METHODOLOGY FOR THE EVALUATION AND DEVELOPMENT OF THE 2008 SECTION 303(D) LIST OF IMPAIRED WATER BODIES FOR KANSAS

Kansas Department of Health and Environment
Watershed Planning Section/Bureau of Water/Division of Environment
February 1, 2008

Page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

*All tables referenced in the 2008 303(d) Listing Methodology are available as an Appendix to the methodology in PDF format

Page intentionally left blank

1.0 BACKGROUND

1.1 REQUIREMENTS UNDER SECTION 303(D) OF THE FEDERAL CLEAN WATER ACT

Section 303(d) of the Clean Water Act requires that States develop a list of water bodies needing additional work beyond existing controls to achieve or maintain water quality standards. This Section 303(d) list is meant to identify waters that require Total Maximum Daily Loads (TMDLs) because technology-based effluent limitations, more stringent State or local effluent limitations, and other pollution control requirements such as best management practices, are not stringent enough to implement applicable water quality standards. 40 CFR 130.7(b)(1).

A TMDL refers to the "total maximum daily load" of a pollutant that achieves compliance with a water quality standard, therefore a TMDL is essentially a regulatory tool which caps the allowable pollutant load to a water body and a planning tool which directs and guides practices that will bring a water body into compliance with the applicable water quality standard.

Under the current federal rules, States are to submit their 2008 Clean Water Act Section 303(d) lists of impaired waters, as well as the methodologies used to prepare them, by April 1, 2008. On October 12, 2006, the U.S. Environmental Protection Agency issued a guidance memorandum regarding 2008 Integrated Reporting (IR) and Listing Decisions, which builds on the 2006 guidance for preparation of the 2008 IR pursuant to sections 303(d), 305(b) and 314 of the Clean Water Act. Because of time constraints, the 2006 303(d) list submitted by Kansas was still under review by Region VII of the US EPA at the time of development of the 2008 303(d) list. The 2006 list wil be incorporated into the 2008 list and submitted April 1, 2008.

1.2 WATER QUALITY STANDARDS (STATE OF KANSAS)

Kansas surface water quality standards create the 'yardstick' by which water bodies are measured against. Kansas surface water quality standards are defined by:

1) designating beneficial uses of the water as contained in K.A.R. 26-16-28d;
2) setting criteria necessary to protect the beneficial uses, contained in K.S.A. 28-16-28c; and
3) establishing an antidegradation policy, contained in K.A.R. 28-16-28c(a).

Beneficial uses of waters in Kansas include aquatic life, domestic water supply, food procurement, groundwater recharge, industrial water supply, irrigation, livestock watering and recreation. In general, most pollutants impair aquatic life, recreation, domestic water supply and food procurement.

1.3 DESCRIPTION OF 303(D) LIST PURPOSE AND LINKAGE TO 305(B) WATER QUALITY REPORT

The generation of this 303(d) List is an essential planning and guidance tool for the state. The Kansas 2008 303(d) list not only identifies those water bodies from the 2004 303(d) list which still require TMDLs, but also determines those new water bodies and pollutants for which TMDLs will be needed. Water bodies are assigned a priority for TMDL development by assessing the

frequency, magnitude and duration of impairment by a pollutant, as well as considering public comment.
2008 represents the first year of integrating the 305(b) report and the 303(d) list in a single report. Nonetheless, fundamental differences remain for the two assessment procedures. The 305(b) report, although based on similar assessment procedures as the 303(d) list, provides an assessment or measure of *all* waters in the state through existing ambient networks and probabilistic monitoring. The 305(b) report provides an overall picture of the water quality and recent status of support for the designated uses of waters within a state.

In contrast, although the 303(d) list relies on the 305(b) assessments in initially identifying impaired water bodies within the state, the assessment procedures used for 303(d) listing, by necessity, are more intensive. The 303(d) list is a subgroup of all surface waters in the state; i.e., those water bodies not meeting one or more water quality standards because of pollutants and needing a TMDL. Because of the associated cost to the state in developing and implementing TMDLs, the state must determine the extent a water body is impaired and its relative severity among other water bodies with some degree of confidence. Hence the need for more vigorous assessment prior to listing a water body as impaired.

1.4 RELATIONSHIP OF 2008 KANSAS 303(D) LIST TO 2006 SUBMITTED 303(D) LIST

Kansas submitted its 2006 303(d) list to EPA on December 26, 2006. Because of delays in review and reconciling changes in categorizing certain waters from the 2004 303(d) list, Region VII has requested Kansas to consolidate its 2006 and 2008 lists into a single submittal on April 1, 2008. This consolidation will facilitate tracking of waters through EPA's Assessment Database (ADB) as well as lead to an expedited review of the list, in conformance with EPA Headquarters goal of timely submissions and approvals in 2008. Therefore, the 2008 303(d) list will indicate changes in category for waters listed on the 2004 303(d) list.

1.5 RELATIONSHIP OF KANSAS 303(D) LIST TO 2006 & 2008 INTEGRATED REPORT GUIDANCE

In as much as practicable, the Kansas 2008 303(d) list will be developed and submitted to the EPA in accordance with the July 29, 2005 and October 12, 2006 guidance. The list viewed for public review includes those waters identified in the 2008 Guidance as "Category 5"; those waters requiring development of a TMDL because of impairment by a pollutant. However, the public list will also list Category 2 waters that represent waters delisted from the 2004 303(d) list and Category 3 waters requiring additional information in order to make listing decisions for future 303(d) lists. Waters that now have a TMDL because of impairments identified from the 1998, 2002 and 2004 lists are identified for the public as are any Category 4B waters that have addressed their impairment by other means than a TMDL. Definitions of the five Categories for waters provided by the guidance from EPA and Kansas' interpretation on using those Categories is provided in **Table 1**.

2.0 ASSESSMENT UNIT DEVELOPMENT

2.1 DESCRIPTION OF KANSAS AMBIENT SURFACE QUALITY NETWORK

Kansas has an extensive water quality monitoring network consisting of 317 active ambient stream chemistry monitoring sites spanning all the major river basins. Of these, there are 165 core sites visited on a bimonthly basis every year, whereas the remaining 152 sites are monitored using a four-year rotational approach. The biological network of monitoring sites includes 180 monitoring sites. Of these, samples are obtained from 60-65 sites each year, including 45 core stations and 15-20 rotational stations sampled three consecutive years per rotation. Fish tissue samples normally are obtained each year from 15-20 water bodies across the state, which includes nine long-term monitoring sites. Water quality information currently is obtained from 121 lakes and wetlands, which includes all 24 federal reservoirs, most state-administered fishing lakes, various other state, county or locally owned lakes, several privately owned but publicly accessible lakes, and seven state or federally owned marshes. Probabilistic stream monitoring of random sites across the state began in 2006 with approximately 50 sites which were sampled four times for chemistry and once for biology that year. Approximately another 50 sites were sampled in 2007. The results from the probabilistic monitoring comprise the findings of the 305(b) assessment report regarding stream water quality. The monitoring networks are illustrated in Figures 1 - 5.

