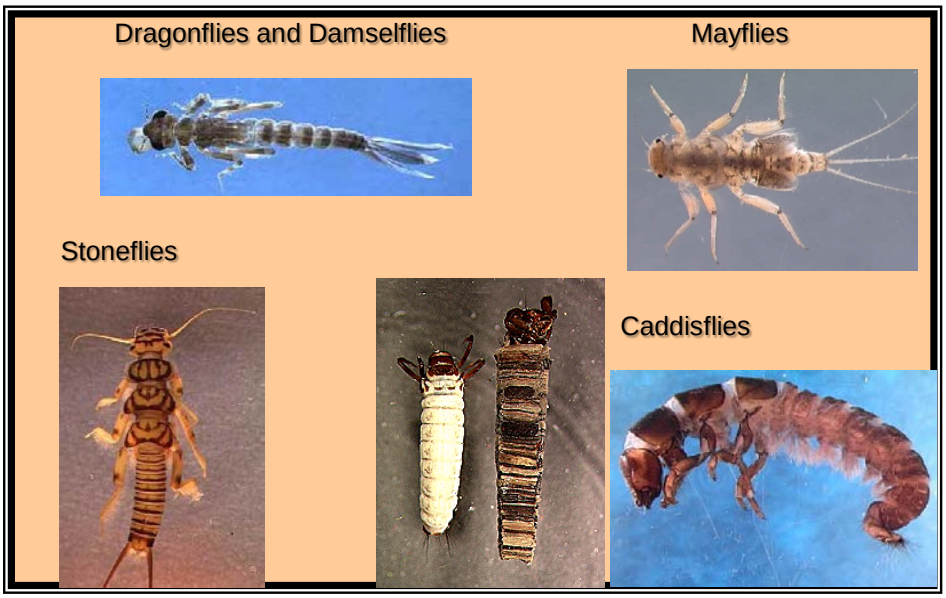
Implementation Procedures For the Narrative Biocriteria Standard



April 2015

ADEQ
Arizona Department of Environmental Quality

ARIZONA DEPARTMENT
OF
ENVIRONMENTAL QUALITY

Douglas A. Ducey
Governor

Henry R. Darwin
Director

APPROVALS

I approve the attached "Implementation Procedures for the Narrative Biocriteria Standard" document as a final document adopted by the Arizona Department of Environmental Quality for use in interpreting the associated Surface Water Quality Standards, 18 A.A.C. 11, Article 1.

Approved by: _____ 4-22-15

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Executive Summary

This document sets forth implementation procedures for the new narrative biocriteria water quality standard. The document provides a narrative biocriteria statement and explains ADEQ's objective basis for determining compliance with this new standard.

The new biocriteria standard for wadeable, perennial streams of Arizona consists of a narrative statement, associated Index of Biological Integrity scores for cold and warm water streams, and a statement of applicability to various water body types. The narrative biocriteria language is as follows:

> *"A wadeable, perennial stream shall support and maintain a community of organisms having a taxa richness, species composition, tolerance, and functional organization comparable to that of a stream with reference conditions in Arizona."*[A.A.C. R18-11-108(E)]

ADEQ will determine compliance with the narrative biocriterion through bioassessment and comparison of the bioassessment results to either a cold water or warm water Arizona Index of Biological Integrity. The biological integrity of a wadeable, perennial stream, as determined by the applicable Arizona Index of Biological Integrity (IBI), is protected at or above the 25th percentile of reference condition. An IBI score that is at or above the 25th percentile of reference condition meets the biocriterion. An IBI score that falls below the 10th percentile of reference condition violates the biocriterion. An IBI score that falls between the 10th and 25th percentile of reference condition is determined to be inconclusive and a verification bioassessment is required to determine whether there is a violation. If the verification sample IBI score falls below the 25th percentile, the biocriterion is violated.

In effect, a violation of the biocriteria standard occurs when a sample result from a study site either: 1) has an IBI score less than the 10th percentile of reference threshold value, or 2) has an IBI score between the 10th and 25th percentile of reference threshold values and a verification sample also falls below the 25th percentile of reference threshold value.

The narrative biocriterion applies only to perennial, wadeable stream segments with either a warm or cold water aquatic life designated use. ADEQ has not characterized reference conditions for other water body types and does not have IBIs for them. The narrative biocriterion does <u>not</u> apply to effluent dependent waters, ephemeral waters, intermittent waters, lakes, or wetlands.

