What to Expect from Ohio's Future Nutrient Regs ??

?

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Agenda

- Nutrients, and their impacts on water quality
- Challenge of regulating nutrients
- OEPA's Nutrients Technical Advisory Group (TAG)
- Nutrient rule framework
- SNAP tool to assess nutrient enrichment in streams
- Rule implementation
- Adaptive management
- Impacts to NPDES permittees

What are Nutrients?

- Nutrients are **necessary** for growth of living organisms
- In natural water bodies, some amount of nutrients are necessary for healthy growth of aquatic organisms: fish, aquatic 'bugs' (macroinvertebrates), zooplankton and photosynthetic microorganisms (algae)
- BUT . . . ***Too much nutrients can be bad!!***
- Two principal nutrients of concern for water quality:
  - **Phosphorus**
  - **Nitrogen**

What is Nutrient Pollution? Why is it a Problem?

- Excess nutrients (phosphorus and/or nitrogen) can allow too much algae to grow – results ranging from unpleasant nuisance to hazardous algal blooms (HABs)
- Excessive growths result in nuisance that impair fishing and other recreational uses
- Algal decomposition results in oxygen depletion in the water – hypoxia ("dead zone") – killing aquatic life
- Excessive algal growth may lead to nonattainment of biocriteria (Ohio water quality criteria)
- Algae can produce taste and odor problems in water supplies

Algal Growth Nutrient Limitation

- Algae are the base of the food chain and essential to aquatic life in natural water bodies
- Algal growth may be limited by several factors
  - Sunlight
  - Temperature
  - pH
  - CO_2
  - Phosphorus
  - Nitrogen
- Algae will increase until their growth is limited by one or more of these factors
- In summer, algal growth is usually limited by nutrients
  - In salt/marine waters, nitrogen is usually the limiting nutrient
  - **In freshwater, phosphorus is the primary limiting nutrient**
- ***Phosphorus is the nutrient of concern for most Ohio waters***

Nutrients of Primary Concern: PHOSPHORUS

- Measured as:
  - Total (TP)
    Total includes particulate and soluble forms of P
  - Dissolved (DP)
    "d*issolved" is also called "soluble" or "orthophosphate"*
- Dissolved P is essentially all bio-available,
- Particulate P can be converted in natural waters and become available also
- Phosphorus is usually the limiting nutrient in freshwater systems
- Phosphorus is generally the 'nutrient of concern' in Ohio waters

Nutrients of Primary Concern: NITROGEN

- Nitrogen is generally not a nutrient of concern for most Ohio waters
  - However, it is a major contributor to hypoxia in the Gulf of Mexico
- Nitrogen exists in several chemical forms:
  - Ammonia, Nitrate, Nitrite, Organic . . . DIN
  - Relevant form in Ohio rulemaking is Dissolved Inorganic Nitrogen (DIN)

Ohio Nutrient Impacts

Lake Erie Watershed
– *subject to eutrophication and hazardous algal blooms (HABs)*

Lakes & Streams statewide
– *may be subject to nuisance growths, HABs*

Ohio River Watershed
drains to the **Gulf of Mexico**
– Northern Gulf *subject to summer hypoxia*
– *HABs on Ohio River*

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Estimated Phosphorus Contribution by Source

Basin	Point Sources	Nonpoint Sources
Lake Erie Basin [1]	21%	70%
Mississippi River Basin [2]	12%	80%

Sources:
1 NCWQR (Heidelberg Univ.), Ohio EPA, Michigan DEQ, Lake Erie Task Force
2 USGS

The Challenge for Nutrient Rule Development

Water Quality Standards and Water Quality Criteria

- **WATER QUALITY STANDARDS** (WQS) have 2 key elements:
  1) **Designated Uses** – e.g., aquatic life, water supply, etc.
  2) **WATER QUALITY CRITERIA** (WQC) protective of designated uses

- **WQC** may be either:
  - Numeric criteria: explicit chemical concentration values such as:
    "*TP ≤ 0.05 mg/l*"
  - Narrative criteria: description of acceptable conditions, such as
    "*Free of phosphorus in quantities that cause algal blooms*"

- Ohio also has **biological WQC** ("biocriteria")

Ohio's Biological WQC: BIOCRITERIA

- Numerical values that describe the biological condition of a water body necessary to protect a designated aquatic life use
- Biocriteria provide a direct measure of attainment of aquatic life uses, while chemical criteria provide an indirect measure
- Ohio has three indices based on species richness, trophic composition, diversity, presence of pollution-tolerant individuals or species, abundance of biomass, and the presence of diseased or abnormal organisms (OAC 3745-1-07)
  - IBI and Miwb (fish)
  - ICI (macroinvertebrates)
- ***Biocriteria take precedence over chemical-specific WQC for demonstration of aquatic life use attainment***

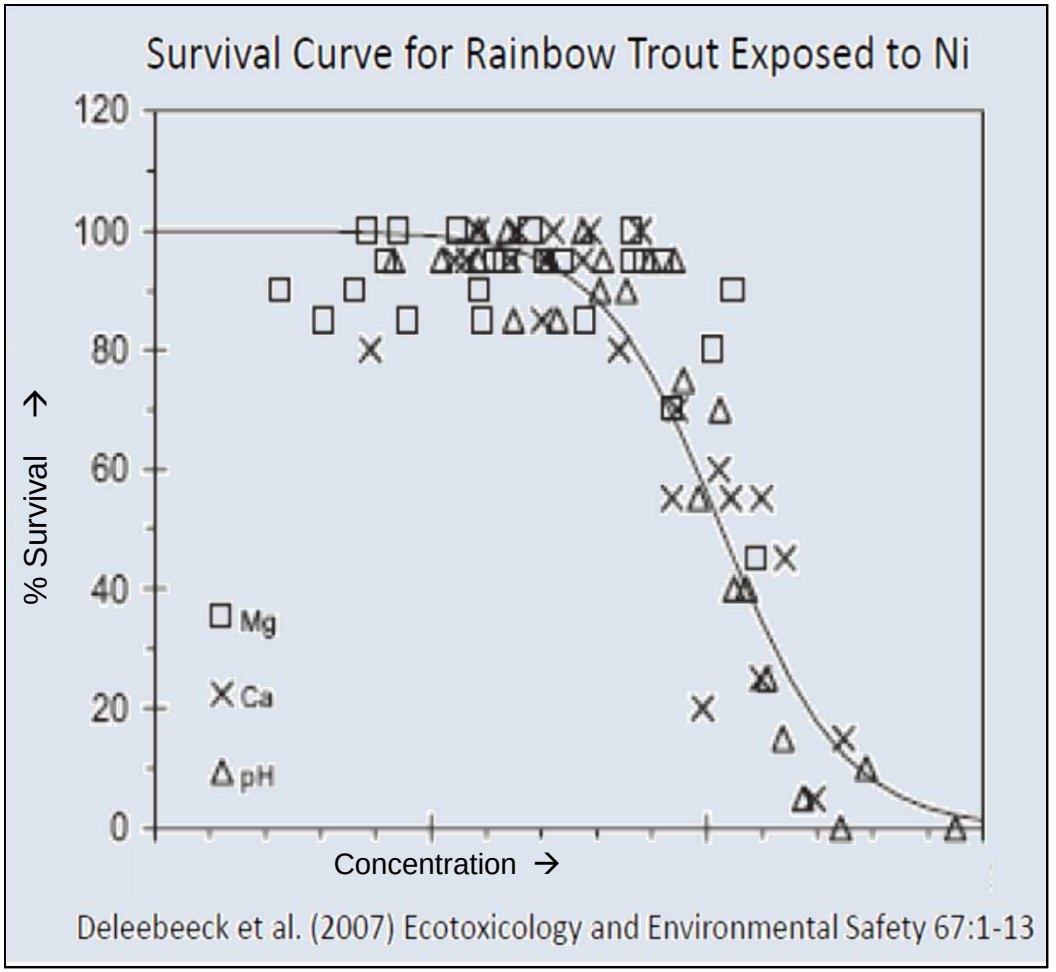
Types of Pollutants and Regulations to Control

- Conventional Pollutants: examples – BOD_5, TSS, O&G
  - Impacts on WQ: depletion of dissolved oxygen; buildup of sludge and scum deposits
  - Regulatory control: typically technology-based effluent limits

- Toxic Pollutants: examples – metals, pesticides, cyanide
  - Impacts on WQ: adverse effects to aquatic life including mortality, reduced growth or reduced reproduction
  - Regulatory control: WQC for each pollutant . . . Water quality-based effluent limits (WQBEL) to assure receiving water body attains WQC for each pollutant

