COLORADO NUTRIENT COALITION
DRAFT NUTRIENT CRITERIA CONCEPT PROPOSAL
LAKES & RESERVOIRS AND RIVERS & STREAMS
SEPTEMBER 1, 2010

Introduction

The Colorado Nutrient Coalition (CNC) is a collection of wastewater dischargers, drinking water providers, stormwater control entities, water purveyors and various other councils and coalitions whose interests are all affected by the adoption of numeric water quality criteria for nutrients. Water is a critical resource to all group members and the cost-effective protection of this resource is paramount to the group. Therefore, the CNC is supportive of the need to control nutrient levels when and where this natural constituent adversely impacts beneficial uses. However, the Water Quality Control Division's (WQCD/Division) initially proposed nutrient standards are so low as compared to historical background conditions as to force the assumption that there is no assimilative capacity in significant portions of waters of the state and all sources of nutrients will have to be severely reduced if not eliminated. The Division's initially proposed nutrient standards for total phosphorus (TP) in milligrams per liter (mg/L), total nitrogen (TN) in mg/L, and Biological Metric in chlorophyll-*a* per liter (Chl-*a*/L) are:

WQCD Suggested Nutrient Criteria for the Protection of Aquatic Life

Receiving Water Type	Use Classification	TP (mg/L)	TN (mg/L)	Biological Metric
Lakes and Reservoirs [1]	Cold Water	0.024	0.490	8 µg Chl-*a*/L
	Warm Water	0.082	0.960	20 µg Chl-*a*/L
Rivers and Streams	Cold Water	0.090	0.824	*
	Warm Water	0.135	1.316	*

1. Lake criteria are the 80th percentile of the summer average, with a once-in-five-year exceedence frequency.

* The nutrient standards for rivers and streams do not include a biological metric that signifies use impairment, however the TP and TN criteria were developed based on a 5% reduction in multi metric index (MMI) score from a reference condition.

Adoption of such requirements would likely have major ramifications on the ability to use existing and future water resources in the state. All areas of the state would be impacted: municipal, commercial, agricultural and even the ability to conduct water transfers. The energy and water supply impacts of over-regulating nutrients would be substantial because attaining extremely stringent effluent limits requires the use of energy intensive treatment processes that create toxic brine and consume a significant percentage of the reclaimed water in the process.

Because nutrients exist in all waters of the state, the standards to be adopted and implemented must be critically evaluated and only adopted with the highest confidence that they truly are neither over nor under protective. The CNC's Technical Evaluation is a critical analysis of the Division's proposal. In lieu of the Division's proposal, the CNC has been evaluating alternative approaches that may provide a more cost-effective and

environmentally beneficial means for setting and implementing nutrient criteria and effluent limits.

The CNC's draft alternative proposal concepts are very general and have not received a thorough vetting and approval by all members of the Coalition. This draft alternative proposal is being provided, as requested by the Division for discussion at the September 8, 2010 Nutrient Criteria Work Group meeting. This proposal must be understood as a continuation of the collaborative discussion among water users, dischargers, the Division and the environmental community. There is no consensus support for this Concept Proposal.

This CNC Alternative Concept Proposal in essence recommends a significant focus on reservoirs that sustain the economic viability of the state; it proposes a range of chlorophyll-*a* standards for various uses of reservoirs; proposes related ranges of total phosphorus to go with those chlorophyll-*a* standards; and provides for default total phosphorus standards from within the ranges. For streams and rivers, it proposes three options for further discussion that in essence rely upon a narrative standard and a protocol to identify when a stream nutrient impairment exists and how to select site specific nutrient limits. Implementation concepts are also included.

The goal of this short paper is to expand the options that can be discussed as the regulated community seeks a proposal by the Division to be submitted to the Commission that will be acceptable to most if not all at the June 2011 hearing. The proposal contemplates that several additional technical implementation procedures will need to be developed (taking into consideration existing technical manuals from EPA and other states) to ensure that necessary and appropriate criteria are adopted to ensure use protection. The CNC is currently evaluating whether to hire three nationally recognized experts to assist in generating these documents.

