March 9, 2012

Arkansas TAG Members' Minority Report to OWRB

Executive Summary

As required in the 2003 Statement of Joint Principles and Actions, in concert with an EPA grant, as well as Oklahoma's review of the Oklahoma Water Quality Standards ("OWQS"), staff of the Oklahoma Water Resources Board ("OWRB") convened an interstate/tribal/EPA technical advisory group ("TAG"). The TAG's objective was to re-evaluate, by 2012, the 0.037 mg/L total phosphorus ("TP") criterion assigned to Oklahoma's six Scenic Rivers. This review process involved state agency staff from Oklahoma and Arkansas representing WQS staff, point and non-point source control staff, US EPA Region 6 staff, and the Cherokee Nation. During 2011, over 200 technical publications were reviewed. Although the reports reviewed provide useful information, they do not substantiate that 0.037 mg/L TP is the necessary or appropriate criterion to protect Oklahoma's Scenic Rivers. Based on a review of these studies, the Arkansas Department of Environmental Quality and the Arkansas Natural Resources Commission (hereinafter referred to as the "Arkansas TAG members") believe there is a significant lack of data specific to the Oklahoma Scenic Rivers and the Oklahoma portion of the Illinois River, in particular. Accordingly, the Arkansas TAG members developed the following four recommendations that we believe should be completed prior to making a final decision on the implementation of 0.037 mg/L or any other numeric standard as Oklahoma's TP criterion.

Arkansas TAG Members' Recommendations

1. Implementation of the 0.037 mg/L total phosphorus standard should be extended for a minimum of 10 years to enable completion of the following specific tasks:

    a. Completion of stressor-response studies on the Illinois River to provide a scientific basis to determine the appropriate numeric standard for the river. The study should use U.S. EPA recommended stressor-response methods including but not limited to Rapid Bioassessment Protocols for the purpose of evaluating the relationship between phosphorus concentrations and biotic indicators of water quality, including but not limited to periphyton biomass and fish and invertebrate indices of biotic integrity. (Allow 5 years).

    b. Completion of EPA's Illinois River Watershed Model, which is currently in progress. (Allow 2 years).

    c. Completion of additional monitoring and time to allow the effects of "legacy phosphorus" to work through the system before additional significant capital investments are made to further reduce phosphorus. (Allow 10 years).

    d. Although Oklahoma's assessment methodology allows a 25% exceedance frequency over a rolling 90-day period, an exceedance frequency is not explicitly included in the TP criterion, creating an inconsistency between the criterion and the assessment methodology. Review of data on reference streams (i.e., streams with little or no human disturbance) in Arkansas and Oklahoma shows

that even reference streams periodically exceed 0.037 mg/L TP; therefore, an appropriate allowable exceedance frequency should be included in the TP criterion. With regard to the averaging period, review of reference stream data shows seasonal and/or flow-related variations are present in reference stream and Scenic River data sets; therefore, an annual averaging period is more appropriate than a monthly geometric mean. An overall re-evaluation of frequency-duration aspects of the TP criterion should be completed in conjunction with a re-evaluation of the magnitude component as described in a).

2. Arkansas and Oklahoma should continue requiring implementation of Nutrient Management Plans, which include the utilization of a Phosphorus Index, for the land application of litter in the Shared Scenic River watersheds.

3. The controls specified for point source dischargers, for both larger and smaller entities, set out in the 2003 Statement of Joint Principles and Actions should be extended through June 30, 2022. Once there is resolution regarding the relevant Oklahoma phosphorus criterion and wasteload allocations have been properly developed, then NPDES permits for the point source dischargers should be adjusted as appropriate when the various permits expire and are considered for renewal.

4. Both states should continue to encourage implementation of voluntary programs to reduce in-stream concentrations of total phosphorus in the Shared Scenic Rivers.

Arkansas TAG Members' Minority Report to OWRB

The following report is prepared by the Arkansas TAG members as a Minority Report in response to OWRB staff's report to OWRB. The Arkansas TAG members appreciate the opportunity to participate in the process to develop a recommendation to the OWRB on Oklahoma's total phosphorus criterion. However, because the Arkansas TAG members cannot agree with the OWRB staff's report recommendations to maintain the total phosphorus standard for Oklahoma's Scenic Rivers as adopted without modification, we have prepared this Minority Report to OWRB.

This report is divided into five sections. Section I provides an overview of the development of Oklahoma's 0.037 mg/L TP criterion and the background for this report. Section II considers information related to the TP criterion's magnitude (0.037 mg/L). Section III discusses the duration (30-day geometric mean) and frequency (at all times) components of the TP criterion. Section IV clarifies that the Scenic Rivers criterion is not intended to address water quality issues in Lake Tenkiller. Section V, the final section, provides the Arkansas TAG members' recommendations to the OWRB.

I. BACKGROUND

The Oklahoma Legislature passed the "Scenic Rivers Act" (82 O.S. 1451-1471) in 1970. The Act identified four streams to be designated as "Scenic River Areas": Flint Creek, Illinois River, Barren Fork Creek, and Upper Mountain Fork River. In 1975, the Oklahoma Legislature added Lee Creek and Little Lee Creek to the list of Oklahoma Scenic Rivers. In 2002, the Oklahoma Water Resources Board promulgated a numeric criterion for total phosphorus in the Oklahoma Scenic Rivers. The specific rule, highlighting the criterion's three components (magnitude, duration and frequency), states:

> *785:45-5-19(c)(2) Nutrients; numerical criterion applicable to waters designated Scenic Rivers.* ***The thirty (30) day geometric mean*** *total phosphorus concentration in waters designated "Scenic River" in Appendix A of this Chapter* ***shall not exceed 0.037 mg/L****. The criterion stated in this subparagraph applies in addition to, and shall be construed so as to be consistent with, any other provision of this Chapter which may be applicable to such waters. Such criterion became effective July 1, 2002 and shall be implemented as authorized by state law through Water Quality Standards Implementation Plans and other rules, permits, settlement agreements, consent orders, compliance orders, compliance schedules or voluntary measures designed to achieve full compliance with the criterion in the stream by June 30, 2012.*

The adoption of the numeric 0.037 mg/L TP criterion was the subject of significant disagreement and controversy. The point and nonpoint source dischargers in northwest Arkansas steadfastly maintain that the 0.037 mg/L criterion for TP is neither attainable nor appropriate, and were based upon faulty science. In 2003, EPA negotiated an agreement

entitled, “Statement of Joint Principles and Actions.” This agreement was signed by Oklahoma and Arkansas agencies. Among other things, the Statement of Joint Principles and Actions provides that, “Oklahoma will re-evaluate Oklahoma’s 0.037 mg/L criterion for total phosphorus in Oklahoma’s Scenic Rivers by 2012, based on the best scientific information available at that time, and with the full, timely inclusion of officials from the State of Arkansas representing both point and nonpoint source dischargers.”

Objectives

The objective of this project was to re-evaluate the Oklahoma Scenic Rivers phosphorus criterion as contemplated by the Statement of Joint Principles and Actions. Because the current criterion has three components, including magnitude (0.037 mg/L), duration (30-day geometric mean), and frequency (shall not exceed), all three of these components were considered part of the criterion re-evaluation.

Process and Method of the Re-evaluation

OWRB staff assembled a Technical Advisory Group (TAG) that included staff designated by officials from EPA, Cherokee Nation and the States of Oklahoma and Arkansas representing both point and nonpoint source dischargers. The TAG consisted of eight members, two of whom represented Arkansas.

The TAG members included:

- Derek Smithee, Chief of the Water Quality Programs Division of the Oklahoma Water Resources Board (Facilitator),
- Shanon Phillips, Director of the Water Quality Division of the Oklahoma Conservation Commission,
- Shellie Chard-McClary, Director of the Water Quality Division of the Oklahoma Department of Environmental Quality,
- Quang Pham of the Oklahoma Department of Agriculture Food and Forestry,
- Cara Cowan-Watts of the Cherokee Nation,
- Melinda McCoy with Region 6 of the U.S. Environmental Protection Agency,
- Ed Swaim, Chief of the Water Resources of the Arkansas Natural Resources Commission, and
- Steve Drown, Chief of the Water Division of the Arkansas Department of Environmental Quality (ADEQ).

A Secondary Data Quality Assurance Project Plan (QAPP) was prepared by OWRB, reviewed by the TAG, and approved by EPA. The process employed in the QAPP consisted solely of a literature review.

To facilitate the literature review, the “best scientific information available” was solicited from the public by way of public announcements utilizing e-mail lists and newspaper publications throughout the Oklahoma Scenic River’s watersheds. A public meeting was held to allow the

general public an opportunity to submit additional scientific information. Those providing comment and technical information included cities and businesses in northwest Arkansas, professors from the University of Arkansas who have conducted studies in the Arkansas portion of the Illinois River watershed, and others. Staff of the OWRB compiled summaries of some of the information reviewed and drafted recommendations for the TAG to advise the OWRB on the total phosphorus criterion. The Arkansas TAG members do not concur with OWRB staff's summaries or the recommendations to maintain the total phosphorus standard as adopted without modification. The Arkansas TAG members strongly support OWRB staff's recommendation that a "holistic study documenting chemical, physical and biological integrity should occur to guide future water quality management of " Oklahoma's Scenic Rivers, but we believe that this study is needed **prior** to the implementation of a total phosphorus standard. Based on the information from the scientific literature review and the marked absence of critical data from the Scenic Rivers in Oklahoma, the Arkansas TAG members developed separate recommendations on the total phosphorus criterion in this Minority Report. The Arkansas TAG members ask the OWRB to consider this Minority Report a stand-alone document separate from the OWRB staff's report.

The reasons the Arkansas TAG members cannot agree with the recommendations to retain Oklahoma's total phosphorus standard as adopted without modification are detailed in the following sections.

II. MAGNITUDE

Factors related to the evaluation of the appropriate magnitude of the 0.037 mg/L TP criterion include: the need for ecological endpoints associated with this numeric value, limitations of the reference stream approach Oklahoma used for its nutrient criterion development, the need for a "stressor-response" approach to support appropriate nutrient criteria, selected findings from studies provided in response to the OWRB "call for data," and other relevant information. These factors are discussed further in this section.

