Overview of Nutrient Criteria Development Approaches

Connie Brower – NCDEQ Water Quality Standards
Chris Ventaloro – NCDEQ Water Quality Standards

NCDP SAC Meeting
October 19th, 2016
Department of Environmental Quality

A Recap of "The Goal"

To Develop

Scientifically Sound,

Defensible,

and

Economically Feasible

Nutrient Criteria

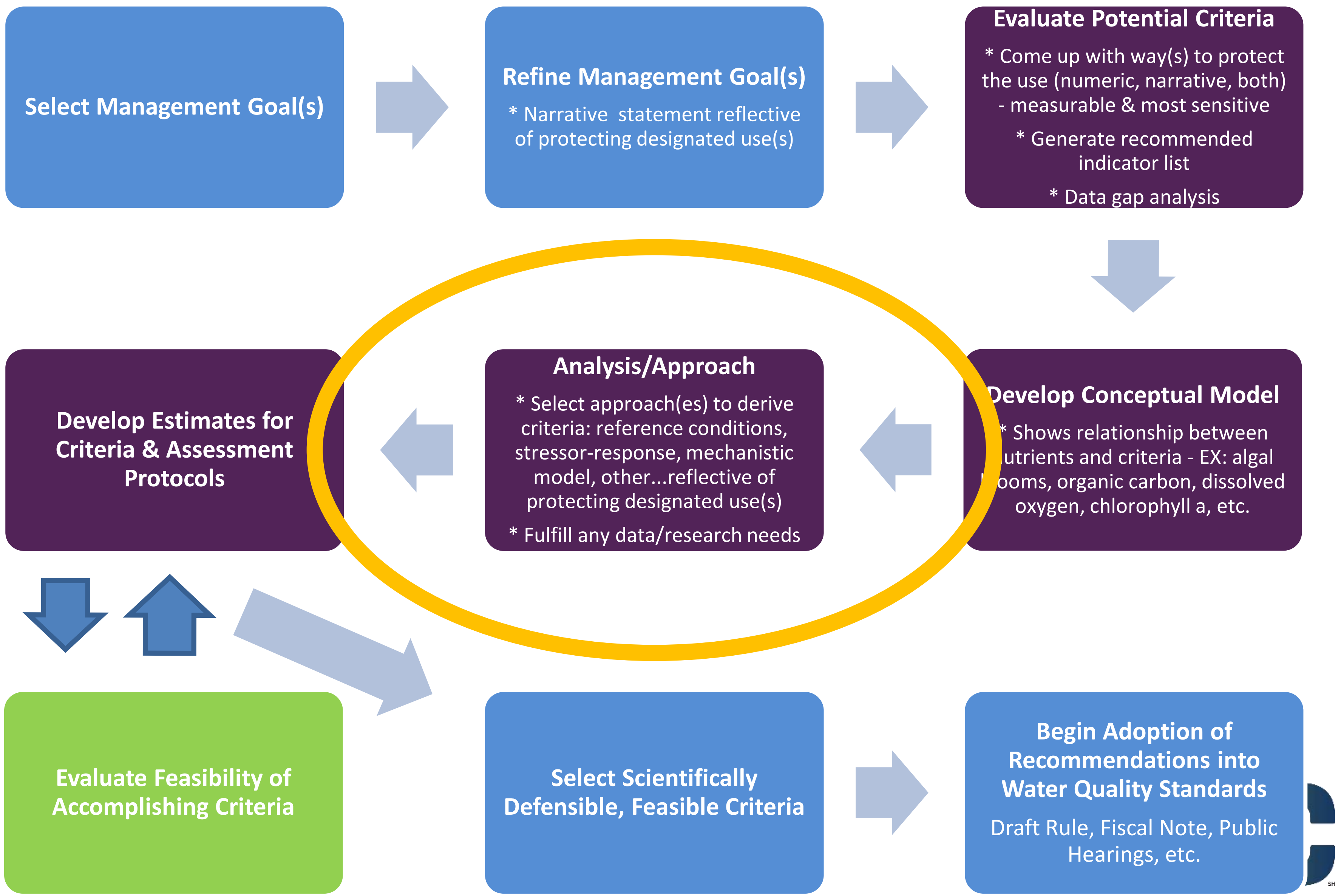
that

Protect the Designated Uses

of

North Carolina's Surface Waters

Nutrient Criteria Development – Where are we now?



Nutrient Criteria Development Process

So far in this process:

- Discussed the designated uses and impairments for HRL
- Defined causal and response variables associated with the designated uses
- Developed a conceptual model to illustrate these relationships

Currently:

- In the process of identifying potential indicators (assessment endpoints) to form the basis of criteria

What's Next?

Apply Nutrient Criteria Development Approaches

Overview of Potential Approaches

- Approaches will provide a framework for development of criteria from the final causal/response indicators

- Assure the scientific defensibility of the criteria by demonstrating the link between the final criteria, the indicators (assessment endpoints) and the designated uses

- Multiple approaches can be used to develop criteria

- Can vary parameter-by-parameter

  Ex: Weight-of-Evidence for Chlorophyll-a, Mechanistic Model for N/P

Overview of Potential Approaches

Approaches:

Reference Condition approach

Stressor-Response Analysis approach

Mechanistic Modeling approach

Combined/Integrated Criteria approach

Weight of Evidence approach

Best Professional Judgement

Others???

Reference Condition Approach

- Derives candidate criteria from observations collected in reference waterbodies
- Reference sites require demonstration of one or more of the following (Stoddard et al. 2006, NLA paper):
  - Minimally disturbed condition
  - Historical condition
  - Least disturbed condition
- Requires monitoring data that show the reference site(s) both reflect and support the designated uses

Stressor-Response Approach

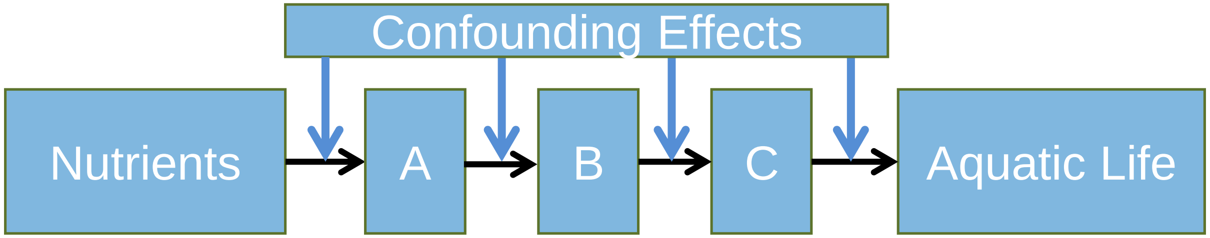
- Estimates a relationship between causal and response indicators using paired stressor-response data
- Requires sufficient data to make this estimate
- Supporting data need to be matched in time and space
  - Ex: nutrient measurements collected in the same stream reach as biological response data.
  - Matched data become harder to find as the number of other variables used in the model increases.
- Resulting criteria link directly to maintenance and support of a designated use

Mechanistic Model Approach

- Uses equations to represent the causal/response parameters and associated ecological processes of a system
- Can predict changes in a system
- Requires sufficient data to characterize a waterbody and for calibration
- Can link causal & response indicators to impairment of designated uses
- EPA has guidance & existing models for a wide range of water quality processes related to nutrient criteria development

Combined/Integrated Criteria

- Useful when it is difficult to link causal and response variables directly to the designated uses
- Integrates causal and response parameters into a single water quality standard.
- Main considerations:
  - Must protect designated uses
  - Must be scientifically defensible



Combined/Integrated Criteria

- Components may include:
  - Numeric Causal criteria (N & P)
  - Measure of Primary Productivity (macrophytes, chlorophyll-a)
  - Measure of Algal Assemblage
  - Measure of Ecosystem Function (continuous pH & DO)
- Criteria structured to integrate causal & response variables

Causal Criteria	Response Criteria	Designated Use
Met	Met	**Attained**
Exceeded	Met	**Attained**
Exceeded	Exceeded	**Not Attained**
Exceeded	No Data	**Not Attained**

Weight of Evidence/ Best Professional Judgement

Weight of Evidence

- Considers all available scientific information to establish criteria based on "cause & effect" relationships
- Must be able to demonstrate support of designated uses

Best Professional Judgement

- Often used where specific information is not available or is not of sufficient quality or quantity to be of value.
- Is relevant when expert opinions can be gathered and a collaborative decision applied to the specific situation
- Must be able to demonstrate support of designated uses

Approaches used by other Region 4 States

- **Alabama**
  - Historical data & BPJ based on consultation with Auburn University professor
  - Modeling in reservoirs with known impairments
- **Florida - Lakes**
  - Stressor-response relationship b/w TN/TP & chlorophyll-a
- **Florida – Streams**
  - Reference condition approach
- **Florida – Springs**
  - Stressor-response relationship b/w nitrate-nitrite & presence of algal mats
- **Georgia**
  - Initial criteria based on reference approach
  - Criteria revised based on mechanistic model approach
- **South Carolina**
  - Criteria derived using an all lakes percentile distribution approach
- **Tennessee**
  - 90^{th} percentile of the state sub-ecoregion databases for TP & nitrate-plus-nitrite

Further Information

Previous SAC member presentations:

Tiffany Crawford

- “Overview of Approaches for Numeric Nutrient Criteria Development”

Lauren Petter

- “NNC Methodologies and Criteria in R4 States”
- “Possible TN & TP Ranges for High Rock Lake”

Bill Hall

- “A Critical Examination of Nutrient Criteria Development using Weight of Evidence/Stressor-Response Methods”

Clifton Bell

- “Case Studies on Water-Body Specific Numeric Nutrient Criteria”

Further Information

EPA's Criteria Development Guidance

https://www.epa.gov/nutrient-policy-data/criteria-development-guidance

- Stressor-Response
- Lakes & Reservoirs
- Rivers & Streams
- Estuarine & Coastal Waters

Toolkit of Resources

https://www.epa.gov/nutrient-policy-data/toolkit-resources-assist-states-adopting-and-implementing-numeric-nutrient

- Numerous EPA resources for adopting numeric nutrient criteria
- Guiding principles for integrated nutrient criteria (bioconfirmation)

Questions?

Department of Environmental Quality

Brown AND Caldwell

North Carolina Nutrient Science Advisory Council

October 19, 2016

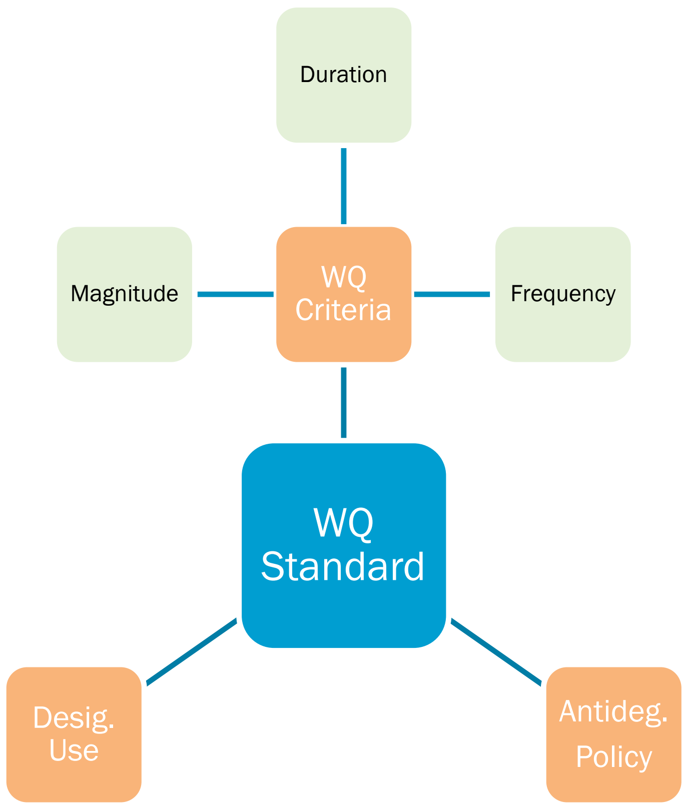
Alternatives to Pass/Fail Nutrient Concentration Criteria

Outline

- Case for why we should consider alternatives to pass/fail nutrient concentration criteria
- Overview and examples of two broad categories of alternatives
  - Numeric translators
  - Bioconfirmation

Case for Considering Alternatives to Pass/Fail Nutrient Concentration Criteria

Exceedance of Water Quality Criteria Triggers a Series of Far-Ranging, Mandatory Actions



- Water quality assessment [integrated 303(d)/305(b) reports]
- Permitting
- Total Maximum Daily Loads
- Implementation plans
- Rate impacts
- Public & private expenditures

Regulatory Requirements for Criteria

- Established at Level “Necessary to Protect Uses”
- Ensure Use Protection with Small Probability of Considerable Over/Under-Protection
- Must Be Consistent With Sound Scientific Evidence-Demonstrated Dose/Response
- Must Account for Major Factors Influencing Pollutant Impact
- Confounded Studies Should Not Be Used for Criteria Derivation (or confounding factors need to be addressed)

Source: W. Hall (2015) referencing USEPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049.

Framing the Question

- **We know we have to address N and/or P from a management standpoint.**
- Real question is whether:
  - Pass/fail TN/TP concentration criteria help us or hurt us in making the correct assessment & management decisions…
  - …or conversely, is it preferable to emphasize response variables.
  - …and if so, how might we accomplish that.

