farthest watering point: feet
Add 10% for slope and fittings: feet
Total friction loss: ft. OR
Total friction loss: psi If friction loss is greater than 10 psi, consider using a larger diameter pipe.
Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi Compare with result in Step 5b.

4) Pump and Pressure Tank Design
a) Summary of energy requirements for the watering system:
Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:
Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)
If a high pressure switch setting of 80 psi or more is required, consider alternate design or
gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks
a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi
Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Common Float Valve Pressure Ranges

Ritchie 3/4" Valve Series

Ritchie 3/4" valves come in four pressure ratings:

- White - 33 GPM, Low (5-40 psi)
- Red - 20 GPM, Moderate (40-60 psi)
- Green - 16.5 GPM, High (60-80 psi) ★
- Blue - 5 GPM, Very High (80-100 psi)

MIRACO

Livestock Water Systems

"Originators of insulated poly waterers"

Part No	GPM	Pressure
#336	14	Low 5 – 40 psi
#521	12.5	High 40 – 80 psi ★
#519	6	High 80 – 90 psi

★ = Typically included as the Standard Valve (Check with Supplier)

Notice that the highest pressure valves reduce the flow rate to below 8gpm. In high pressure situations, you may consider recommending a Pressure Reducing Valve instead of a high-pressure float valve so that the flow rate is not sacrificed.

This information is provided for informational purposes ONLY and is not a recommendation of any product or manufacturer.

Design Parameters

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information
Trough type(s):
Design flow rate: gpm
Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

b) Pipe Information
Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft: ft./100 ft.

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet

The Pipe Information section of the worksheet will be used to:

-Determine the minimum diameter of the pipeline

-Determine the **friction loss** created in the pipeline, which will influence the energy requirements (and therefore the pressure switch settings and pump requirements)

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:
Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
Other: psi OR feet
TOTAL REQUIREMENTS: psi OR feet

b) Pressure Switch Settings Based on System Load:
Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)
If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

c) Dynamic Head added to pump by the watering system:
Dynamic head = higher switch setting of psi x 2.31 = feet
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

d) Minimum Effective Drawdown for Pressure Tank:
Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

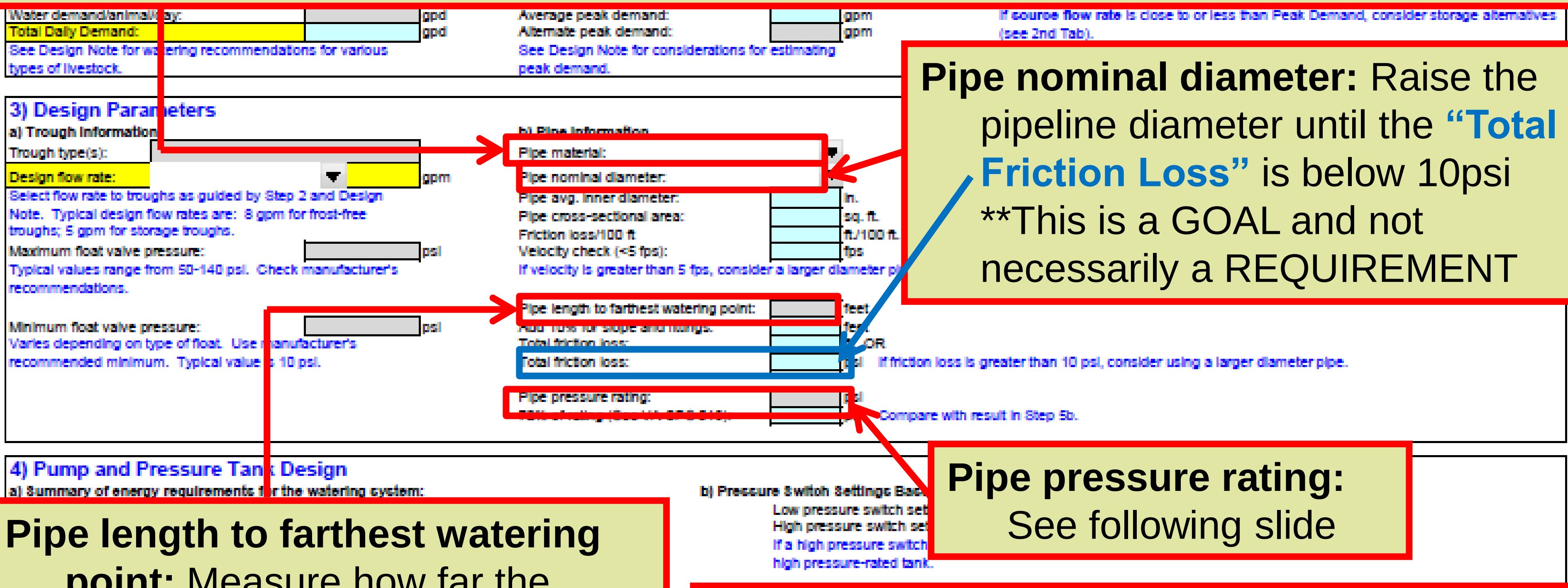
a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi
Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Design Parameters

Pipe Material: Most pressure systems will be installed with plastic (PE or PVC) pipeline to minimize cost.

- If you know plastic will be installed but unsure whether it will be PE or PVC, **select PVC** for calculations because it has a smaller actual inside diameter for each nominal diameter and will give conservative friction loss calculations.



Pipe nominal diameter: Raise the pipeline diameter until the **"Total Friction Loss"** is below 10psi **This is a GOAL and not necessarily a REQUIREMENT

Pipe pressure rating: See following slide

Pipe length to farthest watering point: Measure how far the water will need to travel through the pipeline to the farthest watering location using a total station survey, GIS, or a measuring wheel

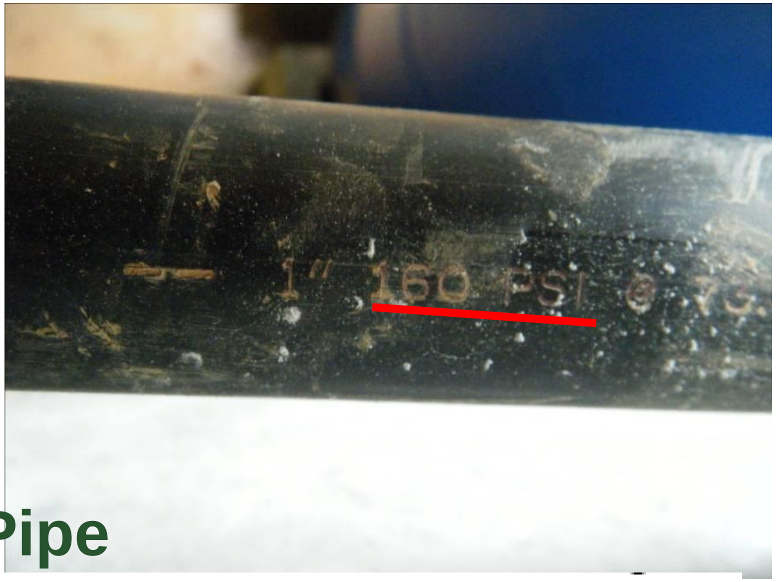
NOTE: If "tee"-ing off of an existing pipeline, be sure to also calculate the friction loss in the existing pipeline. We need to calculate the total friction loss from the pumping location to the destination.

Pipe pressure rating: See DN-614-B-2

Polyethylene (PE) Plastic Pipe

- 250 psi
- 200 psi
- 160 psi
- 125 psi
- 100 psi
- 80 psi

Most commonly used: 160psi+



Polyvinyl Chloride (PVC) Plastic Pipe

Water pressure ratings for Schedule 40 PVC Pipe (PVC1120, PVC1220, PVC2120) are:

Nominal Diameter	Pressure Rating at 73° F
1"	450 psi
1-1/4"	370 psi
1-1/2"	330 psi
2"	280 psi

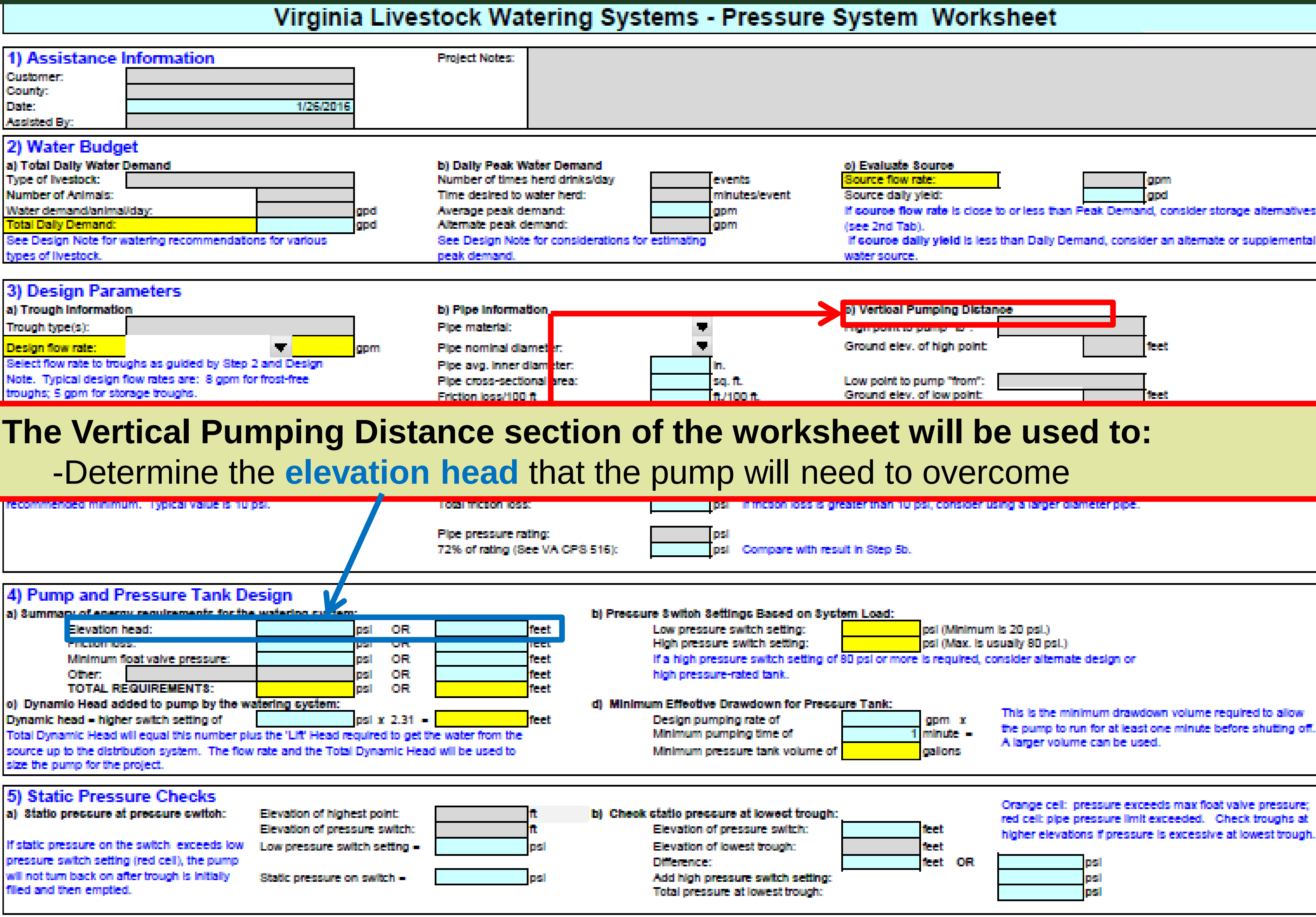
***If unsure whether PE or PVC will be used, use the PE pressure rating value to be conservative

Pipeline Sizes

- All pipeline does not have to be the same size in a system!
- Design the “least cost, technically feasible” alternative
  - Keep the potential for future expansion in mind. If the producer has committed to address farther fields at a later time, go ahead and plan for this.
- Analyze total friction loss to trough(s) – if using two different pipeline sizes, calculate friction loss in both runs and add together.
- Use the run with highest friction loss on the final worksheet that you size the pump with
  - Might *not* be the longest run (if one run has smaller pipe)!

