METHODOLOGY FOR THE EVALUATION AND DEVELOPMENT OF THE 2004 SECTION 303(D) LIST OF IMPAIRED WATER BODIES FOR KANSAS

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Watershed Planning Section/Bureau of Water/Division of Environment
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*All figures referenced in the 2004 303(d) Listing Methodology are available as an Appendix to the methodology in PDF format at http://www.kdhe.state.ks.us/tmdl/303d.htm.

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*All tables referenced in the 2004 303(d) Listing Methodology are available as an Appendix to the methodology in PDF format at http://www.kdhe.state.ks.us/tmdl/303d.htm.

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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 must submit their 2004 Clean Water Act Section 303(d) lists of impaired waters, as well as the methodologies used to prepare them, by April 1, 2004. On July 21, 2003, the U.S. Environmental Protection Agency issued a guidance document (hereafter called the 'EPA Integrated Report Guidance'), which recommends that States combine the Section 303(d) list with the required Section 305(b) report into one Integrated Water Quality Monitoring and Assessment Report (or 'Integrated Report').

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).

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

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 2004 303(d) list not only identifies those water bodies from the 1998 and 2002 303(d) list, which still require TMDLs, but also defines those new water bodies and pollutants for which TMDLs are needed. Water bodies are assigned priority for TMDL development by assessing the frequency, magnitude and duration of impairment by pollutant.

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. Any comparisons made to a 305(b) report should be made to other 305(b) reports through time rather than to a list of impaired water bodies. The 305(b) report provides a picture of the water quality within a state from the perspective of a point or, more accurately, a short period in time.

In contrast, although the 2002 303(d) list relies on the 305(b) report in 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 subgroup of all surface waters in the state; those water bodies not meeting one or more water quality standards. Because of the associated cost to the state in developing and implementing TMDLs, the state must have a certain amount of confidence that a candidate water body truly is impaired. Hence the need for more vigorous assessment prior to listing a water body as impaired.

1.4 Relationship of Kansas 303(d) List to 2004 Integrated Report Guidance

In as much as practicable, the Kansas 2004 303(d) List will be developed and submitted to the EPA in accordance with the July 21, 2003 Integrated Report Guidance. However, the list developed by this methodology constitutes only those waters identified in the Integrated Report Guidance as "Category 5"; those waters requiring development of a TMDL because of impairment by a pollutant. Unless noted otherwise, impaired waters not listed in "Category 5" that originated from the 1998 and 2002 List have been assigned into one of the three subcategories of "Category 4" as defined by the Integrated Report Guidance. The re-categorization of those waters, primarily stemming from the TMDL development over 1999-2003, is on record at KDHE and Region VII, EPA. Definitions of the five Categories for waters provided by the July 21, 2003, Integrated Report Guidance from EPA is provided in Figure 19.

2.0 Assessment Unit Development

2.1 Description of Kansas Ambient Surface Quality Network

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Kansas has an extensive water quality monitoring network consisting of 318 active ambient stream chemistry monitoring sites, 19 sites for fish tissue collection, 68 biological stations and 315 lakes and wetland monitoring sites (Figures 1 - 4).

2.2 Delineation Assessment Units (Contributing Areas to Monitoring Sites)

Of the Kansas Department of Health and Environment's (KDHE) 318 ambient stream chemistry monitoring sites, 165 are fixed (permanent) sites sampled bi-monthly every year, and 153 are rotational sites samples bi-monthly 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. The stream segments of the 2002 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.

312 stream AUs were created from the 318 ambient stream chemistry monitoring sites. The discrepancy between the number of monitoring sites and AUs is because six AUs have two monitoring sites located within their boundaries.