Advantages of Pass/Fail N & P Concentration Criteria

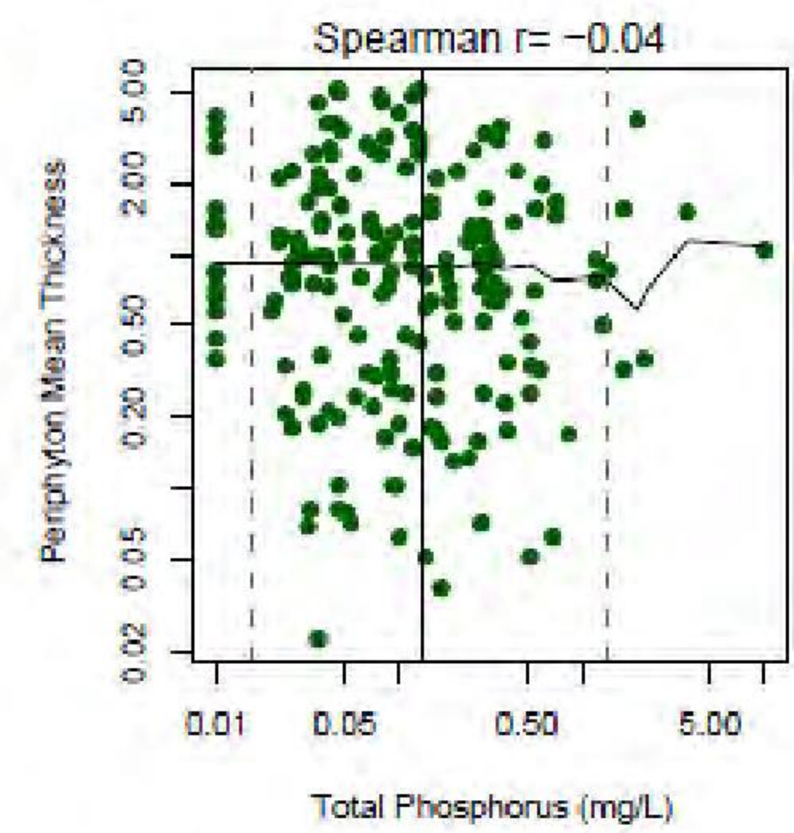
- More environmentally conservative
  - Backup to uncertainty in response measurements
  - Early warning of trends?

- Simplifies permitting in some situations (esp. streams).
  - Simple mixing calculations can serve
  - Not necessary to model responses

Disadvantages of Pass/Fail N & P Concentration Criteria

- For many systems, N & P concentrations are a very poor predictors of responses.
- Some systems are better managed by loads.
- Increase likelihood of assessment errors, with chain of implications.
- Reduces flexibility in implementation.
- Not necessary if we have reasonable certainty in response measurements.

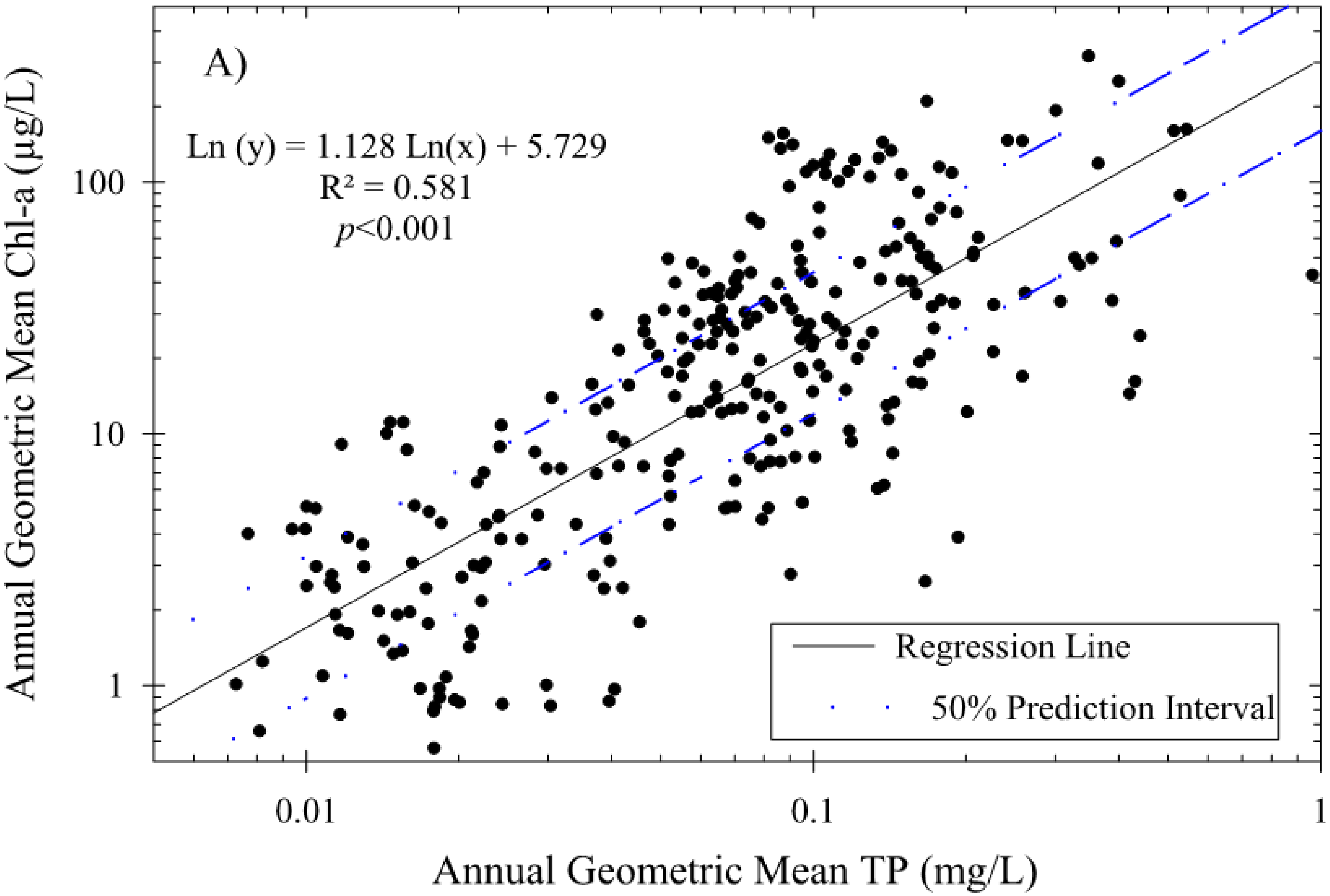
Poor predictive relations: Example from Florida streams



"The relationships between the biological response variables and nutrient levels were confounded by numerous other factors such as color, pH conductivity, and canopy cover. The confounding effects of these other variables result in weak statistical relationships between measures of the biological communities and nutrient levels."

Florida DEP (2012)

Highly variable relations: Example from Florida lakes



Source: Florida DEP (2012)

Nutrient Concentrations Are Another Step Removed from Actual Use Attainment

Farther from Actual Use

Closer to Actual Use

Uncertainty/ Variability

Uncertainty/ Variability

Uncertainty/ Variability

Nutrient Conc.

Response Indicators

Algal Toxin

Human/Aquatic Life Response

TP (mg/L)

CHLa

Microcystin

Illness, toxicity

Some Systems are More Practically Managed by Nutrient Loads instead of Concentrations

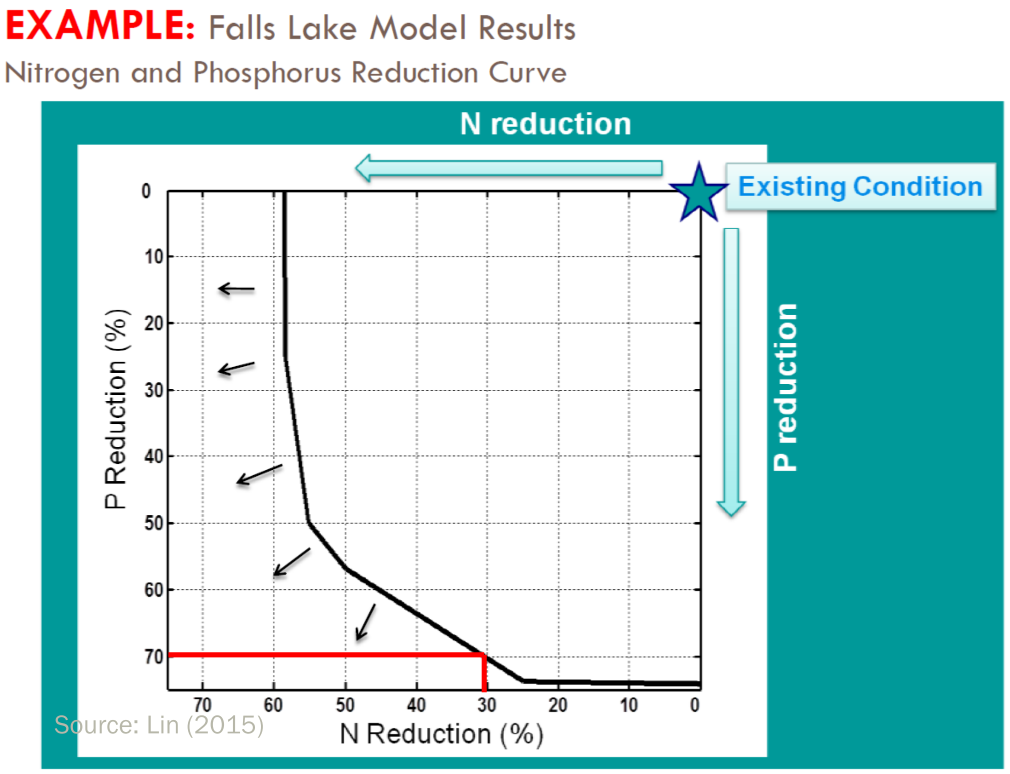
Concentration

- Short term growth potential

Load

- Longer-term growth potential for systems that integrate nutrient inputs over time

Examples of Reduced Flexibility in Implementation



- Water body consistently meets response variable targets but not N, P targets.
- Locked into attaining specific P, N targets even if alternative reduction ratios would also attain desired responses.
- Load targets more conducive than concentrations for trading/offsets

Two Broad Categories of Alternatives to Pass/Fail Nutrient Concentration Criteria

Numeric Translators

Bioconfirmation

Numeric Translators

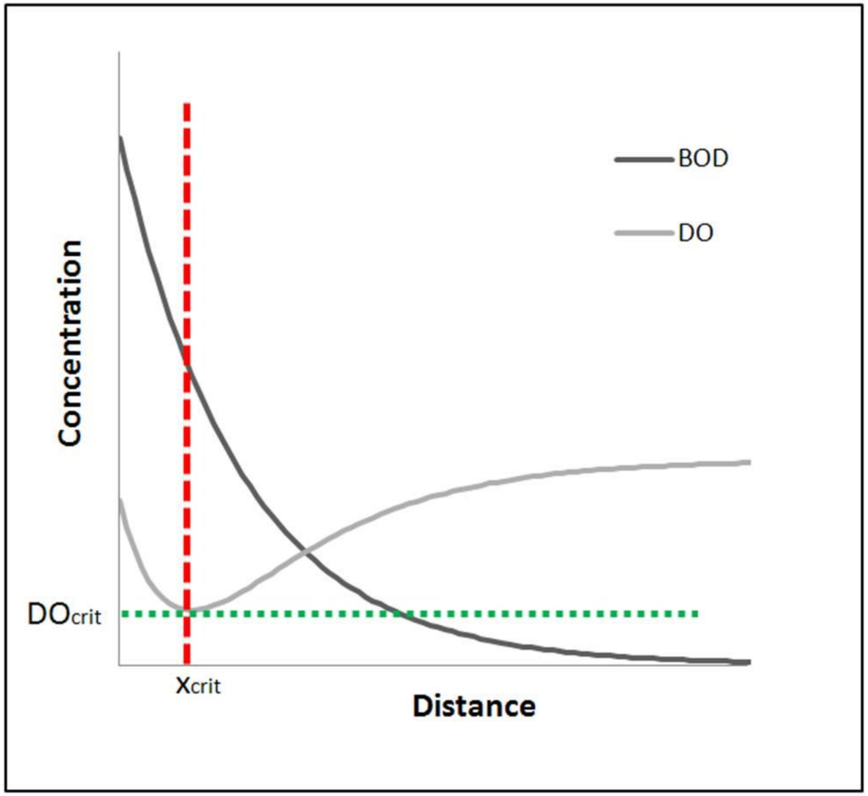
Translator Concept

"States…have the flexibility to adopt numeric criteria to protect designated uses **or to adopt methods…that translate narrative criteria to protect designated uses**…

This procedure could be a mathematical loading/response model…as a "translator" of narrative criteria for water quality parameters…This translator procedure, **together with numeric criteria for response variables**, would provide…the means to set targets for permit limits, assessment, and total maximum daily loads."

