HDR

Plant Optimization, Water Quality, and Regulatory Strategy

Dave Clark, Jennifer A. Frommer, Rich Atoulikian | HDR Engineering, Inc.

Plant Operations and Lab Analysis Workshop

October 21, 2015

HDR

HDR Presents…

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Sector Director

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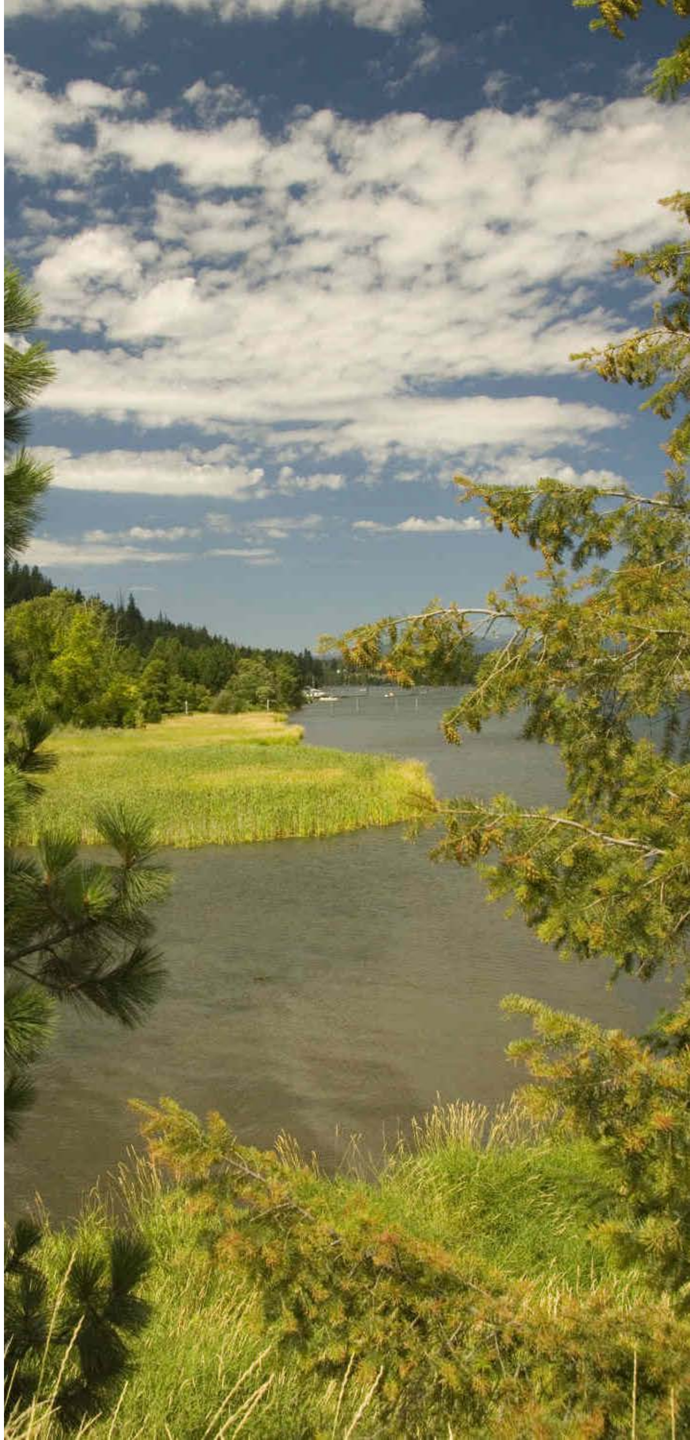
National Regulatory Perspectives

- Strategy grounded in context of the national dialogue on Nutrients
  - National
  - State
  - Nutrient Discharge Permitting
- Awareness of Water Quality tools and drivers in your area
- Plant Optimization techniques with strong ROI
- Tips to inform your approach