ADEQ will determine compliance with the narrative biocriterion based on a macroinvertebrate sample collected from a wadeable, perennial stream with riffle or run habitat that is collected during the appropriate spring index period. The warm water IBI will apply to perennial, wadeable streams found at <5,000' elevation and the cold water IBI will apply to perennial, wadeable streams found at >5,000' elevation. ADEQ methods for biological sample collection and data analysis must be followed to compare bioassessment results to these macroinvertebrate-based IBIs.

Acknowledgments

This guidance document was written by Patrice Spindler of the Monitoring Unit, Surface Water Section, Water Quality Division, at the Arizona Department of Environmental Quality with contributions from Steve Pawlowski, Diana Marsh, Melanie Ford, Jason Jones, Jason Sutter, Debra Daniel and Linda Taunt.

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Introduction

The Environmental Protection Agency (USEPA) has been urging states to develop bioassessment methods and incorporate biocriteria into surface water quality standards since the *Rapid Bioassessment Protocols for Use in Streams and Rivers* were published (Plafkin et al, 1989). Biocriteria provide a direct measurement of biological integrity, one of the three objectives identified in the Clean Water Act. Bioassessment data are important for measuring the attainment of water quality standards for the protection of aquatic life because they utilize surveys of resident living organisms. Correctly collected and applied bioassessment data provide evidence of whether a water body is meeting its designated aquatic life use and can validate whether existing water quality criteria for toxic chemicals and physical parameters are adequately protecting that use.

Biological indicators such as macroinvertebrates, algae and fish integrate the cumulative effects of different stressors such as excess nutrients, toxic chemicals and excessive sediment over time. The biology provides a more reliable assessment of long-term ecological changes in the condition of a water body than do rapidly changing water chemistry measurements or laboratory toxicity tests. As such, the biota provides a unique indicator of ecological health, unlike any other measurement. The USEPA recommends that states use biological assessment data as a core indicator for making aquatic life use determinations (USEPA, 2002a).

Background

The concept of biological integrity is embedded in §101(a) of the Clean Water Act. The primary objective of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." Section 101(a)(2) of the Act sets forth the national goal that "…wherever attainable, an interim goal of water quality which provides for protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved." The intent of this statement is to protect not only what is currently living in our waters but also to provide for maintenance of viable, reproducing populations.

Biological integrity is commonly defined as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley, 1981). This concept refers to the natural assemblage of indigenous organisms that would inhabit a particular area if it had not been affected by human activities. The naturally occurring biological diversity becomes the primary reference condition used to measure and assess the attainment of aquatic life goals. Arizona's narrative biocriterion at A.A.C. R18-11-108(E) is a restatement of Karr's definition of biological integrity. ADEQ defines "reference condition" in the surface water quality rules at A.A.C. R18-11-101(33) as "a set of ecological measurements from a population of relatively undisturbed water bodies within a region that establish a basis for making comparisons of biological condition among samples."

ADEQ began a bioassessment program in 1992 following the USEPA *Rapid Bioassessment Protocols for Use in Streams and Rivers* (Plafkin et al, 1989; Barbour et al., 1999), which provided guidance for development of biological monitoring and assessment procedures.

Standard operating procedures for macroinvertebrate monitoring in perennial, wadeable streams of Arizona and for laboratory processing and taxonomic identification were established and recently updated in the *Biocriteria Program Quality Assurance Program Plan* (ADEQ, 2006). A statewide reference site monitoring network was established to develop indexes of biological integrity as the macroinvertebrate bioassessment tool. Reference site monitoring continues annually.

A classification analysis was performed on the statewide macroinvertebrate dataset to identify regions of statistically different macroinvertebrate communities across the state (Spindler, 2001). Elevation-based regions were the result of the classification analysis, consisting of two broad macroinvertebrate regions and community types:

- A warm water community located below 5,000 feet of elevation
- A cold water community located above 5,000 feet of elevation

All wadeable, non-effluent dependent, perennial streams located in these regions, with some exceptions (see section on applicability) are predicted to have the same general macroinvertebrate community type. Indexes of Biological Integrity (IBI) were developed for both a warm water community and a cold water community type, using Arizona's statewide network of reference site data (Gerritsen and Leppo, 1998; Leppo and Gerritsen, 2000). Background information about reference conditions and the development of the IBIs is presented in the Biocriteria Technical Support document (ADEQ, 2007).