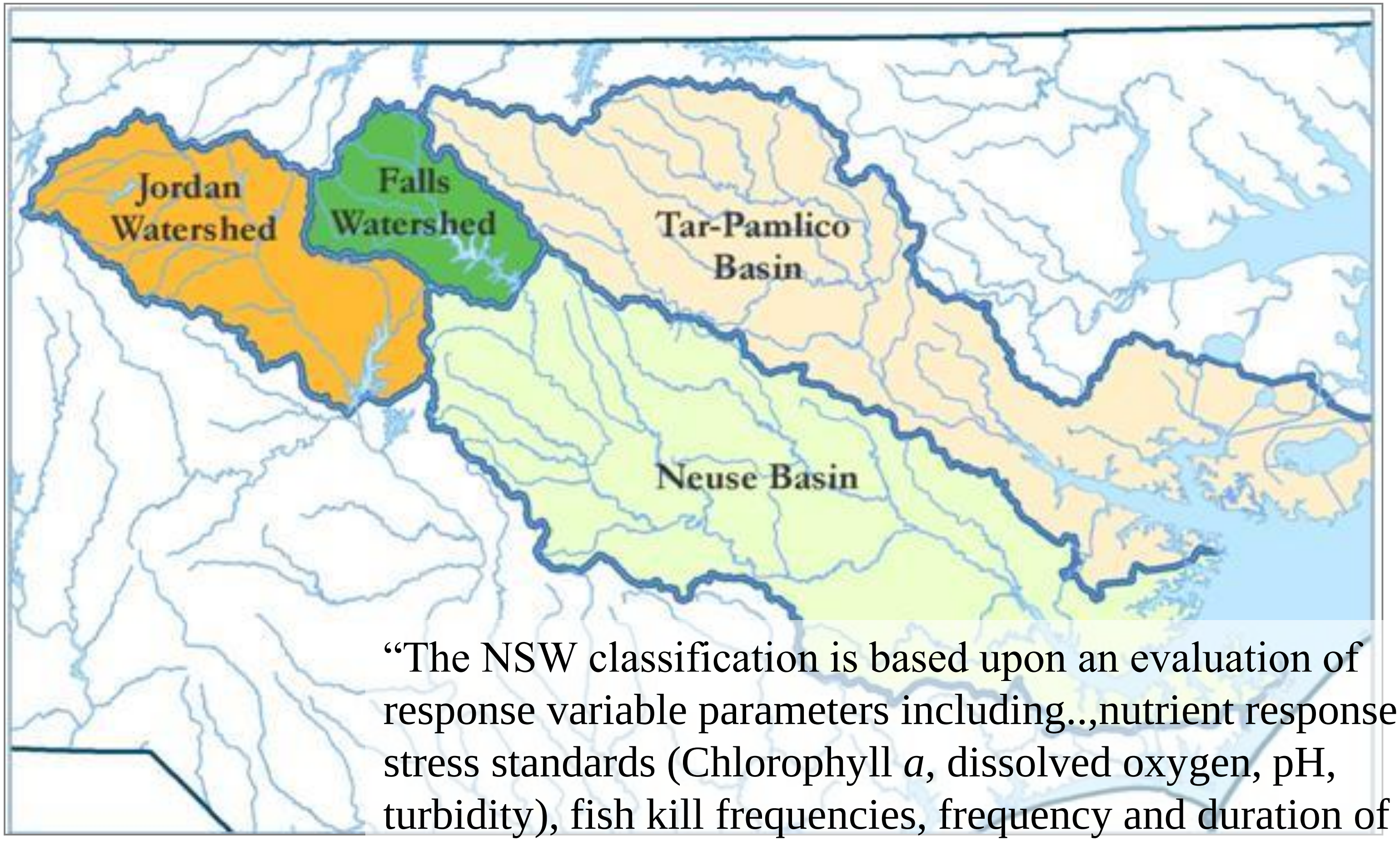
---USEPA (2001), *Development and Adoption of Nutrient Criteria in Water Quality Standards*

BOD5 / DO Analogy



- We do:
  - Set in-stream DO criteria
  - Use translators to relate BOD to DO
  - Set wasteload allocations for BOD
- We (usually) don't:
  - Set in-stream BOD criteria
  - Assess or manage directly on in-stream BOD

Examples of Numeric Translators: North Carolina's Nutrient Strategies



"The NSW classification is based upon an evaluation of response variable parameters including..,nutrient response stress standards (Chlorophyll *a*, dissolved oxygen, pH, turbidity), fish kill frequencies, frequency and duration of algal blooms, taste and odor observations, sediment loading, [and] aesthetic complaints."

- NC DWQ, 2007

Examples of Numeric Translators for Nutrients: Chesapeake Bay Nutrient TMDL

Image source: NASA

- USEPA's "flagship" for watershed-based nutrient management.
- Keyed to three response variables (DO, clarity, CHLA)
- Model used to translate; derive loading goals
- No numeric criteria for nutrient concentrations

Examples of Numeric Translators: California's Nutrient Numeric Endpoints (NNE)

- "Biological response indicators are better suited to evaluate the risk of beneficial use impairment, rather than using pre-defined nutrient limits that may or may not result in mitigation of eutrophication for a particular water body."

--(Sutula and others, 2007)

Examples of Numeric Translators: California's Nutrient Numeric Endpoints (cont.)

California BATHTUB Lake Model Tool

USER INPUTS

Lake Volume	0.6	10^6 m3
Surface area	72050	m2
Average Depth (calc)	8.33	m
Mixed depth	2	m
Net Evap-Precip rate	10	in/per
Secchi depth at typical Chl a	1.5	m
Typical Chl-a	10	µg/L

BATHTUB Calibration Factors

Phosphorus (Kp)	1
Nitrogen (Kn)	1
Chlorophyll a (Kc)	1
Secchi Depth (Ks)	1
Oxygen Depletion (Khod)	1

Delivered Loads for Period of Interest

P Load	640.00	kg
N Load	6405.60	kg
Ortho P	609.73	kg
Inorg N	6048.29	kg
Inflow	1.36	hm3

Target Value for Chlorophyll-a

Chl-a target	25.0	µg/L

Calculate Target from water clarity: Click Here

Other Parameters

Initial Concentration of Dissolved Oxygen
(affects the calculation of oxygen demand)

Initial DO	10	mg/L

Covariance of Natural Log of Chl-a
(affects the calculation of exceedance probabilities)

CV(lnChla)	0.42

Two components:

- Response indicators and regulatory endpoints that specify how to assess water body condition, and
- Nutrient-response models to link response indicators to nutrients and other management controls

Examples of Numeric Translators: Many Lake/Reservoir TMDLs Nationwide

"Loading estimates for nutrient inputs to lakes are required for all of the analysis frameworks available to examine waste load allocations…the loading estimates should define ***<u>mass inputs</u>*** [emphasis added] of the limiting nutrient…"

- USEPA (1983), *Technical Guidance Manual for Performing Wasteload Allocations, Book IV: Lakes, Reservoirs, and Impoundments – Chapter 2: Eutrophication*

Examples of Numeric Translators: Florida's Use of TMDLs as Numeric Nutrient Criteria

- "State-adopted nutrient TMDLs are eligible as site-specific interpretations of the NNC"
- "TMDLs…do not have to be translated into concentrations to be deemed the numeric interpretation of the NNC."

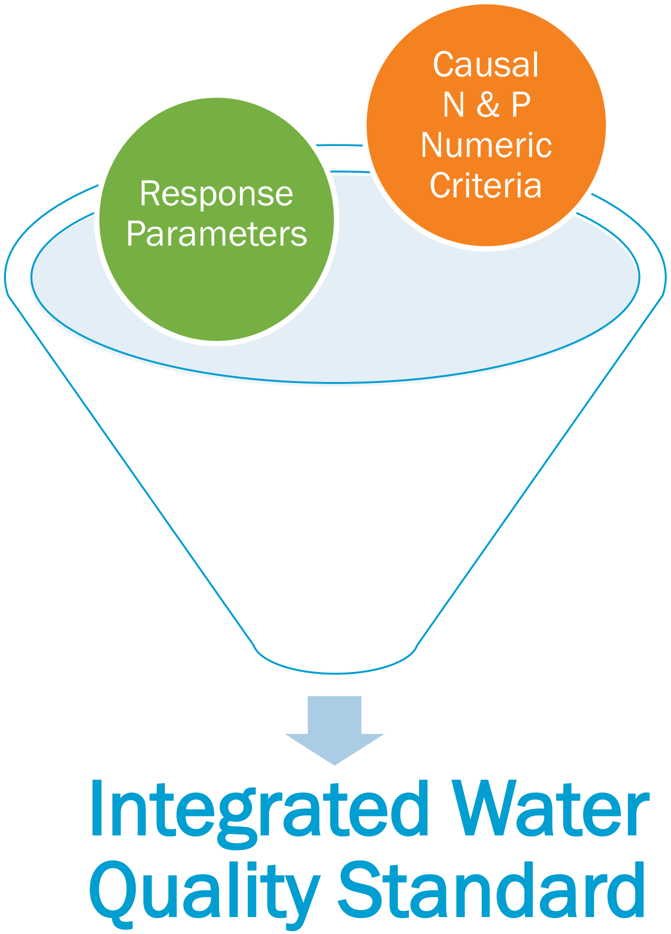
-Florida DEP (2013)

But Aren’t Models Uncertain?

- Yes, one reason we have margins of safety in TMDLs.
- But in most settings, use of concentration-based nutrient criteria does not avoid model-based uncertainty.
- **We still need translators (e.g., models) to relate nutrient sources to causal and response variables.**
- We don’t use models for assessment

Bioconfirmation

What is Bioconfirmation?



What is it?

- Optional approach that integrates causal and response parameters into one water quality standard
- Can give precedence to response variables for assessment

US EPA Guiding Principles on Bioconfirmation

Guidelines cover three categories:

1. Protectiveness
2. Sound Scientific Rationale
3. Expression of the Criterion

EPA United States Environmental Protection Agency | Office of Water Mail Code 4305T | EPA-820-F-13-039 September 2013

Guiding Principles on an Optional Approach for Developing and Implementing a Numeric Nutrient Criterion that Integrates Causal and Response Parameters

Purpose

The purpose of these guiding principles is to offer clarity to states about an optional approach for developing a numeric nutrient criterion that integrates causal (nitrogen and phosphorus) and response parameters into one water quality standard (WQS). The EPA recognizes that

US EPA Guidance on Bioconfirmation

Guiding Principles:

3. Expression of Criterion
   - Causal and response parameters be combined into one criterion
   - All parameters be numeric
   - Duration and frequency must be included
   - Must be expressed in a way that clearly establishes the water quality goal that applies for permitting, assessment/listing, and TMDL decisions
   - Must be constructed in a way that allows for a transparent assessment / listing decision and is reproducible

US EPA Guidance on Bioconfirmation

Guiding Principles:

3. Expression of Criterion should make these situations clear:

Causal Parameter	Response Parameters	Waterbody Condition
Met	Met	Meeting designated use
One or more exceeded	Met	Meeting designated use
One exceeded	Any exceeded	Not meeting designated use
One exceeded	Data unavailable for any	Not meeting designated use
Met	Any exceeded	Not meeting designated use; *further investigation needed to determine cause*

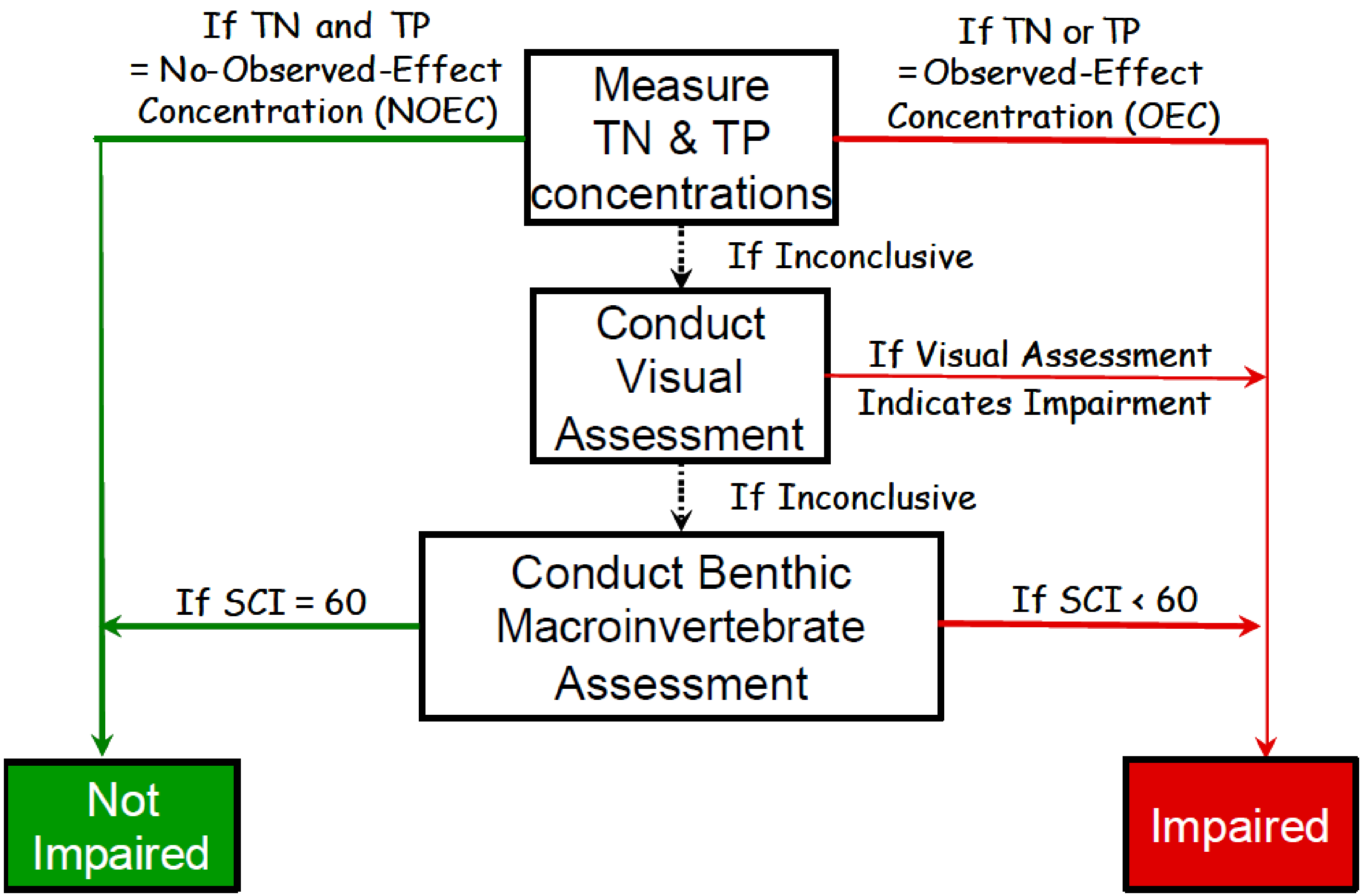
Example: Virginia Nutrient Criteria for Reservoirs

Man-made Lake or Reservoir Name	Location	Chlorophyll a (µg/L)	Total Phosphorus (µg/L)
Able Lake	Stafford County	35	40
Airfield Pond	Sussex County	35	40
Amelia Lake	Amelia County	35	40
Aquia Reservoir (Smith Lake)	Stafford County	35	40
Bark Camp Lake (Corder Bottom Lake, Lee/Scott/Wise Lake)	Scott County	35	40
Beaver Creek Reservoir	Albemarle County	35	40

"The total phosphorus criteria apply only if a specific man-made lake or reservoir received algaecide treatment during the monitoring and assessment period..."