Alternative Proposal Regarding Lakes and Reservoirs

The Division's initial proposal assumed that only two classes of lake/reservoir types existed based on fishery type (cold and warm) and that all such waters regardless of size or location responded similarly to nutrient inputs. A single set of chlorophyll-*a* and nutrient objectives (TN and TP) were also applicable to such waters regardless of primary use, size, morphology, watershed characteristics or location. In the view of the CNC this approach would lead to both significant under and over regulation of nutrients, would establish requirements that are physically unattainable, and could broadly misdirect state and local resources.

Nutrients are not like any other constituents regulated under the Clean Water Act. The primary concern with nutrients is their ability to stimulate excessive plant growth. When this occurs, other negative ecological effects may occur. It is commonly understood that whether or not nutrients cause excess plant growth to occur is dependent strictly upon the physical attributes of the water body (e.g., canopy and velocity for streams and turbidity

and detention time for lakes). The Division's initially proposed approach is purely empirical (i.e., based on the measured nutrient responses for a small set of reservoirs). The reasonableness of the proposed nutrient criteria are a function of the characteristics of the database used to derive the values and the strength of the relationships that were evaluated. For example, in general, most limnologists and water quality modelers would agree that system responses for large, deep lakes should not be applied to smaller shallow lakes. Moreover, most lentic (static) systems in Colorado are man-made (i.e., reservoirs – there are only eight large natural lakes in the state). Reservoir operation and characteristics do not follow those of natural systems and are highly site-specific (e.g., the system may experience its primary loading outside of the main algal growing season or may be drawn down to artificially low levels on a periodic basis and, in addition, the watershed characteristics often define the reasonably attainable algal level). For this reason, EPA guidance (*Nutrient Criteria Technical Guidance Manual – Lakes and Reservoirs* (USEPA April 2000 at 3-5) indicates that such man-made systems should be addressed on a case-by-case basis. In response to comments on its 304(a) criteria for lakes and reservoirs, EPA agreed that reservoirs should not be grouped with lakes and criteria for reservoirs and lakes should be developed separately. 68 *Fed. Reg.* 557, 559 (Jan. 6, 2003).

Based on the advice provided in EPA's April 29, 2010 Science Advisory Board assessment of empirical nutrient criteria derivation methods and a review of approaches implemented in other states (e.g., Minnesota), the key to establishing necessary and appropriate impairment indicators and related nutrient targets to preclude excessive plant growth is a more refined classification system. A more refined classification system helps to ensure that the attributes of the empirical dataset reflect the other waters to which they are being applied. For example, Minnesota's approved lake criteria are different for five state ecoregions, three fishery types and two lake sizes (shallow and deep). By refining the lake classifications, the state was able to account for differing watershed characteristics, varying public expectations regarding water quality, physical factors influencing lake responses to nutrients and the likely controlling uses. Reservoirs and run of the river "lakes" (e.g., Lake Pepin) were to be assessed individually since the watershed characteristics and responses of such waters varied so dramatically from the dataset used to derive the lakes criteria.

The main "problem" with the approach in Colorado is that the vast majority (>90%) of the lentic systems needing nutrient standards are reservoirs that may be highly dynamic systems due to their method of operation. Moreover, the ability to attain a particular chlorophyll-*a* objective is controlled by the size of the reservoir watershed, the diversion water characteristics, the fishery type present and the native soil characteristics. For example, in Florida, naturally elevated phosphate levels in certain watersheds create naturally eutrophic conditions in lakes. In other situations, increased water turbidity prevents excessive plant growth in lakes and reservoirs regardless of the degree of nutrients present (e.g., see EPA Florida WQS proposal for colored lakes). In Colorado, the "natural" watershed may not be the controlling watershed for reservoir response – the actual response could be better or worse based on the waters used to fill the reservoir from other watersheds. This situation means that reservoir nutrient responses may be

expected to vary more than would occur in natural systems. However, this diversity does not preclude the establishment of appropriate regulatory targets, it merely requires that a broader range of possible water quality objectives be considered appropriate depending upon the purpose and location of such waters (e.g., drinking water supply, recreational use fishery or agricultural use/return flow capture) and that only waters with similar operational characteristics can be used to predict water quality responses for regulated waters. Necessarily, this means that some degree of site-specific data will be needed to refine the nutrient level and chlorophyll-*a* targets considered appropriate and attainable for these "unnatural" waters that are of great value to Colorado.