Need for Ecological Endpoints

Unlike water quality standards that are developed to control toxic levels of pollutants, the purpose of the 0.037 mg/L TP standard is to achieve an ecological endpoint. The concentration of phosphorus itself is not the "endpoint." Phosphorus concentrations in combination with a variety of site-specific factors determine the stream response. In the case of Oklahoma's criterion, such endpoints are not clearly defined. Instead, undefined qualitative endpoints are driving an extremely stringent, quantitative standard with an associated implementation cost of hundreds of millions of dollars, with no assurance that the standard is appropriate or can be attainable despite such expenditures.

Specifically, the OWRB staff report provides these qualitative statements regarding ecological endpoints:

> In 2001, it was recognized that both empirical and anecdotal evidence over the preceding two decades indicated that, Illinois River status as a "Scenic River"…was seriously threatened by excess nutrients. These nutrients – primarily phosphorus – were seen to be causing accelerated primary productivity in the Illinois River and Lake Tenkiller, resulting in significant growths of both attached algae (periphyton) and suspended algae (phytoplankton). As a consequence, historical river clarity and substrate quality were being adversely affected to such an extent that, without intervention, the Illinois River's exceptional ecological and recreational significance were in jeopardy.
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> While water quality management programs were already in place to protect designated beneficial uses, this numerical value should assure that water quality greater than that necessary to support beneficial uses is achieved. Based upon input received through personal communications and at informal water quality standards meetings in late 2001, the general consensus was that Oklahoma's six Scenic Rivers should be "better than average.

While the Arkansas TAG members agree that excess nutrient loading can contribute to algae growth, the statements above do not provide an adequate scientific basis (quantitative endpoint) to justify a 0.037 mg/L TP standard. In particular, the "general consensus" that the scenic rivers should be "better than average" is not an adequate basis for establishing an extremely stringent standard that mandates hundreds of millions of dollars of expenditures. Given these "soft" endpoints, the relevant ecological endpoints to be protected by the TP standard must be clearly defined. Then scientific information and monitoring data should be evaluated to determine whether a 0.037 mg/L TP standard is necessary to achieve these endpoints. The importance of evaluating such stressor-response relationships is clearly documented by EPA and the Scientific Advisory Board (SAB), but such evaluations have not been conducted in Oklahoma for the Scenic Rivers.

Furthermore, although EPA has stated that the 0.037 mg/L TP standard "is sufficient" to protect beneficial uses, the Arkansas TAG members do not agree that adequate data have been provided to prove that this low standard is <u>necessary</u> to protect beneficial uses. This is highly relevant to the Oklahoma Standards Review QAPP Data Objective 1 (p. 16) for the standard reevaluation process, which addresses these three perspectives:

- "The Oklahoma Scenic Rivers criterion must preserve unique natural scenic beauty, water conservation, fish, wildlife and outdoor recreational values of these streams,
- The criterion must be protective of the downstream uses of Lake Tenkiller,
- The criterion must be no lower than necessary to accomplish 1) and 2) to reduce costs to point and non-point discharges in the watershed."

In summary, based on the information reviewed to date, cause-and-effect relationships have not been demonstrated for the Oklahoma Scenic Rivers; therefore, an adequate basis for the

0.037 mg/L has not been established in a manner that demonstrates that the standard is no lower than necessary to accomplish its objectives.

Closely related to whether the TP standard is "no lower than necessary" to attain ecological endpoint, is how the ecological condition of the stream has responded to the 40% phosphorus load reduction over the past ten years that has been documented by University of Arkansas professors. Specifically, have "significant growths of attached and suspended algae" been reduced? Matlock and others provided this information in response to the OWRB call for data, summarizing their findings as follows:

> Much of the data collected and analyzed in the basin over the past 20 years was summarized in Haggard et al. (2010). This report summarized the data and results of over 30 contemporary assessments of water quality and ecosystem condition in the Upper Illinois River Basin (i.e., that portion of the Basin in Arkansas); [the Matlock et al. OWRB submission] provides a comprehensive listing of the papers relevant to the Illinois River including 2010 and prior years. Haggard (2010) showed that total phosphorus loads in the Upper Illinois River began to decrease in 2002. Phosphorus concentrations in the Upper Illinois River have been declining for almost a decade. Scott et al. (2011) showed similar decreases in phosphorus concentrations of the Lower Illinois River, especially at the Illinois River near Watts, Oklahoma. No assessments have been conducted on the Lower Illinois River (i.e., that portion of the River in Oklahoma) by OWRB to evaluate if the "exceptional ecological and recreational significance" have improved or changed as a result of a decade of decreasing phosphorus. Without these data there is no credible way to correlate phosphorus loads to the water quality objectives described by the OWRB standard.
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> Matlock et al. (2009) demonstrated that the aquatic ecosystem condition (fish, benthic macro-invertebrate and algae) were less impacted by phosphorus than by other land-use impacts such as hydrologic regime alteration, bank erosion, and riparian cover loss (Matlock et al., 2009). Ecological metrics suggested that in-stream characteristics might have improved in these streams over the past 10 years. The data are not adequately resolved to identify proximal causes of impact or improvement, but the role of phosphorus was not the sole driver in ecosystem structure.

Because the ecological endpoints have not been adequately defined (nor their response to reduced phosphorus concentrations), the Arkansas TAG members recommend a monitoring program to provide the underlying scientific basis for this endpoint and its relationship to total phosphorus <u>prior</u> to implementing a TP standard. As stated by Matlock, Haggard and Sharpley in their July 25, 2011 comment letter to the OWRB:

> The current approach to monitoring water quality in the Illinois River will not measure success at meeting the criteria described by OWRB. The most appropriate

method to measure the "exceptional ecological and recreational significance" of the Illinois River is to assess key ecological characteristics that define "exceptional ecological…significance" and identify water quality characteristics that define "exceptional…recreational significance." These are not difficult to monitor; they are the same characteristics monitored by Matlock et al. (2009) in Spring and Osage Creeks in the Upper Illinois River in 2007-2009. A basin-level assessment strategy should include water quality, ecosystem characteristics, river reach characteristics, and watershed land use characteristics. A five-year assessment, in conjunction with current comprehensive phosphorus emission reduction strategies, would provide the resolution of data to characterize and prioritize causal agents for remaining ecological and recreational impacts from water quality.

Reference Stream Approach

The reference stream approach as used to establish Oklahoma's 0.037 mg/L TP criterion is not appropriate for establishing phosphorus stream standards in the Illinois River, a large watershed with a long-term human use and presence. (The term "reference stream" is used to describe waterbodies that have little or no disturbance from human development.) Representative problems with the reference stream approach used to establish an in-stream phosphorus standard for the Illinois River (in effect at the Arkansas/Oklahoma state line) include:

1. Reference stream conditions summarized in Clark et al. (2000) are clearly identified as being associated with undeveloped watersheds. These are not the conditions present in the Illinois River watershed. It is unrealistic to expect that a stream in a watershed with more than 150-year history of human use, a population of over 300,000 people, and an active agricultural economy will have the same water quality as an undeveloped watershed. Furthermore, if it were somehow feasible to "turn back the clock" to an earlier condition, it is not clear what that condition would be. For example, if the transbasin water in the upper basin were no longer discharged to the watershed, this action would not simply reduce phosphorus loading, it also would reduce the base flows that recreational users have come to expect for canoeing, fishing, etc. While one could potentially envision using the reference stream approach in headwaters streams in undisturbed wilderness areas, it is inappropriate to expect that a watershed with long-term human presence would be able to return to a reference condition.

2. The reference streams near the Illinois River in the Clark et al. (2000) report have significantly different characteristics than the Illinois River. Examples of some of these differences include:

    - North Sylamore Creek and the Cossatot River in Arkansas and the Kiamichi River in Oklahoma have tributary drainage areas of 40-90 square miles, whereas the Illinois River at Watts has a drainage area of over 635 square miles, and approximately 1,600 square miles overall. Although the Buffalo River drainage area in Arkansas is more comparable in size to the Illinois River at Watts, it has

been a protected national river since 1972 and includes a wide publically owned buffer for the length of the river.

- The populations above the North Sylamore, Buffalo River and Cossatot monitoring locations are roughly estimated to be less than 2,000 people in contrast to the approximately 300,000 people in the Illinois River watershed.

- Aerial photos of the watersheds obtained from the USGS gauges at these references streams (provided in Wright Water Engineers submittal to OWRB) show clear differences in land use, with dominant land uses in the reference streams being national forest or state parks, whereas Massey and Haggard (2010) state that the Illinois River includes approximately 13 percent urban area and 46 percent pasture/hayland.

- Other major differences include either no municipal discharges or small (0.1 MGD) municipal discharges in these reference watersheds, as compared to six municipal WWTPs with a combined permitted discharge of 40 MGD in the Illinois River.

- The Illinois River is a sixth-order stream, which will have substantially different physical, chemical and biological characteristics than lower order streams.

All of these factors, as well as others not summarized here, demonstrate that assigning a stream standard based on phosphorus concentrations under substantially different watershed and stream conditions is problematic from both scientific and practical perspectives related to attainability. While other scenic rivers in Oklahoma may have characteristics similar to some of these reference streams used in the Clark et al. (2000) report, an alternative procedure is needed to assign an appropriate standard for the Illinois River that takes into account watershed and stream characteristics.

3. For any given water body (river, lake, stream, wetland, etc.), receiving water impacts are highly site specific (Urbonas 2001, EPA 1999). The following text, excerpted from *Protocol for Developing Nutrient TMDLs* (EPA 1999), provides a sense of the complexity of phosphorus dynamics and associated responses in receiving waters:

> Many natural factors, including light availability, temperature, flow levels, substrate, grazing, bedrock type and elevation, control the levels of macrophytes, periphyton, and phytoplankton in waters. Effective management of eutrophication in a waterbody may require a simultaneous evaluation of several limiting factors.
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> Light availability**.** Shading of the water column inhibits plant growth. Numerous factors can shade waterbodies, including: (1) as plant production increases in the upper water layer, the organisms block the light and prevent it from traveling deeper into the water column; (2)

riparian growth along waterbodies provides shade; and (3) particulates in the water column scatter light, decreasing the amount penetrating the water column and available photosynthesis.

