Livestock Watering
FACTSHEET

BRITISH COLUMBIA
Ministry of Agriculture and Lands

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SELECTING FLOW-THROUGH RATES TO FROST-PROOF WATER TROUGHS

This Factsheet details the requirements to set up a frost-proof winter livestock waterer using the heat of the supply water in a flow-through design. The structural characteristics of the waterer, the air and water temperatures, the wind velocity and the water flow rate are considered in selection tables. These are suggested flow rates only and may vary by other specific site conditions.

Frost-Proofing Using the Supply Water

A winter livestock waterer can be frost-proofed in a number of ways; by using various methods to supply heat; by reducing the heat loss of the waterer or combinations of these (refer to ***Factsheet #590.307-3, Winter Outdoor Livestock Watering***).

One frost-proofing method is to use the heat of the supply water, which will usually have a temperature from 1^0 C to 10^0 C or more, having been warmed by the earth. If this water is circulated through the waterer at a rate that supplies heat matching the heat loss, it will not freeze. Points to consider :

- is there sufficient water in the supply to "waste" as flow-through
- can this waste water be handled and disposed of properly
- if the water is pumped (i.e., gravity flow not possible), is this less expensive than directly heating the water in the bowl

This flow-through frost-proofing method requires energy only to pressurize the water supply. This pressure may come from either gravity or a pumped system.

Gravity Supply

In situations where the terrain is favorable, the supply water may be pressurized for no energy cost, just the pipe costs. Plumb the supply to the waterer and install a suitably sized overflow pipe to take away the flow. No other energy supply is required for winter operation. These are usually the least expensive systems, especially those requiring large flows. If there is a large flow available, sizing the flow-through rate may not be critical. However, proper sizing will make maximum use of gravity water supplies.

Pumped Supply

Where gravity is not an option, water must be pumped for the flow-through circulation. These systems should be sized for the actual water flow required for frost protection to avoid unnecessary energy bills.

Flow-Through Rates

Factors Affecting Flow-Through Rates. For a water flow-through design to be successful, a number of factors must be know, including :

- the structural characteristics of waterer that will be used, including:
  - the water surface area exposed to the air
  - the surface area of the walls (including bottom, and top if used)
  - the insulation value of the walls
- the coldest winter air temperature at the waterer
- the wind conditions at the waterer
- the temperature of the supply water
- the flow rate of the supply water

Selecting A Flow-Through Rate. The following two tables give minimum *continuous* flow-through rates with the following assumptions:

- the waterer structural characteristics are simplified by only using
  - the open water surface area (the major heat loss factor) up to 8 square feet
  - and either uninsulated walls or walls insulated to R5 value
- four air temperatures
- one wind velocity of 50 kilometers per hour
- four water supply temperatures

Note that the table rates are *continuous flows* - if an automatic intermittent flow valve is used it should flow the equivalent volume.

Overflow Design

Problem-free overflow is critical to these systems:

- choose a pipe that is at least one size larger than the supply pipe; even larger for high flow systems
- protect the pipe from plugging by a screen or a "pipe-in-pipe" design as illustrated in Figure 1, below

Figure 1

"Pipe-In-Pipe" Overflow Design
(Not to Scale)

