

# *Factors Which Affect Water Quality in Livestock Ponds*

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Livestock ponds are constructed in ranges and pastures to serve as reservoirs for animal drinking water. A supply of clean drinking water must be located near adequate forage to produce healthy livestock. Overgrazing near the water source will occur where water is in short supply or inadequately distributed. Conversely, undergrazing may take place where forage is abundant but water is unavailable. The volume of water required for livestock depends on the average daily consumption per animal (Table 1.), size of the herd and the duration of time in which the animals will be dependent on a particular water supply.

*Table 1. Water requirements in gallons per head per day for different types of livestock (from USDA Soil Conservation Service Agriculture Handbook Number 590)*

<i>TYPE OF LIVESTOCK</i>	<i>GALLONS PER HEAD PER DAY</i>
Beef cattle & horses	12 to 15
Dairy cows (drinking only)	15
Dairy cows (drinking & barn needs)	35
Hogs	4
Sheep	2

Most livestock ponds should be entirely fenced with gravity fed water supplied from a drainpipe to a stockwater tank. A fence prevents soil erosion and protects stabilizing vegetation on the dam, spillway and pond banks from grazing animals. Livestock exclusion will reduce the filling of the pond basin with the sediment from eroding pond banks. Water quality will improve due to reduced turbidity (or muddiness) as will the overall

Local climatic factors such as annual rainfall and the rate of evaporation will influence the volume of water the pond will be able to hold. Physical land characteristics which include soil type, seepage, watershed vegetation and topography will also influence the pond's shape, volume, depth and surface area. An approximate water volume needed for 1 year is calculated below.

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*Example: Enough water to supply 50 dairy cows and barn with water for one year.*

STEP 1: 50 cows x 35 gallons per head per day x 365 days = 638,750 gallons of water

STEP 2: Determine the amount of water in acre-feet. One acre-foot of water is one acre in surface area, which is one foot deep. 1 acre-foot = 325,850 gallons.

STEP 3: 638,750 gallons / 325,850 = 1.96 acre-feet

STEP 4: A ½ surface acre pond with an AVERAGE DEPTH (not maximum!) Of 6 feet would provide 3 acre-feet (or 977,550 gallons of water. This would allow for some water loss due to drought, evaporation and seepage.

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appearance of the pond. Construction of shallow pond areas less than 2.5 to 3 feet deep should be avoided as they provide habitat for branched and filamentous algae in addition to rooted aquatic plants. Nutrients provided from manure and fertilizer in the watershed's runoff water will fertilize the pond's vegetation. However, aquatic plants will receive these nutrients directly where livestock are allowed to wade in ponds. A pond

will “fill in” due to increased loading of organic matter from manure and decaying aquatic plants, combined with excessive bank erosion. These factors will shorten the life of a pond when compared to one which is properly maintained. A fenced pond may help discourage potential trespassers and drowning victims during summer. During the winter, livestock would not have access to ice covered ponds which can be potentially dangerous to both livestock and humans.

Where ponds are constructed on flat land, water supplied by a gravity fed stock tank may not be practical. These ponds may be fenced in a manner which allows limited livestock access to one or two drinking areas along the pond bank. Typically, the fence will extend out into the pond basin to permit access to water during the dry season, but will not allow extensive wading by large numbers of animals. In some situations, enclosing a pond with a fence is not practical due to herd size and the cost of maintenance. Fencing off the pond’s most vulnerable areas such as the dam and spillway, is practiced on some ranches located in the western United States.

Polluted livestock water may contribute to poor animal health. High concentrations of untreated sewage or manure can pollute human and livestock drinking water. Fecal coliform is composed of bacteria colonies which are excreted in animal and human waste. Experimental data (US EPA, 1981) suggests a maximum coliform count of 4,000 to 20,000 colonies per 100 ml is allowed for animal drinking water, while 1 colony per 100 ml sample is allowed for human drinking water (3 colonies/100 ml is allowed on a short term basis). Research has demonstrated the use of fecal coliform counts to determine the incidence of gastrointestinal illness among swimmers is questionable. *Escherichia coli* (found only in feces) and enterococci bacteria are believed to be largely responsible for illness among bathers. The US EPA (1986) has established the criteria of 35 and 33 enterococci per 100 ml samples for marine and freshwater, respectively (Laws 1993).