The 27 largest lakes by surface area of the 315 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 288 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 98% 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 broken into 12 basins. Maps locating the AUs and monitoring sites were created for each of these 12 basins (Figures 5 - 16). Tables of the registered streams in each assessment unit or in the case of a lake AU, streams and the lake itself, were assembled for each of the 12 basins (Tables 1 - 12). The stream segment layout of each AU in these tables is intended to reproduce the hierarchical stream drainage network, as it exists in an AU. The stream segment that contains the monitoring site is noted within each AU table. Table 13 identifies within which AU each of the 315 monitored lakes and wetlands are located.

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3.0 Data Considerations for 2002 List

3.1 Application of 2002 303(d) List

Certain impairments listed in the 2002 303(d) list will be evaluated for delisting during the generation of the 2004 303(d) list. Section 8 describes the assessment method for delisting decisions. Error corrections to the 2002 list will be made as set forth in Section 3.2.

3.2 2002 303(d) List - Error Corrections

Errors in the 2002 303(d) list will be corrected in the 2004 list. Examples of these corrections to the 2002 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 2004 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 used to generate the assessment of these three sections of the 2004 305(b) report will be translated directly to the 2004 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 that may cause certain discrepancies between the 2004 305(b) report and the 2004 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. The tributaries located within an impaired stream AU will be listed in an appendix of the 303(d) list in tabular form as potential contributors to the impairment found on the main stem. For lake/wetland AUs, if the lake/wetland has directly contributing tributaries associated with it, those tributaries will be listed in the appendix of the 303(d) list in tabular form as potential contributors to the impairment found in the lake. If the lake/wetland AU is defined as just that water body, then reference to potential contributors in the appendix will not be made.

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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:

- 2002 303(d) List;
- 2004 305(b) Report's waters that are not meeting a designated beneficial use;
- Clean Water Act 319 nonpoint source assessments,
- Drinking water source water assessment under Section 1453 of the Safe Drinking Water Act;
- Dilution calculations, trend analyses, or predictive models for determining the physical, chemical or biological integrity of streams, and lakes/wetlands

- KDHE fish consumption advisories,
- Data, information, and water quality problems reported from local, State, or Federal agencies (especially the 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 will request data from various agencies and the public prior to creation of the draft 2004 303(d) list and will accept such data through the end of the public comment period on the draft 2004 303(d) list.

3.5.1 Sample Size Requirements

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 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. A minimum of 3 samples will be required to assess biological and fish tissue data. There are not a minimum number of samples needed for assessing lake/wetland data.

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3.5.2 Temporal Bounds of Data

In an effort to meet the sample size requirements in 3.5.1, data collected from January 1996, through June 2003, will be used for fixed stream chemistry sites or their associated AUs. Data collected from 1990 through June 2003, will be use for rotation chemistry sites or their associated AUs in the assessment of stream chemistry impairment. For data collected from lake/wetland, biological, fish tissue surveys, the same assessment period that is used in the 2004 305(b) Report will be used in the 2004 303(d) List.

3.6 DESIGNATED USE APPLICATIONS

Where possible, the water quality for use support of all monitored waters will be evaluated for potential inclusion on the 2004 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 partial support is defined as excursion rates greater than 10 percent. The nonsupport level (> 25% excursions) is immaterial at this level of screening because additional data analysis will be performed to assign priority within the 2004 303(d) list.

3.6.1 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%
Impaired >10%

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

Fixed stream chemistry sites (almost 8 continuous years of sampling):
Not impaired # 2 violations
Impaired >2 violations

Rotational stream chemistry sites (3 or 4 separate years of sampling in a 14 year period):
Not impaired # 1 violation
Impaired > 1 violation

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3.6.2 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-hours periods within a 30-day period for PCR classes as follows (K.A.R. 28-16-28e (c)(7)(D)(i, ii and iii)):

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)(i and ii)):

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 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.

