Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Water Quality Matters

WATER QUALITY AND CATTLE

IMPORTANCE OF WATER QUALITY TO CATTLE

Water is the nutrient required most by cattle. Water accounts for 50-80% of an animal's weight and is involved in every physiological process. Feed intake is directly related to water intake. There are many factors which affect water intake, and also many compounds in surface and well water which can affect livestock performance and health.

Cattle can tolerate poor water quality better than humans, but if concentrations of specific compounds found in water are high enough, cattle can be affected. Most factors affecting water quality are not fatal to cattle. Cattle may not show clinical signs of illness, but growth, lactation and reproduction may be affected, causing an economic loss to the producer.

Most common water quality problems on the Prairies associated with surface water are:

- Blue-green algae (cyanobacteria)
- Bacteria, viruses and parasites
- Sulphates
- Dissolved solids (TDS).

Some water quality problems associated with groundwater are:

- Sulphates
- Dissolved solids (TDS)
- Nitrates
- Iron and manganese.

Other parameters that may be of concern are:

- Taste and odour
- Temperature
- pH/alkalinity.

Water is the most important nutrient for cattle

WATER CONSUMPTION

The following table outlines water requirements for cattle.

Table 1: Water Requirements for Cattle

Air Temperature	Water Requirements (water / kg dry matter feed intake)
> 35°C	8 - 15L / kg
25 - 35°C	4 - 10L / kg
15 - 25°C	3 - 5L / kg
-5 - 15°C	2 - 4L / kg
< -5°C	2 - 3L / kg

(adapted from: Effect of Environment on Nutrient Requirements of Domestic Animals, 1981, National Research Council)

The water requirements in Table 1 should be adjusted within the ranges in the following ways:

1) Good quality feed, lactating cows and high growth periods of an animal's life cycle increase feed intake.

2) Lactating cows - Increase water consumption by 75%.

Canada

BLUE-GREEN ALGAE (CYANOBACTERIA)

Blue-green algal blooms are common in dugouts or reservoirs that are rich in nutrients. Although commonly referred to as algae, they are really bacteria that may produce foul taste and odour, along with potentially deadly toxins.

The reason why some water bodies produce mainly non-toxic green or brown algae, while others produce blue-green algae, is unknown. Water with excessive nutrients cause high populations of algae in summer when the water is warm and ideally suited.

Algae is a common water quality problem with surface water sources on the Prairies

Blue-green algae produce two types of toxins: Neurotoxins, or nerve toxins, which can cause sudden death; and Hepatotoxins, or liver toxins, which cause death within several hours and up to two days. Clinical signs of hepatotoxins may become apparent within 15 minutes of exposure by cows.

The most common toxin on the Prairies is a liver toxin called microcystin-LR. It is released by the blue-green algae *Microcystis*. In most cases, *Microcystis* in a dugout will be accompanied by the microcystin-LR toxin. Fortunately, labs can identify *Microcystis* using a microscope and will soon be able to test for the toxin. Although these toxins are released during growth, the rapid release of toxins occurs when the algae dies.

Algae dies from a lack of nutrients or with a chemical application, such as copper sulphate or Diquat herbicide. Wind can also concentrate the dead blue-green algae along the downwind shores of a water body.

Positive identification of blue-green algae is difficult without a trained eye and a microscope, but there are tell-tale signs that can be used to identify the bacteria. Often blue-green algae die-off is indicated by a slime on the water's surface appearing similar to green, bluish-green or brownish paint. Also, blue-green algae is composed of tiny cells clumping together, and unlike green algae, cannot be picked by hand from the water.

The best way to avoid blue-green algae problems is to prevent blooms. This can be done by limiting nutrients from entering the water source, aerating the water and by pumping the water to a trough for livestock. To date, there has been no record of blue-green algae poisoning animals drinking from a trough. By placing the intake one metre below the water surface, the intake avoids the regions of concentrated toxins.

Copper sulphate can be applied to dugouts at a rate of one gram per square metre of surface area (a 20 m x 50 m dugout would require 1000 grams or 1 kg). The chemical should be used with caution because it also kills the zooplankton that feed on the algae and is toxic to fish. Doses must be reduced by 50% when dugouts are stocked with fish.

Even with remote watering, water from another source should be used for two weeks following a treatment with a chemical or when an algae die-off occurs.

BACTERIA, VIRUSES AND PARASITES

Bacteria, viruses and parasites are common in dugouts and reservoirs that collect runoff from a manure source or that allow cattle access. There are a large variety of these organisms that can cause a number of different symptoms and production loss. A contaminated water source can spread a pathogen quickly throughout the herd.

Guideline recommendations for maximum levels of coliforms vary from 10 to 5,000 counts per 100 mL, with the lower range for calves and higher range for cows. Direct entry dugouts can reach coliform concentrations exceeding 15,000 counts per mL.

