

Ohio Nutrient Regulations Update



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Imagine the result

Agenda

- Nutrient impacts
- Nutrient criteria development
- Ohio EPA's draft nutrient criteria
- Implementation of Ohio draft nutrient criteria
- Summary



Nutrient-Caused Water Quality Impacts

Nutrient Impacts

- Significant cause of water quality impairment
- Nutrients can cause over-enrichment in receiving water bodies
 - Eutrophication in streams and lakes
 - . . . Excessive algae and other plants growth
 - Non-attainment of biological criteria
 - . . . (Listed as “cause” in many TMDLs)
 - Hypoxia – ‘dead zone’ – in coastal waters

Nutrient Impacts

- Over-enrichment in receiving waters
- Excess phosphorus:
 - potential over-enrichment of **freshwaters**
- Excess nitrogen:
 - potential over-enrichment of **oceans & estuaries**

Ammonia-N → oxygen demand

Ammonia-N → toxicity

NOT nutrient issues!

Ohio Nutrient Impacts

Lake Erie watershed

- subject to eutrophication and algal blooms

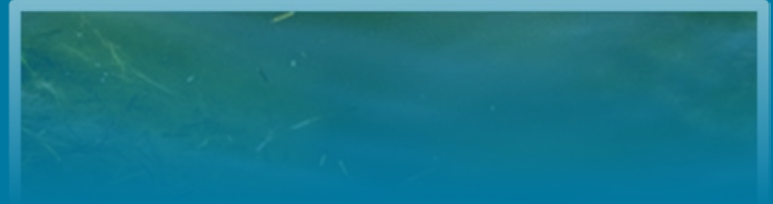
Ohio Lakes & Streams

- subject to nuisance growths

***NOTE:** WWTP effluents and urban storm water contribute **12% TP** and **9% TN**. Agricultural sources contribute **80% TP** and **71% TN**.*

- **Ohio River** watershed drains to the **Gulf of Mexico**
- subject to summer hypoxia





Nutrient Water Quality Criteria Development

EPA Mandate for Nutrient Criteria

- US EPA Nutrient Strategy (1998 - 2001)
 - States required to develop regional, scientifically defensible criteria
- US EPA guidance
 - Eco-region based criteria: “**reference site**” approach
 - Example: typical Guidance TP criteria ~0.07 mg/l
 - Guidance did not promote “**effects-based**” approach
- Slow progress by most states
... US EPA increasingly displeased

Nutrient Criteria: the Challenge

Issue: Nutrients are different from toxic or conventional pollutants

- Effects not predictable through “dose-response” curves . . . Difficult to develop criteria for nutrients
- In 2010, EPA’s Science Advisory Board review critical of US EPA’s “*Empirical Approaches for Nutrient Criteria Derivation*”
- WQ Criteria should be based upon: “stressor-response” (“*cause and effect*”)

Stressor-Response Approach *

- Estimate a relationship between nutrient concentrations and biological response
- Relate to designated use (ideally quantitatively)
- Derive nutrient concentrations protective of designated uses from the observed relationships

* Modified from “*Empirical Approaches for Nutrient Criteria Derivation*”
draft SAB report, 2009

Stressors for Biological Impairment

- **Nutrients**

- Riparian disturbance

- Streambed sedimentation

- In-stream habitat for fish & aquatic organisms

- Riparian vegetative cover

- Salinity (TDS), other water chemistry

Habitat

Reducing nutrients without solving habitat problems will not attain biocriteria WQS

Biological Response Variables

- Productivity – algal growth
 - Measurement of chlorophyll
 - Dissolved oxygen swings
- Biological survey
 - Biocriteria indices: ICI, IBI, MIwb
 - Diversity & number of aquatic species (macroinvertebrates and fish)

Existing Ohio Nutrient Regulation

- Current Ohio status (typical of most states):
 - Narrative criteria: **“Free of nutrients in concentrations that may cause algal blooms”**
 - No numeric criteria for Phosphorus or Nitrogen
- *“Associations Report”* (Ohio EPA, 1999)
 - Used in many TMDLs to establish wasteload allocations

Flawed approach: statistical associations alone cannot prove cause-and-effect
- Water Quality Trading allows trading credits to reduce nutrients

Phosphorus and Current Regs

- Concern: TMDLs for many Ohio watersheds have listed **nutrients** as cause of impairment, although data to support listing may be ambiguous
- Phosphorus was ‘basis of listing’ ... in many cases:
 - “*Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams*” (Ohio EPA, 1999). . . aka ‘***the Associations Report***’
- Often unclear relationships between nutrients (phosphorus) and excessive enrichment
- Currently: 188 POTWs with TP limits; 353 monitor for TP *