As applied to classified lakes and wetlands, Kansas has a Primary Contact Recreation standard of 200 organisms per 100 milliliters derived from a geometric mean calculated from at least five fecal coliform bacteria samples collected from separate 24-hours periods within a 30-day period, in effect from April 1 through October 31 each year. The Secondary Contact Recreation standard for classified lakes and wetlands is 2,000 organisms (fecal coliform bacteria) per 100 mL, in effect from January 1 through December 31 each year (K.A.R. 28-16-28e (c)(7)(B and C)).

3.6.3 Drinking Water

Kansas has a suite of parameters used to protect Domestic Water Supply (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 (excluding chloride and sulfate which will be assessed at the 10% excursion level) will be reviewed at assessment levels by percent excursion as:

Not impaired # 50%
Impaired > 50%

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3.6.4 Agricultural Use: Irrigation and Livestock Watering

Kansas has a number of parameters used to protect agriculture use of water, which includes livestock watering and irrigation supply (K.A.R. 28-16-28e(d) table 1a). Assessment levels by percent excursion will be:

Not impaired # 10%
Impaired >10%

3.6.5 FOOD PROCUREMENT

Kansas has a variety of parameters used to protect food procurement use. Assessment levels by percent excursion will be:

Not impaired # 10%
Impaired >10%

3.6.6 GROUNDWATER SUPPLY

Not assessed by surface water.

4.0 STATISTICAL METHODS FOR LISTING ASSESSMENT

In evaluating water body monitoring data associated with stream chemistry sites using EPA's 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 2004 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 - a)% lower confidence limit (LCL), where for 90% confidence, a = 0.1. Doing so tests the null hypothesis that the true 90th percentile of the concentration distribution is less than or equal to

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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).

4.1 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.

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As an example, to 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 14 was created using this Excel BINOMDIST function. The Table 14 shows, using the BINOMDIST function to get as close to 90% confidence as possible, for *m* = 12 to 50 the minimum number of excursions needed to list a water body as impaired and the confidence level associated with that number.

4.1.1 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.

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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 a = 0.1 rather than 0.05, minimum sample size requirement and recent trend weighting (explained in 4.1.2).

4.1.2 EMPHASIS OF RECENT TRENDS

Table 14 shows with as close to 90% confidence as possible for m = 12 to 50, the minimum number of excursions needed to list a water body 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 water body as impaired from Table 14, 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. Doing so emphasizes recent impairments in the sample data and creates the final step to minimize Type II errors.

5.0 STATISTICAL METHODS FOR ESTABLISHING PRIORITY IN LISTINGS

Although a nonparametric method of analysis will be used to determine whether or not impairment from a pollutant exists for a candidate water body, 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 14), 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.

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5.1 PARAMETRIC ANALYSIS IN ASSIGNING PRIORITY OF LISTED AUS

The comparison by pollutant of the $LCL_{0.9,0.9}$ 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.

5.1.1 DISTRIBUTION TEST

(Sections 5.1.1 - 5.1.3 based on Gibbons, 2001)

The first step for the parametric analysis will be a sample data distribution test for normality. 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 and the test rerun. 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 (5.1.2 and 5.1.3).

5.1.2 Normally Distributed Sample Data

A normal lower confidence limit for the 90th percentile of the sample distribution will be computed as

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

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 $K_{a,p}$ is the one-sided normal tolerance limit factor for (a)100% confidence and p(100)% coverage (Hahn and Meeker, 1991). Table 15 provides values of $K_{0.9,0.9}$ that will be use by KDHE in this analysis. Table 15 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.

5.1.3 Lognormally Distributed Sample Data

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For lognormal data the same method as described in 5.1.1 applies with exponentiation of the resulting limits.

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

where $\bar{y}$ and s_y are the mean and standard deviation of the natural log transformed data. Table 15 is applied in the same manner as 5.1.1.

5.2 Data Below Detection Limits

Modifications to the equations in 5.1.1 and 5.1.2 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 confidence limit can then be computed as previously described (5.1.2).

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 5.1.3.