2.2 DELINEATION ASSESSMENT UNITS (CONTRIBUTING AREAS TO MONITORING SITES)

Of the Kansas Department of Health and Environment's (KDHE) 317 ambient stream chemistry monitoring sites, 165 are fixed (permanent) sites sampled bi-monthly every year, and 152 are rotational sites samples bimonthly every four years. Assessment units (AU) were defined within the state by delineating the unique contributing area to each monitoring site. Groupings at the HUC 14 level were used as the basis for unique contributing areas to these monitoring sites. Once grouped by HUC 14, additional alterations to the boundaries were made using a digital elevation map (DEM) to create unique boundaries for each monitored area. This process ensures that no area has more than one monitoring station with it and that each AU boundary typically includes only tributary segments upstream of the monitoring station. The stream segments of the 2007 Kansas Surface Water Register (KSWR) were placed into each AU and a unique watershed name was assigned to each based on the main stem of each AU. The KSWR was also merged to the National Hydrography Dataset (NHD) and this merge can be used as a translator from the AU stream routing structure in KSWR to a routing structure in NHD.

316 stream AUs were created from the 317 ambient stream chemistry monitoring sites. The discrepancy between the number of monitoring sites and AUs is because one monitoring station is located in Missouri, and monitors a watershed completely contained within Missouri.

The 25 largest lakes and the largest wetland by surface area of the 121 monitored lakes and wetlands were also delineated in the same method, complimenting the existing stream AUs previously created. The establishment of these lake AUs creates unique contributing areas to the larger reservoirs in Kansas. The remainder of the monitored lakes and wetlands are identified

simply as water bodies without a defined contributing area and have been identified as to which AU they are located within.

Generally, biological and fish tissue collection sites are located near a stream or lake monitoring site, so a best match for these sites were found from the existing AUs.

Based upon the combined area of all defined AUs within the state, almost 97% of the contributing areas of Kansas are monitored by the KDHE water quality monitoring program.

2.3 MAP AND TABLE FORMATS USED IN DESCRIPTION OF ASSESSMENT UNITS

For TMDL planning purposes, visual clarity and to make the public participation process consistent with the current state water planning process, the state was divided into 12 river basins. Maps locating the AUs and monitoring sites were created for each of these 12 river basins. Tables of the registered streams in each assessment unit or in the case of a lake AU, streams and the lake itself, are available for each of the 12 river basins from the Watershed Planning Section.

3.0 DATA CONSIDERATIONS FOR 2008 LIST

3.1 APPLICATION OF 2004 303(D) LIST

Certain impairments listed in the 2004 303(d) list will be evaluated for delisting during the generation of the 2008 303(d) list. Section 5.4 and 6.5 describes the assessment method for delisting decisions. Error corrections to the 2004 list will be made as set forth in Section 3.2.

3.2 2004 303(D) LIST - ERROR CORRECTIONS

Errors in the 2004 303(d) list will be corrected in the 2008 list. Examples of these corrections to the 2004 list are typographical list errors and water bodies that were never impaired but certain flaws in the original analysis led to the waters being listed.

3.3 2008 305(B) WATER QUALITY REPORT USE

Because of the relatively small number of sample points from the individual biological, lakes/wetlands and fish tissue network monitoring sites through time, the information and best professional judgment used to generate the assessment of these three sections of the 2008 305(b)

report will be the primary basis for any associated listings in the 2008 303(d) list. The stream chemistry monitoring network sites have a larger number of samples for each monitoring site. This will allow a more intensive statistical assessment of impairment for these sites for inclusion in the 2008 303(d) list.

3.4 SPATIAL APPLICABILITY OF DATA

AUs have been defined based on contributing areas to ambient stream monitoring and lake stations. If an impairment is determined at a monitoring point, the stream segment or lake/wetland associated with that monitoring point will be listed. In the case of a stream AU, this will always be the main stem of the system within the AU and in the case of a lake/wetland AU, it will always be the lake/wetland. If the lake/wetland AU is defined as just that water body, then reference to potential contributors in the appendix will not be made.

3.5 USE OF DATA (CHEMICAL, BIOLOGICAL, INTERNAL, EXTERNAL)

As required by Section 303(d) of the Clean Water Act and 40 CFR 130.7(b)(5), KDHE will compile and consider "all existing and readily available water quality related data and information" in identifying waters to be listed. Existing and readily available data and information includes, but is not limited to:

- 2004 303(d) List;
- 2008 305(b) Report's waters that are not meeting a designated beneficial use;
- Clean Water Act 319 nonpoint source and Watershed Restoration and Protection Strategy assessments,
- Drinking water source water assessment under Section 1453 of the Safe Drinking Water Act;
- KDHE fish consumption advisories,
- Data, information, and water quality problems reported from local, State, or Federal agencies (especially USGS water quality studies), Tribal governments, the public, and academic institutions.

As stated earlier, KDHE operates an extensive water quality monitoring network throughout Kansas and believes it is important that the decision to list a water body be based upon credible evidence. KDHE encourages the submittal of additional data and information from the general public during the list development and public comment period. Data and information can be in the form of analytical results, numeric data or information or narrative/qualitative submittals. When such information is submitted, the observation date, location(s), quality assurance methods and other pertinent information should also be provided. Other pertinent information includes the rationale supporting the observation being considered outside the normal range of conditions. If not

verifiable, narrative and qualitative submittals may not be used in the 303(d) process. However, such information will be considered in the planning of future monitoring activities by KDHE.

In order to solicit available data from other entities, KDHE has published public notice in the Kansas Register on February 7, 14 and 21, 2008 to request data from various agencies and the public at the public hearings (February 20, 2008 in Hays and February 26 in Topeka) prior to submission of the 2008 303(d) list and will accept such data through March 7, 2008.

4.0 STREAM CHEMISTRY METHODOLOGY

4.1 SAMPLE SIZE REQUIREMENTS – STREAM CHEMISTRY

In most cases, a minimum of 12 samples will be required to make a determination of impairment for ambient stream chemistry monitoring sites and their associated AUs. An exception to the minimum sample size requirement would be the case where a sufficient number (3) of criterion excursions to list an AU as impaired have occurred prior to the collection of all 12 samples. In this case, regardless of the result of the remaining samples required to meet the minimum sample size, the assessment will always determine impairment once the sample size requirement is met. Similarly, data from the probabilistic stream monitoring network will indicate impairment if three or more criteria excursions are recorded.

