

# Handout 1

## Establishing a Nutrient Assessment Protocol for Lakes and Reservoirs

### Goal

In 2013, the EPA approved 39 of 75 chlorophyll *a* criteria for reservoirs adopted by TCEQ in the 2010 revisions to the Texas Surface Water Quality Standards. The EPA requested the TCEQ “incorporate its plans and timeline for revising the disapproved chlorophyll *a* criteria” for the remaining 36 reservoirs. The following procedures were developed to achieve this goal, and establish a consistent framework to evaluate reservoirs with or without EPA-approved chlorophyll *a* criteria. Reservoirs which did not have chlorophyll *a* criteria adopted as part of the 2010 TSWQS may be evaluated using the framework developed for reservoirs without approved chlorophyll *a* criteria.

To accomplish this, TCEQ established a protocol to assess numeric nutrient criteria for chlorophyll *a*, and developed an alternative protocol to identify concerns for nutrients as part of the Texas Integrated Report of Surface Water Quality (IR). Potential impacts to existing, designated, presumed or attainable uses from excessive nutrients are evaluated in accordance with the narrative and numeric criteria for nutrients in the TSWQS. These criteria are protective of multiple uses such as contact recreation, aquatic life, and public water supplies.

### Weight of Evidence Framework

While assessing chlorophyll *a* concentrations provides a more meaningful status of the health of a waterbody than simply examining total nitrogen (TN) and total phosphorus (TP), the evaluation of chlorophyll *a* concentration alone does not allow for a holistic analysis of nutrient enrichment in a reservoir. To better assess whether a reservoir is meeting existing, designated, presumed or attainable uses in relation to nutrients, more parameters must be considered. Indicators of biological response include Secchi depth, dissolved oxygen, and the primary response variable of chlorophyll *a*. Causative parameters evaluated as potential stressors include TN and TP.

TCEQ staff developed a weight of evidence approach for nutrient assessment in lakes and reservoirs which involves the use of numeric translators of narrative criteria as “thresholds”, in addition to numeric chlorophyll *a* criteria approved by EPA. Multiple lines of evidence corroborate adverse nutrient conditions before a water body will be identified as impacted, with chlorophyll *a* serving as a primary indicator. This methodology provides a more robust assessment of reservoir conditions, and increases certainty that elevated nutrients are impacting other factors like water clarity, increased algae biomass and dissolved oxygen attainment.

### Assessment Protocol

Results of water quality data are compared to numeric thresholds and criteria in step-wise flow charts. Multiple lines of evidence are evaluated in the flow charts to identify (1) attainment of numeric criteria for nutrients in reservoirs with chlorophyll *a* criteria approved by EPA; and (2) attainment of narrative criteria for nutrients in reservoirs without approved numeric criteria. Separate flow charts were established to determine attainment with numeric and narrative nutrient criteria, and are depicted in Figures 1 and 2 respectively. Exceedances of thresholds for biological response variables and nutrient stressors are assessed to identify nutrient enrichment. This assessment protocol uses samples collected at monitoring sites indicated in Appendix F of the TSWQS for those reservoirs with approved chlorophyll *a* criteria; or from sites closest to the dam for reservoirs without approved criteria. The

assessment will only be conducted for lakes or reservoirs where the full suite of parameters was monitored and reported. If a full suite of parameters is not available, the outcome will be “Not Assessed”.

Compare water quality results to the associated threshold or criteria in Table 1 to determine which variables indicate potential nutrient enrichment. Indicators of nutrient concentrations (TP and TN) are considered causal variables. Chlorophyll *a*, Secchi depth, and dissolved oxygen are considered response variables. Possible attainment outcomes for each type of criteria are listed below:

- Numeric Nutrient Criteria Flow Chart
  - Not Assessed (NA), limited data.
  - Fully Supporting (FS)
  - Not Supporting (NS)
- Narrative Nutrient Criteria Flow Chart
  - Not Assessed (NA), limited data.
  - No Concern (NC)
  - Concern-screening level (CS)

