

2022

ASSESSMENT METHODOLOGY



For the Preparation of:

The 2022 Integrated Water Quality Monitoring and Assessment Report

Pursuant to Clean Water Act Sections 303(d) and 305(b)

TABLE OF CONTENTS

1.0 ASSESSMENT BACKGROUND	1
2.0 INTEGRATED REPORTING CATEGORIES.....	2
3.0 DATA MANAGEMENT.....	5
3.1 Water Quality Data Types and conditions	5
3.2 Data Assembly	6
Period of record for the 2022 305(b) Report:	7
3.3 Data Quality Considerations	8
3.4 Data Quantity Considerations	10
3.5 Data Representativeness Considerations	11
3.6 Statistical Confidence	11
3.7 Internal Data Assessment Method	16
3.8 External Data Assessment Method	16
3.9 Impairment Source Determination.....	16
3.10 Final Attainment Decision Process.....	17
4.0 WATER QUALITY STANDARDS.....	18
4.1 Antidegradation.....	18
4.2 Designated Uses.....	18
4.3 Water Quality Criteria.....	20
5.0 BIOLOGICAL INTEGRITY	21
5.1 Macroinvertebrate Community Analysis.....	24
5.2 Fish Community Analysis.....	26
6.0 SPECIFIC STANDARDS	30
6.1 Temperature	32
6.2 Turbidity	35
6.3 pH.....	38
6.4 Dissolved Oxygen.....	40
6.5 Radioactivity	45
6.6 Bacteria	46
6.7 Toxic Substances	51

6.8 Fish Consumption	54
6.9 Nutrients.....	55
6.10 Mineral Quality	60
6.12 Ammonia.....	63
REFERENCES CITED.....	69

LIST OF TABLES AND FIGURES

Table 1: Minimum number of sample exceedances required to assess as non-attaining (list) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the waterbody is greater than or equal to 10%, 20%, or 25%.	14
Table 2: Maximum number of sample exceedances allowed in order to assess as attaining (de-list) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the waterbody is greater than or equal to 10%, 20%, 25%	15
Table 3: Designated Uses for Arkansas's surface waters and rules used for assessment.	19
Table 4: Macroinvertebrate bioassessment metrics and scoring criteria ¹	24
Table 5: Scoring criteria for macroinvertebrate community attainment decisions (modified from Plafkin et al. 1989).....	26
Table 6: Fish Community Structure Index (CSI) ecoregion values.....	27
Table 7: Biological community assessment determination.	28
Table 8: Aquatic life designated use listing protocol.....	29
Table 9: Ambient toxicity listing protocol.....	29
Table 10: Statewide bacteria assessment criteria.....	50
 Figure 1: Determining Aquatic Life Use designated use attainment Step 1.....	22
Figure 2: Determining Aquatic Life Use designated use attainment Step 2.....	23
Figure 3: Nutrient assessment flowchart for wadeable streams and rivers.....	59

1.0 ASSESSMENT BACKGROUND

Section 305(b) of the Federal Water Pollution Control Act (hereinafter “Clean Water Act”) requires states to perform a comprehensive assessment of the State’s water quality to be reported to the U.S. Environmental Protection Agency (EPA) every two years. The report provides information on the quality of the state’s waters; the extent to which state waters provide for the protection and propagation of a balanced population of fish, shellfish, and wildlife, and allow recreational activities in and on the water; and how pollution control measures are leading to water quality standards attainment.

In addition, Section 303(d) of the Clean Water Act requires each state to identify waters where existing pollution controls are not stringent enough to achieve state water quality standards and establish a priority ranking of these waters. States must develop Total Maximum Daily Loads (TMDLs) or other corrective actions for the identified waters. TMDLs describe the amount of each pollutant a waterbody can receive and not violate water quality standards. States submit the list of impaired waters (303(d) list) to EPA. EPA has the option to approve, disapprove, or take no action on the list within 30 days of submission.

Arkansas Department of Energy and Environment, Division of Environmental Quality (DEQ) follows the specific requirements of 40 C.F.R. § 130.7-130.8 and EPA’s most current 305(b) reporting and 303(d) listing requirements and guidance when developing this assessment methodology. Current EPA guidance recommends producing one report combining requirements of the Clean Water Act for Sections 305(b) reporting and 303(d) submissions. This is, in general, referred to as the Integrated Report (IR).

Arkansas’s combined report is the *Integrated Water Quality Monitoring and Assessment Report* (305(b) Report). The 305(b) Report describes the quality of all of the surface waters of the state that were evaluated for a specified assessment period (period of record). This report is prepared using the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act (EPA 2005)* which is supplemented by memoranda regarding development of the 2008, 2010, 2012, 2014, 2016, 2018, and 2022 305(b) Reports (EPA 2006, 2009, 2011, 2013, 2015, 2017, and 2021 respectively). Arkansas’s waters are evaluated in terms of whether their assigned water quality criteria and designated uses, as delineated in the Arkansas Pollution Control and Ecology Commission’s (APC&EC) Rule¹ 2 *Water Quality Standards for Surface Waters of the State of Arkansas* (APC&EC 2020), herein referred to as Rule 2, are being attained.

Rule 2 provides the foundation for the 305(b) Report, establishing water quality standards for surface waters of the State of Arkansas; designated uses associated with those water quality standards; and criteria and policies established to protect, maintain, and restore designated uses. Water quality data are assessed for compliance with Rule 2 to determine impairment and designated use support, based upon the frequency, duration, and/or magnitude of water quality criteria exceedances as delineated in DEQ’s assessment methodology.

¹ Act 315 of 2019 was enacted by the Arkansas General Assembly requiring revisions of the use of Rule in lieu of Regulation.

2.0 INTEGRATED REPORTING CATEGORIES

Arkansas's waters are assessed based on water quality criteria and designated use support, according to Rule 2 and this assessment methodology. Water quality standard attainment is determined based on support of designated uses and/or criteria in place to protect those designated uses. An assessment unit (AU), previously referred to as a monitoring segment, is the basic unit of record for conducting and reporting water quality assessments. AUs are individual stream reaches, lakes, lake areas, or other defined waterbodies and are grouped by planning segments and 8-digit hydrologic unit codes (HUC). AUs are delineated using GIS layers and several real world considerations such as tributaries, land use boundaries, point source dischargers, monitoring stations, physical breaks, and other factors.

Arkansas's assessments are formatted to reflect EPA's 305(b)/303(d) Integrated Report (IR) guidance (EPA 2005, 2006, 2009, 2011, 2013, 2015, 2017, and 2021) which suggests placing AUs into the following five integrated reporting categories upon assessment. AUs may be assessed as Category 1, 'support' if all water quality criteria and designated uses, for which data are available, are attained. AUs may be assessed as 'non-support' if any water quality criteria or designated use is not attained, and may be placed in Category 4 or 5, as appropriate. AUs may be placed in Category 3 if there is not enough information to make a scientifically defensible attainment decision. Historically, Category 2 is rarely used in Arkansas.

Some impaired AUs will be distinguished between pollutant causes currently without a TMDL (Category 5) and pollutant causes for which TMDLs have already been approved (Category 4a). In some instances, a regulatory response outside of a TMDL is permissible and the AU/pollutant pair is assigned to Category 4b (alternative pollution control) or Category 5 alt. In instances where non-attainment is not caused by a pollutant, AUs will be placed in Category 4c. Examples of this would be naturally occurring deviations from current criteria where site specific criteria would be more appropriate but are yet to be developed. Note that Category 4 waters are not part of the 303(d) list of impaired waterbodies; however, a list of Category 4 waters are public noticed along with the 303(d) list (Category 5).

The 303(d) list of impaired waterbodies (Category 5) consists of AUs not supporting one or more designated use and/or not meeting water quality criteria. Category 5 is prioritized by DEQ for planning and management purposes in accordance with 40 § C.F.R. 130.7 (b)(4) which states: "The list required under §§ 130.7(b)(1) and 130.7(b)(2) of this section shall include a priority ranking for all listed water quality-limited segments still requiring TMDLs, taking into account the severity of the pollution and the uses to be made of such waters and shall identify the pollutants causing or expected to cause violations of the applicable water quality standards. The priority ranking shall specifically include the identification of waters targeted for TMDL development in the next two years." Therefore, any waterbody ranked as "high" within Category 5 may be targeted for TMDL development.

Category 1. Attains all water quality criteria and supports all designated uses; categorized by existence of a TMDL or not for one or more constituents.

1a. Attaining all water quality criteria and supporting all designated uses, no use is threatened. No TMDL exists for any constituents.

1b. Attaining all water quality criteria and supporting all designated uses; however, a TMDL remains in place for one or more constituents.

Category 2. Available data and/or information indicate that some, but not all of the designated uses are supported.

Category 3. Insufficient data and/or information are available to make a use support determination.

3a. No data available.

3b. Insufficient data available.

- Data do not meet all quality requirements outlined in this assessment methodology;
- Waters in which the data are questionable because of Quality Assurance and/or Quality Control (QA/QC) procedures and/or the AU requires confirmation of impairment before a TMDL is scheduled.
- Where limited available data and/or information indicate potential impacts or downward trends in water quality, the following waterbodies in Category 3 may be prioritized (on a case-by-case basis) for additional investigation: waters designated as Extraordinary Resource Waters (ERW), Ecologically Sensitive Waterbody (ESW) or Natural and Scenic Waterways (NSW); domestic water supplies; and waters located in known karst areas.

Category 4. Water quality standards are not attained for one or more designated uses but the development of a TMDL is not required because:

4a. A TMDL has been completed for the listed parameter(s); or

4b. Other management alternatives are expected to result in the attainment of the water quality standard; or

4c. Non-support of the water quality standard is not caused by a pollutant.

Category 5. The waterbody is impaired, or one or more water quality standards are not attained. Waterbodies in Category 5 will be prioritized as:

High

- Truly impaired; develop a TMDL or other corrective action(s) for the listed parameter(s).

Medium

- Waters currently not attaining standards, but may be de-listed with future revisions to APC&EC Rule 2, the state water quality standards; or

- Waters which are impaired by point source discharges and future permit restrictions are expected to correct the problem(s).

Low

- Waters currently not attaining one or more water quality criteria, but assessed designated uses are determined to be supported; or
- There is insufficient data to make a scientifically defensible decision concerning designated use attainment. Where more data and/or information are needed to verify the need for TMDL development or other corrective action(s) for the listed parameter(s), the following waterbodies in Category 5 may be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas; or
- Waters DEQ assessed as unimpaired, but were assessed as impaired by EPA.

Alt

- Waters where alternative restoration approaches may be more immediately beneficial or practicable in achieving WQS than pursuing the TMDL approach in the near-term.

3.0 DATA MANAGEMENT

Data assessment forms the basis of water quality standard attainment decisions. In order to conduct accurate assessments, evaluated data must reflect current ambient surface water quality conditions, adhere to robust quality and quantity considerations, and represent accurate temporal and spatial requirements. Data are assessed based on the current EPA-approved water quality standards for the State of Arkansas (APC&EC, 2020) and this assessment methodology. In some cases, a weight of evidence approach may be used to supersede a preliminary assessment. When this occurs, justification will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. A more robust discussion of how final attainment decisions are determined can be found in Section 3.10 Final Attainment Determination Process.

3.1 WATER QUALITY DATA TYPES AND CONDITIONS

3.1.1 Data Types

Water quality data are collected in a variety of ways in Arkansas and are utilized differently for assessment purposes. Data sets are generally classified as discrete or continuous. Unless otherwise specified, assessment methodologies are designed for use with discrete data sets. When continuous data are used for assessment purposes, assessment methodologies will be identified as such. Different data types will not be combined for assessment purposes. If multiple data types exist for one AU the most appropriate set will be used for assessments based on robustness, scientific soundness, and representativeness. A weight of evidence approach may be applied when making decisions about which data set to use.

3.1.1.1 Discrete Data

Discrete data are generally characterized as data generated from samples taken at the same location with a significant amount of time passing, or a significant event (such as a storm event) occurring between each sample such that potential changes in water chemistry can be noted. These samples can be *in situ* measurements (pH, temperature, etc.) or grab samples to be taken to a lab for analysis (metals, toxics, etc.). An example of a discrete data set would be DEQ's ambient monitoring network where samples are collected from the same locations on a monthly basis. Discrete sampling works well when resources are limited, allowing entities to sample a larger area over time.

3.1.1.2 Continuous Data

Continuous data are generally characterized as data generated from a series of discrete *in situ* samples taken at frequent, regular intervals at the same location over time. Typically, these data are collected using a continuous logging meter taking measurements in regular time increments such as from once a second to once an hour. Water quality parameters typical of this collection are pH, dissolved oxygen, and temperature.

For assessment purposes, DEQ considers two types of continuous data: long-term and short-term. Long-term continuous data spans long time periods, from weeks to years. Long-term continuous data are typically collected at minute to hourly intervals. Short-term continuous data spans a shorter time frame, typically a 48 – 96 hour period. These time periods target diurnal shifts in

certain water quality parameters and measurements are typically collected every few seconds or minutes.

When managing data for assessment purposes, both long-term and short-term continuous data taken in less than hourly readings (example: data recorded every fifteen minutes) will be calculated into hourly averages. All long-term and short-term assessments require at least hourly readings. Short-term continuous data must span 90% of each 24 hour period. Data acceptance will be determined by representativeness.

3.1.2 Data Conditions

At times, data results are “censored,” meaning they are reported as less than some value or greater than some value. This is a common and typical occurrence. DEQ will handle these data in the following ways.

3.1.2.1 Data below detection limits
Data that are lower than detection limits of laboratory methods or equipment are typically represented as less than the numerical detection limit (example: <0.05 mg/L). In these cases, DEQ will use one-half the detection limit and assign that value as the numeric result for that data point (Clarke 1998, Scott et al. 2016, Croghan and Egeghy 2003, and Dixon 2005). In the example, the data point would be 0.025 mg/L. This is done so that the result can be used, as an actual number, in assessment calculations and data management. Numbers with symbols cannot be easily sorted or managed, thus the need to be converted into a usable number.

3.1.2.2 Data above detection limits

Data that are greater than detection limits of laboratory methods will be represented as the numerical detection limit (example: >1500 cfu/100 mL) as long as the detection limit is greater than applicable criteria. In the example, the data point would be 1500 cfu/100 mL, which could be utilized for assessing a ERW, ESW, NSW, Reservoir or Lake in the secondary contact season (criteria = 1490 cfu/100 mL), but could not be used for all other waters in the secondary contact season (criteria = 2050 cfu/100 mL). Maximum detection limits that are below applicable criteria will not be used for assessment purposes.

3.1.2.3 Other data conditions

Some data are represented as approximate. This is common for bacteria data as it is common to extrapolate to a larger sample size than what is analyzed (EPA 2014). Approximate data (Example: ~125 cfu) will be used in assessments by dropping the approximate sign and using the whole number value. In the example, the data point would be 125 cfu. This is done so that the result can be used, as an actual number, in assessment calculations and data management. Numbers with symbols cannot be easily sorted or managed, thus the need to be converted into a usable number.

3.2 DATA ASSEMBLY

Pursuant to 40 C.F.R. § 130.7(b)(5), DEQ assembles and evaluates all existing and readily available water quality data and information, from DEQ and outside entities, to make water quality standard attainment decisions. Data are evaluated for use by determining adherence (or not) to data quality considerations outlined in this document (Sections 3.3 and 6.0 and subsections thereof).