Water contaminated by feces can transmit many disease-causing organisms such as *E.coli*, *Cryptosporidia*, *Salmonella* and *Leptospirosis*. These organisms generally affect young animals but have less effect on mature animals.

One disease that does affect mature animals is *Leptospirosis*. *Leptospirosis* can be spread though water contaminated with *Leptospirosis* bacteria. *Leptospirosis* will result in increased rates of abortion, usually occurring between 2-5 weeks after initial infection.

Cattle often have built-in resistance to many of these contaminants, but the introduction of an uncommon pathogen can rapidly spread through the herd and cause diseases, especially to young animals. Calves are provided some immunity from mother's milk, but are still susceptible to high concentrations of pathogens.

The easiest way to minimize pathogens in water is to prevent inflow from manure sources and prevent direct entry of animals. The sun's ultraviolet rays are effective in killing pathogens in water that is relatively clear. Allowing animals direct entry can stir up particles and prevent ultraviolet rays from destroying harmful pathogens.

SULPHATES

High concentrations of sulphates are common in groundwater on the Prairies, but can also be found in surface sources (drained from saline soils) and groundwater-fed dugouts. At 500 mg/L, sulphates can affect calves, but over time they adapt with few health problems. Sulphate levels over 800 mg/L can affect trace mineral metabolism and cause a deficiency of copper, zinc, iron and manganese. Trace mineral (TM) deficiencies can cause depressed growth rate, infertility and depressed

Table 2: Effects of Sulphate on Cattle

Sulphate Concentration	Effects
500 mg/L	May affect calves
1,000 mg/L	Canadian Water Quality Guideline
2,500mg/L	Affects copper metabolism - deficiency of zinc, iron and manganese - poor conception
7,000 mg/L	Death

A combination of nitrates in feed and water can reach toxic levels and result in death as soon as 3-5 hours after consumption

immune response. Sulphate levels over 1,000 mg/L may also cause thiamin (vitamin B_1) deficiency (nutritional polia). At 7,000 mg/L it can result in death. Guidelines usually recommend a maximum sulphate concentration of 1,000 mg/L, but the effects for concentrations between 1,000 and 2,500 mg/L are not well-documented.

Table 2 outlines the effects of sulphate on cattle.

Reducing sulphates is costly. Present treatment technologies include ion exchange and membranes, such as nanofiltration, but treatment cost is about $1 per cubic metre ($4 per 1000 Imp. gal). Due to the high cost, the best option is to find another source with a lower sulphate concentration and use a pipeline to distribute the water to the point of use.

TOTAL DISSOLVED SOLIDS (TDS)

Total dissolved solids (TDS), or salinity, refers to the mineral quantity of water. TDS includes common salts such as sodium chloride, calcium, magnesium, sulphates and bicarbonates. The main symptom of effects from saline water is diarrhea.

If TDS is high enough, cattle will refuse to drink the water for days, then drink a large amount at once. This can cause the animals to become sick, and even die.

Water with TDS higher than 5,000 mg/L should not be used for lactating or pregnant cows. Most animals will reduce intake at this level. Water with TDS greater than

7,000 mg/L makes it unsuitable by cattle. As with most contaminants, calves are more sensitive to salts in water than grown animals.

Treatment of high TDS water requires a membrane system such as reverse osmosis. As with sulphates, treatment is expensive and the best option is to find another water source.

NITRATES

Nitrates are occasionally found in groundwater that has been contaminated by manure or fertilizer. In dugouts and reservoirs, high nitrate concentrations are rarely found, except following direct runoff from manure or a chemical fertilizer source. Bacteria in the rumen converts nitrates to nitrites, which reduce the oxygen carrying capacity of the blood and can result in cattle suffocating from lack of oxygen.

Recommended limits of nitrates plus nitrites in water for cattle is 100 mg/L as nitrogen (N) or 450 mg/L as nitrates (NO3). This level is rarely seen on the Prairies except for extreme contamination.

Feed may also contain nitrates, therefore nitrate levels in both water and feed should be considered. If nitrate levels in a combined intake of water and feed exceed 0.5 to 1 per cent of intake, either the feed, water source or both should be changed depending on the level of nitrates in the individual source.

A combination of nitrates in feed and water can reach toxic levels and result in death as soon as 3-5 hours after consuming extreme levels. Chronic nitrate toxicity can also occur where clinical signs are not observed. This can result in depressed weight gain and appetite, and a greater susceptibility to infection and abortion. Contaminated water will more often cause chronic nitrate toxicity than acute poisoning.

Removal of nitrates requires an ion exchange, membrane or biological treatment system. Prevention of water source contamination is inexpensive and essential for viable and sustainable farm management.

