# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

*Protecting Texas by Reducing and Preventing Pollution*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
2009 MAR 24 PM 4: 15
CHIEF CLERKS OFFICE

March 24, 2009

LaDonna Castañuela
Texas Commission on Environmental Quality
Attention: Docket Clerk, MC 105
P.O. Box 13087
Austin, Texas 78711-3087

Re: **Executive Director's Exceptions to the Proposal for Decision;**
Application by Lerin Hills, Ltd.;
TPDES Permit No. WQ0014712001;
SOAH Docket No. 582-08-0690; TCEQ DOCKET NO. 2007-1178-MWD

Dear Ms. Castañuela:

Please find enclosed the original and seven, true and correct copies of the Executive Director's Exceptions to the Proposal for Decision in the above referenced matter.

For further questions or inquiries, I can be contacted at (512) 239-3417.

Sincerely,

Kathy J. Humphreys
Staff Attorney
Environmental Law Division

Enclosure

cc: Mailing List

# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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March 24, 2009

The Honorable Shannon Kilgore
Administrative Law Judge
State Office of Administrative Hearings
P.O. Box 13025
Austin, Texas 78711-3025

Re: **Executive Director's Exceptions to the Proposal for Decision;**
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To the Honorable Judge Kilgore:

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APPLICATION BY LERIN HILLS, LTD
FOR TPDES PERMIT NO. WQ0014712001

EXECUTIVE DIRECTOR'S EXCEPTIONS TO THE PROPOSAL FOR DECISION

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CHIEF CLERKS OFFICE

**SOAH DOCKET NO. 582-08-0690**
**TCEQ DOCKET NO. 2007-1178-MWD**

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| **APPLICATION BY LERIN HILLS, LTD FOR TPDES PERMIT NO. WQ0014712001** | § § § § § | **BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS** |

**EXECUTIVE DIRECTOR' S EXCEPTIONS TO THE PROPOSAL FOR DECISION**

**TO THE COMMISSIONERS OF THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY:**

The Executive Director of the Texas Commission on Environmental Quality (TCEQ) submits the following specific exceptions (Exceptions) to the Proposal for Decision (PFD) filed by the Administrative Law Judge (ALJ) relating to the application by Lerin Hills, Ltd. (the Applicant) for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014712001 (the Application) in Kendall County, Texas.

## I. INTRODUCTION

In consideration of the exceptions and policy arguments set forth herein, the Executive Director respectfully requests that the ALJ amend the PFD to support the approval of the Application and the issuance of Draft TPDES Permit No. WQ0014712001 (Draft Permit). Should the ALJ decide not to amend the PFD, the Executive Director requests that the Commission: (1) not adopt the ALJ's Order as presently proposed and attached to the PFD, and (2) adopt a Revised Order approving the Application and the issuance of the Draft Permit. The Executive Director supports the ALJ's findings of fact and conclusions of law not specifically excepted to in these exceptions at this time.

By basing her opinion on the lack of numerical data for nutrients, the ALJ has effectively suspended the TCEQ's antidegration review process. If the Commission adopts the PFD as drafted the Executive Director will be forced to place all new and amendment TPDES permit applications on hold until such time as the TCEQ adopts numeric nutrient criteria for rivers and streams.

## II. STANDARD OF REVIEW

ALJs have the regulatory authority to amend their PFDs in response to exceptions, replies, or briefs filed by the parties.[1] Should the ALJ decide not to amend the PFD, the Commission may modify the ALJ's order or change an ALJ's finding of fact or conclusion of law if the Commission determines that: (1) the ALJ improperly applied or interpreted the law, agency rules or policies, or prior administrative decisions; (2) the ALJ based her decision on a prior administrative decision that is incorrect; or (3) a finding of fact contains a technical error requiring correction.[2] Any amendment to the PFD and the accompanying order must be based solely on the record made before the ALJ, and must include an explanation of the basis of the amendment.[3]

## III. EXCEPTIONS TO FINDINGS OF FACT, CONCLUSION OF LAW, AND ORDERING PROVISIONS

The Executive Director files exceptions to the Findings of Fact 36-40, and 45-46 and Conclusion of Law 7. These findings of fact and conclusions of law are inaccurate, misleading, against the great weight of the evidence in the record, and are contrary to the Texas Surface Water Quality Standards (TSWQS) and Implementation Procedures (IPs). As such, they should be modified by the ALJ or revised by the Commission.

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[1] 30 TEX. ADMIN. CODE § 80.259 (2009) (Tex. Comm'n. Env. Quality, Contested Case Hearings).
[2] TEX. GOV'T. CODE § 2001.058(e) (Vernon Ann. 2009).
[3] *Id.* At § 2003.047(m) (Vernon Ann. 2009).

The ALJ makes four significant errors in her discussion regarding antidegradation, any of which standing alone would be sufficient for the Commission to amend the PFD. The first error occurs in the ALJ's discussion regarding the antidegradation standard where she states "[t]he difficulty here is that Tier 2 antidegradation protection is extremely stringent: it prohibits any greater-then[sic]-de minimis degradation in water quality, even if the degradation has no effect on the uses of the water body."[4] This is a misstatement of the law.

The second significant error occurs when the ALJ recommends denying the application because of the lack of evidence in the record demonstrating that additional nutrient loading by the proposed discharge would not violate the TCEQ's antidegradation policy. The ALJ cited the lack of any quantitative data supporting the Executive Director's determination that degradation would not occur as a basis for her decision. The TSWQS do not require quantitative data for narrative criteria nor the level of detail imposed by the ALJ on the Executive Director in implementing the antidegradation policies in the state of Texas. The Executive Director does not require quantitative data for parameters evaluated using narrative criteria.

The third significant error occurs with the ALJ's use of the term "degradation." Throughout the Proposal for Decision and Order the ALJ misuses the term "degradation," the correct term is "lowering of water quality." While this may seem like a trivial change, because "degradation" is a term of art, the ALJ's incorrect use of it changes its meaning.

The fourth significant error is the requisite burden of proof. According to TCEQ's rules the burden is on the Applicant to demonstrate that the application meets TCEQ's rules by a

[4] Proposal for Decision, Page 32.

preponderance of the evidence.[5] In the Proposal for Decision the ALJ impermissibly raises the burden to "substantial".[6] In other words, the ALJ imposed a higher burden of proof on the Applicant, and by implication the Executive Director to prove that the application meets the TCEQ's rules by "substantial" evidence.

### A. EPA has Approved TCEQ's Surface Water Quality Standards and Implementation Procedures.

TCEQ's antidegradation policy is found in the TSWQS[7] and is further delineated in the IPs. EPA approved the antidegradation portion of the TSWQS in March 2005, and the general criteria portion in April 2008.[8] EPA approved the antidegradation portion of the IPs in November 2002.[9]

### B. Antidegradation Review

One fundamental misunderstanding lies at the heart of the ALJ's PFD and Order; the ALJ incorrectly determined that numeric data demonstrating the effects of nutrient loading on the receiving waters is necessary to satisfy the TCEQ's antidegradation policy. The ALJ cited the lack of any quantitative data supporting the Executive Director's determination that lowering of water quality by more than a de minimis extent would not occur as a basis for her decision.[10] Neither the TSWQS nor the IPs require quantitative data for parameters evaluated using

[5] 30 TEX. ADMIN. CODE §80.17 (2009) (Tex. Comm'n. Env. Quality, Contested Case Hearings).
[6] Proposal for Decision, Page 36.
[7] *See generally,* 30 TEX. ADMIN. CODE Chapter 307 (2009) (Tex. Comm'n. Env. Quality, Contested Case Hearings).
[8] http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/standards/epatime.pdf
[9] ED-11, Page 1. The EPA approved the IPs with two specific exceptions that do not apply to the antidegradation discussion.
[10] "Like Dr. Miertschin and Mr. Price, Mr. Schafer also opined generally that 700 pounds of phosphorus per year would not be too much. In support of his opinion, he cited to the TCEQ staff's experience with permit limitations and hill country streams. However, he acknowledged that staff had not actually performed any before-and-after comparative analyses, and he offered no quantitative data in support of his opinion." Proposal for Decision at 35; Findings of Fact No. 40 & 43, ALJ's Order at 7.

narrative criteria. To demand such a showing would suspend all new and amendment wastewater discharge permit application processing in the state until the TCEQ adopted numeric criteria for all narrative parameters including nutrients.

The ALJ reasoned that since neither the Applicant nor the Executive Director conducted any modeling demonstrating the effect of nutrient loading over time, the determination that degradation would not occur was not supported by the evidence. As previously mentioned, Texas has not established numerical criteria for nutrients such as phosphorus; therefore, these substances are evaluated using narrative criteria. The rules provide "[n]utrients from permitted discharges or other controllable sources shall not cause excessive growth of aquatic vegetation which impairs an existing attainable or designated use."[11] The ALJ's interpretation of the TCEQ's antidegradation policy is flawed in that narrative criteria for nutrients, which are qualitative in nature, do not lend themselves to quantitative analysis. Requiring the Applicant or the Executive Director to determine the background nutrient concentration, conduct modeling to predict the nutrient loading from the proposed discharge, and then apply the *de minimis* threshold to the numeric change in the concentration is not required by the current TSWQS. To demand such a showing would halt all new and amendment wastewater discharge permit application processing in the state until Texas adopted numeric criteria for nutrients.

*1. Multi-tiered Review*

TCEQ's antidegradation review is restricted to TPDES applications that have the potential to increase pollution in waters in the state.[12] This has been interpreted to mean that the review procedures apply only to new or amendment applications that are requesting additional

[11] 30 TEX. ADMIN. CODE § 307.4(e) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).
[12] *Id.* § 307.5(a) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).

pollutant discharge authorizations. A key feature of the TCEQ antidegradation policy is a tiered approach that requires progressive levels of protection and scrutiny based on the aquatic life uses of the water body under review.[13]

A Tier 1 review is performed on all receiving waters. A Tier 1 review ensures that existing water quality uses are not impaired by an increase in pollution loading.[14] A Tier 2 review is performed on water bodies that are expected to exceed the normal range of fishable/swimmable criteria.[15] These water bodies have an existing, designated, or presumed contact recreation use and intermediate, high, or exceptional aquatic life use.[16] The key aspect of a Tier 2 review is that degradation is defined as the lowering of water quality by more than a *de minimis* extent, but not to the extent that an existing use is impaired.[17]

*2. Numeric v. Narrative Criteria*

Texas surface water quality standards are separated into two major categories, numeric criteria and narrative criteria. As the name implies, numeric criteria are expressed as a specific concentration of a constituent necessary to protect a waterbody's use, and provide a quantifiable way to assess water quality and regulate pollution to ensure applicable water quality uses are attained. Narrative criteria address pollutants for which there are no specific numeric criteria, thus provide guidance on limiting aquatic vegetation so that applicable uses are maintained. Narrative criteria define water quality goals to be achieved for all waters in the state. In the absence of numeric criteria, nutrient effluent limitations are derived based on a qualitative range

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[13] *See* 30 TEX. ADMIN. CODE §§ 307.5(b) & (c)(2) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).
[14] *Id.* at §§ 307.5(b)(1) & (c)(2)(A) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).
[15] *Id.* at §§ 307.5(b)(2) & (c)(2)(B) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).
[16] ED-11 (2003 Procedures to Implement the Texas Surface Water Quality Standards) p. 30.
[17] 30 TEX. ADMIN. CODE §§ 307.5(b)(2) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).

of factors; such as, water body type, water body location, degree of impact on aquatic life communities, and available water quality information. Both the narrative and numerical criteria provide a kind of measure for protection of uses; so both are a good measure to protect for potential impairment of uses under Tier 1 of the antidegradation policy.

Texas is one of thirty-six states that have not yet adopted numeric criteria for nutrients in their rivers and streams.[18] Beginning in 1998, the U.S. Environmental Protection Agency (EPA) unveiled a national strategy for the development of regional nutrient criteria, urging States, Territories, and Tribes to develop numeric nutrient water quality standards.[19] A 2007 EPA policy memorandum recognized the inability of many states to adopt numeric nutrient criteria overnight, and suggested the following incremental approach to the adopting numeric standards:

> "If a State needs to implement numeric nutrient criteria incrementally, EPA strongly recommends that States adopt numeric nutrient standards for their priority waters - i.e., waters at greatest risk of nutrient pollution… or of greatest consequence (such as drinking water sources) - first. States may also choose to prioritize their actions for waters where sufficient information is available to move quickly to adopt numeric criteria in the near-term."[20]

The TCEQ has adopted this incremental approach in developing numeric criteria for nutrients, choosing to develop numeric criteria for reservoirs first due to "their importance in sustaining cities, farms, ranches, and industry during times of drought and extreme flows; and because Texas has extensive long-term data on nutrients, water-column chlorophyll *a*, and other relevant parameters in the main pools of large reservoirs."[21] Numeric nutrient criteria for

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[18] State Adoption of Numeric Nutrient Standards (1998-2008), EPA (December 2008), *available at* http://www.epa.gov/waterscience/criteria/nutrient/strategy/status.html (Attachment A).
[19] National Strategy for the Development of Regional Nutrient Criteria, EPA (June 1998). (Attachment B).
[20] Nutrient Pollution and Numeric Water Quality Standards, Policy memorandum issued by the US EPA Assistant Administrator for Water (May 25, 2007). (Attachment C)
[21] Draft Nutrient Criteria Development Plan, TCEQ at 7 (November 3, 2006). (Attachment D).

reservoirs will be proposed as a part of the current triennial revision of the TSWQS.[22] By the same token, data showing the effect of nutrients on rivers and streams in Texas is limited.[23] The TCEQ has stated that,

> "Not only is there limited data on concentrations of chlorophyll *a* and nutrients in attached vegetation, there is also sparse data on the extent of attached vegetation, either algae or rooted macrophytes...Because of the lack of data, the TCEQ and other entities are planning projects to collect nutrient, attached vegetation, and chlorophyll *a* data. Some of these projects will span two or three years with the results not due for delivery until 2008."[24]

During the current triennial revision of the TSWQS, TCEQ staff is considering expanding the narrative criteria for nutrients and developing new IPs to address nutrient impacts on rivers and streams.[25] Numeric nutrient criteria for rivers and streams are not scheduled to be proposed until the next triennial revision of the TSWQS in 2011.[26]

**C. Deference should be given to the Executive Director's interpretation of its antidegradation policy.**

While the ALJ did not specifically rule on the Executive Director's antidegradation review, by finding that the Applicant had not met its burden by failing to provide quantitative data she implicitly ruled that the TCEQ's rules and policies are insufficient. It is well-settled that reviewing courts must give deference to an agency's reasonable interpretation of statutory authority.[27] This deference applies to formal opinions in formal proceedings.[28] Moreover, the Supreme Court has explicitly stated that where "Congress has. . . left a gap for the agency to fill,

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[22] Appendix D (Draft Schedule for Developing Nutrient Criteria), Draft Nutrient Criteria Development Plan, TCEQ (November 3, 2006); *See* Future Revisions of the Texas Surface Water Quality Standards, *available at* http://www.tceq.state.tx.us/permitting/water_quality/wq_assessment/standards/WQ_standards_revisions_future.html
[23] Draft Nutrient Criteria Development Plan, TCEQ at 16 – 17 (November 3, 2006). (Attachment D).
[24] *Id.* at 17.
[25] *Id.* at 17 – 18 (November 3, 2006); *See* Appendix D (Draft Schedule for Developing Nutrient Criteria).
[26] *Id.* Appendix D (Draft Schedule for Developing Nutrient Criteria),
[27] *In re American Homestar of Lancaster, Inc.*, 50 S.W.3d 480, 490-91 (Tex. 2001).
[28] *Fiess v. State Farm Lloyds,* 202 S.W.3d 744, 747 (Tex. 2006).

there is an express delegation of authority to the agency to elucidate a specific provision of the statute by regulation."[29] The Supreme Court has also stated that enforcement and guidance materials, while not entitled to Chevron-style deference still are accorded "respect to the extent they are persuasive."[30]

The EPA may either accept or deny regulations promulgated by an agency.[31] EPA approved TCEQ's antidegradation standards in 2005.[32] Federal regulations require States to adopt water quality criteria which must be based on sound scientific rationale; the criteria can be either numeric or narrative.[33] EPA allows states to choose either narrative or numeric water quality standards for their anti-degradation review. Recently, the EPA has amended guidance materials and published memos encouraging the use of numeric water quality standards in conjunction with the use of narrative water quality standards, but does not mandate the use of numeric criteria for all parameters.[34] As courts have noted, "The agency charged with implementing the statute is not free to evade the unambiguous directions of the law merely for administrative convenience."[35] TCEQ cannot be charged with evading the unambiguous directions of the EPA because it, along with all other states in the county, uses narrative water quality standards in its Tier 2 water quality reviews.

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[29] *Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc.*, 467 U.S. 837, 843-44, 104 S.Ct. 2778, 81 L..Ed..2d 694 (1984).
[30] *Christensen v. Harris County*, 529 U.S. 576, 587, 120 S.Ct. 1655, 146 L. Ed..2d 621 (2000); *Skidmore v. Swift & Co.*, 323 U.S. 134, 140, 65 S.Ct. 161, 89 L. Ed.. 124 (1944).
[31] *Riverside Cement Co. v. Thomas*, 843 F.2d 1248 (9th Cir.1988).
[32] http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/standards/epatime.pdf
[33] 40 C.F.R. § 131.11.
[34] http://www.epa.gov/waterscience/standards/handbook/chapter03.html#section5
[35] *Brown v. Harris*, 491 F.Supp. 845, 847 (D.C.Cal. 1980) *quoting Manhattan General Equipment Co. v. Commissioner of Internal Revenue*, 297 U.S. 129, 134, 56 S.Ct. 397, 400, 80 L. Ed.. 528 (1936).

The fact remains that narrative water quality standards are the starting point at which Tier 2 anti-degradation reviews must begin. While the EPA has stated in guidance materials that it encourages the use of numeric water quality standards, the EPA has recognized the harsh effect of mandating a complete shift to the use of numeric water quality standards. It stated instead that states may incrementally move towards using numeric water quality standards in conjunction with their use of narrative water quality standards.[36] To date, over half of the states have not adopted numeric water quality standards, and more than 2/3 do not have numeric water quality standards for rivers/streams.[37]

Furthermore, the EPA has given examples of how states should incrementally move towards the use of numeric water quality standards, i.e. for water uses in which the public has a high interest of protectedness, like drinking water.[38] The TCEQ's use of narrative water quality standards in its Tier 2 antidegradation review is consistent with EPA regulations, the Texas Water Code, the TSWQS, and the implementation procedures. TCEQ's use of narrative criteria has all the indicia of reasonable interpretation of the relevant statutes and regulations and is therefore entitled to deference. Reviewing courts have given deference to the EPA's approval of agency water quality regulations if the regulations were within promulgated EPA guidelines.[39] The EPA's recommendation of an incremental approach to the implementation of numeric water quality standards may be said to be as a result of the acknowledgment by the Supreme Court that states are not required to use numeric criteria to the exclusion of narrative criteria.[40] In *PUD No.*

[36] http://www.epa.gov/waterscience/criteria/nutrient/policy.html
[37] http://www.epa.gov/waterscience/criteria/nutrient/strategy/status.html
[38] http://www.epa.gov/waterscience/criteria/nutrient/policy.html
[39] *Ohio Valley*, 279 F. Supp. 2d. at 756.
[40] *PUD No. 1 of Jefferson County v. Washington Dept. of Ecology*, 511 U.S. 700, 114 S.Ct. 1900 (1994).

*1 of Jefferson County* the complaining party argued that the 303 water quality standards required the State to use numeric criteria. The Court stated that state water quality criteria need to be sufficient to protect designated uses, but not so specific as to anticipate all potential water quality issues revolving around activity associated with specific waterbodies.[41] States are allowed to enforce broad narrative water quality criteria.[42]

**D. Specific Exceptions to Findings of Fact, Conclusions of Law and Ordering Provisions.**

*1. Exceptions to Finding of Fact No. 45. Lerin Hills has failed to show that there would not be greater-then[sic]-de minimis degradation of the water of Deep Hollow Creek, Frederick Creek, and Upper Cibolo Creek as a result of the proposed discharge.*

a. Overview

The Executive Director objects to Findings of Fact Number 45.[43] The Executive Director respectfully files this objection to clarify the Executive Director's antidegradation rules, policies and review processes. The evidence in this case and the documentation on file with the agency indicate that the Applicant followed TCEQ's rules and policies to show that there would not be degradation of the receiving water. Because the ALJ improperly applied TCEQ's antidegradation rule and policy, the ED recommends that Finding of Fact No. 45 be revised to read, "Lerin Hills demonstrated that there would not be a lowering of the water quality of Deep Hollow Creek, Frederick Creek, and Upper Cibolo Creek by more than a *de minimis* extent as a result of the proposed discharge."

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[41] *Id.*

[42] *Id.*; *Northwest Environmental Advocates v. City of Portland*, 56 F.3d 979 (C.A.9 1995).

[43] Order, Page 7. Finding of Fact 45 states "[L]erin Hills has failed to show that there would not be greater-then [sic]-*de minimis* degradation of the waters of Deep Hollow Creek, Frederick Creek, and Upper Cibolo Creek as the result of the proposed discharge."

b. Discussion

The ALJ misunderstands the Tier 2 review, and thus misapplied it to the Lerin Hills application. TCEQ's rules provide that:

1. waters that exceed fishable/swimmable quality can not be degraded;

2. degradation is the lowering of water quality by more than a de minimis extent but not to the extent that an existing use is impaired; and

3. water quality sufficient to protect existing uses will be maintained.[44]

The ALJ has incorrectly interpreted this standard to mean that there can not be any change in the water chemistry.[45] As Mr. Schaefer testified, all treated wastewater contains nutrients, and it is assumed that the proposed discharge would cause some initial algal growth.[46] Mr. Schaefer went on to testify that an increase in algae in the receiving water does not necessarily mean that the receiving water has been degraded, because the antidegradation policy does not require that there is absolutely no change in the natural water chemistry of the receiving water.[47] At the hearing Mr. Schaefer again testified that a noticeable increase in the level of algae or macrophytic plants in the Hahnfeld pond would not result in significant degradation.[48]

The ALJ noted that it is difficult for the Executive Director and the Applicant to ensure that the Tier 2 "stringent yet vague" standard is met, and then goes on to raise the standard even further.[49] Under the standard proposed by the ALJ, all wastewater discharge permit applications

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[44] 30 TEX. ADMIN. CODE §307.5(2) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).
[45] Proposal for Decision, Page 34.
[46] ED-9, Page 12, Lines 1-8 (Prefiled testimony of Peter Schafer).
[47] *Id.* Page 12, Lines 15-22 (Prefiled testimony of Peter Schafer).
[48] Transcript, pages 551-552.
[49] Proposal for Decision, Page 39.

will fail the Tier 2 review because every discharge changes the water chemistry of the receiving stream.

The Executive Director asserts that the ALJ should have used the standard enunciated in the rules and IPs. The IPs give examples of where degradation is unlikely to occur; one of the examples is where there is an increase in the loading of nutrients, provided it can be reasonably demonstrated that detrimental increases to the growth of algae or aquatic vegetation will not occur.[50] Using their best professional judgment both the Applicant and the Executive Director determined that the treated effluent from Lerin Hills would not cause a lowering of water quality beyond a *de minimis* extent. Dr. Miertschin testified that he does not believe that the discharge will have a measurable impact on the algal growth in the stream or in the impoundments,[51] and that the 0.5 mg/L Total Phosphorus effluent limit is probably not necessary.[52] Peter Schaefer testified that he recommended a 0.5 mg/L Total Phosphorus limit because Deep Hollow Creek and its impoundments are clear hill county water bodies with limited assimilative capacity for nutrients.[53]

Moreover the ALJ states that Mr. Schaefer's testimony indicates that he did not perform the Tier 2 review according to TCEQ's rules and that his Tier 2 review did not add anything meaningful to the Tier 1 review.[54] This is not correct. Mr. Schaefer performed a Tier 2 review and using his professional judgment recommended a 0.5 mg/L Total Phosphorus limit and monitoring for nitrate-nitrogen and total nitrogen as a result of his Tier 2 review.[55] While it is

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[50] ED-11, Page 33 (IPs).
[51] LH-2, Page 20, Lines 7-14.
[52] *Id.*, Page 21, Line 10.
[53] ED-9, Page 13, Lines 16-22.
[54] Proposal for Decision, Page 35.
[55] ED-12; ED-9, Pages 13-14.

true that neither the statute nor the regulations define the term "de minimis," it is equally clear that the Texas Legislature acknowledged that the goal of nondegradation "does not mean zero-contaminant discharge."[56]

c. Segment No. 1908 – Upper Cibolo Creek

In the PFD the ALJ states "[g]iven that there are currently concerns about phosphorus levels in Segment 1908, the ALJ cannot conclude that it is unnecessary for Segment No. 1908 to undergo, and pass, a Tier 2 review in connection with the Lerin Hills application."[57] This statement by the ALJ assumes that a Tier 2 review was not performed in the evaluation of the Lerin Hills' application. Mr. Schaefer performed a Tier 2 review and documented his findings in his June 2006 interoffice memorandum, which was introduced into evidence and available to the ALJ in this case.[58] Mr. Schaefer noted that Segment 1908-Cibolo Creek was listed in the 2002 305(b) Texas Water Quality Inventory for nutrient enrichment concerns for orthophosphorus.[59] He also noted that the segment was listed on the 2002 303 (d) List of Impaired Waterbodies for depressed dissolved oxygen.[60] As a result of his review Mr. Schaefer recommended a total phosphorus limit of 0.5 mg/L be added to the Lerin Hills permit.[61] It appears the ALJ missed, overlooked, or totally ignored this evidence. Failure by the ALJ to acknowledge the existence and importance of this evidence at the very minimum raises concerns about Finding of Fact No. 45 and the conclusions of law that flow from it.

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[56] See TEX. WATER CODE § 26.401(b) (Vernon Ann. 2009) ("... it is the goal of groundwater policy in this state that the existing quality of groundwater not be degraded. This goal of nondegradation does not mean zero-contaminant discharge.").
[57] Proposal for Decision, Page 37.
[58] ED-12.
[59] *Id.*
[60] *Id.*
[61] *Id.*

2. *Exceptions to Finding of Fact No. 36. Predicted concentrations of phosphorus in the SCS impoundment would be 0.42 mg/L, 0.28 mg/L, 0.12 mg/L, and 0.05 mg/L (upstream to downstream), compared to the measured background of 0.035 mg/L or the presumed background of 0.05 mg/L.*

The Executive Director objects to this finding because it makes an incorrect factual assumption, which the ALJ used to ultimately determine that the water quality in the SCS impoundment would be lowered to more than a *de minimis* extent. Because Finding of Fact No. 36 is factually incorrect, the ED recommends it be stricken in its entirety.

Because the background concentration of total phosphorus is not known, nor required, as part of the application process, and because TCEQ's rules dictate that the Executive Director use narrative criteria, not numerical, to evaluate the impact of nutrients, the Executive Director recommends that this Finding be struck as it is irrelevant to the issue of whether the Lerin Hills permit should be issued.

The assumption that the background concentration of total phosphorus is either 0.035 mg/L or 0.05 mg/L is flawed. Dr. Miertschin testified that he visited the Lerin Hills site one time (March 6, 2008) and took one water sample from the Hahnfeld Pond, the impoundment, and the Blanch Pond; and each sample was analyzed for total phosphorus.[62] The laboratory reported a total phosphorus concentration in the sample from the impoundment of 0.035 mg/L, and less than 0.02 mg/L from the Hahnfeld pond.[63] TCEQ policy and guidance require more than one sample to accurately determine the background concentration of a substance. For example, the IP's provide guidance for Permitees that believe certain effluent limits should be adjusted for

[62] LH-2, Page 16, Lines 14-21.
[63] LH-2F (the total phosphorus results for the other two samples were non detectable at a detection limit of 0.02 mg/L).

site-specific conditions.[64] If a Permittee collects samples to obtain site-specific data, at least 30 samples must be taken, but TCEQ would prefer "30-50 samples to ensure that there are at least 30 valid data points and to get a more statistically reliable number. . ."[65] While these samples are not used to determine background concentration, the underlying statistical logic remains the same.

Because the concentration algal growth in a stream is dependent on a variety factors, it takes even an even more rigorous sampling regime to determine the background concentrations of nutrients and algae. According to the EPA, if there is limited nutrient and algal data, then multi-year surveys on a twice monthly or monthly basis may be necessary to determine if nuisance algal problems occur.[66] Frequent sampling is necessary because algal blooms may develop and dissipate rapidly with residual adverse effects, such as fish kills and impaired aquatic habitat,[67] and multi-year sampling is necessary because unusually large annual variability can occur annually in the intensity of nutrient/algal problems, due to timing of weather (primarily scouring storm events or persistent low flow events with long residence time) and seasonality of algal blooms.[68] The reliance by the ALJ on the one sample taken by Dr. Miertschin may have led to a factual assumption that shaped this flawed proposal for decision.

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[64] ED-10, Page 73.
[65] ED-10, Page 74 (Hardness), Page 75 (pH), Page 76 (Chloride), Page 77 (TSS), Page 78 (Total and Dissolved Metals).
[66] http://www.epa.gov/waterscience/criteria/nutrient/guidance/rivers/chapter_5.pdf (Nutrient Criteria Technical Guidance Manual, Page 50. (Attachment E).
[67] *Id.*
[68] *Id.* ("Ideally, water quality monitoring programs produce long-term datasets compiled over multiple years, to capture the natural, seasonal and year-to-year variations in waterbody constituent concentrations (e.g., Dodds et al. 1997; Tate 1990). Multiple-year datasets can be analyzed with statistical rigor to identify the effects of seasonality and unusual flow years (Miltner and Rankin 1998). Once the pattern of natural variation has been described, the data can be analyzed to determine the water quality conditions that degrade the ecological state of the waterbody or effect downstream receiving waters. Long-term data sets have also been extremely important in determining the cost-effectiveness of management techniques for lakes and reservoirs (Cooke et al. 1993). The same should be true

Assuming that one of the values (0.02 mg/L, 0.035 mg/L, or 0.05 mg/L), but without knowing which one, is the correct total phosphorus background concentration, the variation is huge, especially considering that the 0.02 value is really a "less than" value. Dr. Miertschin testified that he used 0.05 mg/L in his model because he did not think the ambient conditions on March 6, 2008 were representative of the critical conditions of warm temperature and base flow.[69] The Executive Director requires that DO modeling assume critical conditions of low ambient flow, full permitted flow and warm temperature.[70]

The second fault with this finding is that it assumes the total phosphorus modeling done by Dr. Miertschin is required by TCEQ's rules, which it is not. As discussed above, the Executive Director evaluates the impact of nutrients using narrative criteria, the Executive Director does not require applicants to model for nutrients. Without an accurate background concentration to compare the model results to, the model is invalid and should not be used in the ALJ's analysis of the impact of the Lerin Hills proposed discharge.

*3. Exceptions to Finding of Fact No. 37. Predicted concentrations of phosphorus in the Hahnfeld Pond would be 0.4 mg/L and 0.3 mg/L, compared to the measured background of less than the detectable limit of 0.02 mg/L.*

For the same reasons enumerated in Exception 2 above, the Executive Director objects to this finding because it makes an incorrect factual assumption, which the ALJ used to ultimately determine that that the water quality in the Hahfeld pond will be lowered to more than a *de minimis* extent. Because Finding of Fact No. 37 is factually incorrect, the ED recommends it be stricken in its entirety.

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for streams and rivers, if not more so (due to greater constituent variability), although management of nutrients to improve quality in streams and rivers has not been as well documented.")

[69] Transcript, Page 99.

[70] ED-11, Page 19.

4. *Exceptions to Finding of Fact No. 39. Lerin Hills' phosphorus modeling uses a uniform decay rate to attempt to reflect removal of phosphorus from the water column, but the modeling does not attempt to reflect cumulative phosphorus loading over time.*

While this is a factual statement, it is neither relevant nor material to the issue of whether the discharge from the Lerin Hills wastewater treatment plant would cause a lowering of the water quality by more than a *de minimis* extent. Because it is neither relevant nor material to the ALJ's ultimate conclusion regarding the issuance of the Lerin Hills TPDES permit, the Executive Director recommends that it be stricken in its entirety.

As discussed above, the Executive Director evaluates the impact of nutrients using narrative criteria; the Executive Director does not require applicants to model for nutrients. Additionally, as Dr. Miertschin testified, nearly all (99%) of the water quality models used in this country are steady-state one-dimensional models.[71] Dr. Miertschin also testified that dynamic models are "incredibly sophisticated" and have "very intense data input requirements."[72] The QUAL-TX users' manual even explains that QUAL-TX is a steady-state one-dimensional water quality model, and is a modified version of QUALL-II.[73] One of the changes in QUAL-TX from QUAL-II is that '[t]he dynamic capability of QUAL-II has been removed because of the steady-state hydraulic assumptions and numerical dispersion inherent with the solution technique."[74]

Simply put, TCEQ uses a steady-state one-dimensional model; and only models for dissolved oxygen. To require applicants to perform any other modeling goes beyond the scope of TCEQ's rules.

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[71] Transcript, Pages 86-87.
[72] *Id.* Page 86, Lines 22-24 and Page 88, Lines 5-7.
[73] RW-6, Page 1.
[74] *Id.* Page 1.

5. *Exceptions to Finding of Fact No. 40. The record in this case includes no attempt to estimate quantitatively the amounts of phosphorus that will be biologically available in the stream system over time as the discharge continues.*

While this is a factual statement, it is neither relevant nor material to the issue of whether the discharge from the Lerin Hills wastewater treatment plant would cause a lowering of the water quality by more than a *de minimis* extent. Because it is neither relevant nor material to the ALJ's ultimate conclusion regarding the issuance of the Lerin Hills TPDES permit, the Executive Director recommends that it be stricken in its entirety.

As discussed above the Executive Director evaluates the impact of nutrients, such as phosphorus, on a receiving water body using narrative criteria. The TCEQ has not developed, nor has EPA required TCEQ to develop, numerical criteria for nutrients. Because there are no numerical criteria for nutrients, even if a party attempted to estimate quantitatively the amounts of phosphorus that will be biologically available over time, the numbers would be meaningless because there would not be anything relevant to compare the estimate to.

6. *Finding of Fact 43. The record in this case includes no attempt to estimate quantitatively the amounts of algal and plant growth that may result from the increased nutrient loading from the proposed discharge.*

While this is a factual statement, it is neither relevant nor material to the issue of whether the discharge from the Lerin Hills wastewater treatment plant would cause a lowering of the water quality by more than a *de minimis* extent. Because it is neither relevant nor material to the ALJ's ultimate conclusion regarding the issuance of the Lerin Hills TPDES permit, the Executive Director recommends that it be stricken in its entirety.

As discussed above, the Executive Director evaluates the impact of algal and plant growth on a receiving water body using narrative criteria. The TCEQ has not developed, nor has

EPA required TCEQ to develop, numerical criteria for algal or plant growth. Because there are no numerical criteria for algal or plant growth, even if a party attempted to estimate quantitatively the additional algal or plant growth, the numbers would be meaningless because there would not be anything relevant to compare the estimate to.

*7. Finding of Fact No. 46. Lerin Hills has not shown that any lowering of water quality resulting from the proposed discharge would be necessary for an [sic] important economic or social development.*

The Executive Director objects to this finding of fact and recommends that it be stricken in its entirety. A showing that an activity that lowers water quality is necessary for important economic or social development is only required where there is a demonstration that the water quality is lowered by more than a *de minimis* extent.[75] As discussed above, the Executive Director contends that the proposed discharge will not cause the water quality of the receiving waters to be lowered by more than a *de minimis* extent. Because the water quality will not be lowered by more than a *de minimis* extent neither the applicant nor the Executive Director was required to make a showing of important economic or social development.

*8. The Executive Director recommends that the ALJ amend Finding of Fact No. 42. An increase in plant and algal growth as a result of the proposed Lerin Hills discharge is likely.*

The Executive Director recommends the ALJ modify this finding to read "[a]n increase in plant and algal growth as a result of the proposed Lerin Hills discharge is likely, however with the effluent limit of 0.5 mg/L (daily average) for Total Phosphorus, the increase will be *de minimis.*"

[75] 30 TEX. ADMIN. CODE § 307.5(b)(2) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).

The Executive Director contends that this amendment is necessary to clarify that any increase in plant and algal growth will not lower the quality of the receiving waters by more than a *de minimis* extent.

*9. The Executive Director recommends that the ALJ amend Conclusion of Law No. 7. The evidence fails to support a conclusion that, as to nutrients and their effect on surface water quality, the draft permit and proposed discharge would satisfy the requirements of the Commission's antidegradation rule in connection with the waters of Deep Hollow Creek, Frederick Creek, and Cibolo Creek. 30 Tex. Admin. Code § 307.5.*

As explained above in the Executive Director's objections to Finding of Fact No. 45, the Executive Director contends that the evidence supports a conclusion that the draft permit satisfies the requirements of the antidegradation rule regarding all of the receiving waters. Accordingly, the Executive Director recommends that Conclusion of Law No. 7 be modified to read, "[t]he evidence ~~fails to support~~ supports a conclusion that, as to nutrients and their effect on surface water quality, the draft permit and proposed discharge would satisfy the requirements of the Commission's antidegradation rule in connection with the waters of Deep Hollow Creek, Frederick Creek, and Cibolo Creek. 30 Tex. Admin. Code § 307.5."

*10. The Executive Director objects to Ordering Provision 1. The application of Lerin Hills, Ltd., for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014712001 is denied.*

Finally, because Lerin Hills, Ltd. has satisfied all applicable statutory and regulatory requirements in its application for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014712001, and that Draft TPDES Permit No. WQ0014712001 meets all applicable statutory and regulatory requirements and can be issued without any additional provisions the Executive Director recommends that Ordering Provision 1 be modified to read "[t]he application of Lerin Hills, Ltd., for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014712001 is ~~denied~~ granted."

## IV. ED'S EXCEPTIONS TO THE ALJ'S USE OF THE TERM "DEGRADATION"

Throughout the Proposal for Decision, the ALJ uses the term "degradation"[76] instead of "lowering of water quality by more than a de minimis extent." The rules define degradation as "a lowering of water quality by more than a de minimis extent, but not to the extent that an existing use is impaired."[77] By arbitrarily substituting "degradation" for "lowering of water quality" the ALJ is modifying the law. For example, on Page 32 of the Proposal for Decision, the ALJ states that "[t]he difficulty here is that Tier 2 antidegradaion protection is extremely stringent: it prohibits *any* greater-then[sic]-*de minimis* degradation in water quality, even if the degradation has no effect on the uses of the water body." In this context by using the term "degradation", the ALJ is assuming that *by definition* the discharge degrades the water body. The question to be addressed by the Tier 2 analysis then becomes "whether the degradation is *de minimis*," rather than "whether there is a lowering of water quality by more than a *de minimis* extent," which is the standard promulgated in the rules.

Additional examples of the use of "degradation" instead of "lowering of water quality" can be found in the following pages of the PFD: Page 30 ("The contested issue to be decided is: would the proposed discharge cause prohibited degradation [lowering] of the water quality of the receiving stream?") Page 33 (the "onus is on the applicant to show, and the ED to ensure through his review, that the lowered DO, and the increases in nutrient concentrations and

[76] Proposal for Decision, Pages 32, 33, 35.
[77] 30 TEX. ADMIN. CODE §307.5(b)(2) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).

resulting biomass, will not degrade [lower] water quality more than a de minimis extent.") Page 34 ("the Commission's antidegradation rule prohibits even degradation [lowering of water quality by more than a de minimis extent] that does not rise to the level of impairing uses.") Page 36 ("the rule imposes on Lerin Hills the challenging task of proving a negative: that there will be no greater than-than-de minimis degradation [lowering of water quality] . . . . The ALJ cannot, based on this record, find that there will be no prohibited degradation [lowering] of water quality of Deep Hollow Creek and Frederick Creek as a result of the proposed discharge.") The substitution of "degradation" for "lowering of water quality" creates a presumption of degradation that may have shaped the ALJ's opinion in this case. When the correct regulatory expression is used and evaluated, the outcome of this case will be different.

## V. EXECUTIVE DIRECTOR'S EXCEPTION TO THE ALJ'S IMPOSITION OF A NEW AND HIGHER BURDEN OF PROOF

The ALJ is correct in stating that the Applicant has the burden of proof in this contested case hearing. That standard of proof is by a preponderance of evidence subject to limited exceptions that are not applicable in this case.[78] In the Order the ALJ correctly enunciates that the Applicant's burden was by a preponderance of the evidence,[79] however, in the Proposal for Decision she impermissibly raised the burden of proof to "substantial," and appeared to have extended the burden of proof to the Executive Director.[80] The ALJ stated that "the burden of proof on this issue [antidegradation] is substantial."[81] Any requirement that an applicant (or the Executive Director) fulfill the standard of "substantial evidence" as a burden of proof is

[78] 30 TEX. ADMIN. CODE § 80.17 (a) (2009) (Tex. Comm'n. Env. Quality, Tex. Surface Water Quality Standards).
[79] Order, Conclusion of Law No. 7.
[80] Proposal for Decision, Page 36.
[81] *Id.*

inappropriate in a contested case hearing. A substantial evidence standard is reserved for de novo review by appellate courts.[82]

Specifically, "substantial evidence" has been used to "keep the courts out of the business of administering regulatory statutes. . ."[83] In a de novo review, it is well-settled that the agency is the primary fact-finding body in administrative process.[84] Such review only determines whether the agency's decision is reasonably supported by substantial evidence.[85] Reviewing courts are not concerned with the correctness of the agency decision.[86] The ALJ's application of the incorrect burden of proof impermissibly prevented the applicant from fulfilling the regulatory requirements for a discharge permit. Additionally, the ALJ's application of incorporating the Executive Director in the incorrect burden of proof will prevent the Executive Director from meeting and affording to others the due process of law.[87]

## VI. CONCLUSION

The Executive Director concludes that Lerin Hills, Ltd. has satisfied all applicable statutory and regulatory requirements in its application for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014712001, and that Draft TPDES Permit No. WQ0014712001 meets all applicable statutory and regulatory requirements and can be issued without any additional provisions.

