From: "Herrington, Chris"
Date Received: 7/1/2011 10:41 AM
Subject: Comments on Nutrient Standards for Streams

The City of Austin (COA) sincerely appreciates the opportunity to provide comments on the nutrient criteria for freshwater streams following the advisory work group meeting on June 20, 2011. Some specific comments arising from the discussions at the work group are summarized here for your convenience.

Criteria Development Methods

COA has successfully modified USGS National Water Quality Assessment methodology for rapid, quantitative benthic chlorophyll-a sampling. Stream substrates may be sub-sampled for benthic chlorophyll-a with approximately the same amount of time and labor required for routine water quality sample collection and analyzed by existing water-column chlorophyll-a methods. Benthic chlorophyll-a concentrations may be associated with trophic status based on available literature (e.g., Dodds et al 1998), ecoregion specific reference conditions, or with stressor-response relationships using dynamic models like the EPA Water Quality Analysis Simulation Program (WASP) that adequately describe nutrient dynamics.

Benthic chlorophyll-a concentrations may be normalized based on sampling area to yield spatially-based productivity estimates (mass chlorophyll-a per unit area) to create a consistent comparison method. COA has successfully employed other methods like periphytometers (Matlock et al 1998) which can be used to calculate Lotic Ecosystem Trophic Status Index values (Matlock et al 1999) that allow for easy quantification of nutrient enrichment by comparing nutrient saturated growth conditions to current ambient conditions as a simple ratio.

COA has been evaluating usability of various visual methods for estimating benthic algae and macrophyte surface coverage and thickness. Except in extremely impaired situations, COA has had difficulty in establishing reliable nutrient stressor-stream response relationships using visual estimation methods, and recommends quantitative sampling methods like the NAWQA benthic chlorophyll-a rock scraping methods.

Dodds, W.K. and J.R. Jones, E.B. Welch. 1998. Suggested Classification of Stream Trophic State: Distribution of Temperate Stream Types by Chlorophyll, total Nitrogen and Phosphorus. Water Resources 32(5): 1455-1462.

Matlock, M.D., and M.E. Matlock, D.E. Storm, M.D. Smolen, W.J. Henley. 1998. Limiting nutrient determination in lotic ecosystems using a quantitative nutrient enrichment periphytometer. Journal of the American Water Resources Association 34(5):1141-1147.

Matlock, M., and D. Storm, M. Smolen, M. Matlock, A. McFarland, L. Hauck. 1999. Development and application of a lotic ecosystem trophic status index. Transactions of the American Society of Agricultural

Engineers 42(3):651-656.

Grouping of Segments

Grouping similar segments based on ecoregions is logical, and least-disturbed reference condition datasets can thus be extended across the applicable region to extend data to cover missing data gaps. COA believes this approach to be consistent with the fundamental goals of the Clean Water Act. Ecoregion boundaries in the Austin area have proven to be reliable indicators of spatially consistent geomorphology, hydrology and soil characteristics and least-disturbed conditions within ecoregions can provide scientifically-based ambient conditions for establishing restoration targets in impaired segments. The grouped, reference condition approach is superior to the use of site-specific

long-term data set characterization including recent data, as employed in the development of nutrient numeric criteria for reservoirs. The inclusion of recent site-specific data does not exclude recent or on-going degradation in the establishment of nutrient criteria and is inconsistent with the goals for establishing historic baseline conditions in the Clean Water Act.

Weight-of-Evidence Approach

Weight of evidence approaches for quantitative nutrient criteria development and especially for future assessment of impairments of nutrient criteria that combine response variables and stressor variables can be highly problematic. For example, combining response variables like chlorophyll-a with dissolved oxygen (DO) or instream nutrient concentrations will lead to criteria that will fail to adequately protect current uses and will lead to assessments that only identify the most severely impaired segments.