Pipeline Size: Future Expansion?

Design Parameters



Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information
Trough type(s):
Design flow rate: gpm
Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

b) Pipe Information
Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft ft./100 ft.

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet

The Vertical Pumping Distance section of the worksheet will be used to:

-Determine the **elevation head** that the pump will need to overcome

recommended minimum. Typical value is 10 psi.

Total friction loss: psi If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi Compare with result in Step 5b.

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:		psi	OR		feet
Friction loss:		psi	OR		feet
Minimum float valve pressure:		psi	OR		feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:		psi	OR		feet

c) Dynamic Head added to pump by the watering system:
Dynamic head = higher switch setting of psi x 2.31 = feet
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:
Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)
If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:
Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi
Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Design Parameters

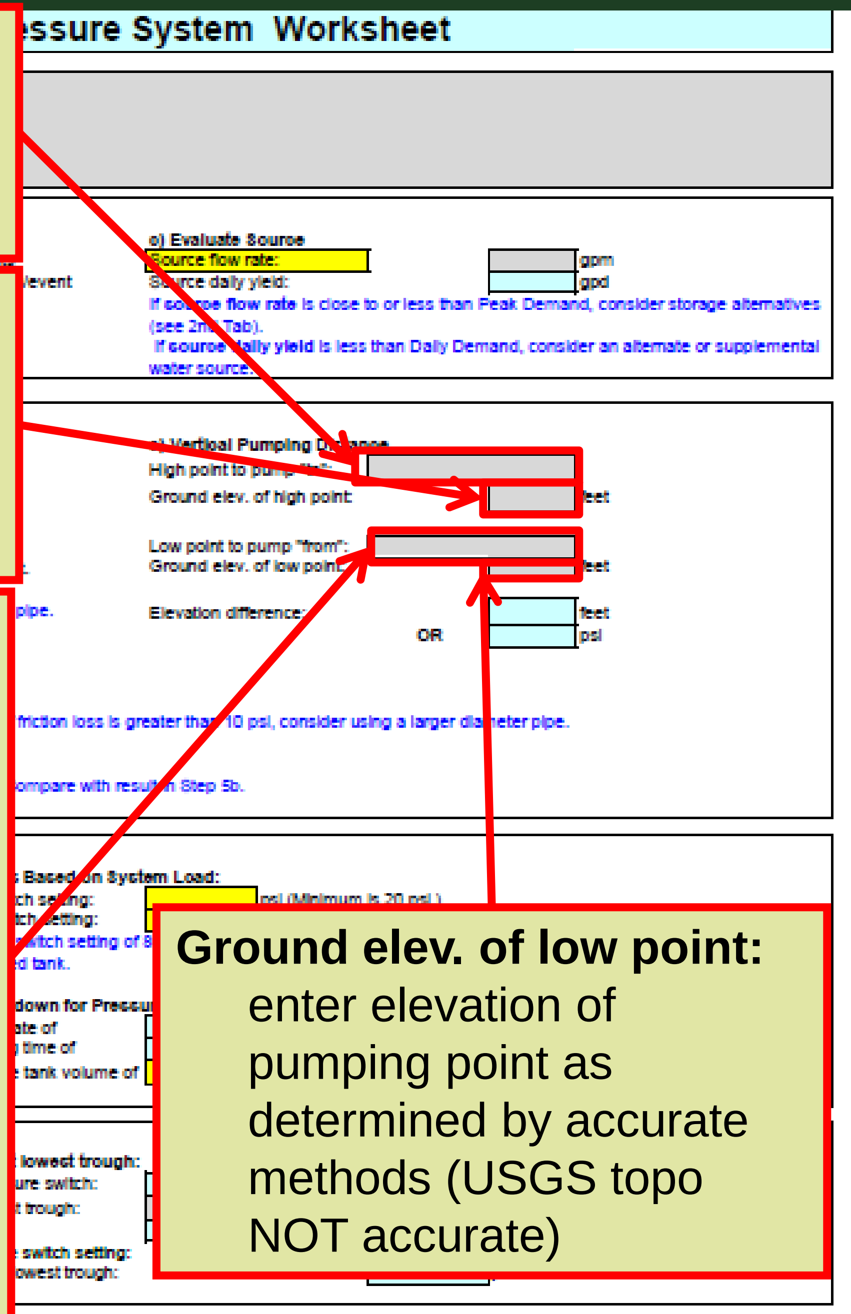
High point to pump "to": enter brief description of the high point in the system
e.g. "Trough 3" or "High point in line between well and Trough 3"

Ground elev. of high point: enter elevation of high point as determined by accurate methods (USGS topo NOT accurate)

- High Point is not always a trough location; can be in the middle of a run of pipeline

Low point to pump "from": ground elevation at the pump location (NOT the low point in the system; we are only concerned with the actual low point in the system later in the worksheet during static pressure checks).
e.g. "Well"

(Keep in mind that the end result of the worksheet will be the "Dynamic Head added to pump by the watering system." We are trying to figure out the *additional* requirements (determined by the pressure switch settings) that the pump will need to overcome once it has already brought the water to the ground elevation at the source.)



Ground elev. of low point: enter elevation of pumping point as determined by accurate methods (USGS topo NOT accurate)

Design Parameters

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information
Trough type(s):
Design flow rate: gpm
Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.
Maximum float valve pressure: psi
Typical values range fr... recommendations.
Minimum float valve pre...
Varies depending on ty... recommended minimu...

b) Pipe Information
Pipe material:
Pipe nominal diameter:
Pipe avg. inner diameter: in.
Pipe cross-sectional area: sq. ft.
Friction loss/100 ft: ft./100 ft.
Velocity check (<5 fps): fps

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet
...difference: feet
OR psi
...0 psi, consider using a larger diameter pipe.

4) Pump and Pr...

a) Summary of energy...
Elevation he...
Friction loss...
Minimum flo...
Other:
TOTAL RE...
psi (Minimum is 20 psi.)
psi (Max. is usually 80 psi.)
...re is required, consider alternate design or

c) Dynamic Head add...
Dynamic head = higher...
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi
Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

If the well is the high point in the system, the "Low point to pump "from"" will be higher than the "High point to pump to", resulting in a NEGATIVE number for the "Elevation difference."

This is not a bad thing!

Design Parameters

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd

If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):
Design flow rate: gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure: psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure: psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe
Pipe
Pipe
Pipe
Frictio
Veloc
If velo

Pipe length to farthest watering point: feet
Add 10% for slope and fittings: feet
Total friction loss: ft. OR
Total friction loss: psi If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet

Elevation difference: feet
OR psi

Key Words:
PUMP "TO"
PUMP "FROM"

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
Other: psi OR feet
TOTAL REQUIREMENTS: psi OR feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:

Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi

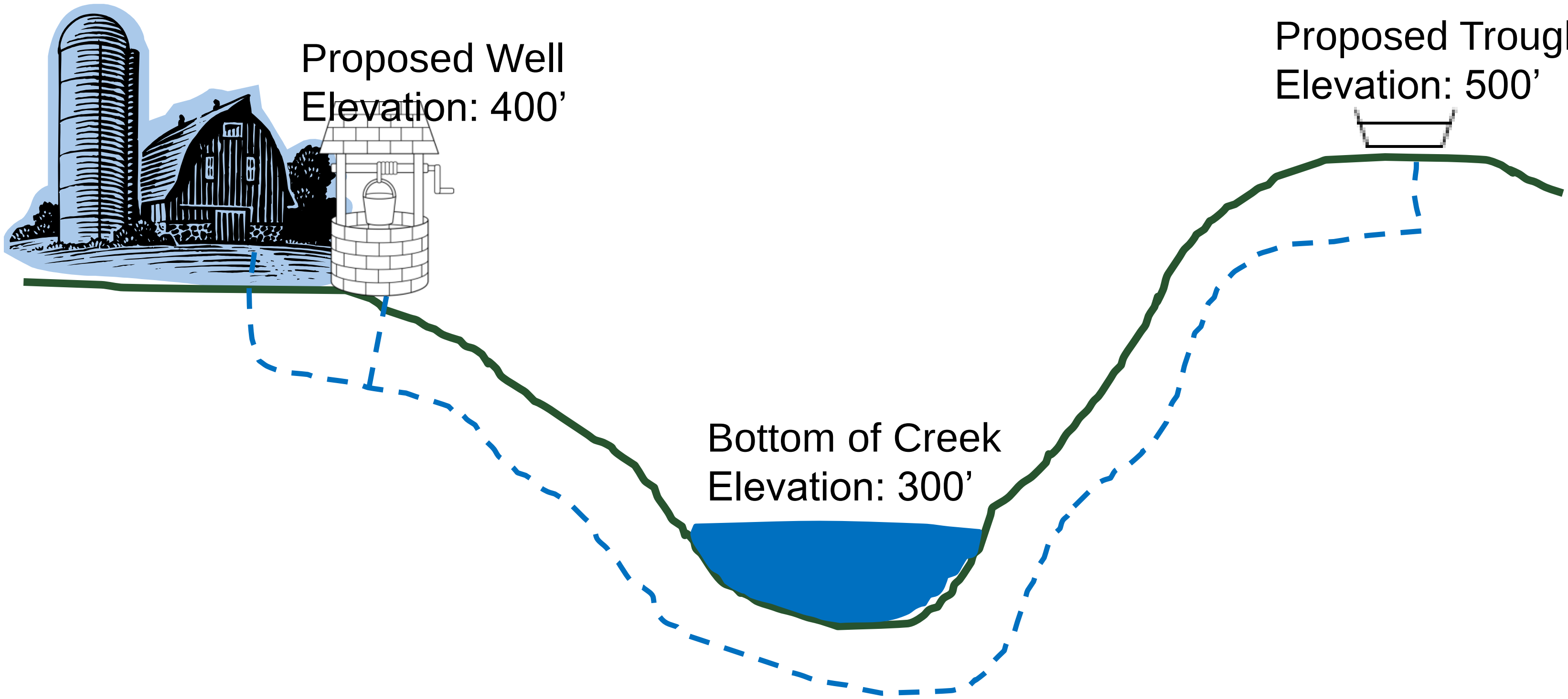
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

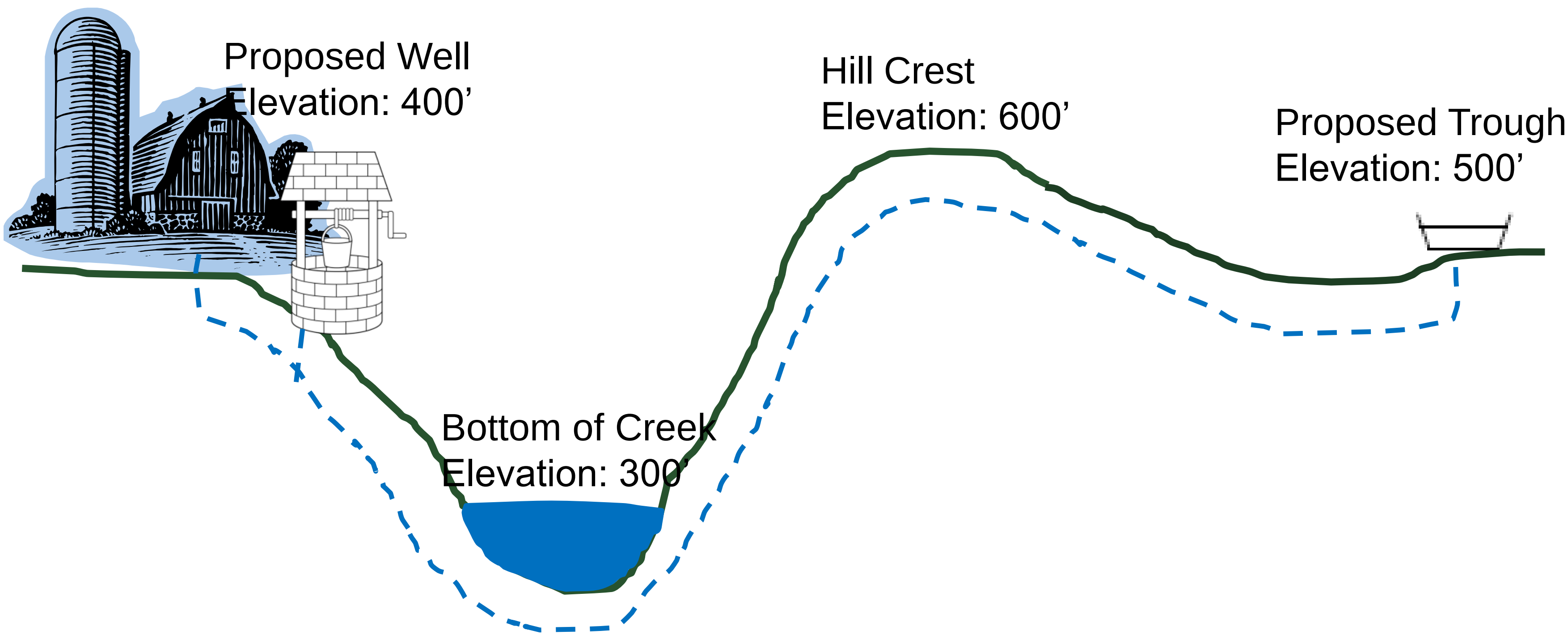
Example



Low point to pump “from”: Well, 400’

