

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

BUREAU OF WATER

# WATER QUALITY STANDARDS WHITE PAPER

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BACTERIA CRITERIA FOR STREAMS



JANUARY 10, 2011

# BACTERIA CRITERIA FOR STREAMS

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## ISSUE

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### Should Kansas change the duration and/or frequency component of its bacteria criteria?

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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K.A.R. 28-16-28e(7) (D) and (E) set *E. coli* bacteria criteria for streams designated as primary contact recreation (high probability of ingestion, such as swimming) and secondary contact recreation (low probability of ingestion, such as wading). Primary Contact waters are further subdivided into three categories: Primary A – public swimming areas; Primary B – publicly accessible streams; and Primary C – no public access. Similarly, Secondary Contact is subdivided into two categories: Secondary a – publicly accessible; and Secondary b – not publicly accessible. Current *E. coli* criteria for each of those categories are set at the following levels:

### Recreational Stream Criteria

USE	Colony Forming Units (CFUs)/100mL	
PRIMARY CONTACT RECREATION	Geometric Mean* April 1 – Oct. 31	Geometric Mean Nov. 1 – March 31
Class A	160	2358
Class B	262	2358
Class C	427	3843
SECONDARY CONTACT RECREATION	Geometric Mean Jan. 1 – Dec. 31	
Class a	2358	
Class b	3843	

*\*A geometric mean is the nth root of the product of n numbers. A geometric mean is used to determine the central tendency of group of numbers that can vary widely. Thus, the geometric mean tends to dampen the effect of very high or low values which would bias an arithmetic mean.*

For both primary and secondary contact recreation, monitoring requirements specify that at least five samples shall be collected during separate 24-hour periods within a 30-day period to assess impairment. Currently, Kansas Statute does not provide for single sample maxima criteria for streams. Single sample maxima criteria are included in regulation for lakes.

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## BACKGROUND

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Fecal bacteria have long been used as indicators for the presence of pathogens (i.e. infectious organisms) in surface waters and the risk of disease from ingestion of contaminated surface water and shellfish. Contact with contaminated water, primarily during recreation can cause gastrointestinal illness (nausea, diarrhea, and vomiting), as well as ear or skin infections. Inhalation of pathogens can cause respiratory illness. The pathogens responsible for disease in surface water can be bacteria, viruses, protozoans, fungi, or parasites (EPA, 1998).

The National Technical Advisory Committee (NATC) of the Department of Interior first proposed federal water quality guidelines for microbiological criteria in 1968. The NATC's criterion was based on studies done by the U.S. Public Health Services in the 1940's and 1950's. The studies were conducted at bathing beaches located on Lake Michigan, the Ohio River, and on Long Island Sound. The NATC concluded that fecal coliforms should be used as the indicator organisms for microbial contamination in surface waters and that primary contact recreation waters should not exceed a log mean (i.e. geometric mean) of 200 colony-forming units (CFUs) per 100 milliliters of water (EPA, 1986).

After issuing their recommendations for bacteria limits, the NATC was criticized over the validity of their data. However, in 1976, the EPA recommended using the NATC's data, to set water quality criteria for bacteria. Subsequently, most states adopted the EPA's recommendations of 200 CFU's/100mL for fecal coliform bacteria as their primary contact recreation standard (EPA, 1986).

The criticism towards the NATC data prompted a series of studies by the EPA from 1972 to 1980 at freshwater and marine beaches. The studies were designed to determine if a relationship existed between different bacteria concentrations and swimming related illnesses. In 1984, the EPA reported their findings in a report titled *Health Effects Criteria for Fresh Recreational Waters*. The report concluded that *swimming associated gastrointestinal illnesses* were directly linked to water quality impairments caused by sewage and that the illnesses were prevalent when concentrations of enterococci and *E. coli* were high. No such relationship with fecal coliform bacteria was found. The study also concluded that the rate of illness in swimmers was roughly the same when using either *E. coli* or enterococci as the indicator (EPA, 1984).

In 1986, the EPA came out with its guidance on *Ambient Water Quality Criteria for Bacteria* based on the findings from the *Health Effects Criteria for Fresh Recreational Waters* report and concluded that the newly recommended indicators, enterococci and *E. coli*, were superior to the fecal coliform group. The rationale was that a positive relationship existed between bacterial density and number of observed illnesses for either of these indicators, while no such relationship was observed for fecal coliform bacteria. It was suggested in the guidance that either enterococci or *E. coli* be used as fresh water indicators. The primary contact recreation criteria for enterococci of 33 CFUs/100ml and 126 CFUs /100mL for *E. coli* were recommended. These numbers were recommended based on an evaluation of a geometric mean of a minimum of five samples collected over a 30-day period, and are considered approximately equivalent to the 200 CFU's/100mL criteria for fecal coliform bacteria (EPA, 1986).