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82 *Lewis*, 550 S.W.2d at 13-15; *Olivarez* , 693 S.W.2d at 931*; Fleetwood Comm'ty Home v. Bost*, 110 S.W.3d 635, 642 (Tex. App.--Austin 2003, no pet.).
83 *Lewis*, 550 S.W.2d at 13.
84 *Fireman's and Policeman's Civil Service Commission v. Brinkmeyer*, 662 S.W.2d 953, 956 (Tex. 1984).
85 *Fireman's*, 662 S.W.2d at 955.
86 *Id.* at 956.
87 *Lewis*, 550 S.W.2d at 13.

Respectfully submitted,
Texas Commission on Environmental Quality

Mark R. Vickery, P.G.
Executive Director

Robert Martinez, Director
Environmental Law Division

By ______________________
Kathy J. Humphreys, Staff Attorney
Environmental Law Division
State Bar No. 24006911
P.O. Box 13087, MC 173
Austin, Texas 78711-3087
(512) 239-3417
REPRESENTING THE EXECUTIVE DIRECTOR OF THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

By ______________________
Timothy J. Reidy, Staff Attorney
Environmental Law Division
State Bar No. 24058069
P.O. Box 13087, MC 173
Austin, Texas 78711-3087
(512) 239-0969
REPRESENTING THE EXECUTIVE DIRECTOR OF THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

## CERTIFICATE OF SERVICE

I certify that on March 24, 2009, a copy of the foregoing Executive Director's Closing Argument was filed with the Office of the Chief Clerk and sent by first class, agency mail and/or facsimile to the persons listed in the attached mailing list.

Kathy J. Humphreys, Staff Attorney
Environmental Law Division

**MAILING LIST**
**For**
**LERIN HILLS, LTD.**
**SOAH DOCKET NO. 582-08-0690**
**TCEQ DOCKET NO. 2007-1178-MWD**
**PERMIT NO. WQ0014712001**

**<u>FOR THE STATE OFFICE OF ADMINISTRATIVE HEARINGS:</u>**

The Honorable Shannon Kilgore
Administrative Law Judge
State Office of Administrative Hearings
PO Box 13025
Austin, TX 78711-3025
Phone: (512) 475-4993
Fax: (512) 475-4994

**<u>FOR THE APPLICANT:</u>**

Danny G. Worrell, Attorney
Brown McCarroll, L.L.P.
111 Congress Ave., Suite 1400
Austin, Texas 78701
Phone: (512) 479-1151
Fax: (512) 479-1101

**<u>FOR THE PUBLIC INTEREST COUNSEL</u>**

Amy Swanholm, Attorney
Texas Commission on Environmental Quality
Public Interest Counsel MC-103
P.O. Box 13087
Austin, Texas 78711-3087
Phone: (512) 239-6823
Fax: (512) 239-6377

**<u>FOR THE CHIEF CLERK</u>**

LaDonna Castañuela
Texas Commission on Environmental Quality
Office of Chief Clerk MC-105
P.O. Box 13087
Austin, Texas 78711-3087
Phone: 239-3300
Fax: 239-3311

**<u>FOR THE PROTESTANT:</u>**

Eric Allmon, Attorney
Lowerre, Frederick, Perales, Allmon, & Rockwell
707 Rio Grande, Suite 200
Austin, Texas 78701
Phone: (512) 469-6000
Fax: (512) 482-9346

**<u>FOR THE EXECUTIVE DIRECTOR:</u>**

Kathy Humphreys, Staff Attorney
Texas Commission on Environmental Quality
Environmental Law Division MC-173
P.O. Box 13087
Austin, Texas 78711-3087
Phone: (512) 239-3417
Fax: (512) 239-0606

Timothy J. Reidy, Staff Attorney
Texas Commission on Environmental Quality
Environmental Law Division MC-173
P.O. Box 13087
Austin, Texas 78711-3087
Phone: (512) 239-0969
Fax: (512) 239-0606

# Attachment A

United States
Environmental Protection Agency

Office of Water
4304

EPA-821-F-08-007
December 2008

EPA

# STATE ADOPTION OF NUMERIC NUTRIENT STANDARDS (1998-2008)

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# Table of Contents

# Notice

Beginning in 1998, EPA recommended in a series of policy memoranda that States accelerate the development and adoption of numeric nutrient water quality standards. These policy memoranda and other related guidance documents are designed to implement national policy. They are not regulations nor do they contain or constitute a determination that new or revised nutrient water quality standards are necessary in a particular or site-specific context to meet the requirements of the Clean Water Act. State and Tribal decision-makers retain discretion to adopt water quality standards based on other scientifically defensible approaches that may differ from the recommendations in EPA guidance.

# 1.0 Purpose of the Report

Nitrogen and phosphorus (or nutrient) pollution is a leading cause of water quality impairments in the U.S. As a consequence, EPA has made protecting and restoring the nation's waters from nitrogen and phosphorus pollution a top priority. This priority was most recently articulated in a memorandum[1] from EPA Assistant Administrator for Water, Benjamin Grumbles, in May 2007 to State, Great Water Body, Interstate, and authorized Tribal Water Programs.

During the past ten years, EPA has worked in partnership with States, Territories, authorized Tribes and certain River Basin Commissions to adopt numeric nutrient criteria into water quality standards. These standards are critical for preventing the harmful effects of nitrogen and phosphorus pollution in the nation's waters and for restoring water quality from the impairments caused by this pollution.

This report follows up on the commitment in the May 2007 memorandum that EPA would periodically publish a report on State progress in adopting numeric nutrient water quality standards[2]. The report focuses on progress made by the 50 States[3] in adopting numeric nutrient standards for their major waterbody types (lakes and reservoirs, rivers and streams, estuaries, and wetlands) since 1998 when EPA released its "National Strategy for the Development of Regional Nutrient Criteria"[4].

It is important to note that there are a range of innovative and effective tools and other management approaches to address nutrient pollution problems, including total maximum daily loads (TMDLs), best management practices (BMPs), trading, economic incentives, and technology-based control approaches. However, EPA believes that numeric nutrient water quality standards provide an important foundation to accelerate, guide, calibrate, and evaluate the implementation of these tools.

# 2.0 Scope of the Nitrogen and Phosphorus Pollution Problem

Excessive amounts of nitrogen and phosphorus in our nation's waterways are a form of pollution that leads to significant adverse ecological impacts. The effects may occur close to the sources of nitrogen and phosphorus pollution or they may be manifested downstream from the sources,

[1] Grumbles, B.H. 2007. U.S. EPA. (Memorandum to Directors of State Water Programs, Directors of Great Water Body Programs, Directors of Authorized Tribal Water Quality Standards Programs and State and Interstate Water Pollution Control Administrators on Nutrient Pollution and Numeric Water Quality Standards. May 25, 2007).

[2] Water quality standards are established by state law or regulation and include designated uses, criteria to protect uses, and anti-degradation policies. This report generally uses the terms "numeric nutrient standards" or "numeric nutrient criteria" to refer to the numeric nutrient criteria adopted into water quality standards by the States. The term water quality criteria is used in two different ways under the CWA. Under CWA section 304(a), EPA publishes recommended water quality criteria guidance that consists of scientific information such as concentrations of specific chemicals or levels of parameters in water that protect aquatic life and human health. States may use these recommended criteria as the basis for water quality criteria legally adopted as elements of State water quality standards under CWA section 303(c).

[3] The five U.S. Territories (U.S. Virgin Islands, Guam, American Samoa, Commonwealth of Northern Mariana Islands, and Commonwealth of Puerto Rico), District of Columbia, River Basin Commissions (Delaware River Basin Commission, Ohio River Valley Sanitation Commission) and authorized Tribes also develop and adopt numeric nutrient standards; however, they are not included in the report's cumulative statistics. The status of the District of Columbia's, each Territory's and River Basin Commission's progress in adopting numeric nutrient standards is noted in Appendix A (State Profiles) and Appendix C (Summary of Territory/Other Numeric Nutrient Standards Adoption: 1998 vs. 2008).

[4] U.S. EPA. 1998. National Strategy for the Development of Regional Nutrient Criteria. Office of Water, Washington, D.C. EPA 822-R-98-002.

sometimes hundreds of miles away. The well-documented adverse effects of nitrogen and phosphorus pollution include harmful algal blooms, reduced spawning grounds and nursery habitats, fish kills, oxygen-starved hypoxic or "dead" zones where fish and aquatic life can no longer survive, and public health concerns related to impaired drinking water sources and increased exposure to toxic microbes such as certain forms of cyanobacteria. Hypoxic events caused by nitrogen and phosphorus pollution have become a national concern with regular, persistent events occurring in the northern Gulf of Mexico, Chesapeake Bay, Long Island Sound, and Hood Canal in Washington State. Collectively, these effects can cause severe economic hardship for local tourist-based and fishing economies. The significance of these events has led EPA, States, and the public to come together to place a priority on public partnerships, collaboration, better science, and improved tools to reduce nutrient pollution.

As noted above, nitrogen and phosphorus pollution is the cause of significant and widespread environmental problems in many of our nation's lakes, reservoirs, rivers, streams, estuaries, and wetlands. It is identified as one of the top causes of water quality impairments in the U.S. and a persistent threat to water quality. In 2006, EPA documented[5] over 3 million acres of lakes, reservoirs, and ponds, 75,000 miles of rivers and streams, nearly 900 square miles of bays and estuaries, and over 70,000 acres of wetlands whose water quality was impaired due to nitrogen and phosphorus pollution. Forty-nine States have Clean Water Act (CWA) Section 303(d)-listed impairments for nitrogen and phosphorus pollution. States have listed over 10,000 nutrient-related impairments, with 15 States listing more than 200 nutrient-related impairments. Population growth, with its accompanying urban, suburban, and agricultural development, increases the sources and magnitude of nitrogen and phosphorus pollution.[6]

# 3.0 Why Numeric Nutrient Standards are Important

State water quality standards are the foundation for protecting the quality of the nation's surface waters and are the cornerstone of the water quality-based control program mandated by the CWA. Standards describe the desired condition of a waterbody and consist of three principal elements: (1) the "designated uses" of the state's waters (e.g., fishing, aquatic life, drinking water); (2) "criteria" specifying the amounts of various pollutants, in either numeric or narrative form, that may be present in those waters without impairing the designated uses; and (3) anti-degradation policies providing for protection of existing water uses and limitations on degradation of high quality waters. EPA has recommended that States adopt numeric nutrient standards. Numeric standards provide a quantitative measure for nitrogen or phosphorus, as well as other parameters. As a result, numeric nutrient standards:

- Provide measurable, objective water quality baselines against which to measure environmental progress;
- Facilitate the writing of protective National Pollution Discharge Elimination System (NPDES) permits;
- Make development of water quality targets in TMDLs faster and easier;

[5] EPA Water Quality Assessment and Total Maximum Daily Loads Information (ATTAINS) website: http://epa.gov/waters/ir/

[6] Sources of nitrogen and phosphorus pollution are typically categorized as point sources (e.g., industrial wastewater discharges, municipal sewage treatment discharges, etc.) and non-point sources (e.g., runoff from agricultural lands, range and pasture lands, suburban lawns, golf courses).

- Increase the effectiveness in evaluating success of nutrient runoff minimization programs;
- Provide quantitative targets to support trading programs;
- Support broader partnerships to employ best management practices (BMPs), land stewardship, wetlands protection, voluntary collaboration, and urban storm water runoff control strategies; and
- Identify the water quality goals being sought, and thus enhance greater public participation and a more transparent process.

# 4.0 Measuring Progress and Reporting Results

This report provides the status of State progress in adopting numeric nutrient criteria into water quality standards in the 10 years since EPA issued its "National Strategy for the Development of Regional Nutrient Criteria" in June 1998. That strategy recognized the growing problem of nitrogen and phosphorus pollution and laid out the expectation that all States should develop numeric standards to protect their waters from this pollution. In 2001[7], EPA reaffirmed the importance of States adopting numeric nutrient standards and encouraged each State to develop a plan to adopt standards. EPA also stated the expectation that States and EPA would mutually agree to those plans. In 2007[8], EPA reiterated its expectation that States adopt numeric nutrient standards and urged States to accelerate the pace for adoption of those standards. To be most effective, numeric nutrient standards should address causal (both total nitrogen [TN] and total phosphorus [TP]) and response (chlorophyll *a* and water clarity) variables for all waters that contribute nutrient loadings to the nation's waterways. Since 1998, EPA has completed a suite of technical tools for States to use in developing numeric nutrient criteria (i.e., technical guidance manuals for deriving criteria and eco-regional numeric nutrient criteria recommendations).

This report provides an update on State progress in adopting numeric nutrient standards. Current status is characterized in terms of numeric nutrient standards adopted by States and approved by EPA for any of EPA's recommended parameters (TN, TP, chlorophyll a, and clarity) for any waterbody type: lakes and reservoirs, rivers and streams, estuaries, and wetlands. This report describes the parameters and waterbody types for which States have adopted numeric nutrient standards and also notes incremental progress towards that goal. This includes State adoption of numeric nutrient water quality standards for one or more parameters for all of one or more waterbody types. EPA also recognizes that States have made positive, incremental steps by adopting criteria for a parameter(s) for selected waters within a waterbody type (e.g., lakes/reservoirs used for recreation versus lakes/reservoirs used solely for drinking water, segments of a river rather than all rivers/streams).

[7] Grubbs, G. 2001. U.S. EPA. (Memorandum to Directors of State Water Programs, Directors of Great Water Body Programs, Directors of Authorized Tribal Water Quality Standards Programs and State and Interstate Water Pollution Control Administrators on Development and Adoption of Nutrient Criteria into Water Quality Standards. November 14, 2001).

[8] Grumbles, B.H. 2007. U.S. EPA. (Memorandum to Directors of State Water Programs, Directors of Great Water Body Programs, Directors of Authorized Tribal Water Quality Standards Programs and State and Interstate Water Pollution Control Administrators on Nutrient Pollution and Numeric Water Quality Standards. May 25, 2007).

The report focuses on the States' adoption of numeric nutrient standards for protection against eutrophication[9] and the effects of eutrophication. The report also documents the status of each State's nutrient criteria plan. A plan, developed by the State, reflects its blueprint for developing and adopting numeric nutrient criteria into water quality standards. Nutrient criteria plans vary by State due to differences in the types of waters within the State, State priorities, and other considerations. In general, however, the plans describe the State's approach for developing numeric nutrient criteria, their process, milestones, and expected dates for the adoption of criteria into their water quality standards. Most nutrient criteria plans[10] reflect shared expectations by States and EPA for developing and adopting numeric nutrient criteria into water quality standards. This report documents which States have nutrient criteria plans, what they provide for, including the waterbodies and parameters for which criteria will be developed, and expected dates of standards adoption.

# 5.0 What States Have Achieved

This report is organized into two sections -- national summaries of progress and State profiles. The State profiles in Appendix A provide the status of each State's currently adopted numeric nutrient standards and plans for future development and adoption. The national summaries are aggregates of data drawn from these profiles.

# National Summaries

### 1998 to 2008: Trends in State Adoption of Numeric Nutrient Standards

States have developed and adopted numeric nutrient standards for a range of nutrient parameters and for a range of waterbody types. Figures 1 and 2 and Table 1 depict the status of numeric nutrient standards adoption in 1998 and 2008, respectively. In 1998, six States had adopted numeric nutrient standards for at least one nutrient parameter for at least one entire waterbody type. By 2008, seven States had adopted numeric nutrient standards for at least one nutrient parameter for at least one entire waterbody type. States have made more progress in adopting numeric nutrient standards for selected waters within a waterbody type. In 1998, seven States had adopted numeric nutrient standards for one or more parameters for part of one or more waterbody types. By 2008, 18 States had adopted numeric nutrient standards for one or more parameters for part of one or more waterbody types. For more detail on State-adopted numeric nutrient standards by year and waterbody type, see Appendix B.

### 2008 Status of State Adoption of Numeric Nutrient Standards

The 2008 status of State numeric nutrient standards adoption by waterbody type is summarized in Table 1. As in Figures 1 and 2, the status of State adoption is differentiated on the following basis: whether a State adopted numeric nutrient standards for both causal and response

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[9] The report excludes numeric nutrient standards developed to protect against the acute toxic effects of nitrogen, specifically nitrate and nitrite ($NO_3$ and $NO_2$, respectively), and phosphorus, specifically elemental phosphorus, on humans and/or livestock utilizing surface waters for drinking and source water supply. Although important, these numeric nutrient standards typically were not developed to protect against eutrophication. Eutrophication is an increase in organic carbon to an aquatic ecosystem caused by primary productivity stimulated by excess nutrients -- typically compounds containing nitrogen or phosphorus. Eutrophication can adversely affect aquatic life, recreation, and human health (e.g., toxic microbe production) uses of waters. The report also excludes numeric turbidity criteria associated with suspended sediments and which were not developed to protect against eutrophication.

[10] Nutrient criteria plans provide a guide for EPA and States to achieve the goal of numeric nutrient standard adoption. They are not legally binding on States, do not constitute criteria, nor meet the requirements of the CWA on their own.

parameters for an entire waterbody type, whether a State adopted numeric nutrient standards for one or more parameters for an entire waterbody type, whether a State has adopted numeric nutrient standards for one or more parameters for selected waters within a waterbody type, and if a State has not adopted numeric nutrient standards. State adoption of numeric nutrient standards for one or more parameters for selected waters within a waterbody type is also noted and further detailed in each State's profile in Appendix A.

Lakes/Reservoirs

- Six States have adopted numeric nutrient standards for one or more parameters for all of their lakes/reservoirs;
- Thirteen States have adopted numeric nutrient standards for one or more parameters for part of their lakes/reservoirs; and
- Thirty-one have not adopted numeric nutrient standards for their lakes/reservoirs.

Rivers/Streams

- Five States have adopted numeric nutrient standards for one or more parameters for all of their rivers/streams;
- Nine States have adopted numeric nutrient standards for one or more parameters for part of their rivers/streams; and
- Thirty-six have not adopted numeric nutrient standards for their rivers/streams.

Estuaries (for the 24 States that have estuaries)

- Three States have adopted numeric nutrient standards for one or more parameters for all of their estuaries;
- Seven States have adopted numeric nutrient standards for one or more parameters for part of their estuaries; and
- Fourteen States have not adopted numeric nutrient standards for their estuaries.

Wetlands

- No State has adopted numeric nutrient standards for one or more parameters for all of its wetlands;
- Four States have adopted numeric nutrient standards for one or more parameters for part of their wetlands;
- Forty-six States have not adopted numeric nutrient standards for their wetlands.

## Status of State Nutrient Criteria Plans

Overall, an analysis of plans indicates the following:

- 46 of 50 States have plans[11] which have been reviewed by EPA and are being used to guide numeric nutrient criteria development.
- Three States (HI[12], OR, and SD) have not submitted a plan to EPA.
- One State (CA) submitted a plan to EPA in 2001, but is no longer using it to guide its numeric nutrient criteria development.

[11] Forty-three of these plans have been mutually agreed to by EPA and the State; three of these plans have not yet been mutually agreed upon.
[12] Hawaii has already adopted standards for its waterbody types.

Of the 46 State plans which EPA reviewed and States use to guide criteria development:

- 33 plans include projected adoption dates for at least one waterbody type. Of these 33 plans, and seven include at least one adoption date that has passed and have not been met. Four include adoption dates that have been met.
- 13 plans do not include projected adoption dates.

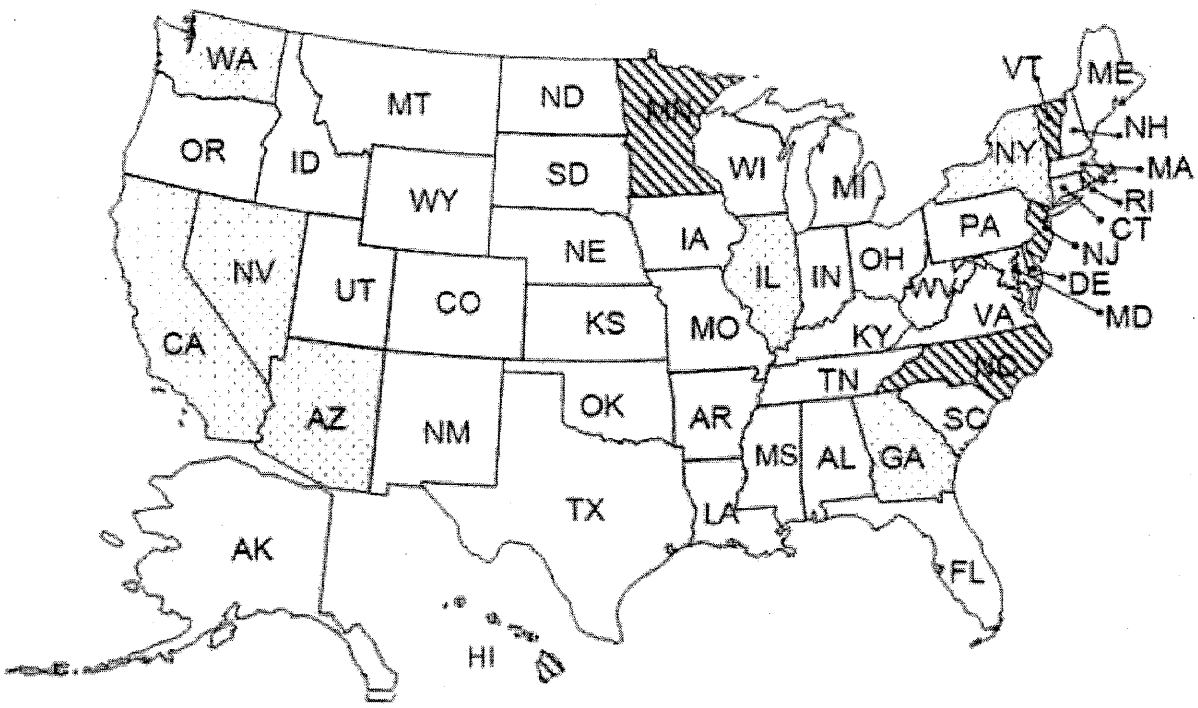
As noted previously, these plans vary considerably in terms of whether they include adoption dates for standards or interim milestone dates for achieving standards adoption. They also vary in terms of whether the original projection dates for adoption of standards have remained unchanged or have been routinely updated. For more detail on each State's plan, see Appendix A.

# State Profiles

Existing numeric nutrient standards are provided in Appendix A and B. Numeric nutrient standards as of 1998 and 2008 are listed. Appendix A also includes State nutrient criteria plan information for developing and adopting numeric nutrient standards to protect against eutrophication and its effects. This information includes the date of the plan, the nutrient parameters being pursued, priority waterbodies considered for criteria adoption, and projected dates for standards adoption.

# Figure 1

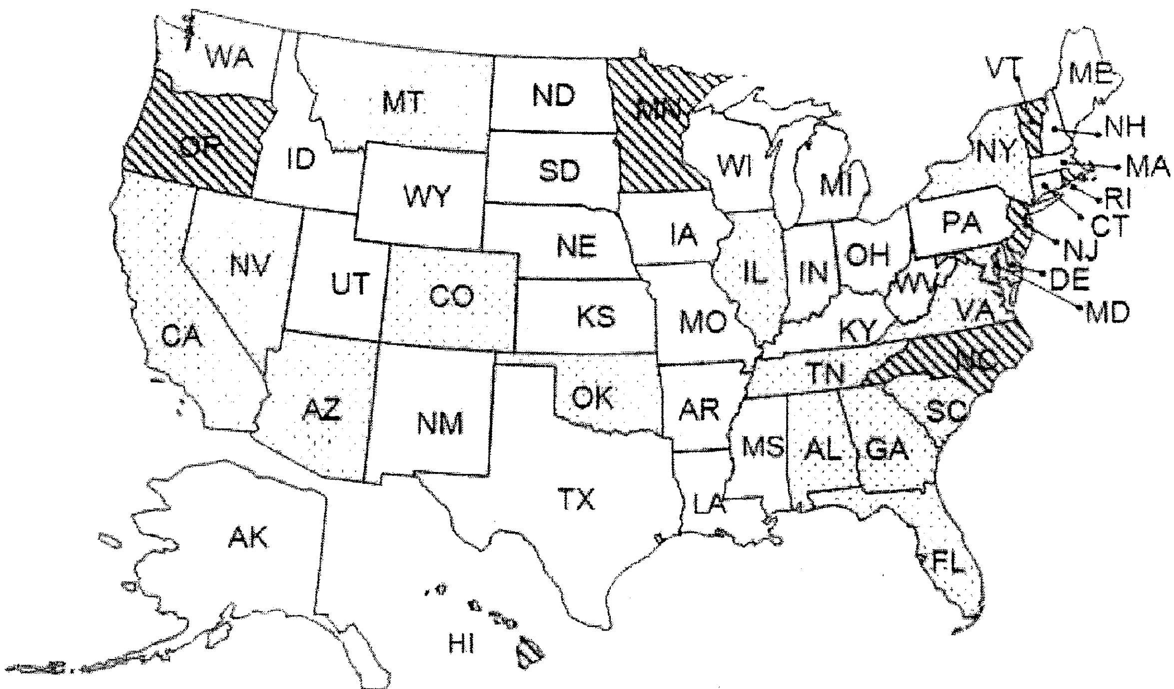
## 1998 Status of State Adoption of Numeric Nutrient Criteria into Water Quality Standards




- Adopted numeric criteria for one or more parameters for at least one entire waterbody type (6 States)
- Adopted numeric criteria for one or more parameters for selected individual waters in a waterbody type (7 States)
- Has not adopted numeric criteria (37 States)

# Figure 2

**2008 Status of State Adoption of Numeric Nutrient Criteria into Water Quality Standards**




Adopted numeric criteria for one or more parameters for at least one entire waterbody type (7 States)

Adopted numeric criteria for one or more parameters for selected individual waters in a waterbody type (18 States)

Has not adopted numeric criteria (25 States)

# Table 1

## Number of States with Adopted Numeric Nutrient Standards by Year and Waterbody Type

| Numeric Nutrient Standards Status by Year | 4 Parameters 4 Waterbody Types[1] | 1+ Parameters 1+ Entire Waterbody Types[2] | 1+ Parameters Selected Waters[3] | No Numeric Criteria[4] |
|---|---|---|---|---|
| 1998 | 0 | 6 | 7 | 37 |
| 2008 | 0 | 7 | 18 | 25 |
| **2008 Numeric Nutrient Standards Status by Waterbody Type** | **4 Parameters 4 Waterbody Types[5]** | **1+ Parameters 1+ Entire Waterbody Types[6]** | **1+ Parameters Selected Waters[7]** | **No Numeric Criteria[4]** |
| Lakes/Reservoirs | 0 | 6 | 13 | 31 |
| Rivers/Streams | 0 | 5 | 9 | 36 |
| Estuaries (24 eligible States) | 0 | 3 | 7 | 14 |
| Wetlands | 0 | 0 | 4 | 46 |

[1] Adopted numeric criteria for all four parameters (TN, TP, Chlorophyll-*a*, and Clarity) for all waterbody types.
[2] Adopted numeric criteria for one or more parameters for at least one entire waterbody type.
[3] Adopted numeric criteria for one or more parameters for selected individual waters in one or more waterbody types.
[4] Has not adopted numeric criteria.
[5] Adopted numeric criteria for all four parameters for the entire waterbody type.
[6] Adopted numeric criteria for one or more parameters for the entire waterbody type.
[7] Adopted numeric criteria for one or more parameters for selected individual waters in a waterbody type.
(See the State Profile for details)

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# APPENDIX A:
## STATE PROFILES

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# Alabama

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | ◘[2] | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From AL Water Quality Criteria, effective December 3, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Numeric criteria for selected lakes (29 of 41 most significant lakes in AL).

## Nutrient Criteria Plan

Y/N: Yes

Date: September 14, 2007 (revised)

Nutrient Parameters: Chlorophyll-*a*, TP, TN, and Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2011

Rivers/Streams - 2012

Estuaries - 2013

Wetlands - 2015

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/al/al_4_wqs.pdf

http://www.adem.alabama.gov/WaterDivision/WQuality/WQMainInfo.htm

N/A = Not Applicable

# Alaska

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From AK Water Quality Standards, effective February 27, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: April, 2004

Nutrient Parameters: TN, TP, Chlorophyll-*a* and Secchi depth.

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2007

Rivers/Streams - After lakes

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ak/ak_10_wqs.pdf

http://dec.alaska.gov/water/wqsar/wqs/Regulations.htm

N/A = Not Applicable

# American Samoa

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ●* | ●* | | ●[2, *] |
| Rivers/Streams | ●* | ●* | | ●[2, *] |
| Estuaries | ●* | ●* | ●* | ●[2, *] |
| Wetlands | ●* | ●* | | ●[2, *] |

● = Statewide ◘ = For selected waterbody

[1] From American Samoa Water Quality Standards, 1999 Revision, effective April 24, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Clarity criteria for turbidity, TSS and light penetration depth.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: No

Date: N/A

Nutrient Parameters: TN, TP, Chlorophyll-*a*, light penetration, turbidity and TSS

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A (standards revised April 24, 2006)

Rivers/Streams - N/A (standards revised April 24, 2006)

Estuaries - N/A (standards revised April 24, 2006)

Wetlands - N/A (standards revised April 24, 2006)

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: http://americansaoma.gov.departments.agencies/epa.htm

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/territories/american_samoa_9_wqs.pdf

N/A = Not Applicable

# Arizona

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ◘[2], * | ◘[2], * | | |
| Rivers/Streams | ◘[2], * | ◘[2], * | | ◘[2], * |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From AZDEQ Water Quality Standards, effective October 22, 2002. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] TN, Nitrate, TP and turbidity for selected waters and designated uses.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: April, 2008 (revised)

Nutrient Parameters: For lakes proposing TN, TP, TKN, Chlorophyll-*a*, Secchi Depth, Blue Green Algae (concentration and abundance), DO, pH

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/az/az_9_wqs.pdf

http://www.azsos.gov/public_services/title_18/18-11.pdf

http://www.azdeq.gov/environ/water/standards/index.html

N/A = Not Applicable

# Arkansas

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Arkansas Pollution Control and Ecology Regulation No. 2: Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas, effective January 24, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: April 14, 2008 (revised)

Nutrient Parameters: For Rivers/Streams: 72-h diurnal DO, pH, nitrite+nitrate-N, TP, ortho-phosphate as P, algal cover, periphyton thickness, algal filament length, Macroinvertebrate Biotic Metrics, Fish Biotic Metrics, Turbidity. For Lakes/Reservoirs: Chlorophyll-*a*, water clarity (Secchi depth), turbidity, nitrogen, and phosphorus.

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: http://www.adeq.state.ar.us

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ar/ar_6_wqs.pdf

http://www.adeq.state.ar.us/water/regulations.htm

N/A = Not Applicable

# California

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes | ◘[2,3,4,5,6,*] | ◘[3,4,5,6,*] | ◘[3,4,7,*] | ◘[3,4,6,7,8,*] |
| Reservoirs | ◘[2,3,5,6,*] | ◘[3,5,6,*] | | ◘[3,6,8,*] |
| Rivers | ◘[2,3,5,6,*] | ◘[3,5,6,*] | | ◘[3,6,8,*] |
| Streams | ◘[2,3,5,6,*] | ◘[3,5,6,*] | | ◘[3,6,8,9,*] |
| Estuaries | ◘[2,6,*] | ◘[6,*] | | ◘[6,8,*] |
| Wetlands | ◘[2,6,*] | ◘[6,*] | | ◘[3,8,*] |

● = Statewide ◘ = For selected waterbody

[1] State numeric nutrient criteria for drinking water/source water protection were not considered in the table. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] From Water Quality Control Plan: Los Angeles Region, effective 2/25/95; Nitrate+Nitrite-N for select waterbodies.

[3] From Water Quality Control Plan for the Lahontan Region, North and South Basins, effective 10/94; Secchi depth in specific waters.

[4] Specific to Fallen Leaf Lake and Lake Tahoe in Lahontan Region.

[5] TN, TP, Nitrate-N & orthophosphate in specific waters in Lahontan Region.

[6] From Water Quality Control Plan for the San Diego Basin, effective 3/12/97: TN, TP, and Secchi depth.

[7] Eagle Lake specific in Lahontan Region for Chl-a.

[8] From Water Quality Control Plan (Basin Plan) for the CA Regional Water Quality Control Board, Central Valley Region, Fourth Edition—1998, The Sacramento River Basin and The San Joaquin River Basin, effective 9/15/98: Turbidity as NTUs: specific criteria for Folsom Lake, American River and Delta waters.

[9] From Amendment to Water Quality Control Plan for the Sacramento and San Joaquin River Basins for Deer Creek, effective 10/15/03: Turbidity as maximum 5 NTUs.

*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: No (but had a plan in 2001)

Date: N/A

Nutrient Parameters: N/A

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - N/A
- Rivers/Streams - N/A
- Estuaries - N/A
- Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ca/index.html

http://www.wq.water.ca.gov/owq_content/regulations.cfm

N/A = Not Applicable

# Colorado

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ◘[2] | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From CO Basic Standards and Methodologies for Surface Water, effective December 31, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] For Cherry Creek Reservoir, Chatfield Reservoir, Dillon Reservoir and Segment 3 of the Blue River.

## Nutrient Criteria Plan

Y/N: Yes

Date: September 26, 2002

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth or turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2010 Rulemaking hearing

Rivers/Streams - 2010 Rulemaking hearing

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/co/reg31-20051231.pdf

http://www.cdphe.state.co.us/regulations/wqccregs/wqccreg31basicstandardsforsurfacewater.pdf

N/A = Not Applicable

# Commonwealth of N. Mariana

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ●* | ●[2,] * | | ●[3,] * |
| Rivers/Streams | ●* | ●[2,] * | | ●[3,] * |
| Estuaries | ●* | ●[2,] * | | ●[3,] * |
| Wetlands | ●* | ●[2,] * | | ●[3,] * |

● = Statewide ◘ = For selected waterbody

[1] From Commonwealth of the Northern Mariana Islands Water Quality Standards, revised October 28, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Includes TP and orthophosphate.
[3] Clarity as turbidity (includes total filterable suspended solids).
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: No

Date: N/A

Nutrient Parameters: TN, TP and Turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A (standards revised October 28, 2004)

Rivers/Streams - N/A (standards revised October 28, 2004)

Estuaries - N/A (standards revised October 28, 2004)

Wetlands - N/A (standards revised October 28, 2004)

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/territories/northern_mariana_9_wqs.pdf

http://www.deq.gov.mp/artdoc/Sec9art52ID133.pdf

N/A = Not Applicable

# Connecticut

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From CT Water Quality Standards, effective December 17, 2002.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes (but plan is not mutually-agreed upon with EPA Region 1)

Date: January 20, 2005 (revised)

Nutrient Parameters: TP, Chlorophyll-*a* and Secchi depth; not considering TN at this time.

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ct/ct_1_wqs.pdf

http://www.ct.gov/dep/lib/dep/water/water_quality_standardsl/wqs.pdf

N/A = Not Applicable

# Delaware

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | ◘[2] | ◘[2] | | ◘[3] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From DE Surface Water Quality Standards as amended July 11, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] For tidal portions of the stream basins of Indian River, Rehoboth Bay, and Little Assawoman Bay, controls needed to attain submerged aquatic vegetation growth season (approximately March 1 to October 31) average levels for dissolved inorganic nitrogen of 0.14 mg/L as N, for dissolved inorganic phosphorus of 0.01 mg/L as P, and for total suspended solids of 20 mg/L shall be instituted.

[3] DE has also adopted dissolved oxygen and Secchi disk criteria for its tidal Chesapeake Bay waters.

## Nutrient Criteria Plan

Y/N: Yes

Date: 2004

Nutrient Parameters: TP, TN, Chlorophyll-*a*, clarity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Summer 2007

Rivers/Streams - Summer 2007

Estuaries - Summer 2007

Wetlands - Summer 2007

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/de/de_3_wqs.pdf

http://www.dnrec.state.de.us/DNREC2000/Divisions/Water/WaterQuality/Standards.htm

N/A = Not Applicable

# District of Columbia

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | ◘[2] | ◘[2, 3] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Title 21 of the District of Columbia Municipal Regulations, Chapter 11, Water Quality Standards, effective February 15, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Apply to tidally influenced Class C waters and their designated uses. Determined by following guidelines documented in the 2003 United States Environmental Protection Agency publication: *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and its Tidal Tributaries*, EPA-903-R-03-002, April 2003.
[3] For tidally influenced Class C waters, water clarity criteria is measured by Secchi Disc depth.

## Nutrient Criteria Plan

Y/N: N/A

Date: N/A

Nutrient Parameters: Note: For the most part, nutrient criteria work for tidal waters was the adoption of the Chesapeake Bay criteria for DC's Potomac River section and the tidal Anacostia River per their October 28, 2005 Triennial Review WQS.

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - N/A
- Rivers/Streams - N/A
- Estuaries - N/A
- Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/dc/dc_3_register.pdf

http://ddoe.dc.gov/ddoe/cwp/view,a,1209,q,495456.asp

N/A = Not Applicable

# Florida

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | ◘[2] | | |

● = Statewide ◘ = For selected waterbody

[1] From FL Surface Water Quality Standards, effective October 10, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] The State's TP numeric criteria for the Everglades Protection Area is not a wetland criteria per se, it is a water column value applied to a glades ecotype which includes the standing and slow flowing surface waters of a marsh system.

## Nutrient Criteria Plan

Y/N: Yes

Date: September 26, 2007 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - 2011
- Rivers/Streams - 2011
- Estuaries - No date
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.dep.state.fl.us/legal/Rules/shared/62-302/62-302.pdf

http://www.dep.state.fl.us/legal/Rules/shared/62-302/302-Table.pdf

http://www.dep.state.fl.us/water/wqssp/surface.htm

N/A = Not Applicable

# Georgia

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ◘[2,*] | ◘[3,*] | ◘[2,*] | |
| Rivers/Streams | | ◘[3,*] | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From GA Rules and Regulations for Water Quality Control Chapter 391-2-6, revised November, 2005. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Numeric criteria for selected lakes.
[3] Numeric criteria for pounds per acre-foot of lake volume per year for selected streams (only streams which are tributaries to lakes in note 2).
*Standard present in 1998 for 3 (of 6) lakes in note 2.

## Nutrient Criteria Plan

Y/N: Yes

Date: April, 2006

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2012

Rivers/Streams - 2013

Estuaries - 2014

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ga/ga_4_wqs.pdf

http://www.georgiaepd.org/Documents/index_water.html

N/A = Not Applicable

# Guam

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ●[2,*] | ●[3,*] | | ●[4] |
| Rivers/Streams | ●[2,*] | ●[3,*] | | ●[4] |
| Estuaries | ●[2,*] | ●[3,*] | | ●[4] |
| Wetlands | ●[2,*] | ●[3,*] | | ●[4] |

● = Statewide ◘ = For selected waterbody

[1] From Guam Water Quality Standards, 2001 Revision. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Numeric standard for nitrate-nitrogen ($NO_3$-N).
[3] Numeric standard for orthophosphate ($PO_4$-P).
[4] Clarity criteria given as turbidity.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: No

Date: N/A

Nutrient Parameters: TN, TP, Turbidity, DO and pH

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A (standards revised 2001)

Rivers/Streams - N/A (standards revised 2001)

Estuaries - N/A (standards revised 2001)

Wetlands - N/A (standards revised 2001)

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/territories/guam_9_wqs.pdf

http://www.guamepa.govguam.net/programs/water/

N/A = Not Applicable

# Hawaii

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | ●[2,*] | ●[*] | | ●[*] |
| Estuaries | ●[2,*] | ●[*] | ●[*] | ●[*] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From HI Administrative Rules Title 11—Water Quality Standards, effective October 28, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Includes TN and nitrate+nitrite as N.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: No

Date: N/A

Nutrient Parameters: TN, TP, Chlorophyll-*a*, turbidity (and others)

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A

Rivers/Streams - N/A (standards revised August 31, 2004)

Estuaries - N/A (standards revised August 31, 2004)

Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/hi/hawaii_9_wqs.pdf

http://gen.doh.hawaii.gov/sites/har/AdmRules1/11-54.pdf

N/A = Not Applicable

# Idaho

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From ID Water Quality Standards, effective June 4, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: November, 2007

Nutrient Parameters: TP, TN, Chlorophyll-*a*, periphyton, macroinvertebrates

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - No date
- Rivers/Streams - No date
- Estuaries - N/A
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/id/id_10_wqs.pdf

http://www.deq.state.id.us/water/data_reports/surface_water/monitoring/standards.cfm

N/A = Not Applicable

# Illinois

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ◘[2,*] | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From IL Water Quality Criteria, effective August 9, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. Illinois has numeric criteria for nitrogen and phosphorus for the open waters of Lake Michigan.

[2] Numeric criteria for phosphorus in any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more, or in any stream at the point where it enters any such reservoir or lake.

*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: September 6, 2006

Nutrient Parameters: Phosphorus, Chlorophyll-*a*

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Winter 2009

Rivers/Streams - Winter 2009

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/il/il_5_c302.pdf

http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp

N/A = Not Applicable

# Indiana

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From IN Water Quality Standards, errata filed August 11, 1997. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. Indiana has numeric criteria for nitrogen and phosphorus for the open waters of Lake Michigan.

