Methodology for the Development

of the

2016 Section 303(d) List in Missouri

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Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program

Missouri
Department of
Natural Resources

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I. Citation and Requirements

A. Citation of Section of Clean Water Act

This document is required by revisions of rules under the Federal Clean Water Act, Section 303(d), 40 CFR 130.7, and the timetable for presenting the finished document to the United States Environmental Protection Agency (EPA) and the public is given in Part 130.10. Section 303(d) requires states to list certain impaired waters and the rules require that states describe how this list will be constructed. Missouri fulfills reporting requirements under Sections 303(d), 305(b) and 314 of the Clean Water Act by the submission to EPA of an integrated report at the time the Section 303(d) list is approved by the Missouri Clean Water Commission. In years when no integrated report is submitted, the Missouri Department of Natural Resources (Department) submits a copy of its statewide water quality assessment database to EPA.

B. U.S. EPA Guidance

In July 2003, EPA issued new guidance entitled "Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act." This guidance gave further recommendations about listing of 303(d) and other waters. In July 2005, EPA published an amended version entitled "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act" (Appendix A). In October 2006, EPA issued a memorandum entitled "Information Concerning 2008 Clean Water Act Sections 303(d), 305(b) and 314 Integrated Reporting and Listing Decisions." This memorandum serves as EPA's guidance for the 2008 reporting cycle and beyond. In subsequent years, EPA has provided additional guidance, but only limited new supplemental information has been provided since the 2008 cycle. Additional information can be found at EPA's website: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/guidance.cfm.

The Department is responsible for administration of the Federal Clean Water Act in Missouri. EPA regulations require that the Department describe the methodology used to develop the state's 303(d) list. Biennially, the methodology is reviewed and revised as necessary, and made available to the public for review and comment. In accordance with the guidance, the Department provides EPA with a document summarizing all comments received and the Department responses to significant comments. EPA's guidance recommends the Department provide: (1) a description of the methodology used to develop the Section 303(d) list; (2) a description of the data and information used to identify (impaired and threatened) waters, including a description of the existing and readily available data and information used; and (3) a rationale for any decision for not using any existing and readily available data and information. The guidance also notes that "prior to submission of its Integrated Report, each state should provide the public with the opportunity to review and comment on the methodology." The guidelines further recommend that the methodology document include information on how interstate or international disagreements concerning the list are resolved.

Placement of Waters within the Five Categories in the 2006[1] EPA Assessment, Listing and Reporting Guidance

The guidance issued by EPA in 2006 recommends all waters of the state be placed in one of five categories.

Category 1

All designated beneficial uses are fully maintained. Data or other information supporting full beneficial use attainment for all designated beneficial uses must be consistent with the state's Listing Methodology Document (LMD). The Department will place a water in Category 1 if the following conditions are met:

- The water has physical and chemical data (at a minimum, water temperature, pH, dissolved oxygen, ammonia, total cobalt, and total copper for streams, and total nitrogen, total phosphorus and secchi depth for lakes) and biological water quality data (at a minimum, *E. coli* or fecal coliform bacteria) that indicates attainment with water quality standards.
- The level of mercury in fish fillets or plugs used for human consumption does not exceed fish tissue guidelines of 0.3 mg/kg or less. Only samples of higher trophic level species (largemouth, smallmouth and Kentucky Spotted bass, sauger, walleye, northern pike, trout, striped bass, white bass, flathead catfish and blue catfish) will be used.
- The water is not rated as "threatened."

Category 2

One or more designated beneficial uses are fully attained but at least one designated beneficial use has inadequate data or information to make a use attainment decision consistent with the state's LMD. The Department will place a water in Category 2 if at least one of the following conditions are met:

- There is inadequate data for water temperature, pH, dissolved oxygen, ammonia, total cobalt or total copper in streams to assess attainment with water quality standards or inadequate total nitrogen, total phosphorus or secchi data in lakes.
- There is inadequate *E. coli* or fecal coliform bacteria data to assess attainment with the whole body contact recreational use.
- There is insufficient fish fillet tissue, or plug data available for mercury to assess attainment with the fish consumption use.

Category 2 waters will be placed in one of two sub-categories.

[1] http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/2005_08_11_tmdl_2006IRG_report_2006irg-sec5.pdf

Category 2A: Waters will be placed in this category if available data, using best professional judgement, suggests compliance with numeric water quality criteria of Tables A or B in Missouri's Water Quality Standards (10 CSR 20-7.031) or other quantitative thresholds for determining use attainment.

Category 2B: Waters will be placed in this category if the available data, using best professional judgment, suggests noncompliance with numeric water quality criteria of Tables A or B in Missouri's Water Quality Standards, or other quantitative thresholds for determining use attainment, and this data is insufficient to support a statistical test or to qualify as representative data. Category 2B waters will be given high priority for additional water quality monitoring.

Category 3

Water quality data are not adequate to assess any of the designated beneficial uses consistent with the LMD. The Department will place a water in Category 3 if data are insufficient to support a statistical test or to qualify as representative data to assess any of the designated beneficial uses. Category 3 waters will be placed in one of two sub-categories.

Category 3A. Waters will be placed in this category if available data, using best professional judgement, suggests compliance with numeric water quality criteria of Tables A or B in Missouri's Water Quality Standards (10 CSR 20-7.031) or other quantitative thresholds for determining use attainment.

Category 3B. Waters will be placed in this category if the available data, using best professional judgement, suggests noncompliance with numeric water quality criteria of Tables A or B in Missouri's Water Quality Standards or other quantitative thresholds for determining use attainment. Category 3B waters will be given high priority for additional water quality monitoring.

Category 4

State Water Quality Standards or other criteria, as per the requirements of Table 1 of this document, are not attained, but a Total Maximum Daily Load (TMDL) study is not required. Category 4 waters will be placed in one of three sub-categories.

Category 4A. EPA has approved a TMDL study that addresses the impairment. The Department will place a water in Category 4A if both the following conditions are met:

- Any portion of the water is rated as being in non-attainment with state Water Quality Standards or other criteria as explained in Table 1 of this document due to one or more discrete pollutants or discrete properties of the water[2], and
- EPA has approved a TMDL for all pollutants that are causing non-attainment.

[2] A discrete pollutant or a discrete property of water is defined here as a specific chemical or other attribute of the water (such as temperature, dissolved oxygen or pH) that causes beneficial use impairment and that can be measured quantitatively.

Category 4B. Water pollution controls required by a local, state or federal authority, are expected to correct the impairment in a reasonable period of time. The Department will place a water in Category 4B if **both** of the following conditions are met:

- Any portion of the water is rated as being in non-attainment with state Water Quality Standards or other criteria as explained in Table 1 of this document due to one or more discrete pollutants or discrete properties of water[2], and
- A water quality based permit that addresses the pollutant(s) causing the designated use impairment has been issued and compliance with the permit limits will eliminate the impairment; or other pollution control requirements have been made that are expected to adequately address the pollutant(s) causing the impairment. This may include implemented voluntary watershed control plans as noted in EPA's guidance document.

Category 4C. Any portion of the water is rated as being in non-attainment with state Water Quality Standards or other criteria as explained in Table 1 of this document, and a discrete pollutant(s) or other discrete property of the water[2] does not cause the impairment. Discrete pollutants may include specific chemical elements (e.g., lead, zinc), chemical compounds (e.g., ammonia, dieldrin, atrazine) or one of the following quantifiable physical, biological or bacteriological conditions: water temperature, percent of gas saturation, amount of dissolved oxygen, pH, deposited sediment, toxicity or counts of fecal coliform or *E. coli* bacteria.

Category 5

At least one discrete pollutant has caused non-attainment with state Water Quality Standards or other criteria as explained in Table 1 of this document, and the water does not meet the qualifications for listing as either Categories 4A or 4B. Category 5 waters are those that are candidates for the state's 303(d) List[3].

If a designated use is not supported and the segment is impaired or threatened, the fact that a specific pollutant is not known does not provide a basis for excluding a segment from Category 5. These segments must be listed as Category 5 unless the state can demonstrate that no discrete pollutant or pollutants causes or contributes to the impairment. Pollutants causing the impairment will be identified through the 303(d) assessment and listing process before a TMDL study is written. The TMDL should be written within the time frame preferred in EPA guidance for TMDL development, when it fits within the state's TMDL prioritization scheme.

Threatened Waters

When a water that would otherwise be in Categories 1, 2, or 3 has a time trend analysis for one or more discrete water quality pollutants indicates the water is currently maintaining all beneficial uses but will not continue to meet these uses before the next listing cycle, it will be considered a "threatened water." A threatened water will be treated as an impaired water and placed in the appropriate Category (4A, 4B, or 5).

[3] The proposed state 303(d) List is determined by the Missouri Clean Water Commission and the final list is determined by the U.S. Environmental Protection Agency.

II. The Methodology Document

A. Procedures and Methods Used to Collect Water Quality Data

Department Monitoring

The major purposes of the Department's water quality monitoring program are:

- to characterize background or reference water quality conditions;
- to better understand daily, flow event and seasonal water quality variations and their underlying processes;
- to characterize aquatic biological communities;
- to assess time trends in water quality;
- to characterize local and regional impacts of point and nonpoint source discharges on water quality;
- to check for compliance with Water Quality Standards or wastewater permit limits;
- to support development of strategies, including Total Maximum Daily Loads, to return impaired waters to compliance with Water Quality Standards. All of these objectives are statewide in scope.

Coordination with Other Monitoring Efforts in Missouri

To maximize efficiency, the Department routinely coordinates its monitoring activities to avoid overlap with other agencies, and to provide and receive interagency input on monitoring study design. Data from other sources is used for meeting the same objectives as Department sponsored monitoring. The agencies most often involved are the U.S. Geological Survey, the U.S. Army Corps of Engineers, EPA, the Missouri Department of Conservation, and the Missouri Department of Health and Senior Services. The Department also tracks the monitoring efforts of the National Park Service, the U.S. Forest Service, several of the state's larger cities, the states of Oklahoma, Arkansas, Kansas, Iowa and Illinois, and graduate level research conducted at universities within Missouri. For those wastewater discharges where the Department has required instream water quality monitoring, the Department may also use monitoring data acquired by wastewater dischargers as a condition of discharge permits issued by the department. In 1995, the Department also began using data collected by volunteers that have passed Quality Assurance/Quality Control tests.

Existing Monitoring Networks and Programs

The following list is a description of the kinds of water quality monitoring activities presently occurring in Missouri.

1. Fixed Station Network

   A. Objective: To better characterize background or reference water quality conditions, to better understand daily, flow event, and seasonal water quality variations and their

underlying processes, to assess time trends and to check for compliance with Water Quality Standards.

B. Design Methodology: Sites were chosen based on one of the following criteria:
   - Site is believed to have water quality representative of many neighboring streams of similar size due to similarity in watershed geology, hydrology and land use, and the absence of any impact from a significant point or discrete nonpoint water pollution source.
   - Site is downstream of a significant point source or discrete nonpoint source area.

C. Number of Sites, Sampling Methods, Sampling Frequency, and Parameters:
   - Department/U.S. Geological Survey cooperative network: 70 sites statewide, horizontally and vertically integrated grab sampled, six to 12 times per year. Samples are analyzed for major ions, nutrients, temperature, pH, dissolved oxygen, specific conductance and flow on all visits, two to four times annually for suspended solids and heavy metals, and for pesticides six times annually at six sites.
   - Department/University of Missouri-Columbia's lake monitoring network. This program has monitored about 249 lakes since 1989. About 75 lakes are monitored each year. Each lake is usually sampled four times during the summer and about 12 are monitored spring through fall for nutrients, chlorophyll, turbidity and suspended solids.
   - Department routine monitoring of finished public drinking water supplies for bacteria and trace contaminants.
   - Routine bacterial monitoring of swimming beaches at Missouri's state parks during the recreational season by the Department's Division of State Parks.
   - Monitoring of sediment quality by the Department at approximately 10 discretionary sites annually. All sites are monitored for several heavy metals and organic contaminants.

2. Special Water Quality Studies

A. Objective: Special water quality studies are used to characterize the water quality impacts from a specific pollutant source area.

B. Design Methodology: These studies are designed to determine the contaminants of concern based on previous water quality studies, effluent sampling and/or Missouri State Operating Permit applications. These studies employ multiple sampling stations downstream and upstream (if appropriate). If contaminants of concern have significant seasonal or daily variation, season of the year and time of day variation must be accounted for in the sampling design.

C. Number of Sites, Sampling Methods, Sampling Frequency and Parameters: The Department conducts or contracts for 10 to15 special studies annually, as funding allows. Each study has multiple sampling sites. Number of sites, sampling frequency and

parameters all vary greatly depending on the study. Intensive studies would also require multiple samples per site over a relatively short time frame.

3. Toxics Monitoring Program

The fixed station network and many of the Department's intensive studies monitor for toxic chemicals. In addition, major municipal and industrial dischargers must monitor for toxicity in their effluents as a condition of their Missouri State Operating Permit.