In 2003, the Kansas Legislature established tiers of recreation for classified streams, and assigned risk levels to the classes of recreation in KSA 82a-2001. The risk levels conformed to the draft EPA implementation guidance for the 1986 criteria guidance document (EPA, 2002). The law specified *E. coli* as the indicator bacteria and further specified the frequency of sampling as five samples over a duration of 30 days. The law did not provide for single sample maxima criteria for streams. Kansas regulations contain single sample maxima (SSM) criteria for lakes. Those criteria are shown in the following table:

### Recreational Lake Criteria

Recreation Use	Colony Forming Units (CFUs)/100mL			
	Geometric Mean April 1 – Oct. 31	Geometric Mean Nov. 1 – March 31	Single Sample Maximum April 1 – Oct. 31	Single Sample Maximum Nov. 1 – March 31
<b>Primary Contact</b>				
Swimming Beach	160	800	732	3655
Public Access	262	1310	1198	6580
Restricted Access	427	2135	1950	9760
<b>Secondary Contact</b>	<b>Geometric Mean Jan. 1 – Dec. 31</b>		<b>Single Sample Maximum Jan. 1 – Dec. 31</b>	
Public Access	2135		9760	
Restricted Access	2135		9760	

Single sample maxima criteria are recommended by EPA as triggers for warning recreators to practice caution or to avoid recreating. Single samples can be utilized to caution recreators within 24-hours instead of waiting a 30-day geometric mean value. Currently available DNA-based test methods can produce single sample results within 2-hours. Congress has mandated rapid test methods for coastal recreation waters. Coastal recreational waters are those waters adjacent to the U.S. coastline as well as the coastline of the Great Lakes.

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### SELECTED AVAILABLE DATA

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Subsequent to the 2003 legislation, EPA clarified the 1986 criteria document in regulations supporting the Beach Act. EPA stated the bacteria criteria sampling did not have to consist of 5 samples over a 30-day period. Due to the manner in which the criteria were developed, the length of a water’s “recreation season” would be a more scientifically appropriate duration for assessing bacteria impairment (69 FR 67218). The rationale for the extended averaging period is that the 1986 criteria were developed by plotting the number of reported swimmer illnesses for an entire recreation season against the geometric mean of all bacteria samples collected over that same recreation season (EPA, 1984). Data were available from one Oklahoma fresh water beach for one year, one Oklahoma fresh water beach for two years and two Pennsylvania fresh waters for three years each, for a total of nine data points. Those nine total data points formed the basis of a linear regression which set the bacteria criteria. A modified plot from the 1984 EPA report titled *Health Effects Criteria for Fresh Recreational Waters* is shown on the next page.

Therefore, the 1986 criteria are based on the geometric mean of all samples collected in a recreation season - typically 90-180 days. Averaging samples over a longer period gives a better picture as to the overall sanitary condition of the water. By limiting the duration to 30 days in the existing criteria, Kansas is being more stringent than required by EPA.

Because of the common misperception that the criteria apply as a single sample or a 30-day average, EPA has clarified that states can modify the frequency and duration of bacteria criteria to better match the science supported by the 1986 criteria. For states in warmer climates, an annual duration might be reasonable. In Kansas, something less than one year would be appropriate due to cooler wintertime temperatures.

If a change were to be made, however, that change would need to be via Legislative action to amend state law due to the fact recreational criteria frequency and duration are specified in KSA 82a-2001.

Additionally, EPA has required States with coastal waters to adopt single sample maxima criteria (SSM). States without coastal recreation waters are not required to adopt SSM, but adoption is recommended by EPA. The idea of the SSM is to provide for a more rapid means of notifying recreators of high levels of bacteria. EPA has acknowledged the SSM need only be used for health advisories, not for impairment decisions or NPDES permit limitations (EPA, 2006). States are allowed to use SSM for impairment or permitting purposes at their own discretion. In Kansas, the streams where an SSM would be most applicable are the Primary A and B waters – those where submersion can take place and the waters are publicly accessible.

An additional factor to take into account is EPA's stated intent to promulgate new bacteria criteria by October 2012. EPA failed to develop new bacteria criteria for coastal waters as required by the Beach Act and was sued by the Natural Resources Defense Council (NRDC) in 2006. In September 2008, EPA and NRDC settled the suit pursuant to a consent decree (NRDC v. Johnson, 2008). A portion of the settlement included EPA publishing new bacteria criteria for coastal waters by October 2012. EPA has since stated it will publish new criteria for all waters – coastal and non-coastal – which would include all of Kansas' waters. If EPA meets its deadline, and there are no further challenges of the criteria, Kansas will likely be required to adopt the new criteria by 2015. Based on preliminary information EPA has provided to stakeholders, those criteria are expected to be significantly different from the current criteria.