COA has observed changes in DO diel patterns with nutrient enrichment. The rate of DO concentration rise and fall across a day sharply increases and decreases in streams experiencing excessive algae growth, although the pattern is highly influenced by short-term site specific conditions (e.g., flow, cloud cover). For most segments in Austin experiencing changes in DO flux from increased primary productivity, the decrease in DO does not fall to levels considered impaired by current aquatic life use standards. DO ambient average concentrations may significantly decrease from 8 to 5 mg/L in nutrient impaired situations. Combining DO impairments and chlorophyll-a will not protect existing high quality waters.

Similarly, tying chlorophyll-a response to instream nutrient concentrations will only identify impairments where all nutrient requirements for algal growth are completely satisfied and excess nutrients are available. COA has encountered scenarios with nutrient enrichment that lead to significant benthic algae impairments although ambient limiting nutrient concentrations remain near detection limits.

Loads and Concentrations

COA appreciates the need for evaluation of both load and concentration perspectives in establishing numeric nutrient criteria. Concentration based criteria are critical, particularly for

the permitting of point source discharges. Load-based criteria cannot be used alone as they neglect the temporal and hydrologic factors that most influence algae growth in the majority of time under non-storm influenced conditions.

Loads are important for regulating non-point source impacts. However, load-based approaches to criteria develop must include well-validated nutrient-response models that accurately account for nutrient dynamics. Steady-state, first-order decay models like QUAL-TX are not appropriate for developing nutrient criteria or implementing nutrient criteria via point source discharge permits.

Implementation and Permitting

All numeric nutrient criteria must be linked to site-specific permit limits to be effective in protecting water quality models. Current procedures for evaluating nutrient limits for discharges to reservoirs, while including many useful prioritization mechanisms, are not effective as they end in the assignment of default (e.g., 1 mg/L total phosphorus discharge limits) permit limits that do not adequately assess if site-specific conditions and default permit limits will protect current uses. An adequate nutrient-response model is needed other than QUAL-TX to enable prediction of receiving water responses to nutrient enrichment so more protective permit limits may be established. Similarly, the numeric nutrient criteria must consider current anti-degradation policies and will hopefully lead to quantitative definitions of degradation.

Tiered Approach

There was discussion at the workgroup of using tiered approaches for developing or applying numeric nutrient criteria, with one potential category being effluent-dominated streams. Applying less protective standards to water bodies that have been degraded by point source discharges permitted after 1972 is inconsistent with the fundamental approach of the Clean Water Act. Completely ephemeral streams without perennial pools that are now effluent dominated may deserve separate consideration, although the impacts on the downstream receiving water cannot be ignored and must be assessed with an adequately protective method other than simple steady-state, first-order decay with distance or dilution. Effluent-dominated streams must be carefully defined, considering the variation in dilution with season and pre-existing condition of the water body prior to commencement of effluent discharge. There is additional merit to a tiered approach to protect the most sensitive first-order headwater streams which have significantly reduced assimilative and dilution capacity relative to large rivers.

Dealing with Censored Observations

COA fully supports proposed improvements to the current substitution methods used by TCEQ for calculating summary statistics of datasets with censored observations. COA successfully uses a variety of distribution and robust methods which have been demonstrated to be superior to substitution or exclusion methods, and encourages TCEQ to review the references listed below.

Allison, P.D. 1995. Survival Analysis Using the SAS System: A Practical Guide. SAS Institute, North Carolina.

Helsel, D.R. 1990. Less than obvious: statistical treatment of data below the detection limit. Environmental Science and Technology 24(12):1766-1774.

Helsel, D.R. 2005. Nondetects and Data Analysis: Statistics for Censored Environmental Data. John Wiley & Sons, New Jersey.

Helsel, D.R. and T.A. Cohn. 1988. Estimation of descriptive statistics tor multiply censored water quality data. Water Resources Research 24(12):1997-2004.

Kaplan, E.L. and P. Meier. 1958. Nonparametric Estimation from Incomplete Observations. Journal of the American Statistical Association 53: 457-481.

TEXAS A&M
HEALTH SCIENCE CENTER
SCHOOL OF RURAL PUBLIC HEALTH

June 29, 2011

Ms. Laurie Fisher
TCEQ, MC-234
PO Box 13087
Austin, Texas 78711-3087

Re: Comments to the Nutrient Criteria Development Advisory Work Group (NCDAWG)

First, I found the last meeting of the Nutrient Criteria Development Advisory Work Group (NCDAWG) engaging and very useful. However, my comments will focus on public health.