4. Biological Monitoring Program

A. Objectives: The objectives of this program are to develop numeric criteria describing "reference" aquatic macroinvertebrate and fish communities in Missouri's streams, to implement these criteria within state Water Quality Standards and to continue a statewide fish and aquatic invertebrate monitoring program.

B. Design Methodology: Development of biocriteria for invertebrates and fish involves identification of reference streams in each of Missouri's 17 ecological drainage units. It also includes intensive sampling of invertebrate and fish communities to quantify temporal and spatial variation in reference streams within ecoregions and variation between ecoregions, and the sampling of chemically and physically impaired streams to test sensitivity of various community metrics to differences in stream quality.

C. Number of Sites, Sampling Methods, Sampling Frequency and Parameters: The Department has conducted biological sampling of aquatic invertebrates for many years. Since 1991, this program has consisted of standardized monitoring of approximately 55 sites twice annually. The Missouri Department of Conservation presently has a statewide fish and aquatic invertebrate monitoring program, the Resource Assessment and Monitoring (RAM) Program, designed to assess and monitor the health of Missouri's stream resources. This program samples a minimum of 450 random and 30 reference sites every five years.

5. Fish Tissue Monitoring Program

A. Objective: Fish tissue monitoring can address two separate objectives. These are: (1) the assessment of ecological health or the health of aquatic biota (usually accomplished by monitoring whole fish samples); and (2) the assessment of human health risk based on the level of contamination of fish tissue plugs, or fillets.

B. Design Methodology: Fish tissue monitoring sites were chosen based on one of the following criteria:

- Site is believed to have water and sediment quality representative of many neighboring streams or lakes of similar size due to similarity in geology, hydrology and land use, and the absence of any known impact from a significant point source or discrete nonpoint water pollution source.

- Site is downstream of a significant point source or discrete nonpoint source area.
- Site has shown fish tissue contamination in the past.

C. Number of Sites, Sampling Methods, Sampling Frequency and Parameters:

The Department plans to maintain fish tissue monitoring program to collect whole fish composite samples[4] at approximately12 fixed sites. In previous years, this was a cooperative effort between EPA and the Department. Each site will be sampled once every two years. The preferred species for these sites are either carp or redhorse sucker.

The Department, EPA, and the Missouri Department of Conservation also sample 40 to 50 discretionary sites annually for two fish fillet composite samples or plug samples (mercury only) from fish of similar size and species. One sample is of a top carnivore such as largemouth bass, smallmouth bass, walleye or sauger. The other sample is for a species of a lower trophic level such as catfish, carp or sucker. This program occasionally samples fish eggs for certain fish species at selected locations. Both of these monitoring programs analyze for several chlorinated hydrocarbon insecticides, PCBs, lead, cadmium, mercury, and fat content.

6. Volunteer Monitoring Program

Two major volunteer monitoring programs are now generating water quality data in Missouri. The first is the Lakes of Missouri Volunteer Program. This cooperative program consists of persons from the Department, the University of Missouri-Columbia and volunteers that monitor approximately 137 sites on 66 lakes, including Lake Taneycomo, Table Rock Lake and several lakes in the Kansas City area. Data from this program is used by the university as part of a long-term study on the limnology of midwestern reservoirs.

The second program involves volunteers who monitor water quality of streams throughout Missouri. The Volunteer Water Quality Monitoring Program is a subprogram of the Missouri Stream Team Program, a cooperative project sponsored by the Department, the Missouri Department of Conservation and the Conservation Federation of Missouri. By the end of 2012 over 5,000 citizen volunteers had attended at least one training workshop. After the introductory class, many proceed on to at least one more class of higher level training: Levels 1, 2, 3 and 4. Each level of training is a prerequisite for the next higher level, as is appropriate data submission. Data generated by Levels 2, 3, and 4 and the new Cooperative Site Investigation Program volunteers represent increasingly higher quality assurance. Of those completing an introductory course, about 35 percent proceed to Levels 1 and 2. One hundred-two volunteers have reached Level 3 and six volunteers have reached Level 4. The Cooperative Site Investigation Program uses trained volunteers to collect samples and transport them to laboratories approved by the Department. Volunteers and Department staff work together to develop a monitoring plan. Currently there are 25 volunteers qualified to work in the Cooperative Site Investigation Program. All Level 2, 3, and 4 volunteers as well as all CSI trained volunteers are required to attend a validation session every 3 years to insure, equipment,

[4] A composite sample is one in which several individual fish are combined to produce one sample.

reagents and methods meet our standards. To date 70 individuals have attended a validation session at least once.

Laboratory Analytical Support

Laboratories used:

- Department/U.S. Geological Survey Cooperative Fixed Station Network: U.S. Geological Survey Lab, Denver, Colorado
- Intensive Surveys: Varies, many are done by the Department's Environmental Services Program
- Toxicity Testing of Effluents: Many commercial laboratories
- Biological Criteria for Aquatic Invertebrates: Department's Environmental Services Program and University of Missouri-Columbia
- Fish Tissue: EPA Region VII Laboratory, Kansas City, Kansas and miscellaneous contract laboratories (Missouri Department of Conservation)
- Missouri State Operating Permit: Self-monitoring or commercial laboratories
- Department's Public Drinking Water Monitoring: Department's Environmental Services Program and commercial laboratories
- Other water quality studies: Many commercial laboratories

B. Identification of All Existing and Readily Available Water Quality Data Sources:

The following data sources are used by the Department to aid in the compilation of the state's 305(b) report. Where quality assurance programs are deemed acceptable, these sources would also be used to develop the state's Section 303(d) list. These sources presently include but are not limited to:

1. Fixed station water quality and sediment data collected and analyzed by the Department's Environmental Services Program personnel.
2. Fixed station water quality data collected by the U.S. Geological Survey under contractual agreements with the Department.
3. Fixed station water quality data collected by the U.S. Geological Survey under contractual agreements to agencies or organizations other than the Department.
4. Fixed station water quality, sediment quality and aquatic biological information collected by the U.S. Geological Survey under their National Stream Quality Accounting Network and the National Water Quality Assessment Monitoring Programs.
5. Fixed station raw water quality data collected by the Kansas City Water Services Department, the St. Louis City Water Company, the Missouri American Water Company (formerly St. Louis County Water Company), Springfield City Utilities and Springfield's Department of Public Works.

6. Fixed station water quality data collected by the U.S. Army Corps of Engineers. The Kansas City, St. Louis and Little Rock Corps Districts have monitoring programs for Corps-operated reservoirs in Missouri.

7. Fixed station water quality data collected by the Arkansas Department of Environmental Quality, the Kansas Department of Health and Environment, the Iowa Department of Natural Resources, and the Illinois Environmental Protection Agency.

8. Fixed station water quality monitoring by corporations**.**

9. Annual fish tissue monitoring programs by the Environmental Protection Agency/Department Regional Ambient Fish Tissue Monitoring Program and the Missouri Department of Conservation.

10. Special water quality surveys conducted by the Department. Most of these surveys are focused on the water quality impacts of specific point source wastewater discharges. Some surveys are of well-delimited nonpoint sources such as abandoned mined lands. These surveys often include physical habitat evaluation and monitoring of aquatic invertebrates as well as water chemistry monitoring.

11. Special water quality surveys conducted by U.S. Geological Survey, including but not limited to:

    a) Geology, hydrology and water quality of various hazardous waste sites,

    b) Geology, hydrology and water quality of various abandoned mining areas,

    c) Hydrology and water quality of urban nonpoint source runoff in St. Louis, Kansas City and Springfield, Missouri, and

    d) Bacterial and nutrient contamination of streams in southern Missouri.

12. Special water quality studies by other agencies such as the Missouri Department of Conservation, the U.S. Public Health Service, and the Missouri Department of Health and Senior Services.

13. Monitoring of fish occurrence and distribution by the Missouri Department of Conservation.

14. Fish Kill and Water Pollution Investigations Reports published by the Missouri Department of Conservation.

15. Selected graduate research projects pertaining to water quality and/or aquatic biology.

16. Water quality, sediment and aquatic biological data collected by the Department, the Environmental Protection Agency or their contractors at hazardous waste sites in Missouri.

17. Self-monitoring of receiving streams by cities, sewer districts and industries, or contractors on their behalf, for those discharges that require this kind of monitoring. This monitoring includes chemical and sometimes toxicity monitoring of some of the larger wastewater discharges, particularly those that discharge to smaller streams and have the greatest potential to affect instream water quality.

18. Compliance monitoring of receiving waters by the Department and EPA. This can include chemical and toxicity monitoring.

19. Bacterial monitoring of streams and lakes by county health departments, community lake associations and other organizations using acceptable analytical methods.

20. Other monitoring activities done under a quality assurance project plan approved by the Department.

21. Fixed station water quality and aquatic invertebrate monitoring by volunteers who have successfully completed the Volunteer Water Quality Monitoring Program Level 2 workshop. Data collected by volunteers who have successfully completed a training Level 2 workshop is considered to be Data Code One. Data generated from Volunteer Training Levels 2, 3 and 4 are considered "screening" level data and can be useful in providing an indication of a water quality problem. For this reason, the data is eligible for use in distinguishing between waters in Categories 2A and 2B or Categories 3A and 3B. Most of this data is not used to place waters in main Categories (1, 2, 3, 4 and 5) because analytical procedures do not use EPA or Standard Methods approved methods. Data from volunteers who have not yet completed a Level 2 training workshop do not have sufficient quality assurance to be used for any assessment purposes. Data generated by volunteers while participating in the Department's Cooperative Site Investigation Program (Section II C1) or other volunteer data that otherwise meets the quality assurance outlined in Section II C2 can be used in the Section 303(d) assessment process.

    The following data sources (22-23) **cannot** be used rate a water as impaired (Categories 4A, 4B, 4C or 5); however, these data sources may be used to direct additional monitoring that would allow a water quality assessment for Section 303(d) listing purposes.

22. Fish Management Basin Plans published by the Missouri Department of Conservation.

23. Fish Consumption Advisories published annually by the Missouri Department of Health and Senior Services. Note: the Department may use data from data source No. 9 (as listed above) to list individual waters as impaired due to contaminated fish tissue.

The Department will review all data of acceptable quality that is submitted to the Department prior to the end of the first public notice of the draft 303(d) list. The Department reserves the right to review and use data of acceptable quality submitted after this date if the data results in a change to the assessment status of the water.

C. Data Quality Considerations

1. DNR Quality Assurance/Quality Control Program

   The Department and EPA Region VII have completed a Quality Management Plan. All environmental data generated directly by the Department, or through contracts funded by the Department, or EPA require a Quality Assurance Project Plan. The agency or organization responsible for collection and/or analysis of the environmental sampling

must write and adhere to a Quality Assurance Project Plan approved through the Department's Quality Management Plan. Any environmental data generated by a monitoring plan with a Department approved Quality Assurance Project Plan is considered suitable for use in the 303(d) assessment process. This includes data generated by volunteers participating in the Department's Cooperative Site Investigation Program. Under this program, the Department's Environmental Services Program will audit selected non-profit (governmental and university) laboratories. Laboratories that pass this audit will be approved for the Cooperative Site Investigation Program. Individual volunteers that collect samples and deliver them to an approved laboratory must first successfully complete Department training in proper collection and handling of samples. The kind of information that should allow the department to make a judgment on the acceptability of a quality assurance program are: (1) a description of the training, and work experience of the persons involved in the program, (2) a description of the field meters used and maintenance and calibration procedures used, (3) a description of sample collection and handling procedures and (4) a description of all analytical methods used for samples taken to a laboratory for analysis.

2. Other Quality Assurance/Quality Control Programs

Data generated in the absence of a Department-approved Quality Assurance Project Plan may be used to determine the 303(d) status of a waterbody if the Department determines that the data is scientifically defensible after making a review of the quality assurance procedures used by the data generator. This review would include: (1) names of all persons involved in the monitoring program, their duties and a description of training and work related experience, (2) all written procedures, Standard Operating Procedures, or Quality Assurance Project Plans pertaining to this monitoring effort, (3) a description of all field methods used, brand names and model numbers of any equipment and a description of calibration and maintenance procedures, and (4) a description of laboratory analytical methods. This review may also include an audit by the Department's Environmental Services Program.

3. Other Data Quality Considerations

3.1 Data Age. For assessing present conditions, more recent data is preferable; however, older data can be used to assess present conditions if the data remains representative of present conditions.

If the Department uses data to make a Section 303(d) list decision that predates the date the list is initially developed by more than seven years, the Department will provide a written justification for the use of such data.

A second consideration is the age of the data relative to significant events that may have an effect on water quality. Data collected prior to the initiation, closure or significant change in a wastewater discharge, or prior to a large spill event or the reclamation of a mining or hazardous waste site, for example, may not be representative of present conditions. Such data would not be used to assess present conditions even if it was less

than seven years old. Such "pre-event" data can be used to determine changes in water quality before and after the event or to show water quality time trends.