Temperature. Temperature affects the rates of photosynthesis and algal growth, and composition of algae species. . . Algal community species composition in a waterbody often changes with temperature. For example, diatoms most often are the dominant algal species at water temperatures of 20° to 25°C, green algae at 30° to 35° C, and blue-green algae (cyanobacteria) above 35° C (Dunne and Leopold, 1978; EPA, 1986b).

Water Velocity. Water movement in large lakes, rivers, and streams influences plant production. Stream velocity has a two-fold effect on periphyton productivity; increasing velocity to a certain level enhances biomass accrual but further increases can result in substantial scouring (Horner et al., 1990). . . In rivers and streams, frequent disturbance from floods (monthly or more frequently) and associated movement of bed materials can scour algae from the surface rapidly and often enough to prevent attainment of high biomass (Horner et al., 1990). Rapid flows can sweep planktonic algae from a river reach, while low flows may provide an opportunity for proliferation.

Substrate. Macrophytes and periphyton are influenced by the type of substrate available. Macrophytes prefer areas of fine sediment in which to root (Wright and McDonnell, 1986, in Quinn, 1991). Thus, the addition and removal of sediment from a system can influence macrophyte growth. Periphyton, because of its need to attach to objects, grows best on large, rough substrates. A covering of sediment over a rocky substrate decreases periphyton biomass (Welch et al., 1992).

Grazing. Dense populations of algae-consuming grazers can lead to negligible algal biomass, in spite of high levels of nutrients (Steinman, 1996). . . Consideration of grazer populations might explain why some streams with high nutrients have low algal biomass.

Bedrock. The natural effects of bedrock type also might help explain trophic state. Streams draining watersheds with phosphorus-rich rocks (such as rocks of sedimentary or volcanic origin) can be enriched naturally and, therefore, control of algal biomass by nutrient reduction in such systems might be difficult. Review of geologic maps and consultation with a local soil scientist might reveal such problems. Bedrock composition has been related to algal biomass in some systems (Biggs, 1995).

The Relationship Between Water Quality and Flow in Streams and Rivers**.** The relationship between water quality and flow in streams and rivers deserves special mention because some impairments are aggravated (or caused primarily) by flow modifications that result from in-stream diversions or catchments. For nutrient TMDLs, stream flow directly influences many physical features (e.g., depth, velocity, turbulence, reaeration, and volatilization), while also indirectly influencing nutrient uptake by attached algae. The velocity and depth associated with specific flow regime also define the residence time in a reach, which directly influences reach temperature and the spatial expression of decay rates. During TMDL development, it is important to identify the flow regimes necessary to satisfy designated uses and to identify situations where flow modifications might make use attainment difficult or impossible. Because of the difficulties associated with addressing these types of impairments, more time might be required to identify and implement acceptable solutions. In some instances, states or territories might choose to undertake a Use Attainability Analysis (UAA) to address the factors affecting the designated use.

4. Trends and thresholds for cause and effect relationships must be determined for the individual water body in question. Some water bodies provide a wide range of beneficial uses and are judged by the public to be of excellent quality, even though total phosphorus concentrations exceed "reference conditions." The appropriate total phosphorus standard for any given water body must be tailored to that water body's hydrology, hydraulics, sediment transport regime, morphology, aquatic life, etc. These concepts were clearly articulated in the April 2010 Scientific Advisory Board (SAB) Ecological Processes and Effects Committee review of EPA's Empirical Approaches for Nutrient Criteria Derivation. The following excerpts from the SAB review are representative of these points (with emphasis added):

   - "For criteria that meet EPA's stated goal of 'protecting against environmental degradation by nutrients,' the underlying causal models must be correct. Habitat condition is a crucial consideration in this regard (e.g., light [for example, canopy cover], hydrology, grazer abundance, velocity, sediment type) that is not adequately addressed in the Guidance. Thus, a major uncertainty inherent in the Guidance is accounting for factors that influence biological responses to nutrient inputs. Addressing this uncertainty requires adequately accounting for these factors in different types of water bodies. Numeric nutrient criteria developed and implemented without consideration of site specific conditions can lead to management actions that may have negative social and economic and unintended environmental consequences without additional environmental protection."

   - "[T]he final document should clearly state that statistical associations may not be biologically relevant and do not prove cause and effect. Without a mechanistic

understanding and a clear causative link between nutrient levels and impairment, there is no assurance that managing for particular nutrient levels will lead to the desired outcome. The Guidance needs to clearly indicate that the empirical stressor-response approach does not result in cause-effect relationships; it only indicates correlations that need to be explored further."

- "The Committee emphasizes the importance of choosing the biological endpoints (i.e., response variables) that respond specifically to nutrients. We note that responses of benthic indices can be related to many types of stress."

- "The examples provided in the Guidance generally do not demonstrate a strong nutrient stressor linkage to beneficial use impairment. The stream examples show very weak correlations that have high levels of uncertainty, and lump data from distinctly different ecosystems where multiple factors in addition to nutrients will contribute to biotic responses. Furthermore, the SAB recommends … "a weight of evidence approach that is used to establish the likelihood of causal relationships between nutrients and their effects for criteria derivation."

Other EPA guidance such as *Nutrient Criteria Technical Guidance Manual: Rivers and Streams* (EPA 2000) provides similar statements, such as: "Streams with similar morphologies may have similar nutrient capacities or responses to nutrient loadings. Rivers and streams are very diverse within ecoregions. The geomorphology of a river or stream – its shape, depth, channel materials – affects the way the waterbody receives, processes and distributes nutrients."

More recently, comparable concerns have been articulated in a June 2011 congressional hearing, as summarized by Bob Gibbs, Subcommittee Chairman of the Water Resources and Environment Subcommittee of the U.S. House of Representatives Committee on Transportation and Infrastructure, 2011.

Stressor-Response Approach

The reference stream approach Oklahoma used to justify the 0.037 mg/L TP standard is an inadequate basis for a nutrient standard development for a watershed such as the Illinois River. Professors Matlock, Haggard and Sharpley clearly expressed support for the stressor-response approach in their comment letter dated July 25, 2011 to OWRB. The Arkansas TAG members strongly agree with their comments, which state:

> The US EPA recommends three scientifically defensible approaches for nutrient criteria development: 1) reference condition approaches, 2) mechanistic modeling, and 3) stressor-response analysis. The initial water quality standard for phosphorus was established using the first approach based largely on the work of Clark et al. (2000). Nutrient concentrations from "relatively un-impacted basins" were analyzed, and the third quartile distribution (75% exceedance level) was selected as the numeric criteria for the Illinois River Basin (0.0375 mg/l total phosphorus). The first procedure (using reference conditions) does not consider

current catchment land use and land cover of streams when developing nutrient criteria. It is our assessment that the third method, the stressor-response analysis, is most appropriate for assessing impacts on complex stream systems with multiple stressors and changing conditions. The stressor-response criteria method published by EPA (USEPA, 2010a) is applied in the site-specific alternative criteria method adopted by USEPA Region 4 for Florida (FDEP, 2011). It is our belief that this method represents the most robust method for development of nutrient criteria of which the goal is to protect the designated uses of Oklahoma Scenic Rivers. This approach is consistent with the goals and intentions of the Task Force. This approach allows stakeholders to develop site-specific alternative criteria (SSAC) for waterbodies. These SSACs replace numeric nutrient criteria where data suggests designated uses are more protected by alternative metrics, are technically sound, and detailed compliance criteria are presented.

This recommendation is consistent with recent independent Scientific Advisory Board Panel's (SAB) "Review of Empirical Approaches for Nutrient Criteria Derivation" (USEPA, 2010b), which stated that "the stressor-response approach is a legitimate, scientifically based method for developing numeric nutrient criteria if the approach is appropriately applied (i.e., not used in isolation but as part of a weight-of-evidence approach)." Further, the Panel suggested that the stressor-response approach be used with other available methodologies in the context of a tiered approach where uncertainties in different approaches are recognized, and weight of evidence is used to establish the likelihood of causal relationships between nutrients and their effects for criteria derivation (USEPA, 2010b). A more recent SAB report reviewing "EPA's draft Approaches for Deriving Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and Southern Inland Flowing Waters" came to the same weight-of-evidence approach to developing numeric nutrient criteria (USEPA, 2011).

Based on the literature cited in Appendix B of the OWRB staff report, it appears that the most current guidance from EPA and the SAB, as well as experience gained in other states regarding establishing nutrient criteria, have been disregarded in the 0.037 mg/L TP standard re-evaluation. The Arkansas TAG members believe this guidance and experience is "new information" that warrants serious reconsideration of Oklahoma's TP standard.

Studies Summary

The following 10 reports were selected and prioritized by OWRB staff and members of the TAG as part of the re-evaluation of the Oklahoma Scenic Rivers Phosphorus Criterion. These reports reflect that there is a significant lack of data specific to the Oklahoma Scenic Rivers and the Oklahoma portion of the Illinois River, which reinforces the Arkansas TAG members' recommendation that additional study of the Illinois River is warranted prior to implementing a TP standard. (Total phosphorus concentration units in the following summaries are written as

reported in the original research articles.) The Arkansas TAG members' comment on the ten references cited in the OWRB staff report follow each OWRB summary.

1) Haggard, B., J. Masoner and C. Becker. 2003. Percentile Distributions of Median Nitrite Plus Nitrate as Nitrogen, Total Nitrogen, and Total Phosphorus Concentrations in Oklahoma Streams, 1973–2001. USGS Water-Resources Investigations Report 03-4084.