* Ohio EPA data

Ohio's Current Nutrient Criteria Development

2003 ... OEPA nutrient criteria development plan

- Study approach: look for 'cause and effect'
- Biological responses: ♦ Effect on algal biomass (chlorophyll *a*) ♦ Effect on biocriteria ♦ Effect on DO

2004 - 2007 ... Data collection

- Typical stream monitoring data, incl: TP; TN (DIN) Chlorophyll *a*; DO; stream physical conditions (cover)
- Mostly small streams; some large rivers in 2007

2008-2009 ... Data evaluation, criteria draft

2010-2011 ... Working draft rule (small streams & rivers)

Draft Rule: Future Nutrient Design Requirements

- Draft Antidegradation Rule (OAC 3745-1-05)
 - *Comment deadline Jun 6, 2011*
- Best Available Demonstrated Control Technology (**BADCT**) includes nutrient treatment limits for new sources

<i>Draft</i> BADCT Design	30-d Limit	7-d Limit
Total Nitrogen	10 mg/l	15 mg/l
Total Phosphorus	2.0 mg/l	3.0 mg/l

- If POTW is expanded, then BADCT will apply to new
- No permit limits until entire plant is upgraded



Ohio EPA's Working Draft: Stream Nutrient Rule Package

Draft Nutrient Rules: 3 Parts

- Criteria for control of nutrient enrichment
 - TIC criterion to indicate enrichment status of stream
 - Nutrient criteria for different streams
- Wasteload Allocation for nutrients
 - How to calculate allowable nutrients discharge
- Reasonable Potential
 - Determine when nutrient criteria are applied

DRAFT: subject to change

TIC : Trophic Index Criterion

Stream Status – Measure of Enrichment

- Multi-metric score based upon evaluations of:
 - Primary productivity
 - Biological health
 - Nutrient concentrations in stream
- TIC will determine applicability of water quality criteria:
 - Total Phosphorus (TP)
 - Dissolved Inorganic Nitrogen (DIN)

$$\begin{aligned} \text{DIN} &= \text{Ammonia} + \text{Nitrate} + \text{Nitrite} \\ &= \text{NH}_3\text{-N} + \text{NO}_3\text{-N} + \text{NO}_2\text{-N} \end{aligned}$$

Trophic Index Criterion:

$$\text{TIC} = P_{\text{chl } a} + P_{\text{DO}} + B + N$$

Metric	Description	Metric Score*
$P_{\text{chl } a}$	Representative benthic chlorophyll <i>a</i> (scrapings from rocks in stream bed)	0 to 4
P_{DO}	Minimum & average instream DO; and 24-hour range (max value minus min value)	0 to 5
B	Biological survey results (ICl, IBI, MIwb) [ref: OAC 3745-1-07, Table 7-15]	0 to 6
N	TP (total phosphorus) and DIN (dissolved inorganic nitrogen = $\text{NH}_3\text{-N} + \text{NO}_x\text{-N}$)	0 to 4

* If no data, metric score is 1

DRAFT: subject to change

Stream Status indicated by TIC

Stream Status == Measure of Enrichment

Status of Stream	TIC
Acceptable – nutrient enrichment is not likely	8 to 19
Threatened – nutrient enrichment is likely now or in the future	4 to 7
Impaired – nutrient enrichment is documented	0 to 3

DRAFT: subject to change

Draft Nutrient Criteria

Criteria will apply if "reasonable potential" is determined

Aquatic Life Use and QHEI	TP (mg/L)	DIN (mg/L)
Exceptional Warmwater Habitat, and all QHEI scores	0.060	3.0
Warmwater Habitat, and QHEI score = 12 to 64	0.16	3.0
All other aquatic life uses, and all QHEI scores	0.30	3.0

- For most streams with drainage areas up to 1,000 sq miles
- Exception may be made for streams 500 to 1,000 sq miles
- Does not apply to small, historically channelized streams i.e., drainage areas < 3.1 sq. mi. (< 2,000 acres)

Water Quality Trading Option

- If Agency believes WQ trading will address nutrient enrichment conditions → less stringent effluent limits plus WQ trading nutrient reduction may be included
- Option allows up to 3 NPDES permit cycles for existing POTWs to meet final nutrient limits
 - Initial and 2nd permits: $TP \leq 1 \text{ mg/l}$; $DIN \leq 10 \text{ mg/l}$
 - Keep interim permit limit as final limit if stream recovers (TIC returns to “acceptable”)

