Livestock Water

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Photo courtesy of Jessie Schultz, NDSU-VDL

Livestock Water Availability

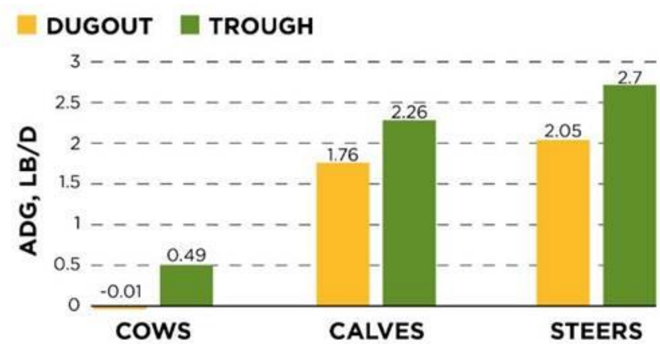
Drinking water availability is more important than drinking water quality. The first step in designing a water distribution system for livestock is to determine the water demand. The majority of beef cattle are managed in pasture systems that depend on convenient waterers at several locations on the farm for maximum production efficiency. Water requirements of beef cattle depend on the stage of production, lactation and environmental temperature. Beef cattle drinking water requirements increase as the weight of the animal increases, pregnancy and lactation, and with elevated environmental temperatures. Drinking water requirements also depend on the moisture in feeds. Limiting water intake reduces feed consumption and animal performance.

Limitation of water intake reduces animal performance quicker and more dramatically than any other nutrient deficiency (Boyles). Water constitutes approximately 60 to 70 percent of an animal's live weight and consuming water is more important than consuming food (Faries, Sweeten & Reagor, 1997). Domesticated animals can live about sixty days without food but only about seven days without water. Livestock should be given all the water they can drink because animals that do not drink enough water may suffer stress or dehydration.

Cows like to insert their muzzle 1 to 2 inches into the water with their head inclined at 60 degrees to drink. They need about 95 square inches of surface area to drink from, and can drink 3 to 5 gallons per minute. Keep water within 800 feet of the grazing animal. This will discourage herd movement and loafing time at the water. Maintain a minimum flow rate of 6 gallons per minute. A properly placed water tank will allow multiple cows to drink at one time. A 6-gallon flow rate will allow the tank to recharge as the cattle drink. Pipe size, pressure, and elevation all affect flow rate. Do not provide shade at the water point. Shade + water = mud and waste. Anything that encourages cattle to loaf in one area means fewer nutrients are being recycled on the growing pasture.

Calves, with cows drinking clean water, gained 9% more ($P < 0.10$) weight than those with cows on pond (direct) but cow weight and backfat thickness were not affected. Yearling heifers having access to clean water gained 23% ($P = 0.045$) and 20% ($P = 0.076$) more weight than those on pond (direct) and pond (trough),

respectively. Cattle avoided water that was contaminated with 0.005% fresh manure by weight when given a choice of clean water. Cattle that had access to clean water spent more time grazing and less time resting than those that were offered pond (trough) or pond (direct).



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Cyanobacterial bloom at Sedan, Kansas

Water Quality for Livestock

Drinking water quality for livestock is essential for animal health and production. Typically, livestock are using surface waters for most of the year. The concern is for higher levels of contaminants in water that can reduce water and feed intake and performance in the animals. Given a choice, livestock will drink and perform better with clean water.

Depending on geographic location, environmental and industrial activities, climactic conditions (snowfall, rain, drought, etc.) and type of water (surface or ground), water quality can vary. The criteria examined in livestock water quality can include odor, taste, total dissolved solids (TDS) or salinity, total dissolved oxygen, toxic minerals, heavy metals, pH, nitrates and nitrites, sodium, sulfate, bacteria, and pesticides. Routine water tests for livestock often include the parameters for TDS, sulfate, nitrates, pH, sodium, conductivity, minerals, and cyanobacteria. This article includes a discussion of several of these common livestock water parameters.