> **OWRB Summary:** Percentile distributions of median nitrite plus nitrate as nitrogen, total nitrogen, and total phosphorous concentrations were calculated from 563 sites in Oklahoma and 4 sites in Arkansas near the Oklahoma and Arkansas border to facilitate development of nutrient criteria for Oklahoma streams. The 50th percentiles of median nitrite plus nitrate as nitrogen, total nitrogen, and total phosphorus concentrations were greater in the Ozark Highland ecoregion and were less in the Ouachita Mountains ecoregion when compared to other geographic areas used to group sites. Nitrate as nitrogen and total phosphorus concentrations currently (2002) used in the Use Support Assessment Protocols for Oklahoma were greater than the 75th percentiles of median nitrite plus nitrate as nitrogen and total phosphorus concentrations calculated for this report.

Arkansas TAG Members Comment: This report presents information regarding in-stream nutrient concentrations in Oklahoma streams between 1973 and 2001. While the report presents information regarding variability in phosphorus concentrations depending on stream order and geographic location, no examination of potential impairment thresholds is included. Thus, the 0.037 mg/L total phosphorus criterion is not supported in this reference. (Additionally, more relevant and current findings were published by Haggard and others in 2010 and 2011 and are available on the OWRB website.)

2) Haggard, B. 2005. Proceedings Report – 3rd Annual Total Maximum Daily Load Conference. Effect of Reduced Effluent Phosphorus Concentrations at the Illinois River, Northwest Arkansas, 1997-2004.

> **OWRB Summary:** Spatial distribution of dissolved P concentrations was evaluated using multiple water quality monitoring sites from the Illinois River, South of Siloam Springs upstream to the effluent discharges in Mud/Clear Creeks, Osage Creek and Spring Creeks. Dissolved P concentrations as great as 10 mg SRP L^{-1} were observed on one sampling in March 2002 at Spring Creek, and dissolved P concentrations throughout the IRDA were generally several orders of magnitude greater than concentrations which typically limit Periphyton growth in streams or that are observed in relatively undeveloped basins. Dissolved P concentrations at the Illinois River, South of Siloam Springs, Arkansas, were less than the Oklahoma Scenic Rivers TP criterion on one sampling date in Feb 2004, and dissolved P concentrations were close to the criterion in April 2004. The results observed in Summer 2003 and 2004 show some mechanism of internal P loading exists in streams draining the IRDA because ambient P concentrations often increase downstream through selected stream reaches. Dissolved P

concentrations at the Illinois River, South of Siloam Springs, Arkansas, were generally around 0.10 SRP L^{-1} and still almost three times greater than the Oklahoma Scenic Rivers TP Criterion.

Arkansas TAG Members' Comment: This publication presents a study of soluble reactive phosphorus concentrations in the Illinois River during 2002, 2003 and 2004. The report identifies that several wastewater treatment plants were upgraded to reduce effluent phosphorus concentrations. These upgrades are reported to have resulted in lower in-stream phosphorus concentrations. It was also observed that an internal phosphorus source, possibly sediment, was contributing to the Illinois River drainage area's phosphorus load. Haggard recommends long-term monitoring to track the recovery of the aquatic system from high effluent phosphorus inputs. The 0.037 mg/L TP criterion is not supported in this paper.

3) Stevenson, et al. 2006. Comparing Effects of Nutrients on Algal Biomass in Streams in Two Regions with Different Disturbance Regimes and with Applications for Developing Nutrient Criteria. Hydrobiologia 561: pp. 149-165.

OWRB Summary: Responses of stream algal biomass to nutrient enrichment were studied in two regions where differences in hydrologic variability cause great differences in herbivory (Kentucky and Michigan). Many measures of algal biomass and nutrient availability were positively correlated in both regions, however the amount of variation explained varied with measures of biomass and nutrient concentration and with region. Most observed responses in benthic algal biomass occurred in nutrient concentrations between **10 and 30 µg TP /L** and between 400 and 1000 µg TN /L.

Arkansas TAG Members' Comment: This publication presents results gathered from an investigation of nutrients and algal biomass in Kentucky and Michigan streams. While the study included 1st to 4th order streams, the majority of streams were 2nd and 3rd order and have limited comparative value to the Illinois River, which at the Oklahoma-Arkansas border is a 6th order stream. Further, the authors state, "We did not find thresholds in algal biomass-nutrient relations…" Based on the stated geographic, ecologic and statistical constraints, this publication provides little, if any, support for the 0.037 mg/L TP criterion.

4) Stevenson, et al. 2008. Algae–P Relationships, Thresholds, and Frequency Distributions Guide Nutrient Criterion Development. J. N. Am. Benthol. Soc., 27(3): pp. 783-799.

OWRB Summary: Thresholds in these responses occurred between 10 and 20 µg/L and helped justify recommending a P criterion between 10 and 12 µg TP/L to protect high quality biological conditions in streams of the Mid-Atlantic Highlands. Increases in TP from 10 to 30 µg/L were associated with responses of benthic diatom assemblages that indicated release from nutrient limitation. Extensive, long-lasting nuisance growths of the filamentous green alga, Cladophora that are unaesthetic and a problem for fishing and recreational use can be prevented by maintaining an average of 30 µg TP/L (Dodds et al. 1997, Stevenson et al. 2006). On the other hand, higher stressor criteria, such as

between 30 and 60 µg TP/L, could be interpreted as protective of ‘‘fish, shellfish, and wildlife’’ that would correspond to the lower, interim goal of the US Clean Water Act.

Arkansas TAG Members' Comment: This publication presents results of an investigation of algae and phosphorus relationships in Mid-Atlantic Highlands streams and provides recommendations for nutrient criteria for wadeable streams in the region. This investigation focused on 1st to 3rd order streams for four out of six years of field sampling, possibly weighting results toward smaller streams. Based on this report's focus on a distant geographic region and smaller streams, it has limited, if any, applicability to the Illinois River. Further, the authors of this report state "multiple analytical approaches can and should be used when developing nutrient criteria to provide the diversity of information that justify criteria to stakeholders…" This is not the process that was applied to develop the 0.037 mg/L TP criterion. In summary, the 0.037 mg/L TP criterion is not supported by this publication.

5) Justus, B.G., et al. 2009. A Comparison of Algal, Macroinvertebrate, and Fish Assemblage Indices for Assessing Low-level Nutrient Enrichment in Wadeable Ozark Streams. Ecol. Indicat.

OWRB Summary: Biotic metric scores were inversely related to nutrients and were generally highest when TN and TP concentrations were less than about 0.40 mg/L and about 0.018 mg/L (respectively), but were generally lowest when concentrations were higher. These TN and TP concentrations are comparable to background concentrations from sites across the United States (Clark et al., 2000; Smith et al., 2003; Herlihy and Sifneos, 2008). Other studies have indicated that substantial changes in macroinvertebrate assemblage structure (Smith et al., 2007) and algal biomass (Stevenson et al., 2006) may occur near these concentrations. The algal index had a much stronger relation to low- to moderate-level nutrient enrichment than did the macroinvertebrate or fish index but all three indices were negatively correlated to nutrient enrichment.

Arkansas TAG Members' Comment: This publication reports relationships between nutrient enrichment and biotic indices in wadeable streams in the Ozark region. Based on this study's focus on wadeable streams, it is likely that that the study population consists of generally smaller streams than the Illinois River. This paper also refers to other studies which identify background phosphorus and nitrogen levels in streams that were similar to the nutrient breakpoints identified in this study. The referenced studies appear focused on smaller streams that were located in often undeveloped watersheds. The breakpoints identified in this publication represent the concentrations of nutrients that correlated with statistically significant differences in biotic indices. These breakpoints are informative when the selected biotic indices are appropriate for the sampling site and are based on expected ecological conditions. In this case, the biotic indices were presumably appropriate for wadeable streams. Consequently, breakpoints identified for larger streams, such as the Illinois River, would be expected to be different. Based on this information, this report does not provide support for the 0.037 mg/L TP criterion.

6) King, R.S., et al. 2009. Final Report: Linking Observational and Experimental Approaches for the Development of Regional Nutrient Criteria for Wadeable Streams.

> **OWRB Summary:** Shifts from periphyton communities comprised of sensitive diatoms, calcareous cyanobacteria, and other non-chlorophyll bearing microbes to communities with higher chlorophyll content and more filamentous algae was repeatedly demonstrated at concentrations of surface-water TP above 20 µg/L. Aquatic macrophyte cover consistently declined in streams with TP >25-50 µg/L. This study suggests that TP levels >20-30 µg/L, coupled with low flows, will cause detrimental declines in minimum dissolved oxygen levels.

Arkansas TAG Members' Comment: This report presents research conducted on Texas streams with typically lower discharge volumes than the Illinois River. Further, the presented mean annual precipitation rates are approximately two-thirds that of the Illinois River, suggesting a significantly different hydrologic regime between the investigated streams and the Illinois River. While the studied streams may experience undesirable growth when TP concentrations exceed 20-30 ug/L, the ecological differences (flow, temperature, canopy shading, etc.) between these sites and the Illinois River limit the transferability of these thresholds. Based on these factors, the Illinois River would likely have different phosphorus change points for these variables.

7) Haggard, B. 2010. Phosphorus Concentrations, Loads, and Sources within the Illinois River Drainage Area, Northwest Arkansas, 1997–2008. J. Environ. Qual. 39: pp. 2113-2120.

> **OWRB Summary:** This study evaluated (i) annual P loads at the Illinois River at Arkansas Highway 59 from calendar year 1997 through 2008, (ii) the relative contribution of effluent P sources to annual riverine P transport, (iii) longitudinal gradients in water column P concentrations downstream from several wastewater treatment plant effluent discharges, and (iv) changes in monthly P loads over the last decade. The relative contribution of P inputs from municipal facilities has decreased from 40% of the annual P load at the Illinois River at Arkansas Highway 59 to <15% in recent years. Flow adjusted monthly P loads showed two distinct trends over time. Flow-adjusted loads significantly increased from 1997 through 2002 and significantly decreased from 2002 through 2008. The concentrations and transport of P within the Illinois River drainage area are significantly decreasing from all the watershed management changes that have occurred.