The following is an example of the range of growing season average chlorophyll-*a* responses in natural lakes to average nutrient concentrations for "deep" lakes (generally more than 15 feet). That range is typically a factor of four (4) (see, *Empirical Approaches for Nutrient Criteria Derivation*, prepared by USEPA Office of Science and Technology, August 17, 2010 for the Science Advisory Board).

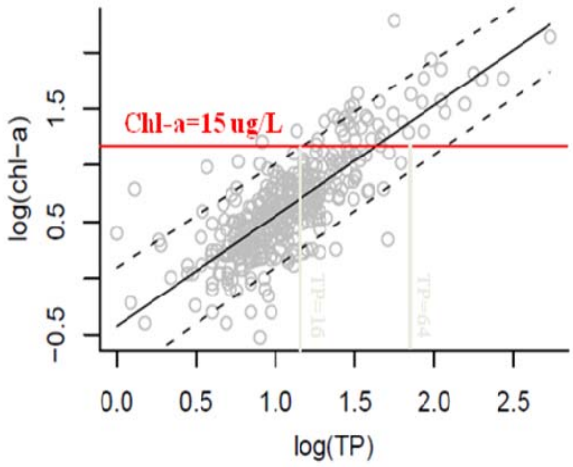
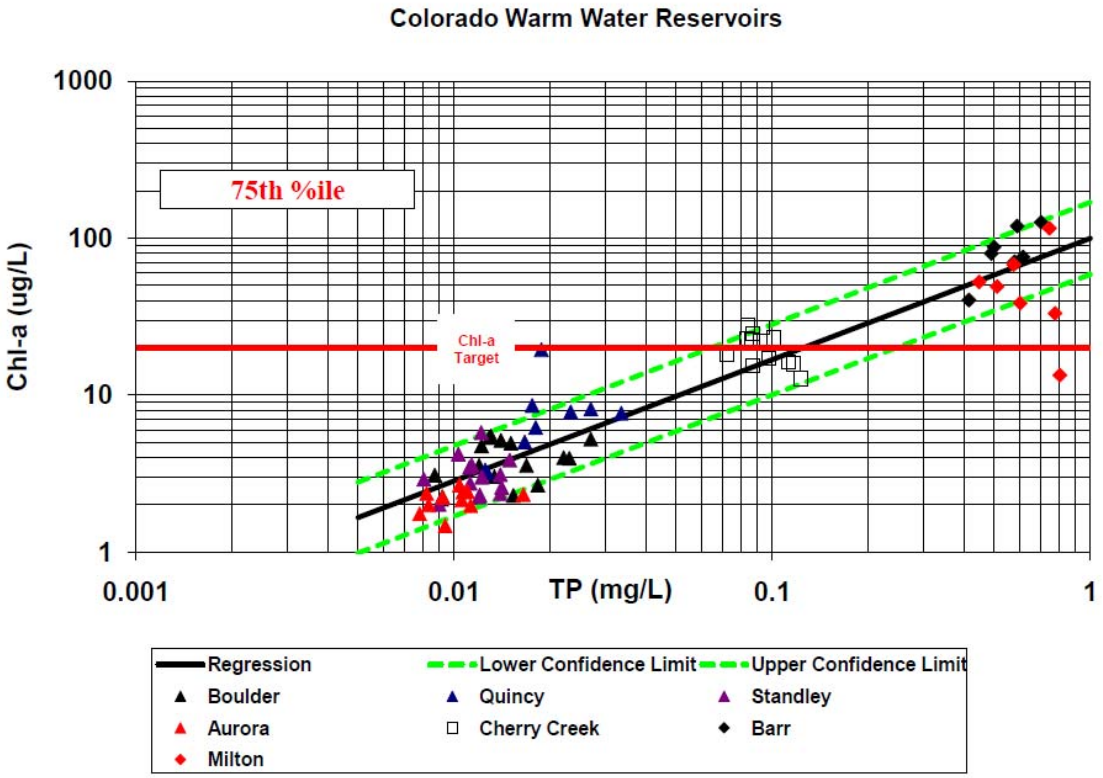