Narrative Biocriteria Standard

The new narrative biocriteria standard for wadeable, perennial streams can be found in the 2009 Surface Water Quality Standards for Arizona in R18-11-108(E). The numeric targets for biocriteria and associated applicability rules are listed in R18-11-108.01. The biocriteria standard overall consists of the narrative biocriterion, statement of applicability, rules explaining how the biocriterion is met, and associated IBI scores for cold and warm water streams. ADEQ added R18-11-108.01 to the surface water quality standards rules, adopted as of January 2009. The narrative biocriteria standard is stated as follows:

> "*A wadeable, perennial stream shall support and maintain a community of organisms having a taxa richness, species composition, tolerance, and functional organization comparable to that of a stream with reference conditions in Arizona."*[A.A.C. R18-11-108(E)]

Applicability

The narrative biocriterion applies only to wadeable perennial streams with either a cold or warm water aquatic life designated use. The Arizona Water Quality Standards (A.A.C. Title 18. Chapter 11) currently list four aquatic life uses: aquatic life (cold water), aquatic life (warm water), aquatic life (ephemeral), and aquatic life (effluent-dependent). Developing biocriteria for the cold and warm water perennial streams have been the priority because of the diverse aquatic and terrestrial life they support and because aquatic communities of perennial streams have predictable community structure and function. ADEQ may revise the biocriteria standard and

develop implementation procedures for other water body types as new scientific information becomes available.

Several stream conditions must be met in order to apply the Arizona Indexes of Biological Integrity (IBI). The sampling site conditions and collection time frame must meet the following conditions:

- Wadeable,
- Perennial (evidence/documentation of perennial flow should be provided),
- Contain riffle or run habitat,
- Are not dominated by bedrock or travertine deposits,
- Sampled during the spring index period (April-May for warm water streams and May-June for cold water streams).

These conditions are important for determining that the study samples are collected from streams that are similar to the reference stream sites, and to prevent sample collections from habitats or during time periods when conditions would lead to a false finding of impairment. **Wadeable** means no deeper than can be safely waded across when collecting samples.

Perennial refers to stream segments which flow continuously throughout the year (excluding effluent dependent waters). If the streamflow at a study site is low flow and potentially intermittent, flow conditions should be monitored during the year prior to sampling to ensure perennial conditions exist prior to the spring macroinvertebrate sample event. Perennial conditions should be documented using one of the following methods: 1) Streamflow should be monitored during the summer season and ideally through the three seasons prior to the spring season to ensure continuous flow, 2) In-stream flow sensors with dataloggers that record daily mean flows, or 3) Photodocumentation of flow at the sampling location during June or throughout all seasons of the prior year.

Riffle habitat refers to the portions of streams where moderate velocities and substrate roughness produce moderately turbulent conditions which break the surface tension of the water and may produce white water (Bain and Stevenson, eds. 1999). **Run habitat** refers to segments of streams where there is moderate velocity water, but non-turbulent conditions which do not break the surface tension of the water and do not produce white water (Bain and Stevenson, eds.1999).

"Not dominated by bedrock or travertine deposits" means that the stream bottom material consists of less than 50% bedrock or travertine across the sampling reach. Streams that are bedrock or travertine dominated have aquatic communities which exhibit limited taxa richness and loss of structure and function when compared with reference conditions.

The spring index period is defined as a period of time following winter runoff in which baseflow conditions will be found in most streams. Baseflow conditions generally occur following the winter rainy season in desert streams during April and May, and in mountain streams following snowmelt conditions in May and June. A minimum period of 4 weeks post-bankfull flood condition is required prior to macroinvertebrate sampling, even during the spring index sampling period. Bankfull flow means the discharge in cubic feet per second, which

corresponds to the annual high flow event having a return interval of 1-2 years. Hydrologic conditions are checked in the office prior to a site visit and field conditions are documented on the SEM Field Form for Macroinvertebrate Sample Collection (Appendix A) in the field prior to macroinvertebrate sampling to confirm that sampling is occurring during the appropriate sample collection conditions. Macroinvertebrate samples are not collected if: a) A bankfull or greater magnitude flow event has occurred within 4 weeks of site visit, or b) Extreme high flow events have occurred (>10-year return interval flood) resulting in deep scouring of the streambed and benthic community such that the macroinvertebrate community will not recover within the spring index period.