-9VAC25-260-187

Example: Virginia's "Screening Approach" for Wadeable Streams



Source: Zipper and others, 2012

Example: Ohio Trophic Index Criterion

Biology	Response (D.O. and Chlorophyll)	Nutrients	Outcome	Notes
Passing	Normal	Low or Elevated	Attaining	
		High *Low probability event	Evaluate potential for downstream impact	Interpretation within broader context of survey may explain result
Passing	Elevated	Attenuated	Attaining	Attenuation documented within survey
		Elevated or High	Evaluate potential for downstream impact; evaluate reasonable potential for projected increases in nutrient concentrations	Directs sampling priority if no data exist for downstream reaches
	High (D.O. range > 9 mg/l) *Low probability event	Low or High	Reasonable potential	Unique site-specific conditions or follow-up sampling may override RP
Marginal	Normal	Low or High	Other locally limiting factors, or evaluate for downstream impact	Directs sampling priority if no data for downstream reaches
	Elevated or High	Low or High	Threatened by over-enrichment	Reasonable potential exists
Failing	Normal	Low or High	Other limiting factors	Document cause of impairment
	Elevated	Low or High	Impaired by over-enrichment	Other limiting factors ruled out as proximate stressors, or not manageable
	High	Low or High	Impaired by over-enrichment	Unequivocal

Credit: Summary of Region 5 Numeric Nutrient Criteria Workshop Presentation

Example: Minnesota's Multi-Metric Criterion (TP and 3 response variables)

Causal and at Least One Response Exceed	Causal and Response Attain	Causal Exceeds, Response Attains
↓	↓	↓
Reasonable Potential Analysis	Protection Potential Analysis	Response Potential Analysis
(Impaired)	**(Not Impaired)**	**(Not Impaired)**

Important to Allow Site-Specific Adjustments to Default Nutrient Concentration Targets

- Otherwise, the power bioconfirmation provides for assessment would be lost for permitting and TMDLs

Example: Wisconsin Uses Generic Code Language on Site-Specific Criteria

- Must have scientific rationale
  - e.g., shorter residence time allows higher P to attain CHLa criterion
- Must be approved on a case-by-case basis
- Must be approved by EPA

Example: Florida Expression of Lake Nutrient Concentrations as a Range

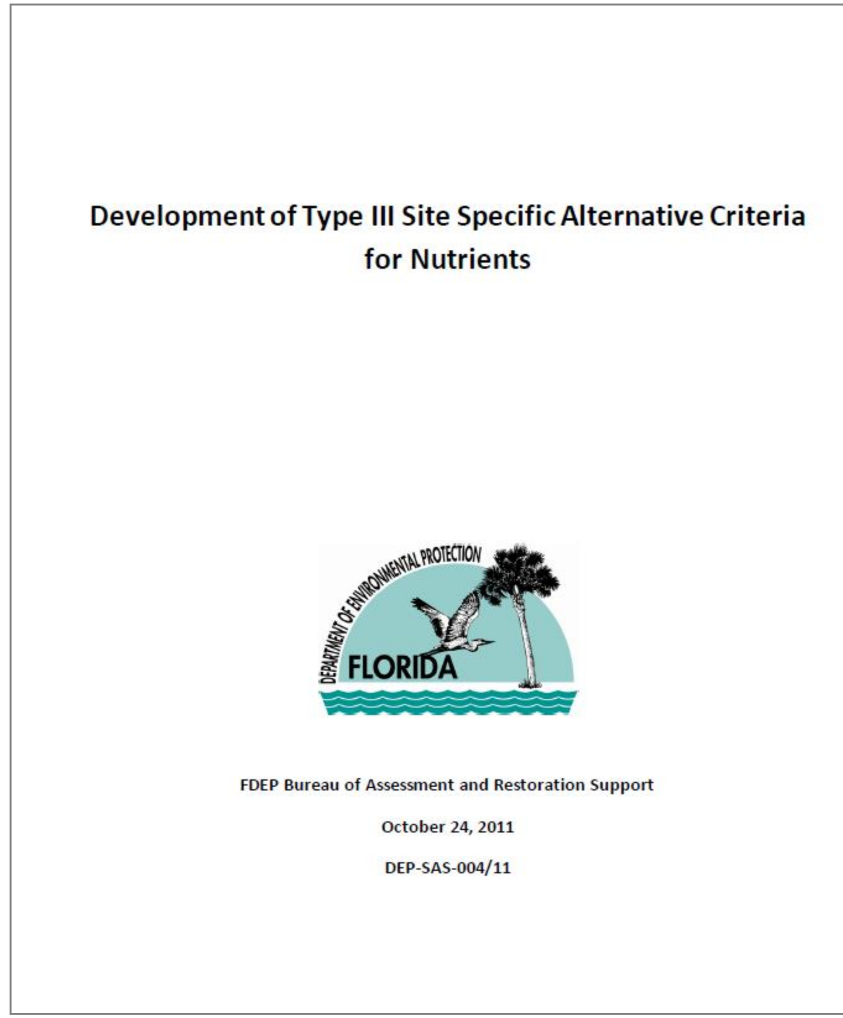
Table 10-3. Total phosphorus and total nitrogen criteria ranges for clear (<40 PCU) and colored Florida lakes (>40 PCU). The lower and upper thresholds were based on the intersection of chlorophyll *a* response concentrations with the 50% predictions intervals shown in Figures 2-28 through 2-31 in EPA (2010b).

Lake Type	Response (Chl-a µg/L)	Stressor	Lower Threshold	Upper Threshold
Clear and Low Conductivity (≤ 40 PCU and ≤ 20 mg/L $CaCO_3$)	6	TP (mg/L)	0.01	0.03
	6	TN (mg/L)	0.51	0.93
Clear but High Conductivity (≤40 PCU but > 20 mg/L $CaCO_3$)	20	TP (mg/L)	0.03	0.09
	20	TN (mg/L)	1.05	1.91
Colored	20	TP (mg/L)	0.05	0.16[1]
	20	TN (mg/L)	1.27	2.23

Source: Florida DEP (2012)

Example: Florida's Type III Site Specific Alternative Criteria

- If biological health assessments demonstrate full aquatic life use support…
- …an SSAC can be established at levels representative of the existing nutrient regime
- Guidance provides detailed procedures & QA requirements


Development of Type III Site Specific Alternative Criteria for Nutrients

Department of Environmental Protection
FLORIDA

FDEP Bureau of Assessment and Restoration Support

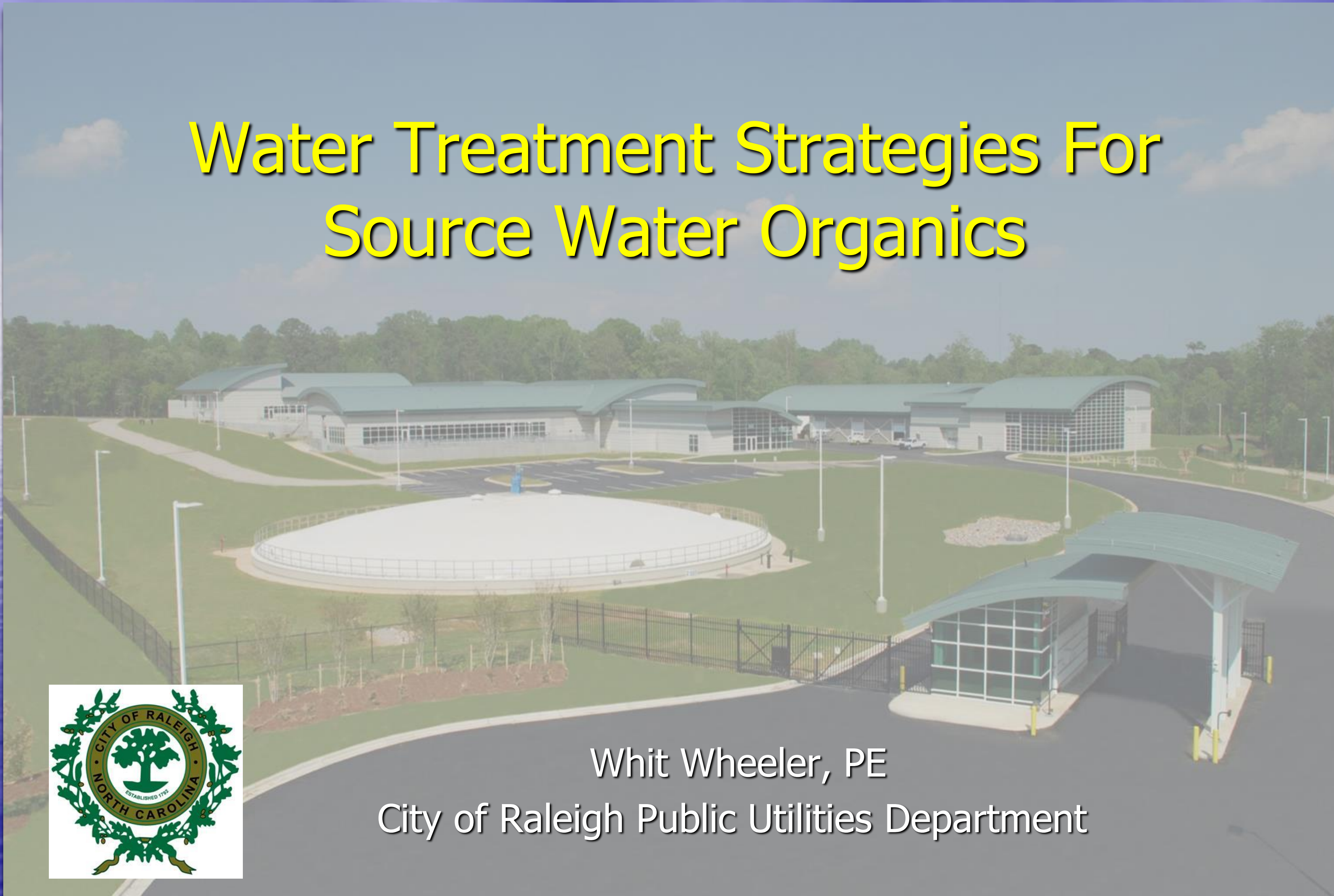
October 24, 2011

DEP-SAS-004/11

Final Thoughts on Alternatives

- Translators are how we have done watershed management for a long time
- Many states going the bioconfirmation route
- Should be accompanied by clear implementation procedures
  - Explain assessment method
  - Allow site-specific criteria
  - Protect existing water quality