6.0 OVERVIEW OF 2004 LISTING METHODOLOGY

Figure 17 charts the Kansas 2004 Listing Methodology as it applies to the previous discussions. From Section 1.4, although Figure 17 charts all categories are as defined in the July 21, 2003 Integrated Report Guidance (category definitions available in Figure 19), only Category 5 will be submitted as the Kansas 2004 303(d) List.

6.1 LAKE AND WETLAND ASSESSMENT UNITS - CATEGORIZATION FOR LISTING

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1) Determine if the lake or wetland assessment unit appears on 2002 Section 303(d) list and has not had a TMDL developed for its specified impairment(s). If so, list in Category 5.

2) For lakes unlisted in 2002 for eutrophication, if lake has designated use of primary contact recreation and chlorophyll a average concentration greater than 12 ppb, list in Category 5.

3) For lakes unlisted in 2002 for eutrophication, if lake has designated use of secondary contact recreation and chlorophyll a average concentration greater than 20 ppb, list in Category 5.

4) If a lake has average total phosphorus concentration greater than 50 ppb over the last five years, list in Category 5.

5) If a wetland has average total phosphorus concentration greater than 100 ppb over the last five years, list in Category 5.

6) If the lake or wetland, for any other parameter, exceeded water quality standards or regional norms for more than one year in the last five, list in Category 5.

6.2 STREAM BIOLOGY - CATEGORIZATION FOR LISTING

1) Determine if the stream biological impairment appears on 2002 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.

6.3 STREAM CHEMISTRY ASSESSMENT UNITS - CATEGORIZATION

From Figure 17 after an initial check to make sure the AU is not already on the 2002 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, 1st priority.

2) Screen for acute aquatic life violations for each monitoring site. If more than 2 samples from a fixed monitoring site (1996-2003 data) exceed acute aquatic life criteria and more than 1 sample from a rotational monitoring site (1990 to 2003 data) exceed acute aquatic life criteria, then the monitoring site's AU will be listed on the 2002 303(d) List (Category 5, 1st priority).

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3) The EPA 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 4.1.

4) If the binomial test indicates impairment then the AU will be placed on the 2004 303(d) List.

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 14) 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 2004 303(d) List.

7.0 ESTABLISHMENT OF PRIORITY WITHIN LIST (CATEGORY 5) FOR TMDL DEVELOPMENT

7.1 LAKE PRIORITY DETERMINATION METHOD

1) First priority goes to lakes with latest five year average chlorophyll a concentrations between 12-16 ppb and has existing primary contact recreation uses.

2) Second priority goes to lakes with latest five year average chlorophyll a concentrations exceeding 40 ppb or total phosphorus concentrations exceeding 100 ppb.

3) Third priority goes to lakes with latest five year average chlorophyll a concentrations between 16-40 ppb, or total phosphorus concentrations between 50-100 ppb.

4) Third priority goes to wetlands with the latest five year average total phosphorus concentration greater than 100 ppb.

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

6) Should any lakes with 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 last five years.

7) For other pollutants, if excursions appears in three or more years of the last five, place in first priority; if excursions appears in two years of the last five, place in second priority.

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7.2 STREAM BIOLOGY PRIORITY METHOD

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

Aquatic Life Support	MBI	KBI-NO	EPT Abundance
Fully Supporting	<4.5	<2.60	>48%
Partially Supporting	4.51-5.39	2.61-2.99	47% - 31%
Non-supporting	>5.4	>3.0	<30%

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

1) First priority goes to streams with two or more of the above metrics showing non-support.

2) Second priority goes to streams with two or more of the above metrics showing partial support or impairments appearing through fish tissue analysis. Second priority would go to a stream with one metric showing full support, one indicating partial support, and one showing non-support.

3) Third priority goes to streams with two of the above metrics showing full support.

4) If percent mussel loss data is available and shows partial or non-support, then the stream priority would be moved up one rank.

Aquatic Life Support	% Mussel Loss
Fully Supporting	<10%
Partially Supporting	11-25%
Non-supporting	>26%

5) Streams that have only one to two biological samples from the latest five years will be deemed Category 3.