WQC based on Dose-Response Relationship

- Well-defined dose-response relationships
- Increasing dose (concentration) reaches a clear response (toxicity) level
- WQC can be applied independently

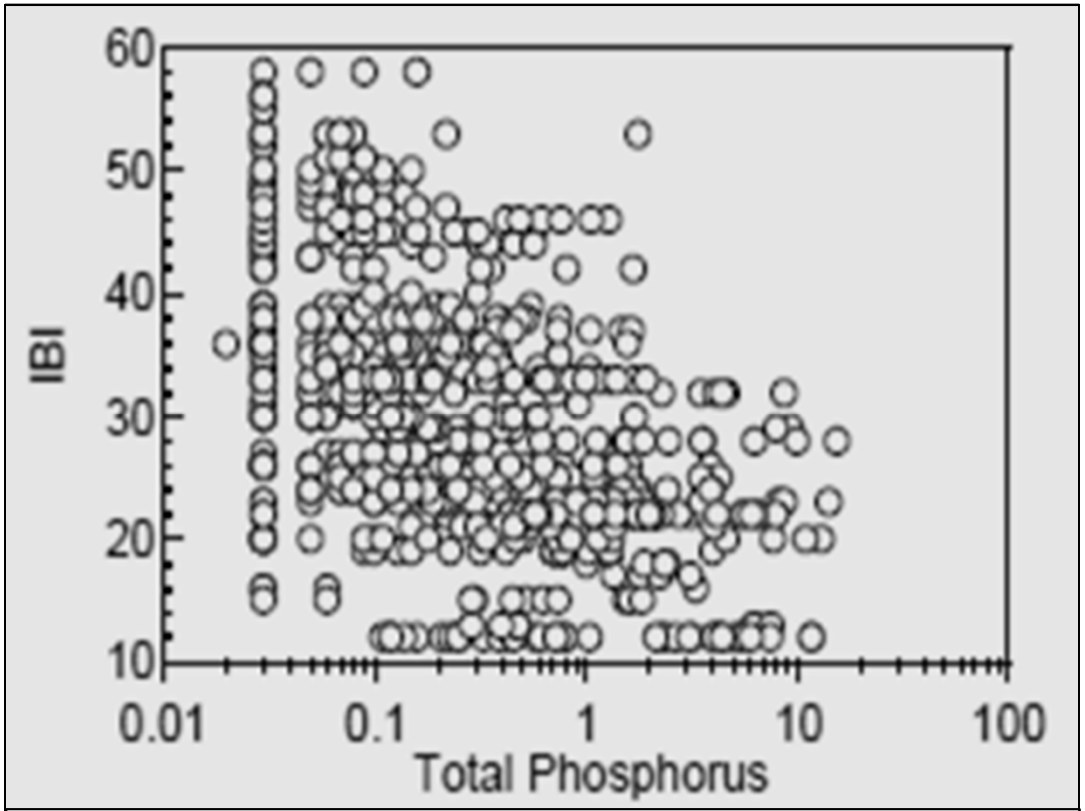


The Challenge for Regulating Nutrients

- Nutrients do not have direct toxic effects
- Simple dose-response relationships do not exist with nutrients
- Relationship between nutrients and aquatic life is indirect and complicated by other physical factors in the stream:
  - Habitat (measured by index: QHEI)
  - Stream morphology (depth, width, shape, slope, bed, banks)
  - Flow regime (may cause sedimentation and/or scouring)
  - Canopy (affects amount of sunlight striking stream)
  - Temperature
- ***'One-size-fits-all' numeric WQC don't work for nutrients!***

Field Nutrient Data Shows Overall Trend but Highly Variable Individual Measurements

- Scatter plot of TP concentration vs. IBI (biocriteria index value) for Ohio streams
- Data shows clear tendency for streams with higher TP concentrations to have reduced biocriteria scores, but impossible to predict biocriteria from a single TP value



Source: "*Association Between Nutrients, Habitat, and the Aquatic Biota of Ohio Rivers and Streams*", OEPA, 1999

OHIO NUTRIENT REDUCTION STRATEGY:
The road from "free froms" to SNAP

- OAC 3745-1-04(E) – Ohio EPA's narrative "free from" (1978)
- OAC 3745-1-07, Table 7-11 – 1.0 mg/l technology-based phosphorus limit for Lake Erie basin dischargers, as part of International Joint Commission (U.S. – Canada Agreement)
- The Associations Report – Ohio EPA's reference stream approach (1999)
- TIC – Trophic Index Criterion – Ohio EPA's first stressor response approach to nutrients (2013)
- SNAP – Stream Nutrient Assessment Procedure (2015)

Ohio Nutrient Reduction Strategy: 1978 - 1999
Case-by-Case based on existing OEPA nutrient rules

- OAC 3745-1-04(E) (First adopted 2/14/78):

  "To every extent practical and possible . . . all surface waters shall be free from nutrients entering the water as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae."

- 3745-1-07 (Table 7-1): limited to lake Erie basin – as part of the U.S.- Canada Agreement

  "In areas where such nuisance growths exist, phosphorus discharges from point sources determined significant by the director shall not exceed a daily average of 1 mg/l, or such stricter requirements as may be imposed by the director . . ."

OHIO NUTRIENT REDUCTION STRATEGY: 1999
The *'Associations Report'* (January 7, 1999)

- Study of unimpacted smaller streams found that TP concentrations were typically < 0.1 mg/l.
- Application of Associations Report to TMDLs: de facto TP Water Quality Standard of 0.11 mg/l.
- Based on U.S. EPA's initial recommendation that states develop numeric standards using the reference stream approach.
- Reference stream approach criticized by U.S. EPA Science Advisory Board, and ultimately rejected by the federal courts in Florida.

OHIO NUTRIENT REDUCTION STRATEGY: 2013

TIC: Trophic Index Criterion

- To better reflect the nutrient-aquatic life relationship and develop a defensible cause-effect connection, OEPA proposed the TIC.
- TIC determined trophic condition of a stream - acceptable, threatened, or impaired – based on weighing of four indicators of water quality: biocriteria, DO swing, Chlorophyll-*a*, and nutrients (TP, DIN).

From TIC to TAG to SNAP

- TIC put out for Early Stakeholder Outreach (ESO) in 2013
- At a high level, the Comments were generally favorable and endorsed the multi-metric biologically-based approach to establishing nutrient WQS
- At ground level, a substantial number of questions and concerns about the TIC were raised
- OEPA created a stakeholder-based technical advisory group ("TAG")
- In coordination with OEPA, the Technical Subgroup of the TAG used the TIC as a starting point to develop an improved assessment tool: the Stream Nutrient Assessment Procedure ("SNAP")

Cause-Effect Demonstration for Phosphorus

- The adequacy of the cause-effect demonstration for phosphorus is the most significant factual and legal dispute associated with new phosphorus water quality criteria.
- Under all state and federal CWA permitting programs, WQBELs placed into NPDES permits must be supported by a demonstration that the discharge, either alone or in conjunction with other discharges, has the "reasonable potential" to cause or contribute to a violation of applicable water quality criteria.

US EPA Mandate for Nutrient Criteria

- US EPA Nutrient Strategy (1998 - 2001)
  - States required to develop regional, scientifically defensible criteria
- US EPA guidance and States' rulemaking
  - 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
  - Contentious nutrient rulemaking in Florida (2008-14)
- In 2010, EPA's Science Advisory Board critical of US EPA's approach
  - WQ Criteria should be based upon: **"stressor-response" ("cause and effect")**

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USEPA Mandate (cont.)

Different Approaches for Nutrients Control Regulation

Independent Application

US EPA

- All WQ criteria must be applied individually
- Nutrient criteria must be met regardless of whether biological criteria are attained

Weight of Evidence

Ohio EPA

- Assessment to determine whether nutrients are cause of non-attainment
- **Only if** nutrients are cause or threat, then nutrient control actions must be imposed

Biological Stressors for Eutrophication

- **Nutrients**
- Stream morphology
- Flow (impoundments, sedimentation, scouring)
- Canopy
- Riparian vegetative cover
- Salinity (TDS), other water chemistry

Habitat

Reducing nutrients without solving habitat problems will not attain biocriteria WQS!