High point to pump “to”: Proposed Trough, 500’

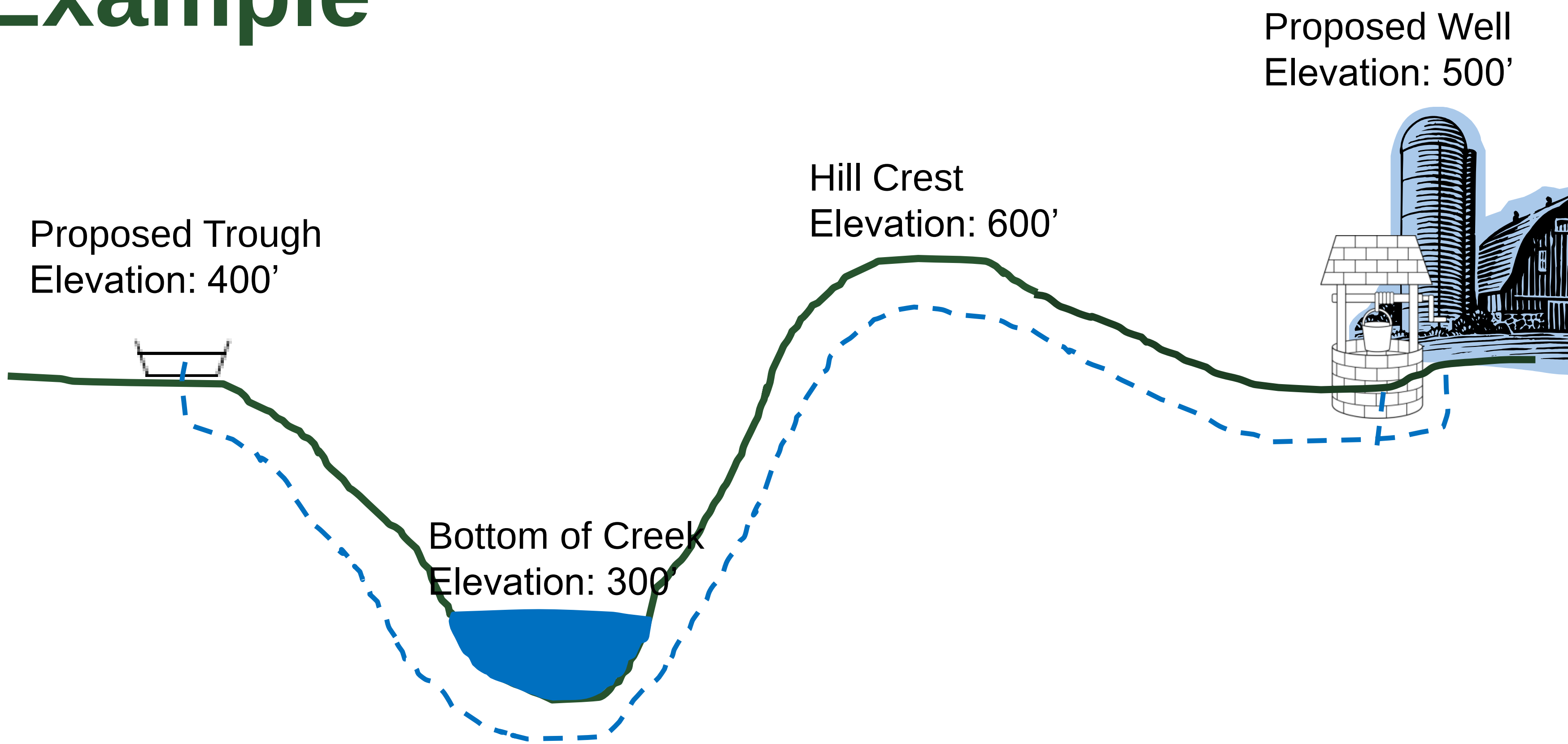
Example



Low point to pump “from”: Well, 400’

High point to pump “to”: Hill Crest, 600’

Example



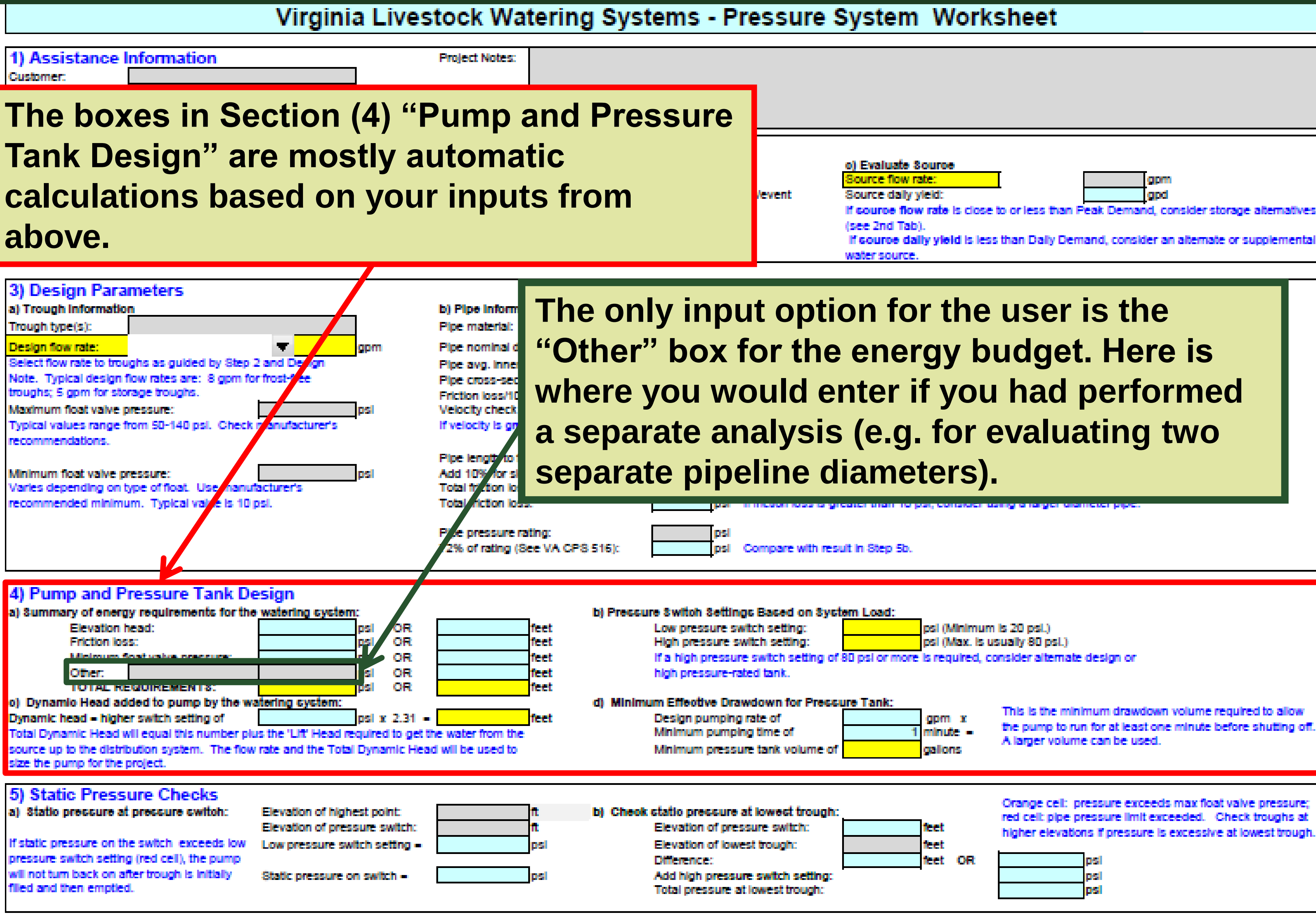
Low point to pump “from”: Well, 500’

High point to pump “to”: Hill Crest, 600’

4) Pump and Pressure Tank Design

The boxes in Section (4) “Pump and Pressure Tank Design” are mostly automatic calculations based on your inputs from above.

The only input option for the user is the “Other” box for the energy budget. Here is where you would enter if you had performed a separate analysis (e.g. for evaluating two separate pipeline diameters).



5) Static Pressure Checks

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand

Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate: gpm
Source daily yield: gpd

If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).

If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

Section (5) "Static Pressure Checks" will help check that there will not be excessive static pressure on:

-the pressure switch, and

-the float valves at the trough(s)

c) Vertical Pumping Distance

High point to pump "to":
Ground elev. of high point: feet

Low point to pump "from":
Ground elev. of low point: feet

Elevation difference: feet OR psi

...tion loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi Compare with result in Step 5b.

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
Other: psi OR feet
TOTAL REQUIREMENTS: psi OR feet

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of psi x 2.31 = feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:

Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

5) Static Pressure Checks

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

“Elevation of highest point:”

- Enter the highest elevation to which water will “stack” in the system.
- This *should* be the same elevation entered in box 3)c) “High point to pump to”.

c) Vertical Pumping Distance
High point to pump "to":
Ground elev. of high point: feet
Low point to pump "from":
Ground elev. of low point: feet
Elevation difference: feet OR psi

...tion loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating: psi
72% of rating (See VA CPS 516): psi Compare with result in Step 5b.

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:
Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
Other: psi OR feet
TOTAL REQUIREMENTS: psi OR feet

c) Dynamic Head added to pump by the watering system:
Dynamic head = higher switch setting of psi x 2.31 = feet
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

“Elevation of pressure switch:”
Enter the elevation of the pressure switch.

d) Minimum Effective Drawdown for Pressure Tank
Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi
Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

5) Static Pressure Checks

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day: events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

Once the elevations are entered for the highest point and the pressure switch, the "Static pressure on switch" will be calculated.

- If the "Static pressure on switch" is greater than the low pressure pressure switch setting (the "cut-in" pressure), then the pressure switch will never activate the pump and the system will not work.
- If the worksheet has been completed correctly, this should never be an issue.

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:
Elevation head: psi OR feet
Friction loss: psi OR feet
Minimum float valve pressure: psi OR feet
Other: psi OR feet
TOTAL REQUIREMENTS: psi OR feet

c) Dynamic Head added to pump by the watering system:
Dynamic head = higher switch setting of psi x 2.31 = feet
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

b) Pressure Switch Settings Based on System Load:
Low pressure switch setting: psi (Minimum is 20 psi.)
High pressure switch setting: psi (Max. is usually 80 psi.)
If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

d) Minimum Effective Drawdown for Pressure Tank:
Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi
Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

5) Static Pressure Checks

Virginia Livestock Watering Systems - Pressure System Worksheet

1) Assistance Information

Customer:
County:
Date: 1/26/2016
Assisted By:

Project Notes:

2) Water Budget

a) Total Daily Water Demand
Type of livestock:
Number of Animals:
Water demand/animal/day: gpd
Total Daily Demand: gpd
See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand
Number of times herd drinks/day events
Time desired to water herd: minutes/event
Average peak demand: gpm
Alternate peak demand: gpm
See Design Note for considerations for estimating peak demand.

c) Evaluate Source
Source flow rate: gpm
Source daily yield: gpd
If source flow rate is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If source daily yield is less than Daily Demand, consider an alternate or supplemental water source.

