Nutrient and Chlorophyll Criteria for Lakes
Implementation Procedure for Permitted Facilities

Missouri Department of Natural Resources
Water Protection Program

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Table of Contents:

Facts, History and Background 2
Intent of the Procedure 3
Evaluation of Lakes 3
Applicability Determination Process 3
Determining Nutrient Criteria 4
Nutrient Criteria Implementation Procedure for Point Source Discharges 5
Regulated Existing Point Source Discharges to Lakes 5
Antidegradation Review of New or Expanded Source Discharges to Lakes 6
Setting Effluent Limits Following a Water Quality Analysis 7
Key Issues of Water Quality Trading 8
Follow-up Evaluation of Lakes 8

Attachments:

Flowchart: Nutrients and Chlorophyll Criteria Implementation Strategy and Procedure for NPDES Permitting

Tables A1-A6. Predictive Values for Phosphorus from Formulas Found on Table L, 10 CSR 20-7.031

Tables B1-B11. Permits Affected by the Nutrient Criteria in *Selected* Watersheds (Note: *List does not include all affected permits*)

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Facts, History and Background

The Missouri Department of Natural Resources' (department) most recent triennial revision of the Water Quality Standards (WQS) regulation (10 CSR 20-7.031) became effective October 30, 2009. A major revision was the establishment of nutrient and chlorophyll standards for lakes and reservoirs (here after, "lakes"). Nutrients and chlorophyll standards include criteria values for total phosphorus (TP), total nitrogen (TN) and chlorophyll (Chl).

The effects of nutrients on designated water uses are complex and variable. Nutrients constitute an essential element of aquatic life, and are not generally toxic. Ammonia is the exception and has toxicity criteria in the rule at 10 CSR 20-7.031, Tables B1 – B3. However, in high concentrations, nutrients in waters have been linked to drinking water-related concerns that include methemoglobinemia, disinfection by-products, cyanotoxins from cyanobacteria, and aesthetic impacts on taste and odor.[1]

General water quality concerns from excess nutrient levels in waters include reduced water clarity potentially affecting recreational use, eutrophication of waters that can lead to low dissolved oxygen from excess algae production and noxious plants. Excess algae and plant production can also affect sensitive aquatic organisms by altering the type and quality of food available.[2]

The department developed a plan for nutrient criteria development that EPA approved in July 2005. The plan calls for development of nutrient criteria for lakes first, to be followed by criteria for streams and rivers, and later, the development of criteria for wetlands and the Missouri and Mississippi Rivers. The 2009 additions to the rule (10 CSR 20-7.031(4)(N) and Tables L, M and N) represent the first stage of nutrient criteria development in Missouri.

The nutrient criteria for lakes are based primarily on hydrological factors, including lake depth (as approximated by dam height), hydraulic residence time, and watershed characteristics. These factors are further modified by consideration of the eco-region in which a lake is located. Specifics of how these factors are applied are described in the rule at 10 CSR 20-7.031(4)(N) and Tables L, M, and N. Numeric values for these factors for most classified lakes are available for distribution (see *Determining Nutrient Criteria*).

Consequently, these hydrological factors produce a range of expected concentrations for TN, TP, and Chl among different lakes. Achievement of compliance with criteria in lakes requires consideration of the entire watershed areas in which they are located. The trophic condition of a lake may be impacted by direct or indirect discharges from point source facilities, and it is also largely a function of overland runoff. Almost all lakes in Missouri are actually reservoirs, meaning there is no real "natural" condition to protect; however, for the protection of water quality for designated uses, an excessive nutrient level is considered an impairment of beneficial uses due to algal growth, lack of water clarity and other values inconsistent with water quality standards. The rule is designed to estimate the threshold between naturally-occurring and cultural eutrophication, which is the progression and aging of a lake from nutrient poor to more nutrient rich conditions.