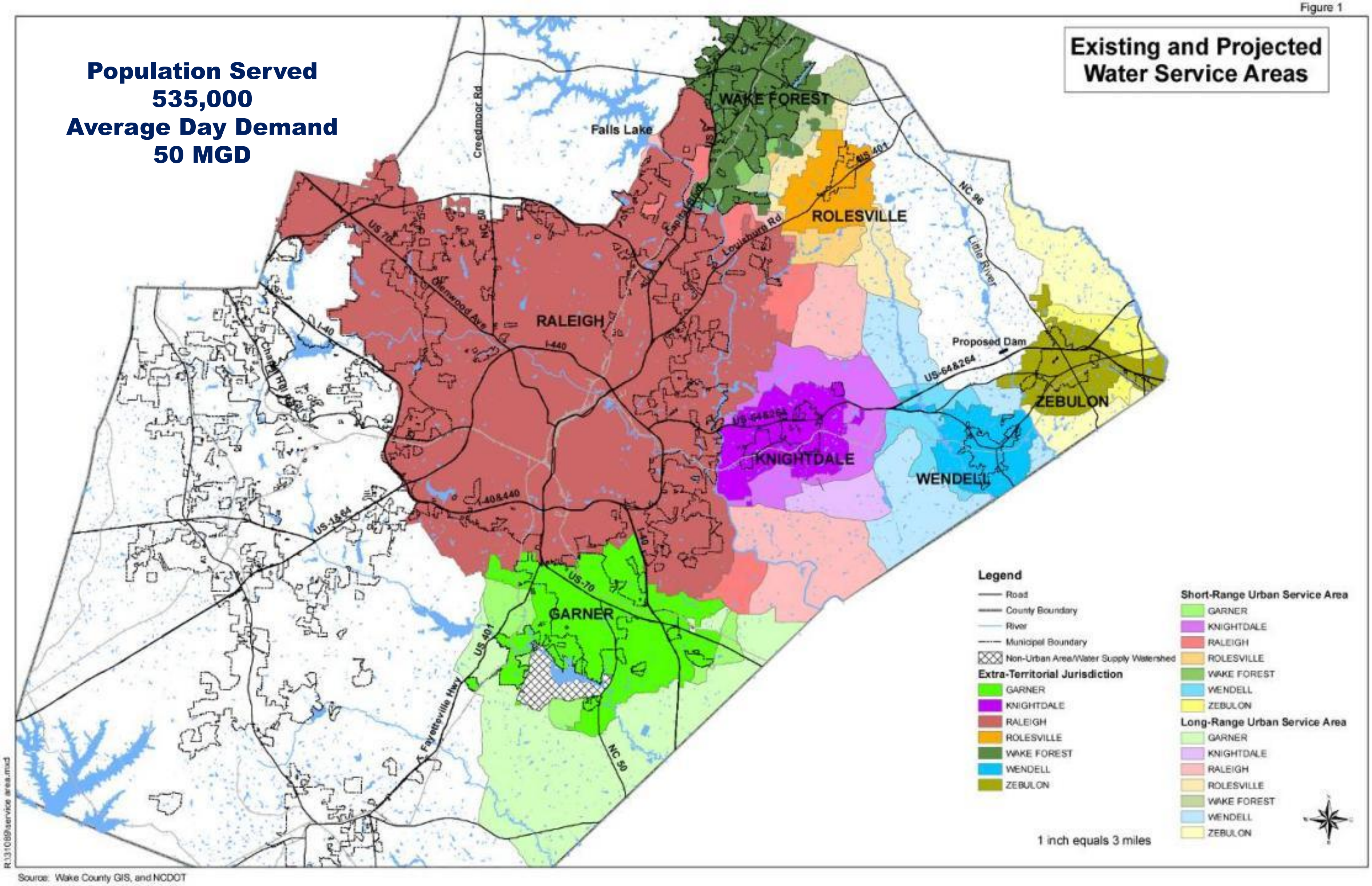
Water Treatment Strategies For Source Water Organics



Whit Wheeler, PE

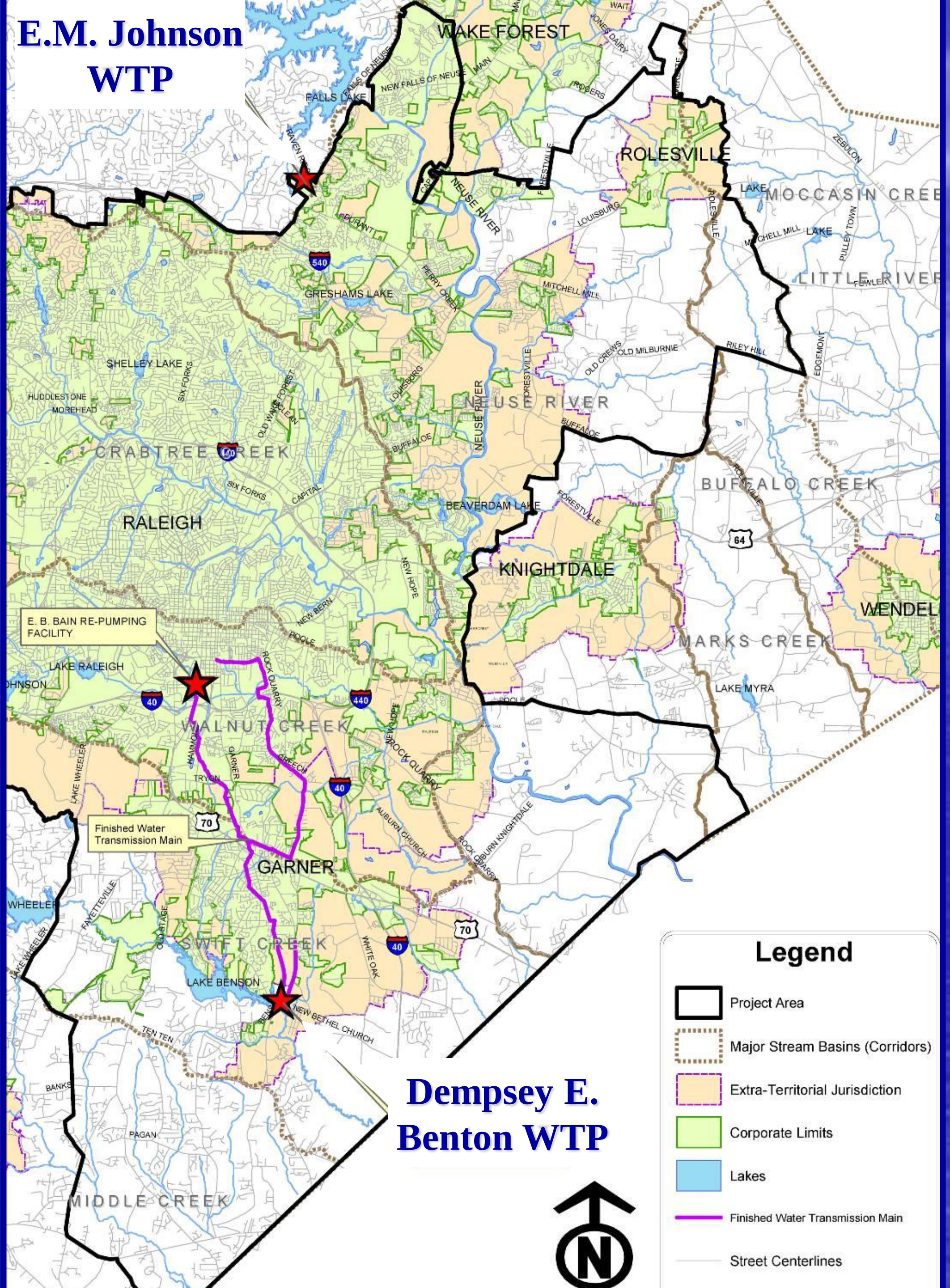
City of Raleigh Public Utilities Department

Population Served
535,000
Average Day Demand
50 MGD



E.M. Johnson WTP : 86 MGD
Source water: Falls Lake (Neuse River)

Dempsey E. Benton WTP
16 MGD
Source water: Lake Benson, Lake Wheeler (Swift Creek)



Falls Lake Water Quality Summary

	Ave	Max	Min
Turbidity (NTU)	4.3	16.5	1.9
Alkalinity (mg/L as $CaCO_3$)	32.5	37.7	14.9
TOC (mg/L)	6.9	12.1	3.1
Iron (mg/L)	0.38	1.07	0.03
Manganese (mg/L)	0.08	0.61	0.01
Apparent Color	65.2	224	17

Lake Benson Water Quality Summary

	Ave	Max	Min
Turbidity (NTU)	10.3	245	2.4
Alkalinity (mg/L as $CaCO_3$)	23.4	36.8	11.6
TOC (mg/L)	7.9	13.7	5.27
Iron (mg/L)	0.60	5.16	0.0
Manganese (mg/L)	0.10	0.96	0.0
Apparent Color	157	1010	48

Source Water Organic Impacts

- Dissolved Organic Carbon reactions with disinfectants form TTHMs and HAAs
- Taste and Odor (MIB /Geosmin)
- Cyanotoxins (EPA UCMR 4, 9 toxins)
- Filter Blinding – Diatoms

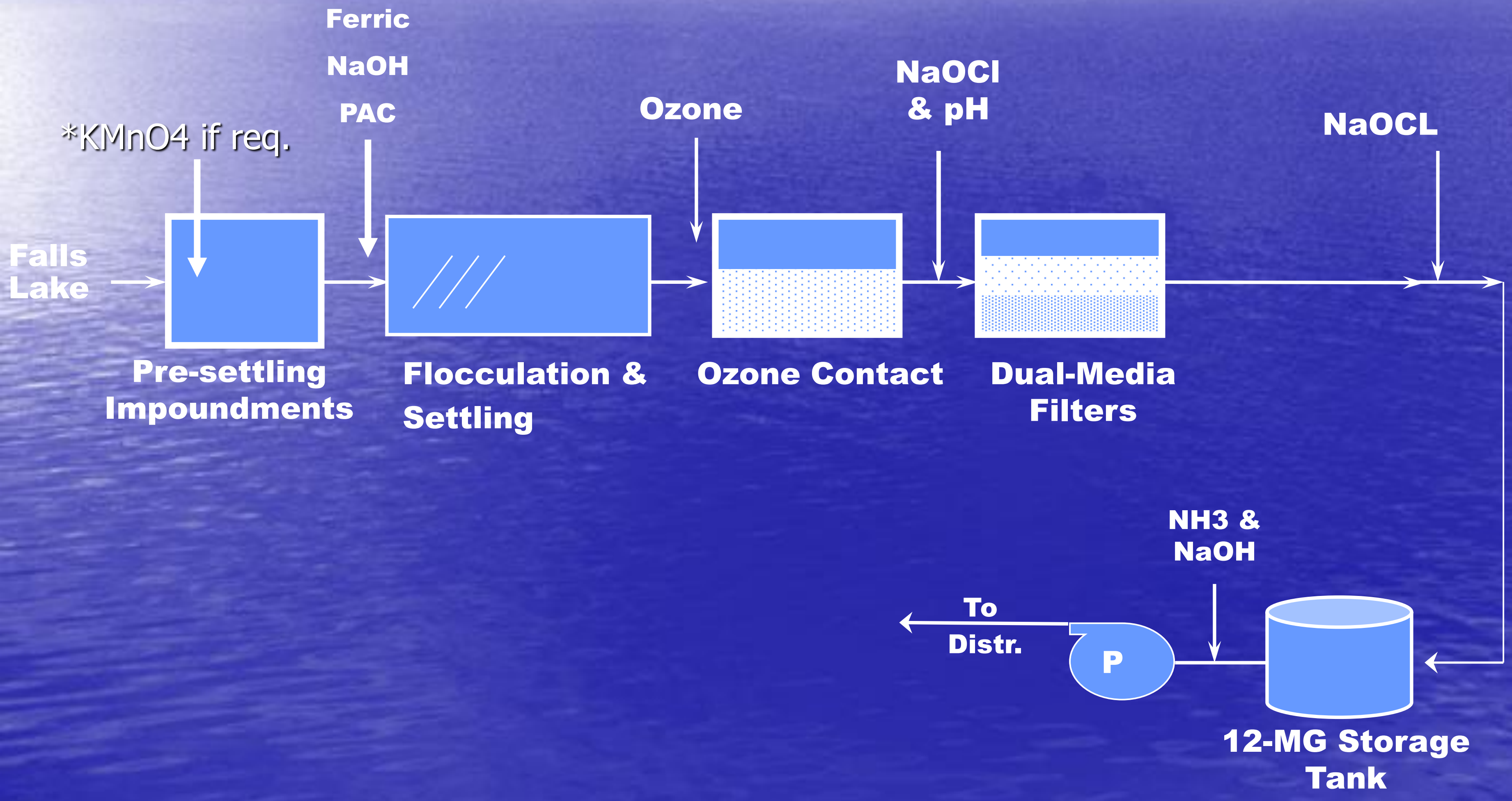
Treatment Goals

- Finished water turbidity less than 0.10 NTU.
- Finished water Fe and Mn less than EPA secondary standards (0.3 and 0.05 mg/L, respectively).
- Required TOC removal 45%.
- Finished Water TOC <2.3 mg/L
- Disinfection by-product formation potential minimized.
- No Taste and Odor Calls!