3.2 Data Type, Amount and Information Content. EPA recommends establishing a series of data codes, and rating data quality by the kind and amount of data present at a particular location (EPA 1997[5]). The codes are single digit numbers from one to four, indicating the relative degree of assurance the user has in the value of a particular environmental data set. Data Code One indicates the least assurance or the least number of samples or analytes and Data Code Four the greatest. Based on EPA's guidance, the Department uses the following rules to assign code numbers to data.

- Data Code[6] One: All data not meeting the requirements of Data Code Two, Three or Four.

- Data Code Two: Chemical data collected quarterly to bimonthly for at least three years, or intensive studies that monitor several nearby sites repeatedly over short periods of time, or at least three fish tissue samples per water body, or at least five bacterial samples collected during the recreational season of one calendar year.

- Data Code Three: Chemical data collected at least monthly for more than three years on a variety of water quality constituents including heavy metals and pesticides; or quantitative biological monitoring of at least one aquatic assemblage (fish, invertebrates or algae) at multiple sites, or multiple samples at a single site when data from that site is supported by biological monitoring at an appropriate control site.

- Data Code Four: Chemical data collected at least monthly for more than three years that provides data on a variety of water quality constituents including heavy metals and pesticides, and including chemical sampling of sediments and fish tissue; or quantitative biological monitoring of at least two aquatic assemblages (fish, invertebrates or algae) at multiple sites.

In Missouri, the primary purpose of Data Code One data is to provide a rapid and inexpensive method of screening large numbers of waters for obvious water quality problems and to determine where more intensive monitoring is needed. In the preparation of the state's 305(b) report, data from all four data quality levels are used. Most of the data is of Data Code One quality, and without Data Code One data, the Department would not be able to assess a majority of the state's waters.

In general, when selecting water bodies for the Missouri 303(d) List, only Data Code Two or higher data are used, unless the problem can be accurately characterized by Data

[5] *Guidelines for the Preparation of the Comprehensive State Water Quality Assessments (305b) and Electronic Updates*, 1997. (http://water.epa.gov/type/watersheds/monitoring/repguid.cfm)
[6] Data Code One is equivalent to data water quality assurance Level One in 10 CSR 20-7.050 General Methodology for Development of Impaired Waters List, subsection (2)(C), Data Code Two is equivalent to Level 2, etc.

Code One data.[7] The reason is that Data Code Two data provides a higher level of assurance that a Water Quality Standard is actually being exceeded and that a TMDL study is necessary. All water bodies placed in Categories 2B or 3B receive high priority for additional monitoring so that data quality is upgraded to at least Data Code Two.

D. How Water Quality Data is Evaluated to Determine Whether or Not Waters are Impaired for 303(d) Listing Purposes

Physical, Chemical, Biological and Toxicity Data

Each reporting cycle, the Department and stakeholders review and revise the guidelines for determining water quality impairment. These guidelines are shown in Tables 1.1 and 1.2 which provide the general rules of data use and assessment and Tables B-1 and B-2 provide details about the specific analytical procedure used. In addition, if time trend data indicates that presently unimpaired waters will become impaired prior to the next listing cycle, these "threatened waters" will be judged to be impaired. Where antidegradation provisions in Missouri's Water Quality Standards apply, those provisions shall be upheld. The numeric criteria included in Table 1.1 have been adopted into the state Water Quality Standards, 10 CSR 20-7.031, and are used, as described in Table 1.1, to make use attainment decisions.

For narrative criteria, the numeric thresholds included in Table 1.2 have not been adopted into state Water Quality Standards. The Department will use a weight of evidence analysis for evaluating all narrative criteria. Under the weight of evidence approach, all available information is examined and the greatest weight is given to data that provide the best supporting evidence. In determining the order of best supporting evidence, best professional judgment will be used to consider factors such as data quality and site-specific environmental conditions. For those analytes with numeric thresholds, the threshold values given in Table 1.2 will trigger a weight of evidence analysis to determine the existence or likelihood of a use impairment and the appropriateness of proposing a 303(d) listing based on narrative criteria. This weight of evidence analysis will include the use of other types of environmental data when it is available or collection of additional data to make the most informed use attainment decision. Examples of other relevant environmental data might include biological data on fish or aquatic invertebrate animals or toxicity testing of water or sediments. See Appendix E for clarification on use of the weight of evidence approach.

When the weight of evidence analysis suggests, but does not provide strong, scientifically defensible evidence of impairment, the Department will place the water body in question in Categories 2B or 3B. The Department will produce a document showing all relevant data and the rationale for the use attainment decision. All such documents will be made available to the public at the time of the first public notice of the proposed 303(d) list. A final recommendation on the listing of a water body based on narrative criteria will only be made after full consideration of all comments on the proposal.

[7] When a listing, amendment or delisting of a 303(d) water is made with only Data Code One data, a document will be prepared that includes a display of all data and a presentation of all statistical tests or other evaluative techniques that documents the scientific defensibility of the data. This requirement applies to all Data Code One data identified in Table 1.1 of this document.

For the interpretation of macroinvertebrate data, where habitat assessment scores indicate habitat is less than 75 percent of reference or appropriate control stream scores, and in the absence of other data indicating impairment by a discrete pollutant, a waterbody judged to be impaired will be placed in Category 4C. When interpreting fish community data, a provisional multi-metric habitat index called the QCPH1 index is used to identify habitat in poor condition (Appendix E). The QCPH1index separates adequate habitat from poor habitat using a 0.39 threshold value; whereby, QCPH1 scores < 0.39 indicate stream habitat is of poor quality, and scores greater than 0.39 indicate available stream habitat is adequate. In the absence of other data indicating impairment by a discrete pollutant, impaired fish communities with poor habitat will be placed in Category 4C. Additional information related to the evaluation of biological data is provided in Appendix E.

For toxic chemicals occurring in benthic sediments, data interpretation will include calculation of a geometric mean for specific toxins from an adequate number of samples, and comparing that value to a corresponding Probable Effect Concentration given by MacDonald *et al.* (2000). The Probable Effect Concentration (PEC) is the level of a pollutant at which harmful effects on the aquatic community are likely to be observed. MacDonald (2000) gave an estimate of accuracy for the ability of individual PECs to predict toxicity. For all metals except arsenic, pollutant geometric means will be compared to 150% of the recommended PEC values. This comparison should meet confidence requirements applied elsewhere in the LMD. When multiple contaminants occur in sediment, toxicity may occur even though the level of each individual pollutant does not reach toxic levels. The method of estimating the synergistic effects of multiple pollutants in sediments given in MacDonald *et al.* (2000) includes the calculation of a PEC Quotient (PECQ). Please see Appendix D for an example calculation of a PECQ. PECQs greater than 0.75 will be judged as toxic.

For the interpretation of toxicity test data, standard acute or chronic bioassay procedures using freshwater aquatic fauna such as, but not limited to, *Ceriodaphnia dubia, Pimephales promelas* or *Hyalella azteca* will provide adequate evidence of toxicity for 303(d) listing purposes. Microtox toxicity tests may be used to list a water as affected by "toxicity" only if there is data of another kind (freshwater toxicity tests, sediment chemistry, water chemistry or biological sampling) that indicates water quality impairment.

For any given water, available data may occur throughout the system and/or be concentrated in certain areas. When the location of pollution sources are known, the Department reserves the right to assess data representative of impacted conditions separately from data representative of unimpacted conditions. Pollution sources include those that may occur at discrete points along a water body, or those which are more diffuse.

TABLE 1.1. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NUMERIC CRITERIA THAT ARE INCLUDED IN STATE WATER QUALITY STANDARDS, 10 CSR 20-7.031

DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
Overall use protection (all designated uses)	No data. Evaluated based on similar land use/ geology as stream with water quality data.[9]	Not applicable	Given same rating as monitored stream with same land use and geology.
Any designated uses	No data available or where only effluent data is available. Results of dilution calculations or water quality modeling	Not applicable	Where models or other dilution calculations indicate noncompliance with allowable pollutant levels and frequencies noted in this table, waters may be added to Category 3B and considered high priority for water quality monitoring.
Protection of Aquatic Life	Water temperature, pH, total dissolved gases, oil and grease.	1-4	Full: No more than 10% of all samples exceed criterion.[10] Non-Attainment: Requirements for full attainment not met.
Losing Streams	E. coli bacteria	1-4	Full: No more than 10% of all samples exceed criterion. Non-Attainment: Requirements for full attainment not met. The criterion for E. coli is 126 counts/100ml. 10 CSR 20-7.031 (4)(C)

[8] See section on Statistical Considerations, Table B-1 and B-2.
[9] This data type is used only for wide-scale assessments of aquatic biota and aquatic habitat for 305(b) Report purposes. This data type is not used in the development of the 303(d) List.
[10] Some sampling periods are wholly or predominantly during the critical period of the year when criteria violations occur. Where the monitoring program presents good evidence of a demarcation between seasons where criteria exceedences occur and seasons when they do not, the 10% exceedence rate will be based on an annual estimate of the frequency of exceedence.

TABLE 1.1. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NUMERIC CRITERIA THAT ARE INCLUDED IN STATE WATER QUALITY STANDARDS, 10 CSR 20-7.031

DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
Protection of Aquatic Life	Dissolved oxygen	1-4	Full: No more than 10% of all samples exceed criterion. Non-Attainment: Requirements for full attainment not met.
Protection of Aquatic Life	Toxic chemicals	1-4	Full: No more than one acute toxic event in three years that results in a documented die-off of aquatic life such as fish, mussels, and crayfish (does not include die-offs due to natural origin). No more than one exceedence of acute or chronic criterion in the last three years for which data is available. Non-Attainment: Requirements for full attainment not met.
Protection of Aquatic Life	Nutrients in Lakes (total phosphorus, total nitrogen, chlorophyll)	1-4	Full: Nutrient levels do not exceed Water Quality Standards following procedures stated in Table B-1. Non-Attainment: Requirements for full attainment not met.[11]
Fish Consumption	Chemicals (water)	1-4	Full: Water quality does not exceed Water Quality Standards following procedures stated in Table B-1. Non-Attainment: Requirements for full attainment not met.
Drinking Water Supply -Raw Water.[12]	Chemical (toxics)	1-4	Full: Water Quality Standards not exceeded following procedures stated in Table B-1. Non-Attainment: Requirements for full attainment not met.

[11] Nutrient criteria will be used in the 2016 LMD only if these criteria appear in the Code of State Regulations, and have not been disapproved by the U.S. Environmental Protection Agency.
[12] Raw water is water from a stream, lake or ground water prior to treatment in a drinking water treatment plant.

TABLE 1.1. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NUMERIC CRITERIA THAT ARE INCLUDED IN STATE WATER QUALITY STANDARDS, 10 CSR 20-7.031

DESIGNATED USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
Drinking Water Supply- Raw Water	Chemical (sulfate, chloride, fluoride)	1-4	Full: Water Quality Standards not exceeded following procedures stated in Table B-1. Non-Attainment: Requirements for full attainment not met.
Drinking Water Supply-Finished Water	Chemical (toxics)	1-4	Full: No Maximum Contaminant Level violations based on Safe Drinking Water Act data evaluation procedures. Non-Attainment: Requirements for full attainment not met. NOTE: Finished water data will not be used for analytes where water quality problems may be caused by the drinking water treatment process such as the formation of Trihalomethanes (THMs) or problems that may be caused by the distribution system (bacteria, lead, copper).
Whole-Body-Contact Recreation and Secondary Contact Recreation	Fecal coliform or *E. coli* count	2-4	Where there are at least five samples per year taken during the recreational season: Full: Water Quality Standards not exceeded as a geometric mean, in any of the last three years for which data is available, for samples collected during seasons for which bacteria criteria apply.[13] Non-Attainment: Requirements for full attainment not met.
Irrigation, Livestock and Wildlife Water	Chemical	1-4	Full: Water Quality Standards not exceeded following procedures stated in Table B-1. Non-Attainment: Requirements for full attainment not met.

[13] A geometric mean of 206 cfu/100 ml for E. coli will be used as a criterion value for Category B Recreational Waters. Because Missouri's Fecal Coliform Standard ended December 31, 2008, any waters appearing on the 2008 303(d) List as a result of the Fecal Coliform Standard will be retained on the list with the pollutant listed as "bacteria" until sufficient E. coli sampling has determined the status of the water.

TABLE 1.2. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
Overall use protection (all beneficial uses)	Narrative criteria for which quantifiable measurements can be made.	1-4	Full: Stream appearance typical of reference or appropriate control streams in this region of the state. Non-Attainment: The weight of evidence, based on the narrative criteria in 10 CSR 20-7.031(3), demonstrates the observed condition exceeds a numeric threshold necessary for the attainment of a beneficial use. For example: Color: Color as measured by the Platinum-Cobalt visual method (SM 2120 B) in a waterbody is statistically significantly higher than a control water. Objectionable Bottom Deposits: The bottom that is covered by sewage sludge, trash or other materials reaching the water due to anthropogenic sources exceeds the amount in reference or control streams by more than twenty percent. Note: Waters in mixing zones and unclassified waters which support aquatic life on an intermittent basis shall be subject to acute toxicity criteria for protection of aquatic life. Waters in the initial Zone of Dilution shall not be subject to acute toxicity criteria.
Protection of Aquatic Life	Toxic Chemicals	1-4	Full: No more than one acute toxic event in three years (does not include ~~fish kills~~ die-offs of aquatic life due to natural origin). No more than one exceedence of acute or

TABLE 1.2. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
			chronic criterion in three years for all toxics.[14, 15] Non-Attainment: Requirements for full attainment not met.