Biological Indicators & Response Variables

- Ohio's biological water quality criteria indices ("biocriteria"):
  - **ICI** (macroinvertebrates)
  - **IBI**, **MIwb** (fish)
- Algal growth response variables
  - Measurement of chlorophyll
  - Diurnal dissolved oxygen swings

Ohio Nutrient Rule Development

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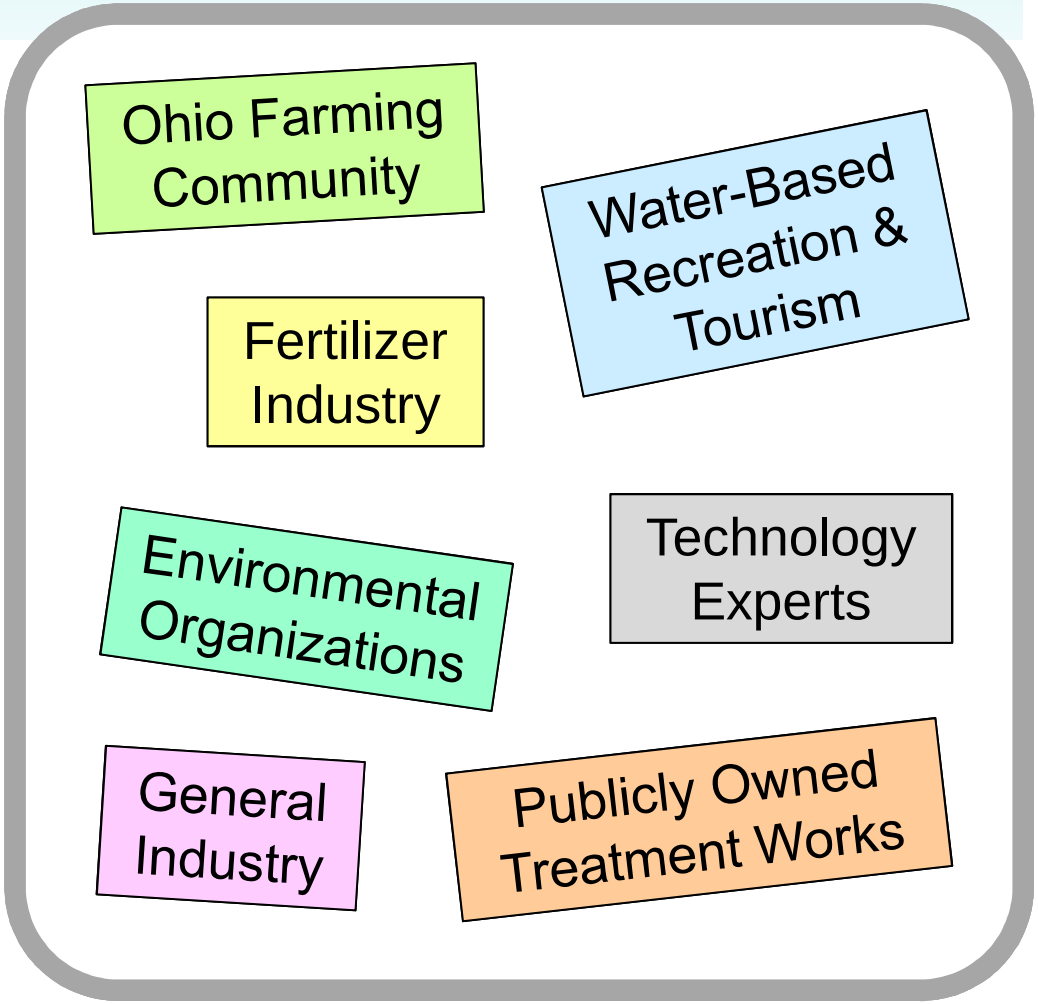
Nutrients Technical Advisory Group (TAG)

- Unique approach for OEPA; first-time for such major rulemaking
- External members, representing all stakeholder groups
- TAG given mission to develop nutrient rule recommendations



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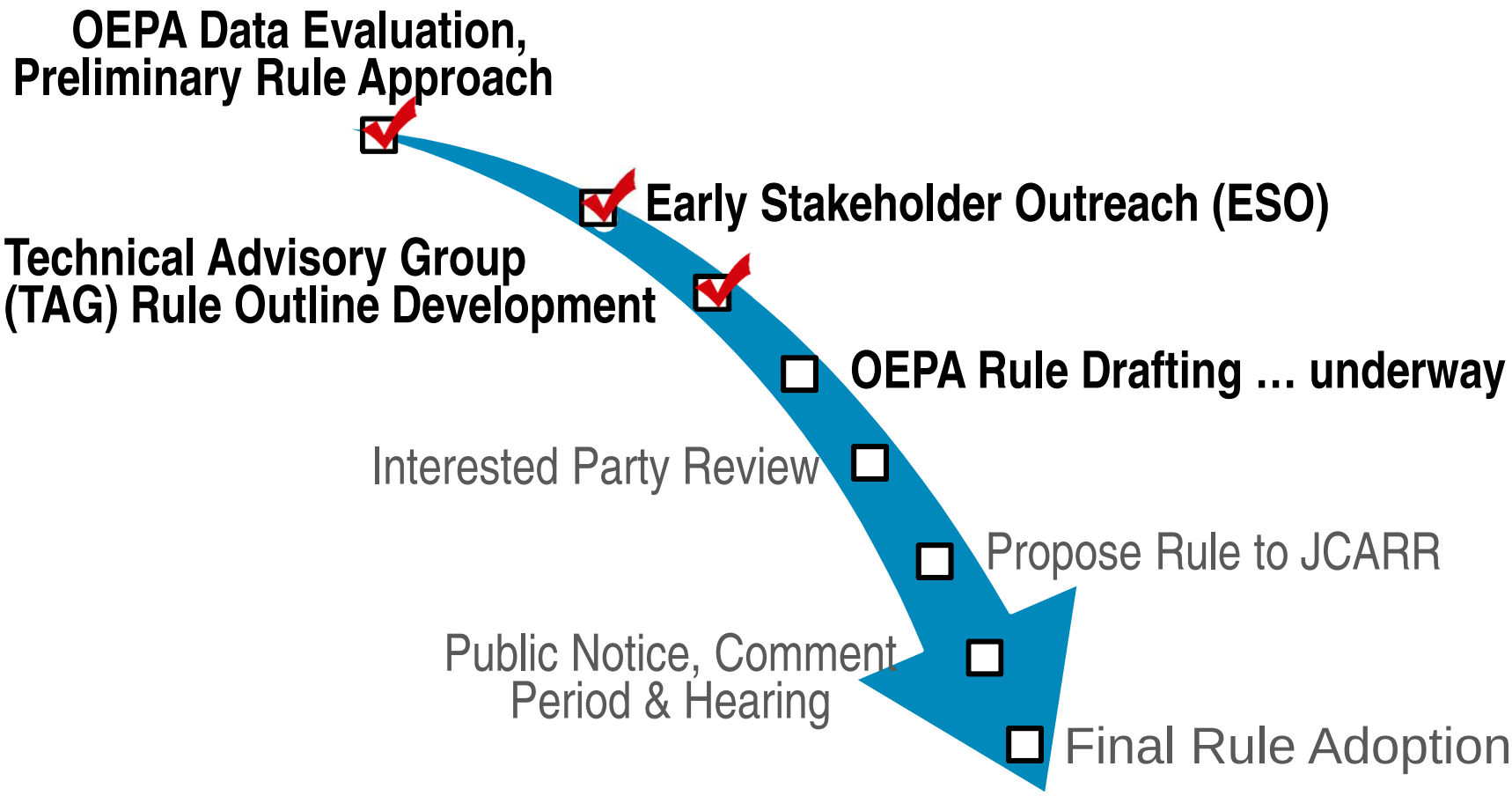
TAG Effort for Nutrient Rule Development

- Nov 2013 – Jun 2015:
  - 15 meetings of full TAG membership + observers
  - Numerous committee and 'sub-group' meetings
- OEPA provided staff consultation
- TAG developed new tool (based upon OEPA prototype) to assess nutrient enrichment condition
- TAG developed nutrients WQS rule framework, including detail aspects for implementation issues
- TAG submitted draft rule framework to OEPA (October & December 2015)

Pathway to Ohio Nutrients Rule



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RULEMAKING IN PROGRESS!

