

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

BUREAU OF WATER

# WATER QUALITY STANDARDS WHITE PAPER

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TEMPERATURE CRITERIA FOR AQUATIC LIFE  
USE



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# TEMPERATURE CRITERIA FOR AQUATIC LIFE USE

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## ISSUE

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### Should Kansas modify temperature criteria for aquatic life use?

It is the mission of the Kansas Department of Health and Environment (KDHE) to protect the health and environment of all Kansans by promoting responsible choices. One facet of this mission is the setting of water quality standards based on the best science available.

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## CURRENT CRITERIA

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### ▪ Aquatic Life Use

- KAR 28-16-28e(c)(2)(C)(i) - *Heat of artificial origin shall not be added to a surface water in excess of the amount that will raise the temperature of the water beyond the mixing zone more than 3° C above natural conditions. Additionally, a discharge to a receiving water shall not lower the temperature of the water beyond the mixing zone more than 3° C below natural conditions. The normal daily and seasonal temperature variations occurring within a surface water before the addition of heated or cooled water of artificial origin shall be maintained.*
- KAR 28-16-28e(c)(2)(C)(ii) - *Temperature criteria applicable to industrial cooling water recycling reservoirs that meet the requirements for classification specified in K.A.R. 28-16-28d(a)(2) shall be established by the secretary on a case-by-case basis to protect the public health, safety, or the environment.*
- Kansas Surface Water Quality Standards – Tables of Numeric Criteria

Table 1g. Temperature, Dissolved Oxygen, And pH Numeric Aquatic Life Criteria.

AQUATIC LIFE USE	DISSOLVED OXYGEN (DO)	PH	TEMPERATURE
SPECIAL	5.0 mg/L <sup>a</sup>	6.5-8.5 <sup>b</sup>	32°C <sup>c</sup>
EXPECTED	5.0 mg/L <sup>a</sup>	6.5-8.5 <sup>b</sup>	32°C <sup>c</sup>
RESTRICTED	5.0 mg/L <sup>a</sup>	6.5-8.5 <sup>b</sup>	32°C <sup>c</sup>

a - The concentration of dissolved oxygen in surface waters shall not be lowered by the influence of artificial sources of pollution.

b - pH range outside the zone of initial dilution.

c - Beyond the zone of initial dilution a discharge shall not elevate the temperature of a receiving surface water above this temperature, except as provided in paragraph (c)(2)(E)(ii).

Note: 32°C is approximately 90°F.

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## BACKGROUND

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Most aquatic organisms are cold-blooded. Their metabolism and ability to survive and reproduce are dependent on the temperature of the water. Natural fluctuation that occurs daily or seasonally affects the aquatic community structure and the geographic distribution of species. Natural seasonal temperature changes are also crucial to the reproductive cycles of many aquatic organisms.

Artificial heat or cooling sources such as cooling water can alter the existing aquatic communities depending on the severity and duration of the exposure. Organisms subjected to stress from toxic materials are less tolerant of temperature extremes. In open waters, elevated temperatures may affect periphyton (algae and other organisms attached to submerged surfaces), benthic invertebrates such as clams and worms, and fish, in addition to causing shifts in algal dominance. EPA's Quality Criteria for Water (1976 & 1986) suggested that the upper tolerance limit for a balanced benthic population structure is approximately 32°C.

EPA recommends freshwater aquatic life criteria for temperature be expressed as maximum and mean limits in the 1976 and 1986 guidance documents "Quality Criteria for Waters". The maximum limit, similar to an acute criterion<sup>1</sup>, is to provide protection against lethal conditions for all life stages. The mean limit, similar to a chronic criterion<sup>2</sup>, is to provide protection for normal functions and reproductivity for aquatic organisms.

The current Kansas Surface Water Quality Standards (KSWQS) state that the maximum temperature allowed outside the zone of initial dilution<sup>3</sup> (ZID) is 32°C (90°F). This maximum limit is designed for warm-water fish species. It is appropriate for Kansas since cool-water fish species are very limited in Kansas and cold-water fish species such as rainbow trout are not native in the state and can not survive year-round in Kansas waters.

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<sup>1</sup> Criteria to protect aquatic life from severe biological harm or death caused by short-term exposure or a single dose to toxic substances. The acute aquatic life criteria may only be legally exceeded in the zone of initial dilution of a discharge in a waterbody.

<sup>2</sup> Criteria to protect aquatic life from long-term adverse health effects. The chronic aquatic life criteria may be legally exceeded in the mixing zone and zone of initial dilution of a discharge in a waterbody.

<sup>3</sup> The region of a surface water in the immediate vicinity of a discharge where acute and chronic criteria may be exceeded. The ZID is normally 10% of the mixing zone.