[1, 2] *An Urgent Call to Action – Report of the State – EPA Nutrient Innovation Task Force*, August 27, 2009

Intent of the Procedure

Because Missouri's new nutrient and chlorophyll WQS for lakes at 10 CSR 20-7.031(4)(N) have become effective, point-source discharges into lakes (considered "waters of the state") or within the watersheds of lakes may be affected. The intent of this procedure is to ensure consistent implementation and gathering of sufficient water quality data to manage discharges to those lakes or into the watersheds of those lakes. This guidance will include procedures to implement Missouri's nutrient and chlorophyll standards for: 1) existing point sources regulated under the Missouri State Operating Permit program (MSOP), or 2) new or expanding point sources. An expanding point source is defined as discharge from a facility that is increasing its dry-weather design flow or organic loading or both. A new point source is defined as the construction of a facility that does not currently possess a MSOP or the introduction of TP or TN in the discharge as a new pollutant of concern in a current MSOP.

The determination of a water body as a "water of the state" is the initial application of the WQS and all surface waters of the state will be addressed in this guidance. This guidance is not intended to address the control of nutrient sources not regulated under the MSOP program. For lakes that have nutrient concentrations higher than the corresponding criteria, modeling will establish the contribution of point and non-point sources within the lake's watershed. Missouri mitigates these nonpoint source contributions through the Best Management Practices (BMP) approach as well as public education and incentive programs. Finally, these new standards will likely lead to the development of a nutrient trading program that would achieve overall nutrient reduction in an efficient and cost-effective manner.

Tables B1 through B11 list permitted point sources that are located within the watersheds of affected lakes (or lakes having nutrient concentration greater than their corresponding criteria. The lists include approximately 2,000 affected permitted facilities, among which 25% are storm water, 25% are general and 50% are site-specific permits. Nearly 85% of these permits are within the watersheds of the 10 largest lakes in the state.

Evaluation of Lakes

Applicability Determination Process

Nutrient criteria (TN, TP and Chl) apply to 1) classified lakes greater than 10 acres in size [10 CSR 20-7.031, Table G], and 2) unclassified lakes as waters of the state that are greater than 10 acres in size and outside the Big River Floodplain eco-region. Waters of the state are defined as (Missouri Statues Chapter 644, Section 644.016): "[A]ll rivers, streams, lakes and other bodies of surface and subsurface water lying within or forming a part of the boundaries of the state which are not entirely confined and located completely upon lands owned, leased or otherwise controlled by a single person or by two or more persons jointly or as tenants in common and includes waters of the United States lying within the state." The department will consider every such lake as a water of the state unless the applicant demonstrates that the lake owner has complete ownership control of the lake drainage area. For determination of waters of the state, a geographic information systems (GIS) layer or plat map showing land ownership within the county of the facility discharge may be used. For the implementation of this rule, GIS will be a vital tool in the applicability determination process. See the department's interactive map viewer at: http://www.dnr.mo.gov/internetmapviewer/ for additional information.

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This implementation procedure addresses qualifying lakes and the watersheds of these lakes. Achievement of compliance with criteria in lakes requires consideration of the entire lake watershed area. Thus, this implementation procedure and the requirements of the WQS apply to discharges that drain into streams within the watershed of an applicable lake. Losing streams that are in the watershed of qualifying lakes are given the same consideration as gaining streams, unless the applicant can demonstrate through dye tracing that water of said stream is losing to a watershed outside of the qualifying lake (a quality assurance project plan is required for dye tracing). To ascertain watershed boundaries of the lake, GIS will be a vital tool in the applicability determination process. For larger lakes, the 8-digit or 12-digit USGS Hydrologic Unit Codes (HUC) watershed boundaries can be used. For smaller lakes, the first consideration may be the 12-digit HUC, but the use of digital 1:24,000 scale topographic maps combined with digital aerial photography or digital elevation model (DEM) layers may be necessary.

Determining Nutrient Criteria

As mentioned in the "Background" section, nutrient criteria for lakes are based primarily on hydrological factors, including lake depth (as approximated by dam height), hydraulic residence time, and watershed characteristics. For the Plains eco-region, the predictive value for TP requires dam height, hydraulic residence time, and percentage of watershed historically covered in prairie. For the Ozark Border and Ozark Highlands eco-regions, dam height is the only factor needed to calculate the predictive value. Records of dam height may be available from the department's Dam and Reservoir Safety Program at http://dnr.mo.gov/env/wrc/damsft/statemap.htm. The Dam and Reservoir System Rules and Regulations provide definitions of terms used in administration of the Missouri Dam Safety Law. The proper method of measuring the height of a dam is based on these definitions. See http://dnr.mo.gov/env/wrc/damsft/damhgt.htm for additional information. The Natural Resources Conservation Service (NRCS) should have records on dams built under the Watershed Protection and Flood Prevention Act (PL-566).