Arkansas TAG Members' Comment: This publication presents research focused on phosphorus concentrations and loads in the Illinois River upstream of the Oklahoma state line between 1997 and 2008. The reported research did not investigate the occurrence of biologic or aesthetic impairments resulting from phosphorus. The report identifies that phosphorus concentrations are significantly decreasing. This report does not support the 0.037 mg/L TP criterion.

8) Smith, A.J. and C.P. Tran. 2010. A Weight-of-Evidence Approach to Define Nutrient Criteria Protective of Aquatic Life in Large Rivers. J. N. Am. Benthol. Soc., 29(3): pp. 875-891 (2010).

> **OWRB Summary:** Based on percentile analysis (median value of the 75th percentile of the reference sites and the 25th percentile of the test sites), numeric nutrient criteria would be: 0.023 mg TP/L. Cumulative probability distributions suggested that threshold responses of biological community metrics occurred between 0.009 and 0.07 mg TP/L. For site clusters based on macroinvertebrate data these values were 0.037 mg TP/L. For clusters based on diatom data these were 0.037 mg TP/L. Based on the weight-of-evidence approach and results from all 3 methods, the proposed guidance values for nutrients in large rivers are 0.03 mg TP/L. These values are similar to those derived by others and provide meaningful nutrient endpoints that would be protective of aquatic life in large rivers.

Arkansas TAG Members' Comment: This publication presents a rationale for using a weight-of-evidence[1] approach for developing nutrient criteria based on research on larger rivers in New York. The authors state, "Nutrient gradients must be related to biological outcomes to develop meaningful nutrient criteria within a regulatory framework." The geographic limitations of the identified nutrient criteria are repeatedly cited by Smith and Tran. Given that the OWRB has not applied a weight-of-evidence approach during the development of the 0.037 mg/L TP criterion, this paper suggests that the 0.037 mg/L TP criterion has not been developed appropriately.

9) Miltner, R.J., A Method and Rationale for Deriving Nutrient Criteria for Small Rivers and Streams in Ohio. Environmental Management, January 2010.

> **OWRB Summary:** This study describes relationships among primary nutrients (phosphorus and nitrogen), benthic chlorophyll a concentrations, daily dissolved oxygen (DO) concentrations, and the condition of macroinvertebrate and fish communities in small rivers and streams in Ohio, USA. Clear associations between nutrients, secondary response indicators (i.e., benthic chlorophyll and DO), and biological condition were found, and change points between the various indicators were identified for use in water quality criteria for nutrients in small rivers and streams (<1300 km2). A change point in benthic chlorophyll a density was detected at an inorganic nitrogen concentration of 0.435 mg/l (±0.599 SD), and a total phosphorus **(TP) concentration of 0.038 mg/l** (±0.085 SD). 0.078 mg/l (i.e., the 90th percentile) approximates an upper limit for the change point.

[1] As defined in this article: "The *weight-of-evidence* approach has been recommended by the USEPA to address the complex nature of deriving nutrient criteria. This approach combines the results from several methods to describe the nutrient-biota relationship in the aquatic environment. After determining the level of confidence placed on results from different analyses, professional judgment is used to weight the end points. The resulting criteria tend to balance the significance of the results with the appropriate levels of protection for aquatic life. However, use of professional judgment mandates that the procedures of applying weights to individual results be transparent when defining the final criteria (USEPA 200e, Tetra Tech 2008)."

Arkansas TAG Members' Comment: This publication presents results gathered during a study of small streams and rivers in Ohio. The author identifies a benthic chlorophyll density change point at 0.038 mg/L TP for the sampled streams. The author restricts the applicability of the results based on stream watershed size: "A practical upper limit of 1300 km^2 drainage area is suggested for the applicability of these results, given that most of the data were collected from streams less than that size…." Near the Oklahoma-Arkansas state line (USGS Gage 07195430), the Illinois River receives runoff from approximately 1,489 km^2, which is slightly larger than the recommended upper limit for comparison. However, downstream near the inlet to Lake Tenkiller (at USGS Gage 07196500), the river is receiving flow from an approximate 2,483 km^2 watershed. Thus, this report does not appear to be intended to guide development of nutrient criteria for rivers with watershed sizes like the Illinois River in Oklahoma. Also, the applicability of these results should be questioned based on the expected differences in geology, climate and topography between Ohio and Oklahoma. Based on watershed size and ecologic differences between Ohio and Oklahoma, this publication does not support the 0.037 mg/L TP criterion.

10) Stevenson, R.J., et al., Phosphorus Regulates Stream Injury by Filamentous Green Algae, Thresholds, DO, and pH. (manuscript in press – Hydrobiologia 2011).

> **OWRB Summary:** Nutrient concentrations, benthic algal biomass, dissolved oxygen, and pH were measured in 70 or more streams during spring and summer in the Illinois River Watershed (IRW) to determine injury to streams that was related to spreading poultry waste on fields. Molar N:P ratios were high and indicated that phosphorus was the most likely limiting nutrient. A threshold response in cover of stream bottoms by filamentous green algae (FGA: *Cladophora*, *Rhizoclonium*, and *Oedogonium*) during spring was observed at **27 µg** TP/L, with increases from averages of 4 to 36 percent cover in streams with TP less than and greater than the TP threshold.

Arkansas TAG Members' Comment: This paper presents results of an investigation of Illinois River watershed streams in 2006 and 2007 as part of research funded by the Office of the Attorney General of Oklahoma to support litigation between the *State of Oklahoma vs. Tyson Foods, Inc., et al*. The underlying research for the Stevenson et al. 2011 paper is posted to the OWRB website in the "Oklahoma Attorney General Files" in a report titled "Nutrient Pollution of Streams in the Illinois River Watershed, Oklahoma: Effects on Water Quality, Aesthetics, and Biodiversity Expert Report of Dr. R. Jan Stevenson for State of Oklahoma in Case No. 05-CU-329-GKF-SAJ State of Oklahoma v. Tyson Foods, et al. (In the United States District Court for the Northern District of Oklahoma)."

Arkansas TAG members have significant concerns about using an "in-press" manuscript derived from a litigation-driven study that has not adequately addressed substantive issues raised by other reputable experts. (Additionally, Arkansas TAG members are not aware of confirmation that this paper has undergone a peer-review process and whether this version of the paper has addressed peer review comments.) If the Stevenson research is considered for purposes of the

Scenic Rivers criterion review, then it is critical that substantive concerns raised by other experts be appropriately addressed and resolved.

At first glance, the Stevenson paper appears to be the only referenced material that provides an applicable stressor-response threshold for the Illinois River. However, closer review of the underlying data shows that this paper focuses on small streams that are, in large part, not relevant to the TP criterion as applied to the Illinois River. Specifically, the paper presents data from 70 sites in the "Illinois River Watershed"; however, during litigation, Professor Stevenson states that "no more than five of these sites would be subject to the proposed 0.037 mg/L TP criterion." (Note: these five sites are associated with either the Illinois River or Flint Creek.) The majority of the sampled sites were smaller tributaries and other features which have different ecologic characteristics than the Illinois River and are not designated Scenic Rivers. As a result, this paper does not provide an identifiable relationship between phosphorus and algae (i.e., a stressor-response) that is relevant to the designated Scenic Rivers subject to the 0.037 mg/L TP criterion.

In addition to concerns regarding the litigation oriented nature of the Stevenson report and representativeness of the data set for the Illinois River, Arkansas TAG members believe the numerous substantive technical issues raised by other experts, namely Jim Chadwick of GEI Consultants and Dr. John Connolly of Quantitative Environmental Analysis, Inc. (QEA), must be considered when reviewing Stephenson's paper. Examples of these substantive issues are provided below.

GEI Consultants, Inc., conducted a review of Stevenson's findings and identified many scientific concerns regarding Stevenson's research and conclusions. GEI's findings are summarized in a January 8, 2009 report titled "Expert Report of James Chadwick." Ten examples of GEI's concerns are quoted directly below.

- "Dr. Stevenson's conclusions are based primarily on weak relationships and are not supported by the available data and analyses."

- "A basic discussion of the biological communities at the sampling sites in the Illinois River Watershed (IRW) is not presented. Dr. Stevenson does not acknowledge that a diverse community of fish and benthic invertebrates exist at almost all sites that were evaluated. In fact, populations of fish and algae in the IRW generally do not exhibit signs of nutrient impairment. Generally weak statistical correlations are relied upon to demonstrate his findings that poultry houses have altered the aquatic biological communities in the IRW. However, correlations should only be used to evaluate relationships; they are not intended to, and do not, imply "cause and effect" (Samuels and Witmer 1999)."

- "Dr. Stevenson's data set is incomplete and confusing with apparently multiple versions of the same data used in the analyses in some cases, and some important data seem to be missing entirely."

- "There are multiple errors, inconsistencies, and incorrect statements in Dr. Stevenson's report and the subsequent analyses, adversely affecting his evaluation and final conclusions."

- "Dr. Stevenson cites the Welch et al. (1988) study and two State of Montana public opinion surveys (McKee 2007) that both conclude nuisance benthic chlorophyll a concentrations typically occur above 10 µg/cm^2 to 15 µg/cm^2. The Welch et al. study uses data collected from streams in Washington and Montana, as well as from streams in Sweden. The results of these studies may well characterize regional perceptions in northwestern United States and Sweden. However, it is highly questionable how applicable their conclusions of nuisance algal growth are to streams in south central United States. It becomes very tenuous in defining what constitutes nuisance algal growth in other geographical regions, because there are numerous site-specific circumstances to consider (Biggs 1996). Furthermore, regional relationships between algae and nutrients are rarely precise or accurate enough to predict changes based on controlling a specific nutrient in streams throughout a region (Stevenson et al. 2006). Many regional factors can affect the algal-nutrient relationship, such as disturbance regime, shading, water chemistry, climate, and geology (Biggs and Thomsen 1995, Biggs et al. 1990, Stevenson et al. 2006). Therefore, site-specific analyses should be used to define what constitutes nuisance algal biomass levels in streams of the IRW."

