**University of Missouri Extension**

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# Water Quality for Livestock Drinking

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Water is a critical nutrient for livestock and poultry. As with feed ingredients, livestock water should meet the nutritional needs of the animal. An adequate and safe water supply is essential to the production of healthy livestock and poultry. Water that adversely affects the growth, reproduction, or productivity of livestock and poultry cannot be considered suitable. Although there is scant research data on the economic effects of water quality on livestock performance, logic tells us that farm water supplies, either surface or ground, should be protected against contamination from microorganisms, chemicals and other pollutants. Substances that originate on livestock farms and often contaminate water supplies include nitrates, bacteria, organic materials, and suspended solids. A high level of suspended solids and an objectionable taste, odor or color in water can cause animals to drink less than they should.

Surface water supplies to which livestock have ready access are always potential candidates for contamination. Shallow dug wells without good surface drainage away from the well may be subject to infiltration of contaminants. The presence of coliform bacteria in a well is an indication that surface water is finding its way into the well. In karst topography, sink holes, losing streams and porous soils may allow direct contamination of fractured rock aquifers.

Water can serve as a reservoir for many different disease organisms and toxins. Stagnant water contaminated with manure or other nutrients may develop blue-green algae, which can poison livestock, causing muscle tremors, liver damage, and death. Farm pond water needs to be observed for the presence of algae and other harmful organisms during hot, dry weather.

Leptospirosis and Fusobacterium are two bacterial contaminants that often use water and mud, respectively, as modes of transportation from animal to animal. Leptospirosis is spread through urine of carrier animals. This disease often manifests itself as reproductive problems. Problems may range from infertility, to low milk production, to widespread late-term abortion. The organism can survive for extended periods of time in surface waters. One should take care to avoid forcing livestock to drink from water sources that may be contaminated with urine.

Fusobacterium infection is more commonly known as "foot-rot." The bacterium is a soil-borne organism found virtually throughout the United States. It is carried on the feet of animals, which then serve to contaminate any body of water they enter. The bacteria then enter through cuts, bruises, or puncture wounds on damaged feet of other animals. Once inside an animal's body, they multiply rapidly and serve to spread the disease. Clinical signs of "foot-rot" are most commonly seen as chronic lameness, often with swelling above the foot. "Foot-rot" can usually be effectively treated with penicillin and sulfa.

When water is suspected of causing health problems in livestock, veterinary assistance should be sought to determine the actual disease. Laboratory diagnostic examination of animals as well as the water supply may be necessary to evaluate the problem. Temporarily changing to a known safe water supply is a useful test to

determine whether the health problems can be solved.

| Water is too often blamed for production or disease problems |
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Thus, the importance of an accurate diagnosis must be emphasized.

Tables 1 through 4 in this guide show the recommended limits of certain pollutants and other substances commonly found in water used for livestock and poultry.

| **Note**<br>These tables should not be used as diagnostic indicators of health problems in livestock |
|---|

Toxicity from a specific mineral or compound depends on its concentration and on relative levels of other components with which it interacts.

# Common water contaminants

The U.S. Environmental Protection Agency recommends that livestock water contain less than 5,000 coliform organisms per 100 milliliters; fecal coliform should be near zero. Alkalinity is expressed either as a pH or as titratable alkalinity in the form of bicarbonates. A pH of 7 is neutral; a pH between 7.0 and 8.0 is mildly alkaline; and a pH of 10 is highly alkaline. Excessive alkalinity can cause physiological and digestive upsets in livestock. Desired and potential problem levels of some common pollutants in livestock water supplies are listed in Table 1. Table 2 shows the safe *upper limits* for several substances that may be contained in livestock water.