Actual values for nutrients and chlorophyll are determined by direct monitoring of the receiving water body. Information on lake water quality is available from the department for existing water quality data or sampling as described in the WQS at 10 CSR 20-7.031(4)(N)4, and existing data are available on the department's website. As a part of nutrient criteria implementation, the department will be sampling lakes with wastewater discharges that could be affecting its nutrient concentrations. A lake owner, lake association, citizen group, permittee or more than one permittee may sample a lake at his or her own expense if all lake sampling has a Quality Assurance Project Plan (QAPP) that is approved by the department's Water Protection Program. Water quality data that were collected without a department-approved QAPP and the quality assurance protocol may be submitted to the department for review. However, such data may not be used to determine nutrient or chlorophyll levels unless there is sufficient evidence for their reliability.

Note: Predictive criteria values for many lakes using the formulas on Table L of 10 CSR 20-7.031 are provided in the attached Tables A1-4.

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Nutrient Criteria Implementation Procedure for Point Source Discharges

Regulated Existing Point Source Discharges to Lakes

All existing permitted discharges within the watersheds of lakes that are affected by the rule will be monitored for nutrient concentrations, as a part of their normal discharge monitoring reports for a defined period. Until a wasteload allocation is developed, the following exemptions from effluent monitoring only may be considered if circumstances warrant:

- The permitted low-flow design flow of a domestic wastewater treatment facility is less than 100,000 gallons per day. For the wasteload allocation development process, the extent of nutrient loading from the facility may be assumed using default concentration values. These default values must assume that these facilities do not have tertiary treatment for nutrients. Typically, untreated municipal waste water contains 4 to 8 mg/L TP and 25 to 35 mg/L TN.[3] Default values will be drawn from within these ranges.
- The facility operates with waste water treatment processes that are clearly demonstrated through existing effluent monitoring data to result in a discharge that does not include any nutrient concentration that is greater than non-impaired natural background levels.

The generalized goal for existing dischargers seeking renewal of their state operating permit within watersheds of or directly to lakes (here after, "affected waters") that have nutrient values in excess of criteria is to have effluent limits for TP and TN based on the calculation of a waste load allocation (WLA). The Water Protection Program develops, or reviews and approves, WLAs prior to implementation into the permitting process. During implementation, adjustment to the loading may be realized from nonpoint source reductions. Water quality trading may also be an option for these facilities.

Depending on the location of a given permitted facility, there are three (3) alternative implementation actions:

- For lakes that are known to exceed their nutrient criteria, DNR staff will develop Total Maximum Daily Loads (TMDL) from which WLAs will be calculated. Appropriate nutrient limits will be derived for each of the permitted facilities of the watershed.
- Lakes for which there are not sufficient data to determine whether nutrient criteria are exceeded, but for which available data indicate that exceedence is likely, DNR will require that all facilities that are located within the watersheds of these lakes to monitor for nutrients as a part of their discharge monitoring reports (DMR). The Department will review the data. If there is a significant probability of impairment because of nutrient loading, the Department will request the affected facilities to develop WLAs that would be applicable to their discharges. Production of these WLAs will require submission of QAPPs and will be subject to approval by the Department.
- Wastewater facilities that are located within the watersheds of lakes for which data indicate that nutrient criteria are not exceeded will only include nutrient monitoring as a part of their DMR if there are insufficient data to determine treatment performance.

Following the development of a WLA, whether or not it is associated with a TMDL, watershed protection staff will work with the permitting staff to develop appropriate and achievable limits

[3] US EPA, 2010. Nutrient Control Design Manual. EPA/600/R-10/100. http://www.epa.gov/nrmrl/pubs/600r10100/600r10100.pdf

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for point sources, taking into consideration the limit of technology (LOT). The implementation plan (IP) will also include a compliance schedule for possible facility modifications to meet these limitations. At the time of permit renewal, if the LOT has been revised downward because of advances in technology that are practicable for the facility, and if the affected water still exceeds criteria, permitting staff will modify the permit accordingly.

If the impairment is caused by a combination of point source discharges, each discharger may be allocated a percentage of the total allocation corresponding to their relative load contribution, their location within the watershed, and the LOT.