If poor quality livestock water is suspected, Sportfish populations may be difficult to sustain in livestock ponds which may be particularly

contact county extension personnel or the state water agency (Kentucky Division of Water 502-564-3410) for sampling procedures and a list of certified water testing labs. Recommended concentration limits of pesticides (for humans) and potentially toxic substances in drinking water for humans, livestock and poultry are presented in Table 2.

Livestock ponds may be constructed for combined uses such as rural fire control, irrigation, fishing and swimming. However, managing ponds for multiple uses may be difficult. Pond volume, the size of the watershed, and the duration, number and type of animals kept in the watershed, will affect nutrient run-off into the pond. When properly applied to pastures, little of the nitrogen and phosphorus contained in inorganic fertilizers is lost in runoff to the pond. Fish populations may benefit from the nutrient run-off from well managed pastures (Boyd, 1990). However, excessive nutrient loading from livestock manure and urine will create water quality problems. Aquatic plants and algae will thrive on excess nutrients and may become difficult to control. In addition to the problems caused by their physical presence, dense populations of plants and algae are usually considered unattractive in appearance. Largemouth bass may have greater difficulty preying upon bluegill in weed-filled ponds. This may result in the overpopulation of bluegill which typically stunts the individual growth of these fish. Chemical control of undesired plants and algae may be expensive and time consuming. Due to label restrictions, certain herbicides and algicides will not be legal, safe or practical to use in livestock watering ponds (see Southern Regional Aquaculture Center Publication: Aquatic Weed Management - Herbicides No. 361). Aquatic dyes may be used to improve the appearance of a livestock pond, however they may do little to control or prevent plant growth.

The color and appearance of the surface water may indicate certain natural (and some unnatural) processes which may have influenced the pond’s water quality. Some common factors affecting pond water and how they appear are listed in Table 3.

susceptible to fish kills caused by dissolved oxygen depletions. Periodic low oxygen conditions are

encouraged by abundant aquatic plant life and organic matter in the pond. Aeration or circulation devices may increase dissolved oxygen content in the water, however they may be expensive to purchase and to install at remote pond sites. Acceptable water quality standards for fish health and growth are provided in Table 4. The more common water quality variables which affect fish health and growth are marked with an asterisk (\*). The Northeastern Regional Aquaculture Center (NRAC) fact sheet, An Introduction to Water Chemistry in Freshwater Aquaculture (No. 170), provides basic information regarding the effects of water quality in fish culture.

*Table 2. Recommended Concentration Limits of Pesticides (for Human Drinking Water) and Potentially Toxic Substances in Drinking Water for Humans, Livestock and Poultry (Taraba, 1989).*

<b><i>PESTICIDE/CHEMICAL(S)</i></b>	<b><i>CONCENTRATION LIMIT IN MG/L</i></b>		
Endrin	.0002 mg/l		
Lindane	.004 mg/l		
Methoxychlor	.1 mg/l		
Toxaphene	.005 mg/l		
Chlorophenoxys	.1 mg/l		
Total trihalomethanes	.1 mg/l		
<b><i>SUBSTANCES</i></b>	<b><i>US EPA<sup>1</sup>(HUMANS)</i></b>	<b><i>NAS<sup>2, 4</sup>(ANIMAL)</i></b>	<b><i>CAST<sup>3, 4</sup>(ANIMAL)</i></b>
Arsenic	0.05 mg/l	0.2 mg/l	0.5 mg/l
Barium	1.0 mg/l	-----	-----
Boron	-----	-----	5.0 mg/l
Cadmium	0.01 mg/l	0.05 mg/l	0.5 mg/l
Chromium	0.05 mg/l	1.0 mg/l	5.0 mg/l
Cobalt	-----	1.0 mg/l	1.0 mg/l
Copper	-----	0.5 mg/l	0.5 mg/l
Cyanide	0.20 mg/l	-----	-----
Fluoride	1.4 mg/l	2.0 mg/l	3.0 mg/l
Lead	0.05 mg/l	0.1 mg/l	0.1 mg/l
Mercury	0.002 mg/l	0.01 mg/l	0.01 mg/l
Nickel	-----	1.0 mg/l	-----
Nitrate as N	10 mg/l	100 mg/l	300 mg/l