"Elevation of lowest trough:" Enter the elevation of the lowest trough to check the static pressure on the trough's float valve.

- **This is the lowest trough in the SYSTEM**
- **If the pressure is excessive at the lowest trough, then check the next lowest trough to see if it has excessive static pressure, too.**
- **Continue checking trough elevations until static pressure is no longer an issue.**

- **For the troughs with high pressure:**
  - **Install a high pressure valve (typically not rated higher than 90 or 100psi)**
  - **Install a *pressure reducing valve* in the supply line**
  - **Install a hybrid system (pressure and gravity)**
    - **using a reservoir on a float valve (see DN-614, Example 5 "Use of a Reservoir for Pressure Relief")**
    - **using a storage trough on a float with a supply line to the lower trough**

Dynamic head = higher switch setting of psi x 2.31 = feet
Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

Design pumping rate of gpm x
Minimum pumping time of 1 minute =
Minimum pressure tank volume of gallons
This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure switch:
Elevation of highest point: ft
Elevation of pressure switch: ft
Low pressure switch setting = psi
Static pressure on switch = psi
If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:
Elevation of pressure switch: feet
Elevation of lowest trough: feet
Difference: feet OR psi
Add high pressure switch setting: psi
Total pressure at lowest trough: psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Virginia Department of Conservation & Recreation

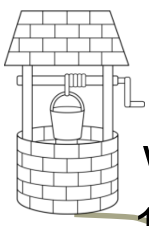
Pressure Reducing Valves

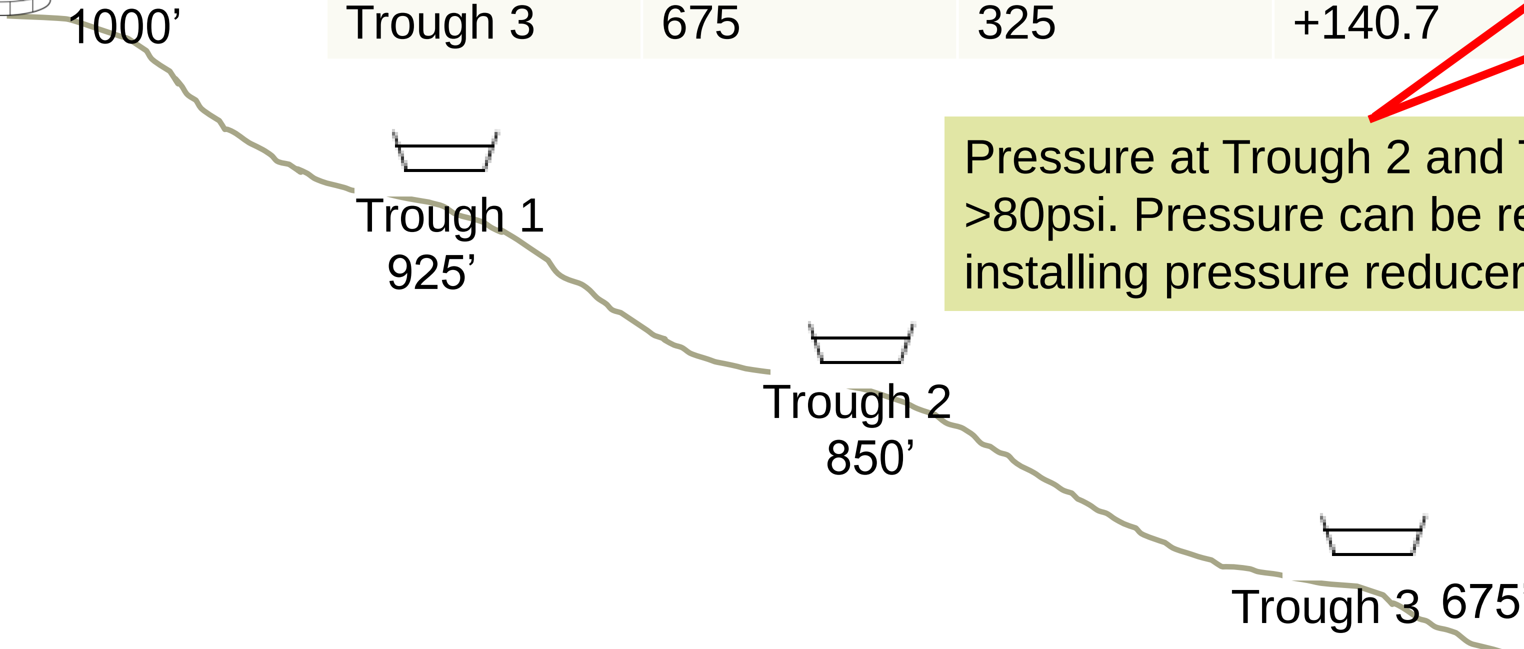
- Can be installed to reduce the pressure in the pipeline
- Will reduce the pressure in the line at the elevation where it is installed
- Pressure will continue to increase downstream of the reducer if the rest of the pipeline is downhill
- Can be installed on spur line to reduce pressure at individual troughs or on trunk line to reduce pressure on entire system downstream

Pressure Reducer Example

Assume a 20/40 pressure switch located at the well.

Feature	Elevation (ft.)	Elevation Diff. from Well (ft.)	Pressure Diff. from Well (psi)	Static Pressure
Well	1000	0	0	40psi
Trough 1	925	75	+32.5	72.5psi
Trough 2	850	150	+64.9	**104.9psi**
Trough 3	675	325	+140.7	**180.7psi**



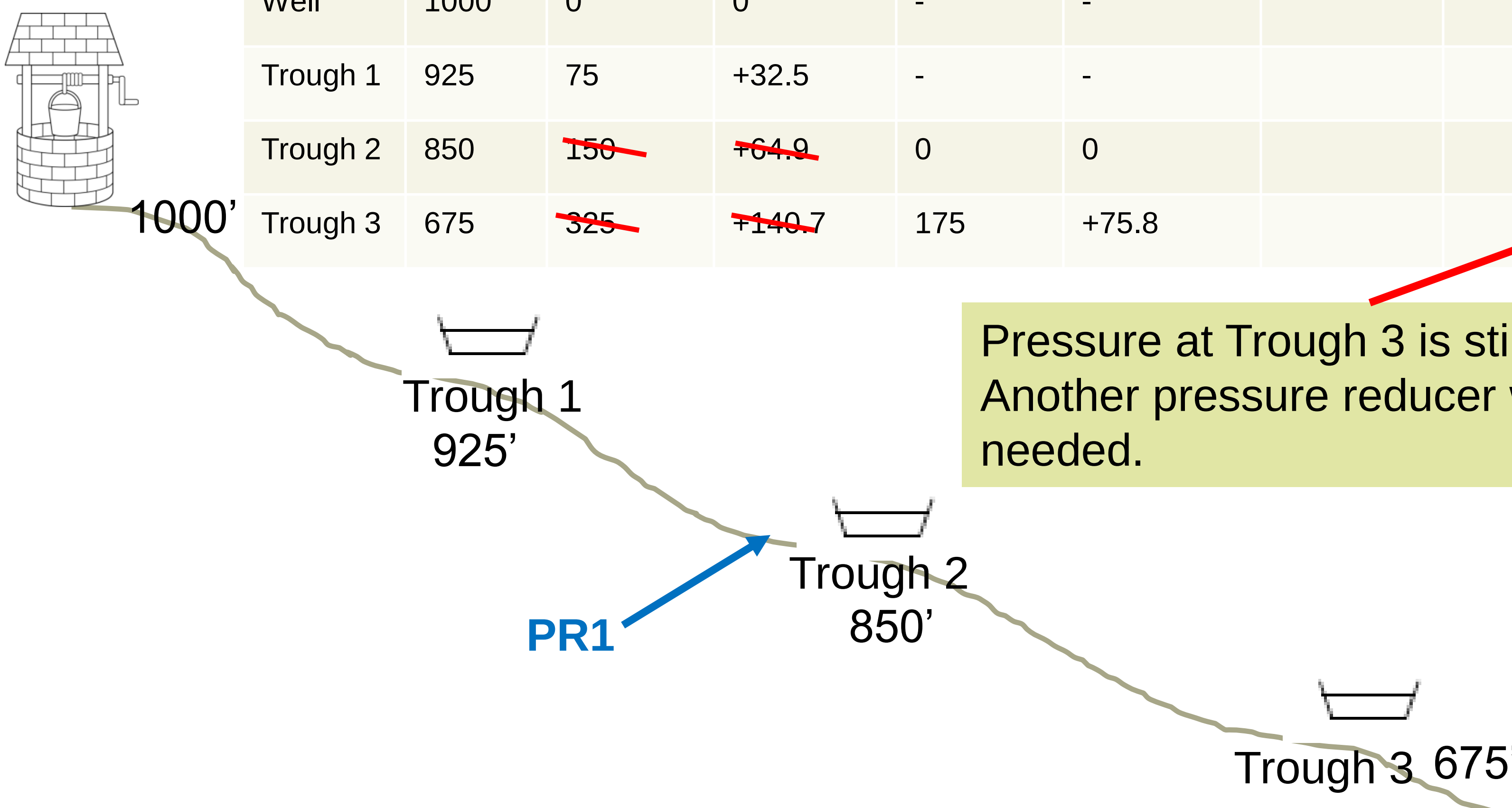


Pressure at Trough 2 and Trough 3 is >80psi. Pressure can be reduced by installing pressure reducers in the line.

Pressure Reducer Example

Assume a 20/40 pressure switch located at the well, and a **pressure reducing valve (PR1) at elevation 850 (just upstream of Trough 2) set to 50psi**.

Feature	Elev. (ft.)	Elevation Diff. from Well (ft.)	Pressure Diff. from Well (psi)	Elev. Diff. from PR1 (ft.)	Pressure Diff. from PR1 (psi)	Elev. Diff. from PR2 (ft.)	Pressure Diff. from PR2 (psi)	Static Pressure at Trough
Well	1000	0	0	-	-			40psi
Trough 1	925	75	+32.5	-	-			72.5psi
Trough 2	850	~~150~~	~~+64.9~~	0	0			**50psi**
Trough 3	675	~~325~~	~~+140.7~~	175	+75.8			**125.8psi**

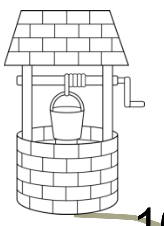


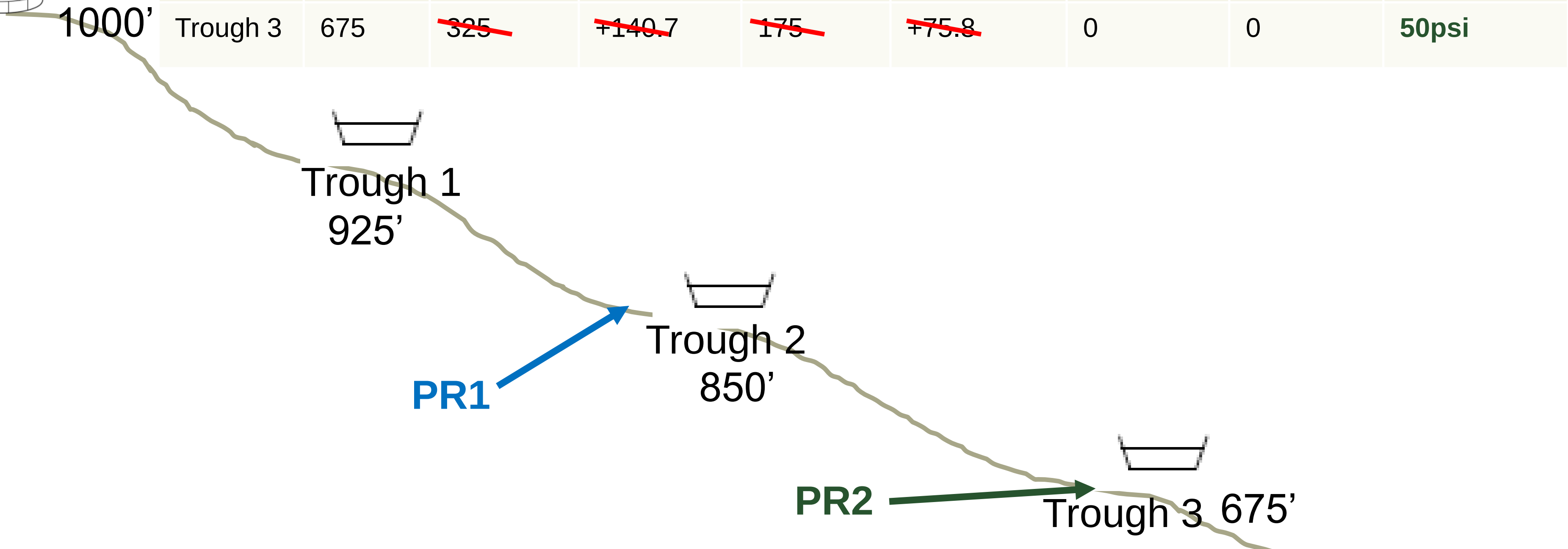
Pressure at Trough 3 is still >80psi. Another pressure reducer will be needed.