**Table 1. Threshold (T) and Criteria (C) Value Determination**

<b>Attainment of Numeric Criteria: Reservoirs with Chl-a criteria APPROVED by EPA</b>		
<b>Parameter</b>	<b>Standard Source</b>	<b>Notes</b>
Secchi Depth <sup>T</sup>	Rule Project no. 2007-002-307-PR	Calculated from historical sampling data, set at the lower parametric prediction interval, 90% CI
Dissolved Oxygen <sup>C</sup>	2014 Surface Water Quality Standards	
Total Nitrogen <sup>T</sup>	University of Arkansas 2013 Report	Determined 0.58 mg/L of TN to be the level at which statistically significant changes in Secchi depth and chl-a occur
Total Phosphorus <sup>T</sup>	Rule Project no. 2007-002-307-PR	Calculated from historical sampling data, set at the upper parametric prediction interval, 90% CI
Chl-a <sup>C</sup>	2014 Surface Water Quality Standards	Appendix F
<b>Attainment of Narrative Criteria: Reservoirs with Chl-a Criteria DISAPPROVED by EPA or no criteria adopted</b>		
<b>Parameter</b>	<b>Standard Source</b>	<b>Notes</b>
Secchi Depth <sup>T</sup>	Rule Project No. 2007-002-307-PR	Calculated from historical sampling data, set at the lower parametric prediction interval, 90% CI
Dissolved Oxygen <sup>C</sup>	2014 Surface Water Quality Standards	
Total Nitrogen <sup>T</sup>	University of Arkansas 2013 Report	Determined 0.58 mg/L of TN to be the level at which statistically significant changes in Secchi depth occur
Total Phosphorus <sup>T</sup>	Rule Project No. 2007-002-307-PR	Calculated from historical sampling data, set at the upper parametric prediction interval, 90% CI
Chl-a <sup>T</sup>	2010 Surface Water Quality Standards (if >30, 30 ug/L used)	Calculated from historical sampling data, set at the upper parametric prediction interval, 95% CI

Additional notes for chlorophyll *a*:

- The values used in place of criteria disapproved by EPA are **more stringent than criteria adopted in the 2010 TSWQS**.
- For reservoirs with EPA disapproved criteria: If a reservoir whose adopted chlorophyll *a* criterion was greater than 30ug/L, then the criterion was capped at 30ug/L. This decision was based on published literature of chlorophyll *a* trends, and EPA’s Technical Support Document *EPA Review of Reservoir-specific Chlorophyll a Criteria for 75 Texas Reservoirs*. Current literature suggests that chlorophyll *a* concentrations greater than 30ug/L can result in nuisance algal blooms, toxic cyanobacteria and toxin production, taste and odor compound production and generation of disinfection byproducts in finished drinking water. Therefore, no reservoirs have thresholds above 30ug/L.
- A level of 40 ug/L of chlorophyll *a* is an indication that a reservoir is approaching hypereutrophic status, as observed in the Trophic Classification of Texas Reservoirs. Several states use 40 ug/L as an upper threshold of nuisance conditions.

## Data Preparation and Manipulation

**Table 2. Data Sources**

Reservoirs with Chl-a criteria APPROVED and DISAPPROVED by EPA		
Parameter	Data Source	Notes
Secchi depth	SWQMIS - Median	
Dissolved Oxygen	2012 Integrated Report	Level of Support (LOS)
Total Nitrogen	SWQMIS - Median	Calculated by parameter availability: 00625 + 00630, 00625 + 00593; or 00625 + 00615+00620.
Total Phosphorus	SWQMIS - Median	
Chl-a	SWQMIS - Median	

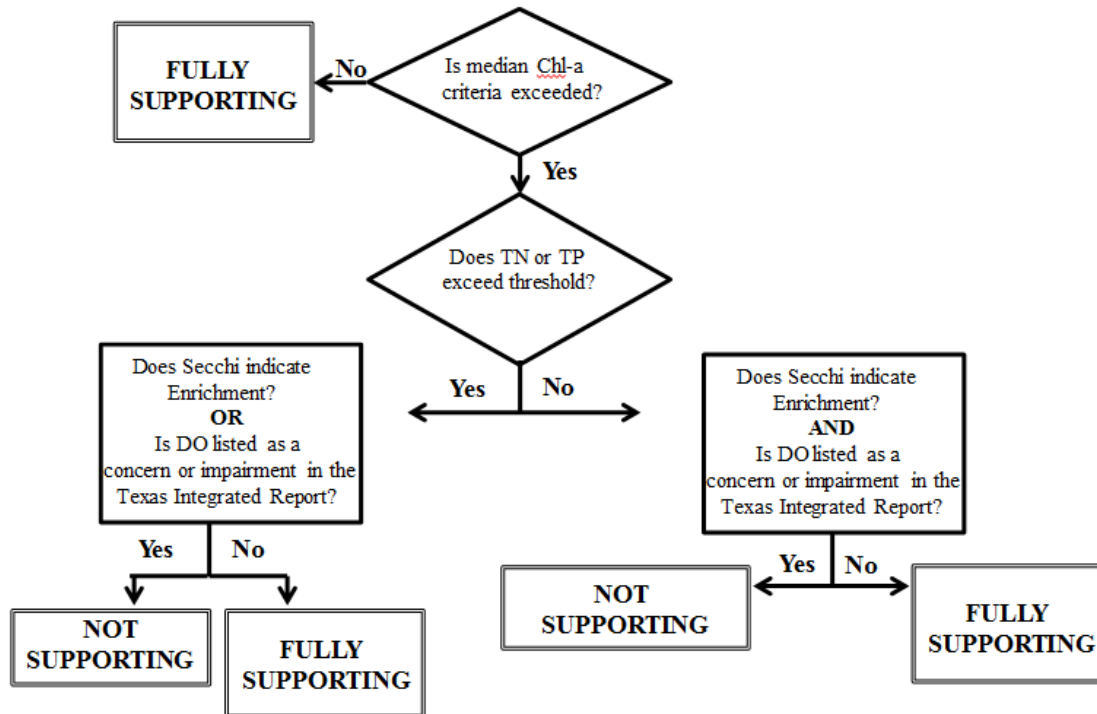
Parameter Codes			
00078	Secchi Depth	00630	Nitrate + Nitrite
00300	Dissolved Oxygen	00625	TKN
00593	Total Nitrate + Nitrite	00665	Total Phosphorus
00615	Nitrite	32211	Chl-a spec
00620	Nitrate	70953	Chl-a fluoro