[14] The test result must be representative of water quality for the entire time period for which acute or chronic criteria apply. For ammonia the chronic exposure period is 30 days, for all other toxics 96 hours. The acute exposure period for all toxics is 24 hours, except for ammonia which has a one hour exposure period. The Department will review all appropriate data, including hydrographic data, to insure only representative data is used. Except on large rivers where storm water flows may persist at relatively unvarying levels for several days, grab samples collected during storm water flows will not be used for assessing chronic toxicity criteria.

[15] In the case of toxic chemicals occurring in benthic sediment rather than in water, the numeric thresholds used to determine the need for further evaluation will be the Probable Effect Concentrations proposed in "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" by MacDonald, D.D. et al. Arch. Environ. Contam. Toxicol. 39,20-31 (2000). These - Probable Effect Concentrations are as follows: 33 mg/kg As; 4.98 mg/kg Cd; 111 mg/kg Cr; 149 mg/kg Cu; 48.6 mg/kg Ni; 128 mg/kg Pb; 459 mg/kg Zn; 561 µg/kg naphthalene; 1170 µg/kg phenanthrene; 1520 µg/kg pyrene; 1050 µg/kg benzo(a)anthracene, 1290 µg/kg chrysene; 1450 µg/kg benzo(a)pyrene; 22,800 µg/kg total polyaromatic hydrocarbons; 676 µg/kg total PCBs. Chlordane 17.6 ug/kg; Sum DDE 31.3 ug/kg; Lindane (gamma-BHC) 4.99 ug/kg. Where multiple sediment contaminants exist, the Probable Effect Concentrations Quotient shall not exceed 0.75. See Table B-1 and Appendix D for more information on the Probable Effect Concentrations Quotient.

TABLE 1.2. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
Protection of Aquatic Life	Biological: Aquatic Macroinvertebr-ates sampled using DNR Protocol.[16, 17]	3-4	Full: For seven or fewer samples and following DNR wadeable streams macroinvertebrate sampling and evaluation protocols, 75% of the stream condition index scores must be 16 or greater. Fauna achieving these scores are considered to be very similar to regional reference streams. For greater than seven samples or for other sampling and evaluation protocols, results must be statistically similar to representative reference or control stream.[18] Non-Attainment: For seven or fewer samples and following DNR wadeable streams macroinvertebrate sampling and evaluation protocols, 75% of the stream condition index scores must be 14 or lower. Fauna achieving these scores are considered to be substantially different from regional reference streams. For more than seven samples or for other sampling and evaluation protocols, results must be statistically dissimilar to control or representative reference streams.
	Biological: MDC Fish Community (RAM) Protocol (Ozark Plateau only)[17]	3-4	Full: For seven or fewer samples and following MDC RAM fish community protocols, 75% of the IBI scores must be 36 or greater. Fauna achieving these scores are considered to be very similar to regional reference streams. For greater than seven samples or for other sampling and evaluation protocols, results must be

[16] DNR invert protocol will not be used for assessment in the Mississippi Alluvial Basin (bootheel area) due to lack of reference streams for comparison.
[17] See Appendix E for additional criteria used to assess biological data.
[18] See Table B-1 and B-2. For test streams that are significantly smaller than bioreference streams where both bioreference streams and small control streams are used to assess the biological integrity of the test stream, the assessment of the data should display and take into account both types of control streams.

TABLE 1.2. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
			statistically similar to representative reference or control streams.[18] Suspected of Impairment: Data not conclusive (Category 2B or 3B). For first and second order streams IBI score < 29. Non-Attainment: First and second order streams will not be assessed for non-attainment. When assessing third to fifth order streams with data sets of seven or fewer samples collected by following MDC RAM fish community protocols, 75% of the IBI scores must be lower than 36. Fauna achieving these scores are considered to be substantially different from regional reference streams. For more than seven samples or for other sampling and evaluation protocols, results must be statistically dissimilar to control or representative reference streams.[19,20]
	Other Biological Data[17]	3-4	Full: Results must be statistically similar to representative reference or control streams. Non-Attainment: Results must be statistically dissimilar to control or representative reference streams.

[19] IBI Scores are from "Biological Criteria for Streams and Fish Communities in Missouri" 2008. Doisy et al. for MDC. If habitat limitations (as measured by either the QCPH1 index or other appropriate methods) are judged to contribute to low fish community scores and this is the only type of data available, the water body will be included in Category 4C, 2B, or 3B. If other types of data exist, the weight of evidence approach will be used as described in this document.

[20] For determining influence of poor habitat on those samples that are deemed as impaired, consultation with MDC RAM staff will be utilized. If, through this consultation, habitat is determined to be a significant possible cause for impairment, the water body will not be rated as impaired, but rather as suspect of impairment (categories 2B or 3B).

TABLE 1.2. METHODS FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS USED FOR 303(D) LISTING PURPOSES: NARRATIVE CRITERIA BASED ON NUMERIC THRESHOLDS NOT CONTAINED IN STATE WATER QUALITY STANDARDS (10 CSR 20-7.031)

BENEFICIAL USES	DATA TYPE	DATA QUALITY CODE	COMPLIANCE WITH WATER QUALITY STANDARDS[8]
Protection of Aquatic Life	Toxicity testing of streams or lakes using aquatic organisms	2	Full: No more than one test result of statistically significant deviation from controls in acute or chronic test in a three-year period. Non-Attainment: Requirements for full attainment not met.
Fish Consumption	Chemicals (tissue)	1-2	Full: Fish tissue levels in fillets, tissue plugs, and eggs do not exceed guidelines.[21] Non-Attainment: Requirements for full attainment not met.

Duration of Assessment Period

Except where the assessment period is specifically noted in Table 1.1, the time period for which data will be used in making the assessments will be determined by data age and data code considerations, as well as representativeness considerations such as those described in footnote 14.

Assessment of Tier Three Waters

Waters given Tier Three protection by the antidegradation rule at 10 CSR 20-7.031(2), shall be considered impaired if data indicate water quality has been reduced in comparison to its historical quality. Historical quality is determined from past data that best describes a water body's water quality following promulgation of the antidegradation rule and at the time the water was given Tier Three protection.

[21] Fish tissue threshold levels are; chlordane 0.1 mg/kg (Crellin, J.R. 1989, *"New Trigger Levels for Chlordane in Fish-Revised Memo"* Mo. Dept. of Health inter-office memorandum. June 16, 1989); mercury 0.3 mg/kg based on "Water Quality Criterion for Protection of Human Health: Methylmercury" EPA-823-R-01-001. Jan. 2001. http://www.epa.gov/waterscience/criteria/methylmercury/merctitl.pdf; PCBs 0.75 mg/kg, MDHSS Memorandum August 30, 2006 *"Development of PCB Risk-based Fish Consumption Limit Tables*"; and lead 0.3- mg/kg (World Health Organization 1972. *"Evaluation of Certain Food Additives and the Contaminants Mercury, Lead and Cadmium".* WHO Technical Report Series No. 505, Sixteenth Report on the Joint FAO/WHO Expert Committee on Food Additives. Geneva 33 pp. Assessment of Mercury will be based on samples solely from the following higher trophic level fish species; walleye, sauger, trout, black bass, white bass, striped bass, northern pike, flathead catfish and blue catfish. In a 2012 DHSS memorandum (not yet approved, but are being considered for future LMD revisions) threshold values are proposed to change as follows: Chlordane 0.2 mg/kg ; Mercury 0.27 mg/kg ; and PCBs = 0.540 ; lead has not changed, but they do add atrazine and PDBEs **(Fish Fillet Advisory Concentrations (FFACs) in Missouri).**

Historical data gathered at the time waters were given Tier Three protection will be used if available. Because historical data may be limited, the historical quality of the waters may be determined by comparing data from the assessed segment with data from a "representative" segment. A representative segment is a body or stretch of water that best reflects the conditions that probably existed at the time the antidegradation rule first applied to the waters being assessed. Examples of possible representative data include 1) data from segments upstream from assessed segments that receive discharges of the quality and quantity that mimic historical discharges to the assessed segment, and 2) data from other bodies of water in the same ecoregion having a similar watershed and landscape and receiving discharges and runoff of the quality and quantity that mimic historical discharges to the assessed segment. The assessment may also use data from the assessed segment gathered between the time of the initiation of Tier Three protection and the last known point in time in which upstream discharges, runoff and watershed conditions remained the same, if the data do not show any significant trends of declining water quality during that period.

The data used in the comparisons will be tested for normality and an appropriate statistical test will be applied. The null hypothesis for such test will be that water quality is the same at the test segment and representative segment. This will be a one-tailed test (the test will consider only the possibility that the assessed segment has poorer water quality) with the alpha level of 0.1, meaning that the test must show greater than a 90 percent probability that the assessed segment has poorer water quality than the representative segment before the assessed segment can be listed as impaired.

Other Types of Information

1. Observation and evaluation of waters for noncompliance with state narrative water quality criteria. Missouri's narrative water quality criteria, as described in 10 CSR 20-7.031 Section (3), may be used to evaluate waters when a quantitative value can be applied to the pollutant. These narrative criteria apply to both classified and unclassified waters and prohibit the following in waters of the state:
    a. Unsightly, putrescent or harmful bottom deposits,
    b. Oil, scum and floating debris,
    c. Unsightly color, turbidity or odor,
    d. Substances or conditions causing toxicity to human, animal or aquatic life,
    e. Human health hazard due to incidental contact,
    f. Acute toxicity to livestock or wildlife, when used as a drinking water supply,
    g. Physical, chemical or hydrologic changes that impair the natural biological community,
    h. Used tires, car bodies, appliances, demolition debris, used vehicles or equipment and any solid waste as defined by Missouri's Solid Waste Law, and
    i. Acute toxicity.

2. Habitat assessment protocols for wadeable streams have been established and are conducted in conjunction with sampling of aquatic macroinvertebrates and fish. Methods for evaluating aquatic macroinvertebrate and fish community data include assessment procedures that account for the presence or absence of representative habitat quality. The Department will not use habitat assessment data alone for assessment purposes.

E. Other 303(d) Listing Considerations

1. Adding to the Existing List or Expanding the Scope of Impairment to a Previously Listed Water

   The listed portion of an impaired water may be increased based on recent monitoring data following the guidelines in this document. One or more new pollutants may be added to the listing for a water already on the list based on recent monitoring data following these same guidelines. Waters not previously listed may be added to the list following the guidelines in this document.

2. Deleting from the Existing List or Decreasing the Scope of Impairment to a Previously Listed Water

   The listed portion of an impaired water may be decreased based on recent monitoring data following the guidelines in this document. One or more pollutants may be deleted from the listing for a water already on the list based on recent monitoring data following guidelines in Table B-2. Waters may be completely removed from the list for several reasons[22], the most common being (1) water has returned to compliance with water quality standards, or (2) the water has an approved TMDL study or Permit in Lieu of a TMDL.

3. Prioritization of Waters for TMDL Development

   Section 303(d) of the Clean Water Act and federal regulation 40 CFR 130.7(b)(4) require states to submit a priority ranking of waters requiring TMDLs. The Department will prioritize development of TMDLs based on several variables including:

   - severity of the water quality problem and risk to public health,
   - amount of time necessary to acquire sufficient data to develop the TMDL,
   - court orders, consent decrees or other formal agreements,
   - budgetary constraints, and
   - amenability of the problem to treatment.

   The Department's TMDL schedule will represent its prioritization. The TMDL Program develops the TMDL schedule which can be found at the following website, http://www.dnr.mo.gov/env/wpp/tmdl/.

4. Resolution of Interstate/International Disagreements

[22] See, "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act". USEPA, Office of Water, Washington DC.

The Department will review the draft 303(d) Lists of all other states with which it shares a border (Missouri River, Mississippi River, Des Moines River and the St. Francis River) or other interstate waters. Where the listing in another state is different than in Missouri, the Department will request the data upon which the listing in the other state is based. This data will be reviewed following all data evaluation guidelines previously discussed in this document. The Missouri Section 303(d) list may be changed pending the evaluation of this additional data.

Appendix A

Excerpt from *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act.* July 29, 2005. USEPA pp. 39-41.

G. How should statistical approaches be used in attainment determinations?

The state's methodology should provide a rationale for any statistical interpretation of data for the purpose of making an assessment determination.

1. Description of statistical methods to be employed in various circumstances:

The methodology should provide a clear explanation of which analytic tools the state uses and under which circumstances. EPA recommends that the methodology explain issues such as the selection of key sample statistics (arithmetic mean concentration, median concentration, or a percentile), null and alternative hypotheses, confidence intervals, and Type I and Type II error thresholds. The choice of a statistic tool should be based on the known or expected distribution of the concentration of a pollutant in the segment (e.g., normal or log normal) in both time and space.

