Water Systems for Livestock

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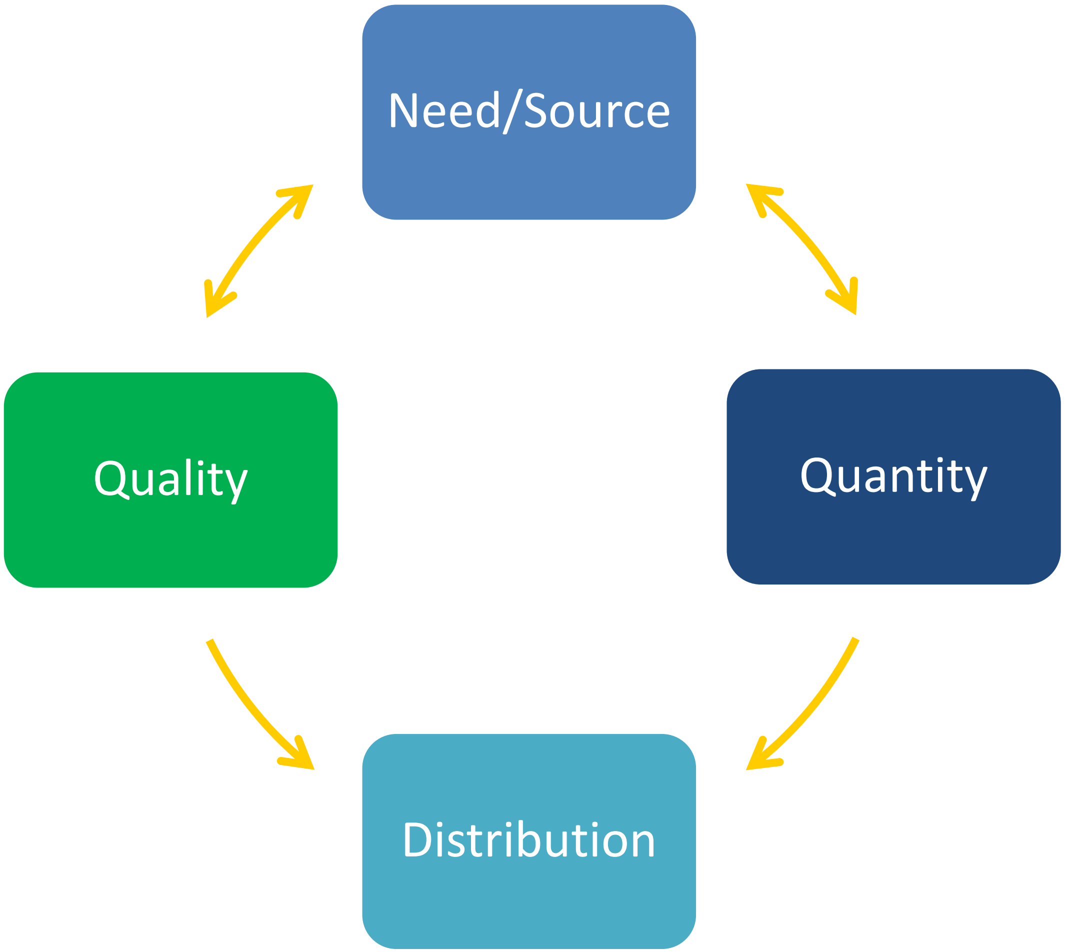
Total Water System Overview



No direct path from need/source to distribution.

Total Water System Overview

Water Need and Source

What is the quantity and quality of water by use and where are possible sources?

Water Quantity

- Supply sizing
- Daily use requirement
- Peak demand determination

Water Quality

Does water quality from the available source meet the need? If not, water treatment?