Notes about the data

- SWQMIS group code “nocri” was created to pull out these parameters.
- Non-detect data point values were halved
  - This is done because SWQM halves the non-detects during assessment and the criteria were created with halved non-detects
- Only the following monitoring codes were utilized: DI, RT, SS, XR, XS, TQ, TI, DL, FL, IS, NS, RG, RS, RW, TS, AC, TM, BS, CT, CS
- Removed all data gathered at a depth greater than 0.3 meters
- Mean, median, count, and standard deviation for each parameter was taken in Excel

**Figure 1. Attainment of Numeric Criteria**

Reservoirs with Chlorophyll *a*  
Criteria approved by EPA

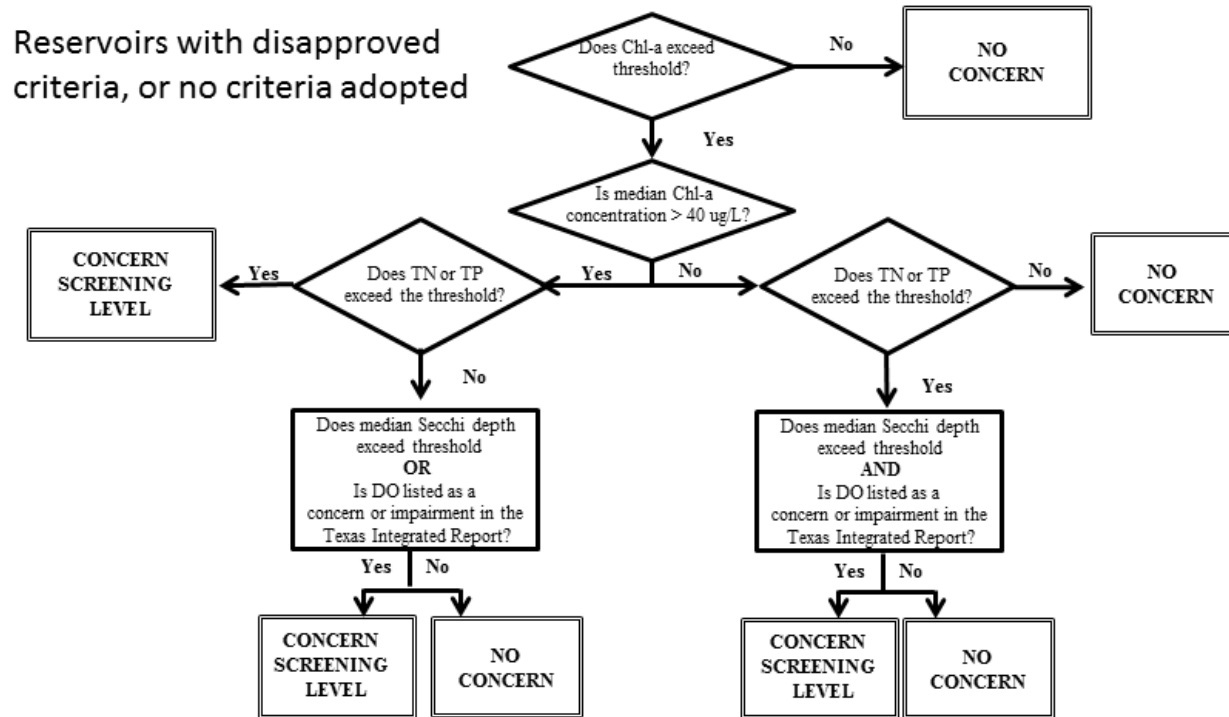


Not Assessed: < 10 samples for any variable

Support: adequate data (>= 10 samples for all variables)

The process for reservoirs with EPA approved chlorophyll *a* criteria begins with evaluation of chlorophyll *a*, then uses a weight of evidence approach to evaluate association with elevated nutrients (TN and TP) and observed ecosystem response (DO and Secchi).

**Figure 2. Attainment of Narrative Criteria**



Not Assessed: < 10 samples for any variable

Adequate Data: >= 10 samples for all variables

The process for reservoirs without EPA approved chlorophyll *a* criteria begins with evaluations for TN and TP, since it is a translation of TCEQ's narrative criteria for nutrients. Narrative criteria §307.4(f): Nutrients from permitted discharges or other controllable sources must not cause excessive growth of aquatic vegetation that impairs an existing, designated, presumed, or attainable use.