## Nutrient Criteria Plan

Y/N: Yes

Date: July, 2008 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity, biological indices and DO

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - End of 2010
- Rivers/Streams - End of 2010
- Estuaries - N/A
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/in/in_5_wqs.pdf

http://www.in.gov/idem/4087.htm

N/A = Not Applicable

# Iowa

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Chapter 61: IA Water Quality Standards, effective July 10, 2002.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: February 3, 2006

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth or turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - March 2007

Rivers/Streams - July 2008

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ia/ia_7_chapter61.pdf

http://www.iowadnr.com/water/standards/criteria.html

N/A = Not Applicable

# Kansas

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Kansas Surface Water Quality Standards: Tables of Numeric Criteria, effective April 27, 2005. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes (but plan is not mutually-agreed upon with EPA Region 7)

Date: December 29, 2004

Nutrient Parameters: TP, TN, Chlorophyll-*a*

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2009

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ks/ks-wqs.pdf

http://www.kdheks.gov/water/

N/A = Not Applicable

# Kentucky

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

• = Statewide ◘ = For selected waterbody

[1] From KY Surface Water Standards, effective December 17, 2004.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: August 10, 2007 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - October 2010

Rivers/Streams - October 2010

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ky/ky-5031-200605.pdf

http://www.water.ky.gov/sw/wqstandards

N/A = Not Applicable

# Louisiana

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From LA Administrative Code Title 33, Part IX, Chapter 11—Surface Water Quality Standards, effective August 6, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: May 12, 2006

Nutrient Parameters: TP, TN, $NO_3$ (for large fast-flowing rivers)

Projected Date for Criteria Adoption:

Lakes/Reservoirs - January 2010

Rivers/Streams - January 2009 (January 2013 for big, interstate rivers)

Estuaries - No date

Wetlands - January 2009

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/la/la_6_wqs.pdf

http://deq.louisiana.gov/portal/Portals/0/planning/regs/title33/33v09.pdf

N/A = Not Applicable

# Maine

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From ME 06-096 CMR 584, Surface Water Quality Criteria for Toxic Pollutants, effective October 9, 2005. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: September 19, 2005 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*

Projected Date for Criteria Adoption: **Note: Draft criteria have been submitted to EPA**

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/me/me_1_rule.pdf

http://www.maine.gov/dep/blwq/docstand/wd/docket/

N/A = Not Applicable

# Maryland

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | ◘[2] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Annotated Code of Maryland Title 26 Department of the Environment, Subtitle 08 Water Pollution, Chapter 02 Water Quality. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] Secchi disk clarity for waters in the Chesapeake bay drainage basin to implement guidance recommendations made by the EPA through the Chesapeake Bay Program. For the Chesapeake Bay, submerged aquatic vegetation (SAV) restoration acreage is a surrogate clarity indicator since clarity will determine the ability for SAVs to thrive and expand into known historic habitat.

## Nutrient Criteria Plan

Y/N: Yes

Date: 2004

Nutrient Parameters: TP, Chlorophyll-*a*, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2007

Rivers/Streams - 2007

Estuaries - Chesapeake Bay completed 2004

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/md/md-ch2-quality-20051130.pdf

http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/wqstandards/index.asp

N/A = Not Applicable

# Massachusetts

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | ◘[2] | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From MA Water Quality Standards, effective March 26, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Nitrogen criteria for selected estuaries.

## Nutrient Criteria Plan

Y/N: Yes

Date: November 3, 2005 (revised)

Nutrient Parameters: TP, TN, dissolved P, Chlorophyll-*a*, filamentous algae coverage, floating plants, Secchi depth, DO

Projected Date for Criteria Adoption: **Note: Draft criteria have been submitted to EPA**

Lakes/Reservoirs - No date

Rivers/Streams - April 2007

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ma/ma_1_wpc.pdf

http://www.mass.gov/dep/water/laws/regulati.htm

N/A = Not Applicable

# Michigan

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From MI Water Quality Standards, effective January 13, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. Michigan has numeric criteria for phosphorus for the open waters of Lake Michigan.

## Nutrient Criteria Plan

Y/N: Yes

Date: March, 2007 (revised)

Nutrient Parameters: TP (will collect TN data to determine if nitrogen criteria is necessary for Michigan.) An evaluation will be made to determine if criteria for Chlorophyll-*a*, Secchi transparency or other response variables should be developed.

Projected Date for Criteria Adoption:

Lakes/Reservoirs - TBA

Rivers/Streams - TBA

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/mi/mi_5_wqs.pdf

http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-11383--,00.html

N/A = Not Applicable

# Minnesota

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ● | ● | ●* |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From MN Water Quality Standards for Protection of Waters of the State dated April 1, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: July, 2008 (revised)

Nutrient Parameters: TP, Chlorophyll-*a*, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Adopted Spring 2008

Rivers/Streams - 2011

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/mn/7050.pdf

http://www.pca.state.mn.us/water/standards/index.html

N/A = Not Applicable

# Mississippi

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From MS Water Quality Criteria for Intrastate, Interstate, and Coastal Waters, effective June 27, 2003. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: July, 2007 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2011

Rivers/Streams - 2011

Estuaries - 2011

Wetlands - No Date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ms/ms_4_wqs.pdf

http://www.deq.state.ms.us/mdeq.nsf/page/wmb_water_quality_standards?opendocument

N/A = Not Applicable

# Missouri

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From MO Rules of DNR, Division 20—Clean Water Commission, Chapter 7—Water Quality, February 29, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: July 25, 2005

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth, turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2009

Rivers/Streams - 2011

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/mo/index.html

http://www.dnr.mo.gov/env/wpp/wqstandards/index.html

N/A = Not Applicable

# Montana

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | ◘[2, 3] | ◘[2, 3] | ◘[2, 3] | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From MT Numeric Water Quality Standards, effective August 17, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] TN, TP and Chl-*a* criteria for selected streams.

[3] From Surface Water Quality Standards and Procedures, Sub-chapter 6, effective February 29, 2008.

## Nutrient Criteria Plan

Y/N: Yes

Date: September 6, 2002

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth, $NO_{2/3}$

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2009

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.deq.state.mt.us/wqinfo/Standards/CompiledDEQ-7.pdf

http://www.deq.state.mt.us/wqinfo/standards/index.asp

N/A = Not Applicable

# Nebraska

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | † | † | † | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From NE DEQ: Chapter 4—Standards for Water Quality,
December 31, 2002. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
†TN, TP and Chl-a criteria for selected lakes/reservoirs adopted by state, but not approved by EPA.

## Nutrient Criteria Plan

Y/N: Yes

Date: February, 2008

Nutrient Parameters: TP, TN, Chlorophyll-*a*

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2011

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ne/ne_7_wqs04.pdf

http://www.deq.state.ne.us/RuleAndR.nsf/pages/117-TOC

N/A = Not Applicable

# Nevada

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ◘ [2, 3] | ◘ [4, *] | ◘ [5, *] | ◘ [2, 6] |
| Rivers/Streams | ◘ [2, 3, *] | ◘ [4, *] | | ◘ [2, 6] |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From NV Water Quality Regulations, effective May 15, 2007.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] For selected waters and uses.
[3] Includes TN and Nitrate-N, Nitrite-N and inorganic nitrogen for selected waters and uses.
[4] Includes TP and total phosphate for selected waters and uses
[5] For Lake Mead only.
[6] Includes turbidity and suspended solids.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: June, 2007

Nutrient Parameters: TN, TP, Chlorophyll-*a*, Turbidity, TSS and DO

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: http://ndep.nv.gov/bwqp/file/strategy_aug_07.pdf

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/nv/nv_9_wqs.pdf

http://ndep.nv.gov/bwqp/stdsw.htm

N/A = Not Applicable

# New Hampshire

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From NH Surface Water Quality Regulations Chapter 1700, December 10, 1999. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: November 14, 2002

Nutrient Parameters: TP, TN, Chlorophyll-*a*, clarity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/nh/nh_1_chapter1700.pdf

http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm

N/A = Not Applicable

# New Jersey

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ◘[2,*] | ●[*] | ◘[3] | ◘[4,*] |
| Rivers/Streams | ◘[2,*] | ●[*] | | ◘[4,*] |
| Estuaries | | | | ◘[4,*] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From NJ Surface Water Quality Standards, effective June, 2008.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Criteria for Nitrate-N for Pinelands (PL) waters and their designated uses.
[3] Established pursuant to the TMDL Report for the non-tidal. Passaic River basin addressing phosphorus impairments dated April 28, 2008.
[4] Turbidity.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes (plan is not mutually-agreed upon with EPA Region 2 and will be revised through stakeholder review)

Date: November, 2008 (revised)

Nutrient Parameters: P

Projected Date for Criteria Adoption/Refinement:

Lakes/Reservoirs - criteria existing, amendments to be adopted in 2010

Rivers/Streams - criteria existing, amendments to be adopted in 2010

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.state.nj.us/dep/wms/bwqsa/docs/0608_SWQS.pdfhttp://www.state.nj.us/dep/wms/bwqsa/swqsdocs.html

http://www.state.nj.us/dep/wms/bwqsa/swqs.htm

N/A = Not Applicable

# New Mexico

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From NM Standards for Interstate and Intrastate Waters, effective December 29, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: January 20, 2006 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity. Secondary variables: DO concentration, DO % saturation, pH, and AFDM.

Projected Date for Criteria Adoption:

Lakes/Reservoirs - December 2011

Rivers/Streams - Rivers = July 2010; Streams = December 2009

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/nm/nm_6_wqs.pdf

http://www.nmenv.state.nm.us/swqb/standards/index.html

N/A = Not Applicable

# New York

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ◘[2,*] | ◘[3,4,*] | | |
| Rivers/Streams | ◘[2,*] | | | |
| Estuaries | | | | |
| Wetlands | ◘[2,*] | | | |

● = Statewide ◘ = For selected

[1] From NY Water Quality Standards, effective February 16, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Nitrite-N for aquatic life use.
[3] Guidance value established for classes A, AA, A-S, and B ponded waters (state regulation at 6 NYCRR 702.15).
[4] Waterbody-specific P criteria for lakes Erie, Ontario, Champlain, and NYC watershed reservoirs.
(http://www.epa.gov/glnpo/solec/94/nutrient/index.htm.#EXECUTIVE)
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: February 1, 2008 (revised)

Nutrient Parameters: TP, DO, pH, Chlorophyll-*a*, clarity (TN only if criterion is shown to be necessary)

Projected Date for Criteria Proposal:

Lakes/Reservoirs - guidance value for human health (water supply) and recreational use proposed in 2009; aquatic life use proposed in 2012

Rivers/Streams - guidance value for aquatic life use proposed in 2009; human health (water supply) and recreational use proposed in 2012

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: http://www.epa.gov/waterscience/standards/wqslibrary/ny/ny_2_water_quality_reg.pdf

WQS: http://www.epa.gov/glnpo/solec/94/nutrient/index.htm.#EXECUTIVE

http://www.dec.ny.gov/chemical/23853.htmlhttp://h2o.enr.state.nc.us/csu/

N/A = Not Applicable

# North Carolina

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | ●[2,*] | ◘[3,*] |
| Rivers/Streams | | | ●[2,*] | ◘[3,*] |
| Estuaries | | | ●[2,*] | ◘[3,*] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From NC Water Quality Standards, as amended effective May 1, 2007.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Numeric chlorophyll-a criteria statewide for waters designated as freshwater aquatic life, saltwater aquatic life, and trout waters (Class C and SC waters).
[3] Numeric turbidity criteria (measured in Nephelometric Turbidity Units) for selected waters.
*Standard present in 1998.

Note: NC has a Nutrient Management Strategy for waters designated as "Nutrient Sensitive Waters" in order to limit the discharge of nutrients (usually nitrogen and phosphorus)

## Nutrient Criteria Plan

Y/N: Yes

Date: October 25, 2005 (revised)

Nutrient Parameters: Chlorophyll-*a*

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - 2010
- Rivers/Streams - No date
- Estuaries - 2010
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/nc/

http://h2o.enr.state.nc.us/csu/

N/A = Not Applicable

# North Dakota

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From ND Standards of Quality for Waters of the State, effective June 15, 2001. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. North Dakota has nutrient values for Class 1 and Class 1a waters where the values are used as guidelines and are not considered numeric criteria.

## Nutrient Criteria Plan

Y/N: Yes

Date: May 18, 2007

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth, DO, TSI

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Year 9 (no date given)

Rivers/Streams - Year 9 (no date given)

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: http://www.epa.gov/waterscience/standards/wqslibrary/nd/index.html

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/nd/nd_8_swq.pdf

http://www.ndhealth.gov/WQ/sw/

N/A = Not Applicable

# Ohio

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From OH Water Quality Standards, effective December 30, 2002. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. Ohio has numeric nutrient criteria for the open waters of Lake Erie.

## Nutrient Criteria Plan

Y/N: Yes

Date: June, 2006

Nutrient Parameters: Causal variables: NOx, NH3, TKN, TP, habitat. Response variables: turbidity, DO, Chlorophyll-*a*, fish, macroinvertebrates

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2009

Rivers/Streams - 2012

Estuaries - N/A

Wetlands - No Date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/oh/oh_5_3745-1-04_wqs.pdf

http://www.epa.state.oh.us/dsw/rules/3745-1.html

N/A = Not Applicable

# Oklahoma

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ◘[2] | ◘[3] | ◘[4] |
| Rivers/Streams | | ◘[2] | | ◘[4] |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Oklahoma's Water Quality Standards, effective November 14, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] Numeric criteria for TP in Lake Encha, Spavinaw Lake and rivers designated as "Scenic Rivers" for aesthetics and antidegradation (0.037 mg/L).

[3] Established in 2006 for selected waters.

[4] Turbidity criteria for the use of fish and wildlife propagation.

## Nutrient Criteria Plan

Y/N: Yes

Date: September, 2006 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - Fall 2008-Summer 2009
- Rivers/Streams - Fall 2009-Summer 2010
- Estuaries - N/A
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: http://www.owrb.ok.gov/quality/standards/standards.php

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ok/ok_6_chap45.pdf

http://www.owrb.ok.gov/quality/standards/standards.php

N/A = Not Applicable

# Oregon

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes | | ◘[2] | ● | |
| Reservoirs | | | ◘[3] | |
| Rivers | | ◘[4] | ● | |
| Streams | | ◘[4] | ● | |
| Estuaries | | | ● | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Water Quality Standards: Beneficial Uses, Policies, and Criteria for Oregon, effective March 2, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] The total phosphorus maximum annual loading for the Clear Lake watershed may be deemed exceeded if the median concentration of total phosphorus from samples collected in the epilimnion between May 1 and September 30 exceed 9 µg/L during two consecutive years.

[3] Except for ponds and reservoirs less than ten acres in surface area, marshes and saline lakes.

[4] Criteria specific to Yamhill River and its tributaries.

## Nutrient Criteria Plan

Y/N: No

Date: N/A

Nutrient Parameters: N/A

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A

Rivers/Streams - N/A

Estuaries - N/A

Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/or/or_10_wqs.pdf

http://www.deq.state.or.us/WQ/standards/standards.htm

N/A = Not Applicable

# Pennsylvania

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From PA Code, Title 25, Chapter 93, Water Quality Standards, effective February 9, 2006. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: May, 2004

Nutrient Parameters: TP, Chlorophyll-a, Secchi depth

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - March 2009
- Rivers/Streams - September 2007
- Estuaries - No date
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/pa/pa_3_code93.pdf

http://www.depweb.state.pa.us/watersupply/cwp/view.asp?a=1261&Q=449151&watersupplyNav=|30184|

N/A = Not Applicable

# Puerto Rico

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ◘[2,*] | | ◘[3,*] |
| Rivers/Streams | | ◘[2,*] | | ◘[3,*] |
| Estuaries | | | | ◘[3,*] |
| Wetlands | | | | ◘[3] |

● = Statewide ◘ = For selected waterbody

[1] From PR Water Quality Standards Regulation amended March, 2003.
State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Total phosphorus shall not exceed 1 mg/L in surface water bodies upstream from reservoirs, in segments of surface water bodies with drinking water intakes or estuarine waters except when it is demonstrated to the satisfaction of the Board that a higher value of total phosphorus in combination with prevailing nitrogen derived nutrients will not contribute to eutrophic conditions in the water body.
[3] Turbidity criteria for class SB, SC and SD waters and their designated uses.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: May 13, 2008

Nutrient Parameters: TKN or TN, TP, Chlorophyll-*a*

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2010

Rivers/Streams - 2011

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/pr/pr_2_wqs.pdf

N/A = Not Applicable

# Rhode Island

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ●* | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From RI Water Quality Regulations, effective January 1, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
*Standard present in 1998 (but is being reviewed at this time).

## Nutrient Criteria Plan

Y/N: Yes

Date: February 1, 2002

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Adopted TP criteria in 1997

Rivers/Streams - No date

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ri/ri_1_wqr.pdf

http://www.dem.ri.gov/programs/benviron/water/quality/index.htm

N/A = Not Applicable

# South Carolina

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ◘[2] | ◘[2] | ◘[2] | ◘[3] |
| Rivers/Streams | | | | ◘[3] |
| Estuaries | | | | ◘[3] |
| Wetlands | | | | ◘[3] |

● = Statewide ◘ = For selected waterbody

[1] From SC Regulation 61-68 Water Classifications and Standards as amended June 25, 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Numeric nutrient criteria for lakes statewide by ecoregion (with small lakes, 40 acres or less, covered by narrative).
[3] Numeric turbidity criteria (measured in Nephelometric Turbidity Units) apply to Outstanding National Resource Waters, Outstanding Resource Waters, freshwater trout waters and shellfish harvesting waters only.

## Nutrient Criteria Plan

Y/N: Yes

Date: September 27, 2007 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date (see existing criteria)

Rivers/Streams - 2011

Estuaries - 2011

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/sc/sc_4_wqs.pdf

http://www.scdhec.net/environment/water/regs/r61-68.pdf

N/A = Not Applicable

# South Dakota

## Existing Numeric Water Quality Standards For Nutrients [1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From SD Surface Water Quality, effective January 27, 1999. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: No

Date: N/A

Nutrient Parameters: N/A

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A

Rivers/Streams - N/A

Estuaries - N/A

Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/sd/sd_8_7451.pdf

http://www.state.sd.us/denr/DES/Surfacewater/surfacequality.htm

N/A = Not Applicable

# Tennessee

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | ◘[2] | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From TN General Water Quality Criteria Chapter 1200-4-3, effective March 27, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Chlorophyll-a criteria for Pickwick Reservoir.
Note: The State has a formalized narrative translator for wadeable streams as referenced in:
http://www.state.tn.us/environment/wpc/publications/nutrient%20final.pdf

## Nutrient Criteria Plan

Y/N: Yes

Date: September 20, 2007 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-a, turbidity

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2012

Rivers/Streams - 2012

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/tn/tn_4_wqs.pdf

http://www.epa.gov/waterscience/standards/wqslibrary/tn/tn_4_4wqs.pdf

http://www.state.tn.us/environment/wpc/publications/

http://www.state.tn.us/environment/wpc/publications/nutrient%20final.pdf

N/A = Not Applicable

# Texas

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From TX Surface Water Quality Standards, effective April 9, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: November 3, 2006 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, solids, DO, Pheophytin-*a*, alkalinity, hardness, stream flow, conductivity, turbidity, temperature, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2008

Rivers/Streams - 2011

Estuaries - 2011

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/tx/tx-wqs-20061215.pdf

http://www.tceq.state.tx.us/nav/eq/eq_swqs.html

N/A = Not Applicable

# Utah

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From UT Standards of Quality for Waters of the State (2005), effective October 17, 2005. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. Utah has "pollution indicator values" that are not considered numeric nutrient criteria.

## Nutrient Criteria Plan

Y/N: Yes

Date: April 4, 2005

Nutrient Parameters: TN, TP, Chlorophyll-*a*, turbidity,

Projected Date for Criteria Adoption:

Lakes/Reservoirs - No date

Rivers/Streams - August 2008

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/ut/ut.pdf

http://www.rules.utah.gov/publicat/code/r317/r317-002.htm

N/A = Not Applicable

# Vermont

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | ●[2,*] | ◘[3,*] | | ●[*] |
| Rivers/Streams | ●[2,*] | ◘[4,*] | | ●[*] |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From VT Water Quality Standards, effective January 1, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Criteria for nitrate-nitrogen.
[3] TP criteria for Lake Champlain and Lake Memphremagog.
[4] TP criteria for streams above 2,500 feet in elevation.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: February 6, 2008 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity

Projected Date for Criteria Adoption: **Note: Draft criteria have been submitted to EPA**

Lakes/Reservoirs - No date

Rivers/Streams - No date

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.nrb.state.vt.us/wrp/publications/wqs.pdf

http://www.nrb.state.vt.us/wrp/publications/wqs.pdf

N/A = Not Applicable

# Virginia

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ◘[2] | ◘[2] | |
| Rivers/Streams | | | | |
| Estuaries | | | ◘[3,4] | ◘[3] |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From VA Water Quality Regulations, effective September 11, 2007. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

[2] Numeric criteria for man-made lakes and reservoirs to protect aquatic life and recreational designated uses from the impacts of nutrients.

[3] Numeric criteria to protect designated uses from the impacts of nutrients and suspended sediment in the Chesapeake Bay and its tidal tributaries (adopted in 2005). For the Chesapeake Bay, submerged aquatic vegetation (SAV) restoration acreage is a surrogate clarity indicator since clarity will determine the ability for SAVs to thrive and expand into known historic habitat.

[4] Chlorophyll a criteria apply to the tidal James River (adopted in 2006).

## Nutrient Criteria Plan

Y/N: Yes

Date: August, 2008 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, turbidity, DO

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Approved August 2007

Rivers/Streams - 2011 (wadeable) and 2012 (non-wadeable)

Estuaries - Approved June 2005, Tidal James and York River January, 2006

Wetlands - Site-specific criteria for Lake Drummond, located within the Great Dismal Swamp, were developed in August, 2007; No date for other wetlands

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/va/va_3_wqs.pdf

http://www.deq.virginia.gov/wqs/

N/A = Not Applicable

# Virgin Islands

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | N/A | N/A | N/A | N/A |
| Rivers/Streams | N/A | N/A | N/A | N/A |
| Estuaries/Coastal | | ●* | | ●* |
| Wetlands | N/A | N/A | N/A | N/A |

● = Statewide ◘ = For selected waterbody

[1] From VI Water Quality Standards adopted in October 2004. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: October 16, 2007

Nutrient Parameters: TP, TKN

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A

Rivers/Streams - N/A

Estuaries - FY 2016

Coastal - FY 2016

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/territories/usvi_wqs.pdf

http://www.dpnr.gov.vi/dep/pubs/index.htm

N/A = Not Applicable

# Washington

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | ◘[2,*] | | |
| Rivers/Streams | | ◘[3,*] | | |
| Estuaries | | | | |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From Water Quality Standards for Surface Waters of the State of WA, effective November 11, 1997. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.
[2] Lake-specific.
[3] Spokane River from Long Lake Dam to Nine Mile Bridge.
*Standard present in 1998.

## Nutrient Criteria Plan

Y/N: Yes

Date: April, 2004

Nutrient Parameters: TP, Chlorophyll-*a*, Secchi depth

Projected Date for Criteria Adoption:

Lakes/Reservoirs - Adopted February, 1998

Rivers/Streams - No date

Estuaries - No date

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/wa/wa_10_chapter173-201a.pdf

http://www.ecy.wa.gov/programs/wq/swqs/index.html

N/A = Not Applicable

# West Virginia

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | † | † | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] Requirements Governing Water Quality Standards (Title 47, Legislative Rule Series 2), effective July, 2008. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards. West Virginia has nitrite-N criteria for aquatic life use in warm water fish streams, trout waters and wetlands, but these are not considered nutrient criteria.

†TP and chlorophyll-a criteria have been adopted by West Virginia, but are not approved by EPA. These criteria are for all lakes with a retention time of ≥14 days, and all other lakes will be covered under future rivers/streams nutrient criteria.

## Nutrient Criteria Plan

Y/N: Yes

Date: May, 2004 (revised)

Nutrient Parameters: TP, TN, Chlorophyll-*a*, Secchi depth, turbidity

Projected Date for Criteria Adoption:

- Lakes/Reservoirs - January 2009
- Rivers/Streams - January 2009
- Estuaries - N/A
- Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/wv/wv_3_series2.pdf

http://www.wvdep.org/item.cfm?ssid=11&ss1id=747

N/A = Not Applicable

# Wisconsin

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1]From Water Quality Standards for Wisconsin Surface Waters, Chapter NR 102, current through August, 1997. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: July, 2007 (revised)

Nutrient Parameters: For Lakes: TP, TN, Chlorophyll-*a*, Secchi depth. For Streams: TP, TN, chlorophyll-a, DO and aquatic community health.

Projected Date for Criteria Adoption:

Lakes/Reservoirs - September 2009

Rivers/Streams - September 2009

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.epa.gov/waterscience/standards/wqslibrary/wi/wi_5_nr102.pdf

http://www.dnr.state.wi.us/org/water/wm/WQS/

N/A = Not Applicable

# Wyoming

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From WY Surface Water Quality Standards, effective January 25, 2002. State numeric nutrient criteria for drinking water/source water protection were not considered in the table, nor were numeric criteria for turbidity which were not developed for protection against nutrient effects. To find the status of the State's adopted numeric nutrient criteria for drinking water protection, follow the internet link below to the State's Water Quality Standards.

## Nutrient Criteria Plan

Y/N: Yes

Date: April 4, 2008

Nutrient Parameters: TN, TP, Chlorophyll-*a*, Secchi depth, phytoplankton, possibly periphyton

Projected Date for Criteria Adoption:

Lakes/Reservoirs - 2013 development, 2015 stakeholder review

Rivers/Streams - 2013 development, 2015 stakeholder review

Estuaries - N/A

Wetlands - No date

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://deq.state.wy.us/wqd/wqdrules/Chapter_01.pdf

http://deq.state.wy.us/wqd/watershed/surfacestandards/index.asp

N/A = Not Applicable

# Delaware River Basin Commission

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | ◘[2] |
| Rivers/Streams | | | | ◘[2] |
| Estuaries | | | | ◘[3] |
| Wetlands | | | | ◘[2] |

● = Statewide ◘ = For selected waterbody

[1] From DRBC Administrative Manual Part III Water Quality Regulations, 18 CFR Part 410 with amendments through 9/16/07.
[2] For non-tidal streams of the Delaware River Basin (those rivers, lakes and other waters that flow across or form a part of state boundaries).
[3] For Delaware River Estuary & Bay including the tidal portions of the tributaries thereof.

## Nutrient Criteria Plan

Y/N: Yes (plan is not mutually-agreed upon with EPA Regions 2 and 3, and will be reviewed annually by the Delaware River Basin Commission)

Date: N/A

Nutrient Parameters: For non-tidal portion of the Delaware River: TP, TN, water clarity and biocriteria consisting of selected algal and macroinvertebrate metrics.

For Delaware Estuary: TN, TP, Chlorophyll-a, water clarity (FTU)

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A

Rivers/Streams - N/A

Estuaries - N/A

Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.nj.gov/drbc/regs/WQRegs_092607.pdf

N/A = Not Applicable

# Ohio River Valley Water Sanitation Commission (ORSANCO)

## Existing Numeric Water Quality Standards For Nutrients[1]

| Waterbody Type | N | P | Chl-a | Clarity |
|---|---|---|---|---|
| Lakes/Reservoirs | | | | |
| Rivers/Streams | ◘[2,3] | | | |
| Estuaries | N/A | N/A | N/A | N/A |
| Wetlands | | | | |

● = Statewide ◘ = For selected waterbody

[1] From ORSANCO Pollution Control Standards for discharges to the Ohio River, 2006 Revision.
[2] Numeric nutrient criteria for ammonia, nitrite+nitrate nitrogen, and nitrite-nitrogen.
[3] Numeric nutrient criteria for the Ohio River.

## Nutrient Criteria Plan

Y/N: Yes

Date: August 22, 2002 (draft-revised)

Nutrient Parameters: ammonia nitrogen, TKN, nitrate-nitrite nitrogen, TP, chlorophyll-a, turbidity, and algae sampling

Projected Date for Criteria Adoption:

Lakes/Reservoirs - N/A

Rivers/Streams - 2005-2006

Estuaries - N/A

Wetlands - N/A

## Links to Nutrient Criteria Plan and Nutrient Water Quality Standards

Plan: N/A

WQS: http://www.orsanco.org/watqual/standards/stand.asp

N/A = Not Applicable

# APPENDIX B:

## SUMMARY OF STATE NUMERIC NUTRIENT STANDARDS ADOPTION: 1998 vs. 2008

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| Numeric Water Quality Standards for Nutrients[1] | | | | |
|---|---|---|---|---|
| **State** | **Waterbody** | **1998** | **August 2008** | **New Since 1998** |
| AL | L | --- | Chl-a[2] | Chl-a[2] |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| AK | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| AZ | L | TN[2], TP[2] | TN[2], N[2,3], TP[2] | N[2,3] |
| | R | TN[2], TP[2], clarity[2] | TN[2], N[2,3], TP[2], clarity[2] | N[2,3] |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| AR | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| CA | L | TN[2], N[2,3], TP[2], P[2,6], Chl-a[2], clarity[2] | TN[2], N[2,3], TP[2], P[2,6], Chl-a[2], clarity[2] | --- |
| | R | TN[2], N[2,3], TP[2], P[2,6], clarity[2] | TN[2], N[2,3], TP[2], P[2,6], clarity[2] | --- |
| | E | TN[2], N[2,3], TP[2], clarity[2] | TN[2], N[2,3], TP[2], clarity[2] | --- |
| | W | TN[2], N[2,3], TP[2], clarity[2] | TN[2], N[2,3], TP[2], clarity[2] | --- |
| CO | L | --- | TP[2] | TP[2] |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| CT | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| DE | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | N[2,3], P[2,6], clarity[2,4] | N[2,3], P[2,6], clarity[2,4] |
| | W | --- | --- | --- |
| FL | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | TP[2] | TP[2] |
| GA | L | TN[2], TP[2], Chl-a[2] | TN[2], TP[2], Chl-a[2] | --- |
| | R | TP[2] | TP[2] | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |

[1] Waterbody: L = lakes/reservoirs; R = rivers/streams; E = estuaries; W = wetlands; N/A = Not Applicable (land-locked State). Parameters without a "2" superscript indicate that all waters within the selected waterbody type are covered by said parameter.
[2] Criteria for selected waters and/or uses (see State specific summaries in Appendix A).
[3] Other forms of nitrogen such as: Nitrate-N, Nitrite-N, Nitrite+Nitrate as N and/or inorganic nitrogen.
[4] Criteria developed as part of the Chesapeake Bay Program.
[5] Narrative translator.
[6] Other forms of phosphorus such as: total phosphate, orthophosphate, inorganic phosphorus and/or soluble phosphorus.
* Numeric nutrient criteria adopted by State, but not approved by EPA. (TN, TP and Chl-a for NE; TP & Chl-a for WV)

| Numeric Water Quality Standards for Nutrients[1] | | | | |
|---|---|---|---|---|
| State | Waterbody | 1998 | August 2008 | New Since 1998 |
| HI | L | --- | --- | --- |
| | R | TN, N[3], TP, clarity | TN, N[3], TP, clarity | --- |
| | E | TN, N[3], TP, Chl-a, clarity | TN, N[3], TP, Chl-a, clarity | --- |
| | W | --- | --- | --- |
| ID | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| IL | L | TP[2] | TP[2] | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| IN | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| IA | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| KS | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| KY | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| LA | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| ME | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| MD | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | Clarity[2,4] | Clarity[2,4] |
| | W | --- | --- | --- |

[1] Waterbody: L = lakes/reservoirs; R = rivers/streams; E = estuaries; W = wetlands; N/A = Not Applicable (land-locked State). Parameters without a "2" superscript indicate that all waters within the selected waterbody type are covered by said parameter.
[2] Criteria for selected waters and/or uses (see State specific summaries in Appendix A).
[3] Other forms of nitrogen such as: Nitrate-N, Nitrite-N, Nitrite+Nitrate as N and/or inorganic nitrogen.
[4] Criteria developed as part of the Chesapeake Bay Program.
[5] Narrative translator.
[6] Other forms of phosphorus such as: total phosphate, orthophosphate, inorganic phosphorus and/or soluble phosphorus.
* Numeric nutrient criteria adopted by State, but not approved by EPA. (TN, TP and Chl-a for NE; TP & Chl-a for WV)

| Numeric Water Quality Standards for Nutrients[1] | | | | |
|---|---|---|---|---|
| State | Waterbody | 1998 | August 2008 | New Since 1998 |
| MA | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | N[2,3] | N[2,3] |
| | W | --- | --- | --- |
| MI | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| MN | L | Clarity | TP, Chl-a, clarity | TP, Chl-a |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| MS | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| MO | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| MT | L | --- | --- | --- |
| | R | --- | TN[2], TP[2], Chl-a[2] | TN[2], TP[2], Chl-a[2] |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| NE | L | --- | * | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| NV | L | TP[2], P[2,6], Chl-a[2] | TN[2], N[2,3], TP[2], P[2,6], Chl-a[2], clarity[2] | TN[2], N[2,3], clarity[2] |
| | R | TN[2], N[2,3], TP[2], P[2,6] | TN[2], N[2,3], TP[2], P[2,6], clarity[2] | Clarity[2] |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| NH | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| NJ | L | N[2,3], TP, clarity[2] | N[2,3], TP, Chl-a[2], clarity[2] | Chl-a[2] |
| | R | N[2,3], TP, clarity[2] | N[2,3], TP, clarity[2] | --- |
| | E | Clarity[2] | Clarity[2] | --- |
| | W | --- | --- | --- |

[1] Waterbody: L = lakes/reservoirs; R = rivers/streams; E = estuaries; W = wetlands; N/A = Not Applicable (land-locked State). Parameters without a "2" superscript indicate that all waters within the selected waterbody type are covered by said parameter.
[2] Criteria for selected waters and/or uses (see State specific summaries in Appendix A).
[3] Other forms of nitrogen such as: Nitrate-N, Nitrite-N, Nitrite+Nitrate as N and/or inorganic nitrogen.
[4] Criteria developed as part of the Chesapeake Bay Program.
[5] Narrative translator.
[6] Other forms of phosphorus such as: total phosphate, orthophosphate, inorganic phosphorus and/or soluble phosphorus.
* Numeric nutrient criteria adopted by State, but not approved by EPA. (TN, TP and Chl-a for NE; TP & Chl-a for WV)

| Numeric Water Quality Standards for Nutrients[1] | | | | |
|---|---|---|---|---|
| State | Waterbody | 1998 | August 2008 | New Since 1998 |
| NM | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| NY | L | N[2,3], TP[2] | N[2,3], TP[2] | --- |
| | R | N[2,3] | N[2,3] | --- |
| | E | --- | --- | --- |
| | W | N[2,3] | N[2,3] | --- |
| NC | L | Chl-a, clarity[2] | Chl-a, clarity[2] | --- |
| | R | Chl-a, clarity[2] | Chl-a, clarity[2] | --- |
| | E | Chl-a, clarity[2] | Chl-a, clarity[2] | --- |
| | W | --- | --- | --- |
| ND | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| OH | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| OK | L | --- | TP[2], Chl-a[2], clarity[2] | TP[2], Chl-a[2], clarity[2] |
| | R | --- | TP[2], clarity[2] | TP[2], clarity[2] |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| OR | L | --- | TP[2], Chl-a | TP[2], Chl-a |
| | R | --- | TP[2], Chl-a | TP[2], Chl-a |
| | E | --- | Chl-a | Chl-a |
| | W | --- | --- | --- |
| PA | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| RI | L | TP | TP | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| SC | L | --- | TN[2], TP[2], Chl-a[2], clarity[2] | TN[2], TP[2], Chl-a[2], clarity[2] |
| | R | --- | Clarity[2] | Clarity[2] |
| | E | --- | Clarity[2] | Clarity[2] |
| | W | --- | Clarity[2] | Clarity[2] |

[1] Waterbody: L = lakes/reservoirs; R = rivers/streams; E = estuaries; W = wetlands; N/A = Not Applicable (land-locked State). Parameters without a "2" superscript indicate that all waters within the selected waterbody type are covered by said parameter.
[2] Criteria for selected waters and/or uses (see State specific summaries in Appendix A).
[3] Other forms of nitrogen such as: Nitrate-N, Nitrite-N, Nitrite+Nitrate as N and/or inorganic nitrogen.
[4] Criteria developed as part of the Chesapeake Bay Program.
[5] Narrative translator.
[6] Other forms of phosphorus such as: total phosphate, orthophosphate, inorganic phosphorus and/or soluble phosphorus.
* Numeric nutrient criteria adopted by State, but not approved by EPA. (TN, TP and Chl-a for NE; TP & Chl-a for WV)

| Numeric Water Quality Standards for Nutrients[1] | | | | |
|---|---|---|---|---|
| State | Waterbody | 1998 | August 2008 | New Since 1998 |
| SD | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| TN | L | --- | Chl-a[2] | Chl-a[2] |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| TX | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| UT | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| VT | L | N[3], TP[2], clarity | N[3], TP[2], clarity | --- |
| | R | N[3], TP[2], clarity | N[3], TP[2], clarity | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| VA | L | --- | TP[2], Chl-a[2] | TP[2], Chl-a[2] |
| | R | --- | --- | --- |
| | E | --- | Chl-a[2,4], clarity[2,4] | Chl-a[2,4], clarity[2,4] |
| | W | --- | --- | --- |
| WA | L | TP[2] | TP[2] | --- |
| | R | TP[2] | TP[2] | --- |
| | E | --- | --- | --- |
| | W | --- | --- | --- |
| WV | L | --- | * | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| WI | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |
| WY | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | N/A | N/A | N/A |
| | W | --- | --- | --- |

[1] Waterbody: L = lakes/reservoirs; R = rivers/streams; E = estuaries; W = wetlands; N/A = Not Applicable (land-locked State). Parameters without a "2" superscript indicate that all waters within the selected waterbody type are covered by said parameter.
[2] Criteria for selected waters and/or uses (see State specific summaries in Appendix A).
[3] Other forms of nitrogen such as: Nitrate-N, Nitrite-N, Nitrite+Nitrate as N and/or inorganic nitrogen.
[4] Criteria developed as part of the Chesapeake Bay Program.
[5] Narrative translator.
[6] Other forms of phosphorus such as: total phosphate, orthophosphate, inorganic phosphorus and/or soluble phosphorus.
* Numeric nutrient criteria adopted by State, but not approved by EPA. (TN, TP and Chl-a for NE; TP & Chl-a for WV)

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# APPENDIX C:

## SUMMARY OF TERRITORY/OTHER NUMERIC NUTRIENT STANDARDS ADOPTION: 1998 vs. 2008

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| Territory/ Others | Numeric Water Quality Standards for Nutrients[1] | | | |
|---|---|---|---|---|
| | Waterbody | 1998 | August 2008 | New Since 1998 |
| AS | L | TN, TP, clarity | TN, TP, clarity | --- |
| | R | TN, TP, clarity | TN, TP, clarity | --- |
| | E | TN, TP, Chl-a, clarity | TN, TP, Chl-a, clarity | --- |
| | W | TN, TP, clarity | TN, TP, clarity | --- |
| CN | L | TN, TP, P[2,6], clarity | TN, TP, P[2,6], clarity | --- |
| | R | TN, TP, P[2,6], clarity | TN, TP, P[2,6], clarity | --- |
| | E | TN, TP, P[2,6], clarity | TN, TP, P[2,6], clarity | --- |
| | W | TN, TP, P[2,6], clarity | TN, TP, P[2,6], clarity | --- |
| DC | L | --- | --- | --- |
| | R | --- | --- | --- |
| | E | --- | Chl-a[2,4], clarity[2,4] | Chl-a[2,4], clarity[2,4] |
| | W | --- | --- | --- |
| GU | L | N[3], P[6] | N[3], P[6], clarity | Clarity |
| | R | N[3], P[6] | N[3], P[6], clarity | Clarity |
| | E | N[3], P[6] | N[3], P[6], clarity | Clarity |
| | W | N[3], P[6] | N[3], P[6], clarity | Clarity |
| PR | L | TP[2], clarity[2] | TP[2], clarity[2] | --- |
| | R | TP[2], clarity[2] | TP[2], clarity[2] | --- |
| | E | Clarity[2] | Clarity[2] | --- |
| | W | --- | Clarity[2] | Clarity[2] |
| VI | L | N/A | N/A | N/A |
| | R | N/A | N/A | N/A |
| | E | TP, clarity | TP, clarity | --- |
| | W | N/A | N/A | N/A |
| CBP | L | --- | Clarity[2] | Clarity[2] |
| | R | --- | Clarity[2] | Clarity[2] |
| | E | --- | Clarity[2] | Clarity[2] |
| | W | --- | Clarity[2] | Clarity[2] |
| DRBC | L | --- | Clarity[2] | Clarity[2] |
| | R | --- | Clarity[2] | Clarity[2] |
| | E | --- | Clarity[2] | Clarity[2] |
| | W | --- | Clarity[2] | Clarity[2] |
| ORSANCO | L | --- | --- | --- |
| | R | --- | N[2,3] | N[2,3] |
| | E | --- | --- | --- |
| | W | --- | --- | --- |

[1] Waterbody: L = lakes/reservoirs; R = rivers/streams; E = estuaries; W = wetlands; N/A = Not Applicable (land-locked State).
[2] Criteria for selected waters and/or uses (see State specific summaries in Appendix A).
[3] Other forms of nitrogen such as: Nitrate-N, Nitrite-N, Nitrite+Nitrate as N and/or inorganic nitrogen.
[4] Criteria developed as part of the Chesapeake Bay Program.
[5] Narrative translator.
[6] Other forms of phosphorus such as: total phosphate, orthophosphate, inorganic phosphorus and/or soluble phosphorus.