4.1.1 TEMPORAL BOUNDS OF DATA – STREAM CHEMISTRY

In an effort to meet the sample size requirements in 4.1, data collected from January 1998, through December 2007, will be used for fixed stream chemistry sites or their associated AUs. Data collected from 1990 through December 2007, will be used for rotational chemistry sites or their associated AUs in the assessment of stream chemistry impairment.

4.2 DESIGNATED USE APPLICATIONS – STREAM CHEMISTRY

Where possible, the water quality for use support of all monitored waters will be evaluated for potential inclusion on the 2008 303(d) List. The designated uses of these waters will determine the level of assessment necessary to evaluate impairment. For a complete list of criteria in conjunction with designated uses see K.A.R. 28-16-28e(d) table 1a.

The assessment levels of the designated uses are generally tailored after those suggested in EPA's *Guidelines for the Preparation of the Comprehensive State Water Quality Assessments and 305(b) Reports and Updates: Supplement*, where impairment is defined as excursion rates greater than 10 percent.

4.2.1 AQUATIC LIFE CONSIDERATIONS

Kansas has two categories of aquatic life support. All parameter standards associated with the *chronic* category of aquatic life support will have an assessment level by percent excursion of:

Not impaired: < 10% as determined by the binomial test (see section 4.3)
Impaired >10%, failing the binomial test (see section 4.3)

The standards associated with the *acute* category will have a dual assessment level depending on the type of sampling site.

Fixed stream chemistry sites (using10 continuous years of sampling):
Not impaired: 3 or less violations
Impaired > 3 violations

Rotational stream chemistry sites (4 to 6 separate years of sampling in a 15 year period):

Less than six years of samples:	Not impaired 0 or1 violation Impaired > 1 violation
Six or more years of samples:	Not impaired 2 or less violations Impaired > 2 violations

4.2.2 INTERPRETATION OF NARRATIVE CRITERIA FOR TOTAL SUSPENDED SOLIDS AND TOTAL PHOSPHORUS

In the 2008 303(d) analysis, KDHE has decided to adopt an adaptive approach to identifying areas where significant total suspended solids or nutrient pollution exists using interpretive numbers that are neither adopted numeric criteria nor likely the final value that will be adopted should Kansas choose to establish numeric criteria for these parameters. The interpretive benchmarks for excessive suspended solids or nutrients identify areas that are the most severely impacted waters, without establishing the absolute concentrations that streams must attain to fully support aquatic life.

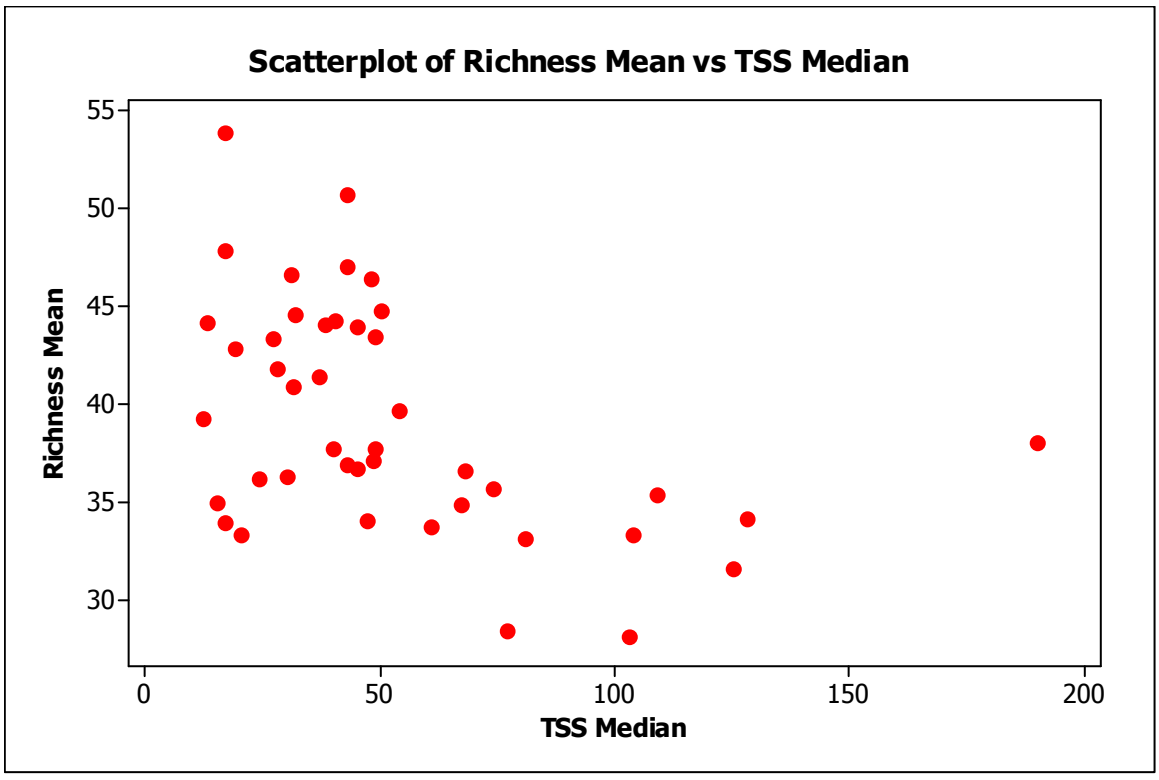
4.2.2.1 TOTAL PHOSPHORUS

K.A.R. specifies that "The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life." In 2001 EPA issued ambient nutrient water quality criteria recommendations for rivers and streams in nutrient ecoregion V, the South Central Cultivated Great Plains, which covers over 65% of Kansas (EPA 822-B-01-014). The recommendations summarized a large dataset and established 67 µg/L total phosphorus as the overall guidance value for the area. While KDHE has not adopted any specific nutrient criteria for phosphorus, some value for interpreting the narrative criteria is needed. Tthere are 3 other ecoregions covering Kansas, and the 67 µg/L value is larger than the TP values corresponding to two of the three ecoregions. Nonetheless, the 67 µg/L values is viewed as a reasonable indicator of acceptable total phosphorus levels in Kansas streams.

Therefore, our initial analysis of total phosphorus concentrations focuses on waters most likely to be impaired and looks for values substantially larger than the 2001 guidance value as an ongoing condition. Specifically, for the purpose of developing the 2008 303(d) list, we shall consider a water as impaired by total phosphorus when a dataset of at least 12 samples for a monitoring site has a median condition of total phosphorus exceeding 201 µg/L, or three times the 2001 guidance value. This interpretive value should not be seen as a final determination of nutrient concentrations acceptable to the state of Kansas, but rather as a first step in addressing the most seriously impaired waters while the state continues to deliberate on what specific nutrient criteria may be adopted in the future.