Past EPA guidance, 1997 305(b) and 2000 CALM, recommended making non-attainment decisions for "conventional pollutants" – Total Suspended Solids, pH, Biochemical Oxygen Demand, fecal coliform bacteria and oil and grease – when more than 10% of measurements exceed the water quality criterion; however, EPA guidance has not encouraged use of the 10% rule with other pollutants, including toxics. Use of this rule when addressing conventional pollutants, is appropriate if its application is consistent with the manner in which the applicable water quality criterion are expressed. An example of a water quality criterion for which an assessment based on the 10% rule would be appropriate is the EPA acute water quality criterion for fecal coliform bacteria, applicable to protection of water contact recreational use. This 1976-issued water quality criterion was expressed as, "...no more than ten percent of the samples exceeding 400 CFU per 100ml, during a 30-day period. This assessment methodology is clearly reflective of the water quality criterion.

On the other hand, use of the 10 percent rule for interpreting water quality data is usually not consistent with water quality criterion expressed either as: (1) instantaneous maxima not to be surpassed at any time; or (2) average concentrations over specified times. In the case of "instantaneous maxima (or minima) never to occur" criteria use of the 10 percent rule typically leads to the belief that segment conditions are equal to or better than specified by the water quality criterion, when they in fact are considerably worse. (That is, pollutant concentrations are above the criterion concentration a far greater proportion of the time than specified by the water quality criterion). Conversely, use of this decision rule in concert with water quality criterion expressed as average concentrations over specific times can lead to

concluding that segment conditions are worse than water quality criterion, when in fact, they are not. If the state applies different decision rules for different types of pollutants (e.g., toxic, conventional, and non-conventional pollutants) and types of standards (e.g., acute versus chronic criteria for aquatic life or human health), the state should provide a reasonable rationale supporting the choice of a particular statistical approach to each of its different sets of pollutants and types of standards.

2. Elucidation of policy choices embedded in selection of particular statistical approaches and use of certain assumptions:

EPA strongly encourages states to highlight policy decisions implicit in the statistical analysis that they have chosen to employ in various circumstances. For example, if hypothesis testing is used, the state should make its decision-making rules transparent by explaining why it chose either "meeting Water Quality Standards" or "not meeting Water Quality Standards" as the null hypothesis (refutable presumption) as a general rule for all waters, a category of waters, or an individual segment. Starting with the assumption that a water is "healthy" when employing hypothesis testing means that a segment will be identified as impaired, and placed in Category 4 or 5, only if substantial amounts of credible evidence exist to refute the presumption. By contrast, making the null hypothesis "Water Quality Standards not being met" shifts the burden of proof to those who believe the segment is, in fact, meeting Water Quality Standards.

Which "null hypothesis" a state selects could likely create contrasting incentives regarding support for additional ambient monitoring among different stakeholders. If the null hypothesis is "meeting standards", there was no previous data on the segment, and no additional existing and readily available data and information is collected, then the "null hypothesis" cannot be rejected, and the segment would not be placed in Category 4 or 5. In this situation, those concerned about possible adverse consequences of having a segment declared "impaired" might have little interest in collection of additional ambient data. Meanwhile, users of the segment would likely want to have the segment monitored, so they can be assured that it is indeed capable of supporting the uses of concern. On the other hand, if the null hypothesis is changed to "segment not meeting Water Quality Standards": then those that would prefer that a particular segment not be labeled "impaired" would probably want more data collected, in hopes of proving that the null hypothesis is not true.

Another key policy issue in hypothesis testing is what significance level to use in deciding whether to reject the null hypothesis. Picking a high level of significance for rejecting the null hypothesis means that great emphasis is being placed on avoiding a Type I error (rejecting the null hypothesis, when in fact, the null hypothesis is true). This means that if a 0.10 significance level is chosen, the state wants to keep the chance of making a Type I error at or below 10 percent. Hence, if the chosen null hypothesis is "segment meeting Water Quality Standards", the state is trying to keep the chance of saying a segment is impaired, when in reality it is not, under 10 percent.

An additional policy issue is the Type II errors (not rejecting the null hypothesis, when it should have been). The probability of Type II errors depends on several factors. One key factor is the number of samples available. With a fixed number of samples, as the probability of Type I error decreases, the probability of a Type II error increases. States would ideally collect enough samples so the chances of making Type I and Type II errors are simultaneously small. Unfortunately, resources needed to collect those numbers of samples are quite often not available.

The final example of a policy issue that a state should describe is the rationale for concentrating limited resources to support data collection and statistical analysis in segments where there are documented water quality problems or where the combination of nonpoint source loadings and point source discharges would indicate a strong potential for a water quality problem to exist.

EPA recommends that, when picking the decision rules and statistical methods to be utilized when interpreting data and information, states attempt to minimize the chances of making either of the following two errors:

- Concluding the segment is impaired, when in fact it is not, and
- Deciding not to declare a segment impaired, when it is in fact impaired.

States should specify in their methodology what significance level they have chosen to use, in various circumstances. The methodology would best describe in "plain English" the likelihood of deciding to list a segment that in reality is not impaired (Type I error if the null hypothesis is "segment not impaired"). Also, EPA encourages states to estimate, in their assessment databases, the probability of making a Type II error (not putting on the 303(d) List a segment that in fact fails to meet Water Quality Standards), when: (1) commonly-available numbers of grab samples are available, and (2) the degree of variance in pollutant concentrations are at commonly encountered levels. For example, if an assessment is being performed with a water quality criterion (WQC) expressed as a 30-day average concentration of a certain pollutant, it would be useful to estimate the probability of a Type II error when the number of available samples over a 30-day period is equal to the average number of samples for that pollutant in segments statewide, or in a given group of segments, assuming a degree of variance in levels of the pollutant often observed over typical 30-day periods.

Appendix B
Statistical Considerations

The most recent EPA guidance on the use of statistics in the 303(d) listing methodology document is given in Appendix A. Within this guidance there are three major recommendations regarding statistics:

- Provide a description of which analytical tools the state uses under various circumstances,
- When conducting hypothesis testing, explain the various circumstances under which the burden of proof is placed on proving the water is impaired and when it is placed on proving the water is unimpaired, and
- Explain the level of statistical significance used under various circumstances.

Description of Analytical Tools

Tables B-1 and B-2 below describe the analytical tools the Department will use to determine when a water is impaired (Table B-1) or when a listed water is no longer impaired (Table B-2).

TABLE B - 1. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING IF WATERS ARE IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule [23]	Significance Level
Narrative Criteria	Color (Narrative)	Hypothesis Test Two Sample, one tailed t-Test	Null Hypothesis: There is no difference in color between test stream and control stream.	Reject Null Hypothesis if calculated "t" value exceeds tabular "t" value for test alpha	0.10

[23] Where hypothesis testing is used for media other than fish tissue, for data sets with five samples or fewer, a 75 percent confidence interval around the appropriate central tendencies will be used to determine use attainment status. Use attainment will be determined as follows: (1) If the criterion value is above this interval (all values within the interval are in conformance with the criterion), rate as unimpaired; (2) If the criterion value falls within this interval, rate as unimpaired and place in Category 2B or 3B; (3) If the criterion value is below this interval (all values within the interval are not in conformance with the criterion), rate as impaired. For fish tissue, this procedure will be used with the following changes: (1) it will apply only to sample sizes of less than four and, (2) a 50% confidence interval will be used in place of the 75% confidence interval.

TABLE B - 1. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING IF WATERS ARE IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule [23]	Significance Level
	Bottom deposits (Narrative)	Hypothesis Test, Two Sample, one tailed "t "Test ; t-Test	Null Hypothesis: Solids of anthropogenic origin cover less than 20% of stream bottom where velocity is less than 0.5 feet/second.	Reject Null Hypothesis if 60% Lower Confidence Limit (LCL) of mean percent fine sediment deposition (pfsd) in stream is greater than the sum of the pfsd in the control and 20 % more of the stream bottom. i.e., where the pfsd is expressed as a decimal, test stream pfsd > (control stream pfsd)+ (0.20)[24]	0.40
Aquatic Life	Biological monitoring (Narrative)	For DNR Invert protocol: Sample sizes of 7 or less, 75% of samples must score 14 or lower. For RAM Fish IBI protocol: Sample sizes of 7 or less, 75% of samples must score less than 36.	Using DNR Invert. protocol: Null Hypothesis: Frequency of full sustaining scores for test stream is the same as for biological criteria reference streams.	Reject Null Hypothesis if frequency of fully sustaining scores on test stream is significantly less than for biological criteria reference streams.	Not Applicable

[24] If data is non-normal a nonparametric test will be used as a comparison of medians. The same 20% difference still applies. With current software the Mann-Whitney test is used.

TABLE B - 1. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING IF WATERS ARE IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule [23]	Significance Level
		For DNR Invert protocol and sample size of 8 or more: Binomial Probability. For RAM Fish IBI protocol and sample size of 8 or more: Binomial Probability.	A direct comparison of frequencies between test and biological criteria reference streams will be made.	Rate as impaired if biological criteria reference stream frequency of fully biologically supporting scores is greater than five percent more than test stream.	0.1
		For other biological data: An appropriate parametric or nonparametric test will be used.	Null Hypothesis, Community metric(s) in test stream is the same as for a reference stream or control streams.	Reject Null Hypothesis If metric scores for test stream are significantly less than reference or control streams.	0.1
			Other biological monitoring to be determined by type of data.	Dependent upon available information.	Dependent upon available information.
Aquatic Life	Toxic chemicals in water. (Numeric)	Not applicable	No more than one toxic event, toxicity test failure or exceedence of acute or chronic criterion in 3 years.	Not applicable	Not applicable
	Toxic chemicals in sediments (Narrative)	Comparison of geometric mean to PEC value, or calculation of a PECQ value.	Waters are judged to be impaired if parameter geomean exceeds PEC[15], or site PECQ is exceeded.	For metals ~~except Arsenic, use 100% PEC threshold. For Arsenic,~~ use 150% of PEC threshold. The PECQ threshold value is 0.75.	Not applicable
Aquatic Life	temperature, pH, total diss. gases, oil and grease, diss. oxygen (Numeric)	Binomial probability	Null Hypothesis: No more than 10% of samples exceed the water quality criterion.	Reject Null Hypothesis if the Type I error rate is less than 0.1 .	Not applicable

TABLE B - 1. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING IF WATERS ARE IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule [23]	Significance Level
Losing Streams	E.coli	Binomial probability	Null Hypothesis: No more than 10% of samples exceed the water quality criterion.	Reject Null Hypothesis if the Type I error rate is less than 0.1 .	0.10
Fish Consumption	Toxic chemicals in water (Numeric)	Hypothesis test 1-sided confidence limit	Null Hypothesis: Levels of contaminants in water do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.40
Fish Consumption	Toxic chemicals in tissue (Narrative)	Four or more samples: Hypothesis test 1-sided confidence limit	Null Hypothesis: Levels in fillet samples or fish eggs do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.40
Drinking Water Supply (Raw)	Toxic chemicals (Numeric)	Hypothesis test 1-sided confidence limit	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.40
Drinking Water Supply (Raw)	Non-toxic chemicals (Numeric)	Hypothesis test 1-sided confidence limit	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.40
Drinking Water Supply (Finished)	Toxic chemicals	Methods stipulated by Safe Drinking Water Act	Methods stipulated by Safe Drinking Water Act.	Methods stipulated by Safe Drinking Water Act.	Methods stipulated by Safe Drinking Water Act.
Whole Body Contact and Secondary Contact Rec.	Bacteria (Numeric)	Geometric mean	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis if the geometric mean is greater than the criterion value.	Not Applicable

TABLE B - 1. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING IF WATERS ARE IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule [23]	Significance Level
Irrigation & Livestock Water	Toxic chemicals (Numeric)	Hypothesis test 1-Sided confidence limit	Null Hypothesis: Levels of contaminants do not exceed criterion.	Reject Null Hypothesis if the 60% LCL is greater than the criterion value.	0.40
Protection of Aquatic Life	Nutrients in lakes (Numeric)	Hypothesis test[25]	Null hypothesis: Criteria are not exceeded.	Reject Null Hypothesis if 60% LCL value is greater than criterion value.	0.40

[25] State nutrient criteria require at least four samples per year taken near the outflow point of the lake (or reservoir) between May 1 and August 31 for at least four different, not necessarily consecutive, years.