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# APPENDIX D:

## CONTACT INFORMATION FOR EPA AND STATE NUTRIENT WATER QUALITY STAFF

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| STATE NUTRIENT COORDINATORS (as of October 2008) | |
|---|---|
| **State/Agency** | **Contact Person** |
| Alabama<br>Dept. of Environmental Management | Lynn Sisk<br>phone: 334-271-7826<br>ls@adem.state.al.us |
| Alaska<br>Dept. of Environmental Conservation | Jim Powell<br>phone: 907-465-5185<br>jim.powell@alaska.gov |
| American Samoa<br>Environmental Protection Agency | Tao'fa Vaiaga'a<br>phone: 684-633-2304<br>tv5551@yahoo.com |
| Arizona<br>Dept. Environmental Quality | Steve Pawlowski<br>phone: 602-771-4219<br>pawlowski.steven@azdeq.gov |
| Arkansas<br>Dept. of Environmental Quality | Mary Barnett<br>phone: 501-682-0666<br>barnett@adeq.state.ar.us |
| California<br>State Water Resources Control Board | Rik Rasmussen<br>phone: 916-341-5549<br>rrasmussen@waterboards.ca.gov |
| Chesapeake Bay Program | Richard Batiuk<br>Phone: 410-267-5731<br>batiuk.richard@epa.gov |
| Colorado<br>Dept. of Public Health & Environ. | phone: 303-692-2000 |
| Commonwealth of the Northern Mariana Islands<br>Div. of Environmental Quality | Brian Bearden<br>phone: 670-664-8510<br>brianbearden@deq.gov.mp |
| Connecticut<br>Dept. Environmental Protection | Mary Becker<br>phone: 860-424-3262<br>mary.becker@po.state.ct.us |
| Delaware<br>Dept. Natural Resources & Environmental Control | David Wolanski<br>phone: 302-739-9939<br>David.Wolanksi@state.de.us |
| Delaware River Basin Commission | Robert Limbeck<br>609-883-9500 ext. 230<br>robert.limbeck@drbc.state.nj.us<br>Edward Santoro<br>609-883-9500 ext. 268<br>edward.santoro@drbc.state.nj.us |
| District of Columbia<br>Dept. of Environment | Shah Nawaz<br>phone: 202-724-7151<br>shah.nawaz@dc.gov |
| Florida<br>Dept. of Environmental Protection | Kenneth Weaver<br>phone: 850-245-8414<br>kenneth.weaver@dep.state.fl.us |

| STATE NUTRIENT COORDINATORS (as of October 2008) | |
|---|---|
| **State/Agency** | **Contact Person** |
| Georgia<br>Environmental Protection Division | Elizabeth Booth<br>phone: 404-675-1675<br>elizabeth_booth@dnr.state.ga.us |
| Guam<br>Environmental Protection Agency | Mike Gawel<br>phone: 671-475-1646<br>mike.gawel@guamepa.net |
| Hawaii<br>Environmental Planning Office | Kelvin H. Sunada<br>phone: 808-586-4337<br>kelvin.sunada@doh.hawaii.gov |
| Idaho<br>Dept. of Environmental Quality | Michael McIntyre<br>phone: 208-373-0570<br>michael.mcintyre@deq.idaho.gov |
| Illinois<br>Environmental Protection Agency | Paul Terrio<br>phone: 217-344-0037 x. 3002<br>pjterrio@usgs.gov |
| Indiana<br>Dept. of Environmental Management | Shivi Selvaratnam<br>phone: 317-308-3088<br>sselvara@idem.in.gov |
| Iowa<br>Dept. of Natural Resources | John Olson<br>phone: 402-471-4201<br>John.Olson@dnr.state.ia.us |
| Kansas<br>Dept. of Health and Environment | Ed Carney<br>phone: 785-296-5575<br>ecarney@kdhe.state.ks.us |
| Kentucky<br>Dept. of Environmental Protection | Tom VanArsdall<br>phone: 502-564-3410<br>Tom.VanArsdall@ky.gov |
| Louisiana<br>Dept. of Environmental Quality | Kristine Pintado<br>phone: 225-219-3596<br>kris.pintado@la.gov |
| Maine<br>Dept. Environmental Protection | Tom Danielson<br>phone: 207-287-7728<br>thomas.j.danielson@maine.gov |
| Maryland<br>Dept. of Environment | John Backus<br>phone: 410-537-3695<br>JBackus@mde.state.md.us |
| Massachusetts<br>Dept. Environmental Protection | Steve Halterman<br>phone: 508-849-4012<br>steven.halterman@state.ma.us<br>Mark Mattson<br>phone: 508-767-2868<br>mark.mattson@state.ma.us |
| Michigan<br>Dept. of Environmental Quality | Sylvia Heaton<br>phone: 517-373-1320<br>heatons@michigan.gov |

| STATE NUTRIENT COORDINATORS (as of October 2008) | |
|---|---|
| **State/Agency** | **Contact Person** |
| Minnesota<br>Pollution Control Agency | Steve Heiskary<br>phone: 651-296-7217<br>steven.heiskary@state.mn.us |
| Mississippi<br>Dept. of Environmental Quality | Kim Caviness<br>phone: 601-961-5390<br>Kim_Caviness@deq.state.ms.us |
| Missouri<br>Dept. of Natural Resources | Mark Osborn<br>phone: 573-522-2019<br>mark.osborn@dnr.mo.gov |
| Montana<br>Dept. of Environmental Quality | Mike Suplee<br>phone: 406-444-0831<br>msuplee@mt.gov |
| Nebraska<br>Dept. of Environmental Quality | John Bender<br>phone: 402-471-4201<br>john.bender@ndeq.state.ne.us |
| Nevada<br>Div. of Environmental Protection | Randy Pahl<br>phone: 775-687-9453<br>rpahl@ndep.nv.gov |
| New Hampshire<br>Dept. Environmental Services | Gregg Comstock<br>phone: 603-271-2983<br>gcomstock@des.state.nh.us |
| New Jersey<br>Dept. Environmental Protection | Debra Hammond<br>phone: 609-777-1753<br>Debra.Hammond@dep.state.nj.us |
| New Mexico<br>Environment Department | Seva Joseph<br>phone: 505-827-0573<br>seva.joseph@state.nm.us |
| New York<br>Dept. Environmental Conservation | Scott Stoner<br>phone: 518-402-8193<br>sxstoner@gw.dec.state.ny.us |
| North Carolina<br>Dept. of Environment and Natural Resources | Connie Brower<br>phone: 919-733-5083 ext. 572<br>connie.brower@ncmail.net |
| North Dakota<br>Dept. of Health | Michael Ell<br>phone: 701-328-5210<br>mell@nd.gov |
| Ohio<br>Environmental Protection Agency | Robert Miltner<br>phone: 614-836-8796<br>bob.miltner@epa.state.oh.us |
| Ohio River Valley Water Sanitation Commission | Greg Youngstrom (R3)<br>513-231-7719 ext.110<br>gregy@orsanco.org |
| Oklahoma<br>Water Resources Board | Phil Moershel<br>phone: 405-530-8952<br>phmoershel@owrb.state.ok.us |

| STATE NUTRIENT COORDINATORS (as of October 2008) | |
|---|---|
| **State/Agency** | **Contact Person** |
| Oregon<br>Dept. of Environmental Quality | Jennifer Wigal<br>phone: 503-229-5323<br>jennifer.wigal@state.or.us |
| Pennsylvania<br>Dept. of Environmental Protection | Will Brown<br>phone: 717-783-2951<br>willbrown@state.pa.us |
| Puerto Rico<br>Environmental Quality Board | Angel Meléndez Aquilar<br>phone: 787-767-8181 ext. 3543<br>AngelMelendez@jca.gobierno.pr |
| Rhode Island<br>Dept. Environmental Management | Connie Carey<br>phone: 401-222-7239<br>connie.carey@dem.ri.gov |
| South Carolina<br>Dept. of Health and<br>Environmental Control | Amy Bennett<br>phone: 803-898-4249<br>Bennetam@dhec.sc.gov |
| South Dakota<br>Dept. of Environment and Natural Resources | Jeanne Goodman<br>phone: 605-773-3351<br>jeannegoodman@state.sd.gov |
| Tennessee<br>Dept. of Environment<br>and Conservation | Gregory Denton<br>phone: 615-532-0699<br>gregory.denton@state.tn.us |
| Texas<br>Commission Environmental Quality | Sidne Tiemann<br>phone: 512-239-4606<br>stiemann@tceq.state.tx.us |
| Utah<br>Dept. of Environmental Quality | William Moellmer<br>phone: 801-538-6329<br>wmoellmer@utah.gov |
| Vermont<br>Dept. Environmental Conservation | Eric Smeltzer<br>phone: 802-241-3792<br>eric.smeltzer@state.vt.us<br>Neil Kamman<br>phone: 802-241-3795<br>neil.kamman@state.vt.us |
| Virgin Islands<br>Dept. Planning & Natural Resources | Anita Nibbs<br>phone: 340-773-1082<br>anita.nibbs@dpnr.gov.vi |
| Virginia<br>Dept. of Environmental Quality | David Whitehurst<br>phone: 804-698-4121<br>dcwhitehurst@deq.virginia.gov |
| Washington<br>Dept. of Natural Resources | Susan Braley<br>phone: 360-407-6414<br>subr461@ecy.wa.gov |
| West Virginia<br>Dept. of Environmental Protection | Scott Mandirola<br>phone: 304-926-0499 ext. 1058<br>scott.g.mandirola@wv.gov |

| STATE NUTRIENT COORDINATORS (as of October 2008) | |
|---|---|
| **State/Agency** | **Contact Person** |
| Wisconsin<br>Dept. of Natural Resources | Jim Baumann<br>phone: 608-266-9277<br>james.baumann@dnr.state.wi.us |
| Wyoming<br>Dept. of Environmental Quality | John Wagner<br>phone: 307-777-7781<br>jwagne@state.wy.us |

| U.S. EPA HEADQUARTER NUTRIENT AND WQS COORDINATORS (AS OF OCTOBER 2008) | |
|---|---|
| **Nutrient Criteria Program** | **Water Quality Standards Program** |
| Office of Water | Office of Water |
| Tiffany Crawford<br>phone: 202-566-2375<br>crawford.tiffany@epa.gov | Sharon Frey (Region 8)<br>phone: 202-566-1480<br>frey.sharon@epa.gov |
| Ifeyinwa Davis<br>phone: 202-566-1096<br>davis.ifeyinwa@epa.gov | Daneille Fuligni (Regions 1, 2 & 7)<br>phone: 202-566-0793<br>fuligni.danielle@epa.gov |
| Todd Doley<br>phone: 202-566-1160<br>doley.todd@epa.gov | Holly Green (Region 6)<br>phone : 202-566-0651<br>green.holly@epa.gov |
| Lisa Larimer<br>phone: 202-566-1017<br>larimer.lisa@epa.gov | Lisa Larimer (Region 5)<br>phone: 202-566-1017<br>larimer.lisa@epa.gov |
| Jacques Oliver<br>phone: 202-566-0630<br>oliver.jacques@epa.gov | Daniella Salvaterra (Regions 4 & 10)<br>phone : 202-564-1631<br>salvaterra.danielle@epa.gov |
| Steve Potts<br>phone: 202-566-1121<br>potts.steve@epa.gov | Caroline Whitehead (Regions 3 & 9)<br>phone: 202-566-2907<br>whitehead.caroline@epa.gov |
| Steve Settle<br>phone: 202-566-0436<br>settle.steve@epa.gov | |
| Jim Keating<br>phone: 202-566-0383<br>keating.jim@epa.gov | |

| U.S. EPA REGIONAL NUTRIENT AND WQS COORDINATORS (AS OF OCTOBER 2008) | |
|---|---|
| **Nutrient Program** | **Water Quality Standards Program** |
| **EPA Region 1 (CT, ME, MA, NH, RI, VT)** | |
| Alfred Basile<br>phone: 617-918-1599<br>basile.alfred@epa.gov | William Beckwith<br>phone: 617-918-1544<br>beckwith.william@epa.gov |
| **EPA Region 2 (NJ, NY, PR, VI)** | |
| Izabela Wojtenko<br>phone: 212-637-3814<br>wojtenko.izabela@epa.gov | Wayne Jackson<br>phone: 212-637-3807<br>jackson.wayne@epa.gov |
| **EPA Region 3 (DC, DE, MD, PA, VA, WV)** | |
| Mark Barath<br>phone: 215-814-2759<br>barath.mark@epa.gov | Cheryl Atkinson<br>phone: 215-814-3392<br>atkinson.cheryl@epa.gov |
| **EPA Region 4 (AL, FL, GA, KY, MS, NC, SC, TN)** | |
| Ed Decker/Lauren Petter<br>phone: 404-562-9383/404-562-9272<br>decker.ed@epa.gov/petter.lauren@epa.gov | Fritz Wagener<br>phone: 404-562-9267<br>wagener.fritz@epa.gov |
| **EPA Region 5 (IL, IN, MI, MN, OH, WI)** | |
| Brian Thompson/Barbara Mazur<br>phone: 312-353-6066/312-886-1491<br>thompson.brian@epa.gov/mazur.barbara@epa.gov | Dave Pfeifer<br>phone: 312-353-9024<br>pfeifer.david@epa.gov |
| **EPA Region 6 (AR, LA, NM, OK, TX)** | |
| Mike Bira<br>phone: 214-665-6668<br>bira.mike@epa.gov | Russell Nelson<br>phone: 214-665-6646<br>nelson.russell@epa.gov |
| **EPA Region 7 (IA, KS, MO, NE)** | |
| Gary Welker<br>phone: 913-551-7177<br>welker.gary@epa.gov | Ann Lavaty<br>phone: 913-551-7370<br>lavaty.ann@epa.gov |
| **EPA Region 8 (CO, MT, ND, SD, UT, WY)** | |
| Tina Laidlaw<br>phone: 406-457-5016<br>laidlaw.tina@epa.gov | Dave Moon<br>phone: 303-312-6833<br>moon.dave@epa.gov |
| **EPA Region 9 (AZ, CA, HI, NV, AS, GU, CN)** | |
| Suesan Saucerman<br>phone: 415-972-3522<br>saucerman.suesan@epa.gov | Terry Fleming<br>phone: 415-972-3462<br>fleming.terrence@epa.gov |

| U.S. EPA REGIONAL NUTRIENT AND WQS COORDINATORS (AS OF OCTOBER 2008) | |
|---|---|
| **Nutrient Program** | **Water Quality Standards Program** |
| **EPA Region 10 (AK, ID, OR, WA)** | |
| Holly Arrigoni<br>phone: 206-553-4350<br>arrigoni.holly@epa.gov | Sally Brough<br>phone: 206-553-1295<br>brough.sally@epa.gov |

# Attachment B

United States
Environmental Protection
Agency

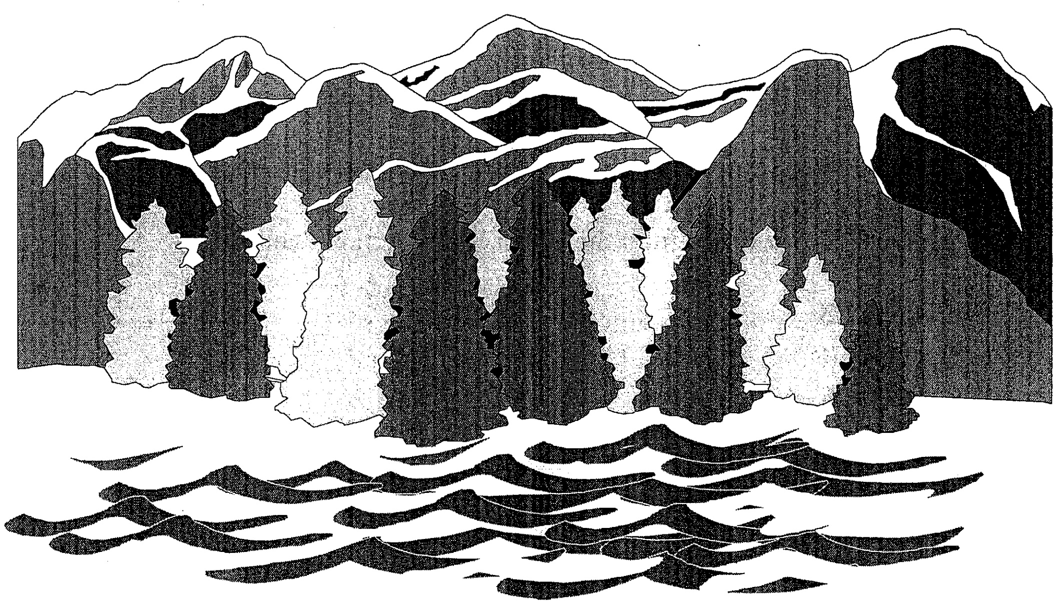
Office of Water
4304

EPA 822-R-98-002
June 1998

EPA

# National Strategy for the Development of Regional Nutrient Criteria

June 1998



## CONTENTS

# PREFACE

In February of this year, President Clinton and Vice President Gore released a comprehensive Clean Water Action Plan. The Action Plan provides a blueprint for Federal agencies to work with States and others stakeholders in restoring and protecting the Nation's water resources and addresses three major goals:

- enhanced protection from public health threats posed by water pollution;
- more effective control of polluted runoff; and
- promotion of water quality restoration and protection on a watershed basis.

A key part of the Action Plan provides for expanded efforts to reduce nutrient overenrichment of waters.

Nutrients, in appropriate amounts, are essential to the health of aquatic systems. Excessive nutrients, however, can result in excessive growth of macrophytes or phytoplankton and potentially harmful algal blooms leading to oxygen declines, imbalance of aquatic species, public health threats, and a general decline in the aquatic resource.

Recent reports on water quality conditions provided by States indicate that nutrients are the leading cause of impairment in lakes and coastal waters and the second leading cause of impairment to rivers and streams. Nutrient overenrichment has also been strongly linked to the large hypoxic zone in the Gulf of Mexico and to recent outbreaks of the toxic microorganism *Pfiesteria* along the Gulf and Mid-Atlantic coasts.

The Action Plan calls on EPA to accelerate the development of scientific information concerning the levels of nutrients that cause water quality problems and to organize this information by different types of waterbodies (e.g. streams, lakes, coastal waters, wetlands) and by geographic regions of the country. EPA is also to work with States and Tribes to adopt criteria (i.e. numeric concentration levels) for nutrients, including nitrogen and phosphorus, as part of enforceable State water quality standards under the Clean Water Act.

This **National Strategy for Development of Nutrient Criteria** describes the approach that EPA will follow in developing nutrient information and working with States and Tribes to adopt nutrient criteria as part of State water quality standards. Some key aspects of the Strategy are described below.

### Region and Waterbody Approach

Section 304(a) of the Clean Water Act directs EPA to develop scientific information on pollutants and to publish "criteria guidance," often expressed as pollutant concentration levels, that will result in attainment of a designated use of the waterbody (e.g. fishing, swimming) that is determined by the State. These concentration levels generally are the same for all types of waterbodies and to all areas of the country. States consider these EPA "criteria guidance" when they adopt water quality standards for waterbodies. A water quality standard commonly includes a designed use for the waterbody and criteria (i.e. concentration levels) for a range of pollutants that will assure that the waterbody will support the designated use.

In the case of nutrients, however, there is a great deal of variability in inherent nutrient levels and nutrient responses throughout the country. This natural variability is due to differences in geology, climate and waterbody type. Because of this variation, EPA's custom of developing scientific information about a pollutant and recommending a single pollutant concentration number to support a designated use for nationwide application is not appropriate for nutrients. EPA believes that distinct geographic regions and types of waterbodies need to be evaluated differently and that recommended nutrient concentration levels need to reflect geographic variation and waterbody types.

### Waterbody-Type Guidance Documents

An essential element of this Strategy is development of waterbody-type guidance documents describing the techniques for assessing the trophic state of a waterbody and methodologies for developing nutrient criteria appropriate to different geographic regions. Separate guidance documents will be developed for rivers, lakes, coastal waters, and wetlands.

Each waterbody guidance document will provide scientific information required by section 304(a) of the Clean Water Act, including recommended nutrient concentration levels that are appropriate for the waterbody type, the geographic region, and various designated uses. EPA will use State databases to develop these criteria guidance documents, supplemented with new regional case studies and demonstration projects to provide additional information. EPA expects that these levels will be expressed as numerical target ranges for variables such as phosphorus, nitrogen, and other nutrient indicators. Guidance documents for rivers, lakes, and coastal waters will be completed by the end of the year 2000 and the guidance document for wetlands will be developed by the end of 2001.

### Adding Nutrients to Water Quality Standards

EPA expects States and Tribes to use the waterbody type guidance documents and nutrient target ranges as a guide in developing and adopting numeric levels for nutrients that support the designated uses of the waterbody as part of State water quality standards. EPA will work with States to support and assist in this process. States should have adopted nutrient criteria that support State designated uses by the end of 2003.

EPA will review and approve the new or revised nutrient elements of water quality standards under Section 303(c)(3) of the Clean Water Act. If EPA disapproves the new standard submitted by a State or Tribe (because EPA determines that it is not scientifically defensible), or if EPA determines that a new or revised nutrient standard is necessary for a State or Tribe (because EPA determines that the State or Tribe has not demonstrated reasonable progress toward developing numerical nutrient standards), EPA will initiate rulemaking to promulgate nutrient criteria values that will support the designated use of the waterbody and are appropriate to the region and waterbody types. Any resulting water quality standard would apply until the State or Tribe adopts, and EPA approves, a revised standard.

Once adopted as part of State or Tribal water quality standards, the nutrient criteria in State standards will become the basis for identifying waters where nutrients result in impairment of water quality and making many management decisions to reduce excessive nutrient levels in these waters.

**National and Regional Nutrient Teams**

The Office of Water will provide additional technical and financial assistance to the Regions and States to accelerate the development of nutrient criteria.

This effort will include the establishment of a National Nutrient Team, including coordinators from each EPA Region. The Regional Coordinator will foster the development and implementation of State projects, databases, nutrient criteria and standards, and the award of financial assistance to States and Tribes to support these endeavors. Each Regional coordinator will be responsible for nutrient management activities for that Region and its member States and Tribes consistent with decisions of the national nutrient program.

Each Regional Coordinator will form a Regional Nutrient Team that includes State and Tribal representatives and other federal and local representatives, as needed, to develop nutrient databases and nutrient target ranges.

I am confident that this effort to include nutrient concentration levels in State water quality standards will be a major step forward for efforts to restore and protect the Nation's waters. I look forward to working with water program managers and other interested parties in this important initiative.

____________________________ _______________

Robert Perciasepe<br>Assistant Administrator<br>Office of Water

Date

**NOTE TO THE READER**

This document sets forth EPA's strategy to develop scientific information (i.e., criteria documents under section 304(a) of the Clean Water Act) which EPA will recommend that States use to adopt nutrient criteria to support State water quality standards. These nutrient criteria provide a critical foundation to address overenrichment problems in the Nation's surface waters. It also provides guidance to States, Tribes and the public regarding how EPA intends to exercise its discretion in implementing the provisions of the Clean Water Act concerning the adoption of water quality standards.

This document is designed to implement national policy on the issues it addresses. It does not, however, substitute for the Clean Water Act or EPA's regulations; nor is it a regulation itself. Thus, it cannot impose legally binding requirements on EPA, States, Tribes or the regulated community and may not apply to some particular situations. EPA, State and Tribal decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA also retains discretion to change the guidance contained in this strategy in the future.

## I. INTRODUCTION

### A. Background

Nutrients, in the appropriate amounts, are essential to the health and continued functioning of natural ecosystems. Depending upon specific characteristics of the receiving waterbodies, they can be present in excessive, limiting, or optimal amounts. Insufficient nutrients will result in less than optimal growth of primary producers (i.e., plants, including phytoplankton and submerged aquatic vegetation). Adequate primary productivity is essential to support all the other trophic levels and a healthy, diverse, and productive ecosystem.

Excessive nutrient loadings will, however, result in excessive growth of macrophytes or phytoplankton and potentially harmful algal blooms (HAB), leading to oxygen declines, imbalance of prey and predator species, public health concerns, and a general decline of the aquatic resource. It is the excesses of these nutrients resulting from human activities, rather than natural spatial and temporal variations, that are the concern of this document and it is this cultural eutrophication that is most appropriately the subject of management efforts.

When nutrient inputs exceed the assimilative capacity of a waterbody system, the system progresses toward hypereutrophic conditions. Symptoms include an overabundance of primary producers, decreased biological diversity, algal blooms (some toxic), low dissolved oxygen, episodic anoxia, loss of vascular plant life, and fish kills. Investigations have shown that the key causative factors are excessive concentrations of the primary nutrients phosphorus and nitrogen.

The term *nutrient* is loosely used to describe a compound that is necessary for metabolism. Nitrogen (N) and phosphorus (P) are required in relatively large amounts by cells and are called macronutrients, as opposed to micronutrients such as iron or molybdenum.

*Nutrient criteria* is intended to be interpreted in its broadest sense, covering both legal and scientific interpretations. Legally, a nutrient criterion is the numeric value which supports a particular beneficial designated use in defining a water quality standard. Scientifically, a nutrient criterion is meant to encompass both causal and response variables (e.g., nitrogen or phosphorus levels), as well as aquatic community response parameters such as but not limited to algal biomass, chlorophyll a, and secchi depth.

Similarly, in this text the problem of *eutrophication* is used to describe an increase of nutrients in a waterbody which results in an <u>overabundance</u> of plant biomass (Flemer, 1972).

The terms *water quality measurement* and *water resource measurement* are both intended to mean a comprehensive array of measurements including chemical, physical, and biological parameters.

In all aquatic ecosystems some general processes determine whether N or P is the limiting macronutrient and can be expressed as the nitrogen-to-phosphorus ratio (N:P). The *Redfield ratio* of N:P for primary producers in marine systems is approximately 16:1 on a molar scale

(Redfield, 1958). In freshwater systems the phosphorus limitation tends to be greater at an N:P ratio of up to about 26:1. Ecosystems that deviate substantially from these ratios are likely to experience nutrient limitation of either N or P (i.e., if the ratio in marine or estuarine waters is less than 16, N could be limiting; if the ratio is greater than 16, P is probably the limiting nutrient).

**B. Nutrient Pollution Problems**

According to the U.S. Environmental Protection Agency's (EPA's) *National Water Quality Inventory: 1996 Report to Congress* (required under section 305(b) of the Clean Water Act), 50 States, Tribes, and other jurisdictions surveyed water quality conditions in 19 percent of the Nation's total 3.6 million miles of rivers and streams.

Some 36% of these surveyed waters were impaired by various pollutants. The leading cause of impairment was siltation, contributing to impairments in 51% of these waters. Nutrients were the second most significant cause of impairment, contributing to impairment of 40% of waters. Excessive nutrients were the leading cause of impairment of affected lakes and impaired coastal waters at 51% and 57% respectively.

Excessive nutrients have also been linked to hypoxia conditions in the Gulf of Mexico and have been associated with outbreaks of *Pfiesteria* in several Gulf and Mid-Atlantic States.

Sources historically associated with nutrient overenrichment are fertilizers, sewage treatment plants, detergents, septic systems, combined sewer overflows, sediment mobilization, animal manure, atmospheric deposition and internal nutrient recycling from sediments. Other factors that can influence overenrichment are light attenuation, land-use practices, and imbalance of primary, secondary, and tertiary producers and consumers (plankton, macrophytes, epiphytes, grazers, predators, and decomposers).

**C. Past Nutrient Reduction Efforts**

Over the years, the EPA's Office of Water has issued a number of technical guidance documents and has supported the development of water quality simulation models and loading estimating models that can be used to assess the impacts of urban, rural, and mixed land use activities on receiving waters.

In addition, some States currently have water quality standards that incorporate criteria, primarily narrative, aimed at controlling problems associated with nutrient overenrichment (see Appendix A for a list of water quality criteria and standards currently in use by States). However, for State, Tribal and local agencies to better understand and manage nutrient impacts to surface waters, additional work is necessary.

According to a State Nutrient Water Quality Standards 1994 EPA Survey:

- ♦ 17 States have no WQS for nitrates/nitrites
- ♦ 21 States have no WQS for phosphorus
- ♦ Many States have narrative standards only
- ♦ 10 States have adopted EPA criteria unrelated to eutrophication (e.g., 10 mg/L for nitrate, or 0.10 ug/L elemental phosphorus)
- ♦ Only 9 criteria (N and P) are waterbody-based

In 1993, the EPA Nutrient Task Force gathered existing data on nutrient problems and currently available tools. It recommended that EPA provide additional assistance to States in developing and implementing appropriate nutrient indicators, assessment methodologies, and models. The first step in carrying out the recommendations of the task force was the nutrient overenrichment assessment workshop held in Washington, DC, on December 4-6, 1995. The workshop was organized around plenary and breakout group discussions on four major waterbody types:

- estuarine and coastal marine water;
- lakes, impoundments/reservoirs, and ponds;
- rivers and streams; and
- wetlands.

Issue papers describing the state of the science, gaps, and user needs in terms of nutrient assessment tools and methodologies for each waterbody type were developed and used as foundations for these group discussions. The results of this workshop, compiled in *National Nutrient Assessment Workshop Proceedings* (EPA 822-R-96-004, 1996), form the basis of this Strategy.

**D. Other Current Nutrient-Related Efforts**

In addition to this Strategy, there are a number of other evolving efforts that focus on elements related to the nutrient overenrichment problem. These include the following:

- **Criteria and Standards Plan**. The Plan describes six new criteria and standards program initiatives that EPA and the States/Tribes will pursue over the next decade including the nutrient criteria effort. The Plan presents a "vision" and strategy for meeting these important new initiatives and improvements. The Plan will guide EPA and the States/Tribes in the development and implementation of criteria and standards and will provide a basis for enhancements to the Total Maximum Daily Load (TMDL) program, National Pollutant Discharge Elimination System (NPDES) permitting, nonpoint source control, wetlands protection and other water resources management efforts.

- **Nonpoint Sources: Picking Up the Pace; A National Strategy for Strengthening Nonpoint Source Pollution Management** (draft, September

1997). This strategy envisions that all States/Tribes, with the active assistance and participation of all stakeholders, will implement dynamic and effective nonpoint source pollution programs to achieve and maintain beneficial uses of water by the end of calendar year 2013.

- **Strategy for Addressing Environmental Public Health Impacts from Animal Feeding Operations (AFOs)** (draft, March 1998). This strategy strives to minimize environmental and public health impacts from AFOs through an effective mix of voluntary and regulatory measures. EPA is working with the US Department of Agriculture to develop a joint USDA/EPA national strategy on Animal Feeding Operations. This joint strategy -- which will supersede the draft EPA AFO Strategy -- will be published in draft form in July and in final form in November.

- **The National Harmful Algal Bloom Research and Monitoring Strategy**. This strategy was developed as an effort to coordinate Federal research and monitoring activities on *Pfiesteria* and other HABs. Federal HAB programs are spread across several Federal agencies, including the National Oceanic and Atmospheric Administration (NOAA); EPA; the Department of Health and Human Services–Centers for Disease Control and Prevention, the Food and Drug Administration, and the National Institute of Environmental Health Sciences (DHHS– CDCP, FDA, and NIEHS); the National Biologic Service (NBS); the National Science Foundation (NSF); and the U.S. Fish and Wildlife Service (USFWS), and an interagency workgroup was formed to address a diverse list of current and planned HAB activities.

  After reporting relevant research and programmatic activities, questions were formulated that addressed the objectives of a comprehensive research strategy. The research questions and objectives were differentiated into near-term and long-term activities, and the workgroup classified each agency activity into groups that reflect the eight objectives cited in *Marine Biotoxins and Harmful Algae: A National Plan* (Anderson *et al.*, 1993). Agency activities have been categorized into these objectives allowing the workgroup to identify obvious coordination points, and data/research gaps.

- **Water Quality Standards Regulation: Advance Notice of Proposed Rule Making (ANPRM).** EPA is about to publish an Advance Notice of Proposed Rulemaking (ANPRM) on the Water Quality Standards Regulation in the Federal Register. The ANPRM solicits public comment on potential revisions to the basic water quality standards program regulation governing State adoption and EPA approval of water quality standards under Section 303(c) of the Clean Water Act. The ANPRM also requests comment on changes in policy and guidance that support the regulation.

  The ANPRM expresses current EPA thinking in a number of areas addressed by the current regulation, policy and guidance and requests comment on that thinking.

One of the main themes of the ANPRM is updating and modernizing water quality standards so that standards may be better implemented on a watershed basis using refined use designations and tailored criteria. New science and assessment methodologies, as well as better data, and new types of data and analysis would need to be used by States and Tribes to refine water quality standards in this manner. The ANPRM highlights the potential resource challenge for States and Tribes and requests comment regarding concerns over resource constraints and ideas for how to address them.

- **The USDA Nutrient Management Policy**. The USDA's Natural Resources Conservation Service (NRCS) proposed a revised nutrient management policy to its National Agronomy Manual. This revised policy will impact the NRCS national conservation practice standards for Nutrient Management (Code 590) and Waste Utilization (Code 633). The nutrient policy discusses certification of plans, describes what is in nutrient management plans, and discusses soil and plant tissue testing, nutrient application rates, record keeping and other special considerations. The revised policy will be adopted after the June 22, 1998 comment period closes.

The groups developing the strategies are all investigating related problems ... land use-nutrient loading relationships, ecological responses, and appropriate mitigation activities. As all of these strategies progress, it will be essential to coordinate the information and activities that result so that consistent policy is developed.

## II. EPA NATIONAL STRATEGY FOR DEVELOPING REGIONAL NUTRIENT CRITERIA

This Strategy proposes to build on the work accomplished to date and to establish an objective, scientifically sound basis for assessing nutrient overenrichment problems. Improving the basis for assessing nutrient overenrichment problems will provide critical support for expanded efforts to control nutrient levels in waters and meet the Nation's clean water goals.

Specifically, this Strategy proposes a two-phase process for the development of water quality standards for nutrients:

1) EPA will develop "nutrient criteria guidance" for nitrogen, phosphorus, and other nutrient parameters such as chlorophyll a, secchi depth, and algal biomass. These criteria will be developed under section 304(a) of the Clean Water Act and will represent EPA's guidance regarding the amounts of those contaminants that may be present in waters without impairing their designated uses. Unlike other criteria guidance that EPA has developed, EPA intends to express nutrient criteria guidance as numerical ranges, reflecting a menu of different values based on the type of waterbody (i.e., streams and rivers, coastal waters and estuaries, lakes and reservoirs, and wetlands) and the region of the country in which the water is located.

2) EPA expects States and Tribes to adopt nutrient water quality criteria

(including N and P concentration levels) to support designated uses of waters. These "nutrient criteria" will be based on EPA's nutrient criteria guidance or other scientifically defensible methods and will be incorporated into the States' water quality standards. The goal is for the States/Tribes to establish these criteria as part of their water quality standards as soon as the appropriate criteria guidance is developed. The target date for adoption of nutrient criteria as part of water quality standards is within three years of completion of the guidance, (i.e., by the end of the calendar year 2003). EPA will step in and promulgate nutrient water quality criteria for a State or Tribe if EPA determines that federal action is necessary.

Adding nutrient criteria to State water quality standards is essential for Federal, State and local agencies, and the public, to better understand, identify, and manage nutrient overenrichment problems in surface waters.

The following sections will present the key elements of the Strategy and describe the tasks and activities that EPA will undertake to promote nutrient assessment and criteria development over the next several years.

**A. The Five Key Elements of the Strategy**

**1) Geographic Region Approach.**

EPA intends to develop nutrient criteria guidance on a regional, rather than a national, basis. The Agency expects States and Tribes to develop water quality criteria and standards for nutrients in their geographic regions based on the guidance provided by EPA. The criteria established would therefore be the product of a joint EPA-State/Tribal effort tailored to that part of the country. This approach permits the objective of overenrichment abatement to be met by recognizing the ambient "natural" background levels of nutrients in each region and then concentrating on the "cultural" eutrophication which exceeds this. As noted below, regional criteria information will be presented for four categories of waterbodies.

Although this Strategy is organized around the four major waterbody types specified below, it is recognized that approaches for assessing regional and waterbody-specific nutrient concerns must consider that waterbody types are not independent from each other, but are part of an interconnected and larger system. With that in mind, the need for integration of concepts associated with the assessment and control of nutrient overenrichment between waterbody types is clear. This understanding of an integrated approach is an important concept to keep in mind during the implementation of this Strategy.

One well-defined spatial framework which can be used to define a region for nutrient assessment is the "ecoregion" system developed by James Omernik of the EPA Corvalis, OR laboratory. While it is acknowledged that several other classification schemes have been developed, for the purposes of this strategy, EPA plans to use Ecoregions as defined by Omernik et al., to initiate development of regional nutrient indicator ranges and, ultimately, to include them in the State and Tribal nutrient water quality criteria. A draft map has been created as a starting point for this process (See figure 1). Still to be determined is what scale of ecoregion is appropriate for the development of regional nutrient criteria guidance within a short period of time (by the end of calendar year 2000). The degree of variability within each of these 14 nutrient ecoregions will determine whether the map needs further refinement. These issues will be resolved once data has been reviewed, analyzed, and discussed at meetings of the National Nutrient Team and its Regional components (see item 4 below). In addition, this does not preclude the use of other classification schemes by Regions and States and Tribes if they are judged to be more appropriate for that part of the country. For more details on the ecoregion concept and how it can be applied in a nutrient assessment see Omernik (1995) and Omernik et al (1988).

Upon determination of the best ecoregion scale, the next task which is integral to the development of nutrient ecoregional ranges is the identification of reference conditions within each of the nutrient ecoregions. Reference conditions refer to information from relatively undisturbed areas within each ecoregion. The concept of reference conditions and how they are selected will be described in more detail in the technical guidance documents.

**2) Waterbody-Type Technical Guidance.**

A major element of this Strategy will be the technical nutrient criteria guidance manuals, which will provide methodologies for developing region-specific nutrient criteria by waterbody type:

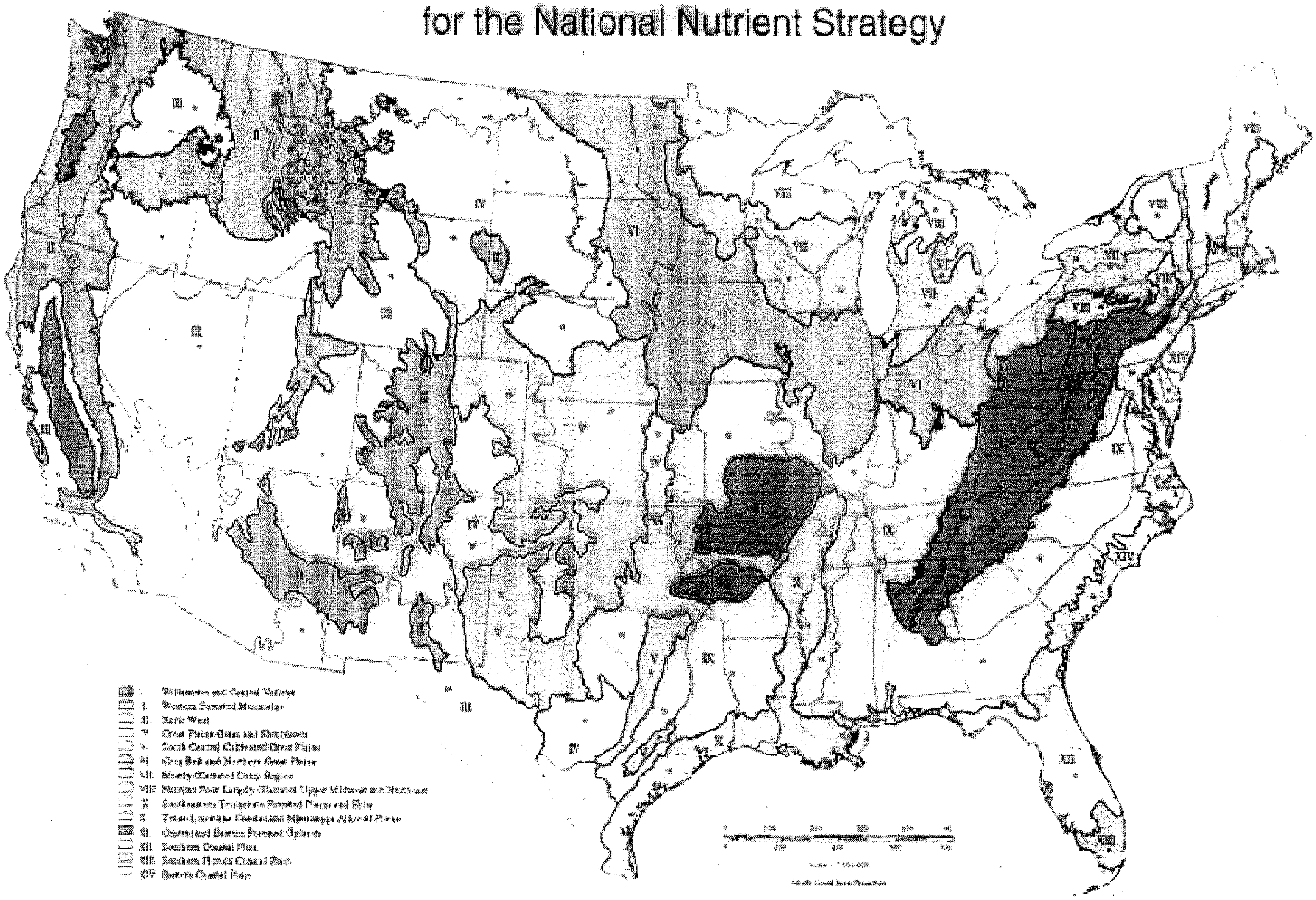
- streams and rivers,
- lakes and reservoirs,
- estuaries and coastal marine waters, and
- wetlands.

These manuals will also include discussions on overenrichment indicators, sampling and analytical techniques, and management methods. The manuals will be designed to be adapted in the various regions of the country.

The manuals will also provide technical assistance to implement nutrient abatement practices and will include data processing and manipulation techniques, best management practices, and case study demonstrations. An outline of the proposed content of the guidance document is in Appendix C, and elements of the technical material are presented in part III of this document. EPA plans to publish guidance documents for streams and rivers, and lakes and reservoirs in 1999; a guidance document on estuaries and coastal marine waters in 2000; and a guidance document on wetlands in 2001. **In each document, where data is available, EPA will also provide target regional nutrient ranges for phosphorus and nitrogen (and potentially other parameters)**, which States and Tribes may elect to use as the basis of their nutrient criteria and standards in lieu of applying the methodology. Where appropriate, they may also use these values as the basis for TMDLs and NPDES permit limits.