Figure 15. Log(TP) vs. log(chl *a*) for EMAP Northeast Lakes Survey. Dashed lines are the 5th and 95th percentile estimated by quantile regression. Solid line is the 50th percentile. Red line indicates where chlorophyll *a* = 15 µg/L. Units are µg/L.

Recognizing the need to account for varying lake responses in broad data sets, EPA's proposed lake criteria for the State of Florida typically varied by a factor of three (3) for a given chlorophyll-*a* response criteria (75 *Fed. Reg.* 4224).

Limited information from Colorado reservoirs shows in the next figure a similar pattern of chlorophyll-*a* response, though the variability of chlorophyll-*a* appears somewhat greater.



Variations in Colorado's reservoir responses to the growing season's average nutrient concentration may be expected to be equal to or greater than the factor of four (4) amount. Lakes in Colorado are expected to have relatively small watershed size given the topography of the state. This means, in general, that the water quality of natural systems should be quite good and exhibit a reduced range of responses, unless the fishery type present is significantly impacting the mobilization of nutrients.

Given the lack of robust data sets needed to classify similar reservoirs, the following approach is suggested to establish an appropriate range of water quality objectives for these diverse waters and to allow consideration of site specific information relevant to the particular water body:

Reservoir chlorophyll-*a* objectives should be determined on the following main attributes:

1. **Elevation** – controls water temperature, extent of growing season, potential watershed size, likely use and likely fishery type;
2. **Primary use** when originally constructed, with consideration of additional permanent uses attained subsequently and expected future uses;
3. **Fishery type** (warm, cold or rough-carp dominated)
4. **Key Morphology**: depth, detention time, degree of manipulation, turbidity and size

5. **Watershed size and primary soil characteristics for waters used to fill the reservoir –** controls the "natural" nutrient loading that the reservoir is expected to receive

For lakes that are natural systems, the Clean Water Act would require, in general, that such waters be protected for their applicable fishery type (warm or cold). Thus, only two tiers of chlorophyll-*a* objectives are needed for these waters. For shallow lakes, in general, it is expected that higher chlorophyll-*a* and nutrient criteria may apply because these systems are generally governed by rooted plant growth. It is not known how many lakes would fit the description of a "shallow" lake (average depth less than 8-10 feet) so the proposed approach provides an allowance for such waters.

The following chlorophyll-*a* and phosphorus criteria are suggested as a basis within which site-specific watershed numeric criteria may be set:

I. The following range of growing season average chlorophyll-*a* objectives, based on fishery resource protection, shall be used as the basis for classifying a lentic system impaired due to nutrients, if the growing season average values are exceeded more frequently than once in three years, on average:

Natural Lakes Exceeding 5 acres in size (warm or cold)*:

Elev. (m):	>2300	2000- 2300	<2000
Chl-*a* (ug/L)	8	10-20	20-30

* If a carp-dominated fishery is present and is not to be eliminated through lake management measures, the applicable chlorophyll-*a* objective must be determined using site-specific information and best professional judgment. Where a range is presented, waters exhibiting algal levels within this condition are not considered impaired until it is determined that a lower value within the range should be attained in order to protect the designated uses.

Reservoirs Exceeding 10 acres in size/excluding all farm ponds

Elev (m):	>2300	2000- 2300	2000-1650	<1650
Chl-*a* (ug/L)	5-12	15-25	20-35	25-50

* If a carp-dominated fishery is present and is not to be eliminated or controlled, the applicable chlorophyll-*a* objective must be determined using site-specific information and best professional judgment.

II. The following range of TP causal concentrations shall be used to ensure that any waters designated as impaired as a result of the exceedence of an applicable chlorophyll-*a* criteria achieve compliance with such criteria.