4.2.2.2 TOTAL SUSPENDED SOLIDS

Total suspended solids (TSS) can be highly variable in stream and river systems, with strong linkages to stream discharge. K.A.R. specifies that "Suspended solids added to surface waters by artificial sources shall not interfere with the behavior, reproduction, physical habitat, or other factors related to the survival and propagation of aquatic or semiaquatic life or terrestrial wildlife." Prior to the development of the 2008 303(d) list of impaired waters, KDHE analyzed 15 years of suspended solids data and associated biological monitoring data. A strong threshold relationship exists at 50 mg/L median TSS, above which streams are unlikely to support a rich diversity of aquatic life. Species richness is strongly correlated with other measures of aquatic life use support, including proportion of ephemeroptera, plecoptera, and trichoptera species, a long-used indicator of acceptable biological condition in Kansas waters.



Therefore, for the purposes of 303(d) analysis, any stream or river with a dataset of at least 12 samples and a median concentration of greater than 50 mg/L TSS shall be listed as impaired, relative to aquatic life support.

4.2.2 CONTACT RECREATION

As applied to classified stream segments, Kansas has a Primary Contact Recreation (PCR) 'not to exceed' standard derived from a geometric mean calculated from at least five *E. coli* samples collected from separate 24-hour periods within a 30-day period for PCR classes as follows (K.A.R. 28-16-28e (c)(7)(D) (table 1i)):

PCR class A; 160 cfu/100mL (in effect from April 1 through October 31 each year)
PCR class A; 2,358 cfu/100mL (in effect from November 1 through March 31 each year)

PCR class B; 262 cfu/100mL (in effect from April 1 through October 31 each year)
PCR class B; 2,358 cfu/100mL (in effect from November 1 through March 31 each year)

PCR class C; 427 cfu/100mL (in effect from April 1 through October 31 each year)
PCR class C; 3,843 cfu/100mL (in effect from November 1 through March 31 each year)

A Secondary Contact Recreation (SCR) 'not to exceed' standard derived from a geometric mean calculated from at least five E. coli samples collected from separate 24-hours periods within a 30-day period for SCR classes is as follows (K.A.R. 28-16-28e (c)(7)(E)(table 1i)):

SCR class A; 2,358 cfu/100mL (in effect January 1 through December 31)
SCR class B; 3,843 cfu/100mL (in effect January 1 through December 31)

KDHE routine stream monitoring protocols to date do not collect data to evaluate compliance with the minimum five-sample geometric mean criterion, therefore these designated uses cannot be assessed by any stream monitoring site within the state. However, there were 17 streams identified by the 2004 303(d) list under Category 3 for bacteria because they were previously listed before the water quality standard changed. These 17 streams were sampled intensively (5 times in a 30 day period) four times in 2006 to determine if they were impaired under the new standard. Those that violated the applicable geometric mean just once are listed as impaired by bacteria in the 2008 303(d) list. Those that did not exceed the geometric mean in any of the four seasonal samplings (Apr-May, Jun-Jul, Aug-Sept, & Oct-Nov) are identified as Category 2waters. Fourteen additional stations in Southeast Kansas were sampled intensively in 2007, with those recording a violation going in Category 5. New Category 3 waters for bacteria are identified based on binomial analysis of the routine monitoring data, if they showed at least 10% of individual samples with counts higher than the criteria value for E.coli bacteria.

4.2.3 DRINKING WATER, IRRIGATION AND LIVESTOCK WATERING USES

Kansas has a suite of parameters used to protect water supply uses (K.A.R. 28-16-28e(d) table 1a). The nitrate standard assessment levels by percent excursion will be:

Not impaired = 0%
Impaired > 0%

All other parameters will be reviewed at assessment levels by binmomial analysis:
Not impaired $\leq$ 10%
Impaired > 10%

4.2.4 FOOD PROCUREMENT

Kansas has a variety of parameters used to protect food procurement use. Assessment will be made by fish tissue levels and consumption advisories.

4.2.5 GROUNDWATER RECHARGE AND INDUSTRIAL USES

Not assessed by surface water.

4.3 STATISTICAL METHODS FOR LISTING ASSESSMENT – STREAM CHEMISTRY

In evaluating water body monitoring data associated with stream chemistry sites using EPA's historical 305(b) guidelines, no more than 10% of the samples obtained from the water body should exceed a regulatory standard for conventional pollutants. This method, called the raw score method, simply sets an upper bound on the percentage of measurements at a monitoring site that may violate a standard. Unfortunately, the raw score method does not provide sufficient information to properly deal with the uncertainty concerning impairment, especially when dealing with smaller sample sizes (National Research Council, 2001).

For the Kansas 2008 303(d) list, candidate water bodies will be screened for impairment based on a nonparametric analysis of a confidence limit on a percentile of interest. Where applicable that percentile of the distribution is given by the assessment level of the review above, again based on EPAs 305(b) guidelines of not more that 10% of the samples allowed to exceed a regulatory standard.

Conceptually, an assessment level of 10% excursion is really the same as the upper 90th percentile of the sample distribution. The question to answer in this evaluation is whether the true concentration for a particular constituent in a candidate water body meets or exceeds the assessment level of a regulatory standard. With only a certain number of samples to analyze from a monitoring site, the population's true concentration can never be known with certainty. However, it is possible to create an interval that will contain a particular percentile of the true concentration distribution with a given level of confidence. The confidence interval approach allows the incorporation of uncertainty in the true parameters of the distribution into a comparison to the regulatory standard.

In evaluating a stream's monitoring site data for impairment this confidence interval for the upper 90th percentile of the distribution can be used to determine, with a certain level of confidence, if a particular pollutant has exceeded the regulatory standard. This determination is based on whether

or not the entire confidence interval exceeds the regulatory criterion. More conservatively, a one-sided lower bound on the true 90th percentile of the concentration distribution can be computed as a 100(1 - α)% Lower Confidence Limit (LCL), where for 90% confidence, α = 0.1. Doing so tests the null hypothesis that the true 90th percentile of the concentration distribution is less than or equal to the regulatory criterion. If we reject the null hypothesis, the pollutant level in the water body is deemed to be an impairment to that water body's designated use(s) (Gibbons, 2001).

4.3.1 Binomial Analysis in Determination of Impairments

(Based on Gibbons, 2001 and Lin, 2000)

To construct a nonparametric confidence limit for the 90th percentile of the concentration distribution from a monitoring site, the fact that the number of samples falling below the p(100)th percentile of the distribution (in this case, $p = 0.9$, where p is between 0 and 1) out of a set of m samples will follow a binomial distribution with parameters m and success probability p, where success is defined as the event that a sample measurement is below the p(100)th percentile. The cumulative binomial distribution (Bin (x; m, p)) represents the probability of getting x or fewer successes in m trials with success probability p, and can be evaluated as

$$Bin(x;m,p) = \sum_{i=0}^{x} \binom{m}{i} p^i (1-p)^{m-i} \qquad \textbf{E4.1}$$

The notation $\binom{m}{i}$ denotes the number of combinations of m things taken i at a time, where

$$\binom{m}{i} = \frac{m!}{i!(m-i)!}$$

and the factorial $m!$ is given by

$$m! = m(m-1)(m-2)\cdots 1$$

Where applicable, KDHE will use a 90% LCL on the 90th percentile of a concentration distribution ($LCL_{0.9,0.9}$) from a stream chemistry monitoring site.