EPA and the Regional teams will collect and organize nutrient data on a geographic basis and develop target nutrient ranges based on historical nutrient data, reference conditions, and expert

# Draft Aggregations of Level III Ecoregions for the National Nutrient Strategy



panel opinion. Where adequate data is available, EPA intends to append these ranges to its waterbody-type guidance manuals. This information can be used by individual States/Tribes which lack sufficient data of their own. Each appendix will be a "stand alone," peer reviewed document for a specific nutrient ecoregion.

As a preliminary measure for development of these nutrient criteria ( i.e., the particular indicators used to assess the overenrichment or potential for overenrichment of a waterbody), EPA is seeking the cooperation of States and Tribes to pool available information in the determination of such ranges of target values for each region of the country. EPA will initially develop ranges for phosphorus, nitrogen, chlorophyll and secchi depth.

Collecting the data necessary to establish ranges for these parameters will be the first priority of the National Nutrient Team and Regional Coordinators. These ranges are intended to reflect the variability of conditions typically associated with particular waterbody types within an ecoregion. In addition, the ranges of target values serve as a starting point for making the proper measurements of waterbody enrichment and overenrichment so the appropriate management can be initiated. The guidance manuals are designed to provide the best methods for such measuring and evaluation.

An essential element of this process is the determination of the natural, background trophic state representative (Reference condition) of that area and waterbody so that abatement management can be directed at the cultural eutrophication of concern. It is not the intention of this strategy or the subsequent program to require States or Tribes to correct a natural enrichment process typical of their region; rather it is the purpose of the strategy to help States and Tribes develop mechanisms to remedy the enrichment effects of human development and commerce which impede the biota and beneficial uses of that waterbody.

**3) Nutrient Criteria and Standards Development.**

Upon completion of all the waterbody-type guidance documents, EPA expects all States and Tribes to adopt and implement numerical nutrient criteria into their water quality standards within three years of publication of waterbody type guidance documents and to complete adoption of nutrient criteria for all waterbodies in the State by no later than December 31, 2003. EPA expects States and Tribes to accomplish this by developing their own regional values in watersheds where applicable data are available, or by using the EPA target nutrient ranges. EPA expects States and Tribes to select a single value within the range as their water quality criterion where data is sufficient.

With regard to criteria and standards development, State and Tribes can choose to use the following approaches:

- The EPA target ranges, or values within those ranges, can be directly adopted by the States or Tribes as their criteria and standards and used to interpret narrative standards.

- The States or Tribes can use the EPA target ranges together with their own databases to develop their own criteria or to evaluate the protectiveness of any numerical nutrient criteria they may already have.

- States or Tribes may elect to use the EPA methodology described in waterbody-type guidance to develop criteria or employ their own approach, independent of the ranges, as long as it is scientifically defensible.

Once submitted to EPA, the Agency will review the new or revised standards under Section 303(c)(3) of the Clean Water Act. If EPA disapproves the new standard submitted by a State or Tribe (e.g., because EPA determines that it is not scientifically defensible), or if EPA determines that a new or revised nutrients standard is necessary for a State or Tribe (e.g., because EPA determines that the State or Tribe has not demonstrated reasonable progress toward developing numerical nutrient standards), EPA will initiate rulemaking to promulgate nutrient criteria values appropriate to the region and waterbody types. Any resulting water quality standard would apply until the State or Tribe adopts and EPA approves a revised standard. In the event EPA promulgates nutrient water quality standards for a State or Tribe, EPA would likely use the point in the range of greatest confidence (i.e., central tendency). When reviewing the adequacy of State/Tribe derived criteria and or ascertaining whether a State or Tribe is making reasonable progress toward developing an adequate nutrient criterion and standard, EPA is likely to use the target ranges.

When the initial target ranges have been established and the States or Tribes have begun the criteria and standard development process, EPA through the Regional Nutrient Coordinators will also provide technical and financial assistance for nutrient management planning and application. This will be through guidance manuals and the services of regional and national specialists associated with the Team, as well as financial assistance also administrated by these Regional Nutrient Coordinators.

**4) Nutrient Teams.**

EPA Headquarters and Regional staff will work closely with State officials and other interested parties in the development of the nutrient criteria. The overall national nutrient criteria project will be managed by a National Nutrient Team. The EPA National Nutrient Team will include Office of Water staff, a Coordinator from each EPA Region, State/Tribal representatives, and representatives of other Federal agencies (See Figures 2 and 3). EPA will provide guidance and support to States/Tribes in the form of technical and financial assistance to help establish their regional programs.

In addition, each Regional Office will select a Regional Nutrient Coordinator and will establish a Regional Nutrient Team. The Regional Coordinator will promote the development and implementation of State and Tribal projects, databases, and nutrient criteria and standards, as well as manage the award of financial assistance to support this endeavor. Specifically, Regional Coordinators will have a large role facilitating the collection of nutrient data from States and Tribes within their Regions. Ultimately, the Regional Coordinators and National Team will work together to develop nutrient ranges for each ecoregion wherever appropriate data is available.

FIG. 2

## National Nutrient Team

EPA HQ Offices (OW, ORD)
10 Regional Coordinators
3-5 States
Other Federal Agencies (USGS, NOAA, USDA, et. al.)

Function:

Establish ecoregion maps for nutrients
Establish best process for collecting data from all sources
Establish best process for analyzing data and developing nutrient criteria (minimum data and statistics)

FIG. 3

## Regional Nutrient Team

1 Regional Nutrient Coordinator
1 HQ Representative
1 State Representative from each State in the Region
Other Federal/State/Local Representatives as needed

Function:

Collect and analyze regional nutrient data
Establish nutrient ranges (criteria)
Award assistance grants to State/Academia where gaps exist in our knowledge

Ten Regional Nutrient Coordinators, one from each Region, have been selected and they have begun the process of forming their Regional Nutrient Teams. Regional Teams will likely include representatives from each State in the Region and other federal, State, local representatives, as needed (including water quality managers, NPDES permit writers, field biologists, monitoring and modeling experts). For example, a regional team could include other Regional EPA specialists such as those in Regional and ORD laboratories, as well as specialists from such agencies as the U.S. Geological Survey (USGS); NOAA– National Marine Fisheries Service (NOAA-NMFS); the U.S. Department of Agriculture-Natural Resources Conservation Service and Cooperative State Research, Education, and Extension Service (USDA– NRCS and CSREES); the U.S. Forest Service (USFS); and the USFWS. State/Tribal counterparts of these agencies and States and Tribes regulatory specialists should also be included. University specialists should be considered, as well as the local communities and environmental and special interest groups. While this list of participants might be the ideal, in reality local circumstances will probably dictate a smaller group whose composition is likely to change with time and needs. However, the agency and community resources described above should, at the very least, be consulted for information and historical perspectives on the waters in question.

As technical guidance and assistance is established in the various States and Tribes, periodic meetings of the Regional Nutrient Team Coordinators should be held to compare experiences, including successes and failures of approaches taken and techniques tried. Key participants, in addition to the Coordinators, should be the specialists and natural resource managers (as described above) who conducted the work so detailed question-and-answer sessions can be held. A proceedings document for each of these meetings should be prepared and circulated among the States and Tribes and agencies promptly so nutrient measurement and management information can be rapidly disseminated.

Following organizational meetings at which the objectives of the program are established, the business of obtaining State and Tribal cooperation in providing nutrient and other enrichment indicator data must be addressed. This is best accomplished by indicating the positive consequences of the information exchange. A trial watershed project, in which the information is actually applied to help solve an overenrichment problem significant to the State/Tribe, is an appropriate way to start. This demonstration project can be initiated in tandem with the overall data-gathering effort and will serve as an incentive to other States/Tribes to become involved.

### 5) Management and Evaluation.

While the primary focus of this Strategy is to develop regional nutrient criteria guidance, it is essential to understand the role criteria and standards play in overall nutrient management. The management of nutrient overenrichment is not just the development of nutrient criteria and the application of standards; it is a management process which must integrate a number of programs and methods including but not limited to: Nonpoint and Watershed programs; NPDES Permitting program; Biosolids Management program.

These various programs offer many options for the resource manager to consider and there are many new programs still being developed. However, there are some fundamental management concepts that should apply in most of these situations. Presented below are ten sequential elements to consider.

This comprehensive approach incorporates all of the key elements essential to good management planning, but the user might find that some steps can be consolidated or that circumstances necessitate a different sequence in the chronology.

1. Problem identification
   Make sure a problem exists and is clearly defined in terms that make it possible to seek a solution.

2. Background investigation
   Use literature searches, questionnaires, interviews, and other background investigations to better describe the problem and determine the information available about it.

3. Data gathering
   Conduct an assessment of water quality including physical, chemical, and biological parameters and related loading sources in the watersheds. This step should usually be of one or more years' duration to accommodate seasonal and annual variation.

4. Identification of key problem areas
   Conduct a thorough assessment of all of the above information.

5. Alternative management options
   Evaluate each possibility and its impact on present uses with respect to scientific validity, cost-effectiveness, and sociopolitical feasibility. Involve local and States and Tribal governments, property owners, citizen groups, and public and business interests in discussions about the optimal approach.

6. Detailed management plan
   Prepare a plan that discusses how to address each key element of the nutrient problem in the most effective sequence. Include a stepwise sequence of coordinated activities in detail. Usually such a management plan is of a maximum 5-year duration. Such a duration accommodates sufficient measurement and seasonal variation but is short enough in planning scope to be included in most budget systems. Longer projects might require sequential management plans.

7. Implementation and communication
   Initiate the management program, including adoption of nutrient water quality criteria and standards and, where appropriate, establishment of nutrients limitations in NPDES permits and development of TMDLs as elements of the program. Maintain community, interest group, and other agency involvement through regular updates on the process. This communication may begin earlier, e.g., at step 4 or sooner, but it

should be emphasized here.

8. Monitoring and periodic review
   Incorporate water quality monitoring before, during, and after the project to demonstrate relative response of the system to management efforts. Build in specific intervals for management review to allow response to changing circumstances; modifications of methods and schedules; and changes in emphasis as needed.

9. Completion and evaluation
   Has the water resource been protected or improved? Give credit to the community and other participants. Report on successes and failures for future applications and on lessons learned.

10. Continue monitoring and maintenance
    Water resource monitoring stations and parameters should continue on a reduced scale. Ensure regular maintenance of management efforts to preserve the effects achieved. Monitoring provides warning of any future degradation, so, if necessary, resource managers can intervene in a timely, cost-effective manner. Close the cycle by returning to step 1 for next generation response.

With a good database predicated on reliable indicators and the development of regional nutrient criteria guidance, States, Tribes, and other jurisdictions will be capable not only of assessing the trophic status of their waters, but also should be able to establish their criteria and plan, prioritize, and evaluate their management responses. In doing so, all five strategy objectives are interrelated at the regional level where problem recognition and remediation are most effective.

## B. How the Elements are Integrated

This national Strategy consists of a **regional, waterbody-type approach** which permits the variability in natural nutrient loadings to waterbodies around the country to be recognized, and criteria to be established which account for this variability. The criteria so developed will also be waterbody-type specific because different waterbodies respond differently to nutrient loadings. Also, in recognition of this discrete, but interrelated enrichment process, the finally developed criteria must limit not only the unacceptable enrichment of a given waterbody or watercourse, but also must factor in the effects of that enrichment on downstream receiving waters.

The **waterbody-type technical guidance manuals** being developed will provide specific guidance to the States and Tribes for making the necessary measurements and for developing the criteria from those measurements, including the establishment of **regional target values** as guidelines. These manuals (including wetlands) are scheduled to be completed by the end of 2001. Each technical guidance manual will include ecoregional target ranges. If there is sufficient data within each of the 14 ecoregions available to develop a nutrient range within each of the ecoregions for the four waterbody types, 56 nutrient range appendices will be developed by the end of 2000. If sufficient nutrient data is not available or is insufficient to develop an acceptable peer reviewed nutrient range, EPA will continue to promote data development in these ecoregions after publication of guidance.

Once the nutrient guidance and ecoregional ranges are completed it is expected that States/Tribes will develop nutrient criteria (see Figure 4).

The implementation of the criteria will be supported by the **regional nutrient teams** by providing technical and logistical expertise as well as funding assistance. The criteria can then be used in **management planning and evaluation** on a watershed basis with community involvement so the ultimate objective of enhancing and protecting our nations water resources is achieved.

## III. WATERBODY-TYPE TECHNICAL GUIDANCE.

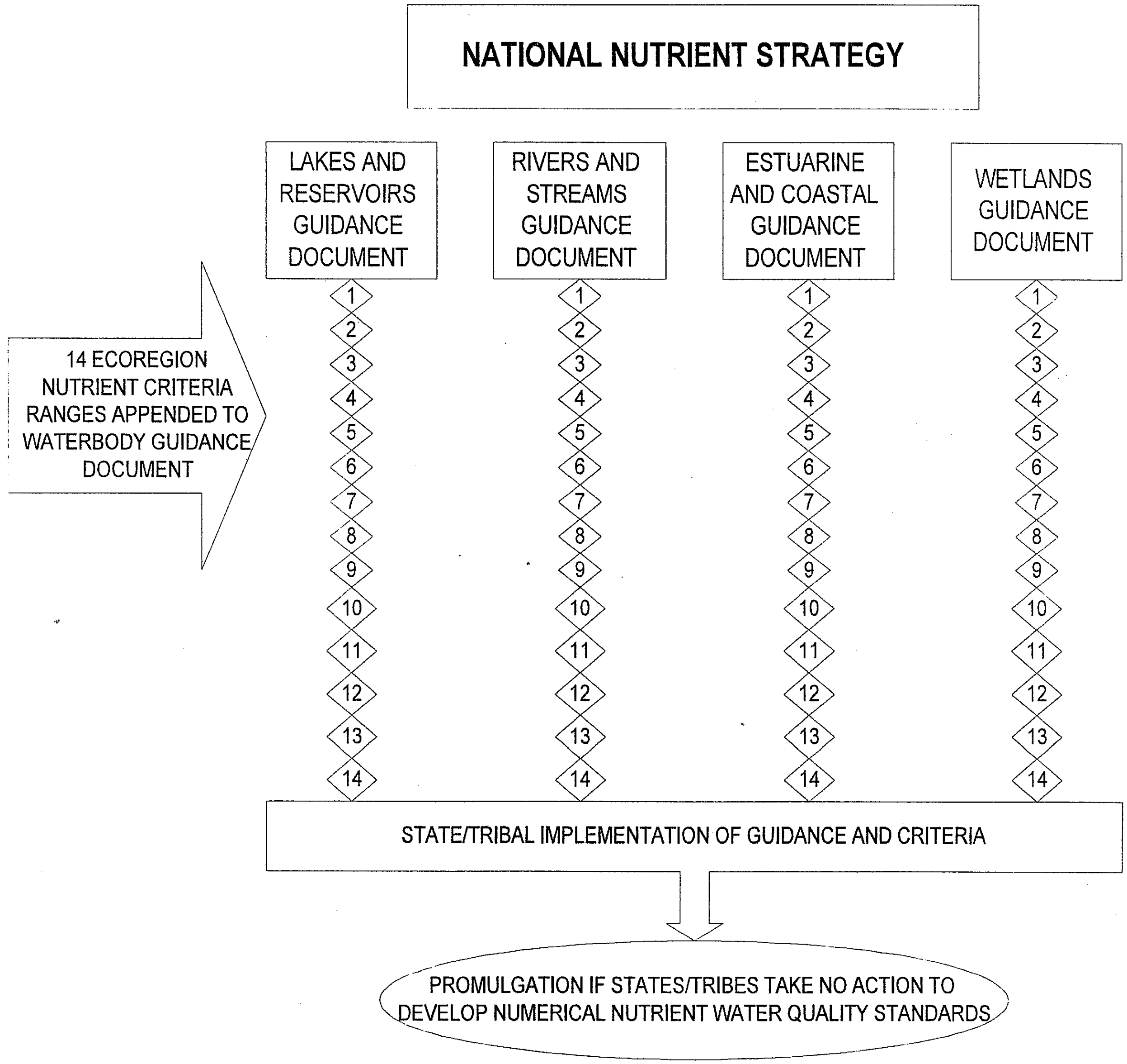
Waterbody-type guidance manuals will provide the standardized methods available to the States/Tribes and other jurisdictions to promote the development of consistent regional databases that reflect conditions in each part of the country. This is important because overenrichment and natural levels of enrichment differ from one geographic area to another, in part because of differing cultural, geologic, and climatologic influences. These factors change the ambient background from one region to another and necessitate a regional approach to these measurements and to the nutrient criteria to be developed.

A key element of each waterbody-type guidance manual is the recommended list of reliable indicators of overenrichment, how they might best be measured, and how and when to collect the necessary samples for this measurement. (These manuals may also include sections addressing the remaining objectives of this strategy, i.e., data storage and assessment, research needs, and best management practices for nutrient impact mitigation.) EPA intends that the publication of these technical guidance documents will help standardize assessments and promote regional interstate cooperation for nutrient control.

The following is a partial listing of overenrichment indicators, data requirements, management options, and research needs recommended by the component nutrient workgroups at the December 1995 meeting in Washington DC, and by subsequent reviewers. Some of these recommendations are qualitative in nature; such indicators are also valuable and definitive in their own right. All of the indicators are meant to serve as a starting point for enrichment assessments, which are expected to be expanded and refined into more quantitative evaluations as the guidance is further developed and as individual States/Tribes make regional adjustments to the methods.

Even as a partial listing, this material may seem remarkably detailed to the general reader for a strategy document. It must be recognized that this strategy is predicated upon the proper

Figure 4


NATIONAL NUTRIENT STRATEGY
LAKES AND RESERVOIRS GUIDANCE DOCUMENT
RIVERS AND STREAMS GUIDANCE DOCUMENT
ESTUARINE AND COASTAL GUIDANCE DOCUMENT
WETLANDS GUIDANCE DOCUMENT
14 ECOREGION NUTRIENT CRITERIA RANGES APPENDED TO WATERBODY GUIDANCE DOCUMENT
1 2 3 4 5 6 7 8 9 10 11 12 13 14
STATE/TRIBAL IMPLEMENTATION OF GUIDANCE AND CRITERIA
PROMULGATION IF STATES/TRIBES TAKE NO ACTION TO DEVELOP NUMERICAL NUTRIENT WATER QUALITY STANDARDS

measurement of valid environmental indicators for the establishment of scientifically defensible nutrient criteria. The identification of the premises upon which these criteria are based is essential to a fair and objective review of this strategy by the public.

## A. INDICATORS

The indicators (parameters) listed below are the initial candidates for inclusion in the guidance documents. Each EPA technical guidance drafting committee will make final recommendations as they further explore the scientific veracity and practicality of the material. Additionally, each document will include recommendations for the most appropriate sampling and analytical techniques.

*LAKES AND RESERVOIRS*

A focus of this guidance will be to establish the connection between lake nutrient environmental impacts to public health concerns, e.g., septic and sewage effluent discharges. This twofold approach relating environmental degradation to potential public health risks (as well as recreational uses and biodiversity concerns) should further stimulate public support of these initiatives. An outline of this proposed guidance document is attached as Appendix C.

The guidance will include and emphasize watershed-scale assessments and management approaches, illustrated by case histories and demonstration projects.

Surveys should address both spatial and temporal variability, including seasonality and in some instances variation over the course of a day. Whenever possible, year-round sampling is advisable. For in-lake surveys, it is presumed that the investigator will design for optimal spatial and bathymetric placement of the stations for that waterbody and that these data will be compared to reference lakes in that classification. Some of the parameters or indicators to consider follow:

- *Early Warning Watershed Indicators*
  — Land use/loading assessments and changes in watersheds (geographic information systems (GIS) are effective tools for evaluating nutrient loadings as a function of land use at a variety of scales). In areas of the country where agriculture and/or animal feeding operations exist, it is imperative to identify and assess these locations of potential sources of nutrients by collecting data on size and location of farms/animal feeding operations within a given watershed.
  — Changes in hydrologic regimes

- *Chemical/Biomass Parameters*
  — Phosphorus (P) concentration (total P (TP) and total dissolved P in hypolimnion )
  — Nitrogen (N) Concentration (total KN, $NO_2$ as N, $NO_3$ as N, and $NH_4$ as N, e.g., total N (TN), also N:P ratios)
  — Chlorophyll (total or chlorophyll *a*)

— Secchi disk depth (m)
— DO (hypolimnetic)

- *Community Structure Parameters*
  — Algal community (composition and biomass)
  — Macroinvertebrate structure (composition and biomass)
  — Fish (composition and biomass)
  — Macrophytes (composition and biomass)

- *Secondary Parameters*
  — Total suspended solids (TSS)
  — Total organic carbon (TOC)

- *Indicators for Immediate Assessment*
  — Preliminary survey data in addition to early warning land use information: TP, total chlorophyll, Secchi depth and DO. These should have established validity, low cost, and they should be readily used in prediction and modeling.

A historical perspective might be helpful to the data assessment process by integrating paleolimnological surveys with an evaluation of land use practices and changes.

*STREAMS AND RIVERS*

It is useful, for assessment purposes, to separate streams and rivers into two categories with optimal reference systems: for plankton-dominated systems and periphyton-dominated systems. The major differentiating characteristic between these two systems is that nutrients saturate the biomass at a much lower level in the periphyton-dominated systems than they do in the plankton-dominated systems. Summarized below are potential nutrient indicators for the plankton- dominated and periphyton-dominated systems. Early warning indicators of potential excess nutrient loadings may be significant shifts in land use patterns or in climatological events or other activities contributing to extreme runoff.

The indicators that follow are not presented in any order of sensitivity or utility.

- Plankton-dominated Systems

— Algal biomass
— Transparency
— TN

- Periphyton-dominated Systems

— Algal biomass (mg/m$^2$ percent coverage)
— Transparency
— TN, dissolved inorganic nitrogen (DIN)

- Appropriate to Either Plankton or Periphyton-dominated Systems

— pH (maximum and diel)

— DO (minimum and diel)

— Ash Free Dry Weight (AFDW)/ Chlorophyll *a*
— Aesthetics (foam, scum)
— Benthic community metabolism

— Secondary production (meiofauna, index macroinvertebrates, fish)
— Hydrologic characteristics
— TP, soluble reactive phosphorus (SRP)

— Sediment composition (physical/chemical)
— Ratios of summer/winter nutrient concentration
— Ratios of dissolved/total nutrient concentrations
— Temperature
— TSS, volatile to suspended solids ratio
— Biointegrity (macroinvertebrate community composition)
— Production/respiration
— Dissolved organic material
— Relative plankton composition of Cyanophyta and dinoflagellates

*ESTUARIES AND COASTAL MARINE WATERS*

Estuaries and coastal marine systems can be subclassified for assessment according to the dominant vegetation type, as was done by the Estuaries Workgroup during the 1995 workshop. However, other systems of classification, such as classification by physical characteristics, can also be used. The participants in the December 1995 workshop selected the following categories: seagrass-dominated, plankton-dominated, and macroalgae-dominated (as indicated below). The indicators associated with these categories can be applied to either short-term or long-term assessments. It should also be noted that there are physical, chemical, and biological indicators other than those listed below (such as fish kills, suspended material, nutrient concentrations, toxins, and benthic invertebrate communities). Early warning indicators of potential excess nutrient loadings might be significant shifts in land use patterns or in climatological events or other activities contributing to extreme runoff. All indicator measurements in these waters must be qualified by attention to tide cycles, density and salinity gradients, and currents when they were made.

- *Seagrass-dominated Systems*
  — Areal surveys of distribution, abundance, and depth of grasses
  — Waterbody-type light requirements (seagrass depth vs. light attenuation)
  — C:N:P ratios in plant leaves
  — Leaf chlorophyll *a*
  — Quantum irradience levels
  — Chlorophyll *a*-to-b ratios
  — Transparency

- *Plankton-dominated Systems*
  — Chlorophyll *a*
  — Algae such as cyanophyta, dinoflagellate, and diatom assemblages including HABs; documentation of the incidence and location of blooms
  — DO determinations that consider cyclic fluctuations and distinguish between natural

and anthropogenic causes
- The role of silica relative to nitrogen and phosphorus in phytoplankton blooms
- Macroinvertebrate and other consumer community changes

- <u>*Macroalgae-dominated Systems*</u>
  - Macroalgae influence on DO concentrations, dissolved organic carbon concentrations, and lower trophic levels.

*WETLANDS*

Methods for assessing nutrient impacts to wetlands are perhaps less established and standardized than those for the other waterbody types. This is due to the variability within wetland types (e.g., bogs, swamps, etc.) and the lack of historic databases in these areas. Some methods developed for lakes and rivers are applicable to wetlands with standing water, but there are few methods appropriate for wetlands that have saturated soils or are infrequently flooded. Surveys of wetlands should address both the spatial and temporal variability in nutrient levels, including seasonal and diel variation. Surveys should also address the variation in nutrient levels both within a wetland and between different wetland types. Some wetlands are often naturally eutrophic and will respond to nutrient additions much differently than bogs and other oligotrophic wetlands. The variability in plant communities (i.e., succession) will also affect how a wetland assimilates nutrients.

The following are suggested methods for assessing the effects of nutrients in wetland habitats. However, for most of these parameters, few baseline data are available with which to compare collected data.

- *Early Warning Watershed Indicators*
  - Land use/loading assessments and changes in watersheds
  - Precipitation, in-flow, runoff, and any extreme climatological or anthropogenic events

- *Chemical/Biomass Parameters*
  - Phosphorus concentration (total)
  - Nitrogen concentration (total, also N:P ratios)
  - Chlorophyll (total or chlorophyll *a*)
  - Secchi disk depth (m) (for wetlands with standing water)
  - DO and soil oxygen demand

- *Biological Assemblage Parameters (e.g., composition, richness, diversity, and indicator species)*
  - Attached microbial community
  - Algae such as dinoflagellates and diatoms
  - Macrophytes including emergent vegetation
  - Macroinvertebrates
  - Fish (for wetlands with standing water)

- *Secondary Parameters*

— TSS
— TOC

Since wetlands differ in their capacity to assimilate nutrients, it might be difficult to evaluate whether a given nutrient load will have a significant ecological impact on a wetland. Biological monitoring is useful to assess the response of wetland plants and animal assemblages to overenrichment and to detect degraded habitats. Microbial, macrophyte communities and algae, such as dinoflagellate and diatom assemblages, are particularly useful for detecting nutrient impacts by measuring their diversity, richness, composition, and structure. These assemblages can be compared to the assemblages found in reference wetlands that range from "minimally disturbed" to severely impacted by nutrient enrichment. Thus, the biological integrity of a wetland can be determined relative to the biologic assemblages present in the reference wetlands. The macroinvertebrate, fish, and plant assemblages can also reflect direct impacts of overenrichment and indirect impacts such as reduced levels of dissolved oxygen.

Another method of monitoring wetlands is to identify the accumulation of organic material over time as an indication of a change in productivity. This can be done by placing pieces of feldspar within wetlands and monitoring them for accumulation. Feldspar does not react with other chemicals in the soil and, therefore, could be used as a benchmark for measuring the buildup of organic material.

There are two systems of wetland classification that might be useful for selecting and comparing wetlands. Cowardin et al. (1979) developed a hierarchical system of wetland classification based largely on the structure of the plant community (e.g., forested, scrub/shrub, emergent, etc.). In addition, Brinson (1993) developed a hydrogeomorphic (HGM) framework for classifying wetlands based on a wetland's landscape position, source of water, and hydrodynamics.

## B. DATA STORAGE AND PROCESSING

Once a standardized methodology for data gathering is available, the States and Tribes will also need a consistent and mutually compatible data storage, retrieval, and assessment system to help them interpret data and convert them to meaningful management information. An element of each waterbody-type guidance document should be convenient desktop, PC-based data storage and modeling programs. Such programs will not only enhance data assessment, but will, if consistent throughout a region, promote coordinated interstate surveys and data sharing. Many States already have sufficient nutrient databases and such data storage systems should be established in consultation with all potential partners. In fact, as Regions develop this aspect of the strategy, it is imperative that they consult with the States/Tribes to establish what systems are most efficient, cost-effective, and appropriate for data sharing without violating resource management confidentiality. EPA is currently engaged in determining the future design of a nationwide database, and this strategy should be compatible with that effort. Ensuring compatibility would include standardization of both data storage systems and models. The success of multi-State cooperation and coordination of monitoring activities will depend on this.

In all cases it will be essential that the quality of the data entered into these databases be carefully documented. Documentation should include information on methods used, minimum detection limits, and comparison to standards. Modelers should use due caution if quality assurance aspects of the data are not available.

Once such a database system is in place, calibrated and verified models can be developed or applied to help predict the likely consequences of management actions or, just as important, the lack thereof. Listed below are suggested needs or available resources appropriate to each waterbody type.

*LAKES AND RESERVOIRS*

***Modeling:***

Modeling is ideal in many ways for lake assessments. The BATHTUB and Reckhow-Simpson technique are two of many examples of existing lake models used by managers to predict trophic responses to estimating nutrient loading adjustments. The BATHTUB applies a series of empirical eutrophication models to morphologically complex lakes and reservoirs. The program performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that accounts for advective and diffusive transport, and nutrient sedimentation. (For details, see *National Nutrient Assessment Workshop Proceedings*, EPA 822-R-96-004, July 1996.)

The goal of this strategy is to provide simple, user-friendly, desktop-based software models for States and Tribes and local governments to aid them in waterbody management decision making. Impoundments/reservoirs often have unique hydrographic profiles and therefore will probably require models calibrated specifically for use with these waterbodies.

*STREAMS AND RIVERS*

***Modeling:***

It is necessary to identify ways to improve on the existing models to examine the interrelationships and links between nutrient sources and nutrient impacts and help to tailor these models to both plankton- and periphyton-dominated systems. Participants at the December 1995 workshop noted in particular that modeling tools are lacking for periphyton-dominated systems, including both simple mass balance or regression relationships and complex process-based models. Below are ways to improve on the existing models' capabilities. For more details on any of the models listed below, see the *National Nutrient Assessment Workshop Proceedings* (EPA 822-R-96-004, July 1996).

- Provide land use connections in watershed-scale models.

- Conduct sensitivity analyses.

- Conduct carbon-based simulations.

- Add temperature simulation to the WASP5 model. WASP5 is widely used in both water quality assessment and toxic modeling. The model considers comprehensive dissolved oxygen and algal processes, but does not include the carbon and silica cycles or full sediment diagenesis model. In addition, its use is limited because it does not account for temperature. Therefore, adding temperature simulation to WASP5 would allow for diurnal temperature variations.

- Add periphyton to the QUAL2E, WASP5, and HSPF models. QUAL2E and HSPF are models that capture the longitudinal transport that dominates in most rivers and streams. QUAL2E and HSPF both consider advection and dispersion. Adding periphyton to these models would allow for simulation of periphyton biomass in the riverine system.

- Introduce load/response relationship (plankton) and concentration/response relationship (periphyton) to pinpoint where nutrient loading reduction can be targeted.

- Develop desktop models that are easily transferred across waterbodies and use the following parameters: TP, TN, total chlorophyll, DO, temperature and transparency (Secchi disk and black disk).

*ESTUARIES AND COASTAL MARINE WATERS*

***Modeling:***

Estuarine and coastal marine models are in the process of development and testing around the country, including efforts on the Chesapeake Bay. Much of this work is promising, and the following are areas requiring further effort.

- *Seagrass-dominated Systems*

  — Develop water quality models, from simple to complex, that look at simulation of chlorophyll *a* concentrations over seagrass beds from nutrient loadings of the surrounding watershed.

  — Develop multiple regression analysis models that simultaneously consider such factors as TSS, color, and chlorophyll *a*.

- *Plankton-dominated Systems*

  — There is a need for an estuarine version of "Vollenweider" relationships to better understand the relation of nutrient loadings to chlorophyll *a*.

- *Macroalgae-dominated Systems*

  — Many databases exist that would allow identification of nutrient loading thresholds for macroalgae-dominated systems.

*WETLANDS*

***Modeling:***

Very few models exist that are capable of predicting wetland responses to nutrient loadings. Of the literature reviewed, Mitsch and Gosselink (1993) and Howard-Williams (1985) offer conceptual diagrams of potential relationships for nutrients in wetlands. Wetlands can function as a source, sink, or transformer for a particular nutrient. A wetland is considered a sink if it has a net accumulation of a nutrient. In contrast, a wetland is considered a source if it exports more of a nutrient than it accumulates. A wetland is a transformer if it transforms a chemical from one form to another, such as from dissolved to particulate form, but does not change the amount going into or out of the wetland (Mitsch and Gosselink, 1993). In some cases, a wetland can be a sink for one nutrient while it is simultaneously a source for another nutrient.

Nutrient models for wetlands, as for all waterbodies, should account for atmospheric, surface, and subsurface inflows and outflows. The models should account for gaseous, aqueous, solid, and sediment-attached forms of the nutrients. The models should also account for the uptake and release of nutrients by living biomass and by decomposition of biomass. In addition, the models should address the seasonal and daily patterns of nutrient uptake and release by plants and animals. Chemical transformations based on changes in pH and concentrations of other chemicals should also be considered. All models should be validated on reference wetlands.

Sediment loading models used to predict TMDL loading rates from storm events can be useful for estimating phosphorus inputs. Some traditional water quality models, such as CEQUAL-W2 and WASP5, have been used for evaluating wetlands. Hydrodynamic models, such as EFDC, are being applied to wetlands in Florida to assess hydrologic response. Analysis of wetlands may also include the assessment of inputs/loadings using a variety of loading models (e.g., SWMM, HSPF) that can be used to predict nutrient and sediment loads to local wetlands (USEPA 1992). Further model development is needed, particularly for wetlands that have saturated soils and are infrequently flooded.

## C. MANAGEMENT AND EVALUATION

The material in this section is not intended to be an all-inclusive list of remediation, protection, and management approaches. However, it is an introductory presentation of some of the readily evident options States and Tribes and other responsible parties can use to make a positive response to the nutrient information they obtain and the water quality criteria States and Tribes develop.

Options also exist that might not be specific to waterbody-type, such as the watershed approach. This approach allows communities to focus resources on a watershed's most serious nutrient sources, which might include animal waste and excess fertilizer runoff. Additional basic management measures can be found in other EPA documents such as *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA 840-B-92-002). The following, as well as additional approaches (such as the development of TMDLs for nutrient-impacted waters, the control of animal waste discharges, and the control of outbreaks of *Pfiesteria* and similar harmful algal blooms), will be explored further in the guidance materials to be developed as part of this strategy.

## MANAGEMENT

In considering the various management options, the resource manager should also keep in mind that the different waterbody types described here may often be interrelated, e.g., streams draining to and from lakes, and rivers entering estuaries and coastal waters. Under these circumstances, the manager should be careful to select for a management plan practices that do not have negative downstream effects. For example, it might not be appropriate to raise a lake level to the detriment of riparian wetlands and influent streams.

### *LAKES AND RESERVOIRS*

Examples of management options to consider when dealing with lakes and reservoirs are provided below.

- Vegetative buffer zones— Preserve or reestablish natural, indigenous vegetation (ground cover, shrubs, trees) in the riparian zone to intercept sediment and nutrient runoff before the runoff reaches the waterbody.

- Watershed land use changes— Identify critical loading sources and promote changes of these land use practices. Examples of practices to promote are implementation of conservation farming; use of manure holding facilities; use of road, commercial, and municipal runoff diversions and detentions; restoration of woodlots in critical drainage areas; land use planning to avoid excessive tiers of lake residences; and on-site septic system use and improvement.

- Habitat restoration— Improve lake nursery and spawning areas to restore a diverse aquatic community and food chain.

- Fish stocking and removal— Perform adjustment of fish communities disrupted by overenrichment by the selective removal of undesired species, the addition of more preferred species.

- Water column precipitation and sediment sealing techniques— Apply alum to the water column to remove P and to seal nutrients into bottom sediments under precipitate.

- Macrophyte harvesting and flow regulation— Perform weed control by use of mechanical harvesters to enhance lake use of nutrients and to remove some nutrients present in biomass. Initiate winter or other episodic drawdowns of lake/reservoir waters to augment sediment removal or consolidation.

- Biomanipulations— Ensure balanced predator stocking or grazer support to control blue-green algae and other nuisance primary producers.

- Relocation of sewage outfalls— Move sewage outfalls to locations that will minimize deleterious impacts to the waterbody.

- Restoration and protection of strategic wetlands— Restore and protect wetlands located in areas critical to water quality concerns.

- Hypolimnetic aeration— Implement techniques designed to aerate the hypolimnion.

- Point source nutrient removal— Remove nutrients at point sources using techniques such as tertiary treatment and phosphorus precipitation.

- Storm water management— Implement storm water BMPs such as constructing ponds, wetlands, infiltration and detention basins, and diversions.

*STREAMS AND RIVERS*

Issues and actions to consider associated with the abatement of nutrients in streams and rivers include:

- Land use— Include land use as a separate early warning indicator (i.e., if development is proposed in a watershed, an environmental impact study should be done to assess the potential impact of such development on the surrounding waterbody).

- Designated use and biomass relationships— Employ public survey techniques to monitor relationships between designated uses and algal biomass.

- Seasonal relationships— Investigate seasonal relationships between nutrients and biomass across streams.

- Nitrogen-phosphorus cycling— Enhance nitrogen-phosphorus cycling on different land uses to reduce mobilization (septic, forest systems).

- Riparian zone management— Introduce riparian buffers, shade the streams, or perform canopy restoration to minimize direct sunlight on surface water. Shading can also reduce the amount of direct air deposition of nitrogen and other nutrient sources.

- Channel restoration— Minimize the nutrient loadings by constructing channels to help reduce the rapid nutrient flush from one segment of the waterbody to another.

- Biological controls— Introduce biomass eating organisms such as caddis fly larvae *(Dicomoecus gilvipes)*, which efficiently remove both periphytic diatoms and filamentous algae from rock substrata.

- Hydrology, hydraulics (flow regime, storm water management, stream regulation)— Identify natural hydrologic regimes and use such information in addressing dam operations to better replicate natural conditions in the area while generating power or preserving intended reservoir levels.

- Impoundment removal— Remove man-made impoundments that have lost their utility and are now causes of flow interruption and sources of excessive algae and water quality degradation.

- Restoration of riparian and floodplain wetlands— Implement programs designed to restore riparian and floodplain wetlands.

- Point source nutrient removal— Remove nutrients at point sources using techniques such as tertiary treatment and phosphorus precipitation.

- Storm water management— Implement storm water BMPs such as constructing ponds, wetlands, infiltration and detention basins, and diversions.

*ESTUARIES AND COASTAL MARINE WATERS*

The following are basic management options to consider for all vegetation system types:

- Land use and development controls— Promote natural vegetative cover in shore areas and zoning restrictions on dense residential or commercial/industrial development along shoreline areas.

- Discharge and dumping regulation and marine sanitation devices— Encourage enhanced Publicly Owned Treatment Works (POTW) design and operation, and the diversion of POTW effluent from sensitive or poorly circulated waters. Promote and enforce marine sanitation device (MSD) regulations including providing adequate pumpout services.

- Restricted estuarine/coastal areas— Protect sensitive waters such as endangered shellfish beds, spawning and nursery areas, and recovering weed beds.

- Shoreline erosion controls— Implement erosion controls on banks subject to wave or ice damage. Restrict access to sensitive shorelines, dune restoration areas, and shorelines susceptible to erosion.

- Seagrass replenishment— Restore weedbeds in estuaries, including wetland areas. Plant and protect emergents and terrestrial riparian vegetation as further protection of tidal zone wetlands from runoff.

*WETLANDS*

Best management options to consider for wetlands include:

- Wetland protection and restoration— Preserve and restore wetlands through the implementation of voluntary and regulatory programs.

- Vegetative buffer zones— Preserve or reestablish natural, indigenous vegetation (ground cover, shrubs, trees) as buffer zones adjacent to wetlands to intercept sediment and nutrient runoff before the runoff reaches the wetland.

- Watershed land use changes— Identify critical land loading sources and promote changes of these land practices. Examples of changes that could be made include the implementation of conservation farming techniques; the reduction of the use of fertilizers on farms and lawns; the construction of manure holding facilities, runoff diversions and detentions, filter strips, and vegetated drainage ways; the implementation of forestry BMPs; the implementation of controls on urbanization and industrial development; and the upgrading of on-site and municipal wastewater treatment systems.

- Land use planning— Protect wetlands by limiting amounts of impervious surfaces, limiting development near waterbodies or steep slopes, and minimizing discharges from storm water, sewer, and septic systems.

- Protect and restore streams entering wetland— Stabilize stream channels and establish riparian buffers to reduce the amount of sediment-attached nutrients entering a wetland.

## EVALUATION

Once the appropriate parameters or indicators have been established, EPA and the States or Tribes will be able to evaluate the effectiveness of the management and regulatory approaches taken. The databases and monitoring systems developed, together with the derived criteria, should be used to assess actual management progress toward ameliorating overenrichment conditions. (This process will be described in detail in each waterbody type specific technical guidance manual.) Where methods and techniques have been successfully employed, the experience may be applied to similar circumstances elsewhere. Where success has not been achieved, the knowledge gained is valuable in developing alternative approaches and in avoiding making the same mistake again. This information should be shared among the Regional Nutrient Teams, through correspondence and national meetings, to enhance management effectiveness.

Periodic program progress reports and budget statements will be prepared for the Office of Water, based on the proceedings described immediately above, so continuity of the program can be maintained, funding and other administrative support provided, and new needs identified and addressed.

The sum total of these reports and proceedings of the periodic national team meetings will provide the necessary feedback to EPA Headquarters to help further development and shaping of national policy with respect to nutrient management of the Nation's waters.

## D. RESEARCH NEEDS

For all four major waterbody types, there are a number of research needs that should be addressed. A number of these research needs are noted below. They are highlighted to indicate areas which each technical guidance drafting group should address to attempt to reduce uncertainty in the assessment process.