Where chlorophyll-*a* is exceeded, the TP range is deemed to be criteria from which a specific criterion is selected. The acceptable growing season average nutrient concentration may be selected within this range based on available site specific information. If there are no available data to render a determination of the necessary TP concentration to ensure compliance with the chlorophyll-*a* objective, the default value shall be determined by averaging the lower end of the range with the central tendency of the range pending the collection of additional site-specific data. (Discussion and illustration of how this selection occurs will be provided at the September 8, 2010 meeting).

Natural Lakes Exceeding 5 acres in size (warm or cold)*:

Elev. (m):	>2300	2000- 2300	<2000
TP (ug/L)	20-65	40 – 120	60 – 180

* If a carp-dominated fishery is present, the applicable total phosphorus objective must be determined using site-specific information and best professional judgment. If modeling determines that a TP concentration either higher or lower than this range is necessary (lower) or sufficient (higher) to achieve the applicable chlorophyll-*a* objective, such TP value is to be established as a site-specific standard.

Reservoirs Exceeding 10 acres in size/excluding all farm ponds

Elev. (m):	>2300	2000- 2300	2000-1650	<1650
TP (ug/L)	20-80	50-160	80-240	100-350

* If a carp-dominated fishery is present and is not to be eliminated or controlled, the applicable chlorophyll-*a* objective must be determined using site-specific information and best professional judgment.

Alternative Proposal Regarding Stream Nutrient Criteria

The establishment of generally applicable stream nutrient objectives and response criteria (e.g., periphyton growth level) is a very complex matter. These systems are much more variable than lakes and reservoirs, and generalized impairment indicators previously recommended by USEPA (i.e., invertebrate indices) are subject to influence by a host of natural and man-influenced conditions. Consequently, no researcher has been able to generate a consistent nutrient-based response for such indicators. Most recently, EPA was unable to show a "stressor response" relationship when evaluating the extensive SCI (stream condition index) data developed by the State of Florida (75 *Fed. Reg.* at 4193). The lack of a demonstrable "cause-and effect" relationship was also confirmed by the

State of Florida. EPA has acknowledged that numerous site-specific factors influence whether or not nutrients will cause adverse impacts in streams (75 *Fed. Reg*. at 4192-95). Professor William Lewis reached a similar conclusion for a range of nutrient concentrations occurring in relatively non-impacted waters in Colorado ranging in elevation from 2100 m to > 2700 m. (*Ecological Responses to Nutrients in Streams and Rivers of the Colorado Mountains and Foothills,* Lewis and McCutchan, *Freshwater Biology 2010*).

Moreover, both of these parties have been unable to show any consistent relationship to periphyton growth in streams. Data evaluated by Lewis in Figures 8 and 5 below for Colorado streams were used to project the range of anticipated in stream conditions. This evaluation showed a 100 fold variation in plant growth for similar nutrient concentrations.

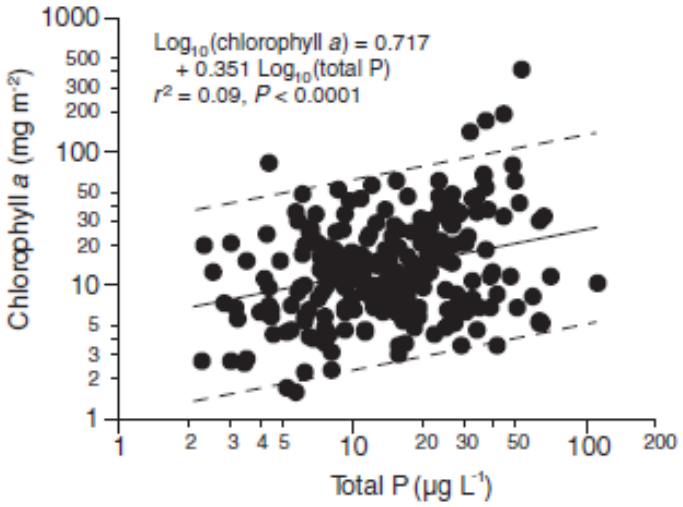


Fig. 8 Simulation results consistent with published meta-analyses, calibrated with variance from our study.