The new narrative biocriterion will not apply to the following water body types: 1) Intermittent streams, 2) Effluent dependent waters, 3) Ephemeral streams, 4) Lakes or 5) Wetlands.

Determining a Biocriteria Standard Violation

ADEQ will determine compliance with the narrative biocriterion from bioassessment sample results collected during appropriate sample collection conditions (Appendix A)and comparison to the applicable Arizona Index of Biological Integrity (IBI) for warm and cold water streams. ADEQ will consider the biological integrity of a wadeable, perennial stream to be adequately maintained and supported when a bioassessment result, as measured by a single IBI score, is at or above the 25th percentile of reference condition. An IBI score that is at or above the 25th percentile of reference score meets the biocriterion. An IBI score that falls below the 10th percentile of reference score violates the biocriterion. An IBI score that falls between the 10th and 25th percentile of reference score is inconclusive and a verification sample is required to determine whether there is a violation. If the verification IBI score is at or above the 25th percentile, the biocriterion is met. If the verification IBI score is less than the 25th percentile, the biocriterion is violated. The IBI scores in Table 1 comprise the thresholds ADEQ adopted in the Water Quality Standards for Surface Waters (A.A.C. R18-11-108.01) to implement the narrative biocriterion:

Table 1. Arizona Index of Biological Integrity thresholds for wadeable, perennial streams with either an aquatic and wildlife (cold) or an aquatic and wildlife (warm) designated use.

Macroinvertebrate bioassessment sample results	**Index of Biological Integrity Score**		
	Cold water	**Warm water**	**Status**
Greater than the 25th percentile of reference condition	≥ 52	≥ 50	Meeting
Greater than the 10th and less than the 25th percentile of reference condition	46 – 51	40 – 49	Inconclusive
Less than the 10th percentile of reference condition	≤ 45	≤ 39	Violating

ADEQ's biological data collection, taxonomy and analysis procedures or comparable procedures shall be followed in order to apply the Arizona Index of Biological Integrity. ADEQ biological field sampling, laboratory methods and analysis procedures can be found in ADEQ's the Biocriteria Program QAPP (ADEQ, 2006) and the Surface Water field procedures document, *Standard Operating Procedures for Surface Water Quality Sampling* (Jones, 2012).

Implementation of Biocriteria and Associated Implementation Procedures in AZPDES Permits

The narrative biocriterion at A.A.C. R18-11-108(E) and the numeric IBI thresholds for wadeable, perennial streams in A.A.C. R18-11-108.01(C) are not intended to be used as a basis for calculating numeric water quality based effluent limits (WQBELs) in AZPDES permits. ADEQ may develop AZPDES permit conditions which require ambient water quality monitoring, including bioassessment, to assess ambient stream conditions and to confirm the effectiveness of point source discharge controls or best management practices. If the permittee believes that the "decision criteria" in Appendix A are not met at a sampling site, permittee must provide a rationale and documentation indicating why sampling conditions are not met to ADEQ within the spring index period. If ADEQ concurs, then sampling would be exempted for that sample period.

Use of Biocriteria for Water Quality Assessment §305(b)

CWA §305(b) water quality assessments will be based on the narrative biocriterion at R18-11-108(E), the biocriteria rules contained in R18-11-108.01A-C, and these implementation procedures. The following guidance is provided for 305b Water Quality Assessment purposes only; guidance for 303d listings of impaired waters is not provided here because the "Impaired Waters Identification Rule" language must be updated first.

A single macroinvertebrate sample will be used to determine whether a sample is attaining or inconclusive in comparison with the Biocriteria Standard. There are several reasons why a single sample is appropriate for bioassessment: 1) a single macroinvertebrate sample represents long-term conditions because the invertebrates reside in the stream year-round, 2) the sampling method is sufficiently rigorous that it limits the amount of variability in sample collection. Precision of the indexes is high, with a standard error of only 7 points on a 100 point scale, for repeat visits across years in the warm water dataset (Gerritsen and Leppo, 1998), 3) the Indexes of Biological Integrity are robust measures of the structure and function of the macroinvertebrate community and limit the variability associated with a single metric, and 4) the reference condition, upon which the Indexes are constructed, consists of replicate samples over a 5-year period and across regions of the state. Reference conditions are a composite by which to compare study reaches, thereby limiting the variability associated with individual reference sites.