- "Regardless, in summer 2006, benthic algal biomass data from IRW streams revealed that 63 of the 67 sites sampled contained biomass estimates less than 10 µg/cm^2, with zero sites greater than 15 µg/cm^2. In spring 2007, 58 of the 70 sites sampled revealed biomass estimates less than 10 µg/cm^2, with only 6 sites revealing biomass estimates greater than 15 µg/cm^2. The majority of sites sampled during both the summer 2006 (64 percent) and spring 2007 (60 percent) revealed benthic algal biomass levels less than 5 µg/cm^2, which is considerably less than that relied upon by Dr. Stevenson as a perceived nuisance concentration."

- "Dr. Stevenson concluded that both planktonic algal biomass and benthic algal biomass were 'significantly related' to TP concentrations during the summer 2006. This observation is not notable as it is a well-studied relationship in the scientific literature. What *is* unusual is that Dr. Stevenson's own analyses reveals that TP only explains approximately 8 percent of the variation observed for either planktonic or benthic algal biomass in streams of the IRW. This indicates that approximately 92 percent of the variation observed in algal biomass is not explained by TP. Dr. Stevenson did not acknowledge that other activities or characteristics in the IRW streams that are obviously more important in determining algal biomass than TP."

- "The fish population data that Dr. Stevenson used in his analyses do not indicate that nutrients are adversely affecting streams in the IRW. The number of fish species present at all sites was variable, but every sampled site included species intolerant of water quality degradation."

- "Dr. Stevenson's original [fish] data set included 37 sites, but 40 percent of these sites were excluded from his final analyses. A number of alleged outliers were also removed from the analysis, which further reduced the data set to a size that is inadequate to represent spatial patterns in fish communities in the entire 1,650 mi^2 IRW. Furthermore, these sites were not necessarily representative of the watershed as a whole. Actually, only a small percentage of the watershed is effectively represented by his 22-site data set."

- "Habitat, a factor that is important in shaping fish communities, was not considered by Dr. Stevenson in his report. [Jim Chadwick's] analysis of physical habitat variables collected in September 2008 revealed that they are indeed important determinants of the IRW fish communities. Physical habitat should not be discounted in evaluating differences in fish communities in the IRW."

Dr. John Connolly's concerns with Stevenson's research are described in the 2009 QEA Expert Report titled "Illinois River Watershed Water Quality and Source Assessment," which was included in the Northwest Arkansas Council's submittal to OWRB and is posted on the OWRB website. Similar to GEI's findings, Dr. Connolly's report states, "Phosphorus is not causing excessive growth of phytoplankton in the Illinois River." This observation is supported by Dr. Connolly's modeling of river velocity and growth conditions, from which he concludes "water flows too quickly through the river for phytoplankton to grow." Dr. Connolly also concludes that "benthic algae are rarely at densities considered a nuisance" for the Illinois River.

In summary, if litigation driven research is to be included as part of OWRB's basis for retaining the 0.037 mg/L TP criterion, then it is critical that concerns with this research be acknowledged and opposing viewpoints considered.

Other Relevant Information

OWRB staff compiled a spreadsheet of recommended criteria and ecological change points (see Appendix B to the OWRB staff report). With the exception of a few of the references provided by University of Arkansas professors, the majority of the literature and references submitted by Arkansas entities were excluded from the bibliography of reviewed documents listed in Appendix A of the OWRB staff report. Many of these excluded references relate to attainability of this standard, as well as EPA's and the SAB's most current thinking regarding use of stressor-response approaches to establishing numeric nutrient criteria. These references contain important <u>new</u> information released by EPA after the reference-stream based approach was used by Oklahoma to assign a 0.037 mg/L TP standard and are essential to evaluating the appropriateness of the 0.037 mg/L TP standard. These references were posted to the OWRB website and should be added to the bibliography attached to the final report containing the recommendations from the OWRB staff and majority TAG members.

After a review of the documents posted to the OWRB website, the Arkansas TAG members make the following observations:

- No literature has been presented that demonstrates that a 0.037 mg/L total phosphorus criterion is necessary to protect the Scenic Rivers. Only approximately eight studies posted on the OWRB website provide information on the Illinois River. For the most part, these studies characterize water quality in the Illinois River, including phosphorus and nitrogen concentrations, but the studies are not tied to impairments associated with excessive periphyton or other biological responses. Additionally, data collected on the Illinois River show that a phosphorus standard of 0.037 mg/L is not consistently attainable, particularly under high flow conditions.

- Many documents demonstrate that multiple factors affect the response of streams to nutrient loading. Examples include tree canopy, stream gradient, streambed conditions (e.g., sand, cobble), hydrology, number of days since "flood event," predation/grazing by fish and snails, and other factors. Although phosphorus is frequently identified as the limiting nutrient, some of the studies identify nitrogen as the limiting nutrient. These factors limit the transferability of stressor-response relationships to watersheds with differing watershed and stream characteristics.

- Multiple documents show a correlation between phosphorus and algal biomass; however, threshold of impairment is not clearly defined in many of these. Generally, when reviewing this type of literature, it is critically important to recognize that **"changepoint analysis" is not equivalent to impairment**. In other words, when numeric phosphorus thresholds are identified as showing a measurable change in ecological response, we do not believe that this changepoint is necessarily the appropriate stream standard because evidence of **a changepoint is not evidence of harm** or impairment.

- With regard to studies showing algal response to nutrients, it is noteworthy that a subset of these documents is based on lake studies, mesocosm studies (experimental water enclosures) or lab research; findings in these settings are not directly transferrable to the Illinois River. Similarly, many of these studies are in clearly different stream conditions than the Illinois River. For example, some studies are explicitly focused on small streams, many are in Canada, the Northeast and Florida.

- Multiple documents identify a threshold of phosphorus concentration causing impairment. In some cases, this phosphorus threshold is low (similar to Oklahoma's standard); in other cases, it may be several times higher. We did not identify studies defining a threshold specifically supported in Arkansas or Oklahoma.

- Stream sediments are identified as a source of internal phosphorus loading in several of the studies. This can be an issue during baseflow (chemical equilibrium adjustments) and high flow conditions (resuspension).

- No document provides information indicating that a 0.037 mg/L stream standard is attainable in the Illinois River watershed or considers costs of attaining such a standard.

- Several of the documents identified concerns with the reference stream approach to establishing nutrient criteria (using either the 25th percentile of all streams or the 75th percentile of reference streams).

In sum, the reports reviewed do not substantiate that 0.037 mg/L TP is the necessary or appropriate criterion to protect Oklahoma Scenic Rivers. Based on a review of these studies, the Arkansas TAG members believe that there is a significant lack of data specific to the Oklahoma Scenic Rivers and the Oklahoma portion of the Illinois River, in particular, which reinforces our recommendation that additional study of the Illinois River is warranted prior to implementing a TP standard.

III. DURATION AND FREQUENCY

Currently, the Oklahoma TP criterion contains both a ”shall not exceed” (frequency) and 30-day geometric mean (duration) component. The OWRB selected a 30-day geometric mean for implementing the Scenic Rivers phosphorus criterion despite the fact that the specific criterion reference used in part as justification for the criteria was based upon a flow weighted annual mean. After the 30-day criterion was adopted, the need for an assessment protocol became evident because monitoring was not adequately funded to provide data suitable for calculation of 30-day geometric means. In 2004, Oklahoma developed and adopted an assessment rule that used data collected over 90 days as a proxy for data collected over 30 days to better represent the uptake of nutrients by algae. This assessment rule required a minimum number of storm events to be included in the data set and allowed a 25% excursion rate for geometric means calculated on a monthly basis.

Based upon settlement of the Florida impaired waters rule lawsuits, EPA now requires assessment in strict accord with the WQS. The latest effort by EPA to promulgate criteria for the State of Florida provides a starting place for this discussion. The stream criteria that EPA promulgated are implemented as an annual geometric mean with an allowed excursion of once every 3 years. EPA expressed in their justification that:

> *“Appropriate duration and frequency components of criteria should be based on how the data used to derive the criteria were analyzed and the implications for protecting designated uses given the effects of exposure at the specified criterion concentration for different periods and recurrence patterns.”*

A primary conclusion of the OWRB staff report includes the statement, “The ‘shall not exceed’ and 30-day geometric mean should be preserved in the Scenic River’s criterion.” Given the virtually certain probability of stream standard exceedances during wet weather conditions based on review of historic water quality data for the Illinois River and expectations related to BMP performance, the current formulation of the standard in terms of magnitude, duration and frequency is not consistently attainable. Review of water quality data for the Illinois River at the state line (Massey and Haggard 2010) indicates the stream sometimes meets the standard under certain types of low flow conditions; however, under wet-weather conditions, when

flows increase and the total suspended solids (TSS) levels correspondingly increases, the river does not meet the total phosphorus (TP) standard. Overall, the concentrations of phosphorus observed in the Illinois River exhibit a high degree of variability, particularly on a seasonal basis and under various flow conditions. This creates an unachievable compliance scenario for Arkansas and Oklahoma communities tributary to scenic rivers.

Setting aside concerns about the magnitude component of the standard, the frequency and duration aspects of the standard need to be re-evaluated to provide for a frequency of allowable exceedances and an averaging period (duration) that reasonably corresponds to seasonal variations and other variable factors. Use of a single "not to exceed 30-day geometric mean" standard is unnecessarily "coarse" when the standard could be easily modified to define a reasonable exceedance frequency and adjust the standard based on factors such as flow and season. Adjustment of duration-frequency aspects of standards is a common practice in many states that balances protection of the stream with practical physical realities in the natural environment (e.g., wet years, floods, drought, etc.).

The following identifies specific comments describing the Arkansas TAG members' concerns related to the averaging period, allowed exceedance frequency, and other statistical aspects of the standard. With regard to allowed exceedance frequency, stormwater-related issues and the role of "legacy" phosphorus are also discussed.