Pressure Reducer Example

Assume a 20/40 pressure switch located at the well, **pressure reducing valve (PR1) at elevation 850 (just upstream of Trough 2) set to 50psi**, and a **pressure reducing valve (PR2) at elevation 675 (just upstream of Trough 2) set to 50psi**.

Feature	Elev. (ft.)	Elevation Diff. from Well (ft.)	Pressure Diff. from Well (psi)	Elev. Diff. from PR1 (ft.)	Pressure Diff. from PR1 (psi)	Elev. Diff. from PR2 (ft.)	Pressure Diff. from PR2 (psi)	Static Pressure at Trough
Well	1000	0	0	-	-	-	-	40psi
Trough 1	925	75	+32.5	-	-	-	-	72.5psi
Trough 2	850	~~150~~	~~+64.9~~	0	0	-	-	**50psi**
Trough 3	675	~~325~~	~~+140.7~~	~~175~~	~~+75.8~~	0	0	**50psi**



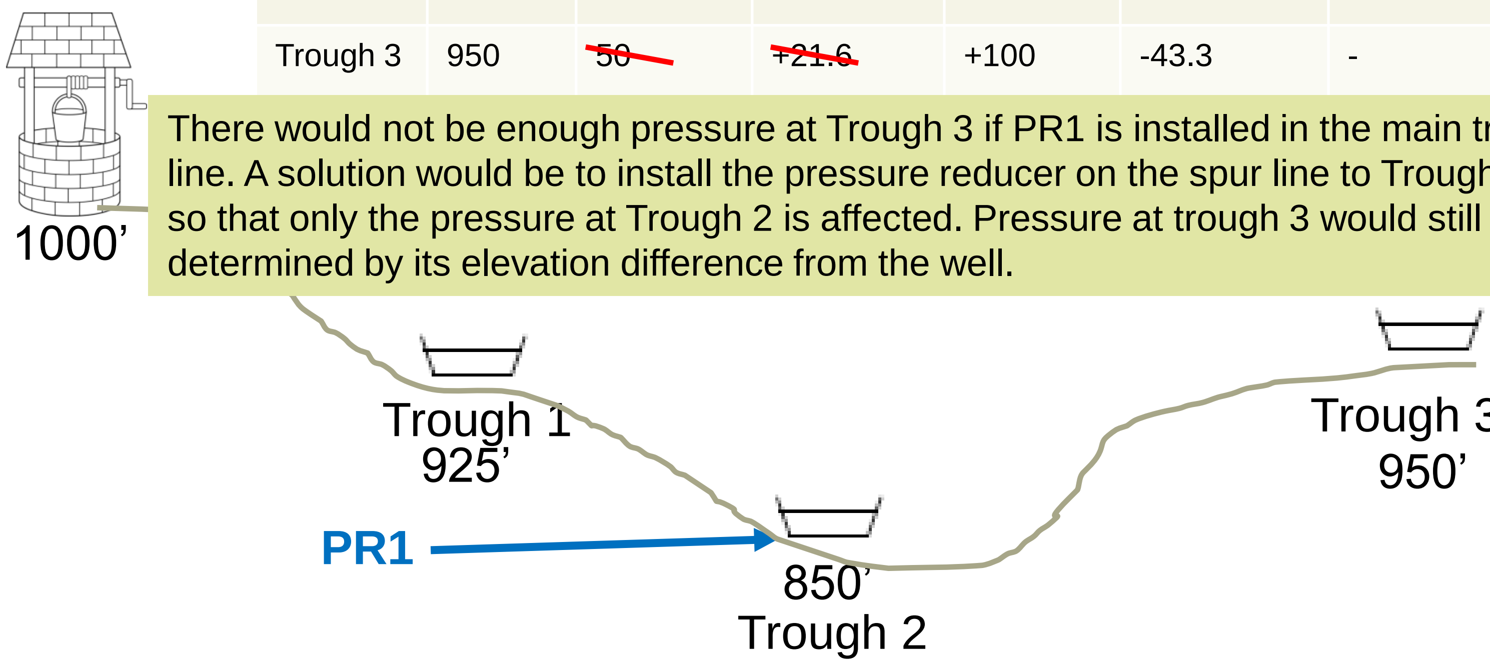


Pressure Reducer Example

What if trough 3 were higher than Trough 2?

Feature	Elev. (ft.)	Elevation Diff. from Well (ft.)	Pressure Diff. from Well (psi)	Elev. Diff. from PR1 (ft.)	Pressure Diff. from PR1 (psi)	Elev. Diff. from PR2 (ft.)	Pressure Diff. from PR2 (psi)	Static Pressure at Trough
Well	1000	0	0	-	-	-	-	40psi
Trough 1	925	75	+32.5	-	-	-	-	72.5psi
Trough 2	850	~~150~~	~~+64.9~~	0	0	-	-	**50psi**
Trough 3	950	~~50~~	~~+21.6~~	+100	-43.3	-	-	**6.7psi**

There would not be enough pressure at Trough 3 if PR1 is installed in the main trunk line. A solution would be to install the pressure reducer on the spur line to Trough 2 so that only the pressure at Trough 2 is affected. Pressure at trough 3 would still be determined by its elevation difference from the well.



Common Misconceptions: #1

- High static pressure issues can be solved by installing a smaller pipeline diameter.

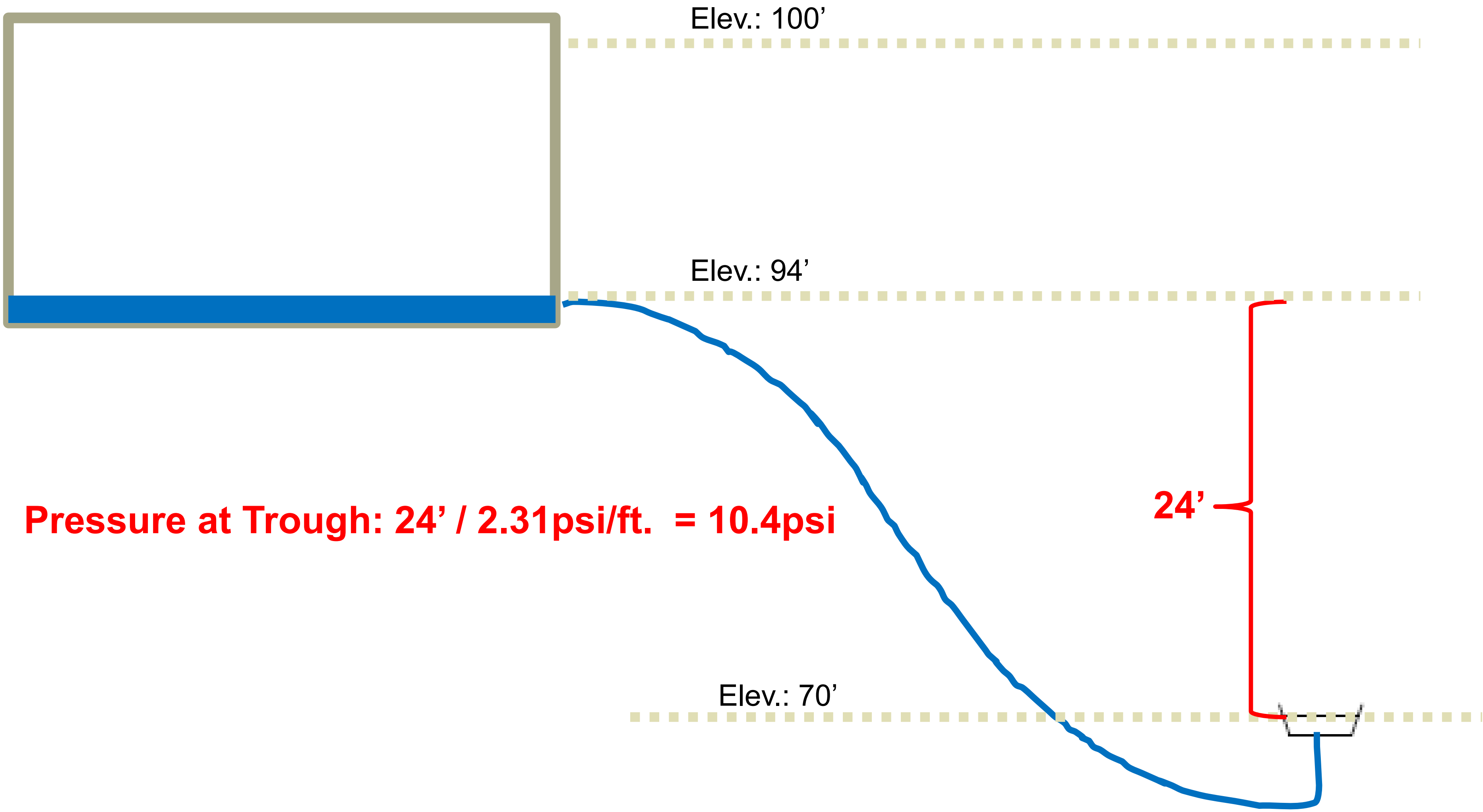
- FALSE: Static pressure is only dependent on the *height* of the column of water, not its diameter.
  - Actually, a smaller pipeline diameter entered into the worksheet can increase the friction loss, and may increase the pressure switch settings (resulting in *higher* static pressure) if you are not paying attention!

Common Misconceptions: #2

- Stored water in a reservoir somehow adds *extra* pressure to the system (more than just the height of the water would add).