As an example, find the minimum number of successes needed to keep a water body off an impaired water body list (or, more importantly, determine the critical number of failures needed to list a water body as impaired), where the number of samples m from a monitoring site is 12. Based on the 90th percentile and with as close to a LCL of 90% as possible, then from E4.1 starting with i = 12 as the first candidate and repeating additional candidates by i - 1 until the cumulative probability is as close to 90% as possible,

$$\binom{12}{12} 0.9^{12}(0.1)^0 = 0.282$$

$$\binom{12}{11} 0.9^{11}(0.1)^1 = 0.377$$ (cumulative probability is 0.282 + 0.377 = 0.659)

$$\binom{12}{10} 0.9^{10}(0.1)^2 = 0.230$$ (cumulative probability = 0.282 + 0.377 + 0.230 = **0.889**)

$$\binom{12}{9} 0.9^{9}(0.1)^3 = 0.085$$ (cumulative probability = 0.282 + 0.377 + 0.230 + 0.085= 0.974)

Comparing cumulative probabilities with an objective of getting as close to 90% as possible we choose the 0.889 option from the above. From this choice, the minimum number of successes out of 12 trials to keep a water body off an impaired list is 10 (or, conversely, 2 failures out of 12 trials). This is the same as saying that 3 failures out of 12 trials will get a water body listed as impaired (or finding only 9 successes out of 12 trials).

In practice, it is a nuisance calculating binomial probabilities by hand. The Microsoft Excel functions BINOMDIST does most of the work for the analyst. Table 2 was created using this Excel BINOMDIST function. Table 2 shows, using the BINOMDIST function to get as close to 90% confidence as possible, for *m* = 12 to 150 the minimum number of excursions needed to list a water body as impaired and the confidence level associated with that number.

4.3.2 Special Considerations in Balancing of Type I and Type II Error

In the case of determining whether or not a water body is impaired, two different kinds of errors can be made. The first is when an unimpaired water body is mistakenly determined to be impaired, called a Type I error. The second is if an impaired water body is erroneously determined to be unimpaired and is called a Type II error. Of special concern to KDHE is Type I error, which could lead to the dedication of time and resources in developing and implementing a TMDL for a water body that was determined to be impaired when it actually is not impaired. In a policy decision, KDHE has chosen to set the acceptable Type I error rate in advance. The 90% confidence limit used by KDHE in its nonparametric method of assessing water bodies for impairment simply means that about 10% of the time a Type I error will occur.

KDHE also has concerns about Type II errors because failure to detect an impairment in a water body when one actually exists also has negative consequences through potential unabated environmental damage stemming from delayed TMDL implementation, and this delay can lead to greater marginal fiscal costs to restore waterbodies. In an effort to reduce the Type II errors associated with the nonparametric method of assessing water bodies, KDHE has added additional balances to minimize it; the choice of $\alpha = 0.1$ rather than 0.05, minimum sample size requirement and recent trend weighting (explained in 4.3.3).

4.3.3 EMPHASIS OF RECENT TRENDS IN STREAMS

Table 2 shows with as close to 90% confidence as possible for m = 12 to 150, the minimum number of excursions needed to list a stream as impaired and the confidence level associated with that number. A final step in the listing methodology will be a check of recent excursions in the samples from a monitoring site. If the number of excursions is within one of the critical number of excursions needed to list a steam as impaired from Table 2, and any one of those excursions occurred in the most recent year of sampling, then that water body will also be placed on the 303(d) list in category 5. Doing so emphasizes recent impairments in the sample data and creates the final step to minimize Type II errors. If the last excursion did not occur in the last year of sampling the water will be put in Category 3 for follow up assessment in the next 303(d) cycle.

4.4 STATISTICAL METHODS FOR ESTABLISHING PRIORITY IN LISTINGS – STREAM CHEMISTRY

Priority among listings for subsequent TMDL development will be established through factoring discussions with interested public, coincidental impairments and the magnitude of exceedances. For the latter, although a nonparametric method of analysis will be used to determine whether or not impairment from a pollutant exists for a candidate stream chemistry monitoring station, the priority for TMDL development will be determined by a parametric method of analysis.

Consider two monitoring sites each with 12 samples and each with 3 excursions. The excursions at one site are slightly above the standard and the excursions at the other site are ten times the standard. By the nonparametric method, the sample data from both sites would cause their associated AUs to be listed (Table 2), but the information about the magnitude of the excursions is lost. Clearly, the site whose excursions are ten times the standard should be given a higher priority for TMDL development than the site whose excursions are only slightly above the standard.

An approach more effective at extracting the information from the available data at each monitoring site will be used to determine the priority for TMDL development of those sites listed by the nonparametric method. This parametric approach not only quantifies the frequency of excursion from criteria but also the magnitude of those excursions for prioritization within the listed AUs by pollutant.

4.4.1 PARAMETRIC ANALYSIS IN ASSIGNING PRIORITY OF LISTED AUS

The comparison by pollutant of the $LCL_{0.9,0.9}$ and the frequency of the impairment violations between listed AUs is the basis for assigning priority for TMDL development in each of the 12 basins in Kansas. The development of the $LCL_{0.9,0.9}$ is described in the remainder of Section 5.

4.4.2 DISTRIBUTION TEST

(Sections 4.4.2 - 4.4.4 based on Gibbons, 2001)

The first step for the parametric analysis will be a sample data distribution test for normality. The Ryan-Joiner (similar to the Shapiro-Wilk) test will be utilized in checking for normal distribution of the sample data. Should the sample data fail this test, it will be log transformed. It has been KDHE's experience to date that the transformed lognormal data typically pass the normality test.

Based on whether or not the sample data needed transformation the following two methods will be applied (4.4.3 and 4.4.4).

4.4.3 Normally Distributed Sample Data

A normal upper tolerance limit for the 90th percentile of the sample distribution will be computed as

$$LCL_{1-\alpha,p} = \bar{x} + K_{\alpha,p}\, s\,,$$

where $\bar{x}$ is the sample mean of the m measurement from the monitoring site,

$$\bar{x} = \sum_{i=1}^{m} \frac{x_i}{m}$$

and s is the observed sample standard deviation,

$$s = \sqrt{\sum_{i=1}^{m} \frac{(x_i - \bar{x})^2}{m-1}}$$

and $K_{\alpha,p}$ is the one-sided normal tolerance limit factor for (α)100% confidence and p(100)% coverage (Hahn and Meeker, 1991). Table 3 provides values of $K_{0.9,0.9}$ that will be use by KDHE in this analysis. Table 3 was created using *StInt* (Meeker and Chow, 1993) and this command driven DOS program and user's manual is available at: http://www.public.iastate.edu/~wqmeeker/other_pages/wqm_software.html.