*LAKES AND RESERVOIRS*

- Phosphorus and nitrogen speciation investigations.
- Sedimentation and nutrient load impacts on trophic states.
- Internal loading and recycling of nutrients regarding biological responses.
- Biomanipulation techniques.
- Better understanding of cascading trophic interactions, i.e., the effects of nutrient changes on one level of the food chain and how the rest of the community is affected.

*STREAMS AND RIVERS*

- Chlorophyll measurements (periphyton).
  — Sampling methods
- Cladophora, diatom, and blue-green alga growth requirements.
  — Field research
- Literature search on stream models (periphyton system).
- Stream bank, riparian zone, and denitrification.
- Investigation of dissolved oxygen and pH amplitude.
- Investigation of community metrics to characterize rivers for nutrient effects.
  — Ecoregions
  — Which metrics are most sensitive?
  — Literature search on indicator taxa
  — Is biointegrity sensitive as an early warning tool?
- Role of fluvial geomorphology as a factor in controlling algae development.
- Whole stream overenrichment studies.
- Investigation of seasonal relationships between nutrients and biomass across streams.

In addition to identifying the above research needs, the December 1995 workshop participants discussed a number of other actions that should be taken to help managers and scientists assess nutrient impacts on river and stream systems. These actions include the following:

- Conduct literature searches on stream modeling techniques, community metrics, and designated use and biomass relationships (e.g., using survey techniques).
- Explore how biological indicators can be used to determine causes of systematic change.
- Explore, on an ecoregional basis, the level at which biomass and chlorophyll *a* concentrations begin to impair beneficial uses of rivers and streams.
- Explore causal linkages observed in stream community metrics.
- Explore how the use of various management options, in addition to nutrient controls, will help maintain designated uses of river and stream systems (e.g., sediment and erosion controls, channel restoration, riparian zone management, etc).
- Involve other organizations in efforts to understand nutrient impacts on river and stream

systems, including volunteer monitoring programs.

*ESTUARIES AND COASTAL MARINE WATERS*

- Resolution of N-P limiting question with salinity gradients.
- Role of dissolved oxygen in estuarine overenrichment.
- Role of sedimentation-turbidity in overenrichment.
- Biological community indicators.
- Tidal and discharge dynamics in estuarine nutrient flux resources including marine loadings vs. watershed resources.
- Impact of shore discharges on estuaries and coastal marine overenrichment including better loading estimation models.
- Models to predict HAB events in eutrophic systems and appropriate response strategy as described in *National Harmful Algal Bloom Research and Monitoring Strategy: an initial focus on Pfiesteria, fish lesions, fish kills and public health* (draft, November 1997).

*WETLANDS*

- Development of an accepted national wetland classification system similar to the hydrogeomorphic system developed by the Army Corps of Engineers.
- Development of a nationwide database for natural wetlands like that currently available for constructed wetlands should be developed. The database should include wetland types and statistical characteristics that apply to each type. A national database could be used to compare the measurement parameters of assessed (impacted) wetlands to an established set of reference conditions.
- Comprehensive literature search to determine what work has already been done on nutrient-related wetland issues.
- Development and testing of biological assessment and monitoring methods for detecting nutrient impacts.
  - — Which biological assemblages are most sensitive?
  - — Which metrics are most sensitive?
- Establishment of a regionalized network of wetlands of different types (e.g., bogs, swamp) across a gradient of nutrient disturbance from "minimally impacted" to degraded.
- Further research on the impacts of nutrients on different wetland types (e.g., bog, marsh, swamp).
- Further research on influence of land use within watersheds on the impacts of nutrients to wetlands.
- Field experimentation to determine nutrient limitation to wetland type and to isolate the effects of nutrients from other variables, such as hydrology, climate, and physical alteration of habitat.
- Models for nutrient inflow, export, and transformation within different wetland types.
- Further investigation of how the bioavailability of nutrients is affected by water chemistry (e.g., pH, dissolved metals) and substrate (e.g., percent clay, percent organic matter).

## APPENDICES

## Appendix A: Summary of Water Quality Criteria and Standards for Nutrient Overenrichment

In 1994, EPA commissioned a study that gathered information on State Water Quality Criteria and Standards for Nutrients. The following is an abstract of that study. Table 1 is a summary of water quality criteria and standards for nutrient enrichment listed by State.

*Nitrogen*

Seventeen States, the District of Columbia, and the Virgin Islands have no specified water quality criteria for nitrates and/or nitrites. Seven States have only narrative criteria for nitrogen. Four States have narrative and quantitative criteria. Nine States use only EPA-recommended nitrate-nitrogen criteria (10 mg/L) for the protection of domestic drinking water supplies. Twelve States and Puerto Rico use EPA-recommended criteria in conjunction with other criteria, either quantitative or narrative. Five States and four U.S. territories have quantitative water quality criteria for nitrogen but do not incorporate EPA-recommended criteria into them.

*Phosphorus*

In the case of phosphorus, 21 States, the District of Columbia, and the Virgin Islands have no specified water quality criteria. Twelve States have narrative criteria addressing phosphorus in general. Seven States have both narrative criteria and quantitative criteria addressing phosphorus. One state, Florida, uses the EPA-recommended phosphorus criterion of 0.10 ug/L for its estuarine and marine waters. Fifteen States and five U.S. territories have quantitative water quality criteria addressing phosphorus but do not use the EPA-recommended numerical criteria.

| TABLE 1<br>SUMMARY OF STATES' EXISTING WATER QUALITY CRITERIA AND STANDARDS FOR NUTRIENT OVERENRICHMENT | | | | |
|---|---|---|---|---|
| **Region/State** | **Nitrate** | **Ammonia** | **Total Nitrogen** | **Total Phosphorus** |
| **Region 1** | | | | |
| Connecticut | | | | ✓ (3) |
| Maine | | | | ✓ (7,3,8) |
| Massachusetts | ✓ (2) | ✓ (2) | | ✓ (2) |
| New Hampshire | | | | ✓ (2) |
| Rhode Island | ✓ (3) | ✓ (3) | | ✓ (3) |
| Vermont | ✓ (2) | ✓ (2) | | ✓ (2) |
| **Region 2** | | | | |
| New Jersey | ✓ (2) | ✓ (2) | | ✓ (9,3) |
| New York | | | | ✓ (2) |
| Puerto Rico | ✓ (9) | ✓ (9) | | ✓ (8,2) |
| Virgin Islands | | | | ✓ (8,9) |
| **Region 3** | | | | |
| Delaware | ✓ (2) | ✓ (2) | | ✓ (2) |
| District of Columbia | | | | |
| Maryland | | | | |
| Pennsylvania | | | | |
| Virginia | | | | ✓ (4) |
| West Virginia | | | | |
| **Region 4** | | | | |
| Alabama | | | | |
| Florida | | | ✓ (2) | ✓ (7,2) |
| Georgia | | | | ✓ (3) |
| Kentucky | | | | ✓ (2) |
| Mississippi | | | | |
| North Carolina | | | | ✓ (3) |
| South Carolina | ✓ (2) | ✓ (2) | | ✓ (3) |
| Tennessee | | | | |

TABLE 1
SUMMARY OF STATES' EXISTING WATER QUALITY CRITERIA AND STANDARDS FOR NUTRIENT OVERENRICHMENT

| Region/State | Nitrate | Ammonia | Total Nitrogen | Total Phosphorus |
|---|---|---|---|---|
| **Region 5** | | | | |
| Illinois | | ✓ (1) | | ✓ (1,3,9) |
| Indiana | | | | ✓ (1,2) |
| Michigan | ✓ (2) | ✓ (2) | | ✓ (2) |
| Minnesota | | | | |
| Ohio | | | | ✓ (2,4) |
| Wisconsin | | | | |
| **Region 6** | | | | |
| Arkansas | ✓ (2) | ✓ (2) | ✓ (2) | ✓ (2) |
| Louisiana | ✓ (2) | ✓ (2) | | ✓ (2) |
| New Mexico | ✓ (2) | ✓ (2) | | ✓ (7,2) |
| Oklahoma | | | | |
| Texas | ✓ (2) | ✓ (2) | | ✓ (2) |
| **Region 7** | | | | |
| Iowa | | | | |
| Kansas | | | | ✓ (2) |
| Nebraska | | | | |
| Missouri | | | | |
| **Region 8** | | | | |
| Colorado | | | | |
| Montana | | | | |
| North Dakota | ✓ (2) | | | ✓ (7,2,9) |
| South Dakota | ✓ (2) | | | ✓ (3) |
| Utah | ✓ (2) | ✓ (2) | | ✓ (7,3) |
| Wyoming | | | | |
| **Region 9** | | | | |
| American Samoa | ✓(2) | ✓(2) | ✓ (1,9) | ✓ (1,9) |
| Arizona | ✓(5) | ✓(5) | ✓ (1,2) | ✓ (1,2) |
| California | ✓ (1,5) | ✓(5) | ✓(1,2) | ✓ (1,6,7) |

| TABLE 1<br>SUMMARY OF STATES' EXISTING WATER QUALITY CRITERIA AND STANDARDS FOR NUTRIENT OVERENRICHMENT | | | | |
|---|---|---|---|---|
| **Region/State** | **Nitrate** | **Ammonia** | **Total Nitrogen** | **Total Phosphorus** |
| Guam | ✓ (2,7) | ✓(5) | ✓(2) | ✓ (2,7) |
| Hawaii | ✓ (1,9) | ✓ (1,9) | ✓ (1,9) | ✓ (1,9) |
| Nevada | ✓ (5) | ✓ (2,5) | ✓(1,7,9) | ✓ (1,7,9) |
| Northern Mariana Islands | ✓(7) | ✓ (5) | ✓ (7) | ✓ (7) |
| Trust Territories of the Pacific Islands | ✓(2) | ✓(2) | ✓ (7) | ✓ (7,9) |
| **Region 10** | | | | |
| Alaska | | | | |
| Idaho | | | | ✓ (2) |
| Oregon | | | | |
| Washington | | | | |

**NOTES FOR TABLE 1**

Blank entry indicates that neither a narrative nor numeric criterion for the nutrient have been specified by the State.

(1) Site-specific numeric values for ambient nutrient levels.

(2) Narrative criteria related to natural conditions, eutrophication and nutrient overenrichment for nitrate, ammonia, inorganic nitrogen, total nitrogen, or total phosphorus.

(3) Narrative criterion that is not related to natural conditions, eutrophication, or nutrient overenrichment issues.

(4) Numeric values for effluent nutrient levels.

(5) Numeric values related to public health (nitrate) or aquatic toxicity (ammonia).

(6) Habitat-based numeric values for ambient nutrient levels.

(7) Water use classification- or water use designation-based numeric values for ambient nutrient levels.

(8) State wide numeric values for ambient nutrient levels.

(9) Waterbody-based ( streams, rivers, lakes, estuaries, coastal/oceanic waters) numeric values for ambient nutrient levels.

## Appendix B: Nutrient Criteria Activities and Timeline

| Year | Activities | Products | Date |
|---|---|---|---|
| 1997 | Publish Final National Nutrient Strategy | Strategy & FR Notice of Availability | 6/98 FR notice |
| 1998 | **Publish Technical Guidance Document for:** | | |
| | Lakes and Reservoirs | Final Guidance | 12/98 |
| | **Demonstrations and Case Studies:** | | |
| | Initiate 3-5 case studies | Methodology validation and regional criteria for Lakes and Reservoirs | On-going |
| | **Outreach Activities & Communication Strategy:** | | |
| | Regional/State Meetings on Strategy and Nutrient Criteria Development | Proceedings | 10/98 |
| | WQS Academy | Presentations | Summer, 1998 |
| | Document availability via Internet | Brochures & Fact Sheets | National Nutrient Strategy |
| | Link info to Regional Nutrient Teams | Training | On-going |
| 1999 | **Publish Technical Guidance Documents for:** | | |
| | Rivers and Streams | Final Guidance | 03/99 |

| Year | Activities | Products | Date |
|---|---|---|---|
| 1999 | **Demonstrations and Case Studies:** | | |
| | Initiate 5-10 case studies | Methodology validation and regional criteria for Rivers and Streams | On-going |
| | | Methodology validation and regional criteria for Marine Coastal Waters and Estuaries | On-going |
| | **Outreach Activities:** | | |
| | Regional/State Meetings on Rivers & Streams/Lakes Guidance | Proceedings | 7/99 |
| | WQS Academy, | Presentations | On-going |
| | Document availability via Internet | Brochures & Fact Sheets | Lakes and Reservoirs |
| **2000-2** | **Publish Technical Documents for:** | | |
| | Coastal Marine Waters and Estuaries | Final guidance | 03/00 |
| | Wetlands | Draft guidance | 03/00 |
| | Data processing and assessment | Final Guidance & National Modeling Database | 4/00 |
| | **Demonstrations and Case Studies:** | | |
| | Maintain ongoing case studies and publish regional criteria | Regional Criteria Guidance | 01-02 |

| Year | Activities | Products | Date |
|---|---|---|---|
| 2000-02 | **Outreach Activities:** | | |
| | Regional/State Meetings on Coastal Waters and Estuaries Guidance | Proceedings | On-going |
| | WQS Academy | Presentations | On-going |
| | Document availability via Internet | Brochures & Fact Sheets | Rivers and Streams |
| | | | Coastal Waters and Estuaries |
| | | | Data processing and Assessment |

**Appendix C: Draft Outline for the Development of Nutrient Criteria for Streams and Rivers, Lakes and Reservoirs, and Estuaries and Coastal Marine Waters.**

## I. Introduction

Concept of Nutrient Criteria
- — Regional in nature
- — Methods and guidance to support development of nutrient criteria
- — Discussion of criteria vs. standards
- — Narrative criteria vs. numeric, but always quantitatively based

Uses of Nutrient Criteria
- — Basis for State/Tribal Water Quality Standards
- — Resource assessment
- — Setting of management priorities
- — Evaluation of management projects
- — Long-range planning
- — Coordination of nutrient management planning and implementation with other related programs

Rationale for Trophic Classification and Tiered Sampling Design
- — Discussion of deriving nutrient reference conditions
- — Discussion of cost-effectiveness of tiers, potential to evolve toward more detailed sampling as needed
- — Detailed discussion of importance of adequate data for decision making compared to budget and level of certainty needed

## II. Conducting Nutrient Surveys

Classification of the surface waters

Indicators
- — How analyzed
- — When to sample
- — Where to sample

Survey Design

Data Storage and Processing

Interpretation

## III. Trophic Classification

How to establish regions

Size classifications

Watershed classifications

Cultural development classes

## IV. Indicators

For each indicator:
- — Method of collection
- — Storage and time constraints
- — Method(s) of analysis
- — Expected range of results and trophic state indicated by geographic region and season

## V. Sampling Design

Number of stations based on waterbody size

Placement of survey stations relative to characteristics of the waterbody and suspected loading sites

Time of year and frequency of sampling

## VI. Data Processing and Storage

Discuss models and software packages

Regional databases and multi-State coordination of efforts

## VII. Interpretation

Synopsis of indicator meanings

Discussion of interrelationships of trophic state and overenrichment indicators

Comprehensive interpretations

## VIII. Detailed Nutrient Investigations for Cause and Effect Determination

Follow-up on initial surveys to generate definitive information

Seasonal adjustments

Relocation of some stations and addition of others
— Importance of basic survey continuity

## IX. Management Response

Should be broad-based and general to indicate potential as opposed to a directive to the community

Types of loadings the indicators reflect
— BMPs and other protection or mitigation measures available

Approaches to achieve protection or change
— Local government
— Communities
— Property owners
— Businesses

Management Planning
— Incorporate the 10-step approach described in Chapter IV of this nutrient strategy document

## X. Evaluation Monitoring

A variation on the original survey plan is used to keep track of the response of the waterbody to the protection or remediation effort

This information is used to assess the relative success of the project and to plan future courses of action
— Evaluation of "before, during, and after" project data

Close the loop in the management process by returning to step 1 of the 10-step process to plan the next phase of management or to apply these results to other similar, nearby waterbodies.

## Appendices

Discussion of how States get from data gathering to using the information in management decision making to incorporation into State policies.

Illustration of these experiences with case studies and names of contacts for further information.

**Appendix D: Drafting Committee for the National Nutrient Strategy**

**Office of Science and Technology**

Nick Baer
USEPA Office of Water
Health and Ecological Criteria Division
(202) 260-1306

Robert Cantilli, National Nutrient Program Coordinator
USEPA Office of Water
Health and Ecological Criteria Division
(202) 260-5546

George Gibson
USEPA Office of Water
Health and Ecological Criteria Division
(202) 260-7580/(410) 573-2618

Patrick Ogbebor
USEPA Office of Water
Permits Division
(202) 260-6322

**Office of Wetlands, Oceans, and Watersheds**

John Heisler
USEPA Office of Water
Oceans and Coastal Protection Division
(202) 260-8632

Kristen Martin
USEPA Office of Water
Assessment and Watershed Protection Division
(202) 260-7108

## APPENDIX E: Excerpt from the Clean Water Action Plan

### Reduce Nutrient Over-enrichment

Nutrients, in the appropriate amounts, are essential to the health and continued functioning of aquatic ecosystems. Excessive nutrient loadings will, however, result in excessive growth of macrophytes or phytoplankton and potentially harmful algal blooms (HAB), leading to oxygen declines, imbalance of aquatic species, public health risks, and a general decline of the aquatic resource. Nutrient over-enrichment has also been strongly linked to the large hypoxic zone in the Gulf of Mexico and to recent outbreaks of *Pfiesteria* along the mid-Atlantic Coast.

State water quality reports indicate that over-enrichment of waters by nutrients (nitrogen and phosphorus) is the biggest overall source of impairment of the nation's rivers and streams, lakes and reservoirs, and estuaries. In the 1996 National Water Quality Inventory, states reported that 40 percent of surveyed rivers, 51 percent of surveyed lakes, and 57 percent of surveyed estuaries were impaired by nutrient enrichment. Agriculture is the most widespread source of these impairments, followed by municipal sewage treatment plants, urban runoff and storm sewers, and various other nonpoint pollution sources, including air deposition.

Define Nutrient Reduction Goals

Although nutrient over-enrichment is clearly a major challenge for the nation's waters, the assessment of the seriousness and extent of the problem is often based on subjective criteria that can result in widely varying assessments. Research to improve the basis for understanding and assessing nutrient over-enrichment problems is critical to better control of nutrient levels in waters and to meeting the nation's clean water goals.

EPA is developing a strategy to establish an objective, scientifically sound basis for assessing nutrient over- enrichment problems. Specifically, EPA will develop nutrient criteria - numerical ranges for acceptable levels of nutrients (i.e., nitrogen and phosphorus) in water. Unlike other criteria that EPA has developed, nutrient criteria will be established as a menu of different numeric values based on the type of water body (i.e., river, estuary, lake) and the region of the country in which the water is located. It is vital that this work be done to provide the technical basis for pollution reduction plans.

EPA will develop nutrient criteria for the various water body types and ecoregions of the country by the year 2000. Under the Clean Water Act, states use pollutant criteria established by EPA as the basis for adopting water quality standards. Within three years of EPA issuance of applicable criteria, all states and tribes with water quality standards should have adopted water quality standards for nutrients. Where a state or tribe fails to adopt a water quality standard for nutrients within the three-year period, EPA will begin to promulgate the nutrient criteria appropriate to the region and water body type. When promulgated, the EPA standard would apply until a state or tribe adopts, and EPA approves, a revised standard.

KEY ACTION: EPA will establish, by the year 2000, numeric criteria for nutrients (i.e., nitrogen and phosphorus) that are tailored to reflect the different types of water bodies (e.g., lakes, rivers, and estuaries) and the different ecoregions of the country, and will assist states in adopting numeric water quality standards based on these criteria over the following three years. If a state does not adopt appropriate nutrient standards, EPA will begin the process of promulgating nutrient standards.

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# Attachment C

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 25 2007

OFFICE OF
WATER

**MEMORANDUM**

SUBJECT: Nutrient Pollution and Numeric Water Quality Standards

FROM: Benjamin H. Grumbles
Assistant Administrator

TO: Directors, State Water Programs
Directors, Great Water Body Programs
Directors, Authorized Tribal Water Quality Standards Programs
State and Interstate Water Pollution Control Administrators

This memo provides a national update on the development of numeric nutrient water quality standards and describes EPA's commitment to accelerating the pace for progress. EPA published its June 1998 national nutrient criteria strategy and some States and Territories have made notable progress in establishing numeric nutrient standards - most recently in connection with the Chesapeake Bay and Tennessee streams. However, overall progress has been uneven over the past nine years. Now is the time for EPA and its partners to take bold steps, relying on a combination of science, innovation and collaboration.

## Why Action is Needed

High nitrogen and phosphorus loadings, or nutrient pollution, result in harmful algal blooms, reduced spawning grounds and nursery habitats, fish kills, oxygen-starved hypoxic or "dead" zones, and public health concerns related to impaired drinking water sources and increased exposure to toxic microbes such as cyanobacteria. Nutrient problems can exhibit themselves locally or much further downstream leading to degraded estuaries, lakes and reservoirs, and to hypoxic zones where fish and aquatic life can no longer survive.

Nutrient pollution is widespread. The most widely known examples of significant nutrient impacts include the Gulf of Mexico and the Chesapeake Bay. For these two areas alone, there are 35 States that contribute the nutrient loadings. There are also known impacts in over 80 estuaries/bays, and thousands of rivers, streams, and lakes. The significance of this impact has led EPA, States, and the public to come together to place an unprecedented priority on public partnerships, collaboration, better science, and improved tools to reduce nutrient pollution.

Virtually every State and Territory is impacted by nutrient-related degradation of our waterways. All but one State and two Territories have Clean Water Act Section 303(d) listed impairments for nutrient pollution. States have listed over 10,000 nutrient and nutrient-related impairments. Fifteen States have more than 200 nutrient-related listings each. For these reasons, Regions have identified nutrient pollution reduction as a priority for EPA.

**Why Numeric Criteria are Important**

Numeric nutrient water quality standards will drive water quality assessments and watershed protection management. They will support improved development of nutrient Total Maximum Daily Loads (TMDLs). Perhaps most importantly, they will create state- and community-developed environmental baselines that allow us to manage more effectively, measure progress, and support broader partnerships based on nutrient trading, Best Management Practices (BMPs), land stewardship, wetlands protection, voluntary collaboration, and urban storm water runoff control strategies. The progress of States and Territories in setting numeric nutrient water quality standards is extremely important to help address nutrient pollution.

Numeric nutrient standards will facilitate more effective and efficient program implementation. Notable progress has been made relying on site-specific application of narrative standards to develop nutrient TMDLs. But this can often be difficult, resource-intensive and time-consuming. Adopting numeric standards, however, has a number of key advantages:

- easier and faster development of TMDLs;
- quantitative targets to support trading programs;
- easier to write protective NPDES permits;
- increased effectiveness in evaluating success of nutrient runoff minimization programs; and
- measurable, objective water quality baselines against which to measure environmental progress.

**What Action is Needed**

Today, EPA is encouraging all States, Territories and authorized Tribes to accelerate their efforts and give priority to adopting numeric nutrient standards or numeric translators for narrative standards for all waters in States and Territories that contribute nutrient loadings to our waterways. Incremental progress can be an effective way to accelerate progress. If a State needs to implement numeric nutrient criteria incrementally, EPA strongly recommends that States adopt numeric nutrient standards for their priority waters – i.e., waters at greatest risk of nutrient pollution (such as those identified through the EPA-USGS SPARROW modeling effort) or of greatest consequence (such as drinking water sources) – first. States may also choose to prioritize their actions for waters where sufficient information is available to move quickly to adopt numeric criteria in the near-term. The State's nutrient criteria plan should reflect the State's approach to setting standards for its waters, and include schedules for adopting those standards.

To be effective, nutrient criteria should address *causal* (both nitrogen and phosphorus) and *response* (chlorophyll-a and transparency) variables for all waters that contribute nutrient loadings to our waterways. EPA encourages the adoption of standards for all four parameters because of the interrelationships between these parameters and its experience showing that controlling *both* nitrogen and phosphorus is important to successfully combating nutrient pollution in all waters. As always, States, Territories and authorized Tribes have the flexibility to address nutrient pollution using a subset of or alternatives to these parameters if they are shown to be scientifically defensible and protective of designated uses. Where a State, Territory or authorized Tribe shows that one causal variable (nitrogen or phosphorus) is the limiting nutrient, it should develop criteria for at least that nutrient. However, if the non-limiting nutrient is likely contributing to a downstream impairment, numeric criteria for that nutrient should be considered as well.

By accelerating the establishment of numeric nutrient standards, state governments and local communities can set goals, establish controls, agree on risk management approaches, measure performance, demonstrate progress, and learn from each other. In a time of scarce resources and competing priorities, we cannot afford delayed or ineffective responses to this major source of environmental degradation. As any environmental professional understands, we can't effectively manage what we can't measure. Numeric environmental baselines help us to measure success, gauge effectiveness, and evaluate alternative approaches.

**Current Status**

Over the last nine years, EPA has taken a number of steps to provide leadership and articulate its goal of working in partnership with States, Territories and authorized Tribes to establish quantitative endpoints to minimize excess nutrient loadings in our Nation's waters. EPA issued a National Strategy for Development of Regional Nutrient Criteria in June 1998, and followed with a November 2001 national action plan for the development and establishment of numeric nutrient criteria. EPA published technical guidance for developing criteria for lakes and reservoirs in May 2000, rivers and streams in June 2000, and estuaries and coastal waters in October 2001. EPA also published recommended nutrient criteria for most streams and lakes in 2001. This combined strategy of EPA, State, Territorial, and Tribal partnership supported by technical assistance was intended to jump-start progress on a difficult and challenging problem.

We have made progress, but we need to move more quickly and more comprehensively in order to meet the growing challenges from increasing population, expanding and more intensive agricultural activities, and spreading urbanization. A number of States and Territories have already moved ahead to establish numeric standards for priority waterbodies. Others are in the process of collecting data and preparing to develop them. Still others are in the earlier stages of planning and deciding which standards development approach will work best for them. A summary of the current status is attached.

**Next Steps**

EPA remains committed to supporting States' and authorized Tribes' efforts to adopt numeric water quality standards for nutrient pollution that are protective of designated uses. As outlined in more detail in the attached numeric nutrient standards strategy, EPA will:

- Provide direct assistance to States close to adopting numeric criteria. For these States, EPA will provide implementation guidance addressing technical and policy issues that States raise, and technical information to support States' rulemaking for standards.

- Build capacity for States that are not as close to adopting numeric criteria. For these States, EPA will provide sampling/monitoring, training, data/statistical analysis, and modeling assistance for developing criteria numbers.

- Build a science-based foundation for developing new criteria in estuaries, wetlands, and large rivers. EPA will complete its suite of nutrient criteria manuals for nutrient criteria, and continues to work to meet the goals of the federal and state Mississippi River/Gulf of Mexico Watershed Nutrient Task Force.

- Clearly and effectively communicate data and information on nutrient pollution. EPA will integrate nutrient messages in water quality standards communications products and outreach.

**Conclusion**

We can take steps now that will make a difference in addressing the challenges of growing nutrient pollution. The first step is to have numeric nutrient criteria in place to enable action. EPA is committing itself to support development of numeric nutrient criteria, and to use EPA's tools and metrics to help States, Territories, and authorized Tribes adopt numeric nutrient standards more quickly. EPA will also continue to do research, develop new tools, and collaborate to strengthen partnerships for consensus solutions.

EPA will work with States and Territories to review their nutrient criteria plans developed over five years ago to ensure they reflect current expectations, realistic goals, and clear interim milestones. Working together, we should ask ourselves what is needed to meet these milestones and then take appropriate action.

We should also continue to advance performance measurement and public accountability. EPA recognizes the importance of keeping the public informed of our joint progress. EPA will periodically publish a report of the status of our joint efforts, including the actions EPA has completed and the progress that States have made in adopting numeric nutrient water quality standards. EPA will also continue to track progress regarding nutrient pollution reduction, such as quarterly reporting of the number of TMDLs completed in nutrient impaired waters in the Mississippi River Basin.

Attachments:
1. OW Numeric Nutrient Standards Strategy
2. Current Status of States & Territories: Numeric Nutrient Criteria for Class of Waters

cc: Marcus Peacock
Regional Administrators

# OW Numeric Nutrient Standards Strategy

**What is the Environmental Problem?**

- Excessive nutrients (nitrogen and phosphorus) can cause negative ecological impacts to waterbodies on a national scale by stimulating harmful algal blooms.
  - Algal blooms block sunlight and result in the destruction of submerged aquatic vegetation (SAV). SAV serves as critically important habitat and food for many organisms.
  - Algal blooms eventually die off and consume dissolved oxygen (DO) from the water column. Low DO concentrations lead to die off of aquatic organisms.
  - One result of algal blooms is decreased biological diversity and populations, including smaller populations of game and commercial fish.
- Excessive nutrients also pose public health risks.
  - Algal blooms can cause taste and odor problems in drinking water.
  - Hazardous algal blooms can cause respiratory distress and neurological problems in swimmers.
  - Excessive nitrates can cause blue baby syndrome.
- Nutrient pollution is occurring at a national scale and has not been completely addressed.
  - 49 states and 4 territories have 303(d) listings due to nutrients, and about 50% of the states have greater than 100 water quality impairments due to nutrients.
  - Over 10,000 impairments are a result of nutrient pollution.

**What is OW's Role in Reversing Nutrient Pollution?**

- The Office of Water, through its Office of Science and Technology (OST), applies science and technology to build a comprehensive framework of state water quality standards, drinking water goals, public health programs, and technology-based solutions to implement the national clean and safe water program in collaboration with national, state, and public partners. As part of this mission, OST develops nutrient water quality criteria recommendations, ensures state adoption of protective nutrient water quality standards, develops tools to aid states in implementing their nutrient standards, and publishes regulations that reduce the discharge of nutrients by industries.
- Over the last 10 years, OST has implemented a strong technical approach to address the negative impacts of nutrient pollution, which includes:
  - Creating a National Nutrient Team and Regional Technical Assistance Groups (RTAGs) with 10 Regional Nutrient Coordinators to support states in the management and evaluation of nutrient pollution.
  - Publishing 26 Ecoregional Nutrient Criteria documents for 13 lakes/reservoirs, 12 rivers/streams, and 1 wetland (Florida Everglades).
  - Publishing technical guidance documents for lakes/reservoirs (2000), rivers/streams (2000), coastal marine waters (2001), and wetlands (released for comment in 2006), and 14 wetland method modules to assist states in assessing wetland conditions.
  - Providing policy recommendations to states to develop nutrient plans which outline parameters they will set, the approach they will use, and the schedule they will follow.
  - Developing tools designed to aid states in developing numeric criteria (e.g., nutrient database for selecting reference conditions, N-Steps to provide scientific assistance on sampling and data analysis, a periphyton sampling methodology for rivers).

**What is the OW National Nutrient Strategy?**

- Water quality standards (WQS) are the backbone of water quality improvements. Once established, numeric standards reduce States' time and effort to establish TMDLs and permits to control nutrient levels.

- Thus, our goal is to accelerate the progress of state adoption of numeric WQS while building the scientific and technical infrastructure for developing new nutrient criteria. To accomplish this goal, we have four general themes:
  1. Provide direct assistance to states close to adopting numeric criteria.
  2. Build capacity of states that are further from adopting numeric criteria.
  3. Build a science-based foundation for developing new section 304(a) criteria for estuaries, wetlands, and large rivers.
  4. Clearly and effectively communicate the dangers of nutrient pollution and the merits of numeric nutrient criteria to states, nutrient sources, and the general public.
- Work conducted under these themes should reflect a collaborative effort/partnership between EPA Offices/Regions, and States that builds on work to date and coordination/relationships between EPA and States.
- We've developed specific projects under each of these themes based on input from states at the All States meeting in February 2006, subsequent discussions with regions, and the discussion with selected state managers at the WQSMA meeting in August 2006.

**Theme 1: Direct Assistance to States Close to Adopting Numeric Criteria.**

- We've identified states that are further along in criteria development for some or all of their waters. These states identified implementation and policy support as their primary need. Under this theme, OST is:
  - Developing implementation guidance that addresses technical and policy issues raised by these states.
  - Issuing a policy memorandum that clarifies EPA'srecommendations, thus providing states with a clear statement supporting their work. EPA will foster adoption of standards reflective of States' priorities, and recognizing the importance of incremental progress.
  - Assessing the benefits and costs of reducing nutrients, thus providing states with information to support their rulemaking to adopt nutrient criteria.
  - Compiling information on treatment and BMP effectiveness, thus providing states with information supporting that their criteria can be attained.
  - Developing common principles for EPA review of state nutrient standards submittals, thus providing assurance to states that EPA review will be consistent among regions.
  - Making all tools more accessible to states via the OST website.

**Theme 2: Build Capacity of States That Are Further From Adopting Numeric Criteria.**

- We've identified states that are further along in criteria development for some or all of their waters. These states identified sampling/monitoring, data/statistical analysis, and assistance in developing criteria numbers as their primary needs. Under this theme, OST is:
  - Providing states with on-demand statistical, sampling and data analysis support through N-STEPS.
  - Providing additional statistical, sampling and data analysis support through a variety of financial vehicles, with funds targeted towards progress with specific states.
  - Holding technical transfer workshops and training in regional offices to provide on-site hands-on training on OST technical tools.
  - Developing modeling tools that allow states to evaluate a causative approach for developing criteria and assessing the likelihood of criteria being attained.
  - Making all tools more accessible to states via the OST website.

**Theme 3: Build a science-based foundation for developing new section 304(a) criteria for estuaries, wetlands, and large rivers.**

- We've published technical guidance documents for developing criteria for lakes and reservoirs, rivers and streams, and estuaries and coastal waters. We still need to publish criteria or develop targets for other waters. Under this theme, OST is:
  - Completing technical guidance for developing wetland criteria.
  - Developing demonstration projects for estuarine and wetland criteria development.
  - Developing the scientific underpinnings for criteria for large rivers.
  - Supporting data collection to support developing criteria for estuaries and watersheds in the northern Gulf of Mexico.
  - Working to meet the goals of the Hypoxia Task Force.

**Theme 4: Clearly and effectively communicate the dangers of nutrient pollution and the merits of numeric nutrient criteria to states, nutrient sources, and the general public.**

- To be successful, we must engage the general public in understanding the consequences of nutrient pollution and the benefits of nutrient controls. Under this theme, OST is:
  - Building web-based and printed materials on the dangers of nutrient pollution.
  - Creating training materials for NGOs on the dangers of nutrient pollution.
  - Improving the OST website to attract more students looking for information on nutrient pollution.

**Current Status of States & Territories Numeric Nutrient Criteria for Class of Waters Adopted Post-1997: Updated May 14, 2007**

Entire Class of Rivers and Streams

| Stage | Num | States |
|---|---|---|
| Has approved criteria for all parameters | 5 | TN, HI, AS, GU, CN |
| Has approved criteria for N, P, or Chlorophyll | 4 | DC, FL, OK*, NV |
| Engaged in developing criteria for all parameters and waters | 6 | MA, ME, VT, KY, MI, WI |
| Collecting data for all parameters or waters | 34 | CT, NH, RI, NJ, NY, PR, DE, MD, PA, VA, AL, FL, GA, MS, NC, SC, IL, IN, MN, OH, AR, LA, OK, NM, TX, IA, KS, MO, NE, CO, MT, UT, AZ, CA |
| Just starting criteria process | 8 | WV, ND, SD, WY, AK, ID, OR, WA |
| Notes: OK*: scenic rivers only | | |

Entire Class of Lakes and Impoundments

| Stage | Num | States |
|---|---|---|
| Has approved criteria for all parameters | 4 | HI, AS, GU, CN |
| Has approved criteria for N, P, or Chlorophyll | 3 | RI, FL, IL |
| Engaged in developing criteria for all parameters and waters | 15 | MA, ME, VT, VA, WV, SC, MI, MN, WI, TX*, OK*, IA, MO, NE, AZ |
| Collecting data for all parameters or waters | 34 | CT, NH, RI, NJ, NY, PR, DE, MD, PA, AL, FL, GA, KY, MS, NC, SC, TN, IL, IN, OH, AR, LA, NM, OK, TX, KS, CO, MT, UT, CA, NV, ID, OR, WA |
| Just starting criteria process | 4 | ND, SD, WY, AK |
| Notes: OK*: drinking water lakes; TX*: large lakes; NE & VA packages in regions for review | | |

# Attachment D

# Texas Commission on Environmental Quality

# Nutrient Criteria Development Plan



**DRAFT November 3, 2006**

# Table of Contents

## Executive Summary

The Environmental Protection Agency (EPA) has mandated that states develop nutrient criteria. The State of Texas has narrative nutrient criteria but no numerical criteria to address nutrients and eutrophication.

The TCEQ staff will develop and evaluate criteria 1) to maintain water quality in water bodies that are relatively unimpacted and 2) to address excessive nutrients and eutrophication where indicated. The TCEQ staff will also develop procedures to assess compliance with criteria and to apply criteria to wastewater permits and other regulatory actions. Preliminary criteria development will focus on major reservoirs; criteria for streams and rivers, estuaries, and wetlands will subsequently be evaluated in that order. This effort will be staged over several years, and the TCEQ staff will provide drafts of criteria and implementation procedures for EPA review throughout the process. As criteria are developed for each water body type, they will be included in subsequent surface water quality standards triennial revisions.

## Purpose

This plan is intended to provide a framework for developing nutrient water quality standards for the state of Texas. The staff of the Texas Commission on Environmental Quality (TCEQ) in conjunction with the U.S. Geological Service (USGS) is evaluating options for nutrient criteria for consideration by the United States Environmental Protection Agency (EPA) and the public during the next triennial revision of the Texas Surface Water Quality Standards (Chapter 307 in Title 30 of the Texas Administrative Code). The plan outlines the work to be performed, status of data analyses, options for criteria development, and time frames for developing and considering nutrient criteria. The information in this plan is subject to change as more information is collected and evaluated and as the information is reviewed by the TCEQ, stakeholders, and the EPA.

## Current Status of Nutrient Regulation in Texas

The State of Texas has no numerical criteria for nutrients but does currently consider nutrient controls by 1) applying narrative criteria to address permitted nutrient loadings at sites of concern, 2) developing watershed rules which require nutrient reductions in wastewater discharges in or near specified water bodies, and 3) employing the TCEQ's antidegradation policy to increases in discharge loads of nutrients. The TCEQ also screens phosphorus and nitrate nitrogen and chlorophyll *a* monitoring data as a preliminary indication of areas of possible concern in the Texas Water Quality Inventory under Section 305(b) of the federal Clean Water Act (CWA).

## Scope of Criteria Development

TheTCEQ is exploring several complementary strategies to develop nutrient criteria. Strategies now being investigated include the following: 1) basing criteria on concentrations of nutrients; 2) basing criteria on direct indicators of eutrophication, such as chlorophyll *a*; 3) developing "translator" procedures that relate concentrations of nitrogen and phosphorus to direct indicators of eutrophication; 4) basing criteria on historical "ambient" averages with a statistical allowance for variability; and 5) developing criteria based on the effect of nutrients or indicators of eutrophication on uses. Work on use-based criteria for reservoirs is being conducted by the Texas Water Conservation Association and other members of the TCEQ nutrient criteria workgroup.

With respect to spatial scales for nutrient criteria, the TCEQ has evaluated the procedures for developing criteria as defined in EPA guidance using 1) EPA''s aggregate ecoregions and 2) smaller Level III ecoregions within Texas. The TCEQ has found that smaller scales and other ways to group reservoirs are needed to address spatial variability in nutrient concentrations and impacts. The TCEQ has evaluated criteria based on 1) data from individual water bodies; 2) grouping water bodies according to geological, chemical, physical, or hydrologic characteristics; and 3) grouping water bodies in smaller geographic regions or watersheds. The USGS performed this work on selected reservoirs with sufficient data for the analysis and found that the largest percentage of variability between reservoirs was explained by reservoir size, watershed size, and ecoregion. This and related information will be used to group reservoirs for additional nutrient evaluations and criteria development.

For assessing water bodies and regulatory actions such as wastewater discharge permits, the TCEQ is also evaluating a "weight of evidence" approach to incorporate historical monitoring data for chlorophyll *a*, total phosphorus, and total nitrogen for individual water bodies. The evaluation of permitted discharges, for example, could be based on screening criteria developed from historical data for all of these variables, in addition to the criteria that might be explicitly listed in the water quality standards (e.g., for chlorophyll *a*). The use of additional screening criteria will be evaluated as options and included in the Procedures to Implement the Texas Surface Water Quality Standards.

## Studies

Much of the development of nutrient criteria is based on evaluation of existing long-term data. In addition, the TCEQ is coordinating several studies that will provide new data where information is lacking. These studies include (1) an assessment of nutrients, dissolved oxygen, and attached vegetation in selected streams in East Texas, (2) a follow-up study to assess nutrients, dissolved oxygen, and attached vegetation in selected streams in Central Texas, and (3) an assessment of dissolved oxygen, nutrients, and chlorophyll *a* in the "transition zone" where streams and rivers enter shallow, backwater areas of reservoirs. Other nutrient-related studies are also being conducted by the Texas Parks and Wildlife Department, universities, regional river authorities, and water districts in Texas.

## Workgroup

The TCEQ has formed a diverse Nutrient Criteria Development Workgroup in order to obtain ongoing stakeholder input from state and federal agencies, Texas river authorities, cities, industry, environmental groups, agriculture representatives, and other interested parties. Six work sessions have been conducted.

## Schedule/History

This revised plan is provided to the EPA as a preliminary indication of the TCEQ staff's efforts in accordance with the EPA's notice in the Federal Register dated January 9, 2001: "Nutrient Criteria Development; Notice of Ecoregional Nutrient Criteria." The EPA stated that 1) "by the end of 2001, each State and authorized Tribe should complete a plan for developing and adopting nutrient criteria into State or Tribal water quality standards", and 2) "by the end of 2004, States and authorized Tribes should adopt nutrient criteria (either numeric criteria or as procedures to translate a narrative nutrient criteria into a quantified endpoint) for the water body type and ecoregions associated with the section 304(a) water quality criteria that EPA publishes by the end of 2001."