Existing dischargers to affected waters with nutrient effluent limitations that seek renewal of their state operating permit will continue to meet these limitations until lake sampling indicates that the use of those effluent limitations is known or expected to produce an effluent that will not endanger or violate water quality. In these cases, an adjusted WLA may be applied to the permit.

Existing dischargers to affected waters without nutrient effluent limitations that seek renewal of their state operating permit and discharging within affected waters that exceed TN, TP and/or Chl criteria will be required to monitor their effluent discharge (see *Follow-up Evaluation of Lakes*) for TP and TN until the TMDL or WLA is developed. After the WLA development process, the WLA and/or appropriate nutrient limits will be imposed (or water quality trading pursued) as permits are renewed.

Existing dischargers without nutrient effluent limitations that seek renewal of their state operating permit and discharging within watersheds of lakes that do not exceed TN, TP and/or Chl criteria or do not have data to show exceedences will have effluent monitoring requirements for TP and TN added to the permit at permit renewal for at least one permit cycle. The frequency of monitoring will be at least quarterly. The department may eliminate nutrient monitoring, or reduce its frequency to suit the water quality situation. Those non-expanding discharges without effluent limitations that have collected sufficient data prior to renewal may be excluded from the required monitoring provided a minimum of 20 samples have been collected over at least a five (5) year period. The department may also not require nutrient monitoring if sufficient data are available for the similar types of treatment facilities or nutrient point sources. These data should allow the department to determine discharge concentration with reliability.

Antidegradation Review of New or Expanded Source Discharges to Lakes

In accordance with the *Missouri Antidegradation Rule and Implementation Procedure* (AIP), all new or expanded regulated discharges are subject to antidegradation review requirements. The AIP is available on the web at http://dnr.mo.gov/env/wpp/docs/aip-cwc-appr-050708.pdf.

New or expanding regulated discharges of nutrients within watersheds of affected lakes that exceed nutrient criteria are prohibited if the discharge would cause or contribute to the impairment. An application may be accepted before the completion of the WLA calculation, if the permittee accepts one of the following available options: 1) wait, meaning no permit will be issued until the WLA is developed by the department (Watershed Protection Section) and approved by EPA; or 2) maintain loading of nutrients, if sufficient effluent data is available to characterize the nutrient concentrations discharged; or 3) conduct an analysis of practicable control technology[4] for the purpose of selecting the LOT that will address nutrient concentrations in the effluent. If options 1-3 are eliminated from consideration, water quality trading when

[4] Affordable and effective in removing nutrients

developed may be considered. Please refer to the Antidegradation Implementation web link for more information on antidegradation review submittal requirements at http://www.dnr.mo.gov/env/wpp/permits/antideg-implementation.htm.

For any new or expanding regulated discharges that would discharge toward affected lakes *not exceeding nutrient criteria or not having data to be evaluated*, the available options include: 1) assuming degradation from TP, TN and Chl and conducting alternative analysis of non-degrading, less-degrading and degrading alternatives for TP and TN as described in the AIP Section II. B for selecting the LOT that will address nutrient concentrations in the effluent; 2) demonstrating that an analysis for an alternative to the proposed discharge analysis is unnecessary as described within the AIP; or 3) conducting water quality trading. To use option #2, the amount of resources that would be required to gather the necessary data to accurately model the lake for minimal degradation will likely be extremely prohibitive for some facilities. Therefore, the department believes that in some cases the most viable approach is Option #1 as described in the AIP Section II.B. Alternatives analysis is the structured evaluation of the reasonableness of less- and non-degrading alternatives to a new or expanded discharge likely to cause significant degradation. Additionally, for significant degradation, an analysis of the social and economic benefits to the community that will occur from any activity involving a new or expanded discharge is required by the AIP. By default, those lakes without existing water quality data also receive this Tier 2 review.

For option #1, in accordance with the AIP, the base case of pollution control is the control required to protect existing uses and to achieve the highest statutory and regulatory requirements. Without the data to accurately model the lake to show the effects of this new or expanded discharge, an assumption of the base case may be made. The department already has shown success in protecting lake water quality and facilities are meeting effluent limitations using phosphorus through the use of effluent regulations for discharge to Lake Taneycomo and Table Rock Lake watersheds. Effluent regulations in 10 CSR 20-7.015(3)(F) and (G) set limits of 0.5 mg/L total phosphorus as a monthly average. Because of the success of this effluent regulation, the department is proposing to use this value for the base case of pollution control for discharge to all lakes in Missouri. However, Missouri's regulatory effluent limitation for TP is not the LOT based on more recent advancements in effluent.