Nutrient Overview

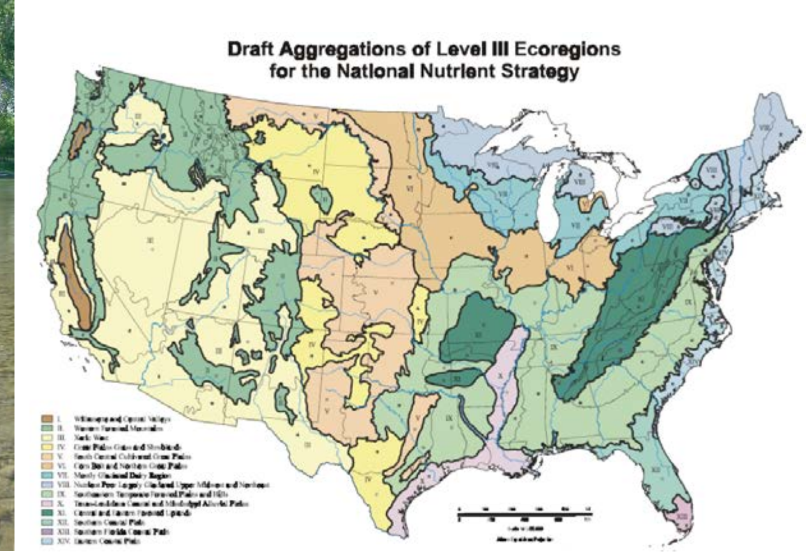
Numeric Nutrient Criteria ➡ Low N and P Concentration Endpoints

Reference Stream Approach

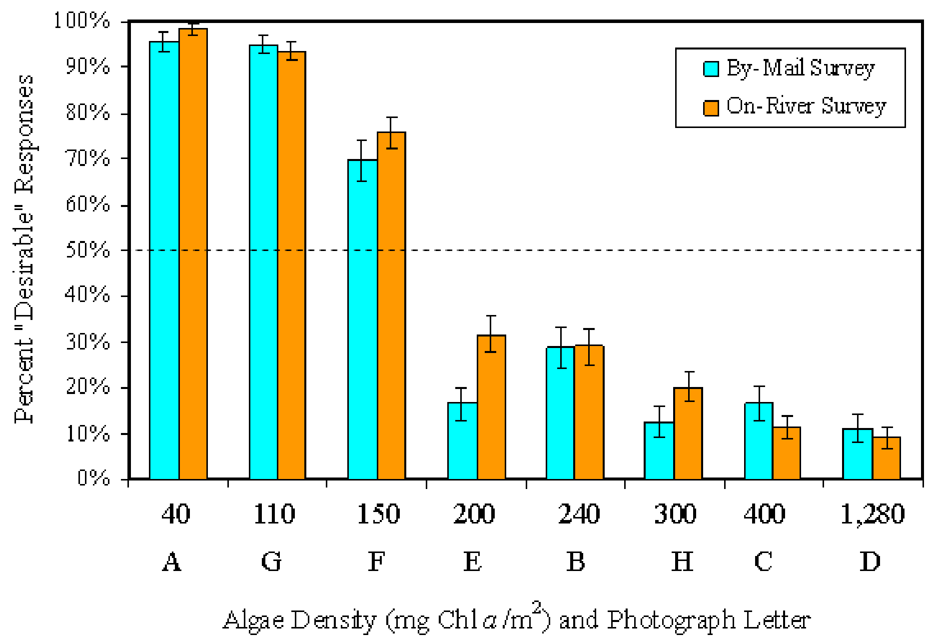
- EPA's Ecoregion Nutrient Criteria

Stressor Response

- D.O., pH
- Chla, Benthic Algae
- Macroinvertebrates
- Fisheries
- Recreation
- Public Perception



"*Typical Concentrations That Protect Uses Are Low*" – Mike Suplee, MDEQ Total Phosphorus 0.05 mg/l Total Nitrogen 0.30 mg/l



Aggregate Level III Ecoregion – Corn Belt and Northern Great Plains VI

Rivers and Streams in Nutrient Ecogreion III (25th percentile)

Nutrient Parameter	Aggregate Nutrient Ecoregion Reference Conditions
Total Phosphorus (mg/L)	0.07625
Total Nitrogen (mg/L)	2.18
Chlorophyll a (ug/L)	2.70
Turbidity (NTU) / (FTU)	6.36