Disclaimer

- *TAG has developed a rule framework with specific recommendations for OEPA to use in drafting nutrient rules for Ohio*
- *Today's presentation summarizes the nutrient rule framework as developed by TAG*
- *Draft rule to be proposed by Ohio EPA may be different!*

Ohio Nutrient Rule Concept

1. Assess stream to determine whether nutrient-caused WQ problem exists
   - Nutrients require a 'new' way of thinking re: non-attainment
   - New assessment tool developed by TAG – based upon OEPA prototype using weight of evidence evaluation
2. IF nutrients impair or threaten stream WQ, then (*and only then*) implement actions to improve WQ and achieve attainment
   - Implement initial management actions
   - Use Adaptive Management (AM)

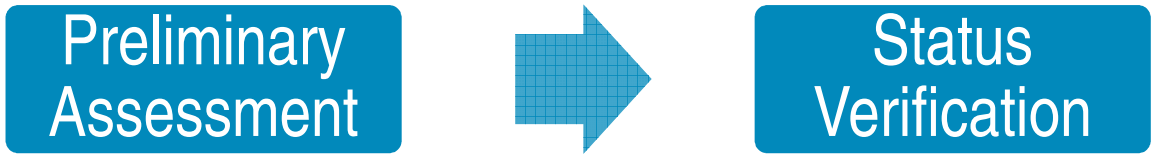
SNAP (Stream Nutrient Assessment Procedure)

SNAP
(Stream Nutrient Assessment Procedure)

A new tool for Ohio:

- "Weight of Evidence" assessment of nutrient enrichment status in a stream segment
  - Looks at multiple measures to assess potential nutrient enrichment

- Two-part assessment procedure:



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Basis of SNAP

FIRST: Determine biological WQ criteria attainment

- **Biocriteria** are a direct measure of WQ designated use attainment

AND: Evaluate key nutrient response indicators

- **24-hour DO swing** (max DO - min DO)
- **Benthic chlorophyll-*a***

THEN: Confirm preliminary condition assessment

- Other stressors – habitat or pollutants?
- If not impaired, determine if threatened

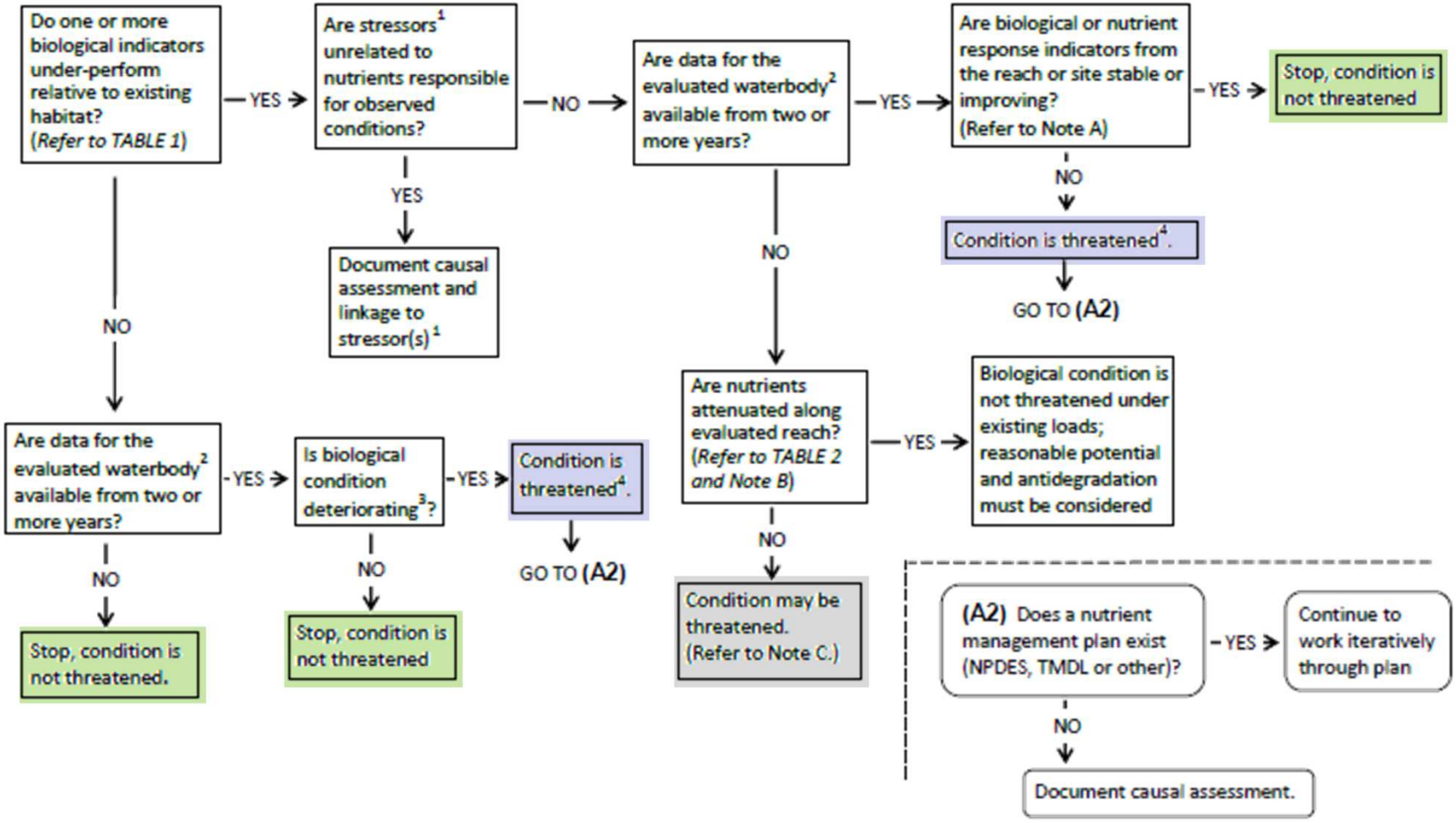
* Note that nutrient concentration is not incorporated. Nutrient concentration is poorly correlated with nutrient-caused impairment!!

Stream Nutrient Assessment Procedure (SNAP)

Step 1	Step 2	Step 3	Step 4	
Biological Criteria	**DO Swing**	**Benthic Chlorophyll**	**Preliminary Assessment: Nutrient Enrichment Status**	
All indices attaining or non-significant departure	Normal or low swings (≤6.5 mg/l)	Low to moderate (≤320 mg/m^2)	Attaining use / not threatened	
		High (>320 mg/m^2)	Attaining use, but may be threatened	*See Flow Chart A*
	Wide swings (>6.5 mg/l)	Low (≤182 mg/m^2)		
		Moderate to high (>182 mg/m^2)		
Non-attaining (one or more indices below non-significant departure)	Normal or low swings (≤6.5 mg/l)	Low to moderate (≤320 mg/m^2)	Impaired, but cause(s) other than nutrients	*See Flow Chart B*
		High (>320 mg/m^2)	Impaired / likely nutrient enriched	*See Flow Chart C*
	Wide swings (>6.5 mg/l)	Low (≤182 mg/m^2)		
		Moderate to high (>182 mg/m^2)	Impaired / Nutrient enriched	

SNAP FLOW CHART A

Decision matrix for determining when biologically attaining condition status is threatened