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Nitrite as N	-----	10 mg/l	10 mg/l
Salinity	-----	3000 <sup>5</sup> mg/l	-----
Sulfate	250 <sup>6</sup> mg/l	-----	-----
Vanadium	-----	0.1 mg/l	1.0 mg/l
Zinc	-----	25.0 mg/l	25.0 mg/l

<sup>1</sup> US Environmental Protection Agency (1981)

<sup>2</sup> National Academy of Sciences (1974)

<sup>3</sup> Council for Agricultural Science and Technology (1974)

<sup>4</sup> Use concentrations as a guideline. Contact an Animal Extension Specialist for recommendations of concentrations exceed these amounts.

<sup>5</sup> Concentrations as high as 10,000 mg/l for cattle

<sup>6</sup> Less sensitive individuals can adjust to amounts as high as 1000 mg/l or more without laxative effects.

*Table 3. Common Occurrences and Possible Causes that Affect the Appearance of Pond Water.*

<b><i>APPEARANCE</i></b>	<b><i>POSSIBLE CAUSE</i></b>
Red, often with a surface film	Euglena “bloom” - microscopic algae (phyto or plant-plankton) which are common in livestock ponds and tanks, birdbaths and puddles, especially during summer
Red or orange masses on pond bottom	Tubificid or sludgeworms - often associated with cold waters which contain animal or fish wastes. Often seen in trout hatchery water retention ponds
Dark green	Typical color of microscopic algae or phytoplankton bloom. If water transparency is less than 18 inches in depth, the bloom is considered dense. This is usually caused by abundant water fertility of nitrogen and phosphorus.
Bright green, often with a surface film	Caused by blue-green algae - common in fish culture and some livestock ponds. Often associated with abundant external nutrient loading, some of these algae contain chemicals responsible for off-flavor in intensively cultured fishes.
Bright blue or clear	Infertile waters which are very transparent. Often these waters have low pH (4.0 - 5.5) and total alkalinity (10 mg/l or less), or have limited sources of nutrients.
Blue-green, or sky blue	Aquatic dyes - typically used on ornamental ponds on golf courses, fountains, and water gardens. Made of inert dyes similar to food coloring, these dyes are added to improve the appearance of the water and may help control establishment of aquatic plants in some instances.
Muddy brown	Turbidity - often caused by erosion of pond banks in windy weather or runoff from disturbed soils in the watershed. Often a problem in new ponds or livestock ponds, as some clay particles are too small to settle, or settle slowly.
Brown (tea color) or black water	1) Waters stained by tannic acid which has leached from the leaves of trees. This is common in streams and ponds where hardwood tree leaves fall into the water. Though stained, the water is usually quite transparent. 2) May indicate a dense bloom of microscopic animals (zooplankton) in a fertilized pond.

<b>APPEARANCE</b>	<b>POSSIBLE CAUSE</b>
Oil-like surface film	1) Most often associated with an algal bloom die-off or other decaying organic matter. 2) May indicate a petroleum product has been spilled into the water.
Surface foam or scum	The result of foam fractionation or protein skimming. This is caused by dissolved and fine suspended particles clinging to air bubbles which are formed at the air/water interface when the water surface is disturbed.
Rapid change from green to blue or clear	1) the result of an algal bloom die-off which may occur naturally over a three or four week period. 2) May be the result of extended periods of cloudy weather which can cause dissolved oxygen depletions and associated algal bloom die-offs. 3) May indicate the presence of a herbicide or algicide.
Rapid change from green to brown or black	Can be caused by a hard rain or a drop in water temperature which can cause water mixing or a "pond turnover." Generally, this is most noticeable in ponds which are deep and more than a few years old.