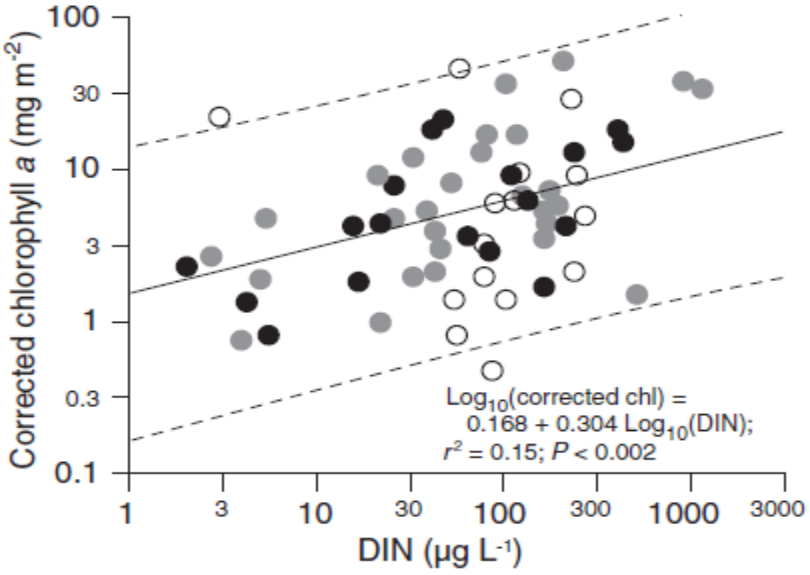
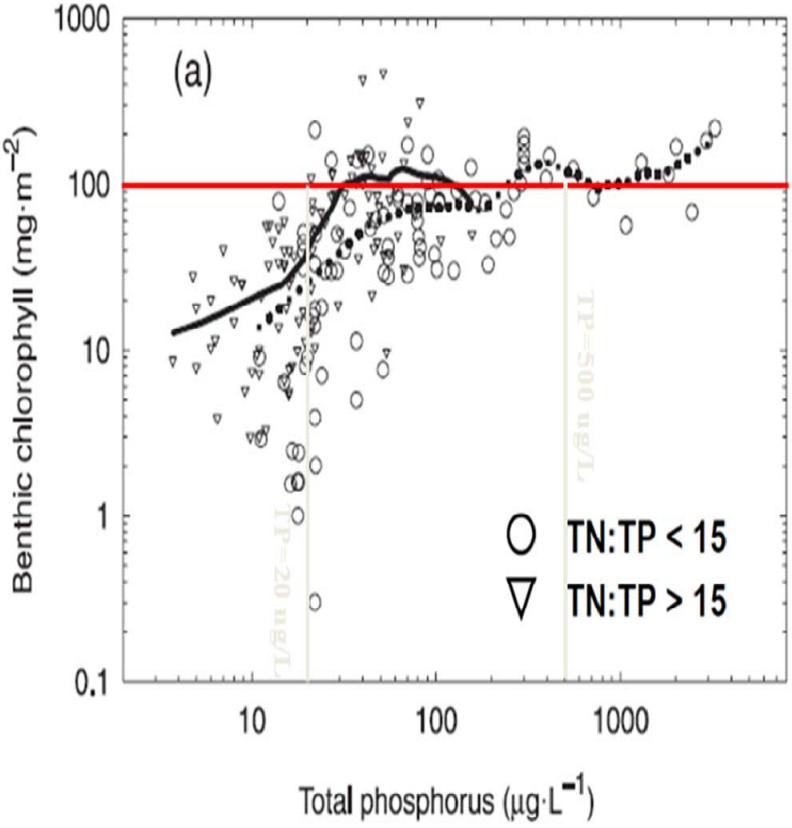


Fig. 5 Frequency distribution of chlorophyll *a* corrected to a common date and elevation (above) and relationship of corrected chlorophyll *a* to dissolved inorganic N (below). Corrected chlorophyll is not related to any other nutrient fractions.