SNAP: FLOW CHART A.
Determines if biology is threatened

Reader's Digest version

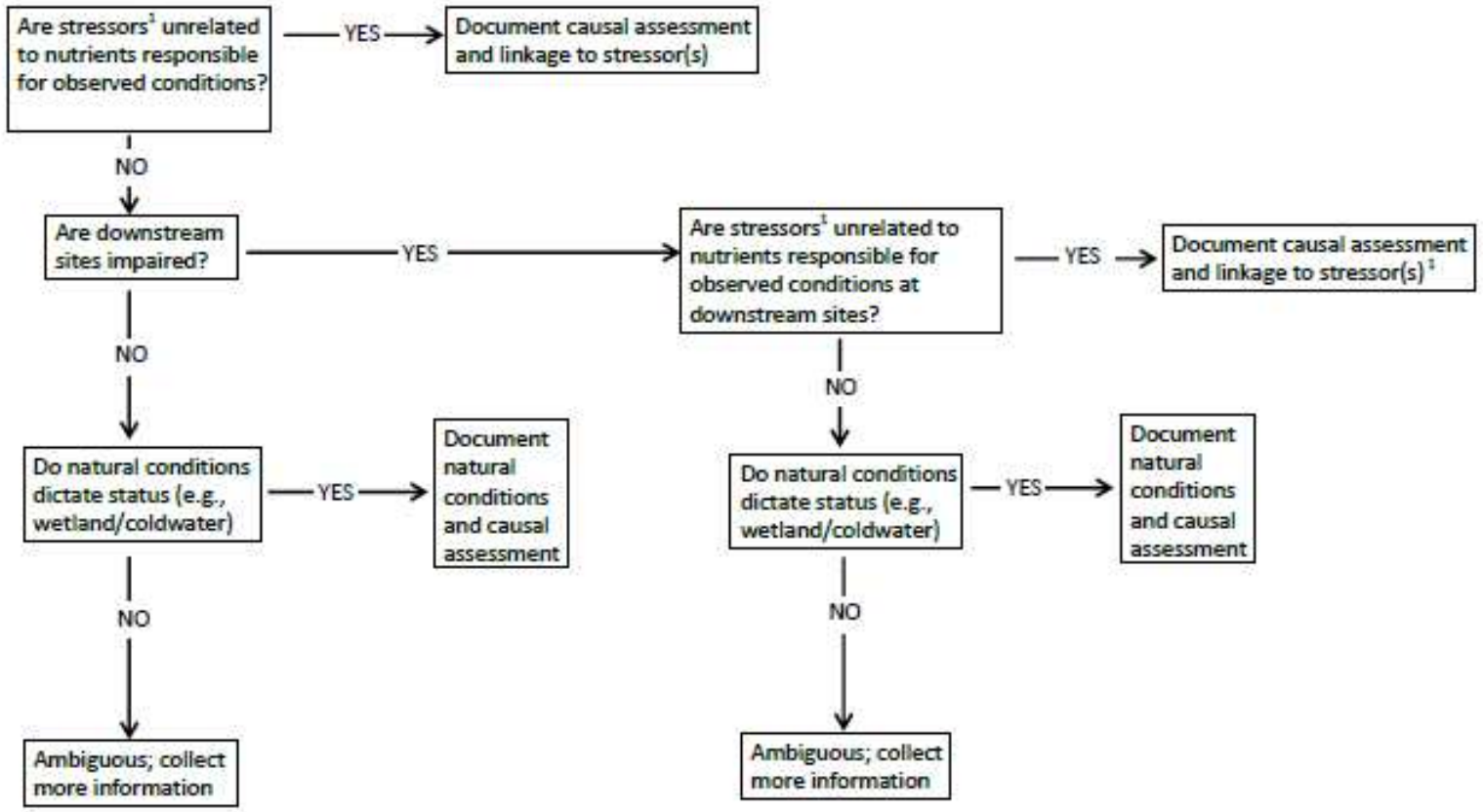
- Used when:
  - biological criteria are attaining
    (may be 'under-performing')

  BUT

  - Nutrient response indicator(s) are elevated
    (DO swing and/or benthic chlorophyll)
- Possible assessment outcomes:
  - Not threatened
  - Threatened by other (non-nutrient) causes
  - Threatened by nutrients

SNAP FLOW CHART B

Decision tree for determining biological impairment caused by stressors other than nutrients



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SNAP: FLOW CHART B.
Determines when biological impairment may be caused by stressors other than nutrients

Reader's Digest version

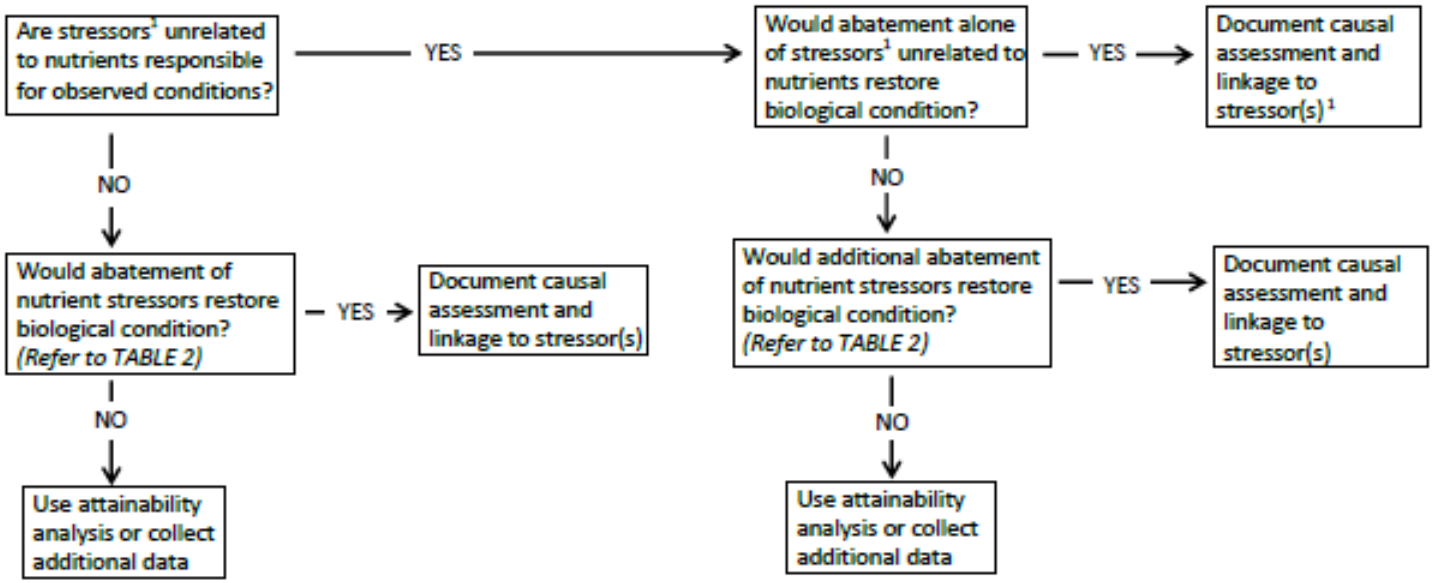
- Used when:
  - one or more biological criteria are non-attaining

  BUT

  - No nutrient response indicators are elevated *(DO swing or benthic chlorophyll)*
- Possible assessment outcomes:
  - Stressors other than nutrients cause impairment
  - Natural conditions / habitat cause impairment
  - Ambiguous . . . collect more information

SNAP FLOW CHART C

Decision tree for confirming biological impairment caused by nutrients



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SNAP: FLOW CHART C.
Confirms when biological impairment is caused by nutrients

Reader's Digest version

- Used when:
  - One or more biological criteria are non-attaining

  AND

  - Either nutrient response indicator is elevated
    (DO swing or benthic chlorophyll)
- Possible assessment outcomes:
  - Abatement of nutrients will "materially improve" biology
  - Abatement of nutrients will not "materially improve" biology; Perform Use Attainability Analysis, or collect additional data
  - Stressors other than nutrients cause impairment

EXAMPLE

Stream Nutrient Assessment Procedure (SNAP)

Step 1	Step 2	Step 3	Step 4	
Biological Criteria	**DO Swing**	**Benthic Chlorophyll**	**Trophic Condition Status**	
All indices attaining or non-significant departure	Normal or low swings (≤6.5 mg/l)	Low to moderate (≤320 mg/m^2)	Attaining use / not threatened	
		High (>320 mg/m^2)	Attaining use, but may be threatened	*See Flow Chart A*
	Wide swings (>6.5 mg/l)	Low (≤182 mg/m^2)		
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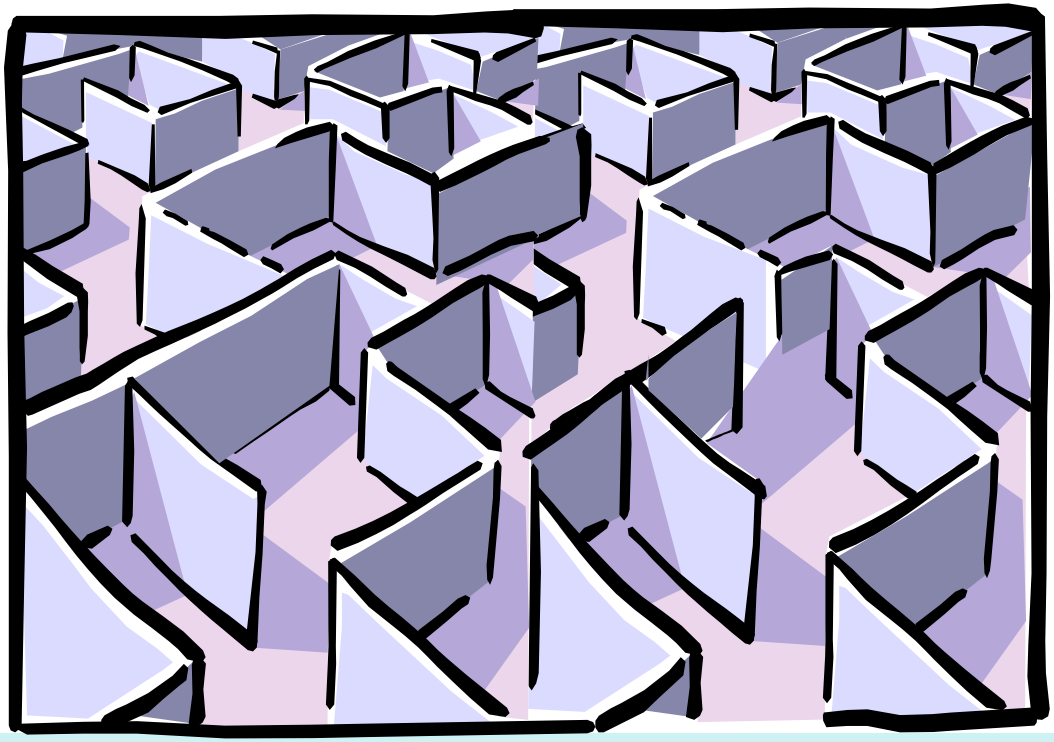
		High (>320 mg/m^2)	Impaired / likely nutrient enriched	*See Flow Chart C*
	Wide swings (>6.5 mg/l)	Low (≤182 mg/m^2)		
		Moderate to high (>182 mg/m^2)	Impaired / Nutrient enriched	

Where will SNAP apply?