IRON AND MANGANESE

Iron and manganese are common in groundwater, but can also be found in dugouts that are poorly aerated. These compounds are not toxic, but can cause blocked pipes. Iron and manganese precipitates when exposed to air and accumulates in pipes. Iron is also a nutrient source for iron bacteria, which can further compound the blocked pipe problem.

To prevent problems in distribution pipes, guidelines recommend iron levels less than 0.3 mg/L and manganese concentrations less than 0.05 mg/L.

Options to remove these vary and may include the following:

- Often aerating or spraying water into a tank can remove significant amounts of iron.
- A softener can also be used for concentrations less than 2 mg/L.
- Other options include oxidants such as chlorine or ozone, or treatment systems involving manganese green sand or biological activity.

ALKALINITY AND pH

Water pH ranging from 6.0 to 8.5 is considered acceptable as a water source for most livestock. Water with a pH less than 5.5 may cause acidosis in cattle, leading to reduced feed intake and performance.

However, acidic waters are uncommon on the Prairies. Mildly alkaline waters contain bicarbonates, but no carbonates. Highly alkaline waters (pH approx. 10) will contain carbonates. Most waters have alkalinities below 800ppm, which is measured as calcium carbonate ($CaCO_3$), and is not harmful to cattle. Excessive alkalinity in water can cause physiological and digestive upset in livestock. Alkalinity can also increase the laxative effects of water with high sulfate levels.

TASTE AND ODOUR

Some researchers speculate that cattle are sensitive to certain taste and odours. Humans identify taste and odours related to blue-green algae, organic matter decay without the presence of oxygen and the presence of various minerals. Whether cattle have similar sensitivities is unknown, but cattle do seem to respond differently to various water types. Some farmers and researchers have identified a sensitivity to chlorine.

Water Constituents Affect Beef Cattle Performance

Constituent	Reduced Performance	Unsuitable for Beef Cattle
Nitrate (ppm)	450 - 1,300	>1,300
Salinity/TDS (ppm)	3,000 - 7,000	>7,000
Sulphate (ppm)	500 - 3,300	>3,300
Fecal coliform (No./100ml)	1,000 - 2,500	>5,000
pH	>8.5	>10

Good management practices of water bodies, such as keeping waterways grassed, preventing livestock access and aerating dugouts are inexpensive ways to minimize tastes and odours and ensure a good quality water source. Treatment to remove taste and odour is expensive but prevention is affordable.

Manure in the water will impact its taste and odour. Cattle have shown a preference to drink at clean water sources over contaminated ones. Cattle will not reduce consumption of contaminated water until manure exceeds 0.25% in the water.

Iron and manganese can affect the odour and taste of water. Since cattle are sensitive to both odour and taste, high levels of iron and manganese may cause them to show preference for one water source over another. It is unknown at this time what levels would result in reduced water intake.

A solar powered remote water system is becoming a common practice on the Prairies

WATER TEMPERATURE

Water temperature may affect water intake by cattle. Research has shown that cool water helps cattle maintain a proper body temperature and can increase water intake, in turn increasing weight gains. If it is possible to maintain cool drinking water, there is a performance advantage to producers.

Groundwater is naturally cool and maintaining this temperature is beneficial. Dugouts maintain a constant temperature during the day, but the temperature does rise in the sun.

Deep dugouts do not warm up to the point where they will have an effect on intake. Small water troughs in the summer and shallow sloughs and dugouts may be a concern. Water in troughs heat up by late afternoon, but cool down during the night.

WATER QUALITY AND WEIGHT GAINS

A few studies have been conducted to examine the effect of water quality and cattle weight gains. These studies have shown that the more water an animal drinks, the more feed it consumes, which leads to greater weight gain.

During a study conducted in Alberta, researchers documented a nine per cent greater weight gain in calves with cows drinking water from a trough compared to those drinking directly from a pond. Steers in the same study showed a 16-19% increase in weight under the same environment.

Another study in Saskatchewan examined four different water treatments and the effect they had on cattle intake and weight gains. This study found that by aerating or coagulating water, cattle will increase their water intake by 10-20% over unaerated water; however, research on weight gains has been variable. The aeration and coagulation treatments are removing many contaminants thus improving taste and odour, which improves intake.

THE BIG PICTURE

Water is the most important nutrient to cattle. It can have many health and production effects. There are definite economic gains to providing an unlimited supply of high quality water. Managing water quality should become as important as the feed source and ration planning in a beef cattle management program.

AUTHORED BY: L. Braul and B. Kirychuk, PFRA, with thanks to W. Willms, B. Lardner, D. Christensen, B. Klemmer, and D. Corkal.

FUNDING: Strategic support and funding for this project has been provided by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF).

ENDORSEMENT: This report should not be taken as an endorsement by PFRA or Agriculture and Agri-Food Canada of any of the products or services mentioned herein.