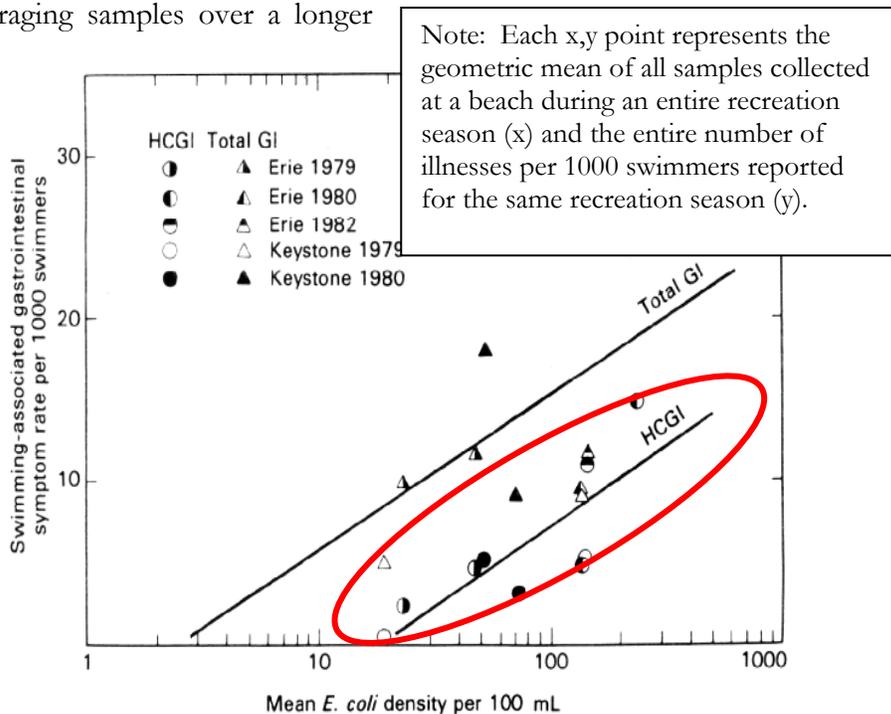


Figure 1. Estimated regression lines for highly credible and total gastrointestinal symptom rates on *E. coli* densities.

With the probable national changes to the bacteria criteria in the next 5 years, the question must be posed as to whether an interim change is worthwhile. As mentioned previously, the change would have to be made by the Legislature.

KDHE can put the idea forth as a Legislative initiative and provide support to the Legislature; however it is ultimately up to the elected officials to determine whether a change can be made. Thus, there is no guarantee that an effort to modify the frequency and duration would be successful.

The benefit of making a change in the frequency and duration component, however, would be to have criteria based on the most sound and up-to-date interpretation of the science behind the existing criteria. By having up-to-date criteria, bacteria stream impairments can be better assessed for actual impairment in the terms the criteria envisioned. It is anticipated fewer streams would be listed for impairment under the recreation season averaging scheme.

The benefit of adding single sample maxima criteria for publicly accessible primary contact streams would be to establish a trigger level for warning the public of excessive bacteria in waters that are used for primary contact recreation. The trigger would more quickly establish the sanitary condition of water as it pertains to recreation.

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## SUMMARY

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The Kansas bacteria criteria for classified streams are found in statute – KSA 82a-2001. The criteria call for sample frequency and duration of 5 samples in a 30-day period. Subsequent to the state law, EPA acknowledged their bacteria criteria guidance should not be interpreted as applying to a geometric mean of 5 samples collected over a 30-day period. The more appropriate interpretation is a geometric mean of all samples collected during the recreation season specified for a particular water. EPA also recommended that States have single sample maxima criteria for establishing health advisories for recreators. Kansas law would need to be amended to allow for changing the frequency and duration components of stream criteria or adding single sample maxima criteria.

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## OPTIONS

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### Option 1:

- Maintain the status quo for bacteria sampling frequency and duration
- Seek Legislative action to change the criteria frequency and duration components, **and/or**

### Option 2:

- Add single sample maxima criteria for publicly accessible primary contact streams (Primary A and Primary B waters).

**Impact Considerations:** Continuation of the status quo could allow some waters to remain listed as impaired due to a short-term (30-day) averaging period. The consequence of listing waters as impaired

include the implication that certain waters are polluted, thus lessening its value and potential uses that could be made of that water. Providing for a longer term averaging period would more closely mirror the EPA recommended criteria and result in fewer waters being listed as impaired.

Inclusion of single sample maximum (SSM) criteria could be used as a trigger to warn the public of potentially unsafe waters. The criterion could also be used as a basis for setting wastewater treatment plant permit limits and/or assessing waters for impairment., however EPA guidance provides states with the option of using the SSM for permitting and assessment purposes. Use of a SSM for listing purposes could result in more waters cited as impaired.

Lastly, EPA is under court order to publish new bacteria criteria by October 2012. Therefore, consideration must be made as to whether it is worth the expenditure of resources necessary to try and affect a short term change in the current criteria when they will be modified after publication of the 2012 criteria. Deferring those changes after 2012 may result in State criteria that are more ably approved by EPA and are based on solid legal footing.

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