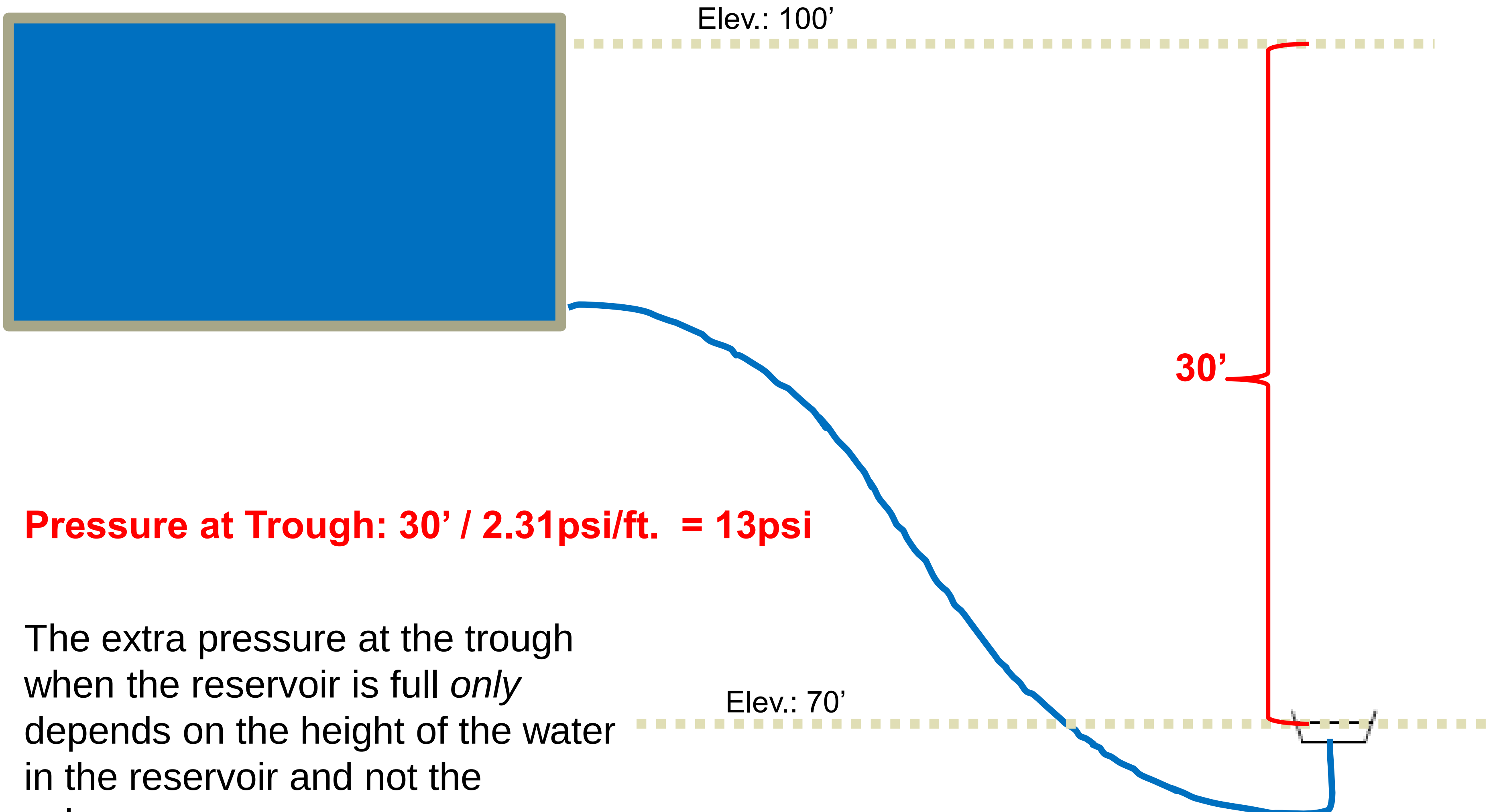
- FALSE: Static pressure is only dependent on the *height* of the column of water, not its diameter.

Example: Empty Reservoir



Pressure at Trough: 24' / 2.31psi/ft. = 10.4psi

Example: Full Reservoir



Pressure at Trough: 30’ / 2.31psi/ft. = 13psi

The extra pressure at the trough when the reservoir is full *only* depends on the height of the water in the reservoir and not the volume.

Common Misconceptions: #3

- Excessive static pressure can be solved by balancing it with high friction loss.

- FALSE: Static pressure refers to the pressure in the system when water is NOT moving. Friction loss only occurs when the water is moving.

Common Misconceptions: #4

- When “Tee”-ing off of an existing pipeline in an existing system, it does not make sense to use a larger diameter pipeline than what is already installed.
- FALSE: Friction loss is cumulative. Using larger diameter pipeline for the new pipeline will minimize friction loss. Always perform calculations for the *existing* AND *new* pipeline to the watering point and add them together.

Common Misconceptions: #5

- Pipeline size does not matter because the orifice of the float valve at the trough is very small and is the “bottleneck” in the system.

- FALSE: As the following slide shows, the orifice of most float valves has a capacity higher than most typical design flow rates.

Common Float Valve Pressure Ranges

Ritchie 3/4" Valve Series

Ritchie 3/4" valves come in four pressure ratings:

- White - 33 GPM, Low (5-40 psi)
- Red - 20 GPM, Moderate (40-60 psi)
- Green - 16.5 GPM, High (60-80 psi) ★
- Blue - 5 GPM, Very High (80-100 psi)

MIRACO Livestock Water Systems

"Originators of insulated poly waterers"

Part No	GPM	Pressure
#336	14	Low 5 – 40 psi
#521	12.5	High 40 – 80 psi ★
#519	6	High 80 – 90 psi

★ = Typically included as the Standard Valve (Check with Supplier)

Notice that the highest pressure valves reduce the flow rate to below 8gpm. In high pressure situations, you may consider recommending a pressure reducing valve instead of a high-pressure valve so that the flow rate is not sacrificed.

You MIGHT have done something wrong IF:

- The well/pressure switch is the highest point in the system and the worksheet calls for a pressure switch larger than 20/40
- The “static pressure on switch” box in Section 5.a. turns red
  – The static pressure on the switch should never be higher than the low switch setting if all inputs on the worksheet are correct.

Considerations for Evaluating an *Existing* Pumping Plant

Information to Gather: Existing Systems

- Age and condition of pumping plant
- Existing Pumping Rate
- Existing Pressure Switch Settings
- Length and diameter of existing pipeline
  - Evaluate for Friction Loss
- Existing Elevations
  - Existing elevations need to be considered for the *“High point to pump “to””* and *“Elevation of lowest trough”*

Age and Condition of Pumping Plant

- Goal: Determine if the existing pumping plant will last for the duration of the practice lifespan
  - How old is the existing pump?
  - Has the landowner ever experienced any problems with the pump?
  - Was the existing pumping plant installed as part of a conservation program? If so, is it still under contract lifespan?

Existing Pumping Rate

- Why does the existing pumping rate matter?
  1. Is the pumping rate sufficient to supply the livestock?
  2. Should be used to size the pipeline if the existing pump will be used
- How to determine:
  - If the well was installed recently, the pumping rate may be listed on the “Water Well Completion Report” at the Health Dept.
    - Look for the pump capacity (different from well yield)
  - Manual Pumping Rate Test:
    - Find a hydrant (something with a full flow orifice) near the pumping plant
    - Open the hydrant up and wait for the pressure tank to empty
    - Once the tank is empty and the switch engages the pump, begin collecting the water in a container of known volume
    - Time how long it takes to fill the container
    - Divide the gallons filled by the time it took (in minutes) to come up with the pumping rate in GPM
- Where to input into worksheet:
  - “Source Flow Rate” → “Design Flow Rate”
  - Also document well yield on worksheet

Pressure Switch Settings

1) Complete the “Pressure System Worksheet” using the existing pumping rate
2) What pressure switch requirements are generated by the worksheet?
3) If the worksheet calls for pressure switch settings that are higher than the existing settings, the total head on the pump will increase, and the contractor/plumber will need to evaluate the impact on the pump
   - This process is for planning purposes: Do we need to plan for a new pump?
   - Sizing pumps is beyond the scope of our responsibility
   - Leave it up to the professionals!

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Pressure Switch Settings Cont'd

- Increasing the head on the pump will reduce its pumping rate
- If you don't have info on the pump (model #), you won't know how the pumping rate will be affected

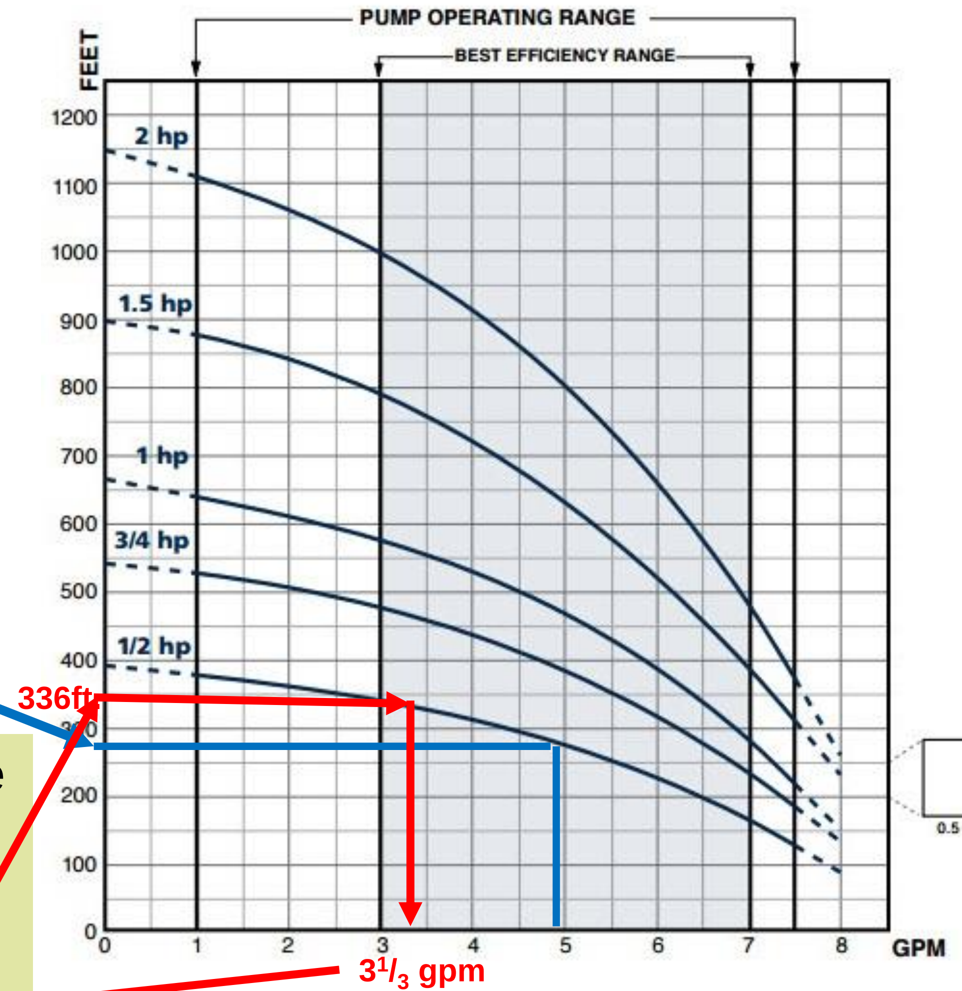
Existing System: at 290ft. of head, **5gpm** pumping rate

Ex. Pump, New Switch: Increase pressure switch from 20/40 to 40/60, a net increase of 20psi.

20psi * 2.31ft/psi = 46.2ft ≈ 46ft of head

New total head on pump: 290ft. + 46.2ft. **= 336ft.**

New Pumping rate: **$3^1/_3$ gpm**



Existing Pump Example

- The following example will show the importance of using the *existing* pumping rate *if* you will be using an *existing* pump.
- The first worksheet will be run as if the planner has assumed an “Alternate Peak Demand” of 8gpm.
- The second worksheet will be run with the actual pumping rate of 15gpm.
- A discussion will follow.

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If an "alternate peak demand" of 8gpm is used for 4-hole troughs, then the friction loss is only **5.2psi** energy requirements of the system are **29.0psi**, resulting in pressure switch settings of **30/50**.

Virginia Livestock Watering Systems - Pressure Sy

1) Assistance Information

Customer:	Example
County:	Example
Date:	9/26/2016
Assisted By:	Raleigh Coleman

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Project Notes: Worksheet 1: Assuming a design flow rate of 8gpm.

2) Water Budget

a) Total Daily Water Demand

Type of livestock:	beef	
Number of Animals:	50	
Water demand/animal/day:	20	gpd
Total Daily Demand:	1000	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day	3	events
Time desired to water herd:	60	minutes/event
Average peak demand:	5.6	gpm
Alternate peak demand:	8	gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:	15	gpm
Source daily yield:	21600	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):	4-Hole Frost-Free	
Design flow rate:	Alternate Peak Demand 8.0	gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure:	80	psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure:	10	psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:	Plastic: PE SIDR-PR	
Pipe nominal diameter:	1 1/4"	
Pipe avg. inner diameter:	1.38	in.
Pipe cross-sectional area:	0.0104	sq. ft.
Friction loss/100 ft	1.1	ft./100 ft.
Velocity check (<5 fps):	1.7	fps

If velocity is greater than 5 fps, consider a larger diameter pipe.