In addition, there is a high level of certainty about making a correct assessment biological condition at the 25^{th} percentile of reference condition, because samples used to calculate the 25^{th} percentile resemble known reference streams of Arizona. Similarly, there is a high level of certainty that wadeable, perennial streams are biologically impaired when the IBI score is less than the 10^{th} percentile of reference condition because they resemble known impaired streams in Arizona. However, there is less certainty about making a determination of "impaired" when IBI scores fall just below the 25^{th} percentile. To avoid having samples falling into the zone of uncertainty around the 25^{th} percentile of reference threshold, a verification sample will be required to verify the IBI score .

When the IBI score for the verification sample falls below the 25^{th} percentile, there is sufficient evidence that the community is degraded, therefore the study reach will be assessed as impaired

for the aquatic life use. These samples will be placed on the Category 3 Planning list. When the IBI score for the verification sample is greater than the 25th percentile, there is sufficient evidence that the community is improving, therefore the study reach will be assessed as attaining the aquatic life use. The verification sample must be collected more than 7 days apart from the original sample or, samples collected within a 7-day timeframe within the same reach shall be averaged for assessment purposes. ADEQ will accept data from outside sources that is collected using ADEQ protocols and meets quality control objectives. If multiple samples have been collected during one spring index period in a study reach, the assessment will be based upon the single most recent sample IBI score.

Determinations of “impairment” using the biocriteria standard cannot be made until the Impaired Waters Identification Rule has been updated in rule.

Definitions:

Bankfull elevation: The channel elevation at which an annual high flow event with a 1-2 year return interval occurs. Bankfull elevation is estimated using regional curves and field measurements and several field indicators are identified to determine if recent high flows have occurred. These indicators are listed in the ADEQ Stream Ecosystem Monitoring field forms.

Bankfull flow means the discharge level in cubic feet per second, which corresponds to the annual high flow event having a return interval of 1-2 years. The"high flow checklist" in the SEM field forms is used to determine in the field whether a high flow has recently occurred.

Biological assessment (Bioassessment): An evaluation of the biological condition of a surface water using biological surveys of the resident living organisms.

Biological criteria (Biocriteria): Narrative expressions or numeric values that describe the reference biological integrity of aquatic communities inhabiting waters of a given designated aquatic life use.

Biological integrity (Biointegrity): The capacity of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region.

Effluent-dependent water: A surface water that consists of discharges of treated wastewater that is classified as an effluent-dependent water by the Director under R18-11-113. An effluent-dependent water is a surface water that, without the discharge of treated wastewater, would be an ephemeral water.

Ephemeral water means a surface water that has a channel that is at all times above the water table, and that flows only in direct response to precipitation.

Index of biological integrity means a multimetric tool used for assessing the condition of a biological community.

Intermittent surface water means a stream or reach of stream that flows continuously only at certain times of the year, as when it receives water from a spring or from another surface source, such as melting snow.

Macroinvertebrates are invertebrate animals that are large enough to be seen with the naked eye and have no backbone or spinal column; such as insects, snails and worms.

Metric means a characteristic of the biota which changes in some predictable way with increased human disturbance.

Perennial surface water means a surface water that flows continuously throughout the year.

Regional reference condition means a set of ecological measurements from a population of relatively undisturbed waterbodies within a region that establish a basis for making comparisons of biological condition among samples.

Riffle habitat refers to the portions of streams where moderate velocities and substrate roughness produce moderately turbulent conditions which break the surface tension of the water and may produce whitewater.

Run habitat refers to segments of streams where there is moderate velocity water, but non-turbulent conditions which do not break the surface tension of the water and do not produce whitewater.

Seasonally intermittent refers to a stream segment which has had no flow in the study reach at some period of time since the last spring index period.

Spring index period means the time period following winter runoff and snowmelt, when baseflow conditions generally occur in Arizona streams. For macroinvertebrate sampling purposes, spring index period is defined as April 1-May 31st for warm water streams and May 1 – June 30th for cold water streams.

Study reach: A macroinvertebrate sample is collected over a stream segment that is 2 meander lengths long or a minimum of 100 meters long in larger streams. It represents biological integrity of the assessment unit within which it is collected.

Wadeable means no deeper than can be safely waded across when collecting samples. ADEQ recommends sampling in streams that are flowing at velocities and depths whose quotient is less than 9 (eg. Velocity <4.5ft/s x 2 ft deep).