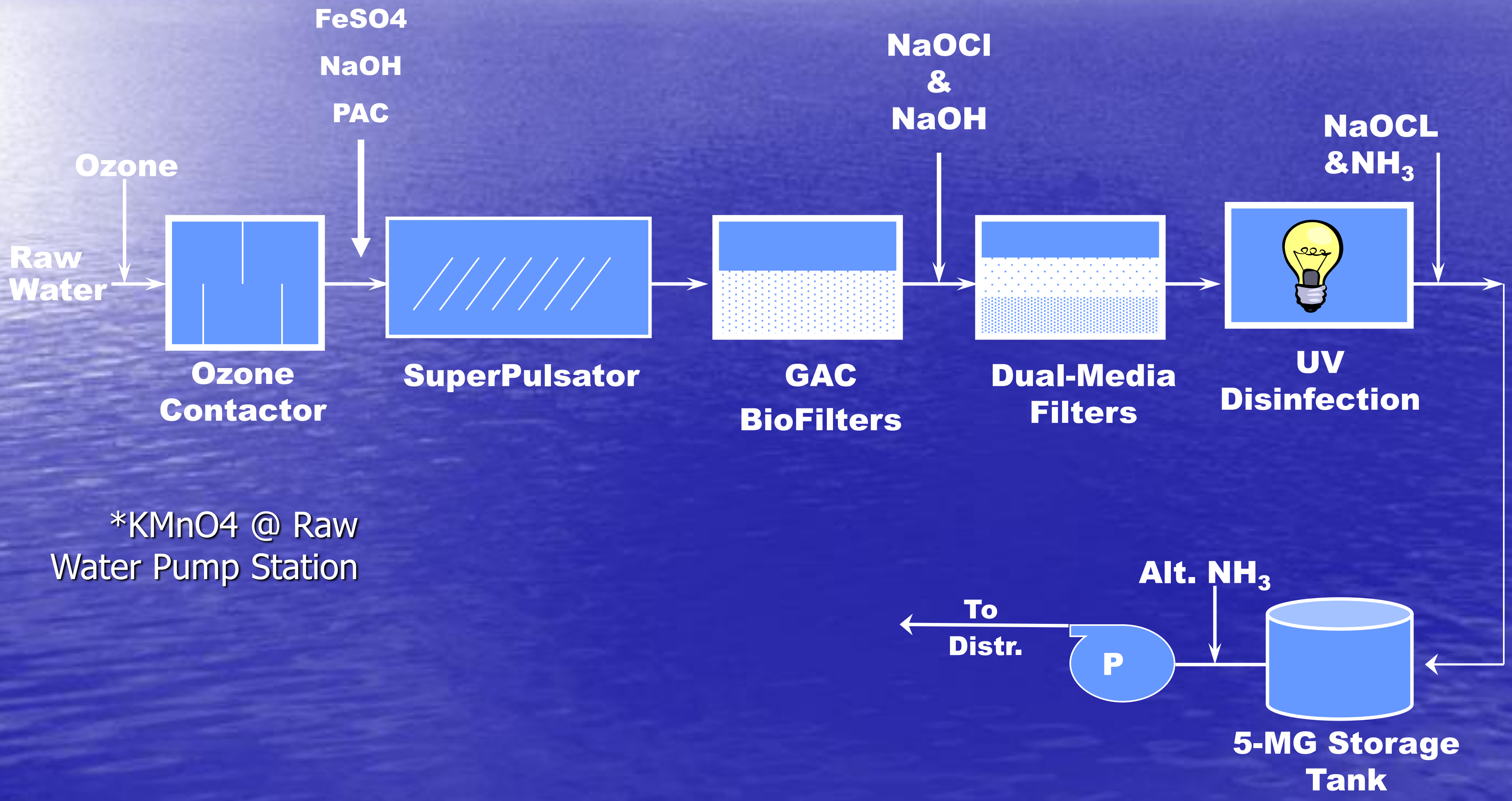
Treatment Strategies

- Enhanced Coagulation, Ferric Sulfate
- Powder Activated Carbon
- Ozone
- Biological Filtration
- Cloramination / UV
- Distribution System Water Age Management
- Ion Exchange
- Aeration

TREATMENT PROCESS FOR THE E.M. JOHNSON WATER PLANT



TREATMENT PROCESS FOR THE DEMPSEY E. BENTON WTP



*KMnO4 @ Raw Water Pump Station

DEB THM Formation Potential

	Raw	Post Ozone	Settled	Post GAC	Post Filter
RESULTS	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)
Chloroform, ppb	863.56	476.19	79.67	62.56	73.15
Bromoform, ppb	<1.0	<1.0	<1.0	<1.0	<1.0
Bromodichloromethane, ppb	18.58	15.27	11.71	9.78	11.82
Chlorodibromomethane, ppb	0.88	1.19	1.77	2.21	2.63
Total THM, ppb	**883**	**493**	**93**	**75**	**88**
pH	7	7.09	6.34	6.4	7.15

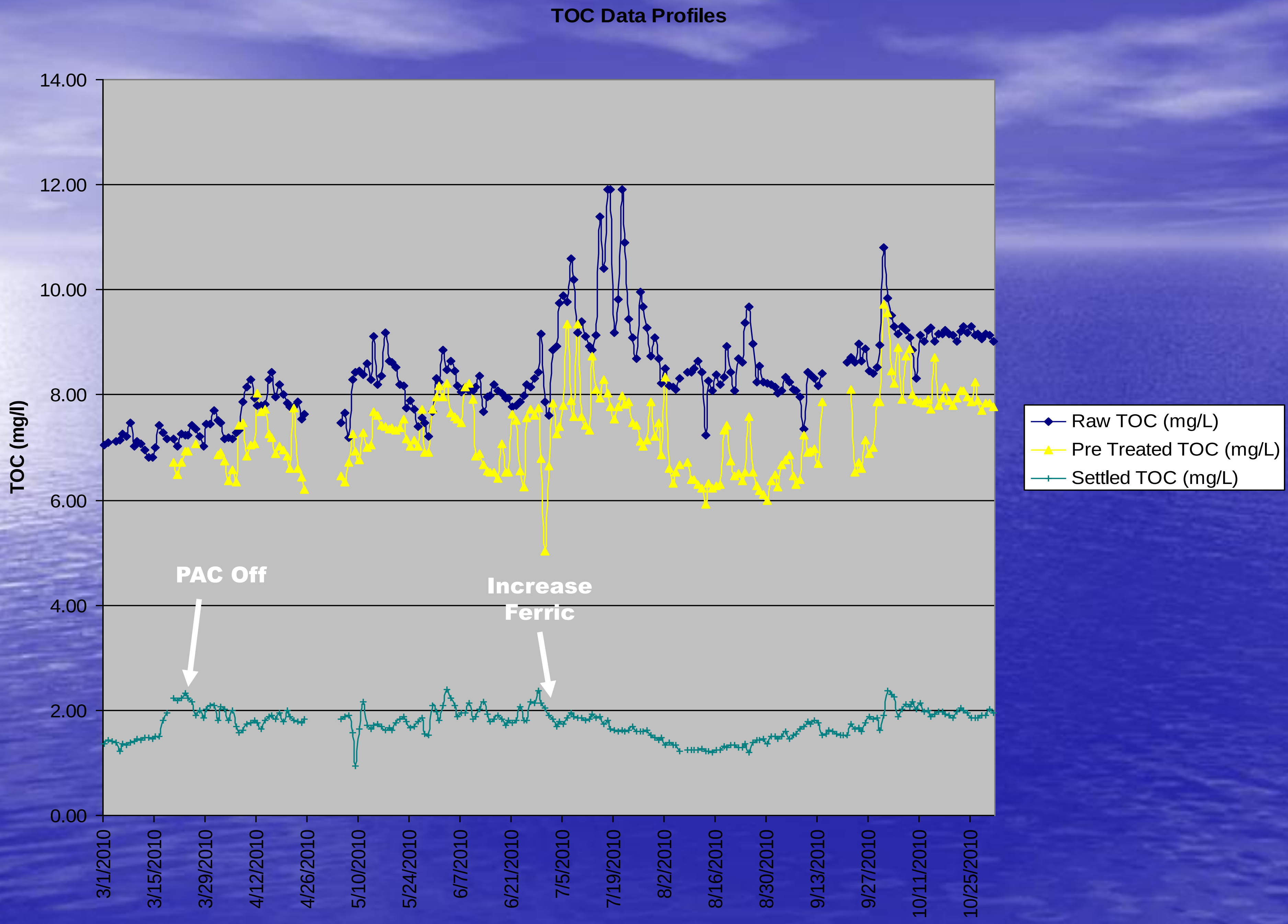
Typical Jar Test

	Ferric Dose	NAOH Dose	ntu	pH	Raw TOC	Jar TOC	% Removal
Jar 1	40 mg/L	10 mg/L	2.14	5.94	*8.39*	4.61	45
Jar 2	50 mg/L	13 mg/L	1.04	5.89	*8.39*	3.35	60
Jar 3	60 mg/L	16 mg/L	0.85	5.78	*8.39*	2.83	66
Jar 4	70 mg/L	19 mg/L	0.85	5.68	*8.39*	2.70	68
Jar 5	80 mg/L	22 mg/L	0.90	5.60	*8.39*	2.50	70
Jar 6	90mg/L	26 mg/L	0.93	5.40	*8.39*	2.27	73