Total Dissolved Solids

Total dissolved solids (TDS) is a gravimetric measurement of all inorganic (minerals, metals, salts) and organic (e.g., pollutants, pesticides, hydrocarbons) substances that pass through a filter. It is not specific as to the type of substances in water. Salinity or dissolved salt content is often used synonymously with TDS based on the assumption that all the dissolved solids are saline.

The guidelines for TDS were established by the National Academy of Sciences in 1974 and are widely accepted **(Table 1)**. High TDS values can adversely affect water palatability and consequently water consumption and indirectly feed consumption and animal performance. A general assumption is that TDS concentrations less than 500 mg/L (or ppm, parts per million) should ensure safety from almost all inorganic substances. With TDS concentrations greater than 500 mg/L, additional water constituents should be identified and quantified. A general recommendation for suitable livestock water quality is to keep the TDS concentration less than 6,000 mg/L.

TDS and electrical conductivity are related measurements in water, but not interchangeable. Electrical conductivity of water is related to the concentration of dissolved ionized solids in water that create the ability for water to conduct an electric current, but is not measuring organic substances. TDS values can be approximated by the electrical conductance in water.

Sulfate

In nature, sulfur (S) can occur in various forms including free and combined with other elements in sulfides and sulfates (SO_4). Weathering of rock formations can leach sulfates from soils into water formations. Sulfate is the most common form of sulfur found in water and can combine with calcium, iron, sodium, and magnesium in

Table 1: Guide for Use of Saline Waters for Livestock and Poultry

Total Soluble Salts of Waters or Salinity (mg/liter or ppm)	Comment or Effect
<1,000	Relatively low level of salinity and no serious burden to any class of livestock or poultry
1,000 – 2,999	Should be satisfactory for all classes of livestock and poultry. May cause temporary and mild diarrhea in livestock not accustomed to them or watery droppings in poultry, but should not affect their health or performance.
3,000 – 4,999	Should be satisfactory for livestock but might cause temporary diarrhea or be refused at first by animals not accustomed to them. They are poor water for poultry, often causing watery feces and at the higher levels of salinity increased mortality and decreased growth, especially in turkeys.
5,000 – 6,999	Waters can be used with reasonable safety for dairy and beef cattle, sheep, swine, and horses. Avoid the use of higher salinity levels for pregnant or lactating animals. Waters not acceptable for poultry, almost always causing a problem, especially at higher limits, where reduced growth and production or increased mortality will probably occur.
7,000 – 10,000	Waters unfit for poultry and probably for swine. Considerable risk for pregnant or lactating cows, horses, sheep and the young of these species or for any animals subjected to heavy heat stress or water loss. Generally, avoid use, although older ruminants, horses, and even poultry and swine may subsist for a period of time under conditions of low stress.
> 10,000	Risk great. Cannot recommend for use under any conditions

Data adapted from National Academy of Sciences. *Nutrients and Toxic Substances in Water for Livestock and Poultry.* 1974. National Academy of Sciences: Washington DC, p. 49.

salts. Elevated concentrations of these salts make water unpalatable to livestock. During droughts, the water sulfate concentration can become more concentrated with hot environmental temperatures. Some aquifers and water formations are naturally very high in sulfates, and once formed, cannot be removed by cost-effective processes (e.g., reverse osmosis, distillation, ion-exchange) for livestock water under typical conditions.

Elevated concentrations of water sulfate can decrease both feed and water intake of animals leading to poor growth and poor performance. At relatively low concentrations of water sulfate at 500 mg/L, copper absorption may be decreased in animals. **Table 2** provides a guide to water sulfate concentrations for livestock. It is generally recommended that the water sulfate concentrations are less than 500 mg/L for livestock. The maximum 'safe level' of water sulfate is considered at 1000 mg/L for cattle under hot weather conditions or consuming moderate dietary sulfur concentrations. The threshold for taste aversion and reduced performance in feedlot cattle is suggested at 2000 mg/L water sulfate. Not uncommonly, the surface and some ground waters in central to western North Dakota have water sulfates approaching or greater than 2,000 to 3,000 + mg/L. High sulfate concentrations can lead to the development of 'polio' or polioencephalomalacia (PEM) and cause sudden death with no lesions or can cause necrosis of brain matter and clinical neurological signs of muscle tremors,