The primary data used in the assessment of Arkansas’s water quality are generated as part of DEQ’s water quality monitoring activities, described in the *State of Arkansas’s Water Quality Monitoring and Assessment Program, Revision 6* (DEQ 2021). Additionally, local, state, and

federal agencies, and other entities are solicited by DEQ to provide water quality data that meets or exceeds DEQ accepted QA/QC protocols.

Any entity may submit water quality data to DEQ without solicitation. All data received will be evaluated for use. The 305(b) report will include a list of all outside entities who provided data as well as a map of where data were collected that were used in assessments.

PERIOD OF RECORD FOR THE 2022 305(B) REPORT:

Toxics and ammonia toxicity analysis: *April 1, 2018 through March 31, 2021*

Beaver Lake site specific nutrient criteria: *January 1, 2016 through December 31, 2020*

All other analyses: *April 1, 2016 through March 31, 2021*

3.2.1 No New Data

If no new qualifying water quality data have been generated for an AU during the current period of record, water quality standard and designated use attainment decisions from the preceding assessment period will be carried forward unless a substantial change in water quality standards or assessment methodology has occurred. If substantial changes in water quality standards or assessment methodology has occurred since the preceding assessment period, and those changes would affect previous assessment decisions, the data from the preceding period of record may be re-assessed using newly-adopted water quality standards and newly defined methodology to determine current water quality standard attainment.

3.2.2 Absence of Data

AUs may be “monitored” or “non-monitored.” A monitored AU contains a water quality monitoring station within its delineated boundaries. A non-monitored AU does not contain a water quality monitoring station within its delineated boundaries. Water quality standard attainment assessments can be made for AUs in the absence of data if it can be reasonably established that non-monitored AUs are similar in watershed characteristic and condition to contiguous monitored AUs. When this occurs, the AU will be identified as “evaluated.”

DEQ will consider land use practices, tributary location, impoundments, point sources, and other hydrological features that could impact the water quality between the station site and the contiguous non-monitored AU. If similarity in watershed characteristic and/or condition cannot be established, contiguous non-monitored AUs will remain unassessed.

Water quality standard non-attainment assessments, in the absence of data, can be made for non-monitored stream segments if it can be reasonably established that the segment is similar with respect to the cause and magnitude of impairment to contiguous monitored waters. However, an evaluation of non-attainment will not be made for non-monitored AUs when the source or the origin of the impairment in contiguous monitored waters is unknown, and/or when the magnitude or frequency of the impairment is such that contiguous segments may not be impacted.

Non-monitored AUs that are evaluated using data from monitored AUs will be noted as such in the Impaired Waterbodies 303(d) list.

3.3 DATA QUALITY CONSIDERATIONS

DEQ maintains a strong commitment to the collection and use of high quality data to support environmental decisions and regulatory programs. DEQ uses data submitted by various entities in different ways, depending on the quality and quantity of the data; however, all data submitted to DEQ will be evaluated for use. Although all existing and readily available water quality data are “evaluated,” not all data can be used to make assessments or attainment decisions. Data sets must first be evaluated for adherence to data quality requirements as defined below.

Data quality requirements are categorized into Phase I and Phase II. Phase I requirements are general to all parameters; whereas Phase II requirements are specific to the parameter being assessed. Phase II requirements are explained in more detail in Section 6.0 and subsections thereof.

Certain Phase I data quality requirements are considered “essential.” These requirements are essential for data to be considered scientifically valid for any purpose. Essential data requirements are listed below along with other Phase I requirements.

Data sets that meet all Phase I and Phase II data quality requirements can be used for attainment decisions. Data sets that fail to meet all quality requirements may be used for screening purposes. However, failure to meet essential quality requirements will exempt those data from use in screening or assessment purposes altogether.

Each individual data set presented for consideration will be evaluated against Phase I data quality requirements. If the data set meets essential Phase I data quality requirements, it will then be evaluated against the remaining Phase I and Phase II data quality requirements. If the data set does not meet essential Phase I data quality requirements it will not be evaluated further.

Phase I Data Quality Requirements

Essential data requirements:

- Be characteristic of the main water mass or distinct hydrologic areas. For example, not taken within a mixing zone, side channel, tributary, or stagnant backwater, etc.
- Be reported in standard units recommended in the relevant approved method and that conform to Rule 2 or can be directly compared or converted to units within Rule 2.
- Have been collected and analyzed under a DEQ accepted QA/QC protocol. Data collection protocols (QAPP and SOP, as apply) should accompany the data.
- All laboratory analyzed parameters (not *in situ*) must be analyzed pursuant to the rules outlined in the Environmental Laboratory Accreditation Program Act, Ark. Code Ann. § 8-2-201 *et seq.* The name and location of the laboratory should accompany the data.
- Be accompanied by precise collection metadata such as time, date, stream name, parameters sampled, and sample site location(s), preferably latitude and longitude in either decimal degrees or degrees, minutes, seconds.
- Be received in either a Microsoft Excel spreadsheet or compatible format not requiring excessive formatting by DEQ, preferably in the template provided by DEQ.
- Have been collected within the period of record for the current assessment cycle.

Phase II Data Quality Requirements

Phase II data quality requirements will be specific for each parameter and will be detailed in the appropriate subsection of Section 6.0 Specific Standards.

If multiple data sets pass Phase I data quality requirements for the same AU, they may be combined and considered as an aggregate data set for Phase II data quality requirements (see Section 3.3.2 Aggregate Data Sets for more information). If only one data set for a given AU passes Phase I data quality requirements it will be considered as a standalone data set for Phase II data quality requirements.

These requirements apply to the entire data set for a given AU, whether individual or aggregate, that will be considered for assessment.

- Meet sampling temporal conditions described for each parameter or designated use being assessed. These conditions include season (time of year) such as “critical season,” “secondary contact season,” or “primary season,” each defined within the applicable parameter.
- Meet data quantity requirements for each parameter or designated use being assessed. If quantity requirements are not met, but all other data quality considerations are met, AUs may be assessed as Category 3b. Insufficient data available.
- Meet data distribution throughout the appropriate season(s) or overall time frame appropriate for each parameter or designated use being assessed. Samples should always be “evenly distributed” for the temporal conditions outlined for each parameter. “Evenly distributed” is defined in Section 6.0. AUs that do not meet specific distribution requirements may be assessed as Category 3b. Insufficient data available.
- Meet sample spatial requirements described for each parameter or designated use being assessed. These can include lake sampling depth, specific sampling locations, or other spatial requirements.

3.3.1 Individual Data Sets

Individual data sets must first meet the Phase I data quality requirements outlined in Section 3.2 above to be considered for assessment purposes. If an individual data set is the only data set for a given AU, then that data set must also meet the Phase II data quality requirements outlined above to be used for attainment purposes.

When more than one individual data set exists for a given AU, each data set will be independently evaluated for use. If water quality data indicate that an AU is not homogenous, resulting in conflicting attainment conclusions, the AU will warrant further examination. The assessor will evaluate data from each station individually to confirm impairments and determine whether or not it would be more appropriate to split an AU. If data indicate that it is more appropriate to split an AU, the resulting AUs will be re-assessed based on data within the newly-defined boundaries for the applicable period of record.

3.3.2 Aggregate Data Sets

AUs are delineated to represent homogenous waters with regard to water quality. Therefore, it follows that any independent sample taken from an AU is representative of conditions within that

AU. Occasionally more than one monitoring station with available data exists within an AU or several entities may provide data for the same monitoring location. Since each independent sample is considered to be representative of the AU at the time of collection, aggregation of independent samples into one data set within an AU may be appropriate. Aggregation can occur for data from the same entity or from different entities. Aggregation of data sets will be evaluated on a case by case basis.

Data sets of different types (e.g. discrete vs. continuous) will not be combined into an aggregate data set. Different data types will always be assessed independently, if available.

Aggregation of data sets may be full or partial. Fully aggregated data sets will use all data points from all available data sets (that meet data requirements) from an AU. Partially aggregated data sets will use a subset of available data points for the AU. These scenarios are described below.

3.3.2.1 Fully aggregating data sets

Individual data sets of the same type (e.g. discrete data) that pass Phase I quality requirements may be combined into a single aggregate data set for that AU. Individual data sets that do not pass Phase II quality requirements on their own may still be used for assessments if, when combined with another data set of the same type, pass Phase II quality requirements as an aggregate set.

3.3.2.2 Partially aggregating data sets

For certain conditions, explained below for both streams and lakes, data sets may be partially aggregated. Partial aggregation of data sets may be appropriate in order to not weight data toward temporal or spatial conditions.

For streams, data sets taken within the same AU on the same day will be partially aggregated. Data sets will be aggregated and duplicate data points per day will be omitted, retaining only the most protective data point per day. This will prevent weighting limited data sets temporally.

For lakes, samples taken at multiple site locations within the same AU, and on the same day may be aggregated if they are taken at different depths. If multiple data sets exist for a single lake AU on the same day, the most protective data point for each depth will be used (provided Phase II depth requirements are met). This will prevent weighting data spatially.

3.4 DATA QUANTITY CONSIDERATIONS

DEQ strives to follow EPA guidance, which encourages collection of adequate data to make well-grounded attainment determinations (EPA 2005). Use of limited data is acceptable to EPA as limited financial, field, and laboratory resources often dictate the number of samples that can be collected and analyzed (EPA 2002). EPA has not established, required, nor encouraged the establishment of rigid minimum sample set size requirements in the water quality standards attainment status determination process (EPA 2005). As such, EPA discourages the use of target sample sizes applied in an assessment methodology as absolute exclusionary rules (EPA 2005).

However, EPA recognizes that assessments based on larger sample sets are more likely to yield accurate conclusions than assessments based on smaller sample sets, and that it may be appropriate to identify an initial sample size screen, but also provide for a further assessment of sample sets that do not meet the target sample size (EPA 2005).

DEQ strives for a minimum of ten (10) water quality samples to make water quality criteria and designated use attainment decisions for most physical and chemical parameters. The primary goal of obtaining ten (10) or more data points is to protect against the occurrence of Type I and Type II errors. A Type I error would result in assessing an assessment unit as non-support when it is actually fully supporting its criteria and uses. A Type II error occurs when an assessment unit is assessed as support despite it actually not meeting its criteria and/or uses.

For water quality and designated use attainment decisions, data sets containing fewer than ten (10) ($n < 10$) data points will be used as a screening sample, unless fewer than ten (10) samples is appropriate for the parameter, such as primary contact season bacteria, or if non-attainment is reached in only one (1) or two (2) samples such as radioactivity, toxics, and ammonia. Surface water AUs with fewer than 10 ($n < 10$) data points and two or more ($n \geq 2$) exceedances will warrant additional monitoring and may be placed into Category 3 for further investigation. Impairments based on this limited data set may be assessed on a case-by-case basis. Once the sample size reaches ten (10) data points or greater ($n \geq 10$) the appropriate rate of exceedance applies.

Specific data quantity requirements are described for each parameter within Section 6.0 and subsections thereof. AUs that fail to meet the Phase II data quantity requirement may be categorized as Category 3, insufficient data to determine attainment.

3.5 DATA REPRESENTATIVENESS CONSIDERATIONS

Spatial and temporal representativeness of data and information must be considered when characterizing annual ambient conditions for a given AU. Specifics of spatial and temporal distribution will be discussed within each parameter in Section 6.0 and subsections thereof of this document.

Spatial and temporal representativeness of a grab sample is a qualitative assessment addressed primarily in sample design through selection of sampling sites and use of procedures that reflect project goals and environment being sampled (i.e., monitoring the presence and magnitude of toxicity at specific sites for potential impacts on aquatic life may require specialized parameter sampling). For assessment purposes, grab samples from a given monitoring site are considered representative of the waterbody for that distance upstream and downstream in which there are no significant influences to the waterbody that might cause a change in water quality (e.g., point source discharges, confluence with another stream, etc.) or when there is an absence of contextual information indicating unstable hydrologic conditions, such as: 1) precipitation, 2) stream flow, 3) differing land use patterns, or 4) historic patterns of pollutant concentrations in the monitoring segment.

Continuous data are considered representative when the data set accurately represents seasonality in the waterbody. Data sets with significant blocks of missing time that do not reflect ambient conditions will not be used for assessment purposes.

3.6 STATISTICAL CONFIDENCE

Past EPA guidelines (EPA 1996 and 2002) have recommended listing waterbody segments as impaired (for conventional pollutants) when “10% of measurements exceed the water quality criterion.” Making attainment decisions by simply applying a literal percent exceedance rate (10 exceedances out of 100 equals 10%) is referred to as a “raw score” assessment method. While this

“raw score” assessment method can be applied, it errs significantly toward making false positive listings (Washington State Department of Ecology 2002).

In an effort to limit or reduce false positive (Type 1 error) listings, DEQ utilizes binomial distribution methodology for certain parameters, as appropriate. It will not be used on parameters where only one or two excursions of the criteria will result in an assessment of non-attainment such as toxics, radioactivity, and ammonia. Additionally, binomial distribution method will not be applied to bacteria data due to assessment language established in Rule 2.507. The binomial distribution method will be applied to the following parameters: temperature, turbidity, pH, dissolved oxygen, and minerals.

When the binomial distribution method is not applied, the specific method used for each parameter is described within applicable Sections 6.1- 6.12.

The binomial distribution method is a non-parametric, robust, and well known method for characterizing the probability of proportions; in this case, the percent a data set exceeds a predetermined constant. Statistical analysis methods, such as the binomial distribution method, are used to increase the confidence level of the final decision of attainment of water quality criteria.

Use of the binomial distribution method also allows DEQ to statistically consider the waterbody as a whole rather than just the available sample set. The “raw score” method only determines exceedances in the available sample set, which are only a representation of the whole waterbody. The binomial distribution method allows for a margin of safety to statistically declare, with a set degree of confidence, that the sample set accurately represent the waterbody as a whole. This is more effective, from an environmental standpoint, than simply determining whether or not the sample set exceed standards.

The EPA suggests that states determine the level of error they are willing to accept during the decision making process. Statistical methods should be employed to help achieve the state’s acceptable level of error. DEQ strives to attain a greater than ninety percent (>90%) confidence level when determining the water quality attainment status of an AU. Table 2 specifies the minimum number of exceedances required per sample size to list an AU on the 303(d) list of impaired waterbodies. Conversely, Table 3 specifies the maximum number of exceedances allowed per sample size to de-list a listed AU. Each table assumes >90% confidence level for a decision with exceedance rates of ten (10), twenty (20), and twenty-five (25) percent using the binomial distribution method.

Utilizing the mathematical functions in Microsoft Excel, the exceedance rates were calculated using the following formula:

`BINOM.INV(X,Y,Z)`

Where:

X = number of samples in the data set (Trials)

Y = percent exceedance rate expressed as a decimal, (Probability_s); 10%=0.10, 20%=0.20, 25%=0.25

Z = confidence level to be attained, expressed as a decimal, (Alpha) 90%=0.9

Text above in parentheses is language input for Microsoft Excel arguments.

Thus, for a data set that contains 10 samples, to be assessed on a 10% exceedance rate and attain a 90% confidence level in the final decision, the formula would be:

`BINOM.INV(10,0.1,0.9)`

Table 1: Minimum number of sample exceedances required to assess as non-attaining (**list**) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the waterbody is greater than or equal to 10%, 20%, or 25% .

10% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10-11	2
12-18	3
19-25	4
26-32	5
33-40	6
41-47	7
48-55	8
56-63	9
64-71	10
72-79	11
80-88	12
89-96	13
97-100	14

20% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10-13	4
14-16	5
17-20	6
21-24	7
25-28	8
29-32	9
33-36	10
37-40	11
41-45	12
46-49	13
50-53	14
54-57	15
58-62	16
63-66	17
67-70	18
71-75	19
76-79	20
80-83	21
84-88	22
89-92	23
93-96	24
97-100	25

25% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10	4
11-13	5
14-16	6
17-19	7
20-23	8
24-26	9
27-29	10
30-33	11
34-36	12
37-39	13
40-43	14
44-46	15
47-50	16
51-53	17
54-57	18
58-60	19
61-64	20
65-67	21
68-71	22
72-74	23
75-78	24
79-81	25
82-85	26
86-88	27
89-92	28
93-96	29
97-99	30
100	31

Table 2: Maximum number of sample exceedances allowed in order to assess as attaining (**de-list**) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the waterbody is greater than or equal to 10%, 20%, 25%.

10% Exceedance Rate	
Sample Size	Maximum Number of Allowable Exceedances to Assess as Attains
10-11	1
12-18	2
19-25	3
26-32	4
33-40	5
41-47	6
48-55	7
56-63	8
64-71	9
72-79	10
80-88	11
89-96	12
97-100	13

20% Exceedance Rate	
Sample Size	Maximum Number of Allowable Exceedances to Assess as Attains
10-13	3
14-16	4
17-20	5
21-24	6
25-28	7
29-32	8
33-36	9
37-40	10
41-45	11
46-49	12
50-53	13
54-57	14
58-62	15
63-66	16
67-70	17
71-75	18
76-79	19
80-83	20
84-88	21
89-92	22
93-96	23
97-100	24

25% Exceedance Rate	
Sample Size	Maximum Number of Allowable Exceedances to Assess as Attains
10	3
11-13	4
14-16	5
17-19	6
20-23	7
24-26	8
27-29	9
30-33	10
34-36	11
37-39	12
40-43	13
44-46	14
47-50	15
51-53	16
54-57	17
58-60	18
61-64	19
65-67	20
68-71	21
72-74	22
75-78	23
79-81	24
82-85	25
86-88	26
89-92	27
93-96	28
97-99	29
100	30

3.7 INTERNAL DATA ASSESSMENT METHOD

Data generated by DEQ will be analyzed using the Water Quality Analysis Reporter (WQAR), Microsoft Excel, R, or other data management software. Attainment results are calculated using the water quality standards in Rule 2 and the processes outlined in DEQ's Assessment Methodology.

Station IDs are assigned to AUs where applicable. AUs with assigned stations are identified as "monitored." AUs without stations, where data from another contiguous segment are used for evaluating attainment, are identified as "evaluated" and the AU containing the station data are linked to the unit without the data for tracking purposes. AUs are identified as "unassessed" when there are no water quality data available with which to evaluate attainment.

Water quality standards and methodology processes have been entered into the WQAR system as standard sets. Standard sets contain specific water quality criteria for parameters that apply to waters. For instance, the "Boston Mountains Less than 10 sqmi" standard set contains specific criteria that apply to Boston Mountain streams with watershed areas of less than 10 square miles for temperature, primary and critical season dissolved oxygen, and turbidity all flows and base flows. The "Boston Mountains Less than 10 sqmi" standard set can then be applied to all AUs in the Boston Mountains ecoregion that have watershed areas of less than 10 square miles. Other standard sets that apply more broadly include parameters such as pH, metals, bacteria, and minerals.

WQAR automatically calculates attainment of each standard using station data pulled directly from DEQ's internal Laboratory Information Management System (LIMS). Attainment is calculated for each standard applied to the monitoring segment for the period of record. The integrated reporting category (Section 2.0) for each parameter is examined and an integrated reporting category is recommended for the monitoring segment.

Any internal data incapable of being assessed by WQAR for any reason will be assessed following the same protocols described below for external data.

3.8 EXTERNAL DATA ASSESSMENT METHOD

Readily available data not generated by DEQ is considered "external data." Because WQAR was created for use with DEQ internal data formatting only, extracted directly from LIMS, external data must be assessed through other means. Typically, external data are presented in Microsoft Excel or Microsoft Excel compatible format and are evaluated using tools available through the Microsoft Excel program.

3.9 IMPAIRMENT SOURCE DETERMINATION

For any monitored AU where a water quality standard has been assessed as non-support, the source(s) of impairment will be identified using available information (field observation, land use maps, point source location, nonpoint source assessment reports, special studies, and knowledge of field personnel familiar with the waterbody).

3.10 FINAL ATTAINMENT DECISION PROCESS

For parameters that allow for both discrete and continuous data (pH, temperature, and dissolved oxygen), data types will not be combined. Discrete data and continuous data will be evaluated separately. Attainment decisions will be based on the most appropriate and protective decision for the AU. Factors that could determine which data set will be used for attainment decisions could include quantity of data, quality of data sets, and time of year data were collected. A weight of evidence approach will be used to make the final attainment decision. When multiple data types meet all quality requirements for a given AU, final attainment decisions will be justified within the 305(b) report and any supporting documentation will be provided.

Occasionally DEQ will make final attainment decisions that differ from the initial attainment result produced from strict adherence to the methods contained within this assessment methodology. These differences in attainment results are made using a weight of evidence approach. Factors that may influence the decision to provide a differing final attainment decision could include, but are not limited to, magnitude, frequency, and duration of data; reports or peer reviewed literature; and DEQ personnel's unique understanding of a particular AU (such as ecoregion transitional zones and anthropogenic modifications within the AU).

Final attainment decisions that differ from initial attainment decisions reached using WQAR (for internal data) or Microsoft Excel (or similar software for external data, biological data, WET data, etc.) will be noted within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

4.0 WATER QUALITY STANDARDS

Water quality standards are comprised of: 1) an antidegradation policy; 2) designated uses; and 3) narrative and numeric criteria, which work in concert to protect water quality.

4.1 ANTIDEGRADATION

An antidegradation policy is a requirement of the federal Clean Water Act, which is designed to prevent or limit future degradation of the nation's waters. Rule 2 contains an antidegradation policy that applies to all surface waters of the state. Per Rule 2.201 existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. Arkansas's High Quality Waters as described in Rule 2.202 and Outstanding Resource Waters, as described in Rule 2.203 are to be protected and maintained for those beneficial uses and water quality for which the outstanding resource designation was granted. These waterbodies may be listed as non-support if the chemical, physical, and/or biological characteristics for which the waterbody was designated have been determined to be impaired or absent, as defined by the following assessment criteria. Per Rule 2.204, in those cases where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act, 33 U.S.C. § 1326.

4.2 DESIGNATED USES

The primary purpose of the 303(d) list of impaired waterbodies is to identify those waters that are not currently supporting one or more designated uses or not attaining one or more water quality criteria. The support/non-support status of designated uses is most often determined utilizing water quality criteria or other water quality indicators. EPA guidance (2005) makes suggestions as to which water quality constituents are protective of which designated uses to determine the support status of those designated uses.

DEQ has developed Table 3 to illustrate which water quality criteria may be used either independently or together to assist in determining the support status of each designated use. The designated use "Other Uses" Rule 2.302(J) is typically not dependent upon current water quality criteria so it is not included in Table 3. Fish Consumption is not a designated use in Rule 2; however it can be used to list a waterbody on the 303(d) list. Fish advisories are issued by the Epidemiology Branch of the Arkansas Department of Health (ADH). Parameters for which no assessment methodology exists in this document were not included within this table.

Table 3: Designated Uses for Arkansas's surface waters and rules used for assessment.

	Extraordinary Resource Waters, Ecologically Sensitive Waterbody, and Natural and Scenic Waterways Rule 2.302 (A), (B), and (C)	Primary and Secondary Contact Rule 2.302 (D) & (E)	Aquatic Life Rule 2.302 (F)	Domestic Water Supply Rule 2.302 (G)	Industrial & Agriculture Water Supply Rule 2.302 (H) & (I)
Biological Integrity Rule 2.405	•		•		
Temperature Rule 2.502	•		•		
Turbidity Rule 2.503	•				
pH Rule 2.504	•				
Dissolved Oxygen Rule 2.505	•		•		
Radioactivity Rule 2.506	•	•	•	•	•
Bacteria Rule 2.507	•	•			
Toxic Substances Rule 2.508	•		•	•	
Nutrients Rule 2.509	•		•		
Site Specific Minerals Rule 2.511(A)	•		•		
Minerals Rule 2.511(C)	•			•	•
Ammonia Rule 2.512	•		•		

4.3 WATER QUALITY CRITERIA

4.3.1 Narrative Criteria

Rule 2 contains narrative criteria (written descriptions) that apply to all waters of the state and are used to evaluate support of applicable designated uses. Narrative criteria include general descriptions, such as the existence of nuisance species, biological integrity, taste and odor producing substances, visible globules on surface waters, nutrients, and toxins.

When listing and delisting methodologies are not specified for a particular narrative criterion within the assessment methodology, the following general methods may be used. Narrative criteria are evaluated by using screening levels established by EPA or other scientific literature, if they are available, as well as other information, including water quality studies, documentation of fish kills or contaminant spills, and photographic evidence. A weight of evidence approach may be used and final attainment decisions will be justified within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

4.3.2 Numeric Criteria

Numeric criteria are values established in Rule 2 that provide a quantitative basis for assessing designated use support, developing permit limitations, and for managing point and nonpoint loadings in Arkansas's surface waters. Listing and delisting methodologies for instream water quality against numerical criteria are outlined in Section 6.0 and subsections thereof.

5.0 BIOLOGICAL INTEGRITY

This section establishes the protocol for assessment of biological integrity for Arkansas's surface waters, per APC&EC Rule 2.405:

For all waters with specific aquatic life use designated in Appendix A, aquatic biota should not be impacted. Aquatic biota should be representative of streams that have the ability to support the designated fishery, taking into consideration the seasonal and natural variability of the aquatic biota community under naturally varying habitat and hydrological conditions; the technical and economic feasibility of the options available to address the relevant conditions; and other factors.

An aquatic biota assessment should compare biota communities that are similar in habitat and hydrologic condition, based upon either an in-stream study including an upstream and downstream comparison, a comparison to a reference water body within the same ecoregion, or a comparison to community characteristics from a composite of reference waters. Such a comparison should consider the seasonal and natural variability of the aquatic biota community. It is the responsibility of the Department to evaluate the data for an aquatic biota assessment to protect aquatic life uses designated in Appendix A. Such data may be used to develop permit effluent limitations or conditions.

ASSESSMENT METHODOLOGY FOR BIOLOGICAL INTEGRITY

Biological integrity is evaluated using macroinvertebrate and/or fish communities collected within the waterbody. At a minimum, biological data must be collected using methods outlined in a Quality Assurance Project Plan with requirements equal to or more stringent than that of DEQ. Results from acute and chronic toxicity tests of vertebrates and invertebrates will also be evaluated, when available, but are not required to make a use determination.

To assess an AU for biological integrity, determine the support status of either macroinvertebrates and/or fish using the methods outlined in Sections 5.1 and/or 5.2. Results from fish and/or macroinvertebrate community analysis, and toxicity test data if available, will be used to determine support or non-support of the aquatic life designated use. Refer to Figures 1 and 2 for a step-wise process regarding use attainment using biological integrity.

There is always the possibility that a biological community may be assessed as non-support due to unrepresentative data such as the collection of a large number of young-of-year specimens and at transition zones between ecoregions. This information and a short explanation will be included in the 305(b) report.

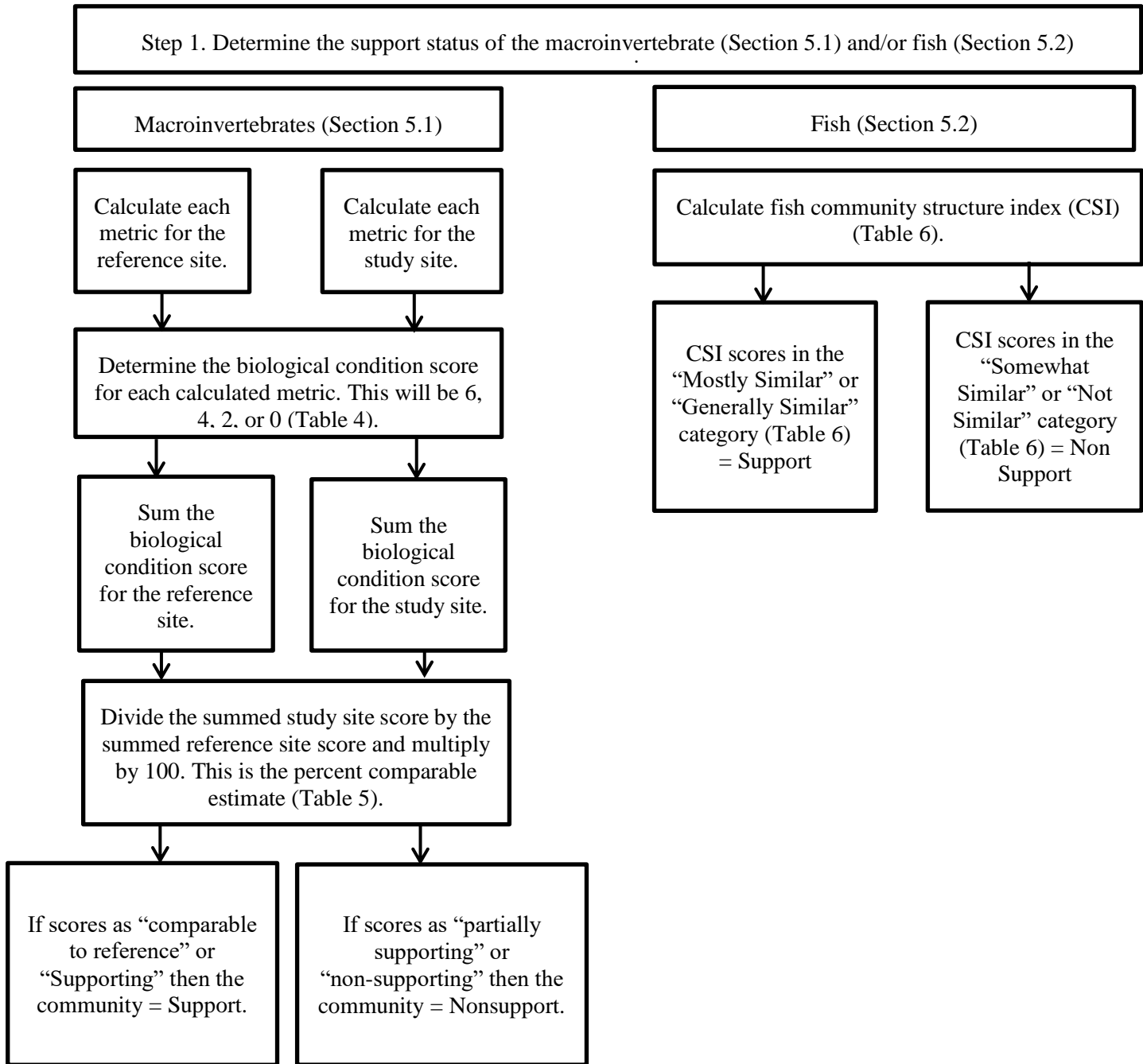


Figure 1: Determining Aquatic Life Use designated use attainment Step 1.