The TCEQ staff previously drafted a preliminary general work plan to further evaluate the EPA's nutrient criteria and investigate additional options which would lead to criteria development. The initial draft work plan was sent to the EPA Region 6 on November 30, 2001, and a letter providing updated information to the work plan was submitted on December 21, 2002. In December 2004, the TCEQ sent the EPA a more detailed plan including information on the TCEQ scope of work for developing nutrients for reservoirs, rivers and streams, and estuaries; schedules; and descriptions of how proposed criteria were calculated. The current plan is an update of the December 2004 plan.

In fiscal year 2005, the TCEQ staff produced draft proposals for nutrient criteria for selected major reservoirs in the state for review by the TCEQ management, stakeholders, and the EPA. Draft proposed criteria are intended to be available for consideration in the next surface water quality standards revisions for Texas. The next major standards revision is scheduled to be in progress through 2006 and 2007 and into 2008. The TCEQ has begun the next water quality standards revision even though major provisions of the previous triennial revision are still being reviewed by the EPA..

Reservoirs have been the TCEQ staff's initial priority, but efforts to develop nutrient criteria for streams and rivers are occurring simultaneously. In the near future, the TCEQ will be consolidating available data for estuaries and adding them to the data base of nutrient information. Investigations into what types of data are available for wetlands will follow.

A preliminary schedule of tentative target dates is presented in Appendix D. Major steps and time frames for revisions of the TCEQ's water quality standards are noted in Appendix E.

## Methods to Develop Nutrient Criteria

### *Nutrient Data Base Development*

There is substantial monitoring data available from the last 30 years for major water bodies in Texas. Historical monitoring data will be used to 1) develop criteria, 2) assess feasibility and effectiveness of the criteria, 3) evaluate impacts of wastewater discharges and other regulatory actions, and 4) determine if relationships between nutrients and response variables, such as chlorophyll *a,* exist. The USGS, through funding from the EPA, has supported the development of nutrient criteria in Texas. One of the USGS tasks was to create a nutrient data base from data downloaded from the TCEQ Texas Regulatory and Compliance System (TRACS) and from the USGS National Water Information System (NWIS). Data available extends back to the 1970's, and the available parameters include those listed in Appendix A. The baseline data base for reservoirs was created from these sources. The USGS data base contained final data sets for chlorophyll a, total phosphorus, and total nitrogen for least impacted reservoirs and those with land use in their water sheds that were less than 20% agriculture and urban. The USGS used this data as well as additional raw TRACS data for other constituents for statistical evaluations.

The USGS completed development of nutrient data bases for 1) reservoirs and 2) streams and rivers in October 2001. The TCEQ and the USGS periodically updated the data bases with newer data as it became available. Data used for developing criteria for reservoirs and for streams and rivers extends from January 1, 1970 to April 30, 2003. An end date was needed to allow for time for data analysis instead of continuous data base updates. Thirty plus years of data was enough to determine if historical trends or patterns existed and was a large enough data set for statistical analysis for many reservoirs. Additional river and stream data may be retrieved from TRACS or replacement data base such as SWQMIS in the future to increase the size of the data set.

The TCEQ took the original data set and restructured it into an ACCESS relational data base format. The TCEQ combined all reservoir and river and stream data into this new relational data base format. As more information is collected on estuaries and wetlands, they can now be added into this single data base.

Additional parameters or data from other sources can also be added as needed. Data collected on individual water bodies not contained in the TRACS or NWIS data bases may also be considered in developing site-specific nutrient criteria.

## Reservoirs

The TCEQ selected reservoirs as the first water body type to develop nutrient criteria because of their importance in sustaining cities, farms, ranches, and industry during times of drought and extreme flows; and because Texas has extensive long-term data on nutrients, water-column chlorophyll *a*, and other relevant parameters in the main pools of large reservoirs.

Phytoplankton are generally a key component of eutrophication in reservoirs, and the long-term availability of chlorophyll *a* data provides a relatively direct measure of phytoplankton abundance. If a reservoir is not aesthetically pleasing for recreation, it often times is a result of large populations of phytoplankton. The initial assumption was that chlorophyll *a* would be a good indicator of the amount of phytoplankton in the water column and therefore eutrophication or impairment.

The TCEQ collects data as do other state and federal agencies, river authorities, water districts, and academia. The body of literature on lakes, which are similar to reservoirs, is also extensive.

I. Applying EPA's Methodology to Texas Reservoirs

The USGS initially evaluated the potential for using EPA's methodology to develop nutrient criteria. Level III ecoregions in Texas were used as the basis for spatial aggregation rather than EPA's aggregate national ecoregions.

Historical data from the main pools of reservoirs in each Level III ecoregion were pooled, and criteria for total phosphorus, total nitrogen, and chlorophyll *a* were calculated as the 25$^{th}$ percentiles for each ecoregion in accordance with EPA guidance. The resulting criteria are listed in Appendix A. The resulting criteria for total phosphorus were lower than EPA's national criteria for large aggregate ecoregions in Level III ecoregions 25, 26, 27, and 32; and higher than EPA's criteria in Level III ecoregions 24, 31, 29, 30, 33, and 35.

Preliminary analyses indicate that criteria calculated by this method are frequently less than the average ambient concentrations of phosphorus, nitrogen, and chlorophyll *a*; even in relatively unimpacted reservoirs. Setting criteria at these levels would result in up to about 50 percent of relatively unimpacted reservoirs not meeting criteria.

II. Criteria Based on Historical Conditions in Individual Reservoirs

Criteria based on historical ambient data on individual reservoirs can be appropriate for those reservoirs that are in good trophic condition. The purpose for nutrient criteria for such reservoirs (termed "least impacted") is to maintain and protect existing conditions. This approach reduces some of the high variability that is inherent in calculations based on aggregated reservoirs. Initial factors used to select "least impacted" reservoirs include the following: 1) availability of historical data, 2) limited urban and agricultural land use in the watershed, 3) absence of major discharges in the nearby watershed, 4) no trend of increasing eutrophication, and 5) judgment of experts with firsthand knowledge of a reservoir's watershed and water quality characteristics.

A. Data selection

For continued analysis and investigations, the TCEQ/USGS selected 110 reservoirs that had sufficient data to support criteria calculations. These reservoirs were the same as those listed and assessed for trophic state in the 2002 TCEQ Texas Water Quality Inventory [305(b) report]. The main pool stations for each reservoir were selected to perform the calculations, and only surface values of a constituent were used. Data from main pool areas was selected because it is readily available. Data from coves, small arms, and transition zones is sparse for many reservoirs, highly variable, and are often representative of relatively small areas of a reservoir. Data was restricted to surface samples because of a lack of uniformly available data from deeper samples. Criteria for total phosphorus, total nitrogen, and chlorophyll *a* were included in this evaluation.

B. Identifying least impacted reservoirs

For preliminary analyses, reservoirs are considered to be least impacted if they have the following characteristics:

1. A total of less than 10% of the land use in the surrounding watershed is a combination of urban land use (such as, high intensity residential, low intensity residential, urban / recreational grasses, and commercial, industrial, transportation land uses) or agricultural land use (such as orchards / vineyards, row crops, small grains, and fallow land). The applicable

watershed is truncated to exclude the watershed of upstream reservoirs. The TCEQ Source Water Assessment and Protection (SWAP) data base was used to determine land use for approximately 3/4 of the 110 reservoirs. For reservoirs not included in the SWAP data base, the USGS acquired land use data from the Nation Land Cover Data set in order to further categorize the remaining reservoirs.

2. There are no major domestic point source discharges directly into the reservoir or within a two-hour water travel time of the reservoir. A major discharge is defined as one which is permitted to discharge more than 1 million gallons per day.

3. There is no apparent historic increase in the trophic condition of the reservoir. The USGS has reviewed the historical data to determine if any trends are apparent over time in the 110 candidate reservoirs. They have reviewed the data looking for trends in time using data collected 1) during all times of the year and 2) during warm months from May 1st thru September 30th.

The preliminary list of least impacted reservoirs was presented to the nutrient criteria advisory group, and their firsthand knowledge of these reservoirs was used to adjust the evolving list (Table 1 of Appendix C). The TCEQ's initial efforts to develop site-specific nutrient criteria have focused on the reservoirs in this list. Additional screening has been conducted to develop draft criteria for all 110 reservoirs, divided into groups with combined urban and agricultural land uses of 10-15%, 15-20%, and > 20% (Tables 2, 3, and 4 of Appendix C). Criteria for these additional groups can be evaluated as options for the upcoming triennial standards revisions.

C. Calculation of Criteria

Preliminary criteria were calculated as the upper confidence interval of the mean, with the assumption that a sample size of 10 is used to assess a statistically significant departure from the mean. Confidence levels evaluated included 80th, 90th, 95th, and 99th percent (one-tailed). The calculation was done for chlorophyll *a*, with supplemental criteria calculated for total phosphorus and total nitrogen where sufficient data was available for the least impacted reservoirs.

III. Criteria Based on Reservoir Groupings

Criteria based on ambient conditions may not be appropriate for all reservoirs – such as reservoirs that have potentially elevated anthropogenic nutrient loadings in comparison to least impacted reservoirs. Other approaches are needed to develop criteria for these reservoirs. The TCEQ/USGS are reviewing historical ambient data to determine how reservoirs may be grouped so that reservoirs with sufficient data can be used as references for similar reservoirs that are 1) potentially impacted, or 2) have insufficient data to calculate nutrient criteria based on historical ambient data.

Reference criteria for each group of similar reservoirs would be calculated on pooled data for the least impacted reservoirs in the group. Calculation procedures would be similar to those described above for individual least impacted reservoirs.

The USGS is using multivariate analyses to assess similarities among reservoirs based on chemical, physical, and biological characteristics of the reservoirs. Previous and ongoing work on the classification of Texas reservoirs by other researchers (e.g., Dr. Al Groeger at Texas State University) will also be considered. Options being investigated for grouping reservoirs include the following:

1. Physical/hydrologic characteristics such as reservoir surface area, volume, shoreline complexity, mean depth, and detention time.

2. Chemical characteristics such as total dissolved solids, pH, alkalinity, inorganic turbidity.

3. Land use and vegetative characteristics of the surrounding watersheds.

4. Geographic proximity and connectivity - such as ecoregions and major watersheds.

## IV. Criteria Based on Protecting Reservoir Uses

Additional ongoing development of reservoir nutrient criteria are based on protecting water quality related uses. Some Texas river authorities and other members of the Texas Water Conservation Association (TWCA) have formed a nutrient criteria committee to conduct use-based evaluations and to coordinate with the TCEQ on results and recommendations.

As part of their evaluations, TWCA has collected data to determine if there is a relationship between nutrients and uses; and to develop recommendations for establishing nutrient criteria to protect recreational uses. Water quality sampling and simultaneous user surveys were collected on nine Texas reservoirs during the warm months of 2003 and 2004. The goal of the study was to observe if chlorophyll *a* affected recreational use according to users' perceptions. The study also evaluated the extent to which the results can be applied to groups of reservoirs beyond the nine reservoirs sampled.

This study was similar to a variety of studies conducted elsewhere in the United States. These earlier studies provide supporting information, but the additional data collection effort was needed to better address reservoir conditions in Texas - particularly the relatively high levels of inorganic turbidity that occur in some Texas reservoirs. The results of this study and similar studies in other states can provide an additional option for approaches to establish nutrient criteria in Texas reservoirs.

Adverse eutrophic impacts on recreational uses, and in some cases on water supply uses, can depend in part on the magnitude and frequency of phytoplankton blooms in addition to average conditions. The TCEQ will be investigating the historical ambient database to 1) determine if algal blooms can be detected, 2) note the frequency of algal "blooms" (if detected) above various target concentrations of chlorophyll *a*, and 3) characterize the relationship between measured "bloom" concentrations and long-term average concentrations of chlorophyll *a* during warm months

## V. Setting Criteria

Based on historical data calculations, the TCEQ is preliminarily setting reservoir criteria based on historical "ambient" medians with a statistical allowance for variability for chlorophyll *a* for individual reservoirs. More chlorophyll *a* data exists for the selected 110 reservoirs than for total phosphorus and total nitrogen. A preliminary list of all 110 reservoirs will be reviewed for appropriateness. Some reservoirs will be removed from the list and other methods investigated for setting criteria. This is particularly relevant for reservoirs with high values of chlorophyll *a*. This list will be presented to the nutrient criteria workgroup, management, and the EPA. Subsequent modifications may occur.

The TCEQ is contemplating using the $99^{th}$ confidence interval to set criteria. The statistical test assumes that the values fluctuate through time around the mean. The calculation does not take into account the probability of high chlorophyll *a* values as a result of reduced water volumes and drought or higher than normal temperatures that can increase algal growth. The $99^{th}$ was selected to reduce the likelihood of listing a water body for nutrients or chlorophyll *a* under conditions that were considered an outlier in the development of the criteria. There are also concerns that chlorophyll *a* values from the fluorometric method, which the TCEQ changed to, will be higher than the spectrophotometric method values, on which the criteria was calculated.

The TCEQ will propose reservoir specific criteria or screening for individual reservoirs in the next triennial revision of the surface water quality standards. Screening and assessment will include the criteria for chlorophyll *a*, but may also include screening for total phosphorus and total nitrogen or a combination of the three.

Currently the TCEQ is only setting criteria for the main pool of reservoirs. Coves, the transition zone, and near shore portions of lakes will be investigated later. The lack of available data in these areas in all but a few reservoirs makes this a good topic for additional study.

VI. Relating Phosphorus and Nitrogen to Chlorophyll *a* Criteria ("Translators")

Criteria based on "response" variables such as chlorophyll *a* are a more direct measure of problem levels of aquatic vegetation. Response variables are directly applicable to monitoring data for the purpose of assessing compliance with criteria. Criteria for response measures need to be related to nutrient concentrations and loads in order to provide screening targets for wastewater permits and TMDLs.

The TCEQ is developing several options to address total nitrogen and total phosphorus. Option one is to develop empirical relationships in the form of regression equations that relate nutrients to chlorophyll *a* using long term monitoring data. The TCEQ, in coordination with the USGS, investigated the correlation between nutrient concentrations and response variables such as chlorophyll *a* and secchi disc depth in Texas. Data for these evaluations is taken from the historical monitoring data for 110 Texas reservoirs. Correlations are poor when data from single reservoirs is independently evaluated. However, preliminary analysis indicates that the statistical relationship of nutrients to chlorophyll *a* improves when 1) the median concentrations of reservoirs are compared rather than individual sampling dates, 2) annual medians of reservoirs are grouped by ecoregions, and 3) a measure of inorganic turbidity (such as total suspended solids minus volatile suspended solids) is included as a variable in regression equations.

Option two is to develop screening criteria for total nitrogen and total phosphorus that are calculated from ambient historical data for individual reservoirs, using the same calculation procedures and statistical assumptions that have been previously described for chlorophyll *a* criteria. These screening criteria would constitute preliminary default targets that could be adjusted where additional information and studies are available.

Option three is to apply a more comprehensive site-specific evaluation of the nutrient - chlorophyll *a* relationship, using a combination of historical data, predictive water quality models, and additional site-specific information such as nutrient enrichment tests. These evaluations would be appropriate for TMDL studies or comparable watershed wasteload evaluations that address nutrient loadings from a variety of point and nonpoint sources.

VII. Implementing Criteria and Controlling Nutrient Impacts for Reservoirs

Procedures to assess standards compliance with monitoring data will be established in 1) Section 307.9 of the *Texas Surface Water Quality Standards*, and 2) *TCEQ Guidance for Screening and Assessing Texas Surface and Finished Drinking Water Quality Data*. Draft options to consider include 1) basing assessments on a mean or median concentration of chlorophyll *a* for at least one year, 2) using near-surface samples as a measure of chlorophyll *a* or nutrients, 3) averaging measurements of chlorophyll *a* taken at stations in the main pool of a reservoir, and 4) addressing total phosphorus and total nitrogen by comparing measured concentrations with secondary screening criteria developed from historical data, as described for chlorophyll *a*.

Procedures to assess and set loading limits on nitrogen and phosphorus from regulated sources, such as permitted wastewater discharges, will be established in the *TCEQ Procedures to Implement the Texas Surface Water Quality Standards.* Draft options to consider include 1) establishing screening concentrations for total nitrogen and total phosphorus that will attain chlorophyll *a* criteria, as described in VI above; 2) using steady-state, completely mixed nutrient models of the entire reservoir to compare loading impacts with screening concentrations for the main pool; 3) evaluating more localized effects with steady-state, completely mixed nutrient models or advective steady-state models, in order to estimate the relative increase in nutrients; 4) establishing allowable localized increases in nutrients based on magnitude and geographic extent, size of wastewater discharge, sensitivity of receiving waters, trophic status and trends of receiving waters, localized impacts of existing discharges into the water body, and approximate extent of dispersion and circulation; 5) defining several levels of technology-based effluent limits for total phosphorus to address projected increases of nutrients that are above acceptable target levels; and 6) evaluating the TCEQ's watershed rule for wastewater discharges to selected reservoirs (Chapter 311 of Title 30 of the Texas Administrative Code) to see if additional reservoirs and wastewater permit conditions should be added.

VIII. Data Needs

Data for river/reservoir transition zones, small coves, and near shore concentrations of nutrients and chlorophyll *a* in reservoirs is limited. Texas reservoirs do have long term historical data for chlorophyll *a*, total phosphorus, and nitrate nitrogen in main pools. Total nitrogen data is available for many reservoirs but is more limited. TWCA's study on levels of chlorophyll *a* that constitute an aesthetic impairment has provided a starting point for evaluating use-based approaches, but additional use-based information is needed to assess fishing, recreation, and drinking water uses. There are a few special studies that have estimated the abundance of rooted macrophytes, and the Texas Parks and Wildlife Department estimates percent coverage of aquatic vegetation during reservoir fisheries surveys. In general, however, there is little data on the extent of attached vegetation in Texas reservoirs. Estimates of background loadings of nutrients are not available for most reservoirs, and experimental data is generally lacking to assess limiting nutrients.

IX. Additional Reservoir Studies

Substantial historical data from fixed station periodic monitoring exists for most Texas reservoirs. Selected studies of dissolved oxygen and nutrient dynamics in the river/reservoir transitional zones are ongoing. Preliminary studies by TWCA and others on use-based criteria have been completed. Special studies of water quality and nutrient conditions have been completed in the past for a variety of reservoirs; such as Lake Arlington, Lake Lavon, Lake Ray Hubbard, Lake Travis, Lake LBJ, Lake Dunlap, Canyon Lake, Lake Livingston, Lake Houston, Lake Bridgeport, Eagle Mountain Lake, Cedar Creek Reservoir, and Richland Chambers Reservoir.

X. Incorporating phosphorus and nitrogen into standards

The TCEQ is evaluating how total phosphorus and total nitrogen can be used in conjunction with chlorophyll *a* criteria. Several options are being considered. One option would be to set screening numbers for phosphorus and nitrogen to be used in standards assessment based on the historical data and variability calculations. Other options will be evaluated after final deliverables for statistical analyses on reservoirs is received from the USGS who is doing the analyses under contract.

XI. Implementing criteria

How a water body will be assessed to meet the nutrient criteria has not been determined. Options available include 1) limiting assessment to the main pool stations used to set the criteria, 2) setting screening levels for chlorophyll *a*, total phosphorus, and total nitrogen, 3) using set screening levels singly or in combination to determine an impairment.

XII. Data Gaps

Data for transition zones, small coves, and near shore concentrations of nutrients and chlorophyll *a* in reservoirs is limited or nonexistent. A study is underway on the transition zone in Texas reservoirs, but that information will not be available for some time.

## Streams and Rivers

After initiating nutrient criteria development on reservoirs, the TCEQ and the USGS began working on developing criteria for rivers and streams. After reservoirs, rivers and streams are the largest data set available on TRACS. Rivers and streams impact downstream reservoirs, receive most of the nutrient load directly from wastewater discharges, and can be locally impacted by nutrients.

I. Applying EPA's Methodology to Texas Streams and Rivers

In a similar analysis as described above for reservoirs, the USGS evaluated the potential for using EPA's methodology to develop nutrient criteria. Level III ecoregions in Texas were used as the basis for spatial aggregation rather than EPA's aggregate national ecoregions.

Historical data from rivers in each Level III ecoregions were pooled, and criteria for total phosphorus, total nitrogen, and chlorophyll *a* were calculated as the $25^{th}$ percentiles for each ecoregion in accordance with EPA guidance.

II. Criteria Based on Historical Conditions in Individual Streams and Rivers

As with reservoirs, criteria based on historical ambient data on individual rivers might be appropriate for those rivers that have relatively small potential for anthropogenic nutrient loadings. The purpose of nutrient criteria for least-impacted rivers would be to maintain and protect existing conditions. Potential factors to select least-impacted rivers include the following: 1) availability of historical data, 2) limited urban and agricultural land use in the watershed, 3) absence of major discharges in the watershed, 4) no trend of increasing eutrophication, and 5) judgment of experts with firsthand knowledge of a water body's watershed and water quality characteristics.

Under this approach, preliminary criteria would be calculated as the upper confidence interval of the mean taking variability into account. Confidence levels to be considered include 80th, 90th, 95th, and 99th percent (one-tailed). Other methods to establish criteria based on historical data can also be considered, as well as other states' approaches.

Criteria can be evaluated for chlorophyll *a*, total phosphorus, and total nitrogen. Preliminary analyses suggest that chlorophyll *a* in water is a useful indicator of eutrophication response in many larger, slower moving Texas rivers. Whether this response is similar in smaller wadeable streams in Texas is under investigation (see study described in VI below). Insufficient data currently exists to define the correlation between nutrients, aquatic vegetation, and use support.

Whether criteria will be set using chlorophyll *a*, nitrogen, or phosphorus is yet to be determined. The USGS is conducting statistical analyses to develop ambient-based criteria with preliminary data, with a target date of September 2007.

## III. Criteria Based on Grouping Streams and Rivers

As with reservoirs, the use of reference groupings for establishing criteria might be useful where ambient conditions in a stream or river are inappropriate to use as baseline criteria. The TCEQ will review historical ambient data to determine how rivers and streams may be grouped so that those with sufficient data can be used as references for similar rivers and streams that are 1) potentially impacted, or 2) have insufficient data to calculate nutrient criteria based on historical ambient data. Calculation procedures would be similar to those described above for individual least impacted reservoirs.

Examples of characteristics to consider for grouping rivers and streams include river basins, ecoregions, average depth, wadeable versus nonwadeable, average and dry-weather flows, flow regime, extent of spring-fed flow, occurrence of tidal influence, water chemistry, land use, substrate type (e.g., gravel, incised sand/clay bottom, sand, bedrock), extent of tree canopy, and percent of flow from wastewater discharges.

## IV. Relating Growth of Aquatic Plants in Rivers to Phosphorus and Nitrogen

For larger rivers, where phytoplankton are an important component of eutrophication, the statistical relationship between nutrient concentrations and water-column chlorophyll *a* will be evaluated. The evaluation will begin with the historical data that exists on phosphorus, nitrogen, and chlorophyll *a*. Measures of inorganic turbidity (such as total suspended solids minus volatile suspended solids) will also be included and are expected to be an important variable in regression equations.

In small streams, and in rivers where rooted macrophytes are the primary form of eutrophication, data on vegetation density that could help define the nutrient/vegetation relationship are available only from limited special-purpose studies. Available studies, such as an extensive survey of nutrient impacts and macrophytes on the Colorado River downstream of Austin, indicate that the relationship of vegetation and nutrients can be difficult to quantify.

A recent study in East Texas on 10 small streams, and a similar study underway on Central Texas streams (described below), will provide the starting point to evaluate relationships between nutrients and attached vegetation in small streams.

## V. Data Needs for Rivers and Streams

Data showing the effect of nutrients on attached algae or rooted macrophytes in streams in Texas is limited. Not only is there limited data on concentrations of chlorophyll *a* and nutrients in attached vegetation, there is also sparse data on the extent of the attached vegetation, either algae or rooted macrophytes.

Additional information on attached vegetation, chlorophyll *a*, and nutrients will allow the TCEQ to use the substantial data available on chlorophyll *a* and nutrients in the water column for comparisons.

In smaller streams and rivers, (and in some shallow, larger rivers dominated by macrophytes), chlorophyll *a* in water does not appear to be as useful an indicator of nutrient enrichment as chlorophyll *a* in attached algae. More study is needed to determine if chlorophyll *a* in attached algae is more important than water column chlorophyll *a* in Texas streams.

Because of the lack of data, the TCEQ and other entities are planning projects to collect nutrient, attached vegetation, and chlorophyll *a* data. Some of these projects will span two or three years with the results not due for delivery until 2008.

## VI. Ongoing Studies

Preliminary sampling for nutrients, water column chlorophyll *a*, and attached vegetation was conducted on small east Texas streams in coordination with the USGS, and results are under evaluation. Current sampling is underway in additional streams in central Texas, and the target date for completing this second study is June 2007. Other state and regional agencies are initiating similar work on Texas streams in other parts of the state.

To address this data gap, the USGS, under contract with the TCEQ/EPA, collected data on nutrient concentrations and the extent of attached vegetation in 10 wadeable streams in East Texas. Sampling included dissolved oxygen measurements over 24 hours, habitat surveys, collection of fish and benthic organisms, biomass estimates of attached algae, and nutrients and conventional parameters in water. Similar sampling occurred in 2005 and 2006 in central Texas streams. The additional stream data will be incorporated into the nutrient data base for evaluation of nutrient criteria.

The goal of the study is to provide data that can be used to develop preliminary options for nutrient criteria that are analogous to those options under consideration for reservoirs. In addition, the effectiveness of sampling procedures will be evaluated to determine if estimates of the extent of attached vegetation can be incorporated in routine, periodic statewide monitoring efforts.

## VII. Controlling Nutrient Impacts for Streams and Rivers

Data showing the effect of nutrients on streams in Texas is limited. Though some chlorophyll *a* water column data exists, little or no data exists for attached algae. In Texas, attached algae in small streams can be a large sink or source of nutrients.

The TCEQ currently evaluates nutrient additions to streams from wastewater discharges on a case-by-case basis under the narrative criterion. Effluent limits for phosphorus have been required for a variety of discharges to streams and rivers that are considered sensitive to nutrient enrichment. Procedures to indicate nutrient concerns based on monitoring data are established in the *TCEQ Guidance for Screening and Assessing Texas Surface and Finished Drinking Water Quality Data.*

The TCEQ staff intend to evaluate the narrative criterion for nutrients during the upcoming revisions of the surface water quality standards, in order to ensure that the criterion facilitates implementation of interim control procedures for nutrient loads.

Additional procedures to assess and set loading limits on nitrogen and phosphorus from regulated sources can be considered for streams and rivers during the upcoming revisions of the *TCEQ Procedures to Implement the Texas Surface Water Quality Standards.* Draft options to consider include 1) using steady-state, advective models (such as QUAL-TX) to estimate the relative increase and distance of downstream impacts; 2) establishing allowable localized increases in nutrients based on magnitude and geographic extent, size of wastewater discharge, sensitivity of receiving waters, trophic status and trends of receiving waters, and localized impacts of existing discharges into the water body; and 3) defining several levels of technology-based effluent limits for total phosphorus to address projected increases of nutrients that are above acceptable target levels; and 4) evaluating the TCEQ's rules that establish phosphorus limits for wastewater discharges to selected watersheds (Chapters 311 and 213 of Title 30 of the Texas Administrative Code) to see if additional streams and wastewater permit conditions should be added.

## *Estuaries*

Nutrient criteria development for estuaries follows reservoirs and rivers in sequence, because of 1) the high complexity and variability of the estuarine environment; 2) the historical emphasis on increasing freshwater inflows and nutrients to estuarine systems to boost fishery production; 3) the larger watershed scale and diverse nutrient contributions to tidal rivers and estuaries; and 4) less information and available analyses to relate nutrient concentrations and load to eutrophication conditions in estuaries.

Excessive nutrients are a potential concern in Texas estuaries. Those concerns include 1) localized sources of loading which can cause eutrophication, 2) development of harmful algal blooms along the Texas coast, 3) increased turbidity due to excessive phytoplankton blooms that reduce light penetration and lower the productivity of seagrasses, and 4) zones of hypoxia in the Gulf of Mexico caused by large sources of nutrient loading.

I. Approaches to Investigate Nutrient Criteria for Estuaries

The TCEQ is initiating evaluation of nutrient criteria for estuaries with the same process that has been previously described for reservoirs and rivers. The TCEQ intends to 1) establish a nutrient database of historical ambient data, as has been accomplished for reservoirs and rivers; 2) evaluate EPA's approach and national criteria; 3) consider preliminary criteria based on historical ambient nutrient and chlorophyll *a* concentrations; 4) analyze available data to try to elucidate the relationship between nutrients and phytoplankton occurrence, 5) consider the results of previous and ongoing evaluations of the effects of freshwater inflows and associated nutrients to Texas estuaries; and 6) consider the role of nutrients in excessive blooms of phytoplankton.

As one option, preliminary evaluations of criteria can be considered using ambient historical monitoring data for phosphorus, nitrogen, and chlorophyll *a*, with statistical allowance for variability – as previously described for reservoirs. Historically based criteria for these parameters might be evaluated as multiple screening criteria, as discussed in more detail for reservoirs. Groupings of reference estuaries in Texas can also be evaluated, but the small number of estuary systems will limit this approach. The transition zone between advective rivers and open estuaries will need additional assessment. Some of the approaches that are now under study for the transition zones where streams and rivers enter reservoirs might be applicable. Separate kinds of evaluations and approaches for criteria might be needed for tidal rivers, shallow transitional estuaries, and open bays.

More extensive analyses of individual estuary systems is anticipated to be needed to evaluate a sufficient range of criteria options. Subsequent updates of the nutrient development plan can consider more detailed approaches towards nutrient criteria for estuaries. There have been a variety of studies of Texas estuaries to evaluate the effect of freshwater inflows on estuarine productivity, and these studies will be relevant in considering nutrient criteria.

II. Data and Information Needs for Estuaries

Data needs and questions to address for criteria development include the following: 1) assessing the level of nutrients and phytoplankton productivity in large tidal rivers where they enter Texas estuaries; 2) defining historical ambient conditions and gradients of nutrients and chlorophyll *a* in highly variable estuarine systems; 3) defining appropriate levels of nutrients to maintain desirable estuarine fishery production while precluding excessive eutrophication; 4) assessing the effects of nutrients and phytoplankton on turbidity and seagrass propagation; and 5) assessing the role of nutrients in blooms of harmful algae.

III. Addressing Nutrient Loads to Estuaries

The TCEQ staff intend to evaluate the narrative criterion for nutrients during the upcoming revisions of the surface water quality standards in order to ensure that the criterion facilitates implementation of interim control procedures for nutrient loads.

Procedures to indicate nutrient concerns based on monitoring data are established in the *TCEQ Guidance for Screening and Assessing Texas Surface and Finished Drinking Water Quality Data*.

The TCEQ currently evaluates nutrient additions from wastewater discharges on a case-by-case basis under the narrative criterion, and recently effluent limits for nitrogen have been considered for discharges to locally sensitive estuarine areas

The TCEQ intends to coordinate with the Gulf of Mexico Program and the Gulf of Mexico Alliance projects that address nutrient loadings to the Gulf of Mexico.

The transition of freshwater streams and rivers to tidal characteristics will have to be investigated. The extent that these areas change over time and the impact that they have on nutrients, water chemistry, and biological communities poses problems similar to those in reservoir transition zones. The TCEQ is currently involved in a transition zone study. It is hoped that this study will provide insights into how nutrient criteria may be developed for coastal waters.

Whether criteria will be set using chlorophyll *a*, nitrogen, or phosphorus or other constituent is yet to be determined. No data analysis is currently underway. The TCEQ is committed to reviewing all available data and running statistical analyses to determine the best method to use to protect the state's estuaries from eutrophication.

Before criteria development can commence, additional questions and issues will need to be resolved. The TCEQ will need to define what portion of tidal waters will be considered estuaries, tidal rivers, or bays. The TCEQ will need to define data gaps.

## *Wetlands*

Texas is estimated to have 6,471,000 acres of inland wetlands and 1,648,000 acres of coastal wetlands. Wetlands in Texas can be adversely impacted by excessive nutrient loadings, mainly from nonpoint sources. There are only a few cases where permitted wastewater discharges flow directly into wetlands areas.

I. Approaches to Investigate Nutrient Criteria for Wetlands

The Nutrient Criteria Technical Guidance Manual for Wetlands is one in a series of EPA documents that support the National Nutrient Strategy to develop water body-specific nutrient criteria. Nutrient Criteria Technical Guidance Manuals have been developed for the water bodies discussed above. The wetlands guidance document will provide background information for the development of nutrient criteria for wetlands. Once EPA provides the document, the TCEQ will evaluate the national approach for it's applicability to Texas wetlands. After that review of the national guidance is complete, this nutrient criteria development plan will be updated to reflect Texas' approach for development of wetland nutrient criteria.

II. Data Needs for Wetlands

Available data on wetlands water quality in TCEQ data bases is very limited. Basic sampling for nutrient concentrations, water column chlorophyll *a*, attached vegetation, and 24-hour dissolved oxygen is needed to describe water quality for a variety of wetlands types in Texas. Baseline data would provide a means to 1) assess wetlands nutrient and vegetative characteristics under relatively unimpacted conditions; 2) define problem levels of enrichment and aquatic vegetation; 3) establish the relationship between nutrients and growth of wetlands vegetation; 4) provide appropriate ambient concentrations on which to base criteria where the goal is to preserve existing conditions; and 5) assess the point at which enrichment impairs wetlands functions and values

There have been several recent projects for wetlands construction or wetlands enhancement that have data collection that could be useful for assessing nutrient impacts. One example has been studies funded by the City of Corpus Christi to assess the effects of an experimental wastewater diversion to a coastal wetland. Future investigation will provide more information on the types of data that would be useful in developing nutrient criteria for wetlands since all resources are currently concentrated on reservoirs and streams and rivers.

Using EPA 106 funding, the TCEQ is coordinating with the U.S. Corps of Engineers to develop a hydrogeomorphic (HGM) assessment of wetlands functions that will be consistent with approaches used in other areas of the U.S.

## Boundary Waters

Texas shares boundary waters with New Mexico, Oklahoma, Arkansas, Louisiana, and Mexico. The TCEQ recognizes that any eventual criteria for shared boundary waters need to be developed in close coordination with adjacent states, EPA, and the International Boundary and Water Commission (for reaches and reservoirs on the Rio Grande). The Regional Technical and Assistance Group for nutrient development will be utilized as a preliminary point of coordination for any criteria developed for boundary waters. The TCEQ also anticipates that separate interstate workgroups may be needed to establish nutrient criteria for shared waters.

As the TCEQ moves into developing criteria for reservoirs and rivers that border Texas and other states and Mexico, they will be contacting these entities to collaborate on nutrient criteria development. The TCEQ is currently participating in the EPA Region VI effort to consolidate and assess nutrient data on the Red River in order to establish a framework for coordinated development of nutrient criteria for this shared boundary water.

# Appendix A: Nutrient Database Constituents

| Table 1: Nutrient Data Base Constituents | |
|---|---|
| **Parameter** | **Notes** |
| Nitrogen | ammonia, nitrate, nitrite, total N, total Kjeldahl N, nitrite + nitrate, organic N |
| Phosphorus | orthophosphorus, total phosphorus |
| Solids | filterable and nonfilterable total suspended solids, volatile suspended solids, tds |
| Dissolved oxygen | membrane, daytime grabs plus 24-hour means for last 3 years |
| Chlorophyll *a* | spectrophotometric |
| Pheophytin *a* | spectrophotometric |
| Alkalinity | bicarbonate, total, filtered, carbonate |
| Hardness | as dissolved CaCO3 |
| Stream flow | instantaneous cubic feet per second |
| Conductivity | |
| Turbidity | Hach Turbidimeter, lab ntu's |
| Temperature | |
| Secchi depth | |

| Table 2: Base Line Nutrient Data Base Constituents for Reservoirs | |
|---|---|
| **Parameter** | **Notes** |
| Nitrogen | total nitrogen |
| Phosphorus | orthophosphorus, total phosphorus |
| Solids | filterable and nonfilterable total suspended solids, volatile suspended solids |
| Chlorophyll *a* | spectrophotometric |
| Turbidity | Hach Turbidimeter, lab ntu's |
| Secchi depth | |

# Appendix B: Examples of Reservoir Criteria for Level III Ecoregions Using EPA's Methodology for Reservoirs

| Ecoregion Name | Ecoregion No. | TP mg/L | TN mg/L | Chlorophyll *a* µg/L |
|---|---|---|---|---|
| Chihuahuan Deserts | 24 | 0.021 | 0.951 | 1.250 |
| Western High Plains | 25 | 0.020 | 3.120 | 2.621 |
| Southwestern Tablelands | 26 | 0.012 | 0.399 | 1.256 |
| Central Great Plains | 27 | 0.026 | 0.456 | 1.408 |
| Southern Texas Plains | 31 | 0.050 | 0.054 | 4.130 |
| Central Oklahoma/Texas Plains | 29 | 0.040 | 0.430 | 1.688 |
| Edwards Plateau | 30 | 0.016 | 0.995 | 7.515 |
| Texas Blackland Prairies | 32 | 0.034 | 0.728 | 3.690 |
| East Central Texas Plains | 33 | 0.060 | 0.858 | 9.165 |
| South Central Plains | 35 | 0.040 | 1.195 | 4.371 |
| Western Gulf Coastal Plain | 34 | 0.147 | 0.566 | 2.646 |

# Appendix C: Least Impacted Reservoirs

## *Table 1: Reservoirs with 0-10% Urban plus Agriculture Land Use in the Watershed*

| Reservoir | % Land Use as Urban plus Agriculture |
|---|---|
| Amistad Reservoir | 0.9 |
| B. A. Steinhagen Reservoir | 3.6 |
| Caddo Lake | 6.1 |
| Canyon Lake | 11.1 |
| Choke Canyon Reservoir | 10.8 |
| Diversion Lake | 3.3 |
| Farmers Creek (Nocona Lake) | 8.6 |
| Houston County Lake | 4.2 |
| Hubbard Creek Reservoir | 6.5 |
| Inks Lake | 3.8 |
| Lake Amon G. Carter | 5.3 |
| Lake Bob Sandlin | 2.8 |
| Lake Bridgeport | 4.2 |
| Lake Buchanan | 9.2 |
| Lake Cisco | 5.8 |
| Lake Corpus Christi | 6 |
| Lake Cypress Springs | 3.2 |
| Lake Georgetown | 3.3 |
| Lake Jacksonville | 11 |
| Lake Limestone | 5 |
| Lake Marble Falls | 6.6 |

| Reservoir | % Land Use as Urban plus Agriculture |
|---|---|
| Lake Murvaul | 1.8 |
| Lake Palo Pinto | 3.9 |
| Lake Travis | 5.9 |
| Lake Tyler | 8.1 |
| Medina Lake | 4.9 |
| O.C. Fisher Reservoir | 4.8 |
| Red Bluff Reservoir | 0.02 |
| Stillhouse Hollow Lake | 4.4 |

***Table 2: Reservoirs with 10-15% Urban plus Agriculture Land Use in the Watershed***

| Reservoir | % Land Use as Urban plus Agriculture |
|---|---|
| Buffalo Springs Lake | 13 |
| Cedar Creek Reservoir | 12 |
| Cox Lake | 12 |
| Lake Arrowhead | 12 |
| Lake Brownwood | 11 |
| Lake Crook | 14 |
| Lake Kickapoo | 13 |
| Lake Lyndon B. Johnson | 11 |
| Lake Ray Roberts | 13 |
| Lake Sweetwater | 14 |
| Lake Texana | 15 |
| Lake Theo | 14 |
| Lake Weatherford | 14 |
| Leon Reservoir | 14 |
| Palo Duro Reservoir | 10 |
| Pat Cleburne Reservoir | 14 |
| Twin Buttes Reservoir | 13 |

## *Table 3: Reservoirs with 15-20% Urban plus Agriculture Land Use in the Watershed*

| Reservoir | % Land Use as Urban plus Agriculture |
|---|---|
| E.V. Spence Reservoir | 17 |
| Eagle Mountain Reservoir | 18 |
| Lake Austin | 16 |
| Lake Coleman | 20 |
| Lake Granbury | 17 |
| Lake Kemp | 19 |
| Lake Livingston | 17 |
| Lake Mackenzie | 17 |
| Lake Worth | 19 |
| Millers Creek Reservoir | 17 |
| Oak Creek Reservoir | 17 |
| Pat Mayse Reservoir | 16 |

## *Table 4: Reservoirs with greater than 20% Urban plus Agriculture Land Use*

| Reservoir | % Land Use as Urban plus Agriculture |
|---|---|
| Aquilla Reservoir | 27 |
| Brady Creek Reservoir | 23 |
| Fin Feather Lake | 82 |
| Granger Lake | 28 |
| Greenbelt Reservoir | 36 |
| Joe Pool Lake | 25 |
| Lake Arlington | 59 |
| Lake Coleman | 20 |
| Lake Colorado | 29 |
| Lake Fort Phantom Hill | 27 |
| Lake Graham | 23 |
| Lake J.B. Thomas | 42 |
| Lake Nasworthy | 31 |
| Lake Ray Hubbard | 23 |
| Lake Stamford | 27 |
| Lake Tanglewood | 64 |
| Lake Texoma | 36 |
| Lake Waxahachie | 24 |
| Lake Whitney | 40 |
| Lake Wichita | 23 |
| Lewisville Lake | 23 |
| Navarro Mills Reservoir | 32 |
| Proctor Lake | 21 |
| Town Lake | 67 |
| White Rock Lake | 73 |