# Mineralized (salty) water

Residents in a large portion of the state of Missouri southeast of an irregular line running from approximately the Bowling Green region to the Nevada region are fortunate to have good quality groundwater generally available within a few hundred feet of the surface in sufficient quantity for large livestock and poultry operations. Unfortunately, northwest of this line, the water from deep, high-yield aquifers is usually too highly mineralized to be used for watering livestock. This area commonly depends on surface water supplies for farms and public uses. The saltiness of water is commonly measured by *total dissolved solids,* which is approximated by the electrical conductance of the water. The mineralized water in northwest Missouri commonly ranges from 2,000 to 10,000 ppm and as high as 30,000 ppm in total dissolved solids (TDS). Chlorides and sulfates are the main mineral constituents. Chlorides range from calcium to sodium chloride (common salt). Sulfates include calcium, magnesium (Epsom salt) and sodium salts. The Missouri Department of Natural Resources, Division of Geology and Land Survey, 573-368-2190, at Rolla can provide guidance on the quantity and quality of groundwater that can be expected at various locations and depths. Table 3 lists the effect of various levels of salinity in drinking water on livestock and poultry.

# Nitrate levels

Nitrates are soluble and move with percolating or runoff water. Therefore, ponds with runoff from heavily fertilized or manured fields and water from poorly cased, shallow wells may contain nitrates. Water from deep wells is usually nitrate free.

Nitrogen in the form of nitrate is not especially toxic, but when reduced in the rumen to nitrite and absorbed into the blood, nitrite reduces the oxygen-carrying capacity of the blood by reacting with hemoglobin.

Ruminants have an ability to convert some nitrate to usable products. However, the rumen microbes in cattle and sheep can readily reduce nitrate to the toxic nitrite form. The total amount of nitrates in the diet is important and subject to change with growing conditions of harvested and pastured forage. For example, during a drought, corn silage may accumulate high concentrations of nitrate and when added to the nitrate present in water may result in a lethal combination. The ensiling process will reduce the nitrate level to acceptable levels after a period of aging for 60 to 90 days in the silo. Unlike other simple-stomached animals such as swine, horses do have a cecum containing microbes capable of converting nitrate to the more toxic nitrite form. The extent and rapidity of this chemical conversion in horses is insufficient to make them as susceptible as ruminants. Fortunately, the preformed nitrite is rarely encountered in sufficient concentrations in water and feed to be a toxic threat. Table 4 provides a guide to the use of water containing nitrates for livestock.

**Table 1**
Desired and potential levels of pollutants in livestock water supplies.

| Substance | Desired range | Problem range |
|---|---|---|
| Total bacteria per 100 milliliters | <200 | >1,000,000 |
| Fecal coliform per 100 milliliters | <1 | >1 for young animals<br>>10 for older animals |
| Fecal strep per 100 milliliters | <1 | >3 for young animals<br>>30 for older animals |
| pH | 6.8 to 7.5 | <5.5 or >8.5 |
| Dissolved solids, milligrams per liter | <500 | >3,000 |
| Total alkalinity, milligrams per liter | <400 | >5,000 |
| Sulfate, milligrams per liter | <250 | >2,000 |
| Phosphate, milligrams per liter | <1 | not established |
| Turbidity, Jackson units | <30 | not established |

**Source**
**From the Agricultural Waste Management Field Handbook, page 1 to 16. Based on research literature and field experience in the northeastern United States.**

**Note**
1 milligram per liter (mg per L) is approximately equal to 1 part per million (ppm).

**Table 2**
Safe upper limits for several substances that may be contained in water for livestock and poultry.

| Substance | Safe upper limit of concentration |
|---|---|
| Aluminum (Al) | 5 ppm |
| Arsenic (As) | 0.2 ppm |
| Boron (B) | 5 ppm |
| Cadmium (Cd) | 0.05 ppm |
| Chromium (Cr) | 1 ppm |
| Cobalt (Co) | 1 ppm |

| | |
|---|---|
| Copper (Cu) | 0.5 ppm |
| Fluoride (F) | 2 ppm |
| Lead (Pb) | 0.05 ppm |
| Mercury (Hg) | 0.01 ppm |
| Nitrate + Nitrite | 100 ppm |
| Nitrite | 10 ppm |
| Selenium (Se) | 0.05 to 0.10 ppm |
| Vanadium (V) | 0.1 ppm |
| Zinc (Zn) | 24 ppm |
| Total dissolved solids | 10,000 ppm |
| Magnesium + sodium sulfates | 5,000 ppm |
| Alkalinity (carbonate + bicarbonate) | 2,000 ppm |