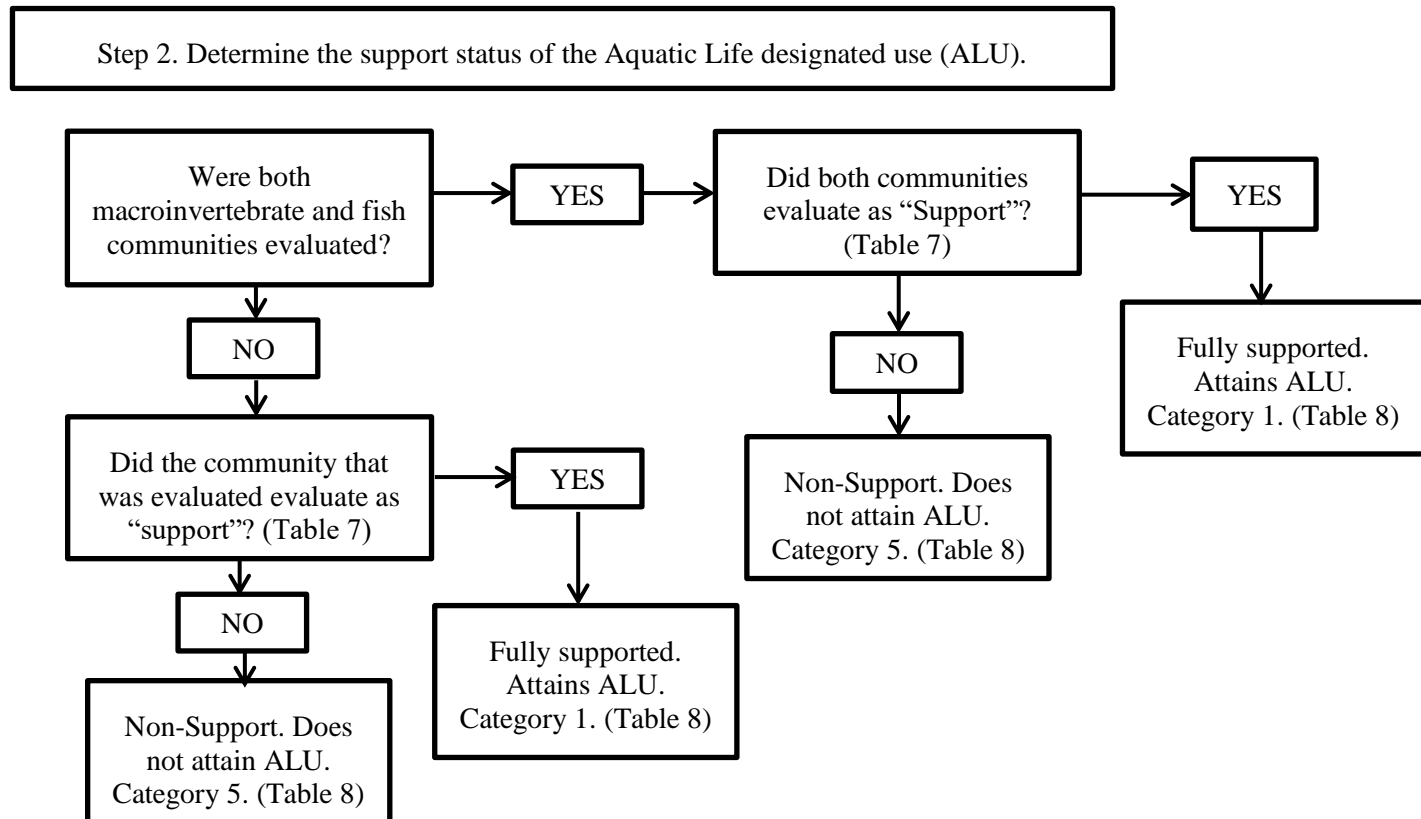


Figure 2: Determining Aquatic Life Use designated use attainment Step 2.

5.1 MACROINVERTEBRATE COMMUNITY ANALYSIS

Modified metrics set forth in *Rapid Bioassessment Protocols for Use in Stream and Rivers* (Plafkin et al. 1989) are used in analysis of macroinvertebrate community samples. Each site will have a Rapid Bioassessment score derived from a multi-metric analysis, which includes: 1) taxa richness, 2) Ephemeroptera-Plecoptera-Trichoptera Index (EPT Index), 3) Hilsenhoff Biotic Index (HBI), 4) percent contribution of dominant taxa, 5) ratio of EPT to Chironomid taxa, and 6) ratio of scrapers to filter-collectors. See *Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan* (ADEQ 2021¹⁰) at the DEQ website: <http://adeq.state.ar.us> for more information. DEQ's metric modification or deviation from Plafkin et al. (1989) includes removal of the ratio of shredders to total taxa metrics. DEQ field sampling methodologies do not include the collection of coarse particulate organic matter (CPOM) (i.e. leaf packs) to evaluate macroinvertebrate communities. Collection of CPOM is required to calculate the ratio of shredders to total taxa.

Macroinvertebrate community analysis is as follows: using raw data, calculate all six metric values (Table 4) for each study site and reference site. Instructions for these calculations are found in Plafkin et al. (1989). Metric values from each study site are compared to metric values from a reference site for five of the six metrics to calculate a percent comparison to reference value. Percent contribution of dominant taxa is not a comparison to reference value, but rather actual percent contribution for the given site. Using the percent comparison to reference values for all six metrics, a bioassessment score (6, 4, 2, or 0) is assigned for each metric (Table 4). Bioassessment scores for each metric per site (study and reference) are summed to create a single biological condition score for that site. The ratio of scores between the sample site to reference site provides the percent comparable estimate for each study site (Table 5). The percent comparable estimate score is then used to determine attainment status of "support" or "non-support" (Table 5).

Table 4: Macroinvertebrate bioassessment metrics and scoring criteria¹.

Metric	Biological Condition Scoring Criteria			
	6	4	2	0
Taxa Richness²	≥80%	<80-60%	<60-40%	<40%
Hilsenhoff Biotic Index³	≥85%	<85-70%	<70-50%	<50%
Ratio of EPT to Chironomid Abundances²	≥75%	<75-50%	<50-25%	<25%
% Contribution of Dominant Taxa⁴	<20%	20-<30%	30-<40%	≥40%
EPT Index²	≥90%	<90-80%	<80%-70	<70%
Ratio of Scrapers to Filter-Collectors²	≥50%	<50-35%	<35-20%	<20%

¹ Modified from Plafkin, J.L. M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington D.C. EPA 440-4-89-001.

² Score is a ratio of study site to reference site X 100.

³ Score is a ratio of reference site to study site X 100.

⁴ Scoring criteria evaluate actual percent contribution, not percent comparability to reference site.

⁵ Range of values obtained. A comparison to the reference site is incorporated in these indices.

Table 5: Scoring criteria for macroinvertebrate community attainment decisions (modified from Plafkin et al. 1989).

	Biological Condition Category	% Comparable Estimate	Attribute
Support	Comparable to reference	≥83%	Comparable to the best situation in an ecoregion.
	Supporting	54-79%	Community structure less than reference site. Taxa richness lower and tolerant forms are more prevalent.
Non-Support	Partially Supporting	21-50%	Obvious decline in community structure with loss of intolerant forms. EPT index reduced.
	Non-supporting	<20%	Community dominated by 1 or 2 taxa, few taxa present.

If the percent comparable estimates fall between the 50-54% cutoff for support vs non-support, a weight of evidence approach may be utilized to make a final support or non-support decision using available physical, chemical, and biological data and information.

5.2 FISH COMMUNITY ANALYSIS

DEQ's Community Structure Index (CSI) (Table 6) will be used in the analysis of fish communities. The CSI was established utilizing information from the 1987 ecoregion survey (APC&EC 1987) and supplemented with data from additional least-disturbed streams identified by DEQ personnel. A group of Arkansas ichthyologists reviewed the data. The current metric scores and similarity ranking categories were established utilizing the prevailing deviations in the ecoregion survey data set and employed best professional judgment. Ecoregion specific metric scores for watersheds (>10 mi²) outlined in *Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan* (ADEQ 2020), available at the DEQ website:

<http://adeq.state.ar.us>, will be calculated for each site and total scores will be evaluated and assessed as follows:

Table 6: Fish Community Structure Index (CSI) ecoregion values.

Ecoregion	Total Score	Category	Attribute
Ozark Highlands	37-45	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	25-36	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	13-24	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-12	Not Similar	Few taxa present and normally dominated by one (1) or two (2) taxa.
Boston Mountains Ouachita Mountains AR River Valley Typical Gulf Coastal Spring-Influenced Gulf Coastal	25-32	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	24-17	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	16-9	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-8	Not Similar	Few taxa present and normally dominated by one (1) or two (2) taxa.
Channel Altered Delta Least-Disturbed Delta	22-28	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	21-15	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	14-8	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-8	Not Similar	Few taxa present and normally dominated by one (1) or two (2) taxa.

AQUATIC LIFE USE ATTAINMENT DETERMINATION

LISTING METHODOLOGY:

AUs may be listed as non-support when one or both of the evaluated biological communities (macroinvertebrates and/or fish) indicate perturbation/degradation (Tables 7* 8), or when one or both of the toxicity test organisms (vertebrate and/or invertebrate) fail greater than one acute or chronic toxicity test in a three-year period (Table 9).

Aquatic life designated use attainment can be assessed using both biological integrity data and water chemistry data. When only water chemistry data are available for an AU and assessment results indicate water quality impairment for temperature, dissolved oxygen, ammonia, radioactivity, site specific minerals, or toxic substances it will be assumed that the aquatic life designated use is not attained. However, if physical and biological data are collected which indicate the aquatic life designated use is attained, the water quality impairment will remain, but it will be noted that the aquatic life designated use is being attained.

DELISTING METHODOLOGY:

AUs may be listed as support when evaluated biological communities (macroinvertebrates and/or fish, which ever community led to the impaired attainment decision) do not indicate perturbation/degradation (Table 8) and when there have been no ambient toxicity test failures, acute or chronic, in a three-year period (Table 9).

Table 7: Biological community assessment determination.

Data Type	Support	Non-Support
Macroinvertebrate Community Data Available	Macroinvertebrate community structure analysis (Table 5) indicates comparable to reference or supporting	Macroinvertebrate community structure analysis (Table 5) indicates partially supporting or non-supporting*
Fish Community Data Available	Community Structure Index score (Table 6) is either mostly or generally similar; general presence of sensitive and indicator species	Community Structure Index score (Table 6) is either somewhat or not similar; absence of sensitive and indicator species*

* The aquatic life designated use may be assessed as support, despite an initial evaluation of non-support, if it is demonstrated that the non-support assessment is due to unrepresentative biological community data and not toxicity; based on acceptable variances in ecoregion community structures. Under certain conditions, biological community data can be skewed due to an unrepresentative sample, which includes but is not limited to:

- Collection of irruptive species (e.g., large percentage of young-of-year in an isolated area that is not representative of the entire AU), which could trigger an inaccurate 'non-support' determination.
- Transitional areas between ecoregions.
- AUs that are intermittent in nature.

A weight of evidence approach is used in these circumstances to prevent the inappropriate listing of waters. If a support determination is made due to an unrepresentative sample, it will be explained in detail in the 305(b) Report and supporting documentation will be provided.

Table 8: Aquatic life designated use listing protocol.

Type of Data Present	Evaluation Result		Final Assessment	Listing Category
	Fish Community	Macroinvertebrate Community		
Fish Community and/or Macroinvertebrate Community	S	S	FS	1
	S	NS	NS	5
	NS	S	NS	5
	NS	NS	NS	5
At Least One Biological Community	S	NA	FS	1
	NA	S	FS	1
	S	S	FS	1
	NA	NA	UA	3
	NS	NA	NS	5
	NA	NS	NS	5

S = Support NS = Non-Support FS = Fully Supporting NA = No Available Data UA = Unassessed

Table 9: Ambient toxicity listing protocol.

Type of Test	Evaluation Result		Final Assessment	Listing Category
	Vertebrate	Invertebrate		
Acute Toxicity	S	S	FS	1
	S	NS	NS	5
	NS	S	NS	5
	NS	NS	NS	5
Chronic Toxicity	S	S	FS	1
	S	NS	NS	5
	NS	S	NS	5
	NS	NS	NS	5

S = Support NS = Non-Support FS = Fully Supporting

6.0 SPECIFIC STANDARDS

Per Rule 2.501 (Applicability), unless otherwise indicated, the following specific criteria shall apply to all surface waters of the state at all times except during periods when flows are less than the applicable critical flow. Streams with regulated flow will be addressed on a case-by-case basis to maintain designated instream uses. These criteria apply outside the applicable mixing zone.

6.0.1 General Description of Phase II Data Quality Requirements

In general, Phase II requirements are categorized into temporal, distribution and quantity, and spatial categories. Phase II data quality requirements are discussed in detail for each parameter within their respective Section (6.1 - 6.12). Each general category is described below.

Temporal requirements

Temporal requirements relate to time of year, season, or other time dependent sample collection considerations. If a parameter does not have a particular season, such as pH, temporal requirements may not be listed for this parameter; or the temporal requirement may read “year-round.” These parameters should be collected throughout the year without preference to any particular season or time of year. Conversely, a parameter with specific seasonal considerations, such as bacteria, will have temporal requirements listed for the particular sampling season(s)—for this example, primary and secondary contact season. “Season” will be defined within the parameter.

As per Phase I data quality requirements, data should be collected within the stated assessment cycle period of record for each parameter.

Distribution and quantity requirements

Distribution requirements are intended to be a guideline unless otherwise explicitly stated. If a parameter says “ten (10) samples evenly distributed over twelve (12) months,” that is intended to be a guideline for minimum sample size and how those samples should be distributed. If more samples are taken over a longer time period, then DEQ would assess the data set for appropriate distribution.

“Evenly distributed” is meant to be a general guideline for sample distribution. It does not mean that monthly samples must be taken exactly thirty (30) days apart without exception or that an exact number of days must exist between each sample in a data set. There is no way to describe or predict every scenario for sample distribution, so “evenly distributed” is intended to be a general guide. “Evenly distributed” is also intended to guard against samples being clumped or concentrated toward one time of the year when the parameter should be collected year-round. DEQ welcomes entities to ask about sample distribution prior to finalizing sampling plans for data intended to be submitted for assessment purposes.

Quantity requirements are intended to be minimum number of samples necessary to assess waters. This applies to both listing and delisting methodologies. Three exceptions exist to this minimum requirement: radioactivity (Section 6.5), toxic substances (Section 6.7), and ammonia (Section 6.12). For these three parameters, an assessment of non-attainment can be achieved before reaching ten (10) samples because these parameters are not assessed based on a percentage for non-attainment purposes; they are assessed as “not attained” whenever an absolute threshold is reached. A minimum of ten (10) samples are still required to delist or to assess as “attains” for these three parameters.

Spatial requirements

Spatial requirements relate to where samples should be taken within the waterbody, if any particular requirements exist beyond Phase I requirements or QAPP requirements. As per Phase I data requirements, all data must be characteristic of the main water mass or hydrologic area. Spatial requirements may also be noted in the QAPP accompanying the data. If no spatial requirements are listed in Phase II data requirements, then collection should adhere to Phase I and QAPP requirements.