Table 2: Recommended maximum sulfate (SO_4) and sulfate-sulfur (SO_4-S) concentrations in water (mg/L or ppm)

SO4	SO4-S	Types
<500	<167	Calves
<1000	<333	Adults
1000-2000	333-667	At risk of adverse health effects in animals
>2000 to >3000	667-1000	Potential 'polio' and death in animals

blindness, head-pressing, lethargy, weakness, recumbancy, convulsions, and death in cattle. Reports of 'polio' in cattle especially in cattle not adapted to higher sulfate water have even occurred with water sulfate concentrations less than 2000 mg/L.

It is thought that cattle can adapt to elevated concentrations of water sulfate if the animals are gradually introduced to them over a period of days to weeks. However, even cattle adapted to high water sulfate concentrations are at risk for reduced water and feed consumption and PEM when the water sulfate levels are greater than 2,500 mg/L. If cattle have to be placed at *high risk* with high water sulfate concentrations (such as 2,500 to 3,000 mg/L) in the pasture water, provide (haul in) an alternative source of 'clean' low sulfate water ever two-to-three days to the cattle, and monitor the animals daily for adverse effects (poor weight gains, poor reproduction, diarrhea) and PEM.

With elevated to high water sulfate concentrations, evaluate all sulfur contributions to the diet both in water, feed, and feed supplements. As a general comment, the Nation Research Council recommends the sulfur concentration in cattle diets be limited to the animal's requirement, which is 0.2% dietary sulfur for dairy and 0.15% dietary sulfur in beef cattle and other ruminants.

Sodium

Sodium chloride toxicity is directly related to water availability. Sodium chloride can be a major constituent of salinity or TDS under natural conditions. High concentrations of sodium can depress water intake and cause diarrhea, dehydration, and loss of appetite with weight loss in animals. Chronic health effects of decreased production have been reported in dairy cows with water sodium concentrations at 1000 mg/L. Serious effects including death can occur at high sodium concentrations of 5000 mg/L in water. While a maximum guideline for sodium in livestock drinking

water has not been established, the general recommendation is to keep sodium concentrations in potable drinking water of cattle to less than 1000 mg/L.

Nitrates

Nitrate can enter water supplies through shallow wells and wells with broken casings in agricultural areas with manure and/or fertilizer contamination and with fertilizer runoff into surface waters. The practice of hauling potable livestock water in tanks previously used for fertilizer is frequently associated with acute nitrate toxicity in cattle; the tanks seem to retain toxic levels of nitrate despite several rises and *use of hauling potable water in tanks used for fertilizer is highly dangerous*. Water contamination with nitrates is a larger concern when feeds and forages contain nitrate levels, which adds to potential nitrate poisoning in cattle.

Nitrates in water or feed are metabolized by rumen microflora to nitrites in cattle. Once absorbed into the bloodstream, nitrites contact red blood cells and alter the iron in hemoglobin to a form that cannot transport oxygen to tissue resulting in oxygen deficiency. Clinical signs can occur within one-half to four hours and include signs of lack of oxygen: rapid breathing, rapid weak pulse, cyanotic (bluish-brown) mucous membrane, frequent urination, weakness, tremors, difficulty moving, convulsions, and death. **Table 3** provides general guidelines for nitrates in water for cattle.

Table 3: Water Nitrate-Interpretation of laboratory analysis Data

Form of Nitrate Measured in mg/L or ppm			Recommend-ations for use in Livestock
Potassium Nitrate (KNO_3)	**Nitrate Nitrogen (NO_3-N)**	**Nitrate (NO_3)**	
0 - 720	0 – 100	0 - 400	Generally considered safe
720 – 2,100	100 – 300	400 – 1,300	CAUTION: Possible problems. Additive effect with nitrate in feed.
>2,100	> 300	>1,300	DANGER. Could cause nitrate poisoning.