This is similar to the results of Dodds published in 2006, presented below.



Lewis concluded from his studies that elevation and other physical conditions controlled the extent of plant growth rather than nutrient concentrations alone. Consequently, there is no scientifically defensible basis for setting any generally applicable nutrient objective for streams. This, of course, does not mean that on an individual basis nutrients never cause adverse effects. Rather, it underscores the conclusion that site specific data must be available in order to make a rational determination regarding whether or not nutrients are causing adverse impacts (i.e., excessive plant growth) in streams.

This indicates that three approaches are scientifically defensible at this time:

1. Set a group of nutrient impairment indicators by regulation that are to be used to assess whether and where stream impairments are occurring, and then derive the protective nutrient level for those waters on a case-by-case basis. Use protocols similar to New Mexico's nutrient assessment protocols to identify impairment likely by nutrients. Such indicators could include some measure of excessive plant growth, such as excessive DO or pH swings or violations, chlorophyll-*a* violations, excessive algae and periphyton density or coverage, and invertebrate loss due to excessive plant growth; or

2. Continue to use narrative criteria approaches and develop guidance documents to describe how stream nutrient impairment determinations and control strategies will be conducted. This guidance would not be adopted as an amendment to the

applicable TVS but would be used to assist in impairment assessments and to determine when nutrient control will assure a reduction in plant growth occurring in the receiving waters.

3. Combine as a single standard the use of biological impairment indicators (DO, pH, chlorophyll-*a*, periphyton coverage, etc.) as condition precedents for triggering application of a numeric default standard, which can be revised to be a site specific standard using guidance based protocols.

Total Nitrogen Regulation

There is no basis at this time to establish a generally applicable TN objective for lakes, reservoirs or streams. In most instances, water quality impact assessments have shown that limiting total phosphorus is either sufficient to reduce excessive plant growth or the preferred method to achieve that objective. However, there are cases where nitrogen may be the key factor for controlling excessive plant growth. To ensure adequate authority to regulate this parameter, the following provisions should be adopted in the TVS and be applicable to all waters of the state:

Where a water quality assessment or other site-specific technical analysis confirms that regulation of total nitrogen or any of its individual components is necessary to ensure excessive plant growth will either not occur or be abated, such a requirement shall be established in the basin hearings as a site-specific nutrient criteria.

Where the drinking water standard of 10 mg/L nitrate applies (end of mixing zone or at the point of diversion), the attainment of the nitrate criteria shall be deemed sufficient attainment of the total nitrogen necessary to protect uses from total nitrogen, unless otherwise shown to be insufficient.

Implementation

<u>Reservoirs/Lakes</u>:

Table Value Standards for Reservoirs would list the above outline of reservoirs by elevation, chlorophyll-*a* ranges and related TP ranges. For subsequent basin hearings, a specific value within these Table Value Standards would be adopted, unless sufficient evidence is provided pursuant to Regulation 31.7 to demonstrate that other site-specific considerations justify other chlorophyll-*a* or total phosphorus standards. Other site-specific evidence might justify additional classifications or subcategories of uses, such as eco-region, shallow depth, detention time, and primary reservoir use (e.g., agricultural storage as primary use and fishery as incidental use.)

Alternatively, sufficient evidence pursuant to Regulation 31.7(3) may enable adoption at the basin hearing of a Temporary Modification resulting in the collection of necessary additional data to resolve uncertainty of the standards or determine that the current

condition is due to natural or irreversible human-induced conditions. Evidence to support a conclusion that the correct standard is uncertain should include the presence of confounding factors such as elevated turbidity, significant depth changes, short detention times, sedimentation, etc. Evidence of uncorrectable conditions include size of the watershed relative to the size and location of the reservoir, relative abundance of nonpoint sources, particularly rural forestry and grasslands, constituting greater than 75% of the loading. During the duration of the Temporary Modification, 303(d) listing of the reservoir shall occur where the specific "pollutant" (as distinct from "pollution") have been identified.