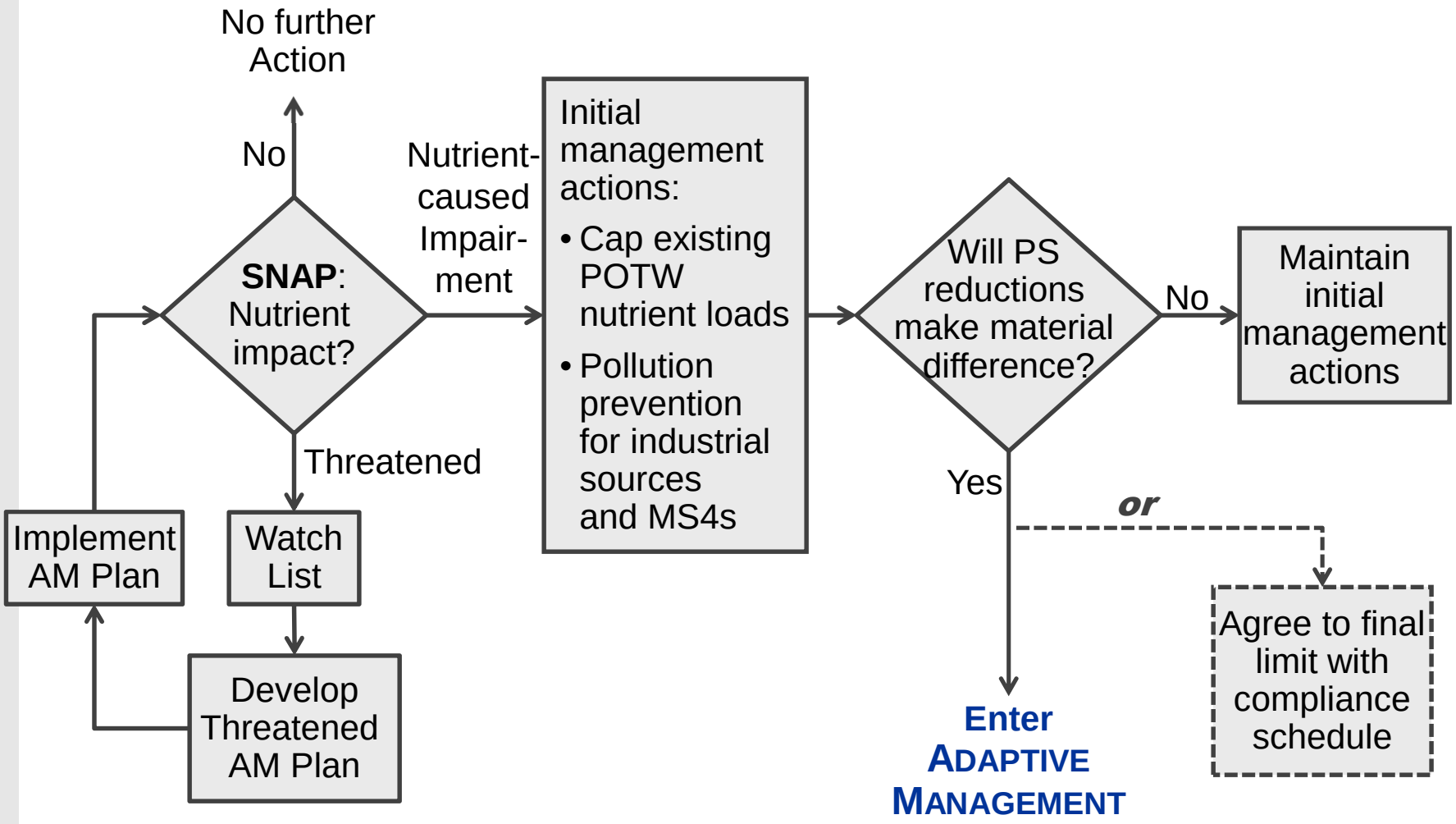
- SNAP will apply where:
  - Free-flowing stream segments
  - Designated aquatic life uses
  - Drainage area less than 1,000 sq.mi.
  - Benthic algae (attached to rocks in streambed) dominates over sestonic algae (suspended in the water)

- SNAP will **not** apply:
  - Large rivers: where sestonic algae dominate over benthic algae
    - Generally: drainage area >1,000 sq.mi.
    - Or segments with drainage area 500 -1000 sq.mi. that behave more like large river segments
  - Headwater and small streams