6) Streams that are designated as being fully supporting on the 2004 305(b) report yet have one or more of the above metrics showing partial support will be deemed Category 2.

7.3 STREAM CHEMISTRY PRIORITY METHOD

Those AUs found to be impaired by a pollutant and placed on the 2004 303(d) List not already assigned to a priority within category 5 will be prioritized for TMDL development. The prioritization method is described in Section 5. The resulting $LCL_{0.9,0.9}$ from the methods in Section 5 will be ordered from highest to lowest by pollutant. The top 3rd of the $LCL_{0.9,0.9}$ by pollutant will be assigned 1st priority within category 5. The middle third will be the 2nd priority and the bottom third the 3rd priority in category 5.

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7.4 ADDITIONAL CONSIDERATIONS IN PRIORITY

Acute aquatic life impairments within category 5 will be place in the 1st priority level. Domestic water supply nitrate impairments within category 5 will also be placed in the 1st priority level. First priority of category 5 impairments will also be assigned for all 1998 303(d) listed waters which still require the development of a TMDL.

7.4.1 WEIGHT OF EVIDENCE APPROACH IN PRIORITY WITHIN LISTING

A biological monitoring site impairment in conjunction with a reasonably related stream chemistry site impairment (or visa versa) located within the same AU will elevate that AU's priority within category 5 to which ever is higher of the two listings. For example, if an AU is listed as impaired by data from an ambient stream chemistry monitoring site for a pollutant and its current priority

level is 2nd priority in category 5, and a biological monitoring site indicates a reasonably related impairment to the aquatic community and it is currently assigned a 3rd priority in category 5, then the priority of the biological site's impairment will be upgraded from 3rd priority to 2nd priority to match the higher priority of the stream chemistry site impairment.

7.4.2 Subdivisions of Priority by Basin Grouping

The priority groupings from Sections 7.1 - 7.4.1 will be placed into the 12 basins in Kansas based on AU location. This defines the next 5 year schedule of TMDL development. The next 5 years of TMDL development will follow the original 5 year schedule by basin and is provided in Table 16. Impaired Assessment Units designated as Priority 1 will have TMDLs developed over 2004-2006.

8.0 Overview of 2004 Delisting Methodology

8.1 Lake and Wetland Assessment Units - Considerations for Delisting

1) For lakes designated for primary contact recreation and listed for eutrophication on the 2002 list, if the two latest sampling dates have chlorophyll a average concentration 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 2002 list for eutrophication, if the two latest samples have chlorophyll a average concentration 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.

8.2 Stream Biology Assessments- Considerations for Delisting

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1) For 2002 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 2002 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.

8.3 Stream Chemistry Assessment Units - Considerations for Delisting

Kansas will not delist any streams on the 2002 303(d) based upon the assessment of data, other than the exception explained in section 8.3.1. Typographical errors and listing errors from the 2002 303(d) List will be corrected in the 2004 303(d) List.

8.3.1 CHRONIC AQUATIC LIFE IMPAIRMENTS - STABLE AND UNSTABLE FLOW ASSESSMENT METHOD

In 2002, for the first time since Kansas began the 303(d) listing process, an assessment was made to determine whether chronic aquatic life impairments existed in the State's streams. EPA 305(b) Guidance (USEPA, 1995) addresses factors to consider regarding toxicant data and these data's application to chronic aquatic life criteria. EPA states "Grab and composite samples can be used in water quality assessments if taken during stable conditions". This statement created the impetus for the State to assess chronic aquatic life use by means of grab samples for the 2002 303(d) list.