4.4.4 Lognormally Distributed Sample Data

For lognormal data the same method as described in 4.4.2 applies with exponentiation of the resulting limits.

$$LCL_{1-\alpha,p} = \exp[\bar{y} + K_{\alpha,p}\, s_y]$$

where $\bar{y}$ and s_y are the mean and standard deviation of the natural log transformed data. Table 3 is applied in the same manner as 4.4.2.

4.4.5 DATA BELOW DETECTION LIMITS

Modifications to the equations in 4.4.2 and 4.4.3 for data below detection limits are described in this section.

(Using Gibbons, 2001)
If the data from a monitoring site are normally distributed and nondetects are present, the adjusted mean of the m samples is computed as:

$$\bar{x} = \left(1 - \frac{m_0}{m}\right)\bar{x}'$$

where $\bar{x}'$ is the average of the m - m_0 detected values, and m_0 is the number of samples in which the pollutant was not detected. The adjusted standard deviation is:

$$s = \sqrt{\left(1 - \frac{m_0}{m}\right)(s') + \frac{m_0}{m}\left(1 - \frac{m_0 - 1}{m - 1}\right)(\bar{x}')^2}$$

where s' is the standard deviation of the m - m_0 detected measurements. The normal tolerance limit can then be computed as previously described (4.4.3).

With nondetects in natural log transformed data, replace $\bar{x}'$ with $\bar{y}'$ and s' with s'_y in the respective equations in this section and follow Section 4.4.4.

4.5 OVERVIEW OF 2008 LISTING METHODOLOGY – STREAM CHEMISTRY

Figure 5 charts the Kansas 2008 Listing Methodology as it applies to the previous discussions. All categories as defined in the EPA Guidance (category definitions available in Table 1) will be submitted as the Kansas 2008 303(d) List. Category 5 waters will be submitted as the Kansas 2008 303(d) list.

4.5.1 STREAM CHEMISTRY ASSESSMENT UNITS - CATEGORIZATION

From Figure 5 after an initial check to make sure the AU is not already on the 2004 303(d) List for the same pollutant, the following ordered steps will apply:

1) Screen for the domestic water supply nitrate criteria where a single excursion provides support for listing in Category 5.

2) Screen for acute aquatic life violations for each monitoring site. If more than 3 samples from a fixed monitoring site (1998-2007 data) exceed acute aquatic life criteria and more than 1 or 2 samples (depending on # of years of data) from a rotational monitoring site

(1990 to 2007 data) exceed acute aquatic life criteria, then the monitoring site's AU will be listed on the 2008 303(d) List (Category 5).

3) The 305b 10% raw score will provide the next screen for the conventional pollutant data from monitoring sites. Those sites that fail the raw score test (>10% excursion) will be subject to the binomial test described in Section 4.3.1.

4) If the binomial test indicates impairment then the AU will be placed on the 2008 303(d) List (Category 5).

5) If the binomial test indicates full support, those sites will be subject to the final screen, a check for evidence of recent excursions in the sample data. If the number of excursions is within one of the critical number of excursions (Table 2) needed to list an AU and any one of those excursions occurred within the most recent year of sampling at the monitoring site, then that AU will also be listed on the 2008 303(d) List in category 5. If the last excursion occurred earlier, the AU will be placed in Category 3 for follow up assessment in 2010.

4.6 STREAM CHEMISTRY PRIORITY METHOD (CATEGORY 5) FOR TMDL DEVELOPMENT

Those AUs found to be impaired by a pollutant and placed on the 2008 303(d) List within category 5 will be prioritized for TMDL development. Priorities will be finalized after consultation with appropriate BACs (Basin Advisory Committees) in the four basins that will have TMDL development from this list over 2008-2010 [Smoky Hill-Saline, Solomon, Upper Republican, Kansas-Lower Republican] and specific WRAPS (Watershed Restoration and Protection Strategy) groups in those basins. Additional factors determining priority will be matching priority among coincidental impairments, interrelations with other impaired waterbodies, relative importance of the waterbody, frequency of excursions and the overall magnitude of those excursions. To determine magnitude, the LCL statistic will be used and the resulting $LCL_{0.9,0.9}$ from the methods in Section 4.4 will be ordered from highest to lowest by pollutant. The impairments from TSS and phosphorus, using median values, were ranked and priorities were assigned after dividing each basin's stations into tri-sections. The third worse median values were initially assigned high priority.

4.7 STREAM CHEMISTRY ASSESSMENT UNITS - CONSIDERATIONS FOR DELISTING

Kansas will delist streams on the 2004 303(d) based upon the assessment of data. If the stream no longer meets the listing requirements as discussed in Section 4.0, the stream may be delisted. Typographical errors and listing errors from the 2004 303(d) List will be corrected in the 2008 303(d) List. If a waterbody has a TMDL developed, the first opportunity for delisting will come in 2012.

5.0 STREAM BIOLOGY METHODOLOGY

5.1 SAMPLE SIZE REQUIREMENTS AND TEMPORAL BOUNDS OF DATA - BIOLOGY

A minimum of 3 samples will be required to assess biological and fish tissue data. For data collected from biological and fish tissue surveys, the same assessment period that is used in the 2008 305(b) Report will be used for the 2008 303(d) List.

5.2 STREAM BIOLOGY - CATEGORIZATION FOR LISTING

1) Determine if the stream biological impairment appears on 2004 Section 303(d) list and has not had a TMDL developed. If so, list in Category 5.

2) For biological monitoring stations with three or more samples over the latest five years, if one or more of the biological metrics indicate partial or non-support, list in Category 5.

3) If fish tissue samples show excessive amounts of bio-accumulative pollutants (PCB, chlordane, mercury, etc.) for three or more years over the latest five years, list in Category 5.

5.3 STREAM BIOLOGY PRIORITY METHOD FOR TMDL DEVELOPMENT

Use the following biological metrics to assess fully supporting streams from those that are partially supporting or non-supporting:

Table 1	MBI	KBI-NO	EPT %	Mussel Loss
Fully Supporting	$\leq$ 4.5	$\leq$ 2.60	$\geq$ 48%	$\leq$ 10%
Partially Supporting	4.51-5.39	2.61-2.99	31%-47%	11%-25%
Non-Supporting	$\geq$ 5.4	$\geq$ 3.0	$\leq$ 30%	$\geq$ 26%

Apply the following criteria on data over the latest five years to determine the priority:

1) First (High) priority goes to streams with three of the above metrics showing non-support. In addition, for basins with only one or two stations reflecting impairment(s), those stations shall also be designated as first priority.