Spatial requirements for lakes and reservoirs are intended to ensure assessment consistent with standards development. Primary contact recreation, secondary contact recreation, and the majority of lake aquatic life productivity occur in the epilimnion (uppermost stratified layer). For these reasons, Arkansas's water quality standards for lakes and reservoirs were developed using data collected within the epilimnion. If no epilimnion exists—due to natural depth limitations or seasonal mixing—samples should be taken between 0.33 and 2.0 meters of the surface unless otherwise noted within the Phase II quality requirements for a parameter.

6.0.2 Continuous data

For assessment purposes, both short-term and long-term continuous data taken in less than hourly readings (example: data recorded every fifteen minutes) will be calculated into hourly averages. Both long-term and short-term continuous data will be evaluated for representativeness. Short-term continuous data must span 90% of the 24 hour period.

6.1 TEMPERATURE

This section establishes the protocol for assessment of temperature criteria within Arkansas's surface waters, per APC&EC Rule 2.502:

The following standards are applicable:

<i>Waterbodies</i>	<i>Limit °C (°F)</i>
<i>Streams</i>	
<i>Ozark Highlands</i>	29 (84.2)
<i>Boston Mountains</i>	31 (87.8)
<i>Arkansas River Valley</i>	31 (87.8)
<i>Ouachita Mountains</i>	30 (86.0)
<i>Springwater-influenced Gulf Coastal</i>	30 (86.0)
<i>Typical Gulf Coastal</i>	30 (86.0)
<i>Least-Altered Delta</i>	30 (86.0)
<i>Channel-Altered Delta</i>	32 (89.6)
<i>White River (Dam #1 to mouth)</i>	32 (89.6)
<i>St. Francis River</i>	32 (89.6)
<i>Mississippi River</i>	32 (89.6)
<i>Arkansas River</i>	32 (89.6)
<i>Ouachita River (L. Missouri to Louisiana state line)</i>	32 (89.6)
<i>Red River</i>	32 (89.6)
<i>Lakes and Reservoirs</i>	32 (89.6)
<i>Trout Waters</i>	20 (68.0)

PHASE II DATA QUALITY REQUIREMENTS FOR TEMPERATURE

Both discrete and long-term continuous data can be considered for temperature assessment of all waters. Short-term continuous data sets, such as 48-96 hour diel studies will be used for screening purposes only.

Streams and Rivers

1. Temporal requirements

- Discrete Data
 - Discrete data should be collected year-round.

- Long-Term Continuous Data
 - For non-trout waters, long-term continuous data should be collected during the critical season.
 - Critical season is defined, in Rule 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
 - Only data above 22 degrees Celsius will be utilized for assessments made using long-term continuous data.
 - For trout waters long-term continuous data should be collected year-round.
2. Minimum distribution and quantity requirements
- Discrete Data
 - Ten (10) discrete samples are required to make temperature attainment decisions.
 - Data must be evenly distributed over at least two (2) years and three (3) quarters per year.
 - Long-Term Continuous Data
 - For non-Trout Waters, data must be evenly distributed throughout the critical season.
 - For Trout Waters Long-term continuous data must cover ten (10) months of a twelve (12) month period
 - Data must be collected at least hourly.
3. Spatial requirements
- None that are not already covered in Phase I requirements.

Lakes and Reservoirs

1. Temporal requirements
- Discrete Data
 - Discrete temperature data should be collected year-round.
 - Long-term Continuous Data
 - Collect long-term continuous data during the critical season.
 - Critical season is defined, in Rule 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
 - Only data above 22 degrees Celsius will be utilized for assessments made using long-term continuous data.
2. Minimum distribution and quantity requirements
- Discrete data
 - A minimum of ten (10) quarterly samples.
 - Long-term Continuous Data
 - Data must be collected throughout the critical season.
 - Data must be collected at least hourly

3. Spatial requirements

- Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR TEMPERATURE

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete and long-term continuous) will not be combined. Refer to Section 3.11 for information regarding final attainment decisions should both types of data exist for an AU. Temperature assessments can be made using long-term continuous data measured for only one critical season; however, if multiple critical season data sets exist from different years, within the period of record, data sets will be combined. Continuous data will be calculated to hourly average for assessment purposes. This average will then be used as a discrete measurement and the total number of hourly averages will be used to determine the size of the sample set for comparison to Table 1. Binomial distribution method will be applied for temperature data assessments, per Section 3.7.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-attainment when, using the **ten (10) percent** exceedance rate within Table 1, greater than or equal to the minimum number of samples allowed for the entire qualifying data set exceed the applicable temperature criteria listed in Rule 2.502 (or site specific in Appendix A) . This methodology applies to both discrete and long-term continuous data sets.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as support when, using the **ten (10) percent** exceedance rate within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable temperature criteria listed in Rule 2.502 (or site specific in Appendix A) . This methodology applies to both discrete and long-term continuous data sets.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.2 TURBIDITY

This section establishes the protocol for assessment of turbidity criteria within Arkansas's surface waters, per APC&EC Rule 2.503:

There shall be no distinctly visible increase in turbidity of receiving waters attributable to discharges or instream activities. The values below should not be exceeded during base flow (June to October) in more than 20% of samples. The values below should not be exceeded during storm flows in more than 25% of samples taken in not less than 24 monthly samples.

<i>Waterbodies</i>	<i>Base Flows Values (NTU)</i>	<i>Storm Flow Values (NTU)</i>
<i>Streams</i>		
<i>Ozark Highlands</i>	<i>10</i>	<i>17</i>
<i>Boston Mountains</i>	<i>10</i>	<i>19</i>
<i>Arkansas River Valley</i>	<i>21</i>	<i>40</i>
<i>Ouachita Mountains</i>	<i>10</i>	<i>18</i>
<i>Springwater-influenced Gulf Coastal</i>	<i>21</i>	<i>32</i>
<i>Typical Gulf Coastal</i>	<i>21</i>	<i>32</i>
<i>Least-Altered Delta</i>	<i>45</i>	<i>84</i>
<i>Channel-Altered Delta</i>	<i>75</i>	<i>250</i>
<i>Arkansas River</i>	<i>50</i>	<i>52</i>
<i>Mississippi River</i>	<i>50</i>	<i>75</i>
<i>Red River</i>	<i>50</i>	<i>150</i>
<i>St. Francis River</i>	<i>75</i>	<i>100</i>
<i>Trout</i>	<i>10</i>	<i>15</i>
<i>Lakes and Reservoirs</i>	<i>25</i>	<i>45</i>

PHASE II DATA QUALITY REQUIREMENTS FOR TURBIDITY

Turbidity assessments can be made with discrete data collected in Nephelometric Turbidity Units (NTU) only. Data collected in Formazin Nephelometric Units (FNU) will be used for screening purposes only.

Short-term and long-term continuous data will be used for screening purposes, if available.

Base Flow

Streams and Rivers

1. Temporal requirements
 - Discrete data should be collected during base flow season.
 - Base flows season is defined, in Rule 2, as June to October.
2. Minimum distribution and quantity requirements
 - Ten (10) discrete samples are required to make turbidity attainment decisions for base flows.
 - Samples must be evenly distributed throughout the base flows season.
 - Samples must be taken over at least two (2) years.
3. Spatial requirements
 - None that are not already covered in Phase I requirements.

Lakes and Reservoirs

1. Temporal requirements
 - Discrete data should be collected during base flows season.
 - Base flow season is defined, in Rule 2, as June to October.
2. Minimum distribution and quantity requirements
 - Five (5) discrete samples are required to make turbidity attainment decisions for base flow.
 - Samples must be taken over at least three (3) years.
3. Spatial requirements
 - Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Storm Flow

All Waters

1. Data temporal requirements
 - Discrete data should be taken year-round. This includes June to October (base flows season).
2. Minimum data distribution and quantity requirements
 - Discrete Data
 - Discrete samples must be taken in no less than twenty-four (24) monthly samples.
 - Samples must be evenly distributed throughout the time period sampled.
3. Spatial requirements
 - For lakes and reservoirs, take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.
 - For streams and rivers, none that are not already covered in Phase I requirements.

ASSESSMENT METHODOLOGY FOR TURBIDITY

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Discrete samples from multiple base flows seasons within the period of record (if exist) will be combined for assessments. If an AU is assessed as not meeting either the base flow or storm flow values, or both, it may be listed as non-attainment for turbidity. Binomial distribution method will be applied to turbidity data, per Section 3.6.

BASE FLOWS LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-attainment when, using the **twenty (20) percent** exceedance rate within Table 1 greater than or equal to the minimum number of samples for the entire qualifying data set from June to October exceed the applicable base flows values listed in APC&EC Rule 2.503.

BASE FLOWS DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as in attainment when, using the **twenty (20) percent** exceedance rate in Table 2, no more than the maximum number of samples allowed for the entire qualifying data set from June to October exceed the applicable base flows values listed in APC&EC Rule 2.503.

STORM FLOWS LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-attainment when, using the **twenty-five (25) percent** exceedance rate within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set (sample set not to be fewer than 24 data points) exceed the applicable storm flows values listed in APC&EC Rule 2.503.

STORM FLOWS DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as in attainment when, using the **twenty-five (25) percent** exceedance rate in Table 2, no more than the maximum number of samples allowed for the entire qualifying data set (sample set not to be fewer than 24 data points) exceed the applicable storm flows values listed in APC&EC Rule 2.503.

6.3 PH

This section establishes the protocol for assessment of pH criteria within Arkansas's surface waters, per APC&EC Rule 2.504:

pH between 6.0 and 9.0 standard units are the applicable standards for streams.

PHASE II DATA QUALITY REQUIREMENTS FOR pH

pH assessments can be made using discrete data, short-term continuous data, or long-term continuous data in streams and rivers; and discrete data and long-term continuous data in lakes and reservoirs.

Streams and Rivers

1. Temporal requirements
 - pH data should be collected year-round.
2. Minimum distribution and quantity requirements
 - Discrete Data
 - Ten (10) discrete samples are required to make pH attainment decisions.
 - Discrete data must be evenly distributed over at least two (2) years and three (3) quarters per year.
 - Short-term Continuous data
 - Two (2) diel deployments of at least forty-eight (48) hours each.
 - Diel deployments must be spaced at least two weeks (14 days) apart.
 - The two diel deployments must be within the same year. You may have multiple years within the period of record (POR), but each year must have two deployments. Multiple years need not be consecutive.
 - Data must be collected at least hourly.
 - Long-term Continuous Data
 - Long-term continuous data must cover ten (10) month of a twelve (12) month period.
 - Data must be collected at least hourly.
3. Spatial requirements
 - None that are not already covered in Phase I requirements.

Lakes and Reservoirs

1. Temporal requirements
 - pH data should be collected year-round.
2. Minimum distribution and quantity requirements
 - Discrete Data
 - A minimum of ten (10) quarterly samples.
 - Long-term Continuous Data
 - Long-term continuous data must cover ten (10) of the twelve (12) month period

- Data must be collected at least hourly.

3. Spatial requirements

- Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR pH

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined. Refer to Section 3.10 for information regarding final attainment decisions should more than one type of data set exist for an AU. Binomial distribution method will be applied to pH data, per Section 3.8.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-attainment when, using the **ten (10) percent** exceedance rate in Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable pH criteria listed in APC&EC Rule 2.504. This methodology applies to discrete, short-term continuous, and long-term continuous data.

AUs may not be listed as “non-attain” if the assessment decision is a result of data representing natural conditions (i.e., anthropogenic activities cannot be identified by DEQ as the source). If this occurs, the basis for determination of natural conditions will be noted in the 305(b) Report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as attainment when, using the **ten (10) percent** exceedance rate within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable pH criteria listed in APC&EC Rule 2.504. This methodology applies to discrete, short-term continuous, and long-term continuous data.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) Report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.4 DISSOLVED OXYGEN

This section establishes the protocol for assessment of dissolved oxygen criteria within Arkansas's surface waters, per APC&EC Rule 2.505 and any site specific dissolved oxygen criteria within Appendix A of Rule 2:

Rivers and Streams

The following dissolved oxygen standards must be met:

Waterbodies	Limit (mg/L)	
	<i>Primary</i>	<i>Critical</i>
Streams		
<i>Ozark Highlands</i>		
<10 mi ² watershed	6	2
10 to 100 mi ²	6	5
>100 mi ² watershed	6	6
<i>Boston Mountains</i>		
<10 mi ² watershed	6	2
>10 mi ² watershed	6	6
<i>Arkansas River Valley</i>		
<10 mi ² watershed	5	2
10 mi ² to 150 mi ²	5	3
151 mi ² to 400 mi ²	5	4
>400 mi ² watershed	5	5
<i>Ouachita Mountains</i>		
<10 mi ² watershed	6	2
>10 mi ² watershed	6	6
<i>Typical Gulf Coastal</i>		
<10 mi ² watershed	5	2
10 mi ² to 500 mi ²	5	3
>500 mi ² watershed	5	5
<i>Springwater-influenced Gulf Coastal</i>		
All size watersheds	6	5
<i>Delta (least-altered and channel altered)</i>		
<10 mi ² watershed	5	2
10 mi ² to 100 mi ²	5	3
>100 mi ² watershed	5	5
<i>Trout Waters</i>		
All size watersheds	6	6

In streams with watersheds of less than 10 mi², it is assumed that insufficient water exists to support a fishery during the critical season. During this time, a dissolved oxygen standard of 2 mg/l will apply to prevent nuisance conditions. However, field verification is required in areas suspected of having significant groundwater flows or enduring pools which may support unique

aquatic biota. In such waters the critical season standard for the next size category of stream shall apply.

All streams with watersheds of less than 10 mi² are expected to support aquatic life during the primary season when stream flows, including discharges, equal or exceed 1 cubic foot per second (cfs). However, when site verification indicates that aquatic life exists at flows below 1 cfs, such aquatic biota will be protected by the primary standard (refer to the State of Arkansas Continuing Planning Process for field verification requirements).

Also, in these streams with watersheds of less than 10 mi², where waste discharges are 1 cfs or more, they are assumed to provide sufficient water to support aquatic life and, therefore, must meet the dissolved oxygen standards of the next size category of streams.

Lakes and Reservoirs

Specific dissolved oxygen standards for lakes and reservoirs shall be 5 mg/L.

PHASE II DATA QUALITY REQUIREMENTS FOR DISSOLVED OXYGEN

Assessments for dissolved oxygen can be made using discrete data, short-term continuous data, or long-term continuous data depending on season. Concurrent temperature data must accompany dissolved oxygen data to be used for assessments.

Trout Waters

1. Temporal requirements

- Discrete data and long-term continuous data
 - Year-round.
- Short-term continuous data
 - Mid-May to mid-September.

2. Minimum data distribution and quantity requirements

- Discrete data
 - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
 - Discrete data must be evenly distributed throughout the year.
 - Discrete data must be evenly distributed over at least two (2) years and three (3) quarters per year.
- Short-term continuous data
 - Two (2) diel deployments of no less than forty-eight (48) hours.
 - Diel deployments must be taken at least two weeks (14 days) apart.
 - The two diel deployments must be within the same year. You may have multiple years within the period of record (POR), but each year must have two deployments. Multiple years need not be consecutive.
 - Data must be collected at least hourly.
- Long-term continuous data
 - Data must cover ten (10) months of a twelve (12) month period.
 - Data must be collected at least hourly.

3. Spatial requirements

- For streams and rivers, none that are not already covered in Phase I requirements.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Non-Trout Waters

Primary Season – Streams and Rivers

1. Temporal requirements

- Discrete, Short-term, and Long-term continuous data
 - Data must be collected during the primary season.
 - “Primary season” is defined as the time of year when water temperatures are less than or equal to 22 degrees Celsius.