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Appendix A: SEM Field Form: Decision criteria for Macroinvertebrate Sample Collection

ADEQ – STREAM ECOSYSTEM MONITORING FIELD FORM REVISED MARCH 2015

SHOULD I SAMPLE MACROINVERTEBRATES?

The target stream habitat for collecting macroinvertebrates must be wadeable, perennial, contain riffle or run habitat, must contain heterogeneous substrates, and must be sampled during the spring index period. Spring index period is April - May for warm water streams and May - June for cold water streams. Use the following specific decision criteria to determine whether to collect a macroinvertebrate sample for assessment purposes. NOTE: Probabilistic sampling still requires that macroinvertebrates be collected from effluent, travertine or bedrock dominated streams. Collect a sample for these sites even though it cannot be used in the assessment.

Parameter	Condition	Action to Take (CHECK BOXES)
Hydrologic Conditions	Baseflow conditions are occurring and it is approximately 4 or more weeks after a bankfull flow event. *	☐ Collect macroinvertebrates
	A bankfull or greater magnitude flow event has occurred within 4 weeks of site visit. Or extreme high flow events have occurred resulting in deep scouring of the streambed and benthic community such that the macroinvertebrate community will not recover within the spring index period.	☐ Do not collect macroinvertebrates
	Extended drought conditions have reduced flow from previously perennial condition to pools only or stagnant wetland habitat.	☐ Do not collect macroinvertebrates
Substrate Type	A substrate consisting of a mixture of some of the following particle sizes is the target condition: boulder, cobble, gravel, sand, clay, silt, bedrock.	☐ Collect macroinvertebrates
	Streams which have substrates dominated (consisting of >50% of that substrate type) by bedrock or travertine are considered non-target conditions (see note for random sites).	☐ Do not collect macroinvertebrates
Waterbody Type	The target waterbody type is a flowing stream with riffle or run (erosional) habitats present.	☐ Collect macroinvertebrates
	Waterbody type is: Effluent dependent stream, wetland, ephemeral stream, lake, or intermittent stream (see note for random sites).	☐ Do not collect macroinvertebrates

* Identification of bankfull and high flow elevation in the field: Using known watershed area, use appropriate Regional Curve and field bankfull indicators to estimate bankfull elevation. Look for debris lines and other high flow markers as an indicator of the most recent high flow stage. See SOP Manual.

Footnotes:

1. Perennial conditions should be documented using one of the following methods: 1) Streamflow should be monitoring during the summer season and ideally through the three seasons prior to the spring season to ensure continuous flow, 2) In-stream flow sensors with dataloggers that record daily mean flows, or 3) Photodocumentation of flow at the sampling location during June or throughout all seasons of the prior year.
2. Identification of bankfull and high flow elevation in the field: Using known watershed area, use the appropriate Regional Curve (Central/Southern AZ or E. Arizona/New Mexico) and field bankfull indicators to estimate bankfull elevation (Jones ed, 2010). Look for debris lines and other high flow markers as an indicator of the most recent high flow stage. If freshly laid debris lines are at higher elevation than the bankfull elevation, then a larger than bankfull flood has occurred during the recent rainy season.This procedure is explained in more detail and a copy of the regional curves is provided in the ADEQ Standard Operating Procedures for Surface Water Quality Sampling (Jones, 2012).
3. Flood magnitudes and recurrence intervals are calculated by the USGS at gage stations across Arizona. The 10 year flood return interval can be estimated from the nearest USGS gage station flow data. The return interval can be determined through 3 different methods: 1) Read from a table of the "Magnitude and probability of instantaneous peak flow" tables found in the USGS document "Statistical summaries of streamflow data and characteristics of drainage basins for selected streamflow-gaging stations in Arizona through Water year 1996" (USGS, 1998), 2) Calculate the flood magnitude for a 10-year frequency using

formulas in “Methods for estimating magnitude and frequency of floods in the Southwestern United States (USGS water supply paper 2433), or 3) Obtain the flood frequency and magnitude data from the USGS StreamStats website when it becomes available (AZ is under development now).

4. If the streamflow at a study site is potentially intermittent, flow conditions should be monitored during the summer season and ideally through the three seasons prior to spring sampling to determine if the “perennial” condition is met.

Appendix B: Procedures for Biological Sampling of Streams and Rivers:

Use the most current version of the *"Standard Operating Procedures for Surface Water Quality Sampling"* located at http://www.azdeq.gov/environ/water/assessment/download/sampling.pdf