2) Second (Medium) priority goes to streams with two of the above metrics showing non-support or impairments appearing through fish tissue analysis. In the event of multiple

partial support designations, best professional judgment may be used to move a station from low priority to medium priority.

3) Third (Low) priority goes to streams with three or more categories designated as partial support or full support.

4) Streams that have only one to two biological samples from the latest five years and show any designation of less than full support that has not previously had a TMDL developed, will be deemed Category 3.

5) Streams that are listed as fully supporting in the 2004 305(b) list and listed as partially supporting in the 2008 305(b) report, where the impairment is potentially drought linked, shall be listed as Category 3.

5.4 STREAM BIOLOGY ASSESSMENTS- CONSIDERATIONS FOR DELISTING

1) For 2004 listed biological monitoring stations, if the latest five years have three or more samples and indicate full-support for all of the biological metrics, delist.

2) For 2004 listed fish tissue samples, if the latest five years have three or more years of monitoring and indicate compliant amounts of bio-accumulative pollutants (PCB, chlordane, mercury, etc.), delist.

6.0 LAKE AND WETLAND METHODOLOGY

6.1 SAMPLE SIZE REQUIREMENTS AND TEMPORAL BOUNDS OF DATA – LAKE/WETLAND

There are not a minimum number of samples needed for assessing lake/wetland data. For data collected from lakes and wetlands, the assessment period from 1998-2007 will be used in the 2008 303(d) List.

6.2 CONTACT RECREATION – LAKE/WETLAND

As applied to classified lakes and wetlands, Kansas has a Primary Contact Recreation (PCR) 'not to exceed' standard derived from a single sample maximum or a geometric mean calculated from at least five E.coli samples collected beyond the mixing zone from separate 24-hour periods within a 30-day period for PCR classes as follows (K.A.R. 28-16-28e(c)(7)(B) (table 1j)):

PCR Swimming Beach; 160 cfu/100mL or single sample maximum of 732 cfu/100mL (in effect from April 1 through October 31 each year)

PCR: Swimming Beach; 800 cfu/100mL or single sample maximum of 3655 cfu/100mL (in effect from November 1 through March 31 each year)

PCR: Public Access; 262 cfu/100mL or single sample maximum of 1198 cfu/100mL (in effect from April 1 through October 31 each year)

PCR: Public Access; 1310 cfu/100mL or single sample maximum of 6580 cfu/100mL (in effect from November 1 through March 31 each year)

PCR: Restricted Access; 427 cfu/100mL or single sample maximum of 1950 cfu/100mL (in effect from April 1 through October 31 each year)

PCR: Restricted Access; 2135 cfu/100mL or single sample maximum of 9760 cfu/100mL (in effect from November 1 through March 31 each year)

A Secondary Contact Recreation (SCR) 'not to exceed' standard derived from a single sample maximum or a geometric mean of at least five samples collected beyond the mixing zone during separate 24-hour periods within a 30-day period for SCR classes are as follows (K.A.R 28-16-28e (c)(7)(c) (table1j)):

SCR: Public Access and Restricted Access; 2135 cfu/100mL or single sample maximum of 9760 cfu/100mL (in effect from January 1 through December 31 each year)

6.3 LAKE AND WETLAND ASSESSMENT UNITS - CATEGORIZATION FOR LISTING

1) Determine if the lake or wetland assessment unit appears on the 2004 Section 303(d) list and has not had a TMDL developed or qualify for Delisting for its specified impairment(s). If a TMDL has not been developed and the impairment does not qualify for Delisting, list in Category 5.

2) For lakes not listed in 2004 for eutrophication, if the lake has a designated use of primary contact recreation and the overall chlorophyll a average concentration is greater than 12 ppb or if the chlorophyll a concentration is greater than 12 ppb for more than one sample since 1998 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5.

3) For lakes not listed in 2004 for eutrophication, if the lake has a designated use of secondary contact recreation and the overall chlorophyll a average concentration is greater than 20 ppb or if the chlorophyll a concentration is greater than 20 ppb for more than one sample since 1998 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5.

4) For lakes not listed in 2004 for eutrophication, if the lake has an existing use of domestic water supply and the overall chlorophyll a average concentration is greater than 10 ppb, list in Category 5.

5) If the lake or wetland, for any other parameter, exceeded water quality standards or regional norms for more than one year since 1998 and one of the excursions has been obtained during the two most recent sampling dates, list in Category 5.

6.4 LAKE PRIORITY (CATEGORY 5) DETERMINATION METHOD FOR TMDL DEVELOPMENT

1) For Lakes previously listed for Eutrophication, but there are no new data since 1998, the lake will be removed from Category 5 and listed as Category 3.

2) For previously and newly listed lakes and wetlands for Eutrophication, priorities will be established based on a comprehensive data evaluation to include a comparison between the overall number of samples over 12 ppb (20 ppb for Secondary Contact Recreation), the recent chlorophyll a averages since 1998 and the overall chlorophyll a average for all available samples. In general, first priority goes to lakes and wetlands with the lowest average chlorophyll a concentrations since 1998 and has existing primary contact recreation uses, generally in the range of 12-18 ppb. Second priority will generally be assigned to lakes with chlorophyll a averages around 18-28ppb. Third priority will generally be assigned to lakes with the highest chlorophyll a averages within their basin. These priorities may be adjusted upon consultation with the applicable BACs and WRAPS.

3) Should any lakes with new eutrophication impairments also have a problem with deficient dissolved oxygen, their priority will be moved up one priority rank.

4) Should any lakes with new eutrophication impairments also have a problem with elevated pH or siltation, their priority will remain based on the level of chlorophyll a present over the evaluation period.

5) For other pollutants, if excursions appears in three or more years since 1998, place in first priority; if excursions appears in two years since 1998, place in second priority.

6.5 LAKE AND WETLAND ASSESSMENT UNITS - CONSIDERATIONS FOR DELISTING

1) For lakes designated for primary contact recreation and listed for eutrophication on the 2004 list, if the two latest sampling dates have chlorophyll a concentrations less than 12 ppb and no TMDL has yet been developed, delist.

2) For lakes and wetlands designated for secondary contact recreation and listed on the 2004 list for eutrophication, if the two latest samples have chlorophyll a concentrations less than 20 ppb and no TMDL has yet been developed, delist.

3) For lakes and wetlands, if the two latest samples, for any other parameter, attain water quality standards or regional norms, delist.