Pipe length to farthest watering poir	1000	feet
Add 10% for slope and fittings:	1100	feet
Total friction loss:	12	ft. OR
Total friction loss:	5.2	psi

If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating:	160	psi
72% of rating (See VA CPS 516):	115	psi

Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":	Trough 1	
Ground elev. of high point:	460	feet
Low point to pump "from":	Well	
Ground elev. of low point:	428	feet
Elevation difference:	32	feet
OR	13.9	psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:	13.9	psi	OR	32	feet
Friction loss:	5.2	psi	OR	12	feet
Minimum float valve pressure:	10	psi	OR	23	feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:	29.0	psi	OR	67	feet

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting:	30	psi (Minimum is 20 psi.)
High pressure switch setting:	50	psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of 50 psi x 2.31 = 116 feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of	8.0	gpm x
Minimum pumping time of	1	minute =
Minimum pressure tank volume	8.0	gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure swit

Elevation of highest point:	480.0	ft
Elevation of pressure switch:	428	ft
Low pressure switch setting =	30	psi
Static pressure on switch =	22.5	psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch:	428	feet		
Elevation of lowest trough:	480	feet		
Difference:	-52	feet	OR	-22.5 psi
Add high pressure switch setting:				50 psi
Total pressure at lowest trough:				27.5 psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

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If the actual pumping rate of 15gpm used, then the friction loss jumps up to **16.6psi** and the energy requirements of the system are **40.5psi** resulting in pressure switch settings of **40/60**.

Virginia Livestock Watering Systems - Pressure Sy

1) Assistance Information

Customer:	Example
County:	Example
Date:	9/26/2016
Assisted By:	Raleigh Coleman

Project Notes: Worksheet 2: Using the existing pumping rate of 20gpm

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2) Water Budget

a) Total Daily Water Demand

Type of livestock:	beef	
Number of Animals:	50	
Water demand/animal/day:	20	gpd
Total Daily Demand:	1000	gpd

See Design Note for watering recommendations for various types of livestock.

b) Daily Peak Water Demand

Number of times herd drinks/day	3	events
Time desired to water herd:	60	minutes/event
Average peak demand:	5.6	gpm
Alternate peak demand:	8	gpm

See Design Note for considerations for estimating peak demand.

c) Evaluate Source

Source flow rate:	15	gpm
Source daily yield:	21600	gpd

If **source flow rate** is close to or less than Peak Demand, consider storage alternatives (see 2nd Tab).
If **source daily yield** is less than Daily Demand, consider an alternate or supplemental water source.

3) Design Parameters

a) Trough Information

Trough type(s):	4-Hole Frost-Free	
Design flow rate:	Source Flow Rate 15.0	gpm

Select flow rate to troughs as guided by Step 2 and Design Note. Typical design flow rates are: 8 gpm for frost-free troughs; 5 gpm for storage troughs.

Maximum float valve pressure:	80	psi

Typical values range from 50-140 psi. Check manufacturer's recommendations.

Minimum float valve pressure:	10	psi

Varies depending on type of float. Use manufacturer's recommended minimum. Typical value is 10 psi.

b) Pipe Information

Pipe material:	Plastic: PE SIDR-PR	
Pipe nominal diameter:	1 1/4"	
Pipe avg. inner diameter:	1.38	in.
Pipe cross-sectional area:	0.0104	sq. ft.
Friction loss/100 ft	3.5	ft./100 ft.
Velocity check (<5 fps):	3.2	fps

If velocity is greater than 5 fps, consider a larger diameter pipe.

Pipe length to farthest watering poir	1000	feet
Add 10% for slope and fittings:	1100	feet
Total friction loss:	38	ft. OR
Total friction loss:	16.6	psi

If friction loss is greater than 10 psi, consider using a larger diameter pipe.

Pipe pressure rating:	160	psi
72% of rating (See VA CPS 516):	115	psi

Compare with result in Step 5b.

c) Vertical Pumping Distance

High point to pump "to":	Trough 1	
Ground elev. of high point:	460	feet
Low point to pump "from":	Well	
Ground elev. of low point:	428	feet
Elevation difference:	32	feet
OR	13.9	psi

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:	13.9	psi	OR	32	feet
Friction loss:	16.6	psi	OR	38	feet
Minimum float valve pressure:	10	psi	OR	23	feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:	40.5	psi	OR	93	feet

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting:	40	psi (Minimum is 20 psi.)
High pressure switch setting:	60	psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of 60 psi x 2.31 = 139 feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of	15.0	gpm x
Minimum pumping time of	1	minute =
Minimum pressure tank volume	15.0	gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure swit

Elevation of highest point:	480.0	ft
Elevation of pressure switch:	428	ft
Low pressure switch setting =	40	psi
Static pressure on switch =	22.5	psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch:	428	feet	
Elevation of lowest trough:	480	feet	
Difference:	-52	feet OR	-22.5 psi
Add high pressure switch setting:			60 psi
Total pressure at lowest trough:			37.5 psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Discussion

- What if the system is designed based on an arbitrary pumping rate of 8gpm when the pump is actually pumping at 15gpm?
  - The energy requirement to deliver the water to the trough is actually 40.5psi
  - It only takes 30psi for water to enter the pressure tank (a 30/50 pressure switch was used based on the 8gpm flow rate)
  - When the pump kicks on, the pressure tank is the “path of least resistance” and will begin to fill first
  - Trough will not fill until sufficient pressure is achieved in the tank
  - → The trough will be “short-circuited” by the tank
- The system may still work, but it will be inefficient and livestock will be waiting for water every time the pressure tank empties
- *Note: This example is exaggerated to illustrate a concept. A 15gpm pumping rate will be unlikely for most standard well pumps*

?

Just remember: use the existing pumping rate as the “design flow rate” if using an existing pumping plant.

(Or, if the existing pump rate is inappropriate, plan for a new pump.)

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Important Point for Existing Pumps:

- Don’t confuse *flow rate* and *pressure*
- A <u>high flow rate</u> does NOT necessarily mean there is <u>too much pressure</u>
- Pressure is governed by the pressure switch
- A high flow rate can actually mean there will not be ENOUGH pressure to overcome the higher friction loss associated with higher flow rates

User Beware: Things that the worksheet will not catch

- Static pressure issues in pipeline if there is a low point in pipeline below the lowest trough
  - Check static pressure (can enter into “Elevation of lowest trough” to check)
  - Compare against 72% of pressure rating
- If the well is higher than the pressure switch: dynamic head added to pump will be *less* than what the worksheet calculates
- If the well is *lower* than the pressure switch: dyanamic head added to pump will be *higher* than what the worksheet calculates

Worksheet Completion

- You might do multiple analyses for various reasons, but only give ONE worksheet to the contractor to show the total dynamic head for the entire system, the design flow rate, pressure switch settings.
- Reference the worksheet in the design so that the contractor knows to look for it.
- Keep the other worksheet(s) in your file to document your calculations.

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Construction Changes

- If the system needs to be changed during construction, re-run the worksheet to see if anything is affected
- Pumps pumping higher GPM than Design Flow Rate can be problematic!
- If the producer uses a pressure switch that is *higher* than what the worksheet called for, add the difference between the two switches to the static pressure check on the worksheet to see if it causes any static pressure issues

EXAMPLE:

4) Pump and Pressure Tank Design

a) Summary of energy requirements for the watering system:

Elevation head:	4.3	psi	OR	10	feet
Friction loss:	8.4	psi	OR	19	feet
Minimum float valve pressure:	10	psi	OR	23	feet
Other:		psi	OR		feet
TOTAL REQUIREMENTS:	22.7	psi	OR	52	feet

b) Pressure Switch Settings Based on System Load:

Low pressure switch setting:	20	psi (Minimum is 20 psi.)
High pressure switch setting:	40	psi (Max. is usually 80 psi.)

If a high pressure switch setting of 80 psi or more is required, consider alternate design or high pressure-rated tank.

c) Dynamic Head added to pump by the watering system:

Dynamic head = higher switch setting of 40 psi x 2.31 = 92 feet

Total Dynamic Head will equal this number plus the 'Lift' Head required to get the water from the source up to the distribution system. The flow rate and the Total Dynamic Head will be used to size the pump for the project.

d) Minimum Effective Drawdown for Pressure Tank:

Design pumping rate of	8.0	gpm x
Minimum pumping time of	1	minute =
Minimum pressure tank volume	8.0	gallons

This is the minimum drawdown volume required to allow the pump to run for at least one minute before shutting off. A larger volume can be used.

5) Static Pressure Checks

a) Static pressure at pressure swit

Elevation of highest point:	360.0	ft
Elevation of pressure switch:	350	ft
Low pressure switch setting =	20	psi
Static pressure on switch =	4.3	psi

If static pressure on the switch exceeds low pressure switch setting (red cell), the pump will not turn back on after trough is initially filled and then emptied.

b) Check static pressure at lowest trough:

Elevation of pressure switch:	350	feet			
Elevation of lowest trough:	275	feet			
Difference:	75	feet	OR	32.5	psi
Add high pressure switch setting:				40	psi
Total pressure at lowest trough:				72.5	psi

Orange cell: pressure exceeds max float valve pressure; red cell: pipe pressure limit exceeded. Check troughs at higher elevations if pressure is excessive at lowest trough.

Worksheet calls for a 20/40 pressure switch. Contractor installed 40/60 pressure switch. There is more than enough pressure to make the system work, but will it create static pressure issues?

40/60 – 20/40 = 20psi increase

72.5 psi (at lowest trough) + 20psi = 92.5 psi***This is too high for standard valves!

A quick note on as-builts…

- The more detailed your as-builts are, the more useful they will be in the future if needed to tie back into the system
  - Did the pipeline route change?
  - Pipeline lengths
  - Pipeline type (ASTM, diameter, pressure rating)
  - Pumping Plant Info (Pump Model Number, Pumping Rate, Pressure Switch Settings, Size of Tank, etc.)
  - Etc…

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NRCS Construction Quality Assurance Plans

<u>Items to be inspected and verified:</u>

- Verify that the landowner has obtained all of the required permits prior to construction.
- Verify that MISS UTILITY is contacted prior to construction for underground utility location.
- Photograph the site, before, during and after construction.
- A pre-construction meeting needs to take place so that all parties involved understand their roles and responsibilities.
- Verify the watering system components were installed in the designed locations.
- **Watering Troughs & Reservoirs**
  - Document the type and number of watering troughs and reservoirs that were installed.
  - Verify that the watering troughs and reservoirs have been installed per the manufacturer's recommendations and in accordance with the design.
  - For frost-free troughs, verify there is a minimum of 18" of concrete from the edge of the trough in each direction.
  - Verify the heavy use area surrounding the trough extends at least 8' from the edge of the trough in each direction.
  - Verify the thickness(es) and the material(s) used for the heavy use area protection are as designed.
  - Verify that the correct type of geotextile was used under the heavy use area protection.

Pipelines

- Verify the type, diameter, length and depth of pipe installed are as designed.
- Verify the installation procedures, including assembly of joints and fittings, are correct for the type of pipeline, as designed.
- For pressure systems, verify that the pipe was pressure tested prior to backfilling.
- Verify that the pipeline trench has been backfilled and properly compacted.
- Verify that a valve has been installed in the lateral(s) to regulate flow to the trough(s) and a means of draining the pipeline between the valve and trough has been installed.

- **Water Wells**
  - Obtain a copy of the Commonwealth of Virginia Water Well Completion Report – Certificate of Completion/County Permit (DEQ form) or the Virginia Department of Health Uniform Water Well Completion Report.
  - Obtain the estimated yield of the well and check against the assumed yield used in designing the system.
  - Obtain information (horsepower rating, performance curve, etc.) about the pump used.
- **Spring Developments**
  - Verify that the spring development is installed as designed, if applicable.
  - Obtain the estimated yield of the spring and check against the assumed yield used in designing the system.
- Verify that the practices installed are functioning as designed.