# Appendix D: Draft Schedule for Developing Nutrient Criteria

## Nutrient Criteria Development Plan

| Task | Date | Done |
|---|---|---|
| Send initial nutrient criteria development plan to EPA | 11/30/01 | ✔ |
| Send revised draft Plan to EPA | 1/31/05 | ✔ |
| Send revised draft Plan to EPA | 12/1/06 | |
| Draft plan mutually agreed upon by the TCEQ and EPA | | |
| Revise draft plan as needed | Ongoing | |

## Criteria Development

**Reservoirs**

| Task | Date | Done |
|---|---|---|
| Complete initial reservoir data base (USGS) | 10/31/01 | ✔ |
| Advisory workgroup meeting 1 | 5/08/02 | ✔ |
| Advisory workgroup meeting 2 | 2/24/03 | ✔ |
| Advisory workgroup meeting 3 | 1/29/04 | ✔ |
| Advisory workgroup meeting 4 | 3/15/05 | ✔ |
| Advisory workgroup meeting 5 | 7/12/05 | ✔ |
| Advisory workgroup meeting 6 | 9/26/05 | ✔ |
| Establish final nutrient data base: 110 reservoirs; Jan 1970 - Apr 2003 | 12/19/03 | ✔ |
| Incorporate additional parameters into data base | Ongoing | |
| Incorporate additional supporting information on individual reservoirs | Ongoing | |
| Review scientific literature that links levels of algae and vegetation with impacts on water quality uses | 12/31/03 | ✔ |
| Develop draft list of least-impacted reservoirs | 4/1/04 | ✔ |
| Evaluate trends over time of nutrients and chlorophyll *a* | 4/21/04 | ✔ |

| Task | Date | Done |
|---|---|---|
| Calculate preliminary draft criteria for selected least impacted reservoirs, based on confidence intervals for the means of chl *a*, TN, TP (80, 90, 95, and 99$^{th}$ confidence levels) | 8/1/04 | ✔ |
| Design and populate ACCESS relational data base with reservoir data. | 7/31/06 | ✔ |
| Conduct analyses to relate levels of nutrients to chlorophyll *a* | Ongoing | |
| Present current status of draft criteria to workgroup | 3/1/2007 | |
| Evaluate results of use-based criteria studies | Ongoing | |
| Send EPA preliminary staff draft of reservoir criteria | 8/31/05 | ✔ |
| Propose numerical nutrient criteria, implementation procedures to be used in permitting, and updates on assessment procedures during next triennial standards revision | [2008] | |
| | | |

**Rivers and Streams**

| Task | Date | Done |
|---|---|---|
| Compile initial nutrient database for rivers and streams | 10/31/01 | ✔ |
| Search peer reviewed literature for articles on nutrients and their impact on rivers and streams. | 4/30/06 | ✔ |
| Stream data added to nutrient data base | 7/31/06 | ✔ |
| Finish data collection on dissolved oxygen, biota, nutrients, and attached algae for 33 East Texas streams | 8/31/06 | ✔ |
| Update workgroup on status of stream studies | 3/1/07 | |
| Incorporate additional information on individual streams and rivers | Ongoing | |
| Conduct preliminary evaluation of criteria for selected rivers based on historical average conditions using EPA methodology | 8/31/05 | ✔ |
| Finish data collection on dissolved oxygen, biota, nutrients, and attached algae for Central Texas streams | 7/31/07 | |
| Evaluate stream data on East and Central Texas streams, and apply results to consideration of nutrient criteria for streams. Deliverables from USGS due 7-31-07 for Central Texas streams. | 9/30/07 | |

| Task | Date | Done |
| --- | --- | --- |
| Expand/revise nutrient development plan and schedule for rivers and streams as needed | Ongoing | |
| During next triennial standards revision, consider expanded narrative criterion and new implementation procedures to address nutrient impacts in rivers and streams | 2008 | |
| Propose numerical nutrient criteria, implementation procedures to be used in permitting, and update assessment procedures during triennial standards revisions | 2011 | |

**Estuaries**

| Task | Date | Done |
| --- | --- | --- |
| Add TRACS data for estuaries into nutrient database | 12/31/06 | |
| Update workgroup on status of estuary database with notice on the web page | 3/1/07 | |
| Search peer reviewed literature for articles on nutrients and their impact on estuaries | Ongoing | |
| Incorporate additional information on individual estuaries | Ongoing | |
| Conduct preliminary evaluation of criteria for selected estuaries based on historical average conditions | 1/31/08 | |
| Expand/revise nutrient development plan and schedule for estuaries as needed | Ongoing | |
| During next triennial standards revision, consider expanded narrative criterion and new implementation procedures to address nutrient impacts in estuaries | 2008 | |
| Consider proposals for numerical nutrient criteria for estuaries during triennial standards revision | [2011] | |

**Wetlands**

| Task | Date | Done |
| --- | --- | --- |
| Review EPA guidance for wetland nutrient criteria | TBD | |
| Search for available data on Texas wetlands | Ongoing | |

| | | |
|---|---|---|
| Update workgroup on status of wetlands database | TBD | |
| Review available data for data gaps | TBD | |
| Formulate needs and ways to fill data gaps and if necessary contracts | TBD | |
| Conduct preliminary evaluation of criteria for selected wetlands based on available data | TBD | |
| Expand/revise nutrient development plan and schedule for wetlands as needed | Ongoing | |
| During next triennial standards revision, consider expanded narrative criterion and new implementation procedures to address nutrient impacts in wetlands | 2008 | |
| Consider proposals for numerical nutrient criteria for wetlands during triennial standards revisions | TBD | |

## Appendix E: Time line for Revising the Texas Water Quality Standards (Title 30, Chapter 307, Texas Administrative Code)

| Days | TASKS |
|---|---|
| 0 | TCEQ initiates rulemaking |
| 30 | Request for preliminary public comments |
| 100 | TCEQ convenes stakeholders workgroup |
| 190 | Preliminary draft of revisions for informal review |
| 260 | Revised draft revisions, preamble, and fiscal note |
| 290 | Draft revisions publicly approved by TCEQ Commissioners |
| 330 | Notice of hearing in Texas Register and mailout |
| 380 | Public hearing |
| 470 | Draft of final revisions and responses to comments |
| 530 | Standards revisions adopted as state rule at TCEQ Agenda. |
| 550 | Standards revisions effective as state administrative rule |
| 610 | Adopted standards published in Texas Register |
| 640 | TCEQ sends adopted revisions to EPA for review and approval |

# Attachment E

United States
Environmental Protection
Agency

Office of Water
Office of Science and Technology
Washington, DC 20460

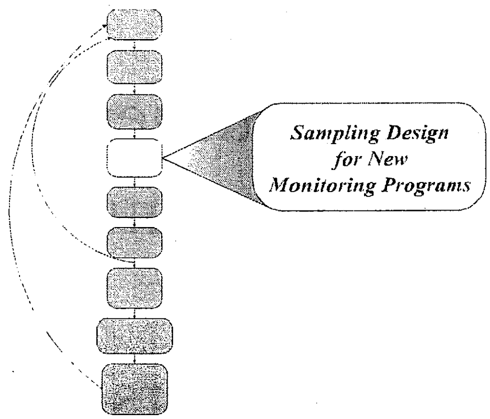
EPA-822-B-00-002
July 2000
www.epa.gov

# Nutrient Criteria Technical Guidance Manual

# Rivers and Streams

The full Rivers and Streams document is available on our web site:
http://www.epa.gov/waterscience/criteria/nutrient/guidance/rivers/

# Chapter 4. Sampling Design for New Monitoring Programs




## 4.1 INTRODUCTION

The purpose of this chapter is to provide technical guidance on designing effective sampling programs for reconnaissance. Appropriate data describing stream nutrient and algal conditions are lacking in many places. Where available data are not sufficient to derive criteria, it will be necessary to collect new data through existing or new monitoring programs. New monitoring programs should be designed to assess nutrient and algal conditions with statistical rigor while maximizing available management resources.

Nutrient monitoring programs are used to better define nutrient and algal relationships within stream systems. At the broadest level, monitoring data should detect:

1. Seasonal patterns in nutrient levels and their relationship to algal biomass levels;

2. The assimilation capacity of the system for nutrients: i.e., how much nutrient loading can be assimilated without causing unacceptable changes in water quality or the algal community (biomass and composition);

3. Whether nutrient concentrations are increasing, decreasing, or staying the same over time.

This Chapter provides discussion on issues to consider with regard to monitoring nutrients and their effects in stream systems. The various forms of nutrients to consider for sampling are discussed in Chapter 3. Field sampling and laboratory methods for nutrient assessment are described in Appendix B.

Monitoring programs are often poorly and inconsistently funded or are improperly designed and carried out, making it difficult to collect a sufficient number of samples over time and space to identify changes in water quality or estimate average conditions with statistical rigor. This Chapter provides a procedural approach for assessing water quality condition and identifying impairment by nutrients and algae in stream reaches. The approaches described below present sampling designs that allow one to obtain a significant amount of information with relatively minimal effort. Probabilistic and stratified random sampling begin with large-scale random monitoring designs that are reduced as nutrient and algal conditions are characterized. The tiered approach to monitoring begins with coarse screening and proceeds to more detailed monitoring protocols as impaired and high-risk systems are identified and targeted for further investigation.

Water quality variables other than the primary variables discussed in Chapter 3, e.g., DO, pH, TSS, etc., should be critically selected in a monitoring design to obtain the most cost-effective information required to assess river system nutrient and algal conditions. Sampling should be designed to answer questions such as: how, when, where and at what levels do nutrient concentration and algal biomass contribute to unacceptable water quality conditions (e.g., offensive odors, aesthetic impairment, degraded habitat for aquatic life, diurnal decreases in DO and pH increases)? These questions are interrelated, and a well-designed program that monitors the primary variables (TN, TP, chl *a*, turbidity) with other water quality variables can contribute to answering them.

## 4.2 SAMPLING PROTOCOL

### CONSIDERATIONS FOR SAMPLING DESIGN

Developing nutrient criteria and monitoring the success of nutrient management programs involve important considerations for sampling design. Initially, the relationships between critical response variables and nutrient concentrations need to be established. Next, reference reaches should be sampled and assessed for specific classes of streams. **Nutrient concentrations and algal biomass levels in reference reaches should define the ecological state that could be attained if impaired reaches were restored.** In some streams and rivers, nutrient levels may be naturally high if bedrock, soils, or wetlands are nutrient-rich sources in the region. However, human actions can exacerbate nutrient enrichment regardless of the natural nutrient condition.

Reach/stream selection for establishing causal relationships between nutrients and algal biomass is based on the need to sample a relatively large number of streams with nutrient concentrations distributed along the entire nutrient gradient for each class of streams in a specific regional setting. Cause-response relationships can also be identified using large sample sizes and streams with low as well as medium and high nutrient concentrations. All ranges of responses should be observed along the gradient from reference condition to high levels of human disturbance. Therefore, streams should be selected based on land-use in the region so that watersheds range from minimally impaired with expected low nutrient runoff to high levels of development (e.g., agriculture, forestry, or urban) with expected high runoff.

Assessing watershed characteristics through aerial photography and the use of geographical information systems (GIS) linked to natural resource and land-use databases, can aid in identifying reference and impaired streams. Some examples of watershed characteristics which can be evaluated using GIS and aerial photography include land-use, land-cover (including riparian vegetation), soils, bedrock, hydrography, infrastructure (e.g., roads, public sewerage systems, private septic systems), and climate. Watersheds with little or no development that receive minimal anthropogenic inputs could potentially contain streams that would serve as reference sites (see section below). Watersheds with a high percentage of their area occupied by nutrient-rich soils, heavily fertilized agricultural land, and extensive unsewered development in coarse soils are likely to contain streams receiving high nutrient loads that could potentially be considered 'at risk' for developing nutrient and algal problems. The USDA agricultural census provides information on agricultural land use (crops, livestock, irrigation, chemicals used) at the national, state, and county levels. Data are available on their website at: http://www.nass.usda.gov/census/.

Once the watershed level has been considered, a more stream-specific investigation can be initiated to better evaluate nutrient and algal conditions. Rivers and streams need adequate light and nutrients to develop and maintain high levels of algal biomass. In addition, attached algae (periphyton) require coarse substrata (cobbles, boulders) and a flow regime that provides sufficient periods between scouring floods (at least one month) to accumulate high levels of biomass. The condition of the riparian zone needs to be considered. Riparian buffer zones may mediate the effects of nonpoint sources of nutrients and turbidity and, depending on the slope of the system, may reduce the velocity of overland runoff to a stream. Riparian wetlands may serve as both sources and sinks for nutrients varying with wetland type, seasonal flows, and degree of disturbance. The presence or absence of streamside trees can affect light limitation in a stream. Light is unlikely to limit algal growth where streamside trees have been removed or the stream is wide, shallow and clear enough to permit sufficient light to reach much of the bottom. Shaded streams may have high nutrient concentrations with no correlative response in algal growth, though the nutrient load may stimulate algal growth further downstream. The relative risk to develop nutrient and algal problems could be assessed by noting how many of the above factors that permit higher algal levels and/or nutrient concentrations are common to a stream or reach.

### WHERE TO SAMPLE

Nutrient inputs can occur at a myriad of points along a river system resulting in highly variable concentrations of nutrients throughout the system. System variability and multiple nutrient input points require numerous sampling sites for assessing the nutrient condition of a river system. Monitoring stations for nutrients in streams and rivers should be located upstream and downstream from major sources of nutrients or diluting waters (e.g., discharges, development, tributaries, areas of major groundwater inputs) to quantify sources and loads.

### WHEN TO SAMPLE

Nutrient and algal problems are frequently seasonal in streams and rivers, so sampling periods can be targeted to the seasonal periods associated with nuisance problems. Nonpoint sources may cause increased nutrient concentrations and turbidity or nuisance algal blooms following periods of high runoff during spring and fall, while point sources of nutrient pollutants may cause low-flow plankton blooms and/or increased nutrient concentrations in pools of streams and in rivers during summer. In most state monitoring programs, sampling is only conducted once during the season when greatest impacts are expected. If only a one-time sampling is possible, then sampling between two to four (2-4) weeks after a storm or high flow event has disturbed algal assemblages (Stevenson and Bahls 1999) is recommended. Two to four weeks will allow sufficient time for algal biomass recovery in streams where algal biomass predominantly consists of diatoms or micro-algae. Alternatively, sampling should be conducted during the growing season at the mean time after flooding for the system of interest. In streams where macro-algae or macrophytes comprise the dominate photosynthetic biomass, recovery of photosynthetic biomass may take one or more growing seasons following a major high-flow event. However, if a high-flow event does not move anchoring substrata, the flow event will only have a nominal effect on photosynthetic biomass. High flow events late in the growing season when algal and macrophyte filaments and fronds are more prone to slough, may cause a reduction in the photosynthetic biomass. A one-time sampling approach may be adequate for indicators of nutrient status, designated use, and biotic integrity. However, criteria and biological or ecological indicator development (see Assessing Algal Biomass below) may require more frequent sampling to observe nutrient conditions that relate to peak algal biomass (Biggs 1996; Stevenson 1996; Stevenson 1997b).

Nutrient concentrations vary with climate-driven changes in flow. Algal blooms, both benthic and planktonic, can develop rapidly and then may dissipate as nutrient supplies are depleted or flow increases. Thus sampling through the season of potential blooms may be necessary to observe peak algal biomass and to characterize the nutrient conditions that caused the bloom. Sampling through the season of potential problems is important for developing cause-response relationships (with which biological and ecological indicators can be developed) and for characterizing reference conditions. Keep in mind that there is a time-lag between nutrient enrichment and algal response. Therefore to characterize algal response to a specific enrichment event, nutrient sampling should be conducted prior to algal sampling. Samples for nutrients should also be collected during the season of lowest algal levels (at least 3 samplings spread over the period) to determine current background levels of algal biomass; avoid the problem of algal uptake attenuating nutrient concentrations, and help provide an estimate of maximum nutrient concentration. Many nutrient monitoring programs are based on quarterly sampling. However, quarterly samples are usually inadequate to detect long-term trends due to year-to-year variation in the window of high flows, the period of high nutrient uptake and algal growth, and the period of algal sloughing at the end of the growing season.

If few nutrient and algal data exist, then multi-year surveys on a twice monthly or monthly basis may be necessary to determine if nuisance algal problems occur. Frequent sampling is necessary because algal blooms may develop and dissipate rapidly with residual adverse effects, such as fish kills and impaired aquatic habitat. Multi-year sampling is necessary because unusually large annual variability can occur annually in the intensity of nutrient/algal problems, due to timing of weather (primarily scouring storm events or persistent low flow events with long residence time) and seasonality of algal blooms.

Ideally, water quality monitoring programs produce long-term datasets compiled over multiple years, to capture the natural, seasonal and year-to-year variations in waterbody constituent concentrations (e.g., Dodds et al. 1997; Tate 1990). Multiple-year datasets can be analyzed with statistical rigor to identify the effects of seasonality and unusual flow years (Miltner and Rankin 1998). Once the pattern of natural variation has been described, the data can be analyzed to determine the water quality conditions that degrade the ecological state of the waterbody or effect downstream receiving waters. Long-term data sets have also been extremely important in determining the cost-effectiveness of management techniques for lakes and reservoirs (Cooke et al. 1993). The same should be true for streams and rivers, if not more so (due to greater constituent variability), although management of nutrients to improve quality in streams and rivers has not been as well documented.

In spite of the documented value of long-term data sets, there is a tendency even in lake/reservoir management to intensively study a waterbody for one year before and one year after treatment. A more cost-effective approach would be to measure only the most essential indices, but to double or triple the monitoring period. Two or more years of data are needed to identify the effects of years with extreme climatic or flow conditions. Low periphyton biomass has often been observed during high-flow summers as well as the reverse, i.e., high biomass-low flow. The cause for that is not entirely clear; high flows may reduce biomass through scouring and/or dilute inputs of ground water nutrients. Whatever the cause, the effect will be "averaged out" enough to discern the overall effect of treatment (e.g., nutrient reduction or diversion) if several years of data are available to minimize the effect of the unusual flow year(s). At the very minimum, two years of data before and two after implementing nutrient management, but preferably three or more each, are recommended to evaluate treatment cost-effectiveness with some degree of certainty. If funds are limited, restricting sampling frequency and/or numbers of constituents analyzed should be considered to preserve a longer-term data set. This will allow for effectiveness of management approaches to be assessed against the high annual variability that is common in most streams. High hydrological variation in a stream from year to year, requires more years of sampling before and after mitigation procedures.

**Characterizing Precision of Estimates**

Estimates of dose-response relationships, nutrient and biological conditions in reference reaches, and stream conditions of a region are based on sampling. Therefore, precision and accuracy must be assessed. Determining precision of measurements for one-time assessments from single samples in a reach is often necessary. The variation associated with one-time assessments from single samples in a reach can often be determined by re-sampling a specific number of reaches during the survey. Measurement variation among replicate samples can then be used to establish the expected variation for one-time assessment of single samples. Re-sampling does not establish the precision of the assessment process, but rather identifies the precision of an individual measurement. Re-sampling frequency is often conducted for one stream reach in every block of ten reaches. However, investigators should adhere to the objectives of re-sampling (often considered an essential element of QA/QC) to establish an assessment of the variation in a one-time/sample assessment. The larger the sample size the better (smaller) will be the estimate of that variation. Often, more than one in ten samples need to be replicated in monitoring programs to provide a reliable estimate of measurement precision.

## APPROACHES TO SAMPLING DESIGN

The following sections discuss two different approaches to sampling design, probabilistic and goal-oriented. Both approaches have advantages and disadvantages that under different circumstances warrant the choice of one approach over the other (Table 3). The decision as to the best approach for sample design in a new monitoring program must be made by the water quality resource manager or management team after carefully considering different approaches.

**Probabilistic Sampling**

Probability sampling, where randomness is required, can be used to determine the variability of nutrient and algae levels in streams and rivers across a state or a region. Random sampling is a generic type of probability sampling where randomness can enter at any stage of the sampling process. Probabilistic sampling – a sampling process wherein randomness is a requisite (Hayek 1994) – can be used to characterize the status of nutrient conditions and biotic integrity in a region's streams and rivers. Probabilistic designs are often modified by stratification (such as classification [Chapter 2]), by deleting "redundant" reaches, or by adding important sites. Stratification or stratified random sampling is a type of probability sampling where a target population is divided into relatively homogenous groups or classes (strata) prior to sampling based on factors that influence variability in that population (Hayek 1994). Analysis of variance can be used to identify statistically different parameter means among the sampling

**Table 3.** Comparison of probabilistic and goal-oriented sampling designs.

| Probabilistic Sampling | Goal-oriented Sampling |
|---|---|
| • random selection of streams from entire population within a region<br>• requires no prior knowledge of streams within the sample population<br>• may require more resources (time and money) to randomly sample stream classes because more streams may be sampled<br>• nutrient condition characterization for a class of streams is more statistically robust<br>• potentially best for regional characterization of stream classes, especially if water quality conditions are not known | • targeted selection of streams based on problematic (reaches known to have nutrient/algal problems) and reference reaches<br>• requires prior knowledge of streams within the sample population<br>• utilizes fewer resources because only targeted streams are sampled<br>• nutrient condition characterization for a class of streams is less statistically robust, though characterization of a targeted stream or reach may be statistically robust<br>• potentially best for site-specific and watershed-specific criteria development when water quality conditions for the reach of interest are known<br>• selection of sites that represent a range of nutrient conditions will facilitate establishment of nutrient-algal relationships for the systems of interest |

strata or classes. The strata are then used as the analysis of variance treatments (Poole 1972). Goal-oriented sampling as described in the tiered approach in this Chapter, is not as easily analyzed by rigorous statistical analyses. Goal-oriented monitoring may be better suited to statistical analyses using basic descriptive statistics and correlational analyses.

Streams are selected for probabilistic sampling by random selection of a sample of streams from the entire population of streams within a region. Thus, all stream reaches within a region must be identified to establish the statistical population of streams; then a sample of all possible streams is selected from that population. The results of collecting and assessing water quality and biotic responses with a probabilistic sample is, presumably, an unbiased estimate of the descriptive statistics (e.g., means, variances, modes, and quartiles) of all streams in a region. Probabilistic sampling designs are commonly modified by stratifying by stream size and stream classes. Otherwise, sample statistics would be most characteristic of the numerous small streams of the dominant stream types in a region.

Many state 305b and watershed monitoring programs utilize modified probabilistic sampling designs. Stratification in many of these programs is based on identifying all stream reaches in a region (or watershed) and then selecting an "appropriate" sample of reaches from the defined population. The sample population is often modified by deleting stream reaches that are too close to other reaches to be different, thereby reducing redundant collection efforts. The selected sample of streams may also be modified by adding sites that are near known sources of impact. Estimates of ecological conditions from these kinds of modified probabilistic sampling designs can be used to characterize the nutrient status, and over time, to distinguish trends in stream nutrient condition within a region. Estimates of regional conditions are best when sites near known sources of impact are removed from the analysis and later compared to the distribution of regional nutrient conditions.

### Goal-Oriented Sampling

A goal-oriented approach to sampling design may be more appropriate when resources are limited. The tiered approach described here focuses the greatest efforts on identifying and characterizing rivers and streams likely to have nutrient problems, and on relatively undisturbed streams, often called reference streams or reaches, that can serve as regional or sub-regional examples of natural biological integrity. Choosing sampling stations that best allow comparison of nutrient concentrations at reference stream or river sites of known condition can conserve financial resources. Goal-oriented sampling also includes some elements of randomness. However, the identification of systems with nutrient problems and reference conditions eliminates the need for selecting a random sample of the population for monitoring.

Goal-oriented sampling assumes some knowledge of the systems sampled. Systems with evidence of impairment are compared to reference systems that are similar in their physical structure. Sites chosen to represent a range of nutrient conditions will facilitate development of nutrient concentration-algal biomass relationships. Goal-oriented sampling requires that the reaches be characterized according to assessed nutrient and algal levels. Comparison of the monitoring data to data collected from reference stream reaches will allow characterization of the sampled streams. Reaches identified as 'at risk' should be evaluated through a sampling program to characterize the degree of impairment. An impaired reach is simply a reach of any length where nutrient concentrations exceed acceptable levels, or algae interfere with beneficial uses. Once characterized, the reaches should be placed in one of the following categories:

1. Impaired reaches – reaches in which nutrients or algal biomass levels interfere with designated uses;

2. High-risk reaches – reaches where nutrient concentrations are high but do not significantly impair designated uses. In high-risk streams impairment is prevented by one or a few factors that could be changed by human actions, though water quality characteristics (e.g., DO, turbidity) are already marginal;

3. Low-risk reaches – reaches where many factors contain nutrient concentrations and algal biomass levels are below problem levels and/or no development is contemplated that would change these conditions.

4. Reference reaches – reaches where nutrient concentrations and algal biomass levels most closely represent the pristine or minimally impaired condition.

Once stream reaches have been classified based on their physical structure (see Chapter 2) and placed into the above categories, specific reaches need to be selected for monitoring. At this point, randomness is introduced; stream reaches should be randomly selected within each class and risk category for monitoring.

Monitoring efforts are often prioritized to best utilize limited resources. Impaired and high-risk streams should be monitored more intensively than low-risk streams. Impaired streams should be monitored to evaluate, implement, and assess management activities to reduce algal biomass and improve water quality. High-risk streams should be monitored to assure that no further degradation takes place. Low-risk streams can be monitored less frequently, but should be monitored frequently enough to identify any increase in nutrients or algae, and/or change of water quality. Reference reaches should be monitored frequently enough to make robust comparisons with impaired and high-risk stream reaches. In addition, monitoring of changes in the watershed can help identify areas where changes are likely to result in degradation of nutrient condition. Human activities within a watershed that can increase the risk of nutrient and/or algal problems include 1) stabilization of flows (reduces scour); 2) reduction of flows (increases light, reduces dilution of nutrients); 3) removal of streamside vegetation (increases light, may decrease depth of stream; and increases the flux of nutrients from the stream hillslope due to reduced uptake from plant roots); 4) discharge of nutrient rich waste water; 5) construction of unsewered residential development (especially in thin coarse soils); 6) over fertilization of agricultural land; 7) development that increases the percent of impervious surface in the watershed; and hence nutrient runoff; and 8) discharge of toxins or release of exotic species that reduce grazer populations.

### IDENTIFYING AND CHARACTERIZING REFERENCE STREAM REACHES

Potential reference streams should be characterized to allow for the identification of appropriate reference streams and reference stream reaches. Classification of streams, as discussed in Chapter 2, will allow appropriate reference reaches to be identified for specific regions and stream types. Stream classification should be supplemented with information on return frequency of flows. Reference streams or reaches may not be available for all stream classes. In this case, data from systems that are as close as possible to the assumed unimpaired state of rivers and streams in that class should be sought from States or Tribes within the same nutrient ecoregion.

The identification of reference *reaches* as opposed to reference *streams* is an important distinction (see Chapter 7, Section 7.2). Identification of impaired and reference streams would be relatively simple if an entire stream had all the same physical characteristics and risk factors. However, only one specific portion of a stream length, a *reach*, may have all the characteristics necessary to produce algal problems. It may not be possible to find an entire stream that has little or no impacts anywhere in its watershed. Therefore, stream *reaches* should be targeted, but their watersheds should also be kept in mind. The stream bed, banks, and riparian zone of a reference reach should be in a fairly natural state, and its watershed as undeveloped as possible. States/Tribes should endeavor to protect such reference reaches from future development.

Streams for reference-reach sampling should be selected based on low levels of human alteration in their watersheds and aquatic habitat. Selecting reference reaches usually involves assessment of land-use within watersheds, and visits to streams to ground-truth expected land-use and check for unsuspected impacts. Sometimes ecological impairment that was not apparent from land-use and local habitat conditions may be identified. Again, sufficient sample size is important to characterize the range of conditions that can be expected in the least impacted systems of the region (see TN case study in Appendix A).

Reference reaches should be identified for each nutrient ecoregion in the State or Tribal lands and then characterized with respect to nutrient concentrations, algal biomass levels, algal community composition and associated environmental conditions including turbidity, light, and substrata as well as factors that are affected by algae, such as DO and pH. For each ecoregion in a state, a minimum of three low impact reference systems should be identified for each stream class. Highest priority should be given to identifying reference streams for those stream types considered to be at the greatest risk from nutrients and algae. Reference stream reaches are often less accessible than reaches adversely affected by nutrient and algal impairments. However, sampling need not be as frequent in reference reaches, except to validate models of algal response to nutrient loads for such reaches.

**Continuation of Less Intensive Monitoring of High-Risk Reaches**

The continuation of monitoring of high-risk reaches should focus on factors likely to increase nutrient concentrations or limit algal growth and on any actions that might alter those factors. For example, if light is limiting, it may be most appropriate to evaluate the potential impact of the removal of streamside trees or of the manipulation of water levels which may kill streamside trees. Stabilization of flows results in the decline of flood-dependent vegetation. Increased grazing levels can reduce streamside trees degrade banks, altering the depth and width of the stream. State/Tribal water quality agencies should encourage adoption of local riparian protection plans where light is limiting to minimize nutrient-caused water quality problems.

If scouring flows limit algal accrual and significantly dilute nutrient loading, a closer evaluation of plans that could manipulate flows (by diversion, damming or altering management at existing structures) is warranted. State/Tribal water quality agencies should inform agencies that regulate water development of the potential impacts of flow manipulation.

Development plans in the watershed should be evaluated where nutrients are limiting (see Defining the Limiting Nutrient, Section 6.2). Changes in point sources can be monitored through the NPDES permit program. Changes in nonpoint sources can be evaluated through the identification and tracking of wetland loss and/or degradation, increased residential development, increased tree harvesting, and shifts to more intensive agriculture with greater fertilizer use or increases in livestock numbers. Local planning agencies should be informed of the risk of increased nutrient loading and encouraged to guide development accordingly. Nutrient levels often gradually increase due to many growing nonpoint sources. Hence, in-stream nutrient monitoring is warranted in nutrient-limited, high-risk reaches if sufficient resources remain after meeting the needs of impaired reaches. Seasonal nutrient levels should be more stable in streams with low algal biomass than in streams with high algal biomass because nutrient concentrations would not be depleted in such streams. Sampling during growing season baseflow and nongrowing season baseflow should provide a limited, yet useful, assessment of trends in nutrient levels from year-to-year.

Whenever development plans appear likely to alter factors that were limiting algae growth in a high-risk reach, instream monitoring should be initiated at a level similar to that described for impaired reaches in order to enhance the understanding of baseline conditions.

## OTHER CONSIDERATIONS FOR MONITORING NUTRIENTS

**Assimilative Capacity**

The assimilative capacity of a stream for nutrients depends on its physical and biological nature. Assimilative capacity is the load of nutrients entering a river system at which nutrient and algal biomass levels remain low enough such that excessive diurnal fluctuations of DO concentrations and pH levels will not occur, recreation and aesthetics will not be negatively impacted, irrigation ditches will not be clogged with algae, and biotic criteria will be consistently met. Such nutrient loads are difficult to predict because nutrients are stored in many forms and released under a variety of conditions, and because the levels of nutrients and algae causing impaired conditions may vary from system to system.

The simplest model applied has been to apply an exponential decline in instream nutrient concentrations below point sources and tributaries, with the rate of decline derived from monitored data. This approach does not quantify mechanisms (such as sedimentation, uptake, dilution by groundwater and denitrification), that can lead to nutrient losses. Such an approach was applied on the Clark Fork River (Dodds et al. 1997) to model the influence of lowered inputs from point sources on instream nutrient concentrations.

**Nutrient Load Attenuation**

A given nutrient load may produce a few kilometers (km) containing unacceptable algal biomass followed by a section of river containing acceptable levels because a river's load is attenuated by retention in algae and sediment. The total length of river containing unacceptable algae biomass levels may change from year-to-year due to changing nutrient loads or changes in other factors (e.g., flow, dilution) that may limit algae growth (see Section 6.2). This phenomenon was illustrated following nutrient control in the Bow River, Alberta, where TDP remained high (25 µg/L) for several km downstream from the treated wastewater source. High TDP in the portions of the stream closest to the point source release resulted in no change in algal biomass, while algae decreased farther downstream as TDP decreased (see Bow River case study, Appendix A). The length of river containing unacceptable algal biomass levels may be hypothetically estimated by the following equation described in Welch et al. (1989).

$$D_c = Q*r*(SRP_i - SRP_c)/[(P/chl\ a\ day)*B_n*T*W*10^3\ m/km])$$

where SRP is in µg/L (mg/m$^3$) producing the threshold nuisance biomass (150 mg chl/m$^2$) in the growth period (nominally ~ 1-4 mg/m$^3$ in channel experiments [Walton et al. 1995]); Q is the daily flow in m$^3$/day; r accounts for the recycle (~ 1.5, after Newbold et al. 1981); $SRP_i$ is the influent concentration (ambient river and groundwater in mg/m$^3$) to the segment; $SRP_c$ is the critical concentration, above which nuisance algal growth occurs; P/chl *a*-day is the average uptake by periphyton with nominal value of 0.2; $B_n$ is the nuisance threshold biomass of 150 mg chl *a*/m$^2$; T is the factor for trophic (consumer) retention (~ 1.2 representing a 20% conversion); and W is average stream width in meters.

This equation is simply the ratio of SRP mass available for uptake in excess of the critical level and the expected demand for SRP by periphyton in an enriched stream reach in which the threshold nuisance biomass is attained. The basis of the formulation is that periphytic biomass will not be reduced unless SRP is less than the critical concentration ($SRP_c$) during low-flow, maximum growth conditions, which has been shown to be quite low in channel experiments (Walton et al. 1995). Low values for the critical P concentration were supported by the Bow River case study (see Appendix A). The length of river with unacceptable algal biomass levels increases as the criterion decreases. The important recycle rate in the equation is a nominal value taken from uptake studies in a natural stream and could be highly variable. More definite predictions of limiting nutrient content and algal biomass changes downstream from a point source requires a dynamic model for algal biomass, such as:

$$dB/dt = (u * L * Bi) - (S + G)$$

where u = nutrient uptake rate in 1/day, L = dimensionless light factor, Bi = periphyton biomass from previous time step in mg chl/$m^2$, S = sloughing loss in mg chl/$m^2$-day and G = grazing loss in mg chl/$m^2$-day (after Elswick 1998).

Estimating nutrient loads to a stream is at least as complex as a detailed nutrient source study for a lake and requires the tracking of nutrient sources upstream and upgradient. In some cases, loading estimates of stream and river systems may be back calculated from the loading estimate for the receiving waterbody. That is, the partition of the nutrient load to a receiving waterbody (lake or estuary) identified as belonging to a particular stream may be used as an estimate of the total load for that stream or reach. Loading is often estimated using a calibrated model that predicts nutrient loads from hydrologic inputs or other parameters if nutrient data are inadequate to calculate load.

The USGS has developed a set of spatially referenced regression models for evaluating nutrient loading in a watershed. The modeling approach is referred to as SPARROW (SPAtially Referenced Regressions On Watershed attributes), a statistical modeling approach that retains spatial referencing for illustrating predictions, and for relating upstream nutrient sources to downstream nutrient loads (Preston and Brakebill 1999) (See Appendix C). Stream-load estimates at gaged monitoring sites are generated from stream-discharge and water quality data by utilizing a log-linear regression model called ESTIMATOR. The ESTIMATOR model estimates daily concentration values based on flow, season, and temporal trend terms (Preston and Brakebill 1999) (see Appendix C).

Better Assessment Science Integrating Point and Nonpoint Sources, or BASINS, is a tool developed by EPA to facilitate water quality analysis on a watershed level for specific waterbodies or stream segments. BASINS was designed to integrate national water quality data, modeling capabilities, and (GIS) so that regional, State, local and Tribal agencies can easily address the effects of both point and nonpoint source pollution and perform sophisticated environmental assessments (http://www.epa.gov/ost/BASINS/).

Models should be used with caution. Models can be used incorrectly and, therefore, can be less accurate than loads calculated from data. Regardless of the method used for calculating loads, subsequent changes in the watershed may alter the relationship between hydrologic and nutrient inputs requiring loads to be re-calculated to reflect those changes.

**Assessing Algal Biomass**

This section focuses on assessing attached algal biomass and how to obtain a meaningful, representative algal biomass sample. Sampling strategies will vary with objectives of programs. Algal sample collection techniques for streams and laboratory methods for the analysis of chlorophyll, AFDM, and other measures of biomass are discussed in Appendix B.

If the goal of sampling is to develop a relationship between nutrients and algal problems for the rivers of a region or to assess status and trends in nutrient-related problem areas of a region (i.e. probabilistic sampling), then one representative estimate of algal assemblage characteristics is all that can be used in an analysis. In most cases, the desired estimate is a mean algal biomass measure for a reach that can be obtained with composite sampling (explained below). However, spatial extent and temporal duration of blooms or nuisance growths may also be important parameters to characterize. More than one sample (or estimate) from a site would result in pseudoreplication (Hurlburt 1984) and would be unacceptable for data analyses which require independent observations of conditions (biotic and nutrient) at each site.

Variability in attached algal biomass estimates due to spatial variability can be reduced by collecting composite samples and by sampling in targeted habitats where algal biomass is relatively uniform (e.g., riffles). Composite sampling calls for combining subsamples from many substrata into a single sample, thus incorporating spatial variability into the one sample. The targeted habitat is usually defined as the habitat in which nuisance problems are greatest, typically the riffles during higher flow seasons and pools during low-flow seasons. Variability in algal biomass assessments should decrease with increasing numbers of riffles and area of stream assessed. Therefore, composite samples should be collected over the entire study reach.

Large scale assessments are particularly important for patchy filamentous algae, which may be best assessed using rapid periphyton surveys (in-stream, visual assessments of periphyton biomass; see Stevenson and Bahls 1999). Streams and rivers shallow enough to be wadeable during the period when nuisance problems are greatest may be sampled randomly across the entire width of the stream. If variability is still too great, the focus of assessments could be reduced to an indicator zone (an area having a high potential for nuisance algal growth) with a narrow range of water velocity, depth, and substratum size. For rivers with unwadeable depths, sampling attached algae is commonly confined to the wadeable portions because deeper portions may not have enough light for dense benthic algal growth. However, SCUBA has been used to sample benthic algae in large rivers (Lowe 1974).

In streams and rivers where nuisance algal problems arise from planktonic algal blooms during low-flow conditions, sources of variability in algal biomass (and related factors like low DO) tend to be due to temporal as opposed to spatial variability. Repeated plankton sampling during the low-flow period is strongly recommended to relate nutrients to peak plankton biomass and potential problems of low DO or noxious (toxic, taste, and odor causing) algal blooms. If the goal of estimating algal biomass at a problem site is to compare estimates of biomass to a criterion, then replicate sampling of at least four samples at that site is recommended to characterize the mean and variance in observations. If the goal of sampling is to develop a relationship between nutrients and algal problems for the rivers of a region, or to assess status and trends for nutrient-related problems, then replicate sampling is not as important as accounting for temporal variability and sampling more sites.

Relating nuisance algal problems to nutrient concentrations during stream low-flow conditions can be complicated by a number of factors. Algal problems may be due to a combination of planktonic algae blooming throughout pools and benthic algae along margins of pools. Planktonic algae may settle into sediments of pools and may generate oxygen demand from those sediments. Thus, thorough sampling designs should be employed that consider both spatial and temporal variability in algal biomass and associated nutrients to ensure development of accurate and precise relationships between nuisance algal problems and nutrients.

Attached algal biomass can vary greatly in time as well as space within the same stream. Temporal variability in algal biomass can be addressed by repeated sampling during periods when high algal biomass is most likely a problem. Alternatively, algal biomass can be sampled during periods of peak biomass following flood disturbances. This period of peak biomass may endure from one week to two months, depending upon nutrient concentrations in streams and the severity of flood events. Repeated assessment of algal biomass in streams can be facilitated by using rapid periphyton surveys to reduce sampling and laboratory assay costs (see Stevenson and Bahls 1999). Even though many measurements are being made through time, only one measurement per site can be used to develop biomass-nutrient relationships because of site-specific dependence and problems of repeated measures from the same site (Green 1979; Sokal and Rohlf 1998).

In some cases, the goal of assessment might be to estimate algal biomass at a problem site to compare estimates of biomass to a criterion. In this case, replicate sampling of at least four or many more samples at a site is recommended to characterize the mean and variance in the mean with replicate samples from a site. If the variability in algal biomass is similar to that in the Clark Fork River (see Appendix A case study), as many as 20 replicate samples may be required to detect small changes, which may be important to monitor restoration efforts.

### INVOLVEMENT OF CITIZEN MONITORING PROGRAMS

Citizen input can be used to assist in identifying and prioritizing potential problem streams. For example, citizens can be asked (through the use of surveys) to identify streams in which they have observed algal biomass levels that interfere with human uses or impair aesthetic enjoyment. They can also be asked to provide their evaluation of which streams have been affected most and which uses have been impaired to the greatest degree.

While state water quality agencies will likely take the lead in monitoring impaired reaches, citizen monitors may provide much of the monitoring on high-risk reaches. If properly trained and directed, citizen volunteers can be valuable in algal and nutrient monitoring. Citizens, with training, can visually assess algal levels, collect algal samples and freeze them for analysis by an approved laboratory, and may also help in the initial characterization of streams. Citizen monitors can frequently provide more complete flow records by visiting gauges more often than state personnel. Once advised that a stream is high-risk and that the limiting factors have been identified, citizens can help monitor development plans that might affect those factors. Involvement in monitoring programs may lead citizens to effective participation in local planning.

Many excellent resources are available for training citizen monitors. EPA has a volunteer monitoring coordinator (Alice Mayio—E-mail: alice.mayio@epamail.epa.gov) and a web site that lists many resources http://www.epa.gov/OWOW/monitoring/volunteer/spring94/ppresf04.html). Numerous non-governmental organizations, such as the Izaak Walton League, have developed citizen monitoring manuals. One of the best is the Streamkeeper's Guide by the Adopt-a-Stream Foundation (600-128th St. SE, Everett, WA 98208, phone 206-316-8592; web site: http://www.streamkeeper.org/).