Biochemical oxygen demand (BOD) is a major parameter used to measure the relative oxygen requirements of wastewaters, effluents, and polluted waters. The BOD test has wide application in measuring waste loadings and the BOD-removal efficiency of treatment plants. However, some problems are associated with the use of BOD, such as high variability of results, toxic substances present may affect BOD values, time-consuming labor-intensive, and most importantly, the five-day period to produce a result may not be representative of the treatment process (Bourgeois, 2001).

Thus, it does not measure a real-time status of the discharge. However, a significant correlation has been found between Total Organic Carbon (TOC) and BOD (Fadini, 2004). TOC test costs are lower, shorter time, and generates less hazardous wastes. I am recommending supercritical water oxidation (SCWO) technology that can measure Total Inorganic Carbon (TIC), Non-Purgeable Organic Carbon (NPOC), and Total Organic Carbon (TOC).

Current research objectives are to acquire laboratory data results from various known concentration levels of sucrose and glucose-glutamic acid (S-GGA) standards being analyzed in tandem for BOD & SCWO-TOC. From the data, statistical analysis will be employed to determine linear relationships between SCWO-TOC & BOD. Additional laboratory methods will be appraised and refined to insure that high quality accurate results can be reproduced and mathematically assessed for future correlation of research for raw and effluent sewages.

Known concentrations of sucrose samples are utilized to simulate different levels of wastewater. To obtain the initial microbial population capable of oxidizing the organic material in the samples, we inoculate them with a fixed amount of PolySeed®. The initial dissolved oxygen (DO) is then measured, and the samples are sealed and incubated at 20.4°C for 5 days. After the incubation, DO is measured again, and the BOD is calculated from the difference between the initial and final DO according to standard method.

In the meantime, the same levels S-GGA standard will be analyzed by Standard Method 5310-D for SWCO-TOC using supercritical water oxidation technology. TOC levels will be read on each individual sample the first day and then after the 5-day incubation period.

The BOD and TOC results will be recorded and all results will then be statistically evaluated and reviewed to determine the mathematical inter-relationship and robustness of SCWO-TOC & BOD. Other mathematics and novel laboratory approaches may be applied as needed due to the fact that there is no known correlation study published for recognized standard concentration levels of comparative data between SCWO-TOC & BOD.

Sincerely:

Vincent R. Nathan

Vincent R. Nathan, PhD, MPH
Associate Professor
Environmental & Occupational Health

References:

Bourgeois Wilfrid, Burgess Joanna E, Stuetz Richard M. (2001). *Review On-line monitoring of wastewater quality: a review.* Journal of Chemical Technology and Biotechnology. 76: 337-348.

Fadini Pedro Sergio, Jardim Wilson F., Guimaraes Jose Roberto. (2004). *Evaluation of Organic Load Measurement Techniques in a sewage and Waste Stabilisation Pond*. J. Braz. Chem. Soc. 15(1): 131-135.

TPWD Preliminary Comments on Nutrient Criteria
Following Stakeholder Meeting June 20, 2011
July 1, 2011

TPWD appreciates the opportunity to provide preliminary comments on the process of developing numeric nutrient criteria for waterbodies in Texas. Irrespective of waterbody type, the following are goals that we expect the process to meet:

- Fulfills the antidegradation language of the standards and conserves the current status of unimpaired systems
- Establishes meaningful targets for restoring water quality in systems with elevated nutrient concentrations
- Reflects localized conditions, which may include categorization by hydrology, stream size, land use, geography, water quality, salinity, canopy, etc.
- Can detect declines in conditions before a waterbody is impaired
- Looks at all sources of nutrients (point and non-point sources)
- Considers all nutrient sinks, as appropriate to the waterbody type, including phytoplankton, periphyton, benthic algae, drift macroalgae and macrophytes
- Considers both causal and response variables

In addition, we have some concerns that are applicable to the process, irrespective of waterbody type:

- It is important at this early stage to identify stream, river and estuarine areas of concern, either because they are currently impaired (even if based on best professional judgment and at a fairly qualitative level) or because they are trending downward and likely to be impaired in the future. This process could help to confirm whether our concerns and approach are valid.
- It is difficult to correlate biological responses with instantaneous concentrations of water column nutrients and chlorophyll-*a*. We encourage more integrative measures of systems, such as consideration of nutrient loadings and integrative measures of nutrient response. One potentially useful integrative measure involves estimates of system metabolism (productivity and respiration) from diel dissolved oxygen data (Sorenson et al. 1999, Peterson et al. 2001, Porter 2011).
- The utility of a "weight of evidence" approach is not clear. While this method sounds promising, in data-limited situations such as this, the decision-making appears to be based more on the level of risk that can be tolerated, echoing the Type I vs. Type II error discussions that the group has had previously. We are concerned that any procedure developed not be overly cautious and thus unable to detect problems at an appropriately early stage, before significant ecosystem damage occurs. Should TCEQ investigate a "weight of evidence" approach, TPWD would like to be kept informed of the details, as we may wish to explore alternative formulations.
- Prior to using datasets, we recommend accounting for and excluding highly anomalous data. For example, there was a fish-killing freeze in the lower Laguna Madre on December 25-27, 2004 (TPWD 2004). Over 24,000 dead fish were counted along the shoreline. This would account for the large spike in TN observed at TCEQ station 13446 in segment 2491 (depicted in the handout provided at the stakeholder meeting). The choice to include or exclude highly anomalous data will profoundly affect the result obtained for the 90th (or other) percentile. TPWD recommends using typical data and excluding highly anomalous data from consideration. Similarly, we recommend identification of and some thoughtful allowance for Acts of God (e.g., hurricanes, floods, freezes).
- As we have expressed previously, failure to require sufficiently low detection limits results in the state's clearest waters receiving the least protection. We support TCEQ's efforts to require more meaningful detection limits and recommend that TCEQ revise the previously established 5.0 µg/L chlorophyll-*a* detection limit currently in place for reservoirs.

Streams and rivers

Two options were proposed in the handouts:

1. Base criteria on historical levels of chlorophyll- *a* (in rivers), TP, TN (as available) and transparency in reference groups of streams and rivers

2. "Stressor/response analyses," relating TP and TN (as available) to observed effects on biological indices, DO, chlorophyll- *a* (in rivers), attached algae abundance (in streams), biological indices for fish and macroinvertebrates, 2011 University of Arkansas project

Streams and rivers represent a complex picture from the standpoint of variation in geography, land use, hydrology, natural riparian areas, etc. They also receive point and non-point source inputs. Consequently, we support an approach that classifies streams based upon similar characteristics.

We suggest that numeric nutrient criteria be established for TP and TN in rivers and streams, in conjunction with one or more easily measured response indicators. We note that recent work by King (King and Winemiller 2009) has suggested TP thresholds for change in biological communities in central Texas. Diurnal dissolved oxygen may have some predictive ability and constraints or bounds can be established (magnitude of change, rate of change, etc.).

Periphyton biomass may be relatively easy to measure and be an indicator of stream condition (Kiesling et al. 2006, King and Winemiller 2009, Mabe 2007, Radloff et al. 2009). Characterization of periphyton levels by rapid assessment in the field, taxonomic identification of attached algal communities, algal bloom and nuisance algae characterization are also possibilities, but would require careful analysis to determine their utility.

Other dose-response indicators may be more complex to measure or interpret. For instance, a potential problem in using fish or benthic biological indices is that streams may be degraded by the time a response is observed. Further, the current indices have not been comprehensively evaluated statewide for their sensitivity to nutrient inputs, which would necessitate additional work.