Data adapted from Stoletenow, C. and Lardy G. *Nitrate Poisoning of Livestock.* NDSU Extension Service, NDSU: Fargo, ND. May 2008. V-839

Table 4: Recommended concentration limits for selected toxic substances in drinking water for livestock based on US EPA, National Academy of Science, or Canada guidelines

Substance	Safe Upper Limit of Concentration (mg/L or ppm)
Alkalinity	<2000 (Canada)
Aluminum	5
Arsenic	0.2
Boron	5.0
Cadmium	0.5
Calcium	1000 (Canada)
Copper	0.5
Iron	No value limit, 0.4 (Canada)
Fluoride	2.0
Hardness	2000
Lead	0.1
Magnesium	< 250 (Canada)
Manganese	No value limit; 0.05 (Canada)
Nitrate	100 to 440
Nitrite	33
pH	5.5 – 8.3 (Canada)
Selenium	0.05
Sodium	1000
Sulfate	<500 to 1000 (Canada)
Zinc	25
Total bacteria/100 mL	<200 desired, with >1,000,000 being a problem range
Coliforms	Recommend <5,000/200 mL with fecal coliforms near zero (Exception Grade A dairies should have no fecal coliforms in sanitary water supply)

Data adapted from Morgan S.E. Water quality for cattle. Vet Clin Food Anim 27 (2011) 285-295. (Source data from T. Carson. Current knowledge of water quality and safety for livestock. Vet Clin N Amer: Food Animal Practice 2000; 16; 455-464
Raisbeck M.R., Riker S.L., Tate C.M. ET. Al. Water Quality for Wyoming Livestock & Wildlife A Review of the Literature Pertaining to Health Effects of Inorganic Contaminants. UW Dept. Veterinary Science & Renewable Resources, Wyoming Dept. Game & Fish, Wyoming Dept. Environmental Quality, 107 pgs.

Toxic Substances

A variety of contaminants can enter water sources and be potentially harmful to livestock. **Table 4** lists a selected number of substances that could affect the health of cattle. Additional factors of the animals' diet, other mineral sources, environment, and stage of animal's growth and production could influence possible adverse effects of these substances in livestock water.

There are no regulations controlling microorganisms or bacteria in water used in animal production, except for Grade A dairies. Contamination of water sources with infectious organisms, such a Leptospira, Salmonella, Fusobacteria, and *Clostridium botulinum*, have been reported, especially in stagnant and non-flowing water.

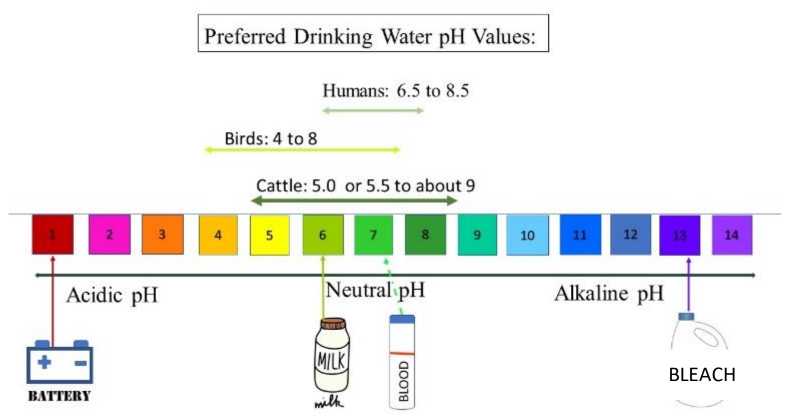
pH

This year the North Dakota Veterinary Diagnostic Laboratory (NDSU-VDL) has detected elevated pH values in livestock surface waters, especially in western North Dakota. Generally, the normal pH values of livestock water range from approximately 5.5 or 6.0 up to about 8.0 to 9.0. Birds can tolerate a pH range of 4 to 8, with an alkaline pH greater than 8 associated with reduced water consumption.