RAW 9.68 6.8

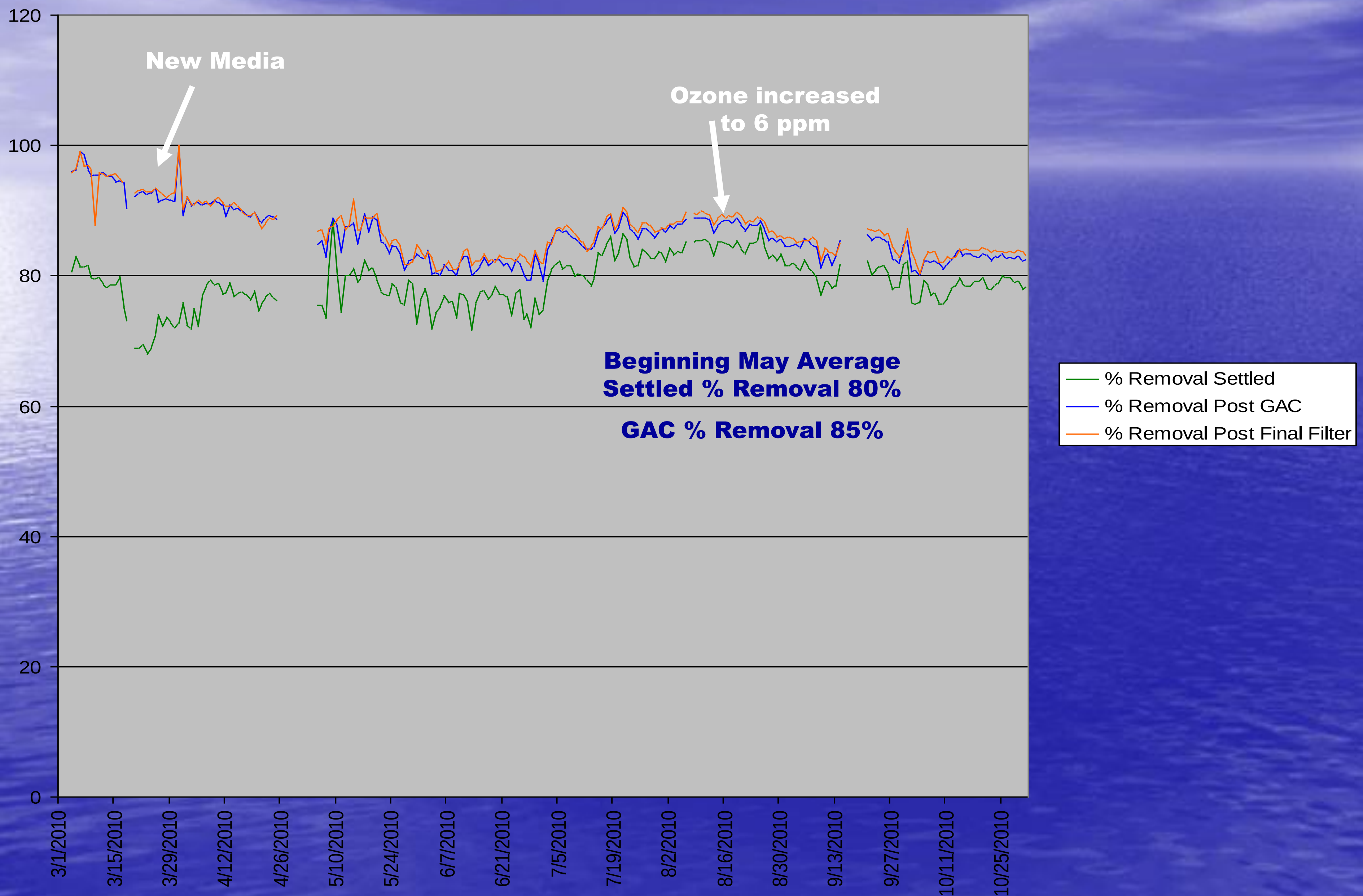
Powder Activated Carbon

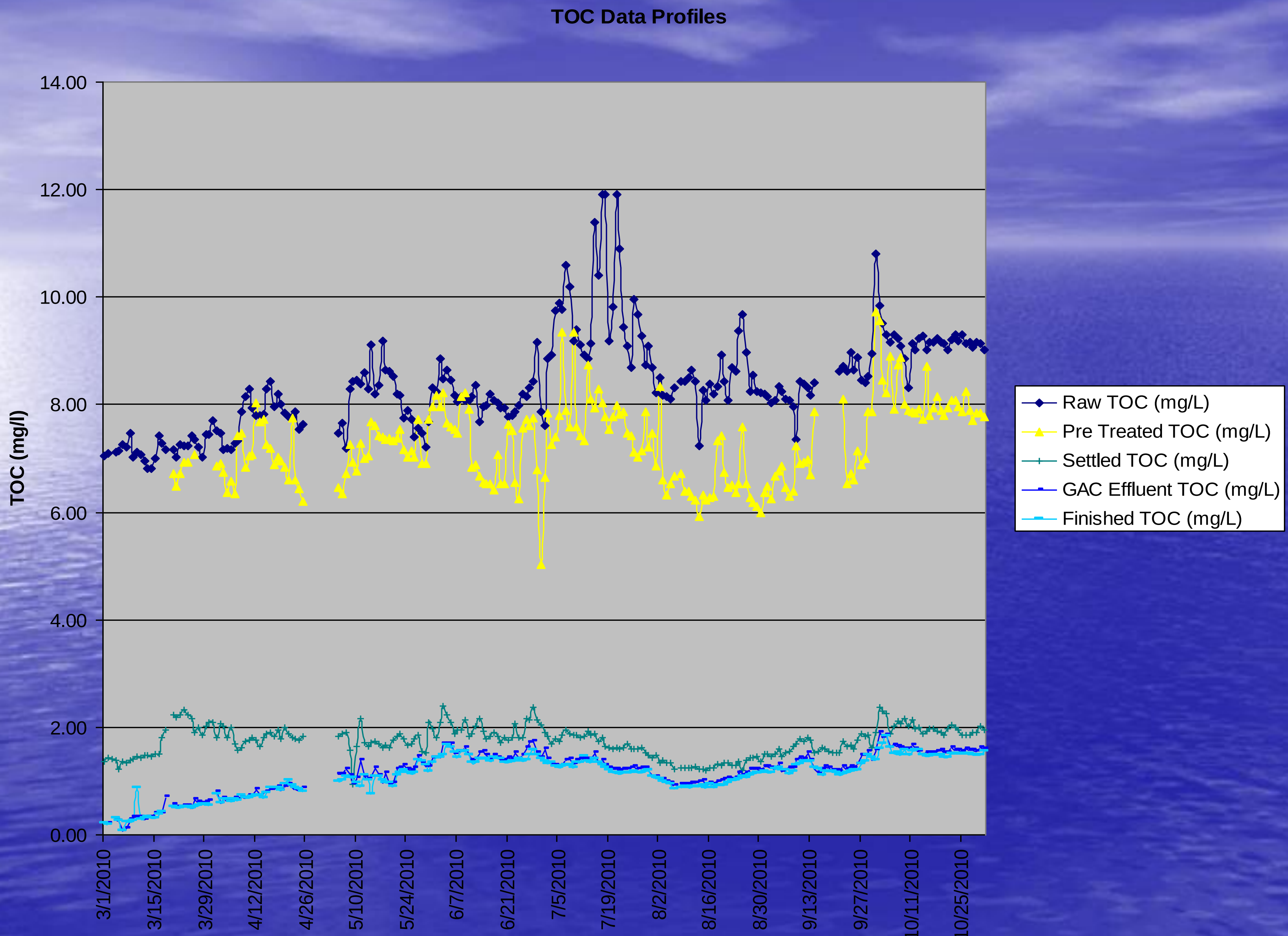
- Aqua Nuchar @ 3-5 ppm
- PAC feed suspended for 13 days
- During the 13 days without the addition of PAC, the settled water TOC removal averaged 71%. In the two weeks prior with PAC addition the settled water TOC removal averaged 80%. Approximately 0.75 ppm difference in settled water TOC.



TOC Data Profiles
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
TOC (mg/l)
PAC Off
Increase
Ferric
3/1/2010
3/15/2010
3/29/2010
4/12/2010
4/26/2010
5/10/2010
5/24/2010
6/7/2010
6/21/2010
7/5/2010
7/19/2010
8/2/2010
8/16/2010
8/30/2010
9/13/2010
9/27/2010
10/11/2010
10/25/2010
Raw TOC (mg/L)
Pre Treated TOC (mg/L)
Settled TOC (mg/L)

TOC Removal By GAC Filters




TOC Data Profiles
TOC (mg/l)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
3/1/2010
3/15/2010
3/29/2010
4/12/2010
4/26/2010
5/10/2010
5/24/2010
6/7/2010
6/21/2010
7/5/2010
7/19/2010
8/2/2010
8/16/2010
8/30/2010
9/13/2010
9/27/2010
10/11/2010
10/25/2010
Raw TOC (mg/L)
Pre Treated TOC (mg/L)
Settled TOC (mg/L)
GAC Effluent TOC (mg/L)
Finished TOC (mg/L)

DEB Plant Comparison of TOC/DOC

11/10/2010	Settled water	TOC	2.073
11/10/2010	Settled water	DOC	2.037
11/10/2010	GAC effluent	TOC	1.746
11/10/2010 Raw TOC 8.9	GAC effluent	DOC	1.724

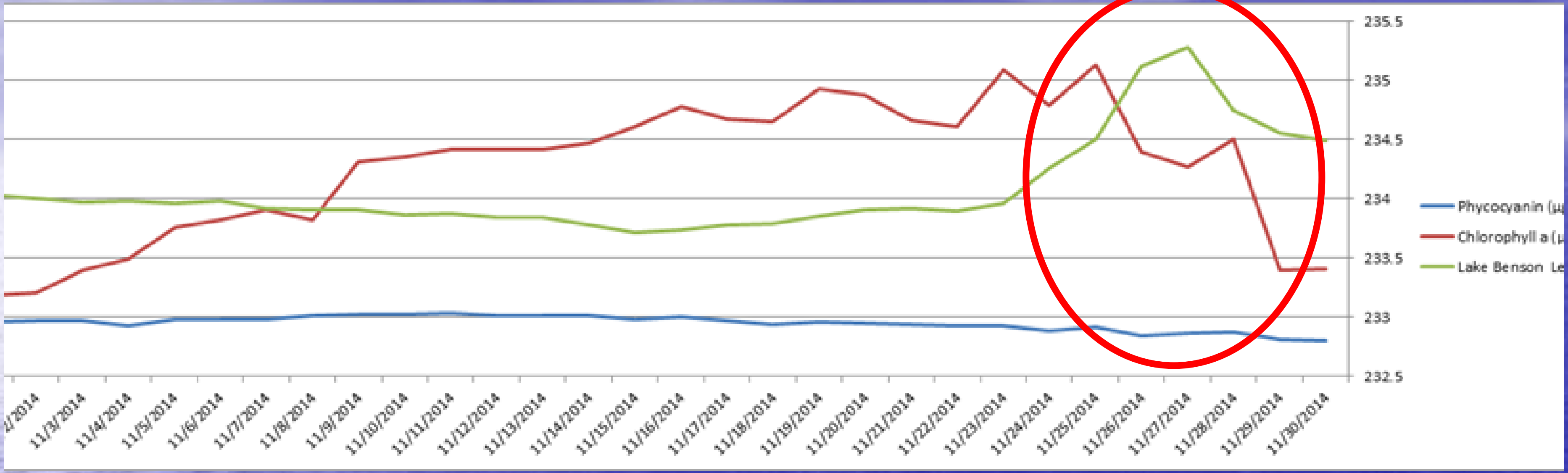
Treatment Results

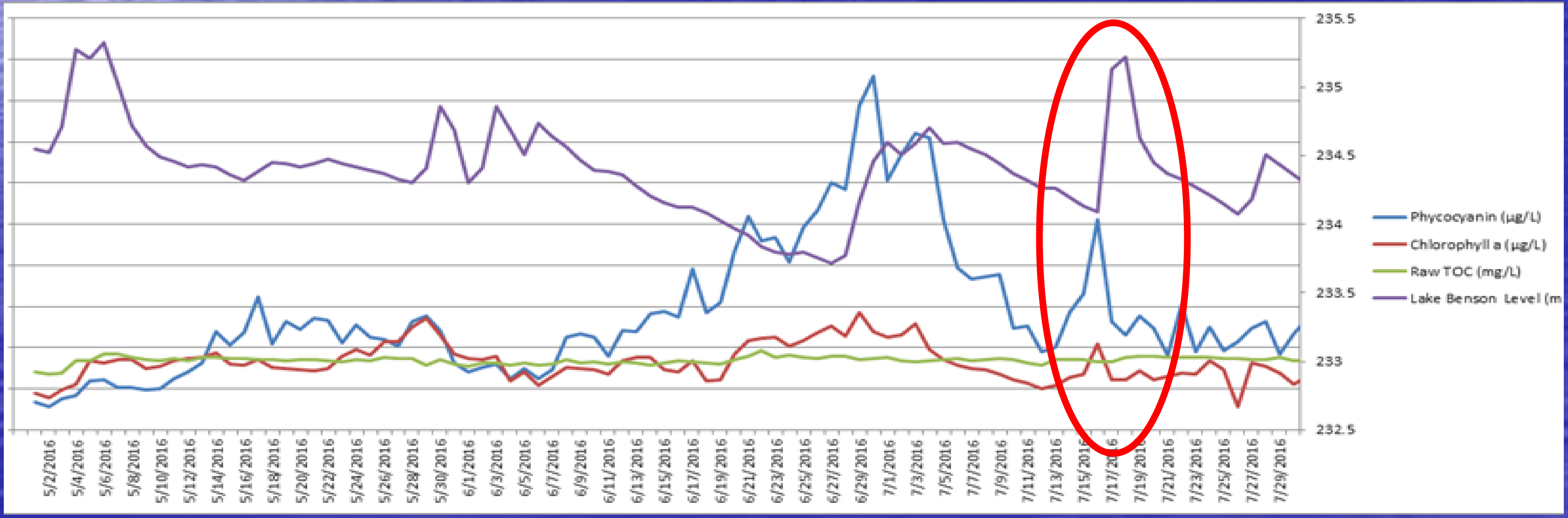
- TOC Removal — 63% EMJ / 75% DEB.
- Turbidity — <0.1 NTU 95% of time
- Iron — .01 mg/L
- Manganese — .01 mg/L

Disinfection Byproducts

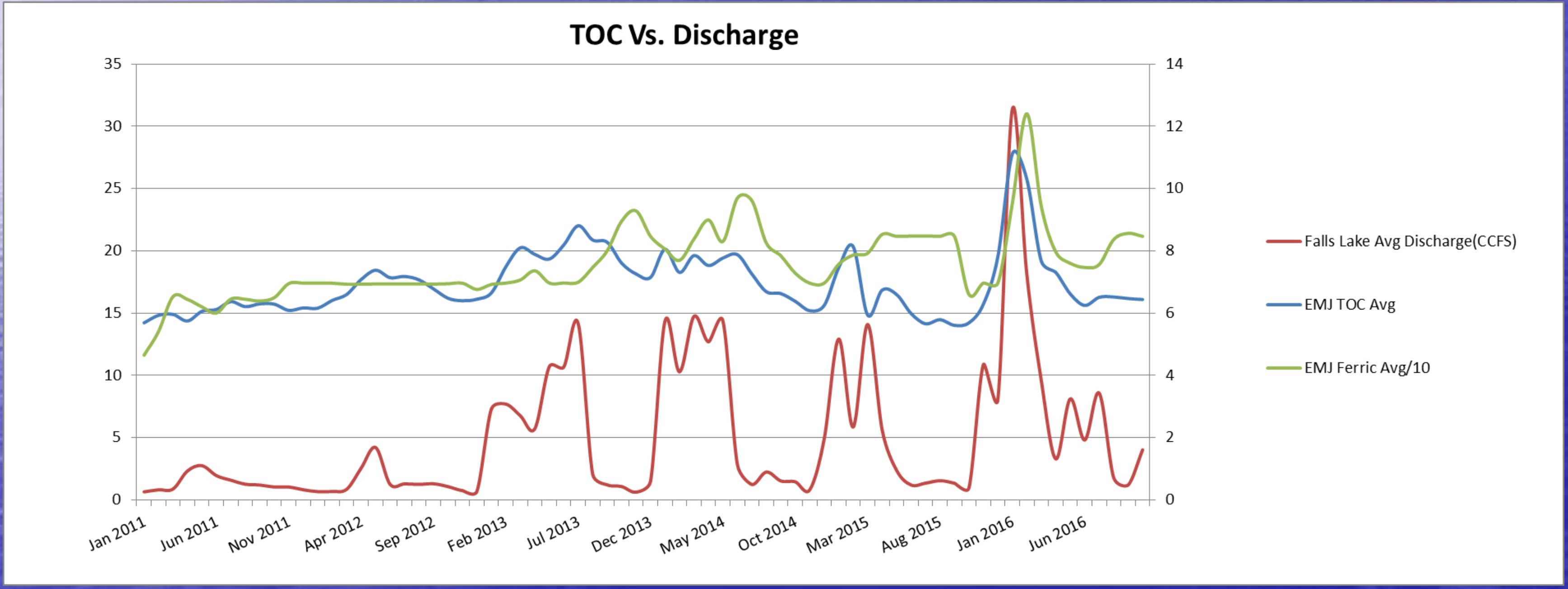
Site Location	TTHMs, ppb				HAA5, ppb			
	2013	2014	2015	2016	2013	2014	2015	2016
1221 New Bern Ave	26.8	21.3	18.1	24.8	14.6	13.6	10.1	20.4
11700 New Leesville Rd	38.3	34.0	32.8	47.3	22.3	23.5	18.3	39.7
7911 Fayetteville Rd	25.9	17.8	17.5	22.5	13.2	11.7	9.70	13.9
720 Powell Dr	26.6	17.9	17.6	22.6	14.1	11.8	13.9	18.0
301 Hein Dr	33.1	23.9	23.1	22.8	19.9	17.9	16.2	16.6
2128 Mingo Bluff Blvd	29.8	27.7	26.0	36.8	16.9	19.1	13.9	24.8
1695 Timber Dr	25.5	18.8	17.5	23.1	12.6	11.6	10.2	15.7
1406 N Arendell Ave	28.9	28.9	26.2	36.7	11.9	21.3	11.5	27.0
236 Jamison Dr	31.0	22.8	21.5	21.7	17.5	17.0	14.4	17.7
22 E. Rowan St	27.6	25.8	24.8	38.6	17.8	17.5	13.3	32.6
7816 Fairlake Dr	44.4	39.8	37.5	51.0	25.3	26.2	20.8	40.0
10700 World Trade Blvd	41.0	38.0	34.1	48.0	23.8	24.6	17.6	34.8