Lakes and Reservoirs in Nutrient Ecogreion III (25th percentile)

Nutrient Parameter	Aggregate Nutrient Ecoregion Reference Conditions
Total Phosphorus (mg/L)	0.0375
Total Nitrogen (mg/L)	0.781
Chlorophyll a (ug/L)	8.59
Secchi depth (meters)	1.356

- Western Ohio example
  - Eastern Corn Belt Plains

Challenges in establishing Nutrient Criteria

- Identifying Threshold of Harm to Beneficial Uses
  - Reference condition
  - Stressor-response
  - Mechanistic modeling

> *"Typical Concentrations That Protect Uses Are Low"* – Mike Suplee, MDEQ
> Total Phosphorus 0.05 mg/l
> Total Nitrogen 0.30 mg/l

- Translation of In-stream Criteria to Effluent Discharge Permit Limits

Numeric Nutrient Criteria and Limits of Wastewater Treatment Technology[1]

Parameter	Typical Municipal Raw Wastewater, mg/l	Secondary Effluent (No Nutrient Removal), mg/l	Advanced Wastewater Treatment [1]			Typical In-Stream Nutrient Criteria, mg/l
			Typical Biological Nutrient Removal (BNR), mg/l	Enhanced Nutrient Removal (ENR), mg/l	Limits of Treatment Technology, mg/l	
Total Phosphorus	4 to 8	4 to 6	1	0.25 to 0.50	0.05 to 0.07	0.01 to 0.076
Total Nitrogen	25 to 35	20 to 30	10	4 to 6	3 to 4	0.310 to 2.18

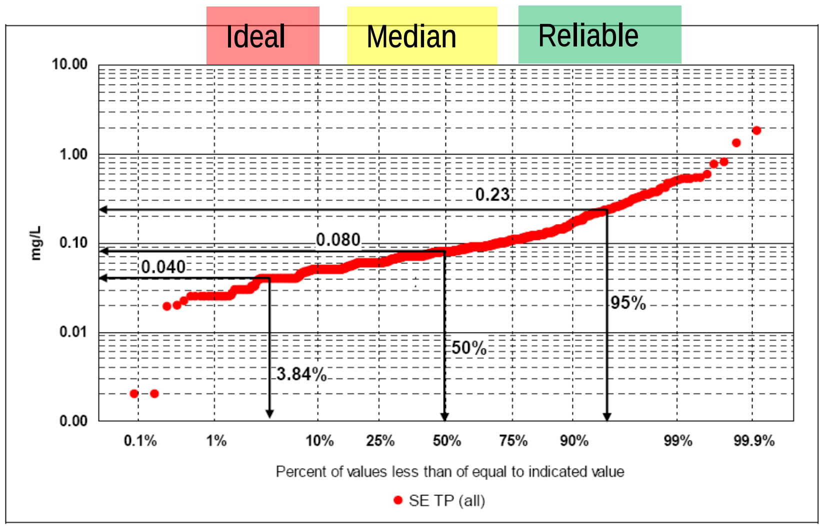
[1] *Ignoring Considerations of Variability and Reliability of Wastewater Treatment Performance*

Water Environment Research Foundation (WERF) "*Nutrient Management: Regulatory Approaches to Protect Water Quality, Volume 1 – Review of Existing Practices*," Project #NUTR1R06i

Water Quality and Advanced Wastewater Treatment

- Waterbody Numeric Nutrient Standards Based on Natural Conditions Are Very Low
  - o Lower Than Treatment Technologies Are Capable of Achieving If Applied "End-of-Pipe"
- Effectiveness of Advanced Treatment for Nutrient Removal
  - o Variability in Treatment Performance
  - o Reliability
  - o Effluent Speciation
    - Bioavailability
- Translation to Discharge Permits
  - o 303(d) Impairment Listings and TMDLs
  - o Direct Application to Discharge Permits