7.0 ADDITIONAL CONSIDERATIONS

7.1 ADDITIONAL CONSIDERATIONS IN PRIORITY

Domestic water supply nitrate impairments within category 5 will also be placed in the 1st priority level. For the primary basins that will have TMDLs written within 2008 – 2010: (Smoky Hill-Saline, Solomon, Upper Republican and Kansas-Lower Republican), priorities for TMDL development will be displayed in the 303(d) list. For the other eight basins that will not have TMDLs developed until after the 2008 303(d) list is prepared, all impairments will be set as low priority and will be re-evaluated during preparation of the 2010 list.

7.2 CATEGORY 3 WATERS

In addition to streams that are identified as needing more intensive bacteria sampling over the next listing cycle, a number of stream biology and lake stations are identified as Category 3 because they have insufficient data. In the case of stream biology, one additional seasonal sample is necessary to determine its listing status for 2010. For lakes, no data has been collected since 1997, though the data from prior to 1998 indicated some degree of impairment. Contemporary sampling will determine the listing status for these lakes. Streams placed in Category 3 because of binomial analysis came one excursion short of listing and the last excursion occurred prior to the last year of sampling will be reassessed as part of the 2010 listing process.

7.3 BASIN ADVISORY COMMITTEE INPUT

In some cases, Basin Advisory Committees associated with the State Water Plan and comprising individuals residing within each of the twelve river basins will offer input to revise the priority listing of certain waters within their basins. Typically, this input serves to elevate a waterbody that was originally not scheduled to have a TMDL developed in the next cycle and direct its TMDL be prepared. Similarly, input from watershed and lake specific WRAPS groups may offer input on priorities of listed waters.

8.0 PUBLIC PARTICIPATION

The public was invited to comment on this methodology and the draft list generated through this methodology. A draft of this methodology was posted on the KDHE TMDL Web site http://www.kdheks.gov/tmdl/index.htm. The draft list was released on February 7, 2008 for public review and comment. The priorities within the list may be modified based on feedback provided by

the Basin Advisory Committees (BACs). BACs set priorities within their basins and these priorities may influence which TMDLs will be developed within the basin.

8.1 PUBLIC HEARING DATES AND LOCATIONS

KDHE will hold two public hearings to receive comments on the proposed 2008 Section 303(d) List. The two hearings will be in Hays on February 20, 2008 and Topeka on February 26, 2008.

8.2 PUBLIC COMMENTS AND AGENCY RESPONSE

Public comments will be taken at the two public hearings through March 7, 2008. Late interest in commenting on the list of impaired waters and the methodology may prompt KDHE to extend the open period. After the public record closes, KDHE will consider the received comments, formulate a response to those comments and will post the comments and responses on its TMDL Web site.

9.0 SUBMITTAL TO EPA REGION 7

The finalized Section 303(d) List for 2008, public comments received by KDHE regarding the 303(d) List, and KDHE response to public comments is submitted to EPA Region 7 on April 1, 2008.

10.0 REFERENCES

National Research Council. 2001. Assessing the TMDL Approach to Water Quality Management. Committee to Assess the Scientific Basis of the Total Maximum Daily Load Approach to Water Pollution Reduction. Water Science and Technology Board. Division on Earth and Life Studies. Washington D.C. Page 41.

Lin, P., D. Meeter, and X. Niu. 2000. A Nonparametric Procedure for Listing and Delisting Impaired Waters Based on Criterion Exceedances. Technical Report. Department of Statistics, Florida State University, Tallahassee, FL.

Gibbons, R.D. 2001. A Statistical Approach for Performing Water Quality Impairment Assessments Under the TMDL Program. In: Proceedings of the TMDL Science Issues Conference - St. Louis, MO. p. 187-198.

Hahn, G.J., and W.Q, Meeker. 1991. Statistical Intervals: A Guide for Practitioners. Wiley, New York.

Meeker, W.Q. and I.S. Chow. 1993. *StInt* - A Computer Program for Computing Statistical Intervals. Department of Statistics, Iowa State University, Ames, IA.

USEPA, Office of Water, 1995. Guidelines for Preparation of the 1996 State Water Quality Assessment (305(b)) Reports. Washington, DC. p. (3-(18)). EPA 841 B-95-001.

Table 1

Five EPA Reporting Categories and Kansas Interpretation

Category 1: All designation uses are supported, no use is threatened; **Kansas**: Water has never been listed

Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported; **Kansas**: Water use was previously listed but now has water quality sufficient to support designated uses

Category 3: There is insufficient available data and/or information to make a use support designation; **Kansas**: No recent data to indicate use support, water falls short of statistical impairment, bacteria data

Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed

Kansas:

4a: TMDL has been developed for water
4b: NPDES permits addressed impairment or watershed planning is addressing atrazine problem
4c: Pollution (typically insufficient hydrology) is causing impairment

Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed; **Kansas**: 303(d) list

Table 2
Binomial Listing Critiera Critical Values

Samples	Exceedences	Confidence Level %
12	3	0.889
13	3	0.866
14	4	0.956
15	4	0.944
16	4	0.932
17	4	0.917
18	4	0.902
19	4	0.885
20	4	0.867
21	5	0.948
22	5	0.938
23	5	0.927
24	5	0.915
25	5	0.902
26	5	0.888
27	5	0.873
28	5	0.858
29	6	0.936
30	6	0.927
31	6	0.917
32	6	0.906
33	6	0.894
34	6	0.881
35	6	0.868
36	7	0.937
37	7	0.929
38	7	0.920
39	7	0.911
40	7	0.900
41	7	0.890
42	7	0.879
43	7	0.867
44	8	0.932
45	8	0.924
46	8	0.916
47	8	0.907
48	8	0.898
49	8	0.888
50	8	0.878
51	9	0.936
52	9	0.929
53	9	0.922
54	9	0.914
55	9	0.906
56	9	0.897
57	9	0.888
58	9	0.879
59	9	0.869
60	10	0.927
61	10	0.920
62	10	0.913
63	10	0.905
64	10	0.897
65	10	0.889
66	10	0.880
67	10	0.871
68	11	0.926
69	11	0.920
70	11	0.913
71	11	0.906
72	11	0.898
73	11	0.890
74	11	0.882
75	11	0.874
76	12	0.926
77	12	0.920
78	12	0.913
79	12	0.907
80	12	0.900
81	12	0.892
82	12	0.885
83	12	0.877
84	13	0.926
85	13	0.920
86	13	0.914
87	13	0.908
88	13	0.901
89	13	0.894
90	13	0.887
91	13	0.880
92	14	0.927
93	14	0.921
94	14	0.915
95	14	0.910
96	14	0.903
97	14	0.897
98	14	0.890
99	14	0.883
100	15	0.927
101	15	0.922
102	15	0.917
103	15	0.911
104	15	0.906
105	15	0.899

Summary of logic used to place watersheds (stream assessments units (AU)) into the categories for the Kansas 2008 303(d) List