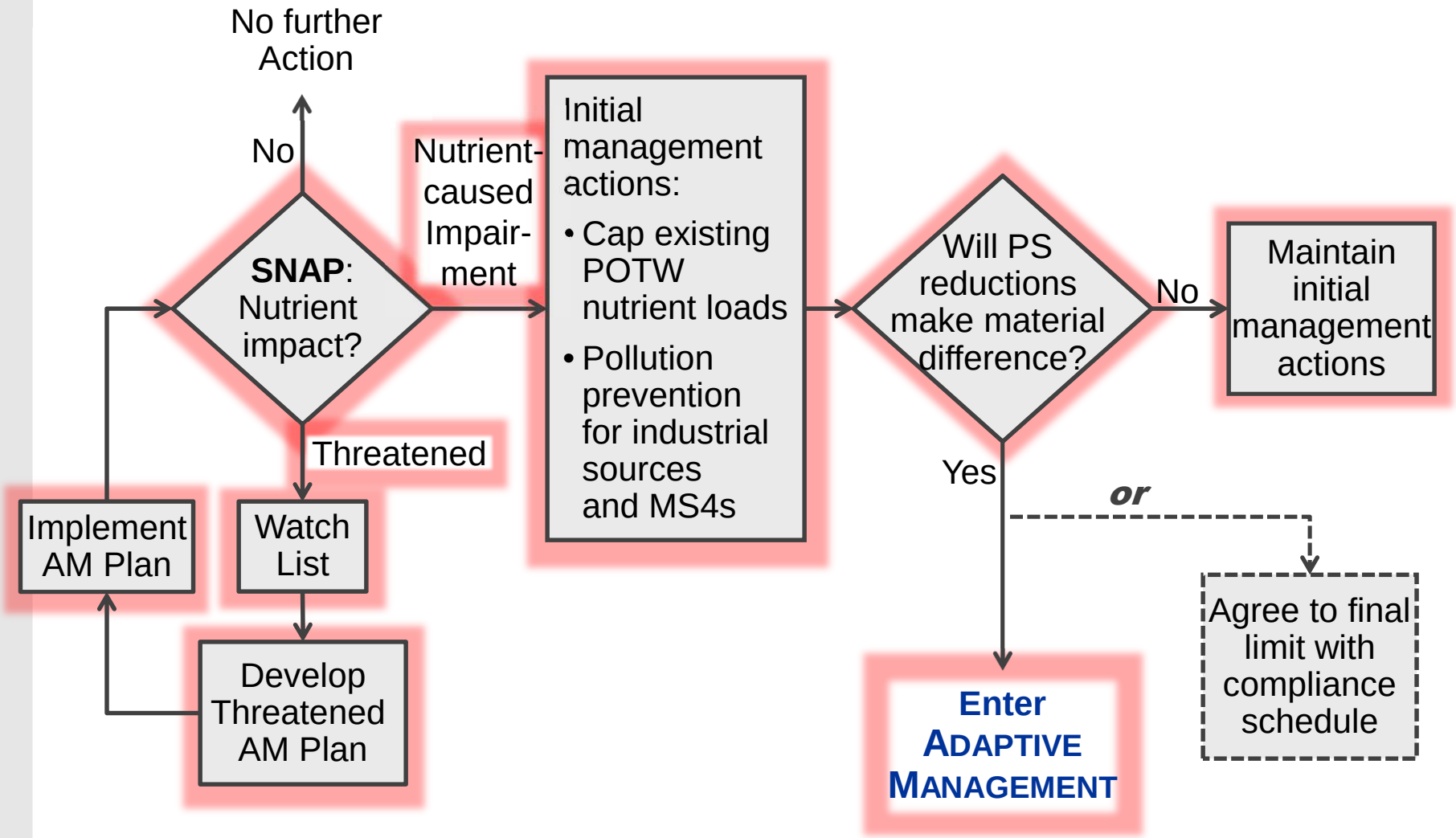


Rule Implementation Framework

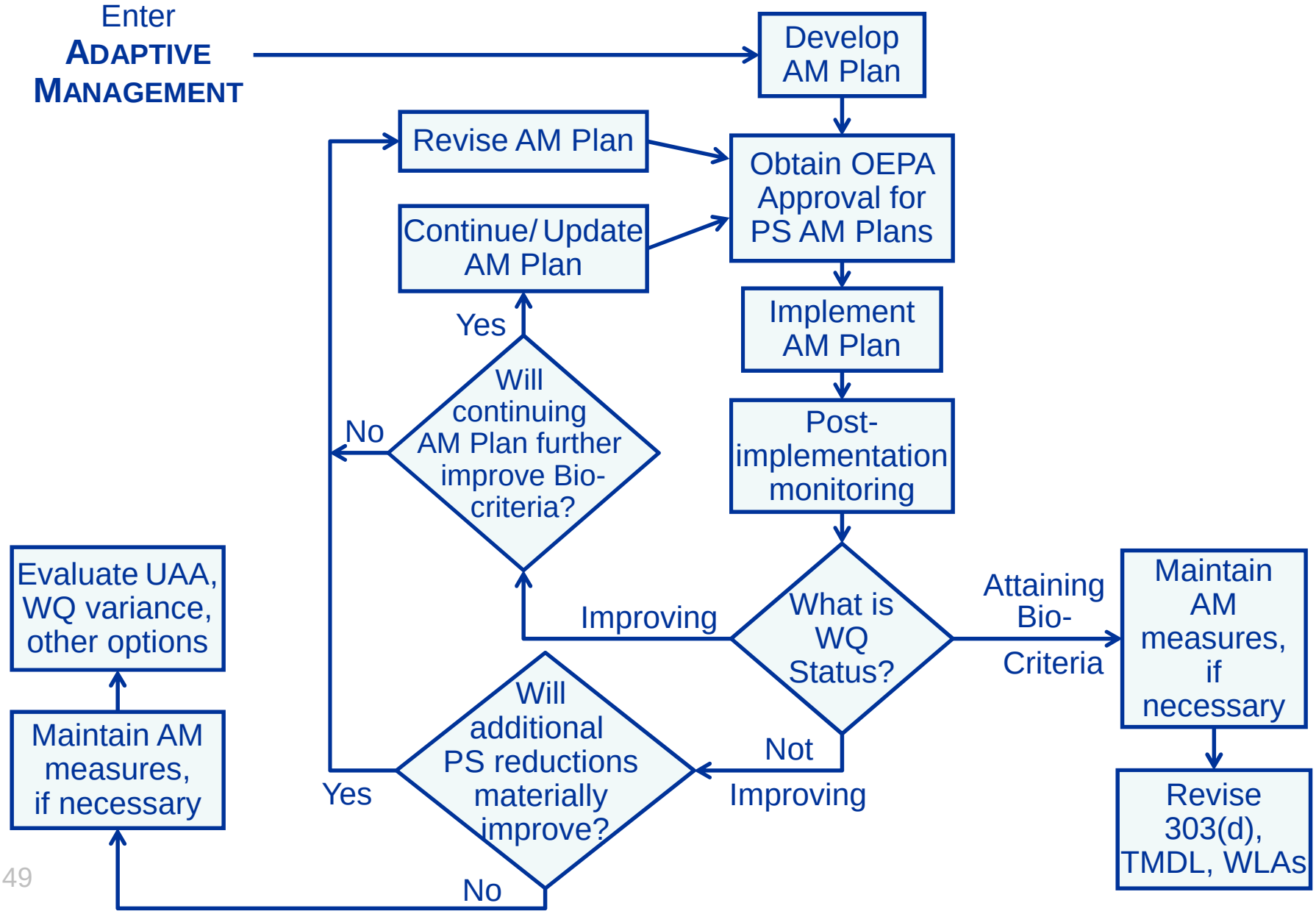
Nutrient Rule Implementation



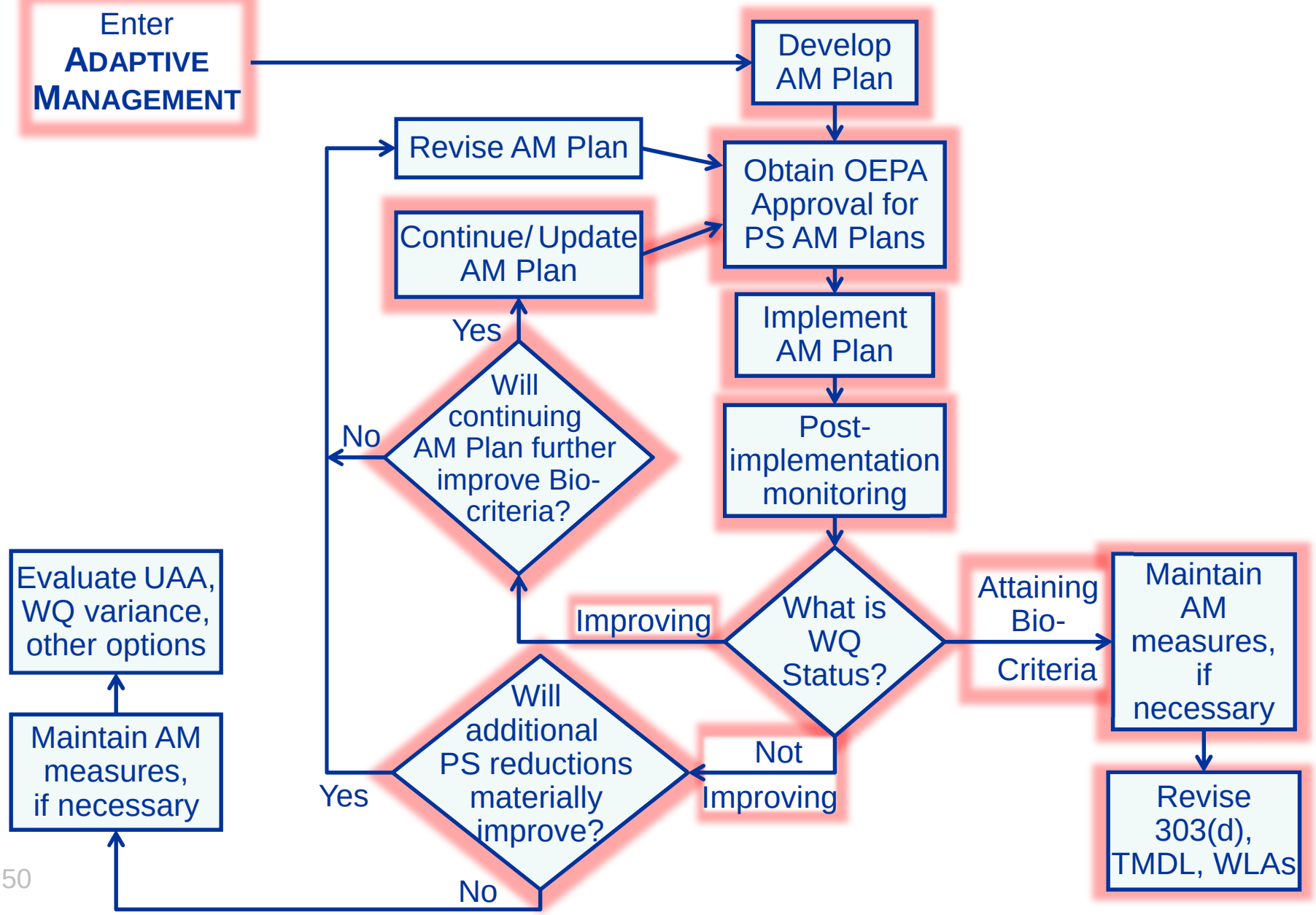
Nutrient Rule Implementation



Nutrient Rule Adaptive Management



Nutrient Rule Adaptive Management



Target Concentrations & Target Loads

IF SNAP determines stream segment is either impaired or threatened by nutrients . . .