2. Minimum data distribution and quantity requirements

- Discrete data
 - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
 - Discrete data must be evenly distributed throughout the primary season.
 - Discrete data must be distributed over at least two (2) primary seasons.
- Short-term continuous
 - Two (2) diel deployments of no less than forty-eight (48) hours
 - Diel deployments must be taken at least two weeks (14 days) apart
 - The two diel deployments must be within the same year. You may have multiple years within the period of record (POR), but each year must have two deployments. Multiple years need not be consecutive.
 - Data must be collected at least hourly.
- Long-term continuous data
 - Data must be evenly distributed throughout the primary season.
 - Data must be collected at least hourly.

3. Spatial requirements

- None that are not already covered in Phase I requirements.

Critical Season – Streams and Rivers

1. Temporal requirements

- Discrete, Short-term, and Long-term continuous data
 - Data must be collected during the critical season.
 - “Critical season” is defined as the time of year when water temperatures are greater than 22 degrees Celsius.

2. Minimum data distribution and quantity requirements

- Discrete data
 - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
 - Discrete data must be evenly distributed throughout the critical season.
 - Discrete data must be distributed over at least two critical seasons.

- Short-term continuous data
 - Two (2) diel deployments of no less than forty-eight (48) hours each
 - Diel deployments must be taken at least two weeks (14 days) apart beginning post-retrieval.
 - The two diel deployments must be within the same year. You may have multiple years within the POR, but each year must have two deployments. Multiple years need not be consecutive.
 - Data must be collected at least hourly.
- Long-term continuous data
 - Data must be evenly distributed throughout the critical season.
 - Data must be collected at least hourly.

3. Spatial requirements

- None that are not already covered in Phase I requirements.

Lakes and Reservoirs

1. Temporal requirements

- Discrete, Short-term, and Long-term continuous data
 - Year-round.

2. Minimum data distribution and quantity requirements

- Discrete data
 - A minimum of ten (10) quarterly samples.
- Short-term continuous data
 - Two (2) diel deployments of no less than forty-eight (48) hours each with at least hourly readings are required for attainment decisions.
 - Diel deployments must be taken at least two weeks (14 days) apart when water temperatures are greater than 22 degrees Celsius.
 - The two diel deployments must be within the same year. You may have multiple years within the POR, but each year must have two deployments. Years need not be consecutive.
 - Data must be collected at least hourly.
- Long-term continuous data
 - Data must be evenly distributed throughout the critical season.
 - Data must be collected at least hourly.

3. Spatial requirements

- Taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR DISSOLVED OXYGEN

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined. Refer to Section 3.10 for information regarding final attainment decisions should more than one type of data set exist for an AU. Concurrent

temperature data must accompany dissolved oxygen data for attainment decisions. Binomial distribution method will be applied to all data types of dissolved oxygen data, per Section 3.6. If long-term continuous data sets do not meet requirements for long-term assessments, they may be used to assess critical season if they meet short-term data requirements. Continuous data sets will be calculated into hourly averages.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-attainment when, using the **ten (10) percent** exceedance rate within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set fail to meet the minimum applicable dissolved oxygen criteria listed in APC&EC Rule 2.505 (or site specific in Appendix A) for either the primary or critical season, or year-round, as appropriate. This methodology applies to discrete, short-term continuous, and long-term continuous data.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as attainment when, using the **ten (10) percent** exceedance rate within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set fail to meet the applicable dissolved oxygen criteria listed in APC&EC Rule 2.505 (or site specific in Appendix A). Delisting methodology will be used for the same condition that it was listed on (primary or critical season, or year-round). This methodology applies to discrete, short-term continuous, and long-term continuous data.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.5 RADIOACTIVITY

This section establishes the protocol for assessment of radioactivity criteria within Arkansas's surface waters, per APC&EC Rule 2.506:

The Rules for the Control of Sources of Ionizing Radiation of the Division of Radiological Health, Arkansas Department of Health, limits the maximum permissible levels of radiation that may be present in effluents to surface waters in uncontrollable areas. These limits shall apply for the purposes of these standards, except that in no case shall the levels of dissolved radium-226 and strontium-90 exceed 3 and 10 picocuries/liter, respectively, in the receiving water after mixing, nor shall the gross beta concentration exceed 1000 picocuries/liter.

PHASE II DATA QUALITY REQUIREMENTS FOR RADIOACTIVITY

Assessments for radioactivity will be made using discrete data only.

1. Data temporal requirements:

- Discrete data should be collected year-round.

2. Minimum Data distribution and quantity requirements:

- Ten (10) samples are required to make attainment decisions for radioactivity; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For streams and rivers samples must be evenly distributed over at least two (2) years and three (3) quarters per year; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For lakes and reservoirs a minimum of ten (10) quarterly samples; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.

3. Spatial requirements

- None that are not already covered in Phase I requirements.

ASSESSMENT METHODOLOGY FOR RADIOACTIVITY

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-attainment when a **single sample within the period of record exceeds** the concentration of 3 picocuries/Liter for radium-226, or the concentration of 10 picocuries/Liter for strontium-90, or if the gross beta concentration exceeds 1000 picocuries/liter per APC&EC Rule 2.506, even if the minimum of ten (10) samples has not been reached.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as attainment when **no samples in the period of record exceed** the concentration of 3 picocuries/Liter for radium-226, or the concentration of 10 picocuries/Liter for strontium-90, or if the gross beta concentration does not exceeds 1000 picocuries/liter per APC&EC Rule 2.506. A minimum of ten (10) samples must be reached to make an assessment of attainment.

6.6 BACTERIA

This section establishes the protocol for assessment of bacteria criteria within Arkansas's surface waters, per APC&EC Rule 2.507:

For the purposes of this rule, all streams with watersheds less than 10 mi² shall not be designated for primary contact unless and until site verification indicates that such use is attainable. No mixing zones are allowed for discharges of bacteria.

*For assessment of ambient waters as impaired by bacteria, the below listed applicable values for *E. coli* shall not be exceeded in more than 25% of samples in no less than eight (8) samples taken during the primary contact season or during the secondary contact season.*

The following standards are applicable:

<u>Contact Recreation Seasons</u>	<u>Limit (col/100mL)</u>			
<u>Primary Contact¹</u>	<u><i>E. coli</i></u>		<u>Fecal Coliform</u>	
	<u>IS³</u>	<u>GM⁴</u>	<u>IS³</u>	<u>GM⁴</u>
	ERW, ESW, NSW, Reservoirs, Lakes	298 126	400	200
	410	-	400	200
All Other Waters				
 <u>Secondary Contact⁵</u>				
ERW, ESW, NSW, Reservoirs, Lakes ²	1490	630	2000	1000
	2050	-	2000	1000
All Other Waters				

¹ May 1 to September 30

³ For assessment of Individual Sample Criteria– at least eight (8) data points

⁴ For calculation and assessment of Geometric Mean – calculated on a minimum of five (5) samples spaced evenly and within a thirty (30)-day period.

⁵ October 1 to April 30

The Arkansas Department of Health has the responsibility of approving or disapproving surface waters for public water supply and of approving or disapproving the suitability of specifically delineated outdoor bathing places for body contact recreation, and it has issued rules and regulations pertaining to such uses.

PHASE II DATA QUALITY REQUIREMENTS FOR BACTERIA

Bacterial assessments are made with discrete *Escherichia coli* (*E. coli*) data. In the absence of *E. coli* data, discrete fecal coliform data may be utilized.

Primary Contact Season

1. Data temporal requirements

- Discrete data must be collected during primary contact season.
 - Primary contact season is defined, in Rule 2, as May 1 to September 30.

2. Minimum data distribution and quantity requirements

- Individual Samples
 - A minimum of one (1) primary contact season is required.
 - Eight (8) discrete samples are required per primary contact season used for assessment.
 - Discrete data must be evenly spaced within the primary contact season (within the same calendar year).
- Geometric Mean
 - Five (5) discrete samples spaced evenly and within a thirty-day period are required to calculate geometric mean.

3. Spatial Requirements

- Individual Samples
 - Applicable for assessments in all waters.
- Geometric Mean
 - *E. coli* - Applicable for assessments only in ERW, ESW, NSW waters; lakes; and reservoirs. In all other waters, geometric mean is not applicable and individual samples must be used for assessment.
 - Fecal Coliform – Applicable for assessments in all waters.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Secondary Contact Season

1. Data temporal requirements

- Discrete data must be collected during secondary contact season.
 - Secondary contact season is defined, in Rule 2, as October 1 to April 30.

2. Minimum Data distribution and quantity requirements

- Individual Samples
 - A minimum of one (1) secondary contact season is required.
 - Eight (8) discrete samples are required per secondary contact season used for assessment.
 - Discrete data must be evenly spaced within the secondary contact season.
- Geometric Mean
 - Five (5) discrete samples spaced evenly and within a thirty-day period are required to calculate geometric mean.

3. Spatial Requirements

- Individual Samples
 - Applicable for assessments in all waters.
- Geometric Mean
 - *E. coli* - Applicable for assessments only in ERW, ESW, NSW waters; lakes; and reservoirs. In all other waters, geometric mean is not applicable and individual samples must be used for assessment.
 - Fecal Coliform – Applicable for assessments in all waters.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR BACTERIA

Bacterial assessments are made with discrete *Escherichia coli* (*E. coli*) data. In the absence of *E. coli* bacteria data, fecal coliform bacteria data may be utilized for assessments. Bacterial assessments are made with discrete data only. Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Data in most probable number (MPN) units will be evaluated for use in assessments of *E. coli*.

Assessments can be made using individual samples or geometric mean (as appropriate per spatial requirements described above). If adequate data sets exist for both single sample and geometric mean assessment (within the same year), both methods will be assessed separately and the most protective result will be used as the final assessment decision.

Binomial distribution method will not be applied. A straight mathematical 25% exceedance rate will be used to assess attainment (Example: 2 exceedances in 8 samples equal 25%).

For assessment of ambient waters using bacteria:

- **Primary Contact**
 - Individual Samples - Assessments can be made using data from only one primary contact season within the period of record; however, if complete data sets exist for more than one primary contact season within the period of record, data sets will be combined for assessment. Each primary season must contain eight (8) evenly distributed samples (per Phase II requirements above). Primary contact seasons with fewer than eight (8) samples will not be combined with data from other primary contact seasons and will not be used for assessment purposes.
 - Geometric Mean - All geometric means calculated for any primary contact season within the period of record will be considered for assessment purposes. All samples within a thirty day period that meet the “evenly spaced” requirement must be used for geometric mean calculation. Example: If daily measurements exist for a thirty day period, all thirty readings must be used, not just any five or more of those readings.
- **Secondary Contact**
 - Individual Samples - Assessments can be made using data from only one secondary contact season within the period of record; however, if complete data sets exist for more than one secondary contact season within the period of record, data sets will be combined for assessment. Each secondary season must contain eight (8) evenly distributed samples (per Phase II requirements above). Secondary contact seasons with fewer than eight (8) samples will not be combined with data from other secondary contact seasons and will not be used for assessment purposes.
 - Geometric Mean - All geometric means calculated for any secondary contact season within the period of record will be considered for assessment purposes. All samples within a thirty day period that meet the “evenly spaced” requirement must be used for geometric mean calculation. Example: If daily readings exist for a thirty day period, all thirty readings must be used, not just any five or more of those readings.

LISTING METHODOLOGY:

Individual Samples

Stream, river, reservoir, and lake AUs may be assessed as non-support when the applicable criteria is exceeded in **greater than 25 percent** of samples collected during months within the applicable contact season (as described above).

If the assessment of non-support is based on only one (1) season of data (eight (8) discrete samples within one primary contact season, or within one secondary contact season), the AU may be placed in Category 3 and more data may be collected for re-assessment in a future assessment cycle.

If the assessment of non-support is based on more than one season of data, the AU will be placed in Category 5, truly impaired.

Geometric Mean

Stream, river, reservoir, and lake AUs may be assessed as non-support **when the geometric mean for the applicable contact season is exceeded**. If one or more geometric mean calculations within the season exceed the criteria the AU may be assessed as non-support.

DELISTING METHODOLOGY:

Individual Samples

Stream, river, reservoir, and lake AUs may be assessed as support when the applicable criteria is **exceeded in 25 percent or less** of samples collected during months within the applicable contact season (as described above). This assessment result will apply for single season and multi-season assessments.

Geometric Mean

Stream, river, reservoir, and lake AUs will be assessed as support **when the geometric mean for the applicable contact season is not exceeded**. If more than one geometric mean calculation exists, all must not exceed the criteria.

Table 10: Statewide bacteria assessment criteria.

<i>Escherichia coli</i>		CRITERIA	SUPPORT	NON-SUPPORT
PRIMARY CONTACT	ERW, ESW, and NSW Waters	GM 126 col/100 mL*	≤ criteria	> criteria
	Lakes, Reservoirs	298 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
	All other waters	410 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
SECONDARY CONTACT	ERW, ESW, and NSW Waters	GM 630 col/100 mL*	≤ criteria	> criteria
	Lakes, Reservoirs	1490 col/100 mL (Oct. - April)	≤ 25% exceedance	>25% exceedance
	All other waters	2050 col/100 mL (Oct. - April)	≤ 25% exceedance	>25% exceedance
FECAL COLIFORM		CRITERIA	SUPPORT	NON-SUPPORT
<u>PRIMARY CONTACT</u>		GM 200 col/100 mL*	≤ criteria	> criteria
All Waters including ERW, ESW, NSW, Lakes, and Reservoirs		400 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
<u>SECONDARY CONTACT</u>		GM 1000 col/100 mL*	≤ criteria	> criteria
All Waters including ERW, ESW, NSW, Lakes, and Reservoirs		2000 col/100 mL (Oct. - April)	≤ 25% exceedance	>25% exceedance

ERW: Extraordinary Resource Water, **NSW:** Natural and Scenic Waterway, **ESW:** Ecologically Sensitive Water

*Geometric mean can be calculated for any 30-day period within a season (primary season May 1 through September 30; secondary season October 1 through April 30).