KSWQS also state the changes allowed to the temperature of a waterbody by artificial sources outside the mixing zones<sup>4</sup> are less than or equal to 3°C (approx 5°F). EPA’s contemporary guidance documents recommend the allowable change criteria to include separate temperature change limitations for streams and lakes. Two sets of criteria are preferred because of differences in assimilative capacities as well as aquatic ecosystems between streams and lakes. Streams are likely to have much smaller volumes of water than lakes and thus less assimilative capacities for heat sources.

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**SELECTED AVAILABLE DATA**

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The 1977 EPA guidance document “Temperature Criteria for Freshwater Fish” states that “a 5°F (2.8°C) rise in temperature could only be acceptable under low flow conditions for a particular month and any increase in flow could result in a reduced increment of temperature rise since the amount of heat added could not be increased”. The document also recommends that “For lakes and reservoirs, the temperature rise limitation was 3°F (1.7°C) based on the monthly average of the maximum daily temperature”.

The three states in EPA Region 7 (Nebraska, Missouri, and Iowa) all have separate limits for allowable changes in streams and lakes. The table below is a summary of the temperature criteria in these three states.

	<b>Nebraska</b>	<b>Iowa</b>	<b>Missouri</b>
<b>Maximum Limits</b>	Warm-water 90°F/32°C Cold-water 72°F/22°C	Cold-water 20°C Lakes and most streams 32°C	Warm-water 90°F (32 2/9 °C); Cool-water 84°F (28 8/9 °C); Cold-water 68°F (20°C)
<b>Allowable Changes in Streams</b>	Increase ≤ 5°F/3°C	Increase ≤ 3°C or ≤ 2°C for cold-water; Rate of change ≤ 1°C/hr	Increase ≤ 5°F (2 7/9 °C) or ≤ 2°F (1 1/9 °C) for cold-water
<b>Allowable Changes in Lakes</b>	Increase ≤ 3°F/2°C for epilimnion	Increase ≤ 2°C; Rate of change ≤ 1°C/hr	No measureable rise allowed; w/ exception for 3 lakes (to meet stream limits)
<b>Special Zones</b>	Parts of Missouri River max 85°F/29°C and increase ≤ 4°F/2°C	Monthly limits for Mississippi River	Monthly limits for Mississippi River

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<sup>4</sup> The designated portion of a stream or lake where a discharge is incompletely mixed with the receiving surface water. Concentrations of certain pollutants may legally exceed chronic water quality criteria associated with the designated uses

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## SUMMARY

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Temperature is important for the survival and reproduction of aquatic organisms. Artificial heat sources can disturb the balance and cause long lasting effects to the aquatic ecosystems depending on the intensity and duration of the exposure. EPA recommends two sets of numeric aquatic life criteria for temperature, short-term maximum limits and medium-term mean values. Many states including all four EPA Region 7 states have set limits for allowable changes of temperature in waters, which provide medium to long term protection for aquatic organisms.

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## OPTIONS

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KDHE has a few options it can consider during this review process:

- Option 1
  - Keep the current numeric criteria
  
- Option 2
  - Add a new allowable change limit for lakes of 2°C
  - Designate the current allowable change limit of 3°C for streams only

**Impact Considerations:** The option to reduce the allowable temperature increase only in lakes and reservoirs would bring Kansas criteria in line with current EPA recommendations and peer states. The reduced temperature rise would be more protective of aquatic life allowing for potentially larger and healthier populations of desired species if new sources of heat discharge are proposed for lakes or reservoirs that support recreational fishing. We see little cost associated with the lowering of the criterion. Temperature limitations in lakes and reservoirs apply almost exclusively to power generating facilities. The three significant power plants with reservoir discharges have their temperature limits measured at the dam outlets of the reservoirs and not the points of discharge. Thus, entire reservoirs would have to experience in excess of a 2°C rise in temperature to incur a permit violation. Such a situation is a virtual impossibility.

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## REFERENCES

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1. State of Iowa. Temperature Criteria in Water Quality Standards. Chapter 61.3(3). <http://www.iowadnr.gov/water/standards/temperature.html>
2. State of Missouri. Water Quality Standards. Missouri 10 CSR 20-7.031. <http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7.pdf>
3. State of Nebraska. “Standards for Water Quality”. Nebraska Administrative Code, Title 117, Chapter 4. <http://www.deq.state.ne.us/RuleAndR.nsf/pages/117-TOC>

4. U.S. Environmental Protection Agency. (1976). "Quality Criteria for Water". EPA-440/9-76-023. <http://www.epa.gov/waterscience/criteria/library/redbook.pdf>
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6. U.S. Environmental Protection Agency. (1977). "Temperature Criteria for Freshwater Fish: Protocol and Procedures". EPA-600/3-77-061.