Water Distribution

- Pipe and pump system design
- Intermediate water storage
- Water treatment incorporation

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Potential Water Sources

- Ground water accessed by using well
- Surface water impoundment
- Public water

Water Need

- Daily water need for livestock inventory
- Drinking rate of animals needed to estimate peak water demand
- Simultaneous water uses needed to estimate peak water demand

Primary Water Uses and Quantities for Various Livestock Operations			
Livestock Type	Drinking Water (gallons/animal/day)	Supplemental Cooling Water (gallons/head/day)	Wash Water
Swine			Building Wash Water (gallons/head/day)
Breeding & Gestation	6	1 to 5	0.1
Farrowing	8	20	1
Nursery	1	0 to 2	0.05
Grow-Finish	4	1	0.1

Primary Water Uses and Quantities for Various Livestock Operations			
Livestock Type	Drinking Water (gallons/animal/ day)	Supplemental Cooling Water (gallons/head/day)	Wash Water
Dairy			Milking Parlor (gallons/cow/day)
Calves	6 to 10		
Heifers	10 to 15		
Dry Cows	20 to 30	8 to 12	
Milking Cows	35 to 50	10 to 15	10 to 50

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Primary Water Uses and Quantities for Various Livestock Operations			
Livestock Type	Drinking Water (gallons/animal/day)	Supplemental Cooling Water (gallons/head/day)	Wash Water
Beef			
Cow-calf pairs	30 to 35		
Dry cows	30		
Calves	12		
Growing cattle, 400-800 lbs	12 to 24		
Bred Heifers (800 lbs)	24		
Bulls	30 to 40		

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Water Quality

- What is the quality of water required for the use?
- What is the water quality available from the water source?
- Does the quality of the source exceed the quality of the need?
- If not, can a different source with higher quality be located or is water treatment required?

Water Quantity - General

- Estimate daily water need based on use values
- Estimate peak water need based on use values and behavior of animals
  - Single animal water drinking rate
  - Number of animals drinking at one time
  - Additional water uses when animals are drinking

Water Quantity - Example

- 1,200 head swine wean-finish facility
  - 40 pens with 2 drinkers per pen
  - Finish pigs use 5 gallons per head per day (drinking & cooling) with a drinking rate at about 1.5 quarts per minute
- Daily need – 6,000 gallons per day (1,200 x 5) – deliver in 12 hrs ➔ 8.33 gpm
- Peak need – 30 gpm (40 pens with a drinking rate of 3 quarts per minute)

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Water Quantity - Wells

- Determine if well can deliver daily demand
- If daily demand not met, additional wells or water sources must be located or size of operation downsized.
- Can well supply peak water use demand?
- If peak demand not met, intermediate water storage and booster pump is required.

Water Quantity - Impoundments

- Size pump and pipe system to supply peak demand.
- Water impoundment should be large enough to store at least one year and better - two year water supply.
- Ensure enough watershed area draining runoff is large enough to refill impoundment within a normal year.
- Are other surface water sources needed to refill impoundment?

Water Distribution System Design

(All Sites and Situations Aren't Equal!)

Hydrant Flow
What do you see?

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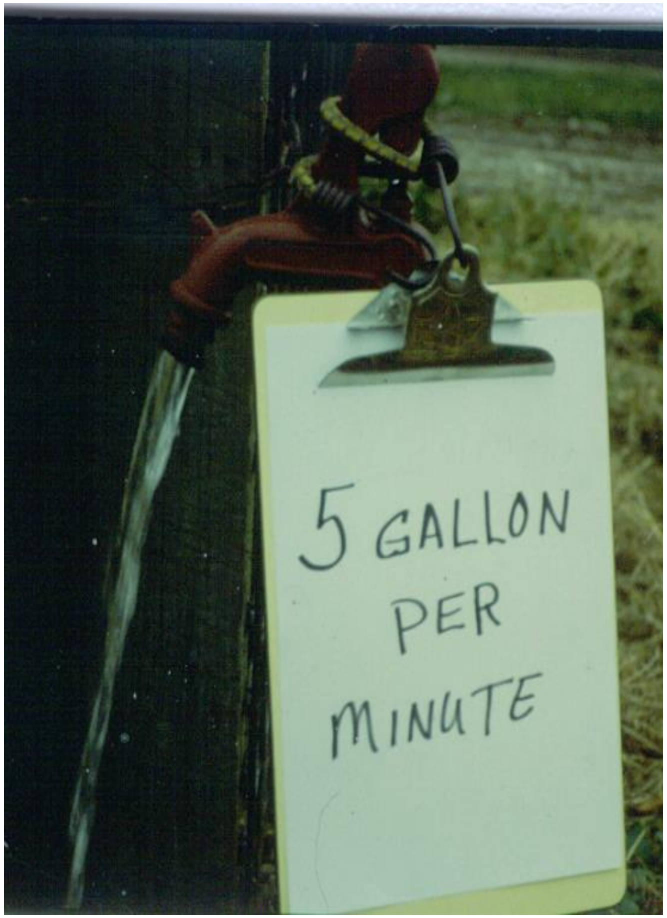
Measured flow from same hydrants on the same day