Estuaries

For more than 30 years, the TPWD Coastal Fisheries Division has surveyed fish populations in Texas bays and estuaries. These data indicate that overall abundance and diversity have improved coast-wide since the TPWD monitoring program was initiated. We find that TPWD can manage the Texas coastal fishery for multiple uses under a diversity of nutrient levels; however, it could not work effectively with a hypereutrophic situation, especially situations that induce "dead zones." Low dissolved oxygen is the leading cause of fish kills in Texas coastal waters (Thronson and Quigg 2008). Thus, it is desirable to avoid a process that leads to increased nutrient levels.

Estuaries are complex systems. Because of the ease of measurement of chlorophyll-*a*, there is a tendency to focus on it as a measure of nutrient response. However, nutrient cycling in estuaries is not limited solely to phytoplankton. Other plants, such as seagrasses, drift macroalgae, benthic algae and epiphytic algae also respond to nutrient levels. In considering nutrient impacts, we recommend that TCEQ adopt measures that address the whole nutrient cycle or somehow integrate the community response, such as DO measures. We are concerned that none of the three proposed options for estuaries seems to incorporate any response other than phytoplankton growth.

Shallow, near-shore waters often include special habitats, such as seagrasses, mangroves and Spartina, which are critical in sustaining coastal fisheries. TPWD recommends that TCEQ's estuarine nutrient criteria address these special habitats to ensure that fisheries are protected.

TPWD has expressed a concern that TCEQ's method for establishing reservoir nutrient criteria lacks power to detect change. Recall that our calculations indicated that criteria were routinely set such that assessed medians will have to be 1.5-3 times higher than the historic medians before there is a 50% chance of suggesting that change has occurred. Since open bay stations, much like main pools of reservoirs, are expected to be slower to reflect nutrient enrichment than secondary and tertiary bays or coves, we reiterate our concern that it is vitally important that nutrient criteria have adequate power to detect real change. TPWD's goal in establishing nutrient criteria is to detect real changes in nutrient levels before catastrophic change occurs in aquatic communities.

References

Kiesling, R.L., C.E. Hornig, M.G. Canova and S.C. Aragon-Long. 2006. Twenty-four Hour Dissolved Oxygen and Use Attainment Study - Texas. USGS report prepared for Texas Commission on Environmental Quality. Austin, Texas.

King, R.S., and K.O. Winemiller. 2009. Development of Biologicla Indicators of Nutrient Enrichment for Application in Texas Streams. Report prepared pursuant to §106 Water Pollution Control Grant # 98665304.

Mabe, J. 2007. Nutrient and Biological Conditions of Selected Small Streams in the Edwards Plateau, Central Texas, 2005-06, and Implications for Development of Nutrient Criteria. Scientific Investigations Report 2007-5195. United States Geological Survey in cooperation with the Texas Commission on Environmental Quality, Austin, Texas.

Peterson, D.A., S.D. Porter, and S.M. Kinsey. 2001. Chemical and biological indicators of nutrient enrichment in the Yellowstone River Basin, Montana and Wyoming, August 2000: Study design and preliminary results. USGS National Water Quality Assessment Water-Resources Investigations Report 01-4238.

Porter, S.D. 2011. Water quality & river metabolism in the upper Rio Grande near Big Bend National Park. Presentation to TPWD Water Quality Team on June 1, 2011.

Radloff, P.L., C. Contreras, A.Whisenant, and J.M. Bronson. 2009. Nutrient Effects in Small Brazos Basin Streams. Report prepared pursuant to U. S. Fish and Wildlife Service State Wildlife Grant No. TX-T28-1.

Sorenson, S.K., S.D. Porter, K.B. Akers, M.A. Harris, S.J. Kalkhoff, K.E. Lee, L.R. Roberts, and P.J. Terrio. 1999. Water Quality and Habitat Conditions in Upper Midwest Streams Relative to Riparian Vegetation and Soil Characteristics, August 1997: Study Design, Methods and Data. USGS Open-File Report 99-202.

TPWD. 2004. News release: Freeze Fish Kill Surfaces in Lower Laguna Madre. Issued December 29, 2004.

Thronson, A. and A. Quigg. 2008. Fifty-Five Years of Fish Kills in Coastal Texas. Estuaries and Coasts. 31: 802-813. DOI 10.1007/s12237-008-9056-5.