1. The 30-day averaging period (duration) is not appropriate for measuring compliance with the proposed criterion.

   First, it is not clear what level of averaging or aggregation was performed on the data used to derive the 0.037 mg/L TP criterion (a percentile). In other words, was the proposed percentile criterion generated from a dataset of site medians, site averages, site percentiles, site 30-day averages, or individual data points? It is well understood that averaging reduces statistical variation. For example, if the dataset used to generate proposed criteria is composed of long-term site averages (or medians), why would the compliance averaging period be less than an annual value? Although not specifically defined, it appears that the 0.037 mg/L TP criterion underpinned by the Clark report is the 75th percentile of a 5-year flow weighted site average. Such an expression suggests that an averaging period in excess of 1 year is supported by underlying studies.

   The second reason for concern is the rate of biological response. A question exists as to whether there is any information or evidence that suggests that the algal community and aquatic life beneficial uses in the Illinois River quantitatively respond to a 30-day nutrient pulse above 0.037 mg/L. The averaging period needs to be linked to biological response, and further consideration should be given to the comparability of the 30-day averaging period with timescales used in deriving the proposed criterion.

   The OWRB should consider revising duration and frequencies to better align with the Florida approach that more appropriately links longer-term nutrient concentrations with

community-wide (e.g., algae, macroinvertebrates, and fish) response. A longer-term averaging period is also supported by the document titled "Justification for Revisions to Oklahoma's Water Quality Standards, OAC 785:45" set forth to support the 2001 /2002 Water Quality Standards revision process.

2. A higher excursion frequency should be included in the criterion.

   All experimental data are uncertain, including information used to derive ambient water quality criteria. A means of expressing experimental findings is by calculating a central tendency (magnitude), over a defined period (duration), and providing an estimate of variability (frequency) such as a standard error. The point being that magnitude, duration, and frequency are inherently linked. The importance of this linkage is noted in the OWRB staff report (pg. 16) where EPA recommends that "Appropriate duration and frequency components of criteria be based on how the data were used to derive the criteria and the implications for protecting the designated use given the effects of exposure..." The OWRB staff report appears to focus on the latter consideration by justifying the averaging period (30-days) and excursion frequency (shall not exceed) based on diatom response kinetics. It is our understanding that the proposed criterion was based on the Clark Report where the 0.037 mg/L value is described as the flow-weighted 75th percentile of all undeveloped streams. The use of a 75th percentile clearly infers an expected exceedance frequency – even in undeveloped watersheds. The OWRB staff report suggests that wet-weather exceedances should be addressed through geometric averaging but provides little evidence for this conclusion.

   If the OWRB does not conduct a more robust analysis of appropriate exceedance frequency, then, at a minimum, the 25% excursion frequency currently allowed in the Oklahoma assessment methodology should be explicitly incorporated into the TP criterion.

3. Mixing of magnitude, duration, and frequencies (MDF) from different studies should be carefully re-evaluated (i.e., meta-analysis).

   With few exceptions, all experimental datasets have unique MDFs. For example, two summer growing season studies (averaging period~3 months) may have significantly different central tendency and exceedance parameters due to sampling frequency (e.g., daily, weekly etc.). Therefore, giving the same weight of evidence to studies with lower resolution (i.e., fewer data points) or a fundamentally different study design should be *carefully* reevaluated. Intermixing of studies to arrive at weight-of-evidence endpoints may result in MDF-sets that were not achieved in any of the underlying studies. Also, OWRB staff report, Appendix B does not list MDF values for cited studies.

4. The "shall not exceed" excursion frequency appears to be more stringent than what is allowed for toxic pollutants.

The OWRB staff report (pg. 19) points out that "the nature of the impact from toxic events by far eclipse the nature and extent of the impact from excessive algae." As mentioned by OWRB, criteria for toxic pollutants have allowed excursion frequencies (e.g., one in three years etc.). The proposed TP criterion does not include an excursion frequency and is therefore more restrictive than a toxic criterion. Implicit in such a comparison is that the 0.037 mg/L criterion would result in excessive algae. It is the Arkansas TAG members' understanding that no such relationship or targeted level of algae has been identified by OWRB.

5. The concept of prolonged unchecked growth in relation to duration and frequency components is unproven.

   The OWRB staff report states that several factors (light, grazers, scour etc., from pg. 16), not just nutrients, limit algal growth. The statement that unchecked growth could 'in essence' occur with a 33% exceedance frequency is unproven and may not be realistic. Unchecked growth would occur if all other limiting processes (e.g., grazing, scour, light limitation etc.) were to concomitantly cease for an extended period. The likelihood of such an event is low and assumes that the cumulative allowed exceedance period occurs uninterrupted. Furthermore, OWRB should consider that time periods that likely feature elevated phosphorus concentrations (i.e., wet-weather runoff) also frequently coincide with scour and light limitation processes. For these time periods, excursions from the proposed criterion are not likely to result in an increase of stream algae above an endpoint that will reasonably protect beneficial uses in the Illinois River.

6. Cited rationale for duration and excursion frequencies focus on producer (i.e., diatoms) response and are poorly linked with proposed criterion.

   The relationship between primary producers and consumers is confounded as a result of seasonal effects and negative feedbacks. Much of the rationale for the duration and excursion frequencies focus on diatom response and give little mention of the range or uncertainty of the phosphorus concentrations that caused these responses. Furthermore, OWRB has not defined what quantified level of diatoms or other indicator assemblage is being prevented or protected by the TP criterion. Much of the OWRB staff report attempts to justify a TP criterion based on algal responses from literature, but has not specified an algal metric or biomass that is considered objectionable.

7. A criterion justified through referencing of algal response literature should include a quantified response variable.

   On the bottom of page 19, the OWRB staff report states that "frequent short term excursions can result in a prolonged increase in algal standing crop followed by shifts in grazer communities and ultimately the fish community." This statement inferring predictable bottom-up trophic cascade should be supported by several citations. If such a response were consistent and quantifiable, promulgation of national stream nutrient

criteria would have soon followed the 1998 Clean Water Action Plan. Instead, the majority of states (14 years later) have yet to adopt stream nutrient criteria due to the uncertainty between nutrients and fishable goals of the Clean Water Act.

8. An excessive percentage of TP measurements data are below detection limits, affecting statistical values.

   In addition to issues related to frequency-duration, another statistical aspect of the standard that is unclear is the role of laboratory analytical detection limits in determining the proposed TP criterion. The ability to quantify an environmental parameter, such as TP, is constrained by the ability to measure it. The proposed criterion magnitude of 0.037 mg/L is near or below the method detection-level of several EPA-approved analytical methods for TP. The Arkansas TAG members are not aware of information that 1) describes how many reference stream measurements were below detection limit, 2) discusses how non-detection levels were dealt with in deriving the criterion, and 3) evaluates the uncertainty in the criterion contributed by non-detectable values. USGS gauge stations within "undeveloped watersheds" located near the study area have significant percentages of non-detect values (Table 1).

Table 1. Preliminary summary of quantified total phosphorus data (pcode 00665) available from U.S. Geological Survey monitoring locations nearest the Illinois River Basin. Locations cited as 'undeveloped' watersheds in Clark Report.

Site No.	Station Name	Drainage Area ($mi.^2$)	Period of Record	Sample Count	Non-Detects
6929315	Paddy Creek above Slabtown Spring, MO	30	4/19/1993 - 6/19/2006	42	31 (73.8%)
7056000	Buffalo River near St. Joe, AR	829	4/10/1974 - 3/23/2004	353	104 (29.5%)
7060710	North Sylamore Creek near Fifty Six, AR	58.1	10/24/1969 - 10/4/2011	369	173 (46.9%)
7335700	Kiamichi River near Big Cedar, OK	40.1	7/17/1973 - 2/21/1996	179	32 (17.9%)
7340300	Cossatot River near Vandervoort, AR	89.6	11/18/1985 - 12/1/2011	136	111 (81.6%)

Storm Events

Closely related to allowable exceedance frequency and averaging period is whether a 0.037 mg/L TP standard is attainable under runoff conditions. Arkansas stakeholders have provided a substantial number of references that clearly show that the 0.037 mg/L is not attainable during runoff conditions, as described below with regard to 1) runoff quality, 2) treated runoff quality, 3) "legacy phosphorus" effects and 4) agriculture and non-point source BMPs. The July 29, 2011 Wright Water Engineers ("WWE") submittal to OWRB can be reviewed in more detail for underlying supporting information, but several key aspects are provided in condensed form below.

1. Runoff Quality

Total phosphorus concentrations in runoff from both developed and undeveloped areas routinely exceed 0.037 mg/L. Scientific monitoring data from multiple sources (as provided in WWE July 29, 2011 submittal to OWRB) indicate that the median and average total phosphorus concentrations in runoff from multiple land use categories, including both developed and

undeveloped areas, routinely exceed 0.037 mg/L. Depending on the land use and the data source, concentrations are commonly reported to be an order of magnitude higher than the 0.037 mg/L standard. Although there are instream attenuation factors which reduce source runoff concentrations relative to the instream concentrations, the extent of attenuation will vary based on a variety of factors and may not provide the reductions necessary to meet a 0.037 mg/L instream total phosphorus standard, given that runoff concentrations are usually several times to one or more orders of magnitude higher than the 0.037 mg/L standard. This finding is relevant to whether a 0.037 mg/L total phosphorus standard is attainable, given the practical reality that it is not physically or economically feasible to treat all runoff in an inhabited watershed.

This finding is relevant for municipalities in Arkansas and Oklahoma. For example, the City of Tulsa 2010 NPDES Permit Annual Report provides an annual summary of urban runoff water quality for the City for over 15 years (1994-2010). Median total phosphorus runoff event mean concentrations ("EMCs") range from 0.15 to 0.47 mg/L and are accompanied by a statement that "no significant degradation of water quality has occurred during this reporting period" (City of Tulsa 2010). The median value for 2009-2010 was 0.30 mg/L, nearly an order of magnitude above the 0.037 mg/L standard.