TABLE B - 2. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING WHEN WATERS ARE NO LONGER IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule	Significance Level
Narrative Criteria	Color (Narrative)	Same as Table B-1	Same as Table B-1	Same as Table B-1	0.40
	Bottom deposits (Narrative)	Same as Table B-1	Same as Table B-1	Same as Table B-1	0.40
Aquatic Life	Biological monitoring (Narrative)	DNR Invert Protocol: For 7 or less samples, same as Table B-1. RAM Fish IBI Protocol: For 7 or less samples, same as Table B-1.	Same as Table B-1	Same as Table B-1	Same as Table B-1
		For DNR Invert Protocol For 8 or more samples, same as Table B-1. RAM Fish IBI Protocol: For 8 or more samples, same as Table B-1.	Same as Table B-1	Same as Table B-1	0.4
		For other biological data: Same as Table B-1.	Same as Table B-1	Same as Table B-1	0.40
	Toxic chemicals in water	Same as Table B-1	Same as Table B-1	Same as Table B-1	Same as Table B-1
	Toxic chemicals in sediments	Comparison of geomean to PEC value, or calculation of a PECQ value.	Water is judged to be unimpaired if parameter geomean is equal to or less than PEC[15], or site PECQ equaled or not exceeded.	For metals ~~except Arsenic, use 100% PEC threshold. For Arsenic,~~ use 150% of PEC threshold. The PECQ threshold value is 0.75.	Not applicable
Aquatic Life	Temperature, pH, total diss. gases, oil and grease, diss. oxygen	Same as Table B-1	Same as Table B-1	Same as Table B-1	Same as Table B-1
		Same as Table B-1	Same as Table B-1	Same as Table B-1	Same as Table B-1
Losing Streams	E. coli	Same as Table B-1	Same as Table B-1	Same as Table B-1	Same as Table B-1

TABLE B - 2. DESCRIPTION OF ANALYTICAL TOOLS FOR DETERMINING WHEN WATERS ARE NO LONGER IMPAIRED

Designated Use	Analytes	Analytical Tool	Decision Rule/ Hypothesis	Criterion Used with the Decision Rule	Significance Level
Fish Consumption	Toxic chemicals in water	Same as Table B-1	Same as Table B-1	Reject null hypothesis if the 60% UCL is greater than the criterion value.	0.40
	Toxic chemicals in tissue	Same as Table B-1	Same as Table B-1	Reject null hypothesis if the 60% UCL is greater than the criterion value.	0.40
Drinking Water Supply (Raw)	Toxic chemicals	Same as Table B-1	Same as Table B-1	Reject null hypothesis if the 60% UCL is greater than the criterion value.	0.40
Drinking Water Supply (Raw)	Non-toxic chemicals	Same as Table B-1	Same as Table B-1	Reject null hypothesis if the 60% UCL is greater than the criterion value.	0.40
Drinking Water Supply (Finished)	Toxic chemicals	Same as Table B-1	Same as Table B-1	Same as Table B-1	Same as Table B-1
Whole Body Contact and Secondary Contact Rec.	Bacteria	Same as Table B-1	Same as Table B-1	Same as Table B-1	Not applicable
Irrigation & Livestock Water	Toxic chemicals	Same as Table B-1	Same as Table B-1	Reject null hypothesis if the 60% UCL is greater than the criterion value.	0.40
Protection of Aquatic Life	Nutrients in lakes	Same as Table B-1	Same as Table B-1	Same as Table B-1	0.40

Rationale for the Burden-of-Proof

Hypothesis testing is a common statistical practice. The procedure involves first stating a hypothesis you want to test, such as "the most frequently seen color on clothing at a St. Louis Cardinals game is red" and then the opposite or null hypothesis "red is not the most frequently seen color on clothing at a Cardinals game." Then a statistical test is applied to the data (a sample of the predominant color of clothing worn by 200 fans at a Cardinals game on July 12) and based on an analysis of that data, one of the two hypotheses is chosen as correct.

In hypothesis testing, the burden-of-proof is always on the alternate hypothesis. In other words, there must be very convincing data to make us conclude that the null hypothesis is not true and that we must accept the alternate hypothesis. How convincing the data must be is stated as the "significance level" of the test. A significance level of 0.10 means that there must be at least a 90 percent probability that the alternate hypothesis is true before we can accept it and reject the null hypothesis.

For analysis of a specific kind of data, either the test significance level or the statement of null and alternative hypotheses, or both, can be varied to achieve the desired degree of statistical rigor. The Department has chosen to maintain a consistent set of null and alternate hypotheses for all our statistical procedures. The null hypothesis will be that the water body in question is unimpaired and the alternate hypothesis will be that it is impaired. Varying the level of statistical rigor will be accomplished by varying the test significance level. For determining impairment (Table B-1) test significance levels are set at either 0.1 or 0.4, meaning the data must show a 90% or 60% probability respectively, that the water body is impaired. However, if the Department retained these same test significance levels in determining when an impaired water had been restored to an unimpaired status (Table B-2) some undesirable results can occur.

For example, using a 0.1 significance level for determining both impairment and nonimpairment; if the sample data indicate the stream had a 92 percent probability of being impaired, it would be rated as impaired. If subsequent data was collected and added to the database and the data now showed the water had an 88 percent chance of being impaired, it would be rated as unimpaired. Judging as unimpaired a water with only a 12 percent probability of being unimpaired is clearly a poor decision. To correct this problem, the Department will use a test significance level of 0.4 for some analytes and 0.6 for others. This will increase our confidence in determining compliance with criteria to 40 percent and 60 percent respectively under the worst case conditions, and for most databases will provide an even higher level of confidence.

Level of Significance Used in Tests

The choice of significance levels is largely related to two concerns. The first is concern is with matching error rates with the severity of the consequences of making a decision error. The second addresses the need to balance, to the degree practicable, Type I and Type II error rates.
For relatively small databases, the disparity between Type I and Type II errors can be large. The table below shows error rates calculated using the binomial distribution for two very similar situations. Type I error rates are based on a stream with a 10 percent exceedence rate of a standard and Type II error rates for a stream with a 15 percent exceedence rate of a standard. Note that when sample size remains the same, as Type 1 error rates decrease Type II error rates increase (Table B-3). Also note that for a given Type I error rate, the Type II error rate declines as sample size increases.

Table B-3. Effects of Type I error rates on Type II error rates. Type I error rates are based on a stream with a 10 percent exceedence rate of a standard and Type II error rates for a stream with a 15 percent exceedence rate of a standard.

Total No. of Samples	No. Samples Meeting Std.	Type I Error Rate	Type II Error Rate
18	17	0.850	0.479
18	16	0.550	0.719
18	15	0.266	0.897
18	14	0.098	0.958
18	13	0.028	0.988

Table B-4. Effects of Type I error rates and sample size on Type II error rates. Type I error rates are based on a stream with a 10 percent exceedence rate of a standard and Type II error rates for a stream with a 15 percent exceedence rate of a standard.

Total No. of Samples	No. Samples Meeting Std.	Type I Error Rate	Type II Error Rate
6	5	0.469	0.953
11	9	0.303	0.930
18	15	0.266	0.897
25	21	0.236	0.836

Use of the Binomial Probability Distribution for Interpretation of the Ten Percent Rule

There are two options for assessing data for compliance with the ten percent rule. One is to simply calculate the percent of time the criterion value is not met and to judge the water to be impaired if this value is greater than ten percent. The second method is to use some evaluative procedure that can review the data and provide a probability statement regarding the compliance with the ten percent rule. Since the latter option allows assessment decisions relative to specific test significance levels and the first option does not, the latter option is preferred. The procedure chosen is the binomial probability distribution and calculation of the Type I error rate.

Other Statistical Considerations

Prior to calculation of confidence limits, the normality of the data set will be evaluated. If normality is improved by a data transformation, the confidence limits will be calculated on the transformed data.

Time of sample collection may be biased and interfere with an accurate measurement of frequency of exceedence of a criterion. Data sets composed mainly or entirely of storm water data or data collected only during a season when water quality problems are expected could result in a biased estimate of the true exceedence frequency. In these cases, the department may use methods to estimate the true annual frequency and display these calculations whenever they result in a change in the impairment status of a water.

For waters judged to be impaired based on biological data where data evaluation procedures are not specifically noted in Table 1, the statistical procedure used, test assumptions and results will be reported.

Appendix C
Examples of Statistical Procedures

Two Sample "t" Test for Color

Null Hypothesis: Amount of color is no greater in test stream than in a control stream. (As stated, this is a one-sided test, meaning that we are only interested in determining whether or not the color level in the test stream is greater than in a control stream.) If the null hypothesis had been "amount of color is different in the test and control streams" we would have been interested in determining if the amount of color was either less than or greater than the control stream, a two-sided test).

Significance Level (also known as the alpha level): 0.10

Data Set: Platinum-Cobalt color units data for the test stream and a control stream samples collected at each stream on same date.

Test Stream	70	45	35	45	60	60	80
Control Stream	50	40	20	40	30	40	75
Difference (T-C)	20	5	15	5	30	20	5

Statistics for the Difference: Mean = 14.28, standard deviation = 9.76, n = 7
Calculated "t" value = (square root of n)(mean)/standard deviation = 3.86
Tabular "t" value is taken from a table of the "t" distribution for 2 alpha (0.20) and n-1 degrees of freedom. Tabular "t" = 1.44.

Since calculated "t" value is greater than tabular t value, reject the null hypothesis and conclude that the test stream is impaired by color.

Statistical Procedure for Mercury in Fish Tissue

Data Set: data in µg/Kg 130, 230, 450. Mean = 270, Standard Deviation = 163.7
The 60% Lower Confidence Limit Interval = the sample mean minus the quantity:
((0.253)(163.7)/square root 3) = 23.9. Thus the 60% LCL Confidence Interval is 246.088 µg/Kg.

The criterion value is 300 µg/Kg. Therefore, since the 60% LCL Confidence Interval is less than the criterion value, the water is judged to be unimpaired by mercury in fish tissue, and the waterbody is placed in either Category 2B or 3B.

Appendix D

The Meaning of the Sediment Quotient and How to Calculate It

The Probable Effect Concentration (PEC) is the level of a pollutant at which harmful effects on the aquatic community are likely to be observed. While sediment criteria in the form of a PEC are given for several individual contaminants, it is recognized that when multiple contaminants occur in sediment, toxicity may occur even though the level of each individual pollutant does not reach toxic levels. The method of estimating the synergistic effects of multiple pollutants in sediments given in MacDonald *et al.* (2000) includes the calculation of a PEC Quotient. This calculation is made by dividing the pollutant concentration(s) in the sample by the PEC value for that pollutant. For single samples, the quotients are summed, and then normalized by dividing that sum by the number of pollutants in the formula. When multiple samples are available, the geomean (as calculated for specific pollutants) will be placed in the numerator position for each pollutant included in the equation.

Example: A sediment sample contains the following results in mg/kg:

Arsenic 2.5, Cadmium 4.5, Copper 17, Lead 100, Zinc 260.

The PEC values for these five pollutants in respective order are:

33, 4.98, 149, 128, 459.

PEC Quotient =

$$((2.5/(33)) + (4.5/(4.98)) + (17/(149)) + (100/(128)) + (260/(459)))/5 = 0.488$$

Using PEC Quotients to Judge Toxicity

Based on research by MacDonald *et al.* (2000) 83% of sediment samples with PEC Quotients less than 0.5 were non-toxic while 85% of sediment samples with PEC quotients greater than 0.5 were toxic. Therefore, to accurately assess the synergistic effects of sediment contaminants on aquatic life, the Department will judge PEC Quotients greater than 0.75 as toxic**.**

Appendix E

Evaluation of Biological Data

Introduction

Methods for assessing biological data typically receive considerable attention during public comment periods for the development of Listing Methodology Documents. Currently, a defined set of biocriteria are used to evaluate biological data for assessing compliance with water quality standards. These biological criteria contain numeric thresholds, that when exceeded relative to prescribed assessment methods, serve as a basis for identifying candidate waters for Section 303(d) listing. Biocriteria are based on three types of biological data, including: (1) aquatic macroinvertebrate community data; (2) fish community data; and, (3) a catch-all class referred to as "other biological data".

The purpose of this appendix is to describe the methods used to evaluate these three types of biological data. This appendix includes the following: background information on the development and scoring of biological criteria, procedures for assessing biological data, methods used to ensure sample representativeness, and additional information used to aid in assessing biological data such as the weight of evidence approach.

Aquatic Macroinvertebrate Community Data

The Department conducts aquatic macroinvertebrate bioassessments to determine macroinvertebrate community health as a function of water quality and habitat. Almost all macroinvertebrate monitoring is "targeted," where the health of the community from the "target" stream is compared to healthy macroinvertebrate communities from reference streams of the same general size and in the same ecological drainage unit (EDU).

The Department's approach to monitoring and evaluating aquatic macroinvertebrates is largely based on the document *Biological Criteria for Wadeable/Perennial Streams of Missouri* (MDNR 2002). This document provides numeric biological criteria (biocriteria) relevant to the protection of aquatic life use for wadeable streams in the state. Biocriteria were developed using wadeable reference streams that occur in specific EDUs as mapped by the Missouri Resource Assessment Partnership. For macroinvertebrates, the numeric biocriterion translator is expressed as a multiple metric index referred to as the Macroinvertebrate Stream Condition Index (MSCI). The MSCI includes four metrics: Taxa Richness (TR); Ephemeroptera, Plecoptera, and Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Diversity Index (SDI). These metrics are considered indicators of stream health, and change predictably in response to the environmental condition of a stream.