The NDSU VDL has detected alkaline or basic pH values > 10 and up to 10.5 in water. At these elevated water pH values, animals can have irritation to the mouth and oral cavity, burning or irritation of the eyes, and refusal to drink. Water with a pH greater than 9.0 could result in health problems related to chronic or mild alkalosis in dairy cows. Extremes of water pH may dissolve materials from the ditches, pipes etc. and some could be toxic or impart an unpleasant taste to the water, particularly a metallic taste with high water pH that cattle appear not to like. Little data is available on adverse effects of drinking highly alkaline or basic water in livestock. Often the high pH lakes or ponds contain a high concentration of minerals, particularly dissolved salts: sodium, calcium, magnesium carbonates and bicarbonates, sulfates, and other elements.

Possible explanations for elevated water pH values include that in North Dakota over the last few years wet conditions could saturate alkaline soils and mobilize different constituents into wetlands. Apparently, North Dakota has some alkaline seeps that can contribute to the elevated water pH value. High water pH is the outcome of many interacting chemical and biological processes. Problems can occur in high pH pond water where the total alkalinity or buffering capacity of water, defined as the ability to neutralize acids and bases (amount of carbonate, bicarbonate, and hydroxides in water) far exceeds water hardness (the amount of calcium and magnesium in water). While several management practices have been tried to reduce high pH water, some have significant drawbacks and often only achieve temporary benefits.

Note that human drinking water pH standards of 6.5 to 8.5 were established decades ago for aesthetic purposes and to protect plumbing from corrosion, rather than upon health-based criteria. In fact, it is not uncommon for some of the water treatment plants to release water with a pH range of 8.5 to 9.0 to help control pipe corrosion and minimize the potential to dissolve metals because the pH of water controls the solubility and concentrations of elements in water.



NDSU Lab filtering cyanobacteria bloom in water sample

Cyanobacterial *Microcystis* bloom from North Dakota, photo courtesy of Dr. Kevin Sedivec, NDSU Range Science Program

Cyanobacteria

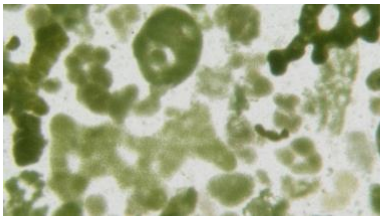
The occurrence of cyanobacteria or Harmful Algae Blooms (cHAB) appears to be increasing in the upper Midwest, possibly due to increased awareness and increased environmental temperatures. Cyanobacteria are photosynthetic bacteria that multiply or bloom in 1) sunlight, 2) stagnant or low-flowing water, 3) hot weather generally greater than 75 to 80 ºF for several days, and 4) enrichment of water with nutrients, especially phosphorus and nitrogen from livestock manure or fertilizer runoff into water. These blooms can occur quickly and be moved from shoreline-to-shoreline by wind action. Some of the cyanobacteria (e.g. *Microcystis* spp.) have gas vesicles in their cells providing buoyancy and appear as "pea-soup" green scum on the water during a bloom and often give-off a 'musty' or 'septic' odor. Some cyanobacteria are dispersed throughout the water column (e.g., *Cylindrospermopsis* spp.) and provide a general green discoloration of water, while other cyanobacteria (e.g., *Planktothrix* spp.) can be found in the bottom sediment and float to the surface when sediment is disturbed or mobilized by storm events.

A variety of cyanobacteria can proliferate in Midwest waters. These cyanobacteria may or may not produce different toxins called cyanotoxins that affect body organs, primarily the liver and nervous system (Table 5).

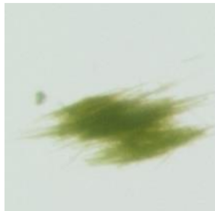
Unfortunately, veterinarians do not have good data on the amount of toxin in water related to potential harm in the animal or dose: response data. Lacking that data and not knowing if the cyanobacteria produced toxin(s), often we estimate potential harm to animals based on 1) the observation of a cyanobacterial bloom in the water and 2) a laboratory microscopic determination of the presence and possible concentration of cyanobacteria in a representative water sample. Several private laboratories and veterinary diagnostic labs can provide microscopic determination of possible cyanobacteria in a water sample. The critical factor for any water test for cyanobacteria is for the livestock producer to take a 'representative' sample of the suspect water where the bloom is located or where animals died.