- Water Quality Target Load (WQTL) shall be determined for total phosphorus (TP) only,

UNLESS

- If nitrogen is found to be limiting or co-limiting, then WQTL shall be determined for dissolved inorganic nitrogen (DIN)

Water Quality Target Concentration

a) If necessary data available or readily available, calculate water quality target concentration (WQTC) using WQ modeling based on achieving stream segment
   - DO swing ≤ 6.5 mg/l, and
   - Benthic chlorophyll *a* ≤ 320 mg/m^2

b) If necessary data not available, use provisional WQTC
   - TP = 0.40 mg/l
   - DIN = 3.6 mg/l

Water Quality Target Load

- Using WQTC as developed, calculate WQTL:

WQTL = (WQTC) x (stream flow)

  - Stream flow exceeded 80 percent of time during growing season [*20th percentile*]
    - 20th percentile flow > 7Q10 flow used to develop wasteload allocations for other pollutants

- WQTL may be used to determine:
  - WLAs and LAs in TMDLs
  - Permit limits

Adaptive Management

Adaptive Management (AM)

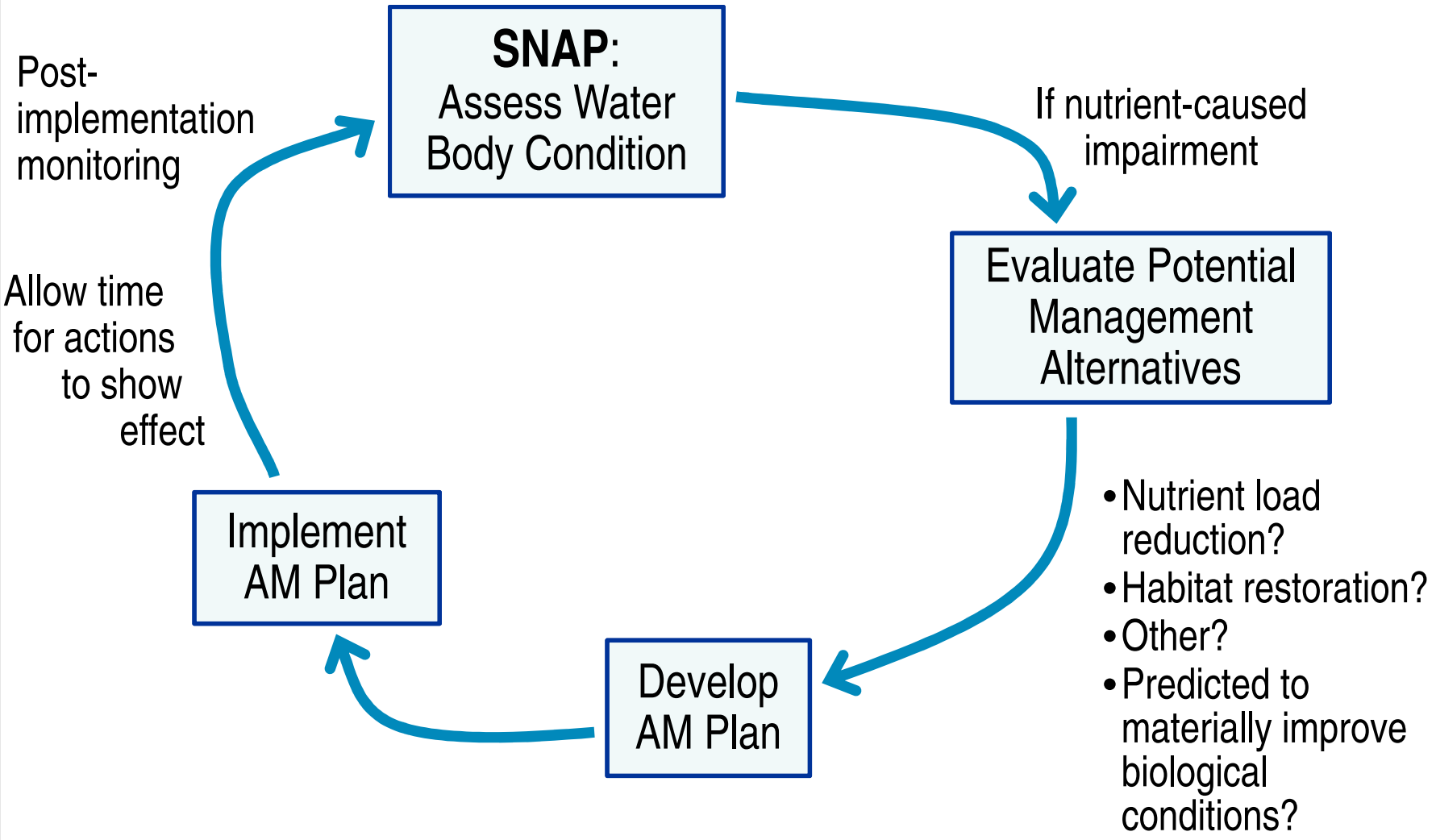
- AM is an iterative process to design and implement cost-effective management actions to abate impairments to water quality caused in whole or part by nutrients

- Because of uncertainty about causal and restorative links between aquatic biology, nutrients, and other stressors – AM provides opportunity to implement alternatives, evaluate effectiveness, then adapt and continue implementation

Adaptive Management Plans

- Developed by: permittee (PS); watershed partners (NPS)
- Submit: for approval (PS to OEPA);
  for endorsement (NPS to OEPA & ODNR)
- For point sources, approved AM Plan becomes part of the NPDES permit
  . . . therefore enforceable!
- Following implementation, monitoring & assessment: – AM Plan to be maintained and/or revised, and implementation continued

Adaptive Management



AM Plan Elements

- One or more management alternatives
  - designed to materially improve biological conditions and reduce adverse nutrient impacts
- Description of actions to be taken (who/what/when)
- How AM actions will be maintained
- Implementation time schedule
- Estimated cost and benefits
- Post-implementation monitoring program

Potential AM Plan Alternatives

- Nutrient reduction
  - Wastewater treatment nutrient removal
  - NPS nutrient load reduction
- Riparian and habitat restoration and improvement
- Effluent trading
- Watershed management practices
- Other actions

Objective: reduce nutrient loading, or implement other watershed improvement to reduce nutrient-related biological impairment

Implementation in Permits

Implementation in Permits

- SNAP assessment will result in one of four findings:
  1) No nutrient-caused impact to biocriteria
  2) Nutrients are threatening attainment of biocriteria
  3) Nutrients are causing impairment of biocriteria
  4) Factors other than nutrients are causing impairment

- If no nutrient-caused impairment (#1 or #4), ***NO*** nutrient permit limits

If Nutrients are Threatening Attainment

IF SNAP shows threat to stream segment's designated aquatic life use

- Permits to existing point sources will:
  - Cap existing POTW nutrient loads at existing effluent quality (EEQ)
  - Require pollution prevention measures for industrial point sources

If Nutrients are Cause of Impairment

IF SNAP shows nutrients are **material cause** of impairment, OEPA will:

- Initial action: Cap existing POTW nutrient loads at EEQ, and require pollution prevention for industries
- Evaluate whether PS nutrient load reductions **alone** will materially improve stream biology

Then PS shall either:

- Develop & implement adaptive management plan (AMP)

OR

- Comply with final permit limits & compliance schedule

When to Impose Nutrient Controls

- Nutrient controls (WQTL or AM) **only** if PS nutrient reductions alone will result in material improvement in biocriteria scores

- Permit controls for TP only, unless evidence that DIN is limiting or co-limiting

Considerations Prior to Permit Limits or AMPs

OEPA must consider:

- Technical feasibility of meeting limits / implementing AMP
- Projected environmental benefits of meeting limits / AMPs and compliance schedules
- Costs, cost-effectiveness, and affordability of implementing measures to meet limits / AMPs

NPDES Permit Compliance Schedules

- May extend to multiple permit cycles
  - *Particularly important for AM*
- Provide time for evaluation of technical feasibility, environmental benefits, costs, and affordability
- Allow time to perform engineering studies to evaluate alternatives
- Allow time for detailed design, contract bidding, construction, startup & initial process troubleshooting

Numeric Permit Limit Details

- Nutrient limits to be imposed as **seasonal average** for growing season (typically May - October)
- Nutrient limits to be imposed as **mass loads**
- Interim limits cannot be imposed:
  - If facility improvements to achieve interim limits would substantially increase cost of subsequent modifications to achieve anticipated final limits
  - If no reasonable expectation that interim limits will materially improve biological condition