Metric values are determined directly from macroinvertebrate sampling. To calculate the MSCI, each metric is normalized to unitless values of 5, 3, or 1, which are then added together for a total possible score of 20. MSCI scores are divided into three levels of stream condition, Fully Biologically Supporting (16-20), Partially Biologically Supporting (10-14), and Non-Biologically Supporting (4-8). Partially and Non-Biologically Supporting streams may be considered impaired and are candidates for Section 303(d) listing.

Unitless metric values (5, 3, or 1) were developed from the lower quartile of the distribution of each metric as calculated from reference streams for each EDU. The lower quartile (25^{th} percentile) of each metric equates to the minimum value still representative of unimpaired conditions. In operational assessments, metric values below the lower quartile of reference conditions are typically judged as impaired (United States Environmental Protection Agency 1996, Ohio Environmental Protection Agency 1990, Barbour et al. 1996). Moreover, using the 25^{th} percentile of reference conditions for each metric as a standard for impairment allows natural variability to be filtered out. For metrics with values that decrease with increasing impairment (TR, EPTT, SDI), any value above the lower quartile of the reference distribution receives a score of five. For the BI, whose value increases with increasing impairment, any value below the upper quartile (75^{th} percentile) of the reference distribution receives a score of five. The remainder of each metrics potential quartile range below the lower quartile is bisected, and scored either a three or a one. If the metric value is less than or equal to the quartile value and greater than the bisection value it is scored a three. If the metric value is less than or equal to the bisection value it is scored a one.

MSCI meeting data quality considerations may be assessed for the protection of aquatic life using the following procedures.

Determining Full Attainment of Aquatic Life Use:
For seven or fewer samples, 75% of the MSCI scores must be 16 or greater. Fauna achieving these scores are considered to be very similar to biocriteria reference streams.
For eight or more samples, results must be statistically similar to representative reference or control streams.

Determining Non-Attainment of Aquatic Life Use:
For seven or fewer samples, 75% of the MSCI scores must be 14 or lower. Fauna achieving these scores are considered to be substantially different from biocriteria reference streams. For eight or more samples, results must be statistically dissimilar to representative reference or control streams.

Data will be judged inconclusive when outcomes do not meet requirements for decisions of full or non-attainment.

As noted, when eight or more samples are available, results must be statistically similar or dissimilar to reference or control conditions in order to make an attainment decision. To accomplish this, a binomial probability Type I error rate is calculated based on the null hypothesis that the test stream would have a similar percentage of MSCI scores that are 16 or greater as reference streams. The significance level is set at 0.1, which is in fact the probability of committing a Type I error (rejecting a true null hypothesis). When the Type 1 error rate is less than 0.1, the null hypothesis is rejected; when the Type I error rate is greater than 0.1, the null hypothesis is accepted. For comparing samples from a test stream to samples collected from reference streams in the same EDU, the percentage of samples from reference streams scoring 16 or greater is used to determine the probability of "success" and "failure" in the binomial probability equation. For example,

if 84% of the reference stream MSCI scores in a particular EDU are 16 or greater, then 0.84 would be used as the probability of success and 0.16 would be used as the probability of failure. Note that Table B-1 states to "rate a stream as impaired if biological criteria reference stream frequency of fully biologically supporting scores is greater than five percent more than the test stream," thus, a value of 0.79 (0.84 - 0.05) would actually be used as the probability of success in the binomial distribution equation.

Binomial Probability Example:
Reference streams from the Ozark/Gasconade EDU classified as riffle/pool stream types with warm water temperature regimes produce fully biologically supporting streams 85.7% of the time. In the test stream of interest, six of 10 samples resulted in MSCI scores of 16 or more. Calculate the Type I error rate for the probability of getting six or fewer fully biologically supporting scores in 10 samples.

The binomial probability formula may be summarized as:

$$p^n + (n!/ X!(n-X)!*p^n q^{n-x}) = 1$$

Where,
Sample Size (n) = 10
Number of Successes (X) = 6
Probabilty of Success (p) = 0.857 - 0.05 = 0.807
Probability of Failure (q) = 0.193
Binomial Distribution Coefficients = n!/ X!(n-X)!

The equation may then be written as:

= 1 - ((0.807^10) + ((10*(0.807^9)*(0.193))) + ((45*(0.807^8)*(0.193^2)) + ((120*(0.807^7) * (0.193^3)))

= 0.109

Since 0.109 is greater than the test significance level (minimum allowable Type I error rate) of 0.1, we accept the null hypothesis that the test stream has the same percent of fully biologically supporting scores as the same type of reference streams from the Ozark/Gasconade EDU. Thus, this test stream would be judged as unimpaired.

If under the same scenario, there were only 5 samples from the test stream with MSCI scores of 16 or greater, the Type 1 error rate would change to 0.028, and since this value is less than the significance level of 0.1, the stream would be judged as impaired.

Within each EDU, MSCI scores are categorized by sampling regime (Glide/Pool vs. Riffle/Pool) and temperature regime (warm water vs. cold water). The percentage of fully biologically supporting scores for the Mississippi River Alluvial Basin/Black/Cache EDU is not available since there are no reference sites in this region. Percentages of fully biologically supporting samples per EDU is not included here, but can be made available upon request. The percentage of reference streams per EDU that are fully biologically supporting may change periodically as additional macroinvertebrate samples are collected and processed from reference samples in an EDU.

Sample Representativeness

DNR field and laboratory methods used to collect and process macroinvertebrate samples are contained in the document *Semi-Quantitative Macroinvertebrate Stream Bioassessment* (MDNR 2012a). Macroinvertebrates are identified to levels following standard operating procedures contained in *Taxonomic Levels for Macroinvertebrate Identifications* (MDNR 2012b). Macroinvertebrate monitoring is accompanied by physical habitat evaluations as described in the document *Stream Habitat Assessment* (MDNR 2010). For the assessment of macroinvertebrate samples, available information must be meet data code levels three and four as described in Section II.C of this LMD. Data coded as levels three and four represent environmental data providing the greatest degree of assurance. Thus, at a minimum, macroinvetebrate assessments include multiple samples from a single site, or samples from multiple sites within a single reach.

It is important to avoid situations where poor or inadequate habitat prohibits macroinverterbate communities from being assessed as fully biologically supporting. Therefore, when assessing macroinvertebrate samples, the quality of available habitat must be similar to that of reference streams within the appropriate EDU. The Department's policy for addressing this concern has been to exclude MSCI scores from an assessment when accompanying habitat scores are less than 75 percent of the mean habitat scores from reference streams of the appropriate EDU. The following procedures outline the Department's method for assessing macroinvertebrate communities from sites with poor or inadequate habitat.

Assessing Macroinvertebrate Communities from Poor/Inadequate Habitat:

-If less than half the macroinvertebrate samples in an assessed stream segment have habitat scores less than 75 percent of the mean score for reference streams in that EDU, any sample that scores less than 16 and has a habitat score less than 75 percent of the mean reference stream score for that EDU, is excluded from the assessment process.

-If at least half the macroinvertebrate samples in an assessed stream segment have habitat scores less than 75 percent of the mean score for reference streams in that EDU and the assessment results in a judgment that the invertebrate community is impaired, the assessed segment will be placed in category 4C, impairment due to poor aquatic habitat.

-If one portion of the assessment reach contains two or more samples with habitat scores less than 75 percent of reference streams from that EDU while the remaining portion does not, the portion of the stream with poor habitat scores could be separately assessed as a category 4C stream permitting low MSCI scores.

Macroinvertebrate sampling methods vary by stream type. One method is used in riffle/pool predominant streams, and the other method is for glide/pool predominant streams. For each stream type, macroinverterbate sampling targets three habitats. For riffle/pool streams, the three habitats sampled are flowing water over coarse substrate, non-flowing water over depositional substrate, and rootmat substrate. For glide/pool streams, the three habitats sampled are non-flowing water over depositional substrate, large woody debris substrate, and rootmat substrate. In some instances, one or more of the habitats sampled can be limited or missing from a stream reach, which may affect an MSCI score. Macroinvertebrate samples based on only two habitats may have a MSCI score equal to or greater than 16, but it is also possible that a missing habitat may lead to a decreased MSCI score. Although MDNR stream habitat assessment procedures take into account a number of physical habitat parameters from the sample reach (for example, riparian vegetation width, channel alteration, bank stability, bank vegetation protection, etc.), they do not exclusively measure the quality or quantity of the three predominant habitats from each stream. When evaluating potentially impaired macroinvertebrate communities, the number of habitats sampled, in addition to the stream habitat assessment score, will be considered to ensure MSCI scores less than 16 are properly attributed to poor water quality or poor/inadequate habitat condition.

Biologists responsible for conducting biological assessments will determine the extent to which habitat availability is responsible for a non-supporting (<16) MSCI score. If it is apparent that a non-supporting MSCI score was due to limited habitat, these effects will be stated in the biological assessment report. This limitation will then be considered when deciding which Listing Methodology Category is most appropriate for an individual stream. This procedure, as part of an MDNR biological assessment, will aid in determining whether impaired macroinvertebrate samples have MSCI scores based on poor water quality conditions versus habitat limitations.

To ensure assessments are based on representative macroinverterbrate samples, samples collected during or shortly after prolonged drought, shortly after major flood events, or any other conditions that fall outside the range of environmental conditions under which reference streams in the EDU were sampled, will not be used to make an attainment decision for a Section 303(d) listing or any other water quality assessment purposes. Sample "representativeness" is judged by Water Protection Program (WPP) staff after reading the biomonitoring report for that stream, and if needed, consultation with biologists from DNR's Environmental Services Program. Regarding smaller deviations from "normal" conditions, roughly 20 percent of reference samples failing to meet a fully biologically supporting MSCI score were collected following weather/climate extremes; as a result, biological criteria for a given EDU are inclusive of samples collected during not only ideal macroinvertebrate-rearing conditions, but also during the weather extremes that Missouri has to offer.

Assessing Small Streams

Occasionally, macroinvertebrate monitoring is needed to assess streams smaller than average wadeable/perennial reference streams listed in Table I of Missouri's Water Quality Standards. Smaller streams may include Class C streams (streams that may cease flow in dry periods but maintain permanent pools which support aquatic life) or those which are unclassified. Assessing small streams involves comparing test stream and candidate reference stream MSCI scores first

to, Wadeable/Perennial Reference Stream (WPRS) criteria, and second, to each other. In DNR's Biological Criteria Database, there are 16 candidate reference streams labeled as Class P, 23 labeled as Class C, and 24 labeled as Class U; and in previous work by DNR, when the MSCI was calculated according to WPRS criteria, the failure rate for such candidate reference streams was 31%, 39% and 70%, respectively. The data trend showed a higher failure rate for increasingly smaller high quality streams when scored using WPRS biological criteria. This demonstrates the need to utilize candidate reference streams in biological stream assessments.

For test streams that are smaller than wadeable perennial reference streams, DNR also samples five candidate reference streams (small control streams) of same or similar size and Valley Segment Type (VST) in the same EDU twice during the same year the test stream is sampled (additional information about the selection small control streams is provided below). Although in most cases the DNR samples small candidate reference streams concurrently with test streams, existing data may be used if a robust candidate reference stream data set exists for the EDU. If the ten small candidate reference stream scores are similar to wadeable perennial reference stream criteria, then they and the test stream are considered to have a Class C or Class P general warm water beneficial use, and the MSCI scoring system in the LMD should be used. If the small candidate reference streams have scores lower than the wadeable perennial reference streams, the assumption is that the small candidate reference streams, and the test stream, represent designated uses related to stream size that are not yet approved by EPA in the state's water quality standards. The current assessment method for test streams that are smaller than reference streams is stated below.

- If the 10 candidate reference stream (small control stream) scores are similar to WPRSs and meet LMD criteria for an unimpaired invertebrate community, then the test stream will be assessed using MSCI based procedures in the LMD.

- If the 10 candidate reference stream scores are lower than those of WPRSs and do not meet the LMD criteria for an unimpaired invertebrate community, then:

    a. The test stream will be assessed as having an unimpaired macroinvertebrate community if the test stream scores meet the LMD criteria for an unimpaired community;
    b. The test stream data will be judged inconclusive if test stream scores are similar to candidate reference stream scores;
    c. The test stream will be assessed as having a "suspect" macroinvertebrate community if its scores are slightly lower than the candidate reference streams; or,
    d. The test stream will be assessed as having an "impaired" macroinvertebrate community if its scores are much lower than the candidate reference streams.

This method of assessing small streams will be used only until such time as the aquatic habitat protection use categories based on watershed size classifications of Headwater, Creek, Small

River, Large River and Great River are ~~is~~ promulgated into Missouri water quality standards and appropriate biological metrics are established for stream size and permanence.

The approach for determining a "suspect" or "impaired" macroinvertebrate community will be made using a direct comparison between all streams being evaluated, which may include the use of percent and/or mean calculations as determined on a case by case basis. All work will be documented on the macroinvertebrate assessment worksheet and be made available during the public notice period.