6.7 TOXIC SUBSTANCES

This section establishes the protocol for assessment of toxic substances criteria within Arkansas's surface waters, per APC&EC Rule 2.508:

Toxic substances shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant or aquatic life or to interfere with the normal propagation, growth and survival of the indigenous aquatic biota. For non-permit issues and as a guideline for evaluating toxic substances not listed in the following tables, the Division may consider No Observed Effect Concentrations or other literature values as appropriate. For the substances listed below, the following standards shall apply:

ALL WATERBODIES - AQUATIC LIFE CRITERIA

<u>Substance</u>	<u>Acute Values (µg/L)</u>	<u>Chronic Values (µg/L)</u> (24-hr Average)
PCBs		0.0140
Aldrin	3.0	
Dieldrin	2.5	0.0019
DDT (& metabolites)	1.1	0.0010
Endrin *	0.18	0.0023
Toxaphene	0.73	0.0002
Chlordane	2.4	0.0043
Endosulfan *	0.22	0.056
Heptachlor	0.52	0.0038
Hexachlorocyclohexane *	2.0	0.080
Pentachlorophenol	$e^{[1.005(\text{pH})-4.869]}$	$e^{[1.005(\text{pH})-5.134]}$
Chlorpyrifos	0.083	0.041

* Total of all isomers

DISSOLVED METALS*

<u>Acute Criteria (CMC) - µg/L(ppb)</u>			<u>Chronic Criteria (CCC) - µg/L(ppb)</u>		
<u>Substance</u>	<u>Formula</u>	<u>X Conversion</u>	<u>Formula</u>	<u>X Conversion</u>	
Cadmium	$e^{[1.128(\ln \text{hardness})]-3.828}$	(a)	$e^{[0.7852(\ln \text{hardness})]-3.490}$		(c)
Chromium(III)	$e^{[0.819(\ln \text{hardness})]+3.688}$	0.316	$e^{[0.8190(\ln \text{hardness})]+1.561}$		0.860
Chromium (VI)	16	0.982	11		0.962
Copper	$e^{[0.9422(\ln \text{hardness})]-1.464}$	0.960	$e^{[0.8545(\ln \text{hardness})]-1.465}$		0.960
Lead	$e^{[1.273(\ln \text{hardness})]-1.460}$	(b)	$e^{[1.273(\ln \text{hardness})]-4.705}$		(b)
Mercury	2.4	0.85	0.012**		NONE
Nickel	$e^{[0.8460(\ln \text{hardness})]+3.3612}$	0.998	$e^{[0.8460(\ln \text{hardness})]+1.1645}$		0.997
Selenium**	20	NONE	5		NONE
Silver	$e^{[1.72(\ln \text{hardness})]-6.52}$	0.85	-----		NONE
Zinc	$e^{[0.8473(\ln \text{hardness})]+0.8604}$	0.978	$e^{[0.8473(\ln \text{hardness})]+0.7614}$		0.986
Cyanide**	22.36	NONE	5.2		NONE

*These values may be adjusted by a site specific Water Effects Ratio (WER) as defined in 40 CFR Part 131.36 (c).

(a) Calculated as: $1.136672 - [(\ln \text{hardness})(0.041838)]$

(b) Calculated as: $1.46203 - [(\ln \text{hardness})(0.145712)]$

(c) Calculated as: $1.101672 - [(\ln \text{hardness})(0.041838)]$

**Expressed as total recoverable. Mercury based on bioaccumulation of residues in aquatic organisms, rather than toxicity.

ALL WATERBODIES - HUMAN HEALTH CRITERIA

<u>Substance</u>	<u>Criteria (ng/L)*</u>
Dioxin (2,3,7,8 TCDD)	0.001
Chlordane	5.0
PCBs (polychlorinated biphenyls)	0.4
alpha Hexachlorocyclohexane	37.3
Beryllium	4000**
Dieldrin	1.2
Toxaphene	6.3
* Criteria based on a lifetime risk factor of 10^{-5} .	
**4000 ng/l is also represented as 4.0 ug/l, which is the Maximum contaminant level (MCL) under the EPA Safe Drinking Water Act [40 U.S.C. s/s 300f et seq. (1974)]	

PHASE II DATA QUALITY REQUIREMENTS FOR TOXICS

Only discrete data will be used to make attainment decisions regarding toxicity. Concurrent instream hardness data must accompany metals data for metals toxicity attainment decisions unless toxic data falls below minimum criteria calculated at 25 mg/L hardness.

Streams and Rivers

1. Data temporal requirements:
 - Assessments can be made with discrete samples taken throughout the calendar year or period of record. There is no designated “season” for toxics.
2. Data distribution and quantity requirements:
 - Ten (10) samples are required to make toxic criteria attainment decisions; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
 - Data must be evenly distributed over at least two (2) years and three (3) quarters per year; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
3. Spatial requirements
 - None that are not already covered in Phase I requirements.

Lakes and Reservoirs

1. Temporal requirements
 - Collect toxics data quarterly, at a minimum.
2. Minimum distribution and quantity requirements
 - A minimum of ten (10) quarterly samples; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
3. Spatial requirements
 - Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR TOXIC SUBSTANCES

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Metals toxicity will be evaluated based on instream hardness values at the time of sample collection. If the ambient hardness value is less than 25 mg/L, then a hardness value of 25 mg/L will be used to calculate metals toxicity.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-support when **more than one (>1)** exceedance of the criterion, per APC&EC Rule 2.508, occurs during the period of record, even if the minimum of ten (10) samples has not been reached.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as support when there are **one or fewer (≤ 1)** exceedances of the criterion, per APC&EC Rule 2.508, during the period of record. A minimum of ten (10) samples must be reached to make an assessment of attainment.

6.8 FISH CONSUMPTION

This section establishes the protocol for determining attainment of fish consumption within Arkansas's surface waters.

ASSESSMENT METHODOLOGY FOR FISH CONSUMPTION

Fish consumption listings are based on fish consumption advisories issued by the Epidemiology Branch at Arkansas Department of Health.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as non-support for fish consumption if a primary segment of the fish community (e.g., all predators or all largemouth bass) has restrictions for any group of people (e.g., general population or high risk groups).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as support if there are no fish consumption restrictions or only a *limited consumption* of fish is recommended (e.g., no more than 2 meals per month or no consumption of fish over 15 inches).

6.9 NUTRIENTS

This section establishes the protocol for assessment of nutrients within Arkansas's surface water, per APC&EC Rule 2.509:

(A) Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody. Impairment of a waterbody from excess nutrients is dependent on the natural waterbody characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of waterbody, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in an impairment, based upon Department assessment methodology, by any Arkansas established numeric water quality standard, the waterbody will be determined to be impaired by nutrients.

(B) Site Specific Nutrient Standards

<i>Lake</i>	<i>Chlorophyll a (ug/L)**</i>	<i>Secchi Transparency (m)***</i>
<i>Beaver Lake*</i>	<i>8</i>	<i>1.1</i>

**These standards are for measurement at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.*

***Growing season geometric mean (May - October)*

****Annual Average*

SCREENING REQUIREMENTS FOR NUTRIENTS IN WADEABLE STREAMS

Total Nitrogen (TN) and Total Phosphorus (TP) data will be screened per respective ecoregion using the 75th percentile of all available TN and TP for the appropriate period of record that have passed Phase 1 requirements.

Arithmetic mean TN and TP concentrations for each assessment unit will then be compared to the 75th percentile screening values for the appropriate ecoregion and evaluated according to Figure 3. Data in each assessment unit for comparison against ecoregion values must meet the following requirements:

- Discrete Data
 - Ten (10) discrete samples are needed to make TN or TP attainment decisions.
 - Data must be evenly distributed over at least two (2) years and three (3) quarters per year.

PHASE II DATA QUALITY REQUIREMENTS FOR NUTRIENTS

Continuous and biological data requirements must be met for full nutrient assessment. Either short-term or long-term continuous data are required, not both. The 75th percentile screening values are calculated from only discrete samples collected during the period of record. Nutrient

screenings will be made by calculating the average concentration of each site for the period of record which will be compared to the 75th percentile for that ecoregion. For purposes of nutrient assessment, a “year” is defined as a 12 month period.

Streams and Rivers

1. Temporal requirements:

- Short-term and Long-term Continuous Data
 - Diel dissolved oxygen and pH deployments must be collected within the same critical season (same year) as discrete total nitrogen and total phosphorus samples.
 - Critical season is defined, in Rule 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
- Biological Communities
 - Fish communities must be collected during the same critical season as the diel dissolved oxygen and pH deployments.
 - Macroinvertebrate communities must be collected during the same year as fish collections, during fall base flow conditions.

2. Minimum distribution and quantity requirements

- Short-term Continuous Data
 - Two (2) diel deployments of at least 48 hours each with at least hourly readings are required.
 - Diel deployments must be spaced at least two weeks (14 days) apart within the same critical season.

Long-term Continuous Data

- Data must be evenly distributed throughout the critical season
- Data must be collected at least hourly.
- Biological Communities
 - One (1) fish community or one (1) macroinvertebrate community data set is required per year.

3. Spatial and other requirements

- Short-term and Long-term Continuous
 - None that are not already covered in Phase I requirements.
- Biological Communities
 - Must be collected in representative habitats of the stream segments.
 - Must satisfy biological community sampling protocols.

Beaver Lake

1. Temporal requirements

- Secchi Disk Transparency

- Secchi disk transparency depths should be collected year-round. Beaver Lake Secchi disk readings will be assessed on a calendar year.
 - Growing Season Chlorophyll *a* Geometric Mean
 - Chlorophyll *a* should be collected during the growing season.
 - Growing season is defined as May – October per Rule 2.509(B).
2. Minimum distribution and quantity requirements
- Secchi Disk Transparency
 - Ten (10) discrete samples evenly distributed over twelve (12) calendar months are required per year to calculate an annual average.
 - Growing Season Chlorophyll *a* Geometric Mean
 - Five (5) evenly distributed discrete samples are required per growing season to calculate a geometric mean.
3. Spatial requirements
- Secchi Disk Transparency and Growing Season Chlorophyll *a* Geometric Mean
 - All data shall be collected at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.
 - All parameter (Chlorophyll *a*, DO, pH, temperature, etc.; excluding Secchi disk) samples are to be taken (between 0.33 and 2.0 meters).

ASSESSMENT METHODOLOGY FOR NUTRIENTS

To date, assessment methodologies for nutrients have only been developed for, and only apply to, wadeable streams (Figure 3) and Beaver Lake. Methodologies for wadeable streams were developed defining “wadeable” as fourth order streams and smaller using Strahler stream order (Strahler 1952). Site verification and best professional judgement was used to classify an AU as wadeable.

Nutrient assessment relies on “paired data.” This means that physical, chemical, and biological data must be collected within the same year or season. Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined.

Beaver Lake Secchi disk readings and growing season chlorophyll *a* concentrations will be assessed per calendar year. If multiple chlorophyll *a* samples exist on the same day, but at the different depths, the most protective sample at each depth will be used for assessments.

LISTING METHODOLOGY FOR WADEABLE STREAMS:

Wadeable stream and river AUs will be listed as non-support for nutrients when the following conditions occur:

- The mean total phosphorus or total nitrogen concentration of the monitoring segment is greater than the 75th percentile of the total phosphorus or total nitrogen data from wadeable stream and river AUs within an ecoregion, **and**

- When either the short-term or long-term data sets indicate at least one of the two water quality translators, as listed in the flow chart, are exceeded (as per methodologies in Sections 6.3 and 6.4), **and**
- One or both biological communities, as listed in the flow chart, are evaluated as impaired.

Water quality translators are dissolved oxygen and pH. Two separate, 48 hour data sets within the same critical season (when water temperatures are greater than 22°C) are required for evaluation.

The dissolved oxygen translator is a 10% exceedance of the water quality criteria as described in Section 6.4. The pH translator is considered to be exceeded when pH varies from the criteria of between 6.0 and 9.0 standard units and assessment is described in Section 6.3.

Any wadeable stream or river segment that exceeds screening level criteria, but lacks adequate data to assess may be placed into Category 3b, Insufficient Data. Category 3 streams may be prioritized based on the magnitude of nutrient concentration, available data, and staff resources.

SUPPORT AND DELISTING METHODOLOGY FOR WADEABLE STREAMS:

Support Methodology

Wadeable streams and river AUs may be assessed as support when:

- The mean total phosphorus or total nitrogen concentration of the monitoring segment is less than the 75th percentile of the total phosphorus or total nitrogen data from wadeable stream and river AUs within an ecoregion.

Delisting Methodology

- The mean total phosphorus or total nitrogen concentration of the monitoring segment is less than the 75th percentile of the total phosphorus or total nitrogen data from wadeable stream and river AUs within an ecoregion, **and**
- When neither the short-term or long-term data sets indicate water quality translators, as listed in the flow chart, are not exceeded (as per methodologies in 6.3 and 6.4), **and**
- Biological communities used to make the listing are evaluated as unimpaired.

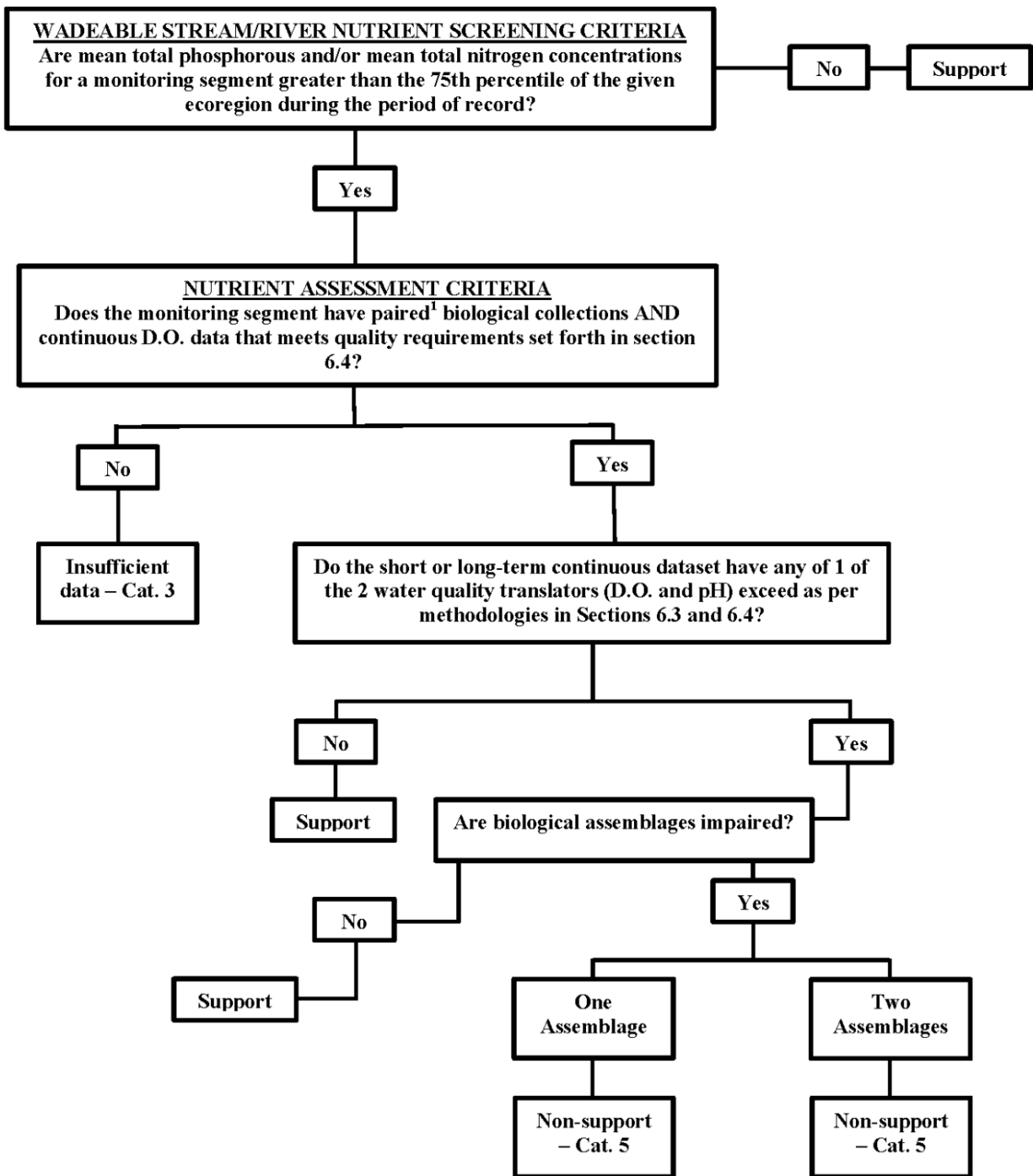
LISTING METHODOLOGY FOR BEAVER LAKE:

The Hickory Creek AU of Beaver Lake may be listed as non-support of its domestic water supply designated use when there are **three or more (≥3) geometric mean** exceedances of the chlorophyll *a* criteria within the five-year period of record.