Wasteload Allocation for Nutrients

- Wasteload Allocation: mass balance equation

$$\left(\begin{array}{c} \text{Mass of} \\ \text{nutrients in} \\ \text{upstream} \end{array} \right) + \left(\begin{array}{c} \text{Mass of} \\ \text{nutrients in} \\ \text{discharge} \end{array} \right) \leq \left(\begin{array}{c} \text{Allowable} \\ \text{mass of} \\ \text{nutrients for} \\ \text{WQ Criterion} \end{array} \right)$$

- Design stream flow:
 - Summer flow exceeded 80% of time (**20th-percentile**)
 - Winter flow exceeded 80% of time (**20th-percentile**)

20th-percentile flows are larger than the 7Q10 stream flow used for other pollutant WLAs

Reasonable Potential

- Determines whether NPDES limits are necessary
- Reasonable Potential to cause or contribute to excessive nutrient enrichment (i.e., exceed nutrient WQC) whenever:
 - **for Total Phosphorus (TP)**
 - TIC = 7 or less
 - **for Dissolved Inorganic Nitrogen (DIN)**
 - TIC = 7 or less, AND
 - Receiving water is nitrogen limited (Molar ratio of DIN to TP is 7 to 1 or less)

Subject to Change . . . ?

- Ohio EPA and US EPA not yet in agreement
 - How to account for uncertainty and “reasonable potential”?
- Ohio EPA proposes TIC as multi-metric assessment of overall stream status – ‘measurement of enrichment’
 - If ‘weight of evidence’ suggests no excessive enrichment, then nutrient criteria should not be applied to establish limits in NPDES permit



'Draft' Example

TIC and Reasonable Potential:

City of Columbus WWTPs

EXAMPLE

Scioto River downstream of Columbus Southerly & Jackson Pike WWTPs

Metric	Evaluation ('estimate')	Metric Score
$P_{chl\ a}$	No chlorophyll data (default value = 1)	1
P_{DO}	Minimum DO >5.0; 24-hr avg DO >6.0; and 24-hr range < 6.0	5
B	Biological survey (all indices meet warmwater habitat – or non-significant departure from)	6
N	TP = 0.041 to 0.10 mg/l; DIN = 1.1 to 3.0 mg/l	1
TIC	$TIC = P_{chl\ a} + P_{DO} + B + N$	13

If TIC = 8 to 16, stream status = "acceptable"

EXAMPLE

Scioto River downstream of Columbus Southerly & Jackson Pike WWTPs

- TIC (estimated value = **13**) . . . indicates “nutrient enrichment is not likely” → no TP permit limit
- DIN : TP ratio:
 - DIN = 2.65 mg/l = 0.189 mmole/l
 - TP = 0.32 mg/l = 0.0103 mmole/l
 - Molar DIN:TP ratio = **18.3** . . . indicates stream is not nitrogen limited → no DIN permit limit



Summing Up

Draft Ohio Nutrient Criteria Rules

- Stressor–response concept to develop criteria / rules
- Weight of evidence approach to determine stream status
 - **Trophic Index Criterion (TIC)**
 - *measurement of enrichment*
- TIC used to determine criteria applicability
- DIN criteria applied only if stream is nitrogen limited
- If applied, criteria will be stringent:
 - **TP:** 0.06 or 0.16 or 0.3 (mg/l)
 - **DIN:** 3.0 (mg/l)

Implementation Details ?

- How to determine metrics for TIC ?
 - Multiple data values: Median? Average? Min / Max?
 - Preponderance of evidence?
- Existing TP limits based upon TMDLs
 - What if TIC indicates no reasonable potential?
- Final rule must be approved by US EPA
 - Will there be changes ?

What Impact on POTWs ?

- Expect most plants will not have effluent nutrient limits
- If nutrient limits – expect TP only in nearly all cases
- Effluent limits may be higher than WQ criteria
 - Depends upon stream flow – if significant dilution then TP limits may be greater than 0.06 / 0.16 / 0.30 mg/l
- Effluent limits could be near treatment technology limits
- WQ trading option to achieve NPS nutrient reductions

Anticipated Schedule for Ohio's Nutrient Rules

✓ *November 2010 – sent 'working draft' rules to Region 5*

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- Spring 2011 – Draft rules for Interested Party Review
- Fall 2011 – File proposed rules
- Spring 2012 – Adopt rules
- Summer 2012 – Rules effective

opportunity
for public
comments

Credits

Thanks for information provided by:

Dan Dudley, Bob Miltner &

George Elmaraghy (Ohio EPA)

Questions ?



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Imagine the result