Thus, for the base case treatment (see *Municipal Nutrient Removal Technologies Reference Document*, September 2008), proposed treatment alternatives must have the capacity to attain an effluent discharge for TP of 0.5 mg/L and TN of 10 mg/L as a monthly average. In addition, the applicant may demonstrate that these base-case treatment capacities are not achievable. The department selected the current regulatory effluent limitation for TP discharges as mentioned above because of the lack of appropriate methodology to derive water quality-based effluent limits for the base case that comply with water quality standards at the lake outflow. The TN monthly average follows the rationale that a TN-to-TP ratio of 20:1 is protective of water quality standards.

Setting Effluent Limits Following a Water Quality Analysis

If the WLA for impaired lakes or data for non-impaired lakes reveal that additional TP and/or TN reduction is needed by the permittee, more protective effluent limits would be imposed in a permit modification with a schedule of compliance to bring the facility into compliance with the new effluent limitation. Facilities may accomplish additional nutrient reduction through facility upgrades, elimination of nutrient discharge or through water quality trading, when developed and if available. The Missouri Department of Natural Resources' Effluent Regulations at 10 CSR 20-

7.015(3)(B)4 indicates that "where the use of effluent limitations set forth in section (3) is known or expected to produce an effluent that will endanger or violate water quality, the department may either—conduct waste load allocation studies in order to arrive at a limitation which protects the water quality of the state or set specific effluent limitations for individual dischargers to protect the water quality of the receiving streams. When a waste load allocation study is conducted for a stream or stream segment [within a lake's watershed], all permits for discharges in the study area shall be modified to reflect the limits established in the waste load allocation study."

Key Issues of Water Quality Trading

Water quality goals for nutrients may be achieved through coordination and cooperation among those responsible for point and nonpoint discharges of nutrients to affected waters. Trading of effluent limits between affected parties can be useful in achieving water quality standards effectively and economically.

Currently, there is no water quality trading program in Missouri. Implementation of such a program will require rulemaking and adequate staffing. The Water Protection Program intends to develop the regulations for a trading program during a future rulemaking.

Note: The establishment of a nutrient trading agreement does not, by itself, create sufficient cause for removing a water body from a 303(d) list.

Follow-up Evaluation of Lakes

A reasonable potential analysis (RPA) of effluent monitoring data as described in EPA's *Technical Support Document for Water Quality-Based Toxics Control*; 505/2-90-001 (TSD) is not possible for any effluent limitation developed under the TMDL process or through alternative analysis. The primary reason is that compliance with water quality standards is near the outflow of the lake. The TSD's RPA methodology does not account for several natural phenomena including seasonal (summer) sequestration of nutrients in the hypolimnion, long-term storage of nutrients in lake sediments, decay of nutrients from discharges in the watersheds before reaching the lake or the dilution process from lake discharge to the lake outflow. Thus, the evaluation of compliance with nutrient and chlorophyll criteria for existing or newly imposed effluent limitations is near the outflow of the lake. See the *Regulated Existing Nutrient Point Sources to Lakes* above for additional procedures.

Nutrient and chlorophyll concentrations within individual lakes are seasonal and vary yearly due to climatic conditions as well as changes in land use within watersheds. Evaluation of lake nutrients requires sufficient data to account for natural nutrient and chlorophyll concentration variability. As specified in 10 CSR 20-7.031(4)(N)4, a valid determination of a lake's nutrient status requires at least four years of data collected near the outflow of the lake, with a minimum of four samples taken each year and uniformly spaced between May 1 and August 31. Evaluation is based on a comparison of the criterion with the geometric mean of all samples taken within this period. However, for the purpose of this procedure and to proactively reduce any threat to lake water quality, lake nutrient status will be based on a moving geometric mean of at least three consecutive records. Equally spaced samples of any one of the three parameters may be used to calculate the geometric mean and evaluate the likelihood of criteria exceedence. As data become available, the moving geometric mean may include up to four years worth of data.

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