Table 4. Water Quality Standards for Fish Culture (Meade, 1989)

*Alkalinity (as CaCO <sub>3</sub> )	10-400 mg/l	Aluminum (Al)	<0.01 mg/l
* Ammonia (NH <sub>3</sub> )	<0.02 mg/l	Arsenic (As)	<0.05 mg/l
Barium (Ba)	5.0 mg/l	Cadmium	
		Alkalinity <100 mg/l	0.0005 mg/l
		Alkalinity > 100 mg/l	0.005 mg/l
Calcium (Ca)	4-160 mg/l	Carbon dioxide (CO <sub>2</sub> )	0-10 mg/l
Chlorine (Cl)	<0.003 mg/l	Chromium (Cr)	0.03 mg/l
Copper		* Dissolved Oxygen (Do)	5 mg/l to saturation
Alkalinity <100 mg/l	0.006 mg/l		
Alkalinity >100 mg/l	0.03 mg/l		
*Hardness, total	10-400 mg/l	Hydrogen cyanide (HCN)	<0.005 mg/l
Hydrogen sulfide (H <sub>2</sub> S)	<0.003 mg/l	Iron (Fe)	0.1 mg/l
Lead (Pb)	<0.02 mg/l	Magnesium (Mg)	<15mg/l
Manganese (Mn)	<0.01 mg/l	Mercury (Hg)	0.2 mg/l
Nitrogen (N)	<100% total gas pressure, <103% as nitrogen gas	Nitrate (NO <sub>3</sub> )	0-3.0 mg/l
*Nitrite (NO <sub>2</sub> )	0.1 mg/l in soft water	Nickel (Ni)	<0.1 mg/l
PCB (polychlorinated biphenyls)	0.002 mg/l	*pH	6.5-8.0
Potassium (K)	<5.0 mg/l	Salinity	<5%
Selenium (Se)	<0.01 mg/l	Silver (Ag)	<0.003 mg/l
Sodium (Na)	75 mg/l	Sulfate (SO <sub>4</sub> )	<50.0 mg/l
Sulfur (S)	<1.0 mg/l	Total dissolved solids	<400 mg/l

*Alkalinity (as CaCO <sub>3</sub> )	10-400 mg/l	Aluminum (Al)	<0.01 mg/l
		(TDS)	
Total suspended solids (TSS)	<80 mg/l	Uranium (U)	<0.1 mg/l
Vanadium (V)	<0.1 mg/l	Zinc (Zn)	<0.005 mg/l
Zirconium	<0.01 mg/l		

\* denotes most common water quality characteristics which will influence fish health and growth

For additional assistance regarding the planning, construction, and management of livestock ponds, contact the county offices of the Cooperative Agricultural Extension Service or the Natural Resources Conservation Services (formerly the Soil Conservation Service).

## REFERENCES

Anonymous, 1982. Ponds - Planning, Design, Construction, Agriculture Handbook Number 590. United States Department of Agriculture, Soil Conservation Service.

Boyd, C. E. 1990. Water Quality in Ponds for Aquaculture. Alabama Agricultural Experiment Station, Auburn University, Alabama 36849.

Buttner, J.K., R.W. Soderburg and D.E. Terlizzi, 1993. An Introduction to Water Chemistry in Freshwater Aquaculture, Fact Sheet No. 170. Northeastern Regional Aquaculture Center, University of Massachusetts Dartmouth, North Dartmouth, Massachusetts 02747.

Laws, E.A. 1993. Aquatic Pollution: An Introductory Text, second edition. John Wiley & Sons, Inc., New York.

Meade, J.W. 1989. Aquaculture Management. An AVI Book. Published by Van Nostrand Reinhold, New York.

Murphy, T.R. and J.L. Shelton 1989. Aquatic Weed Management: Herbicide, Fact Sheet No. 361. Southern Regional Aquaculture Center, Kentucky State University, Frankfort, KY 40601.

Taraba, J.L. 1989. Water Supply Quality and Testing, Fact Sheet AEN-55. University of Kentucky, Department of Agricultural Engineering.