**Source**
***When Is Water Good Enough for Livestock?* Montana State Extension.**

**Table 3**
Effect of salinity of drinking water on livestock and poultry (Water Quality Criteria, 1972).

| Soluble salt (mg per L) | Effect |
|---|---|
| <1,000 | Low level of salinity; present no serious burden to any class of livestock or poultry |
| 1,000 to 2,999 | Satisfactory for all classes of livestock and poultry; may cause temporary, mild diarrhea in livestock; and water droppings in poultry at higher levels; no effect on health or performance |
| 3,000 to 4,999 | Satisfactory for livestock; may cause temporary diarrhea or be refused by animals no accustomed to it; poor water for poultry causing watery feces and, at high levels, increased mortality and decreased growth (especially in turkeys). |
| 5,000 to 6,999 | Reasonable safety for dairy and beef cattle, sheep, swine, and horses; avoid use for pregnant or lactating animals; not acceptable for poultry, causes decreased growth and production or increased mortality. |
| 7,000 to 10,000 | Unfit for poultry and swine; risk in using for pregnant or lactating cows, horses, sheep, the young of these species, or animals subjected to heavy heat stress or water loss; use should be avoided, although older ruminants, horses, poultry, and swine may subsist for long periods under conditions of low stress. |
| >10,000 | Risks are great; cannot be recommended for use under any conditions. |

**Source**
**Agricultural Waste Management Field Handbook, page 1 to 17.**

**Table 4**
Guide to use of waters containing nitrates for livestock.

| Nitrate content* as parts per million (ppm) of nitrate nitrogen ($NO_3$-N)** | Comments |
|---|---|
| Less than 100 | Experimental evidence indicates this water should not harm livestock or poultry. |

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|---|---|
| 100 to 300 | This water by itself should not harm livestock or poultry. If hays or silages contain high levels of nitrate this water may contribute significantly to a nitrate problem in cattle, sheep, or horses. |
| More than 300 | This water could cause typical nitrate poisoning in cattle, sheep, or horses, and its use for these animals is not recommended. Because this level of nitrate contributes to the salts content in a significant amount, use of this water for swine or poultry should be avoided. |

**Source**
**Water Quality for Livestock and Poultry, FO-1864-GO. University of Minnesota Extension Division, 1990.**

*** The values shown include nitrate and nitrite nitrogen. In no case should the waters contain more than 50 ppm nitrite nitrogen (NO2N) because of the greater toxicity of the nitrite form.**
****1 ppm of nitrate nitrogen is equivalent to 4.4 ppm of nitrate (NO3).**

**Note**
The maximum level of nitrate as N in water for human consumption (as set by the US EPA) is 10 milligrams per liter.

# Achieving quality water

To achieve high-quality surface water, fence livestock out of the pond or stream and pipe the water to a tank or other waterer. To obtain the best water from a pond, provide a grassed watershed where no chemicals or manure are applied and float a screened pipe intake about 2 feet below the surface. Water can be pumped from a stream or, in some cases, can be piped to a tank by gravity. An alternative is to allow limited access for livestock to drink from a pond or stream. Spring water may need to be pumped to the desired waterer location, or the spring may need to be developed to provide the head necessary for gravity flow.

Well sites should be graded to drain surface water away from the well casing. Wells should be cased to comply with the Missouri Well Construction Rules. Wells should be located as far as practical from septic tanks (50 feet minimum), septic fields (100 feet minimum), chemical mixing areas (300 feet minimum), feedlots (100 feet minimum), earthen manure storage basins and lagoons (300 feet minimum), and land application areas for manure (300 feet minimum).

Under the EPA's Unified National Strategy for Animal Feeding Operations, the desired outcome is for all concentrated animal feeding operations to develop and implement a comprehensive nutrient management plan. Such a plan should address, as necessary, feed management, manure handling and storage, land application of manure, land management, record keeping, and other utilization options. In addition to nutrients, the plan should address other pollutants, such as pathogens, to minimize the effects of animal feeding operations on water quality and public health.