2. Treated Stormwater Effluent Quality

Despite the fact that well designed and maintained urban stormwater BMPs can significantly reduce total phosphorus in urban runoff, scientific monitoring data demonstrate that the median total phosphorus concentrations achieved in runoff treated by a wide range of urban stormwater BMP types exceed 0.037 mg/L, regardless of the BMP type. This finding is based on monitoring from hundreds of BMPs contained in the International Stormwater BMP Database, as explained in the WWE submittal to OWRB and presentation at Tahlequah. Other BMP performance databases and technical papers, manuals, books, etc., also support this finding. Additionally, national researchers generally agree that there is an "irreducible concentration" beyond which urban stormwater BMPs would not be expected to remove pollutants. Estimates for irreducible concentrations vary based on BMP type, but are typically more than twice the 0.037 mg/L standard, even for BMP categories that perform very well for total phosphorus reduction.

To consistently meet a 0.037 mg/L limit for urban runoff discharges, it would be necessary to construct advanced treatment systems. For example, this could require large stormwater storage facilities (to attenuate the large peak flows common in urban settings to suitable levels for treatment), followed by chemical addition for coagulation/sedimentation and then sand filtration. This would go far beyond the realm of state-of-the-practice stormwater treatment technology and entail enormous planning/design/construction/operation and maintenance costs. Even without going to these lengths, implementing conventional BMPs such as bioretention and sand filters would cost an estimated $265 million to $ 1.05 billion in the existing urban area in Arkansas in the Illinois River watershed, much of which would require retrofits. As previously discussed, there are serious technical and non-technical constraints to widespread BMP retrofitting, with the leading issue being "who pays." Despite the significant

investment this would require, effluent phosphorus concentrations would still be expected to exceed the standard.

3. Control of Existing In-Channel Sediment Sources of "Legacy Phosphorus"

Phosphorus already present in streambed sediments represents an ongoing "legacy" source of phosphorus that is impractical to eliminate or remove, but which can result in increased instream phosphorus concentrations as chemical equilibrium in the stream adjusts over time and when higher flow conditions resuspend deposited sediments.

Haggard and Sharpley (2007), Haggard et al. (2010), Scott et al. (2011), Rogers (2010) and others have published findings related to sources of "legacy phosphorus" in the Illinois River. Such sources of phosphorus may continue after source control practices are implemented in a watershed. As noted by Haggard and Sharpley (2007), sediments act as either sinks or sources of phosphorus and thus, may be influential in determining the time frame over which changes occur in watersheds after management strategies have been implemented. This phenomenon of "legacy phosphorus" and lag time between implementation of controls and observed water quality benefits is also noted in other publications such as EPA (1999) (citing Maki et al. [1983]*) and the National Academy of Sciences (2011) regarding the Chesapeake Bay. The Arkansas TAG members are not aware of large-scale river sediment stabilization projects that have been conducted to minimize scour, resuspension and downstream transport of accumulated deposits for the purpose of meeting a stringent total phosphorus standard. Additionally, we are not aware of case studies or other scientific evidence to suggest that channel modifications of this kind would be feasible in the Illinois River and its tributaries. The permitting, design, construction and maintenance challenges at this scale make the concept infeasible.

Given the lack of practical controls expected to be available to control legacy phosphorus, the phosphorus-rich sediments that have accumulated over many years will continue to be released as the chemical equilibrium of the stream adjusts and as deposited sediments are resuspended under certain flow conditions. Currently, the 0.037 mg/L phosphorus standard does not provide for such instream sources that have become part of background loading in stream systems such as the Illinois River.

4. Agricultural BMPs

Considerable work has been conducted by the University of Arkansas faculty, Oklahoma State University faculty, and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service related to agricultural BMPs. Research is available summarizing percent reductions expected to be associated with various agricultural BMP practices, as documented in the *Conservation Practice Modeling Guide for SWAT and APEX* (Wailder et al. 2009). The EPA also provides performance estimates and cost data in *National Management Measures to Control Nonpoint Source Pollution from Agriculture* (EPA 2003).

Although there are many effective agricultural BMPs that can help to reduce phosphorus loading, as evidenced by the 40 percent reduction in total phosphorus loading in the Illinois

River at the Arkansas-Oklahoma state line. (Reductions are due to a combination of controls at wastewater treatment plants and implementation of agricultural BMPs.) Key documents related to phosphorus control in agricultural practices can be obtained from the University of Arkansas website (http://www.uaex.edu/). Even when such agricultural BMPs are aggressively implemented, the 0.037 mg/L standard would not be expected to be consistently attainable.

The Arkansas TAG members also would like to reiterate that Arkansas passed and is enforcing comprehensive regulations pertaining to the use of poultry litter and commercial fertilizers in the Illinois River Watershed. In the past six years alone, Northwest Arkansas poultry companies have spent over $2 million to facilitate the transfer of poultry litter out of the Illinois River watershed. These same companies have funded $1.1 million in conservation projects through the Oklahoma Scenic Rivers Commission. Arkansas will expend $30 million in CREP funds ($24 million federal grant and $6 million state matching funds) for riparian buffers and nonpoint source controls in the Arkansas side of the Illinois River watershed. Northwest Arkansas stakeholders are providing the state matching funds for this federal grant.

Municipal Wastewater Treatment Plants

Fulfilling their commitment to the first Joint Principles and Actions Agreement, Arkansas WWTP dischargers upgraded their facilities at a cost of $225 million for capital equipment and system upgrades alone, with a resulting 2010 average TP concentration of 0.37 mg/L. Additionally, the cities have implemented plans for managing wastewater treatment biosolids and controlling urban runoff to further reduce phosphorus concentrations in the watershed. These efforts, combined with a mandatory program of phosphorus-based fertilizer controls in the Illinois River in Arkansas and improved agricultural practices have already resulted in a 40 percent reduction of phosphorus loading to the river.

Analysis conducted by Arkansas cities shows that modification of their existing facilities to consistently achieve a lower phosphorus limit (0.1 mg/L TP, which is considered the current practical treatment limit) would require expenditures of $80 million to $100 million in capital equipment alone, without considering the added long-term costs of operation and maintenance. Chemical and energy costs for additional treatment are substantial.

Real consideration must be given to whether the 0.037 mg/L TP standard is attainable. Considerable technical literature was provided in this regard, but these sources do not appear to have been considered by the OWRB, as evidenced by exclusion of this information in OWRB staff report, Appendix B. Specifically, approximately 50 references related to urban runoff quality, BMP performance and non-point source BMPs were provided that demonstrate that this standard is not consistently attainable.

IV. Relationship of the Scenic River Criterion to Lake Tenkiller

OWRB's call for technical information suggests that the protection of Lake Tenkiller is a factor to be considered by the TAG. Lake Tenkiller is an entirely separate issue beyond the scope of the Statement of Joint Principles and Actions. OWRB has already established a water quality

standard for Lake Tenkiller based upon chlorophyll a. That standard was not part of the 2003 Statement of Joint Principles and Actions and should not be part of the ongoing review of the Scenic Rivers standard. The water quality standard under review was adopted by OWRB under the authority of the Oklahoma Scenic Rivers Act (Okla. Stat. Tit 82, Ch. 21). The purpose of the Scenic Rivers Act is to protect and preserve water quality in certain designated reaches of six specific rivers. The Scenic Rivers Act does not authorize OWRB to promulgate an in-stream water quality standard for the purpose of protecting the use of waterbodies other than the designated scenic rivers. Lake Tenkiller is neither a Scenic River nor does it have any applicable total phosphorus standard. If OWRB desires to adopt a phosphorus-based water quality standard for the protection of Lake Tenkiller, it should do so in a separate rulemaking authorized by and conducted in accordance with legislation other than the Oklahoma Scenic Rivers Act.

V. Arkansas TAG Members' Recommendations

1. Implementation of the 0.037 mg/L total phosphorus standard should be extended for a minimum of 10 years to enable completion of the following specific tasks:

    a. Completion of stressor-response studies on the Illinois River to provide a scientific basis to determine the appropriate numeric standard for the river. The study should use U.S. EPA recommended stressor-response methods including but not limited to Rapid Bioassessment Protocols for the purpose of evaluating the relationship between phosphorus concentrations and biotic indicators of water quality, including but not limited to periphyton biomass and fish and invertebrate indices of biotic integrity. (Allow 5 years).

    b. Completion of EPA's Illinois River Watershed Model, which is currently in progress. (Allow 2 years).

    c. Completion of additional monitoring and time to allow the effects of "legacy phosphorus" to work through the system before additional significant capital investments are made to further reduce phosphorus. (Allow 10 years).

    d. Although Oklahoma's assessment methodology allows a 25% exceedance frequency over a rolling 90-day period, an exceedance frequency is not explicitly included in the TP criterion, creating an inconsistency between the criterion and the assessment methodology. Review of data on reference streams (i.e., streams with little or no human disturbance) in Arkansas and Oklahoma shows that even reference streams periodically exceed 0.037 mg/L TP; therefore, an appropriate allowable exceedance frequency should be included in the TP criterion. With regard to the averaging period, review of reference stream data shows seasonal and/or flow-related variations are present in reference stream and Scenic River data sets; therefore, an annual averaging period is more appropriate than a monthly geometric mean. An overall re-evaluation of frequency-duration aspects of the TP criterion should be

completed in conjunction with a re-evaluation of the magnitude component as described in a).

2. Arkansas and Oklahoma should continue requiring implementation of Nutrient Management Plans, which include the utilization of a Phosphorus Index, for the land application of litter in the Shared Scenic River watersheds.

3. The controls specified for point source dischargers, for both larger and smaller entities, set out in the 2003 Statement of Joint Principles and Actions should be extended through June 30, 2022. Once there is resolution regarding the relevant Oklahoma phosphorus criterion and wasteload allocations have been properly developed, then NPDES permits for the point source dischargers should be adjusted as appropriate when the various permits expire and are considered for renewal.

4. Both states should continue to encourage implementation of voluntary programs to reduce instream concentrations of total phosphorus in the Shared Scenic Rivers.