The Hickory Creek AU of Beaver Lake may be listed as non-support of its domestic water supply designated use when there are **three or more (≥3) annual average** exceedances of the secchi transparency criteria within the five-year period of record.

DELISTING METHODOLOGY FOR BEAVER LAKE:

The Hickory Creek AU of Beaver Lake may be listed as supporting its domestic water supply designated use when there are **no more than two (2) geometric mean** exceedances of the chlorophyll *a* criteria **and no more than two (2) annual averages** exceedances of the secchi transparency criteria within the five-year period of record.



¹ Paired data/collections are defined as combined physical, chemical, and biological collections within the same calendar year and/or season.

² D. O. data must be continuous, either long-term or short-term.

³ Section 5.0 discusses the determining factors for biological impairment.

Figure 3: Nutrient assessment flowchart for wadeable streams and rivers.

6.10 MINERAL QUALITY

6.10.1 Site specific minerals for aquatic life use

This section establishes the protocol for assessment of site specific mineral criteria within Arkansas's waters, per APC&EC Rule 2.511 (A):

(A) Site Specific Mineral Quality Criteria

Mineral quality shall not be altered by municipal, industrial, other waste discharges or instream activities so as to interfere with designated uses. The following criteria apply to the streams indicated.

PHASE II DATA QUALITY REQUIREMENTS FOR MINERALS FOR AQUATIC LIFE USE

Only discrete data will be used to make assessments for minerals. All Phase II considerations apply to waters with site specific minerals criteria Rule 2.511(A)).

1. Data temporal requirements

- Discrete data should be collected year-round.

2. Minimum data distribution and quantity requirements

- Ten (10) discrete samples are required to make minerals attainment decisions.
- For streams and rivers, discrete samples must be evenly distributed over at least two (2) years and three (3) quarters per year.
- For lakes and reservoirs a minimum of ten (10) quarterly samples.

3. Spatial requirements

- For streams and rivers, none that are not already covered in Phase I requirements.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR SITE SPECIFIC MINERAL QUALITY FOR AQUATIC LIFE USE

Waters with site specific mineral criteria are assessed according to site specific values for chlorides, sulfates, and/or TDS listed in APC&EC Rule 2.511(A). Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Binomial distribution method will be applied to site specific mineral data, per Section 3.6.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs with site specific mineral criteria may be assessed as non-support when, using the **twenty-five (25) percent** exceedance rate within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable site specific mineral criteria listed in APC&EC Rule 2.511(A).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs with site specific mineral criteria may be assessed as support when, using the **twenty-five (25) percent** exceedance rate within Table 2, no more than

the maximum number of samples allowed for the entire qualifying data set exceed the applicable site specific mineral criteria listed in APC&EC Rule 2.511(A).6.10.2 Mineral Quality for Domestic, Agricultural, and Industrial Water Supply Uses

This section establishes the protocol for assessment of mineral quality for domestic, agriculture, and industrial water supply designated uses within Arkansas's surface waters, per APC&EC Rule 2.511(C):

(C) Domestic Water Supply Criteria

In no case shall discharges cause concentrations in any waterbody to exceed 250, 250 and 500 mg/L of chlorides, sulfates and total dissolved solids, respectively, or cause concentrations to exceed the applicable criteria, except in accordance with Rules 2.306 and 2.308.

This section is written in accordance with the Federal Safe Drinking Water Act (40 § C.F.R 143.3) and also establishes the protocol for assessing impairment due to exceedance of limits for agricultural and industrial water supplies.

PHASE II DATA QUALITY REQUIREMENTS FOR MINERAL QUALITY FOR DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USES

Minerals data (chloride, sulfates, TDS) will be used to assess well as Domestic, Agricultural, and Industrial Water Supply Uses. Only discrete data will be used.

Streams and Rivers

1. Data temporal requirements
 - Discrete data should be collected year-round.
2. Minimum data distribution and quantity requirements
 - Ten (10) discrete samples are required to make minerals attainment decisions.
 - Discrete samples must be evenly distributed over at least two (2) years and three (3) quarters per year.
3. Spatial requirements
 - None that are not already covered in Phase I requirements.

Lakes and Reservoirs

1. Temporal requirements
 - Collect minerals data quarterly, at a minimum.
2. Minimum distribution and quantity requirements
 - A minimum of ten (10) quarterly samples.
3. Spatial requirements
 - Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USE

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Binomial distribution method will be applied to non-site specific mineral data, as per Section 3.6.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as non-support when, using the **ten (10) percent** exceedance rate within Table 1, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable mineral criteria listed in APC&EC Rule 2.511(C).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be assessed as support when, using the **ten (10) percent** exceedance rate within Table 2, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable mineral criteria listed in APC&EC Rule 2.511(C).

6.12 AMMONIA

This section establishes the protocol for assessment of ammonia criteria in Arkansas's surface waters, per APC&EC Rule 2.512:

The total ammonia nitrogen (N) criteria and the frequency of occurrence are as follows:

(A)The one-hour average concentration of total ammonia nitrogen shall not exceed, more than once every three years on the average, the acute criterion as shown in the following table:

pH-Dependent Values of the CMC (Acute Criterion)- mg/L

<i>pH</i>	<i>Salmonids*</i>	<i>Salmonids</i>
	<i>Present</i>	<i>Absent</i>
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

** Family of fishes, which includes trout.*

(B) The monthly average concentration of total ammonia nitrogen shall not exceed those values shown as the chronic criterion in the following tables:

<u>Temperature and pH-Dependent Values of the CCC (Chronic Criterion)</u>										
<u>for Fish Early Life Stages Present – mg/L</u>										
	<u>Temperature °C</u>									
<u>pH</u>	<u>0</u>	<u>14</u>	<u>16</u>	<u>18</u>	<u>20</u>	<u>22</u>	<u>24</u>	<u>26</u>	<u>28</u>	<u>30</u>
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

**Temperature and pH-Dependent Values of the CCC (Chronic Criterion)
for Fish Early Life Stages Absent – mg/L**

Temperature °C										
<u>pH</u>	<u>0-7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15*</u>	<u>16*</u>
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442

**At 15° C and above, the criterion for fish Early Life Stage absent is the same as the criterion for fish Early Life Stage present.*

- (C) *The highest four-day average within a 30-day period should not exceed 2.5 times the chronic values shown above.*
- (D) *Temperature values used will be 14° C when fish early life stages are absent and the ecoregion temperature standard for the season when fish early life stages are present. The pH values will be the ecoregion mean value from least-disturbed stream data.*

PHASE II DATA QUALITY REQUIREMENTS FOR AMMONIA:

Only discrete data will be used for ammonia assessments. Total ammonia nitrogen discrete samples must be paired with concurrently measured *in situ* pH and temperature data, as applicable unless ammonia data falls below minimum criterion from APC&EC Rule 2.512(A)–(C).

Acute Criterion – Rule 2.512(A)

1. Data temporal requirements

- Discrete data should be collected year-round.

2. Minimum data distribution and quantity requirements

- Ten (10) discrete samples are required to make attainment decisions for ammonia; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For streams and rivers:
 - Discrete samples must be evenly distributed over at least two (2) years and three (3) seasons per year; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For lakes and reservoirs:
 - A minimum of ten (10) quarterly samples over not less than three (3) years; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.

3. Spatial requirements

- None that are not already covered in Phase I requirements.
- Take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Chronic Criterion – Rule 2.512(B) Fish Early Life Stage Present

1. Data temporal requirements

- Assessments can be made with discrete samples collected when early life stage fishes are present (year-round for brown-trout waters; April – October for all other waters).

2. Minimum data distribution and quantity requirements

- Ten (10) discrete samples are required to make attainment decisions for ammonia; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For streams and rivers, discrete samples must be evenly distributed over at least two (2) years evenly distributed throughout applicable season; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For lakes and reservoirs, a minimum of ten (10) quarterly; unless an assessment of non-attainment can be reached in fewer than ten (10) samples

3. Spatial requirements

- For streams and rivers, none that are not already covered in Phase I requirements.
- For lakes and reservoirs, take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

Chronic Criterion – Rule 2.512(C) Fish Early Life Stage Absent

1. Data temporal requirements

- Assessments can be made with discrete samples collected when early life stage fish are absent (year-round for brown trout waters, November 1 – March 31 for all other waters)

2. Minimum data distribution and quantity requirements

- Ten (10) discrete samples are required to make attainment decisions for ammonia; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For streams and rivers, discrete samples must be evenly distributed over at least two (2) years and three (3) seasons; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
- For lakes and reservoirs, a minimum of ten (10) quarterly samples; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.

3. Spatial requirements

- For streams and rivers, none that are not already covered in Phase I requirements.
- For lakes and reservoirs, take samples within the epilimnion (if present). Sample depth shall be between 0.33 and 2.0 meters.

ASSESSMENT METHODOLOGY FOR AMMONIA:

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Total ammonia nitrogen will be evaluated based on concurrently measured instream pH and temperature, as applicable, at the time of sample collection using APC&EC Rule 2.512(A)–(C) criteria. In instances where pH, temperature, or both, as applicable fall between the values in APC&EC Rule 2.512(A)–(C), the most protective values will be used. The Chronic Criterion for fish early life stages present (Rule 2.512(B)) apply when early life stage fishes are present in rivers and streams, or within the epilimnion of lakes and reservoirs. The criterion shall be applied as 1) the arithmetic mean of the analytical results of consecutive-day samples when available, or 2) the result of individual grab samples. In the event there is only one sample per month, that sample will serve as the “monthly average” for purposes of ammonia assessment.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs may be listed as non-support for ammonia toxicity if any one of the following criteria are violated:

For Rule 2.512(A) Acute Criterion - If more than one (>1) violation of the 1-hour average concentration of total ammonia nitrogen exceeds the calculated acute criterion within the 3-year period of record, even if the minimum of ten (10) samples has not been reached.

For Rule 2.512(B) Chronic Criterion Fish Early Life Stage Present - If the monthly average concentration of total ammonia nitrogen exceeds the chronic criterion, even if the minimum of ten (10) samples has not been reached. To get the chronic criterion, use the monthly average of corresponding pH and temperature values.

For Rule 2.512(C) Chronic Criterion Fish Early Life Stage Absent - If the highest 4-day average within a 30-day period exceeds 2.5 times the chronic criterion, even if the minimum of ten (10)

samples has not been reached. To get the chronic criterion, use the 4-day average of corresponding pH and temperature values.

DELISTING METHODOLOGY:

An AU can only be delisted by the same criterion that was used to list it. For example, if an AU was listed using the Rule 2.512(A) acute criterion, it can only be delisted using the Rule 2.512(A) acute criterion delisting methodology. Stream and river AUs, as well as lakes and reservoirs, may be listed as support for ammonia toxicity criteria:

For Rule 2.512(A) Acute Criterion - If no more than one violation of the 1-hour average concentration of total ammonia nitrogen exceeds the calculated acute criterion within the 3-year period of record. A minimum of ten (10) samples must be reached to make an assessment of attainment.

For Rule 2.512(B) Chronic Criterion Fish Early Life Stage Present - If the monthly average concentration of total ammonia nitrogen does not exceed the chronic criterion. A minimum of ten (10) samples must be reached to make an assessment of attainment.

For Rule 2.512(C) Chronic Criterion Fish Early Life Stage Absent - If the highest 4-day average within a 30-day period does not exceed 2.5 times the chronic criterion. A minimum of ten (10) samples must be reached to make an assessment of attainment.

REFERENCES CITED

- Arkansas Department of Environmental Quality (ADEQ). 2016. Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan (QTRAK #16-155).
- Arkansas Department of Environmental Quality (ADEQ). 2013. State of Arkansas Water Quality Monitoring and Assessment Program, Revision 5.
- Arkansas Department of Pollution Control and Ecology. 1987. Physical, Chemical, and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas's Ecoregions. Volume 1: Data Compilation.
- Arkansas Pollution Control and Ecology Commission (APC&EC). 2017. Rule 2: Rule Establishing Water Quality Standards for Surface Waters of the State of Arkansas.
- Clarke, Joan U. 1998. Evaluation of Censored Data Methods to Allow Statistical Comparisons Among Very Small Samples with Below Detection Limit Observations. *Environ. Sci. Technol.* 32(1), pp 177 – 183.
- Croghan, C. and P. P. Egeghy. 2003. Methods of Dealing with Values Below the Limit of Detection Using SAS. Presented at Southeastern SAS user group, St. Petersburg, FL. September 22-24, 2003.
- Dixon, P.M. 2005. A statistical test to show negligible trend. *Ecology* 86:1751-1756.
- Environmental Protection Agency (EPA). 1996. Guidance for data quality assessment: practical methods for data analysis. EPA QA/G-9. EPA/600/R-96/084. July 1996. Washington, D.C.
- Environmental Protection Agency (EPA). 2002. Consolidated Assessment and Listing Methodology(CALM): Towards a compendium of best practices. Office of Wetlands, Oceans, and Watersheds. Washington, D.C.
- Environmental Protection Agency (EPA). 2005. Guidance for 2006 assessment, listing and reporting requirements pursuant to sections 303(d), 305(b), and 314 of the Clean Water Act. Watershed Branch, Assessment and Watershed Protection Division, Office of Wetlands, Oceans, and Watersheds. Washington, D.C.
- Environmental Protection Agency (EPA). 2006. Information concerning 2008 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. October 12, 2006. Washington, D.C.
- Environmental Protection Agency (EPA). 2009. Information concerning 2010 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. May 5, 2009. Washington, D.C.
- Environmental Protection Agency (EPA). 2011. Information concerning 2012 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. REVIEW DRAFT. Washington, D.C.

- Environmental Protection Agency (EPA). 2013. Information concerning 2014 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. September 3, 2013. Washington, D.C.
- Environmental Protection Agency (EPA). 2014. Method 1603: *Escherichia coli* (*E. coli*) in Water b Membrane Filtration Using Modified membrane-Thermotolerant *Escherichia coli* Agar (Modified mTEC). September 2014. EPA-821-R-14-010. Office of Water.
- Environmental Protection Agency (EPA). 2015. Information concerning 2016 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. August 13, 2015. Washington, D.C.
- Environmental Protection Agency (EPA). 2017. Information concerning 2018 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. December 22, 2017. Washington, D.C.
- Environmental Protection Agency (EPA). 2021. Information concerning 2022 Clean Water Act sections 303(d), 305(b), and 314 integrated reporting and listing decisions. Memorandum from the Office of Wetlands, Oceans, and Watersheds. March 31, 2021. Washington, D.C.
- Plafkin, J.L. M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington D.C. EPA 440-4-89-001
- Scott, J. T., B. E. Haggard, and E. M. Grantz. 2016. Database Analysis to Support Nutrient Criteria Development (Phase III). Arkansas Water Resources Center, Fayetteville, AR, MSC Publication 383:445 pp.
- Strahler, A. N. 1952. Hypsometric (area-altitude) analysis of erosional topology. Geological Society of America Bulletin. 63(11): 1117-1142.
- Washington State Department of Ecology. 2002. *Additional Clarification of the Binomial Distribution Method*. Addendum to 2002 Water Quality Policy 1-11. Accessed online at: http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/binomialclarification.pdf