At a minimum, the nutrient management plan should prevent the application of nutrients at rates that will exceed the capacity of the soil and planned crop needs. Soils, crop material and manure should be tested to determine nutrient needs. Manure application equipment should be calibrated to ensure that the quantity of material being applied conforms to a plan. Records of crops removed annually and the total amount of effluent applied will allow producers to maintain the desired nutrient balance.

# Water testing

Annual water tests are recommended for private wells, especially for shallow wells, and whenever a problem is suspected. Owners of private wells can have their water tested by collecting a sample themselves or by hiring a qualified person to do so. The sample should be taken to a certified laboratory for analysis. Sample

bottles should be obtained from the testing laboratory or local health department, because containers may be especially prepared for a specific contaminant. Sampling and handling procedures depend on the water quality concern and should be followed carefully.

Water analyses typically include the following tests:

- Total coliform bacteria
- pH (acid or alkaline level)
- Total dissolved solids
- Total soluble salt
- Salinity
- Hardness
- Nitrates
- Sulfate
- Other factors such as toxicity problems with specific minerals or pesticides, or occasionally, heavy algae growth

There are no regulations governing the number of microorganisms or bacteria in water used for livestock production unless the farm is a Grade A dairy. In that case, the water must be from a supply that provides water of safe and sanitary quality with no detectable fecal coliform bacteria. Within the state of Missouri, a Grade A milk law presents well construction guidelines for Grade A dairies. Water must be tested after any repairs or modifications to the water supply system. In addition, specific requirements prohibit backsiphoning from outdoor livestock water tanks.

Normally, hard water does not interfere with livestock performance; however, hard waters can cause difficulty in washing of milking equipment and causes water heaters to "lime up." Contaminates such as iron and sand will clog pipelines. Well water with high iron content may have problems with iron bacteria forming a red, slimy mass that can clog well screens and require periodic treatment with chlorine. Some wells produce considerable amounts of sand. A sand separator should be installed at the beginning of a pipeline in such a case. Sand separators are available through suppliers of trickle irrigation equipment. Sulfur waters are corrosive and have a bad odor.

Rural water is a reliable source but may be too costly for large livestock operations. However, consider connection to the rural source as a backup supply. Backflow prevention valves shall be used to prevent contamination of the rural water supply. In most cases, rural water districts require an air gap because backflow valves are not safe enough.

# Laboratories for water quality tests at MU

Many commercial laboratories provide testing for water quality. Contact your local Natural Resources Conservation Service office or MU Extension center for a list of commercial laboratories.

The following laboratories at the MU perform water quality tests:

- **Veterinary Medical Diagnostic Laboratory**
  Toxicology Section
  573-882-6811
- **Soil and Plant Testing Laboratory**
  Department of Agronomy
  573-882-0623

# For further information


- *Agricultural Waste Management Field Handbook,* Part 651, National Engineering Handbook. Washington, D.C.: Natural Resources Conservation Department, U.S. Department of Agriculture, 1992.
- Crawford, R.J., Jr., and E. Cole. 1999. Effect of water source and quality on water intake and performance of cows and calves grazing tall fescue. Southwest Missouri Agricultural Research and Education Center 1999 Research Report, pp. 2 to 8.
- FO-1864-GO. Water Quality for Livestock and Poultry. 1990. Extension Distribution Center, University of Minnesota.
- Missouri Livestock Watering Systems Handbooks 1 and 2. 1997. USDA Natural Resources Conservation Service, Columbia, Mo.
- Water Quality for Livestock and Poultry, Guide M-112. 1995. New Mexico State Extension, Las Cruces, N.M.


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## Related MU Extension publications

- G1800, Sources for Farm and Home Water Supply http://extension.missouri.edu/publications/DisplayPub.aspx?P=G1800
- G1801, How to Size a Farm and Home Water System http://extension.missouri.edu/publications/DisplayPub.aspx?P=G1801
- G1805, A System for Pond Water Purification http://extension.missouri.edu/publications/DisplayPub.aspx?P=G1805
- MWPS14, Private Water Systems Handbook http://extension.missouri.edu/publications/DisplayPub.aspx?P=MWPS14
- MWPS6, Beef Housing and Equipment Handbook http://extension.missouri.edu/publications/DisplayPub.aspx?P=MWPS6

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