Selecting Small Candidate Reference Streams

Accurately assessing streams that are smaller than reference streams begins with properly selecting small candidate reference streams. Candidate reference streams are smaller than WPRS streams and have been identified as "best available" reference stream segments in the same EDU as the test stream according to watershed, riparian and in-channel conditions. The selection of candidate reference streams is consistent with framework provided by Hughes et al. (1986) with added requirements that candidate reference streams must be from the same EDU and have the same or similar values for VST parameters. If candidate reference streams perform well when compared to WPRS, then test streams of similar size and VST are expected to do so as well. VST parameters important for selection are based on temperature, stream size, flow, geology, and relative gradient, with emphasis placed on the first three parameters.

The stepwise process for candidate reference stream selection is listed below.

1. Determine test stream reaches to be assessed.
2. Identify appropriate EDU.
3. Determine five variable VST of test stream segments (1^{st} digit = temperature; 2^{nd} digit = size; 3^{rd} digit = flow; 4^{th} digit = geology; and 5^{th} digit = relative gradient).
4. Filter all stream segments within the same EDU for the relevant five variable VSTs (1^{st} and 2^{nd} digits especially critical for small streams).
5. Filter all potential VST stream segments for stressors against available GIS layers (e.g. point source, landfills, CAFOs, lakes, reservoirs, mining, etc.).
6. Filter all potential VST stream segments against historical reports and databases.
7. Develop candidate stream list with coordinates for field verification.
8. Field verify candidate list for actual use (e.g. animal grazing, in-stream habitat, riparian habitat, representativeness, gravel mining, and other obvious human stressors).
9. Rank order candidate sites, eliminate obvious stressed sites, and select at least top five sites.
10. Calculate land use-land cover and compare to EDU.
11. Collect chemical, biological, habitat, and possibly sediment field data.

12. After multiple sampling events evaluate field data, land use, and historical data in biological assessment report.
13. If field data are satisfactory, retain candidate reference stream label in database.

Fish Community Data

The Department utilizes fish community data to determine if aquatic life use is supported in certain types of Missouri streams. When properly evaluated, fish communities serve as important indicators of stream health. In Missouri, fish communities are surveyed by the Missouri Department of Conservation (MDC). MDC selects an aquatic subregion to sample each year, and therein, surveys randomly selected streams of 2nd to 5th order in size. Fish sampling follows procedures described in the document *Resource Assessment and Monitoring Program: Standard Operational Procedures--Fish Sampling* (Combes 2011). Numeric biocriteria for fish are represented by the fish Index of Biotic Integrity (fIBI). Development of the fIBI is described in the document *Biological Criteria for Stream Fish Communities of Missouri* (Doisy et al. 2008).

The fIBI is a multi-metric index made up of nine individual metrics, which include: (1) number (#) of native individuals; (2) # of native darter species; (3) # of native benthic species; (4) # of native water column species; (5) # of native minnow species; (6) # of all native lithophilic species; (7) percentage (%) of native insectivore cyprinid individuals; (8) % of native sunfish individuals; and, (9) % of the three top dominant species. Values for each metric, as directly calculated from the fish community sample, are converted to unitless scores of 1, 3, or 5 according to criteria in Doisy et al. (2008). The fIBI is then calculated by adding these unitless values together for a total possible score of 45. Doisy et al. (2008) established an impairment threshold of 36 (where the 25th percentile of reference sites represented a score of 37), with values equal to or greater than 36 representing unimpaired communities, and values less than 36 representing impaired communities. For more information regarding fIBI scoring, please see Doisy et al. (2008).

Based on consultation between the Department and MDC, the fIBI impairment threshold value of 36 was used as the numeric biocriterion translator for making an attainment decision for aquatic life (Table 1.2 in the LMD). Work by Doisy et al. (2008) focused on streams 3rd to 5th order in size, and the fIBI was only validated for streams in the Ozark ecoregion, not for streams in the Central Plains and Mississippi Alluvial Basin. Therefore, when assessing streams with the fIBI, the index may only be applied to streams 3rd to 5th order in size from the Ozark ecoregion. Assessment procedures are outlined below.

Full Attainment

For seven or fewer samples and following MDC RAM fish community protocols, 75% of fIBI scores must be 36 or greater. Fauna achieving these scores are considered to be very similar to Ozark reference streams.

For eight or more samples, the percent of samples scoring 36 or greater must be statistically similar to representative reference or control streams. For determining this a binomial probability Type I error rate (0.1) is calculated based

on the hypothesis that the test stream would have the same percentage (75%) of fIBI scores greater than 36 as reference streams. If the Type I error rate is more than 0.1, the fish community would be rated as unimpaired.

Non-Attainment
For seven or fewer samples and following MDC RAM fish community protocols, 75 percent of the fIBI scores must be lower than 36. Fauna achieving these scores are considered to be substantially different than regional reference streams.

For eight or more samples, the percent of samples scoring 36 or less must be statistically dissimilar to representative reference or control streams. For determining this a binomial probability Type I error rate is calcualted based on the hypothesis that the test stream would have the same percentage (75%) of fIBI scores greater than 36 as reference streams. If the Type I error rate is less than 0.1, the fish community would be rated as impaired.

Data will be judged inconclusive when outcomes do not meet requirements for decisions of full or non-attainment.

With the exception of two subtle differences, use of the binomial probability for fish community samples will follow the example provided for macroinvertebrate samples in the previous section. First, instead of test stream samples being compared to reference streams of the same EDU, they will be compared to reference streams from the Ozark ecoregion. Secondly, the probability of success used in the binomial distribution equation will always be set to 0.70 since Table B-1 states to "rate a stream as impaired if biological criteria reference stream frequency of fully biologically supporting scores is greater than five percent more than the test stream."

While 1st and 2nd order stream data will not be used to judge a stream as impaired for Section 303(d) purposes, the Department may use the above assessment procedures to judge first and second order streams as unimpaired. Moreover, should samples contain fIBI scores less than 29, the Department may judge the stream as "suspected of impairment" using the above procedures.

Considerations for the Influence of Habitat Quality and Sample Representativeness
Low fIBI scores that are substantially different than reference streams could be the result of water quality problems, habitat problems, or both. When low fIBI scores are established, it is necessary to review additional information to differentiate between an impairment caused by water quality and one that is caused by habitat. The collection of a fish community sample is also accompanied by a survey of physical habitat from the sampled reach. MDC sampling protocol for stream habitat follows procedures provided by Peck et al. (2006). With MDC guidance, the Department utilizes this habitat data and other available information to assure that an assessment of aquatic life attainment based on fish data is only the result of water quality, and that an impairment resulting from habitat is categorized as such. This section describes the procedures used to assure low fIBI scores are the result of water quality problems and not habitat degradation. The below information outlines the Department's provisional method to identify unrepresentative samples and low fIBI scores with questionable habitat condition, and ensure corresponding fish IBI scores are not used for Section 303(d) listing.

A. Following recommendations from the biocriteria workgroup, the Department will consult MDC about the habitat condition of particular streams when assessing low fIBI scores.

B. Samples may be considered for Section 303(d) listing if they were collected in ONLY the Ozark ecoregion, and based upon best professional judgment from MDC Staff, the samples were collected during normal representative conditions. Samples collected from the Central Plains and Mississippi Alluvial Basin are excluded from the Section 303(d) listing.

C. Only samples from streams 3rd to 5th order in size may be considered for Section 303(d) listing. Samples from 1st or 2nd order stream sizes are excluded from Section 303(d) consideration; however, they may be placed into Categories 2B and 3B if an impairment is suspected, or into Categories 1, 2A, or 3A if sample scores indicate a stream is unimpaired. Samples from lower stream orders are surveyed under a different RAM Program protocol than 3rd to 5th order streams.

D. Samples that are ineligible for Section 303(d) listing include those collected on losing streams, as defined by the Department of Geology and Land Survey, or, collected in close proximity to losing streams. Additionally, ineligible samples may also include those collected on streams that were considered to have natural flow issues (such as substantial subsurface flow) preventing good fish IBI scores from being obtained, as determined through best professional judgment of MDC Staff.

E. Fish IBI scores must be accompanied by habitat samples with a QCPH1 habitat index score. MDC was asked to analyze meaningful habitat metrics and identify samples where habitat metrics seemed to indicate potential habitat concerns. As a result, a provisional index named QCPH1 was developed. QCPH1 values less than 0.39 indicate poor habitat, while values greater than 0.39 suggest adequate habitat is available. The QCPH1 comprises six sub-metrics indicative of substrate quality, channel disturbance, channel volume, channel spatial complexity, fish cover, and tractive force and velocity. The QCPH1 index is calculated as follows:

$$QCPH1 = ((\text{Substrate Quality} * \text{Channel Disturbance} * \text{Channel Volume} * \text{Channel Spatial Complexity} * \text{Fish Cover} * \text{Tractive Force \& Velocity})^{1/6})$$

Where sub-metrics are determined by:

Substrate Quality = ((embeddedness + small particles)/2) * ((filamentous algae + aquatic macrophyte)/2) * bedrock and hardpan

Channel Disturbance = concrete * riprap * inlet/outlet pipes * relative bed stability * residual pool observed to expected ratio

Channel Volume = ((dry substrate+width depth product + residual pool + wetted width)/4)

Channel Spatial Complexity = (coefficient of variation of mean depth + coefficient of variation of mean wetted width + fish cover variety)/3

Fish Cover = ((all natural fish cover + ((brush and overhanging vegetation + boulders + undercut bank + large woody debris)/4) + large types of fish cover)/3)

Tractive Force & Velocity = ((mean slope + depth * slope)/2)

Unimpaired fish IBI samples (fIBI ≥ 36) with QCPH1 index scores below the 0.39 threshold value, or samples without a QCPH1 score altogether, are eliminated from consideration for Category 5 and instead placed into Categories 2B or 3B should an impairment be suspected. Impaired fish communities (fIBI < 36) with QCPH1 scores < 0.39 can be placed into Category 4C (non-discrete pollutant/habitat impairment). Impaired fish communities (fIBI < 36) with adequate habitat scores (QCPH1 > 0.39) can be placed into Category 5. Appropriate streams with unimpaired fish communities and adequate habitat (QCPH1 > 0.39) may be used to judge a stream as unimpaired.

Similar to macroinvertebrates, assessment of fish community information must be based on data coded level three or four as described in Section II.C of the LMD. Data coded as levels three and four represent environmental data with the greatest degree of assurance, and thus, assessments will include multiple samples from a single site, or samples from multiple sites within a single reach.

Following the Department's provisional methodology, fish community samples available for assessment (using procedures in Table 1.2, Table B-1, and Table B-2) include only those from 3rd to 5th order Ozark Plateau streams, collected under normal, representative conditions, where habitat seemed to be good, and where there were no issues with inadequate flow or water volume.

Other Biological Data

The Department may periodically, on a case by case basis, use biological data other than MSCI or fIBI scores for assessing attainment of aquatic life. Other biological data may include information on single indicator aquatic species that are ecologically or recreationally important, or individual measures of community health that respond predictably to environmental stress. Measures of community health could be represented by aspects of structure, composition, individual health, and processes of the aquatic biota. Examples could include measures of density or diversity of aquatic organisms, replacement of pollution intolerant taxa, or even the presence of biochemical markers.

Other biological data should be collected under a well vetted study that is documented in a scientific report, a weight of evidence should be established, and the report should be referenced in the 303(d) listing worksheet. If other biological data is a critical component of the community and has been adversely affected by the presence of a pollutant or stressor, then such data would indicate a water body is impaired. The Department's use of other biological data is in agreement

with EPA's policy on independent applicability for making attainment decisions, which is intended to protect against dismissing valuable information when diagnosing an impairment of aquatic life.

The use of other biological data in waterbody assessments occurs infrequently, but when available, it is usually assessed in combination with other information collected within the waterbody of interest. The Department will avoid using other biological data as the sole justification for a Section 303(d) listing; however, other biological data will be used as part of a weight of evidence analysis for making the most informed assessment decision.

Weight of Evidence Analysis

When evaluating narrative criteria, the Department will use a weight of evidence analysis for assessing numeric translators which have not been adopted into state Water Quality Standards. Under the weight of evidence approach, all available information is examined and the greatest weight is given to data providing the "best supporting evidence" for an attainment decision. Determination of "best supporting evidence" will be made using best professional judgment, considering factors such as data quality and site-specific environmental conditions. The weight of evidence analysis will include the use of other types of environmental data when available, including fish tissue, sediment chemistry, MSCI and fIBI scores, and other biological data.

Biological data will be given greater weight in a weight of evidence analysis for making an attainment decision for aquatic life use and subsequently a Section 303(d) listing. Whether or not numeric translators of biological criteria are met is a strong indicator for the attainment of aquatic life use. Moreover, the Department retains a high degree of confidence in an attainment decision based on biological data that is representative of water quality condition.

When the weight of evidence analysis suggests, but does not provide strong, scientifically defensible evidence of impairment, the Department will place the water body in question in Categories 2B or 3B. The Department will produce a document showing all relevant data and the rationale for the attainment decision. All such documents will be made available to the public at the time of the first public notice of the proposed 303(d) list. A final recommendation on the listing of a waterbody based on narrative criteria will only be made after full consideration of all comments on the proposed list.

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