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Why the difference

- Situation
  - The pipe from the well supplies the hydrant delivering 8.6 gpm and 200 feet further from the well on the same pipe is the hydrant delivering 5.0 gpm.
  - Only one hydrant was measured at a time
  - Site is basically flat so no elevation impact.
- Result – The reduced flow is caused by friction loss in small diameter pipe (probably ¾ inch diameter)

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Pipe Design Equation

$$\mathbf{P_a + Z_a + Pump = P_b + Z_b + Loss}$$

Where: P_a – Pressure at point A

Z_a – Elevation at point A

Pump – Head pressure added by pump

P_b – Pressure at point B

Loss – Friction loss from pipe

2.31 feet of head = 1 pound per square inch (psi)

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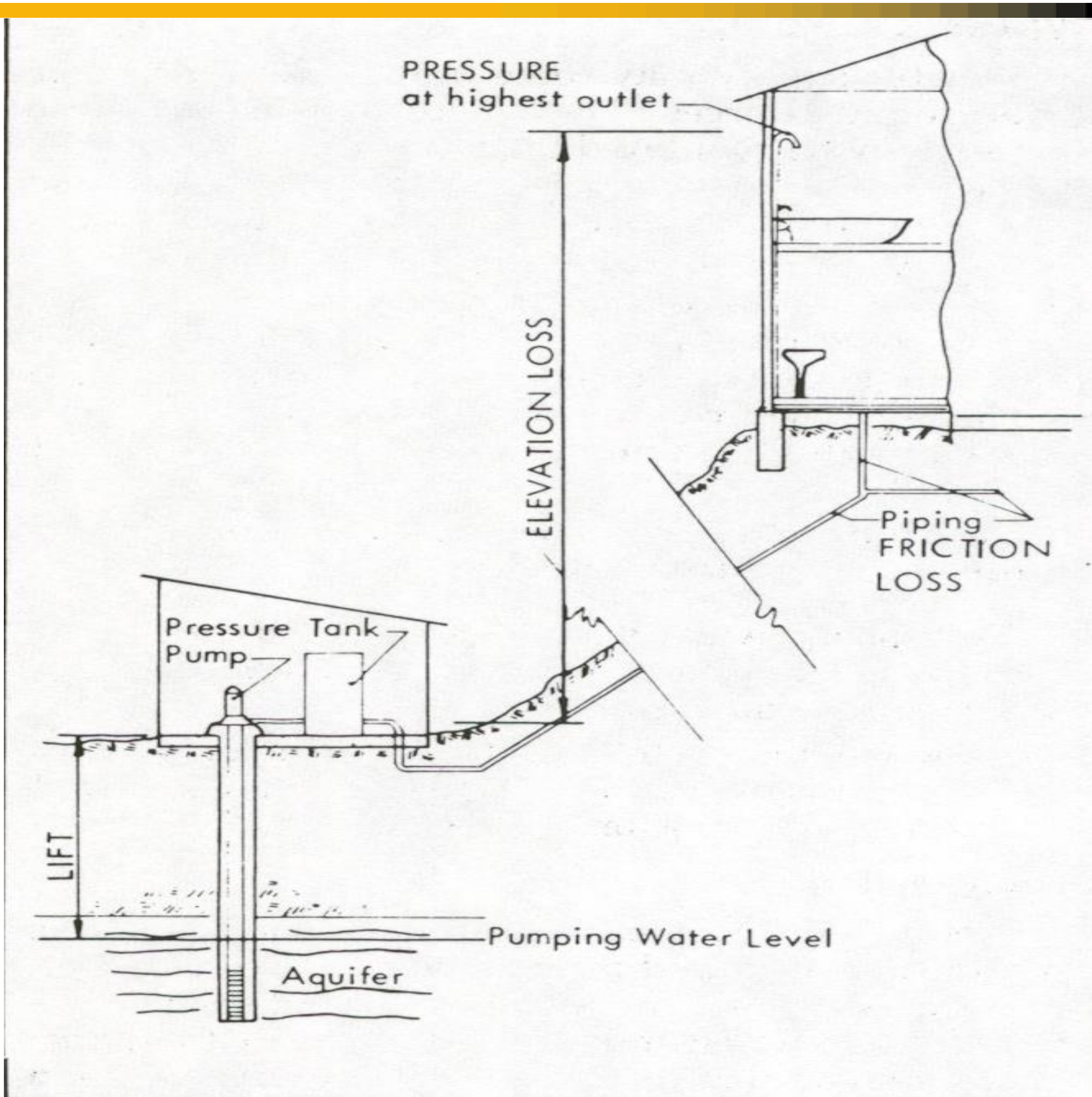
Sources of Total Head