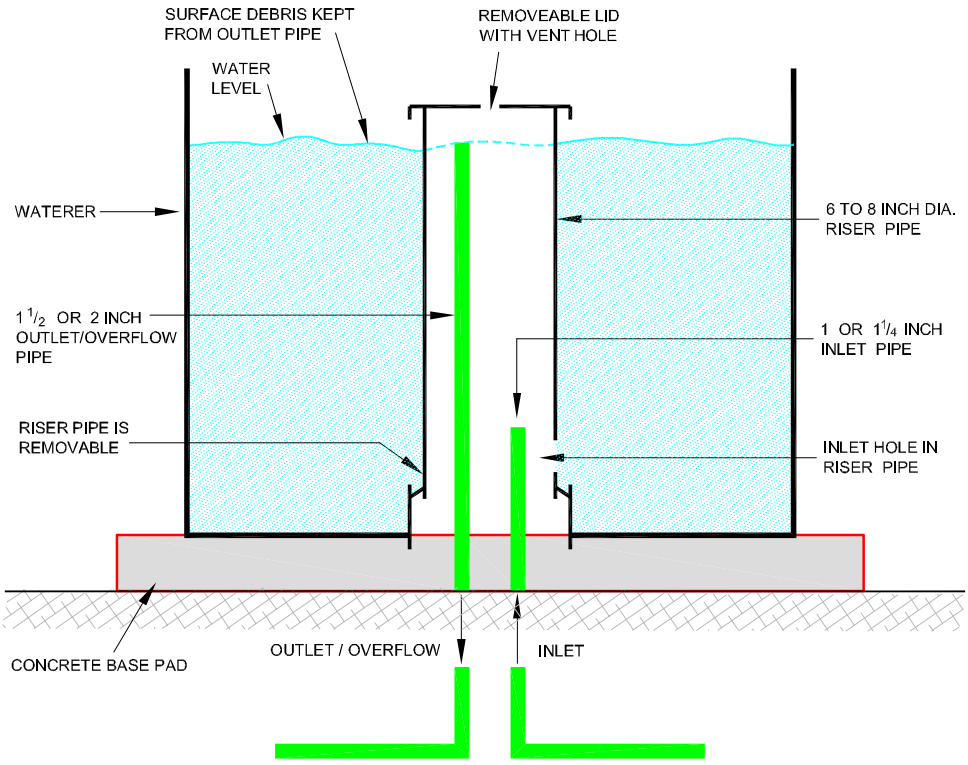

TABLE 1 MINIMUM CONTINUOUS FLOW RATES (USGPM) FOR FROST PROTECTION WHEN WALLS ARE *INSULATED TO R5*

Air ^{0}C	Wind kph	Water ^{0}C	Square Feet of Open Water Surface Area 1	2	4	6	8
		2	0.2	0.3	0.8	1.2	1.6
-10	50	4	0.1	0.2	0.4	0.7	0.9
		6	0.1	0.1	0.3	0.5	0.7
		8	0.1	0.1	0.3	0.4	0.5
		2	0.3	0.6	1.3	1.9	2.6
-20	50	4	0.1	0.3	0.7	1.0	1.4
		6	0.1	0.2	0.5	0.7	1.0
		8	0.1	0.2	0.4	0.6	0.8
		2	0.3	0.8	1.8	2.8	3.7
-30	50	4	0.2	0.4	0.9	1.5	2.0
		6	0.1	0.3	0.7	1.0	1.4
		8	0.1	0.2	0.5	0.8	1.1
		2	0.5	1.1	2.3	3.6	4.9
-40	50	4	0.2	0.6	1.2	1.9	2.5
		6	0.2	0.4	0.8	1.3	1.8
		8	0.1	0.3	0.7	1.0	1.4

TABLE 2 MINIMUM CONTINUOUS FLOW RATES (USGPM) FOR FROST PROTECTION WHEN THERE IS *NO WALL INSULATION*

Air ^{0}C	Wind kph	Water ^{0}C	Square Feet of Open Water Surface Area 1	2	4	6	8
		2	0.6	1.0	1.6	2.3	2.8
-10	50	4	0.3	0.5	0.9	1.3	1.6
		6	0.2	0.4	0.7	0.9	1.2
		8	0.2	0.3	0.5	0.8	0.9
		2	1.1	1.8	3.0	4.0	5.0
-20	50	4	0.6	0.9	1.6	2.1	2.7
		6	0.4	0.7	1.1	1.5	1.9
		8	0.3	0.5	0.9	1.2	1.5
		2	1.6	2.6	4.3	5.8	7.3
-30	50	4	0.8	1.3	2.2	3.0	3.8
		6	0.6	0.9	1.5	2.1	2.6
		8	0.4	0.7	1.2	1.6	2.1
		2	2.1	3.4	5.7	7.7	9.5
-40	50	4	1.1	1.8	2.9	4.0	4.9
		6	0.7	1.2	2.0	2.7	3.4
		8	0.6	0.9	1.5	2.1	2.6

Note: **1.** These tables are based on waterers that have: * a fixed 20 inches height; and
* a length that is twice the width

2. The flow rates given in these tables are *continuous flow rates*, in US gallons per minute, required 24 hours a day during the stated conditions to prevent freezing of the waterer.

3. These tables are for a few specific conditions. Flow rates for other combinations of air temperature, wind speed, water temperature and waterer size and open water surface area will require different flow rates.

4. The numbers in these tables have been rounded to one decimal point.

Example Selection of a Flow-Through Rate

To use the tables, use the following procedure:

- first, decide what is the air temperature in the cold of winter
- secondly, what is the temperature of the supply water
- thirdly, what are the characteristics of the waterer
  - what is the open surface area of the waterer
  - what is the insulation value of the walls

For waterers with walls insulated to R5 (i.e., 1 inch of extruded polystyrene foam board or equivalent) use Table 1. For waterers with no wall insulation, use Table 2.

Example Flow Rate. A waterer is in -30^{0}C winter conditions with up to 50 kph wind. The supply water is at 4^{0}C. The waterer has R5 insulated walls and two watering bowls, each 15 inches wide by 18 inches long.

- as the waterer has insulated walls, use Table 1
- the open water surface area = 2 (15 x 18 /144) square feet
  = 2 (1.9) square feet = 3.8 square feet
  use 4 square feet
- using the -30^{0}C / 50 kph / 4^{0}C line on Table 1, an open water surface area of 4 square feet requires a *continuous flow-through rate* of 0.9 US gpm to match the heat loss from the waterer and keep it from freezing
- if this waterer has a continuous water flow-through rate of at least 0.9 USgpm the surface will not ice over in the -30^{0}C and 50 kph wind winter conditions

Random Pointers

System Shut Off. All waterers require a shut off of the pressurized water supply. A buried "stop and waste" valve (to drain the supply line up to the waterer) may be used that is located below frost level and activated by a rod above ground. The waterer will require draining as well.

System Drain. If a "stop and waste" valve (self-draining) is not used, install a drain for both the supply line that is above the frost level and the waterer.

Disposal of Overflow Water. All flow-through water must be disposed of properly. Water should be directed back to the same drainage basin where possible. The overflow pipe could also be run to a buried rock pit. Flow must not be allowed to freeze, as the waterer frost protection will be lost.

Use of Lid. Heat loss can be reduced by using an insulated lid to cover the open water surface area when the waterer is not used, as at night.

More Information

For other aspects of winter livestock watering refer to various *Livestock Watering Factsheets* in this *Handbook* series.

Producers who have situations that are not covered in the tables of this Factsheet should call their local Ministry of Agriculture and Lands office or call the contact name below. Other flow-through rates can be selected from the design spread sheet for conditions beyond those given here.

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