During the 2002 303(d) List development, time did not allow for a review of the hydrologic conditions associated with individual grab samples. It has always been the intent of the State that this review of the hydrologic condition as it existed at the time grab samples were collected should occur prior to TMDL development. 'Stable condition' excursions of chronic aquatic life criteria are true violations, while 'unstable condition' excursions of chronic aquatic life criteria, since they do not meet the definition of a criteria violation as it applies to chronic aquatic life, will be not be assessed as an exceedance. What follows is the method to be employed by the State for making this 'stable versus unstable' determination.

The original premise of EPA guidance on chronic aquatic life assessments was related to a 4-day composite sample. In following the original intent (4-day composite concept), even though Kansas does not collect data in this fashion (only grab samples are collected), the review of hydrologic conditions will be based upon 4 days of flow. These 4 days of flow will be the average daily flow on the date a grab sample was collected and the three days prior to that date. The entire determination of stable or unstable conditions is based upon a statistical measure of the amount of variation in these 4 days of flow. The smaller this variation, the more stable the condition during which a grab sample was collected.

The statistic used is the coefficient of variation (CV) found by dividing the standard deviation of the 4 flow days by the mean of those 4 flow days. The CV is expressed as a percentage (actually, it is the standard deviation that is given as a percentage of the mean). The smaller this percentage, the more stable the condition during the 4 days of interest. Kansas believes that a very conservative demarcation of stable and unstable conditions is a CV of 20%. A stable condition will be defined as the 4 days of interest whose average daily flow CV is 20% or less; unstable conditions will be a CV of greater than 20%.

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All 2002 303(d) toxicant listings showing impairment for chronic aquatic life will be reviewed during the 2004 303(d) listing process using the method outlined in section 8.3.1. A grab sample that is determined to have occurred during unstable conditions will be redefined as meeting chronic aquatic life criteria and grab samples that are determined to have occurred during stable flow will continue to be considered excursion from chronic aquatic life criteria. Once the proposed methodology is applied to all grab samples from a previously listed monitoring site that was originally determined to supporting chronic aquatic life criteria in the 2002 303(d) List, the site will be re-assessed following the assessment methodology for the 2004 303(d) List for support of the chronic aquatic life designated use.

If it is found that the revised number of excursions is no longer large enough to support a determination of impairment to chronic aquatic life (Table 14), the AU and impairment will be removed from the 303(d) list and EPA will be supplied the data and findings supporting this action. Kansas believes this delisting is reasonable and correct, since it will be demonstrated that an incomplete analysis of the original data led to the assessment unit be listed and a more recent and accurate analysis of the data shows that the applicable designated uses are supported. If it is found that the revised number of excursions is still large enough to support the determination of impairment the listing will be carried into the 2004 303(d) list, priority for TMDL development will be assigned and a TMDL will be written for the toxicant.

9.0 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 at http://www.kdhe.state.ks.us/tmdl/303d.htm on November 3, 2003. The draft list was released on January 30, 2004 for public review and comment.

9.1 PUBLIC HEARING DATES AND LOCATIONS

KDHE held three public hearings to receive comments on the proposed 2004 Section 303(d) List. The date, time and locations were as follows:

February 24, 2004, 7:00 p.m., Lee Richardson Zoo, Finnup Center, Garden City, Kansas.

February 25, 2004, 7:00 p.m., Great Plains Nature Center, Coleman Auditorium, 6232 E. 29th St. North, Wichita, Kansas.

February 26, 2004, 7:00 p.m., Memorial Hall, 2nd Floor Auditorium, 120 SW 10th, Topeka, Kansas.

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9.2 PUBLIC COMMENTS AND AGENCY RESPONSE

Public comments will be taken at the three public hearings and during the original open comment period spanning February 2 through March 1, 2004. Late interest in commenting on the list of impaired waters and the methodology may prompt KDHE to extend the open period. The public record closed on March 1, 2004, and KDHE has considered the received comments, formulated a response to those comments and will post the comments and responses on its TMDL Web site.

10.0 SUBMITTAL TO EPA REGION 7

The finalized Section 303(d) List for 2004, 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, 2004.

11.0 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.

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