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Hazen-Williams Formula

$$H = \frac{10.44\, Q^{1.852}\, L}{C^{1.852}\, D^{4.871}}$$

Where: C – dimensionless pipe coefficient

D – inside pipe diameter (inches)

Q – flow rate of water in pipe (gpm)

L – length of pipe (feet)

H – pipe friction loss in feet of head

Table 3. Friction loss table for plastic pipe in feet/100 feet of pipe, nominal I.D./actual I.D.

gpm	3/4/0.824	1/1.049	1.25/1.380	1.5/1.610	2/2.067	2.5/2.469	3/3.216
2	1.0	0.3	—	—	—	—	—
4	3.7	1.2	0.3	0.1	—	—	—
6	7.9	2.4	0.6	0.3	—	—	—
8	—	4.1	1.1	0.5	—	—	—
10	—	6.3	1.6	0.8	0.2	—	—
12	—	—	2.3	1.1	0.3	—	—
14	—	—	3.1	1.5	0.4	—	—
16	—	—	3.9	1.9	0.5	—	—
18	—	—	4.9	2.3	0.7	—	—
20	—	—	—	2.8	0.8	0.3	—
30	—	—	—	—	1.8	0.7	—
35	—	—	—	—	2.3	—	—
40	—	—	—	—	3.0	1.3	0.3
50	—	—	—	—	—	1.9	0.5

Source: Midwest Plan Service publication MWPS-14, *Private Water Systems*.

Table 4. Equivalent length in pipe diameters (L/d) of various valves and fittings.

Type of fitting	L/d
Globe valves, fully open	340
Gate valves, fully open	13
Gate valves, 3/4 open	35
Gate valves, 1/2 open	160
Swing check valves, fully open	135
In-line ball check valves, fully open	150
90 degree standard elbow	20–30
45 degree standard elbow	16
90 degree street elbow	50
Standard tee, flow through run	20
Standard tee, flow through branch	60

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Pump Power

The power required to pump water is:

$$\frac{\text{gpm} \times \text{pressure in feet}}{3{,}960 \times \text{pump efficiency*}} = \text{motor horsepower (hp)}$$

* Pump efficiency expressed as a decimal.

Gravity Flow Water Systems

- Use same pipe design equation
- Pump head pressure added is zero
- Usually pressure at point A is zero
- Elevation difference from point A to point B is the energy available to overcome pipe friction and move water through pipe

QUESTIONS?

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