Cyanobacterial bloom conditions generally are more frequent during late summer and early fall with higher water temperatures, but can occur from spring through fall, and cyanobacteria are described as overwintering under ice in the Arctic region. The cyanobacteria *Microcystis* spp. can produce potent liver toxins or microcystins that can cause clinical signs of diarrhea, jaundice, inappetence, ataxia, weakness, shock, seizures, and death in animals. These toxins can also cross the blood-brain-barrier and cause neurologic clinical signs. The cyanobacteria *Anabaena* spp. (also known as *Dolichospermum* spp.) appear as a 'string of

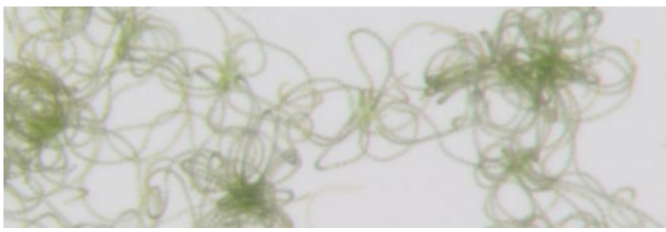
pearls' microscopically and can produce both liver and neurotoxins. These neuro toxins can cause tremors, seizures, respiratory paralysis, and death in animals within minutes to hours. *Aphanizomenon* spp. are cyanobacteria that seem to bloom more in the late summer and fall and can produce liver and neurotoxins.



Microcystis spp



Aphanizomenon spp



Anabaena spp (Dolichospermum)

The factors that cause cyanobacteria to produce blooms and toxins are not well-understood. These cyanobacterial blooms can harm the environment, and animal and human health. The bloom decay can release toxins into the water and diminish oxygen in the water causing plant, fish and animal die-off.

A limited number of laboratories can analyze and quantify specific cyanotoxins in a water sample, but the cost per toxin tested can be prohibitive. Because of the rapidly changing situation of a bloom in a water body, often the best approach is to recognize the potential of a cyanobacterial bloom and remove or fence the cattle from access to the water. Microscopic identification of the cyanobacterial genus in the suspect bloom can be helpful in evaluating potential toxicity to livestock.

Table 5: Summary of Cyanotoxins produced by Cyano-bacteria or Harmful Blue-green Algae in upper Midwest

Toxin	**Target Organ in Mammals**	**Cyanobacteria**
Microcystins	Liver	*Microcystis, Anabaena (Dolichospermum), Planktothrix (Oscillatoria), Aphanizomenon*
Nodularin	Liver	*Nodularia*
Anatoxin-a	Nervous system	*Anabaena (Dolichospermum), Planktothrix (Oscillatoria), Aphanizomenon, Cylindrospermopsis*
Anatoxin-a(S)	Nervous system	*Anabaena (Dolichospermum)*
Cylindrospermopsins	Liver	*Cylindrospermopsis, Anabaena (Dolichospermum), Aphanizomenon*
Saxitoxins	Nervous system	*Anabaena (Dolichospermum) Cylindrospermopsis Aphanizomenon*

Data adapted from: EPA Cyanobacteria and cyanotoxins: Information for drinking water systems. 2014.
Siyonen K. and Jones G. Chapter 3. Cyanobacterial toxins. In: Chorus I. Bartram J., eds: Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management. E & FN Spon: London, UK. ©1999 WHO.

Treatments for Cyanobacterial or Harmful Blue-green Algae Bloom

The 'old-timers' approach to prevent cyanobacterial blooms in surface water was to add specifically barley straw bales to the water source(s). Modern science has not identified the specific agent in barley straw that could prevent a cyanobacterial bloom and has not confirmed or totally refuted the benefit of barley straw. Another possible way to prevent cyanobacterial blooms on a smaller pond is to float straw on the surface and prevent entry of sunlight into the water and development of a bloom.

To control the growth of algae in water storage tanks, try to prevent light entry and buildup of organic pollutants. The use of 1 ounce of unscented chlorine bleach per 30 gallons of water, hold for 12 hours, drain the tank, and refill with clean water can kill certain bacteria in a tank. Another treatment regime is to add 8 ounces of unscented chlorine bleach per 1000 gallons of water to supply 3 to 5 mg/L or ppm of chlorine to the water tank. Note that chlorine bleach can be inactivated by the presence of organic material and over time chlorine can dissipate into the atmosphere decreasing effectiveness.