Streams:

Table Value Standards for streams could be narrative standards only or variations such as confirmatory evidence of biological impacts that cause a default numeric standard to spring into use, e.g., TVS is 0.5 mg/L TP (avoids the need for filtration pending confirmation that nutrient control will produce expected benefits)-(*footnote: standard only applies if watershed is impaired by nutrient.)

Implementation is triggered by permitting, primarily. As a condition to determine reasonable potential to cause a violation of a narrative standard or springing standard, three to five years of data would be collected to determine if biological indicators are triggered. That is, for example, that DO is less than 5 mg/L for more than 15% of the four (4) grab samples in a 24 hour day; DO percent saturation is greater than 120%; pH is greater than 9 in more than 15 % of four (4) samples in 24 hour day; algae on stable substrate above a certain threshold level covers greater than 50% of the stream bottom; presence of anoxic layer due to excessive plant growth. Total nitrogen and total phosphorus data would also be collected for the stream segment. MMI scores for the segment, if related to the other biological indicators that are exceeding their trigger values, and are below MMI thresholds for the biotype, would be relevant in implementing the narrative standard to determine the basis for 303(d) listing, per Listing Methodology 2010 III D. 5 a at page 28.

Interim Permitting Measures Pending TMDL Completion

The consequence of 303(d) listing would be the implementation of a TMDL and derivation of TMDL based effluent limits, stormwater BMPs, nonpoint source BMPs, and other control regulation requirements. Pending the TMDL, interim effluent limits should be based upon state regulation, such as required by Temporary Modification, Discharger Specific Variance, or Control Regulation applicable to nonpoint sources as well as point sources. In the absence of a specific standard and pending the derivation of a TMDL target, incremental reduction to 1 mg/L TP or equivalent offsets by nonpoint sources shall be made by point sources. (1 mg/L TP is selected as a technology threshold most readily implemented to minimize nutrient related impacts from mechanical wastewater facilities). The TMDL will refine the more specific reduction necessary. Where the point source is less than 50% of the loading, no reduction is required. If any reductions are

implemented, that loading reduction is returned as a potential credit for point source expansion.

Consistent with the 2010 303(d) Listing Methodology at III D, listing based upon unknown pollutants shall not prohibit new or expanded discharges into the segment until the pollutant is identified. Permitting decisions may be affected once the pollutant is identified as causing impairment. Colorado's permitting policy needs to enable discharge at other than the water quality standard during the conduct of the TMDL. It is recommended that where point source loads are at least 25% of the overall TP loading to an impaired stream, an interim water quality based objective of 1 mg/L TP (annual average) would be applied to mechanical wastewater treatment facilities to avoid further impairment as local growth occurs and to reasonably minimize the impact of point source loadings to the system. Maintaining equity among point and nonpoint sources should be a guiding principle in the development and implementation of TMDLs. Where point sources are less than 15% of the overall TP loading for the total watershed, they should be deemed "*de minimus*" dischargers and no requirement for reduction in loading should occur until significant and measurable nonpoint source reductions have occurred, unless the TMDL evaluation confirms that significant water quality benefits will be obtained by reducing point source loadings. For situations where point sources account for 15-25% of the watershed load, the Division should use its best professional judgment on the need for an interim reduction in point source loadings pending TMDL completion.

Reasonable Potential Considerations

Lack of biological confirmation of excessive plant growth, as evidenced by DO, pH, chlorophyll-*a*, taste and odor, turbidity, secchi depth or other indicators of excessive plant growth, in the receiving waters is evidence of no reasonable potential to cause excursion of chlorophyll-*a* criteria or other nutrient standards necessary to protect the use. In this case, nutrient limits should not be applied.

Lagoons: No changes in lagoon technology shall be required until (i) the receiving water has been determined to be impaired and a causal relationship has been established between nutrients and impairment; (ii) a TMDL is completed; (iii) nonpoint source reduction programs/methods have been implemented; and (iv) the lagoon discharge has been determined to be greater than 25% of the TP load for the total watershed (i.e., the lagoon is not a *de minimus* contributor). As a matter of phasing and pending State of Colorado funding of small communities, all POTWs serving populations of less than 5,000 are deferred from increased treatment requirements beyond current systems.