Lake Benson Level and Algae

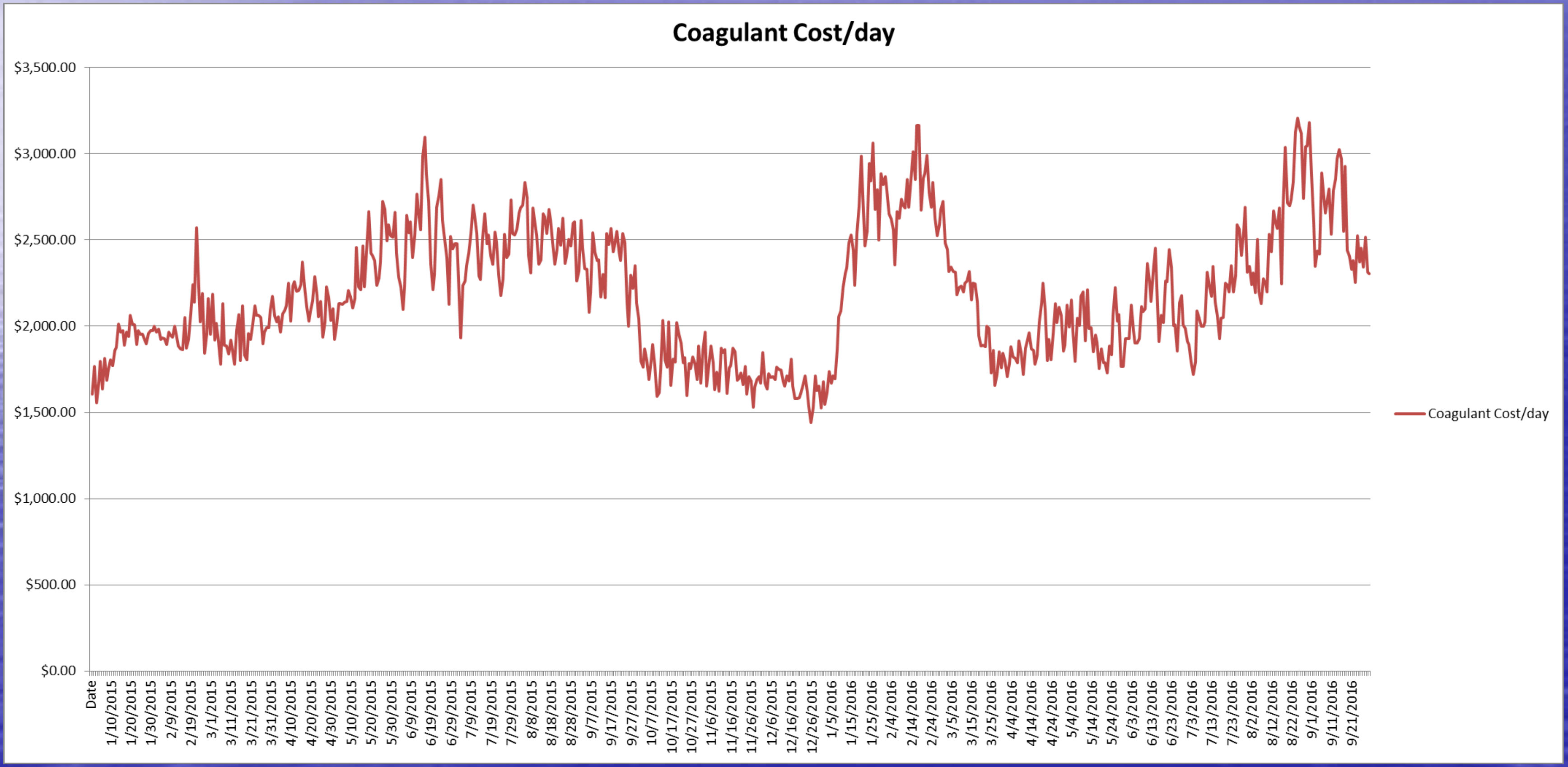




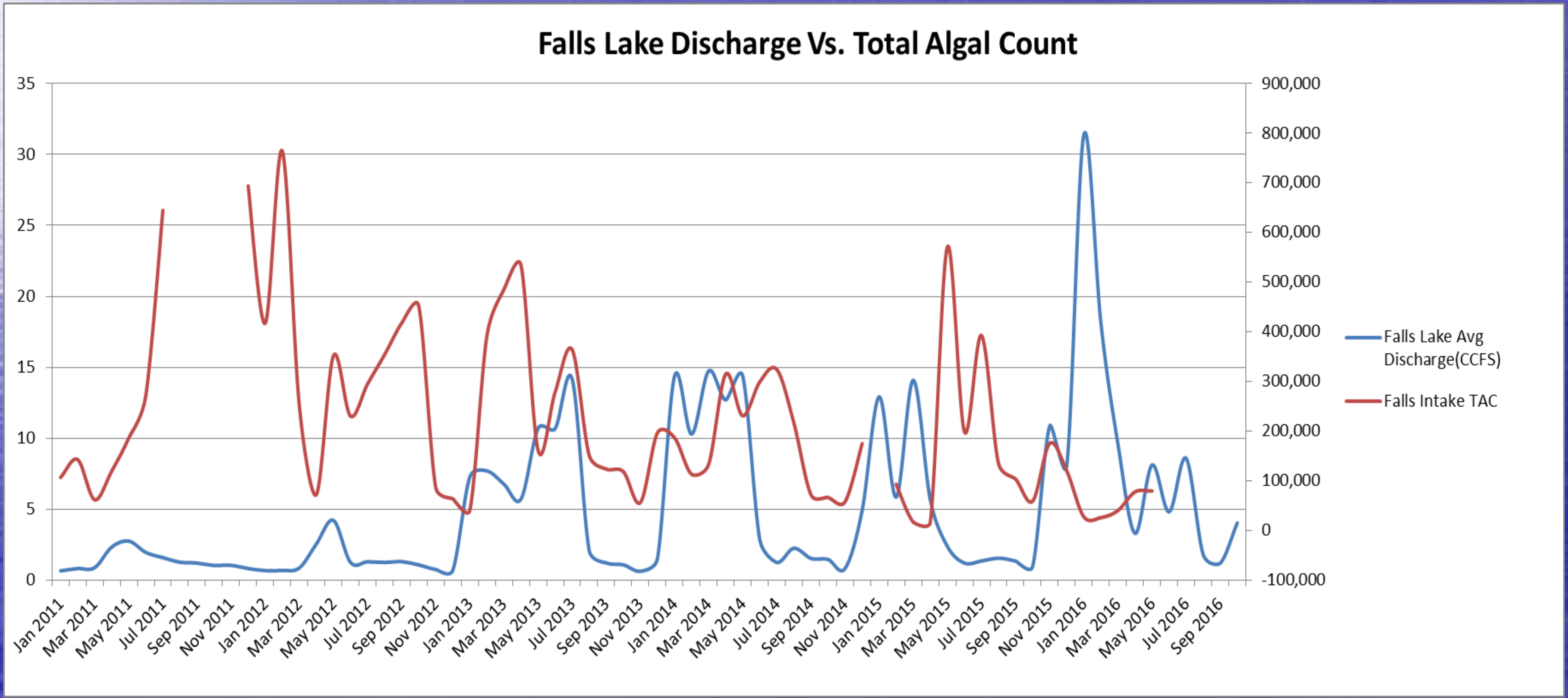
TOC, Ferric Dose, Lake Discharge



Ferric Sulfate Chemical Cost



Algal Count Trend



Questions?

NORTH CAROLINA

Nothing Compares

October 19, 2016

NCDP Scientific Advisory Council
Department of Environmental Quality
Division of Water Resources

2016 NC 303(d) List

- Water Quality Assessment Methods Review
- Summary of water quality assessments by method
- Summary of Category 5 assessments-303(d) List
- Public review process and information

Assessment Categories

1
Meeting criteria
2

3 No info/inconclusive

4
Criteria exceeded
303(d) List 5

Water Quality Assessment Methods

- Five 303(d) assessment methods-
  - Numeric criteria (Dissolved Oxygen, chlorophyll *a,* high pH)
  - Biological criteria (benthos community diversity)
  - Pathogen criteria (fecal coliform bacteria)
  - Shellfish Harvesting criteria (growing area classifications)
  - Fish Consumption criteria (DHHS advisories)
- Assessment Period 2010-2014

Standards and Associated Uses

Examples

- Numeric Standards for Aquatic Life Protection -76
  - Chlorophyll a 40 µg/l all waters
  - Chlorophyll a 15 µg/l Trout
  - pH low 6 freshwater 6.8 saltwater
  - pH high 9 freshwater 8.5 saltwater
  - DO low 4.0 mg/l freshwater 5.0 saltwater 6.0 Trout
- Numeric Standards for Water Supply Protection- 18
  - NO_2+NO_3 10mg/l
- Numeric Standards for Recreation, shellfish harvesting and fish consumption

Numeric Criteria Assessment Methods

Assessment Criteria

- Applied to 88 Parameters of Interest with water quality standards
- Most water quality standards in NC are **NOT TO EXCEED –NTE**
- Not a "Use Support Assessment"- Water Quality Standards Assessment
- Assessment in **Category 5** or 303(d) assessment
  - **N>9**
  - **Greater than 10% exceedance of numeric standard**
  - **Greater than 90% confidence that numeric standard is exceeded in at least 10% of samples**

Numeric Criteria Assessment Methods

Example

- Example-Dissolved Oxygen
- Standard-…."is not less than 4.0 mg/l"
  - N=**60**
  - 10 samples less than 4 mg/l or **16.7%** exceedance
  - Confidence in 10% exceedance=**92.65**

- Assessment Unit (water body) assessed as **Exceeding Criteria**
- Assessed in **Category 5** for Low Dissolved Oxygen- 303(d) Listing

Standards and Assessment Methods

Approvals and Review

- Standards approved by NC and EPA
- Assessment Methods of Standards for 303(d) purposes approved by EMC
- EPA uses guidance and NC standards to review 303(d) list
- EPA has ultimate approval of 303(d) list
- EPA does not approve the assessment method

- 199 Numeric standards **Exceeding Criteria**
- Most common Parameters assessed in **Category 5**
  - Copper- 47
  - Dissolved oxygen- 35
  - Turbidity-37
  - pH (Low)-27
  - Chlorophyll *a* – 24

Biological Assessment Methods

Criteria

- Using benthos and fish community data
- **Narrative standard-**
- Criteria
  - Fair, Poor or Severe biological rating
- Results in **Category 5** or 303(d) list assessment
- If there is another Aquatic Life Parameter in **Category 5** then the biological exceedance is assessed in **Category 4**.

Biological Assessment Methods

Draft Summary for Public Review

- 339 biological assessments **Exceeding Criteria (Category 5)**
- Benthos-263
- Fish Community-76

Pathogen Indicator Assessment Methods

Criteria

- Based on Fecal Coliform Bacteria (Freshwater) and Enterrococci Data (Saltwater)
- **Criteria very similar to the standard- duration and frequency (magnitude?)**
  - N>=5 samples within a 30 day period
  - Geometric Mean> 200 (Fecal) >35 (Enterro) or
  - Greater than 20% >400 (Fecal only)
- Results in Category 5 or 303(d) list assessment

Pathogen Indicator Assessment Methods

Draft Summary for Public Review

- 67 Exceeding Pathogen Criteria (Category 5)
- Fecal coliform-53
- Enterrococci-14

Shellfish Harvesting Assessment Methods

Criteria

- Based on Growing Area Classification
- Criteria
  - Not Approved for shellfish harvesting
- Results in Category 5 or 303(d) list assessment
- Note: fecal coliform standard for shellfish harvesting not used for assessment

Shellfish Harvesting Assessment Methods

Summary

- 565 Exceeding Shellfish Harvesting Criteria

Fish Consumption Assessment Methods

Criteria

- Based on DHHS Fish Consumption Advisories
- Criteria
  - DHHS Consumption Advisory
  - Fish Tissue data present
- Results in Category 5 or 303(d) list assessment

Fish Consumption Assessment Methods

Draft Summary for Public Review

- 37 Exceeding Fish Consumption Criteria
- PCB- 36
- Dioxin- 1

- Note- 13,390 category 4t assessments for Mercury (statewide TMDL)

Changes from 2014 Assessment

- Exceeding Criteria to Meeting Criteria
  - 41 (31 removed from 303(d) List)
    - No longer exceeding in 10% of samples
    - Biological rating meeting criteria
    - Natural conditions assessments
- Exceeding Criteria to Data Inconclusive
  - 67 (66 removed from 303(d) List)
    - 19 confidence criterion not met
    - 45 metals that EPA placed on 2014 303(d) List not based on EMC methods
- Meeting Criteria to Exceeding Criteria
  - 35 (33 added to 303(d) List)

  - 2014 Category 5 assessments= 1249 in 1109 AUs vs.
  - 2016 Category 5 assessments=1237 in 1133 AUs

New Category 5 Assessments

2016 Additions to 303(d) List

- 73 New Category 5 Assessments
  - Benthos- 21
  - Turbidity-11
  - Fish Community- 10
  - pH Low-9
  - Chlorophyll *a* - 7
  - Enterococcus- 4
  - pH High-4
  - Dissolved Oxygen-3
  - PCB Advisory - 2
  - Hardness- 1
  - Shellfish Growing Area- 1

Discussion Topics

- Implementing Standards in permits vs. are you meeting criteria in Waters of NC (WONC)
- EPA guidance vs. EMC methods
- Greater than 1 in 3 years exceedance method
- Statistical confidence in 10% exceedance
- Compliance with standards vs Meeting Assessment Criteria

Thank you. Questions?

Department of Environmental Quality