Table 6: Side effects reported after numerous copper sulfate treatment upper Midwest lakes

Copper Sulfate Treatment Side Effects
1) Intended temporary killing of algae with recovery of algal population within 7 to 21 days post treatment – so very ineffective. Repeat blooms could be more severe
2) Accelerated phosphorus recycling from the lakebed
3) Fish kills
4) Copper accumulation in the sediments that may render the water source unusable for sheep
5) Depletion of dissolved oxygen by decomposition of dead algae
6) Tolerance adjustments of certain algae to higher copper sulfate doses
7) Shift of species from green to harmful blue-green algae and from game fish to rough fish
8) Disappearance of macrophytes or large aquatic plants and benthic macroinvertebrates

Hanson M.J., Stefan H.G. Side effects of 58 years of copper sulfate treatment of the Fairmont Lakes, Minnesota. Journal American Water Resources Association. Vol 20, 1984. https://doi.org/10.1111/j/1752-1688.1984.tb04797.x

Concerns for use of copper sulfate compounds to treat harmful blue-green algae or cyanobacterial blooms

The practice of routinely applying algaecides to water sources should be discouraged. Copper sulfate has been used to treat harmful blue-green algae or cyanobacterial blooms in sloughs or ponds used for livestock water. While copper sulfate can quickly lyse the algal cells releasing algal toxins into the water, the use of copper sulfate in a water body has several requirements in North Dakota. There are also recommended restrictions for use, as well as side-effects that can be potentially harmful to the environment (Table 6).

If using copper sulfate in a body of water in North Dakota, the North Dakota Environmental Quality, Division of Water (701-328-5210) should be contacted to discuss the following requirements:

1) The chemical must be labeled a pesticide with a manufacturer's label.
2) Applicators must fill out the pesticide applicators notification 20 days prior to application of any pesticide. The pesticide application general permit can be found at https://deq.nd.gov/publications/wq/2_NDPDES/PesticideApp/PesticideDischargeGeneralPermit.pdf.
3) The chemical must be labeled a pesticide with a manufacturer's label.

Prior to application of copper sulfate to treat a harmful blue-green algae bloom:

1) Determine the correct copper formulation.
2) Calculate proper dose (pounds of copper sulfate per surface acre of water). The dose application of copper sulfate to water is based on the surface area of water and treated for the top two feet of lake surface where the blue-green algae grow, not the entire volume of the water body.

3) Know the water hardness and alkalinity. In hard water or alkaline water (high water pH is fairly common in North Dakota) the copper sulfate tends to settle out of water to the bottom within 24 hours after application and then is not effective to treat the bloom. Copper sulfate can persist in sediment and become potentially toxic to plant and animal life.
4) Consider target species and potential effects on fish and benthic invertebrates.
5) Be aware that livestock should be prevented from access to treated water for at least 10 to 14 days post treatment.
6) Toxins released from lysis of blue-green algae can remain in algal mats on the shore or in the water for up to 4 to 6 weeks and be a hazard to livestock.

Be aware that many copper sulfate products are not allowed for use in water. Aquatic copper products are available. Chelated copper remains in solution longer with greater contact with the algae. Copper not in solution or applied to shorelines is not effective. The best method to avoid harmful algal blooms is to develop an alternative water source such as a well with a solar pump and tank. Another option is to fence the water source and establish a vegetated buffer that will filter the water flowing into the dugout. Installation of an intake, solar pump and tank would complete the system. While an algal bloom may still occur, the buffer and lack of cattle loafing in and around the water should improve the conditions.

Both the North Dakota State University- Veterinary Diagnostic Lab at Fargo, ND (www.vdl.ndsu.edu) and the Kansas State University Veterinary Diagnostic Lab at Manhattan, KS (www.ksvdl.org) provide livestock water testing and microscopic identification of cyanobacteria.

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