- Ensure that all disturbed areas have been re-vegetated and/or protected from erosion.
- Verify that any design changes have been documented and approved by someone with the appropriate EJAA.
- Verify that the appropriate As-Built documentation has been completed.
- Site specific items to be inspected and verified: ______________________________

  ____

  ____

Resources for Further Study

- NRCS Virginia Engineering Design Note 614 (DN-614)
- NRCS Engineering Field Handbook, Chapter 3: Hydraulics

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Questions?

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Discussion of 3 Common Systems

-Conventional
-Remote Pressure Tank
-Reservoir with Pump on Timer

DN-614-II-1

Part II: Design Examples

Part I presented an overview of concepts and the general process for planning, designing, installing, and maintaining a livestock watering system. Part II presents eight examples to illustrate different design strategies. Calculations and discussion are based on the Virginia Livestock Watering Systems calculation worksheets. The spreadsheet tool addresses pressure systems, gravity systems, and hybrid systems and provides a means for performing design calculations as well as for documenting key information.

1. Conventional Pressure System

1. Pressure Systems

A typical pressure system scenario involves using a pump to move water from a source to one or more troughs using utility-supplied electricity to power the pump motor. A pressure tank is used to protect the pump from rapid on and off cycling. The design calculations are aimed at sizing the pipeline, determining the energy required by the distribution system (to aid pump selection), sizing the pressure tank, and checking that system pressures are within mechanical and material limits. Usually the pressure tank and pressure switch are located near the pump. The calculations presented in this section cover the typical case. However, there may be good reason to place the pressure tank (and possibly the pressure switch) at a location remote from the pump – these situations are addressed with examples in Part II. The basic design steps are the same, however.

- Typically the least-cost alternative for systems with wells with yields that can meet the peak demand

2. Remote Pressure Tank

DN-614-II-3

Example 2 – Pressure System with a Remote Pressure Tank

In Example 1, the pump, pressure tank, and pressure switch are located close to each other. In some cases, it is advantageous to locate the pressure tank at some distance from the pump. Reasons for using a remote pressure tank include:

- Reducing the pressure, size, and expense of the pressure tank by placing it at an elevation between the pump and the highest trough.
- Convenience of location (for example, using an existing shelter to house the pressure tank). See Example 3 for such a scenario.

In such cases, consideration should also be given to the location of the pressure switch.

1) If the pressure switch is located with the pressure tank, the wire to the pump will have to be placed in the pipeline ditch where it is subject to damage by lightning or burrowing animals. As distance from the pump increases, the heavier the wire gauge required and the greater the wire cost. (See Appendix A-6.)

2) If the pressure switch is located near the pump and away from the pressure tank, there is greater fluctuation in the pressure sensed at the switch due to the increased distance from the tank. To reduce "flutter" (rapid switching on and off), and thus to protect the pump from premature wear, a snubber (small orifice) can be installed. See Appendix B-3 for a pressure switch with a snubber detail drawing.

3. Reservoir with Pump on Timer

Hybrid or Pressure-Energy Systems:

A hybrid system uses pressure energy from a pump to transport water to a reservoir and then uses the reservoir's potential energy to deliver the water to the troughs which are topographically downhill. The pump can be placed on a timer to ensure that the pump is on for a given amount of time to fill the reservoir. This approach replaces the pressure tank and pressure switch for preventing pump burn-out due to short-cycle pumping. Reservoirs can also serve as pressure reducers in cases where troughs are much lower in elevation than the source. Part II discusses a variety of energy strategies.

DN-614-II-14

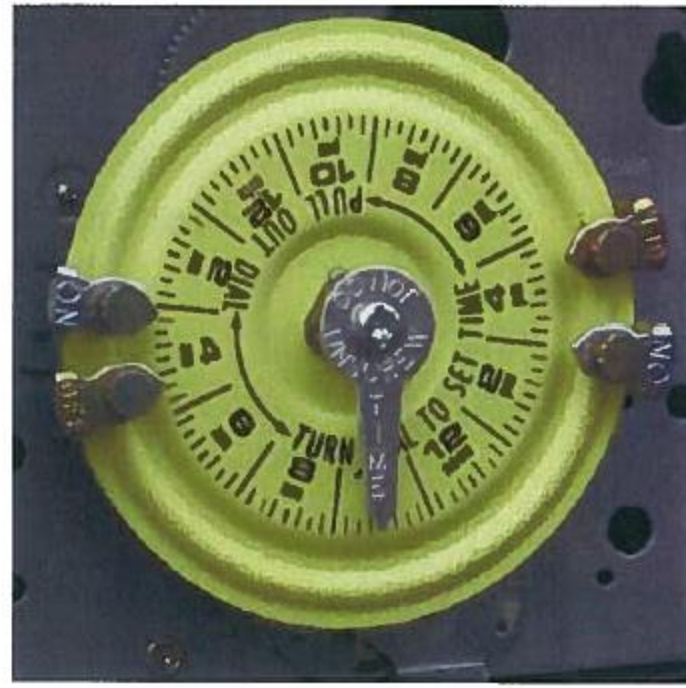
Example 5 – Use of a Reservoir for Pressure Relief

DN-614-II-18

Example 6 – Reservoir System on Timer

d) **If Pumping to a Reservoir,** compute the following to determine the energy that needs to be supplied by the pump to get the water to the reservoir:

i. Record the desired pumping rate (gpm) to the reservoir. This value is **not** the same as the design flow rate to the troughs. Choose a rate that will fill the reservoir in a timely manner without exceeding the flow rate of the source. Choose a flow rate that will allow the selected pump to run long enough to avoid premature wear from short cycling. A run time of 3-6 hours, two times a day is typical. A timer controls when the pump is on. The timer in the photograph is set to run the pump from 3:00 AM-4:30 AM and again from 3:00 PM–4:30 PM.



Pump timer. Photograph courtesy of Mountain Castles SWCD.

The pumping rate and corresponding head must also be compatible with the pumps available from the supplier. Once the pump has been selected, re-work the calculations below using the flow rate from the pump's performance curve.

ii. Determine the pumping duration required to meet the daily water demand from Step 2a:

$$Pumping\ duration\ (min.) = \frac{Daily\ demand\ (gpd)}{Desired\ pumping\ rate\ (gpm)}$$

- Float-valve systems: Troughs are tee-ed off from a main line with flow to each trough controlled by a float valve. Flow to a trough shuts off when the trough is filled, and thus, static pressure can be of concern if there is sufficient head.

- Cascading systems: Troughs are connected in series by way of their overflow pipes. There are no float valves – instead, water overflows from one trough to the next lower trough. Overflow from the last trough is generally directed back to the natural drainage system.

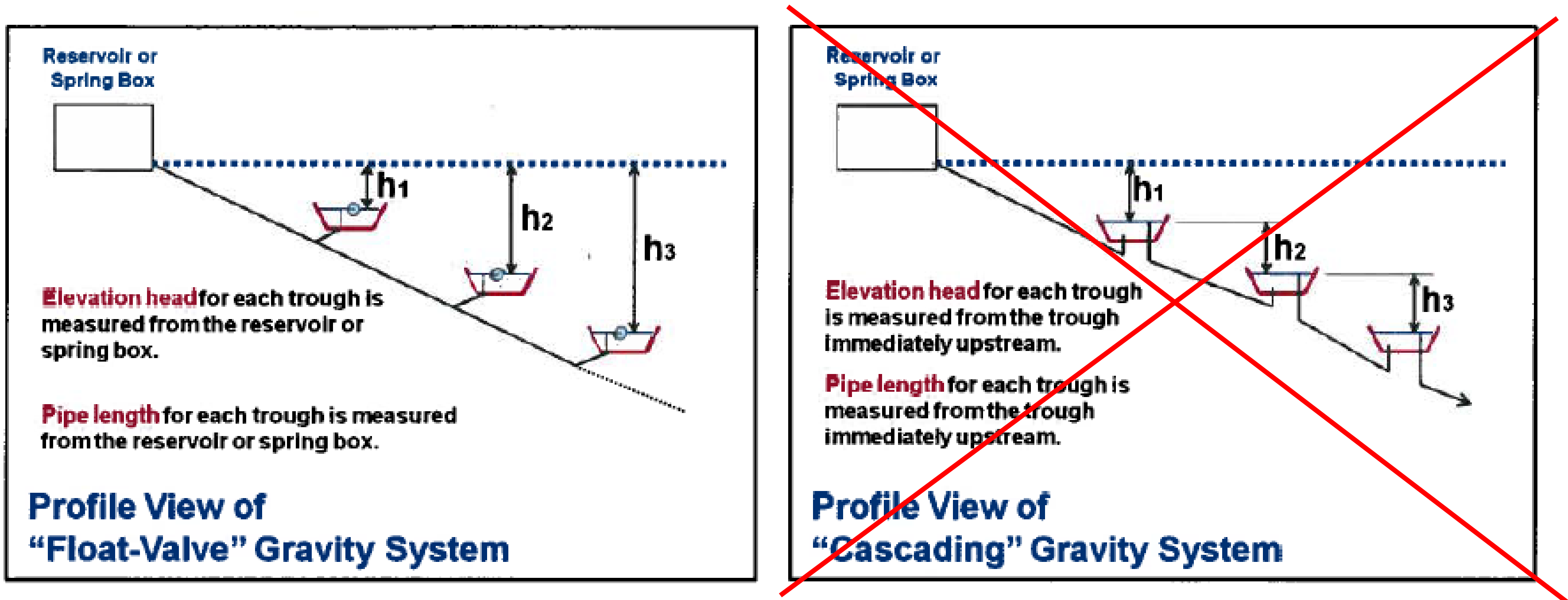


Figure I-5. Float Valve vs. Cascading Trough Arrangements.

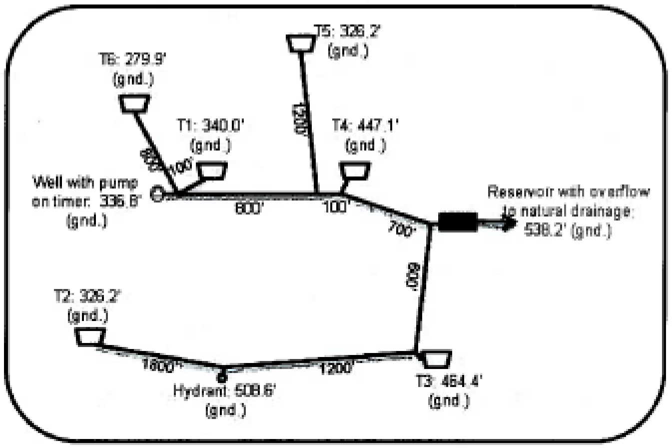


Figure II-15. Layout for Example 6 – Reservoir System on Timer

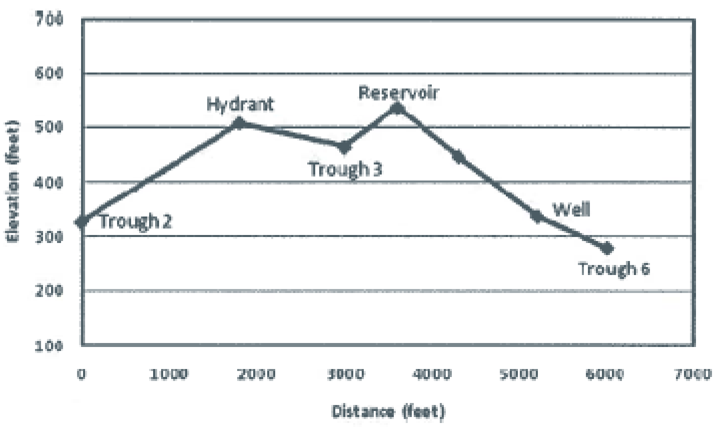


Figure II-16. Profile for Example 6.