Technology Performance Statistics

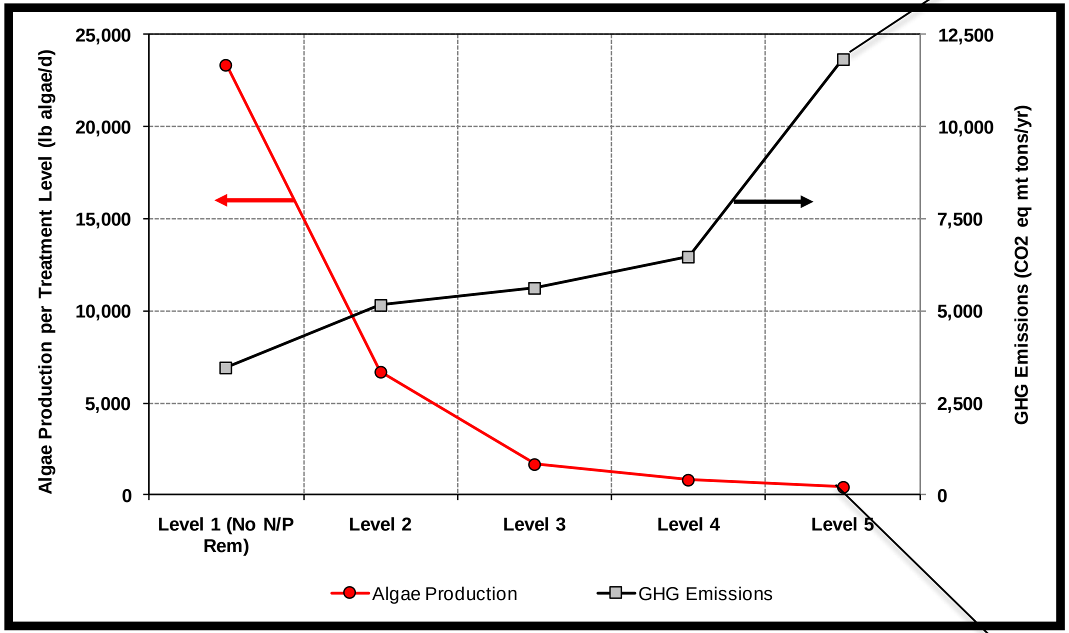


Neethling, JB; Stensel, H.D.; Parker, D.S.; Bott, C.B.; Murthy, S.; Pramanik, A.; Clark, D. (2009) What is the Limit of Technology (LOT)? A Rational and Quantitative Approach. *Proceedings of the WEF Nutrient Removal Conference*, Washington DC, Water Environment Federation, Alexandria, Virginia.

Sustainable Nutrient Removal and Balanced Decision Making – Net Benefit?

Advanced Nutrient Removal Treatment

Algal Production Potential v. Greenhouse Gas Production



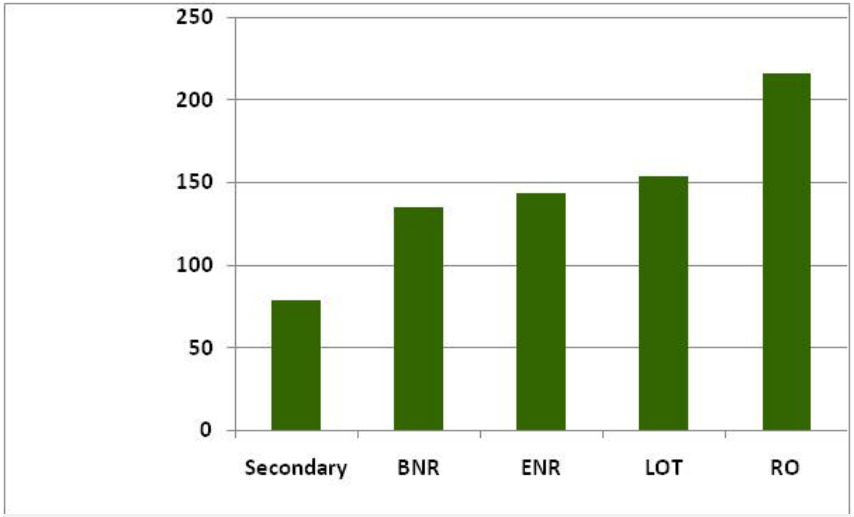
Increasing GHG Emissions

Diminishing Water Quality Benefit

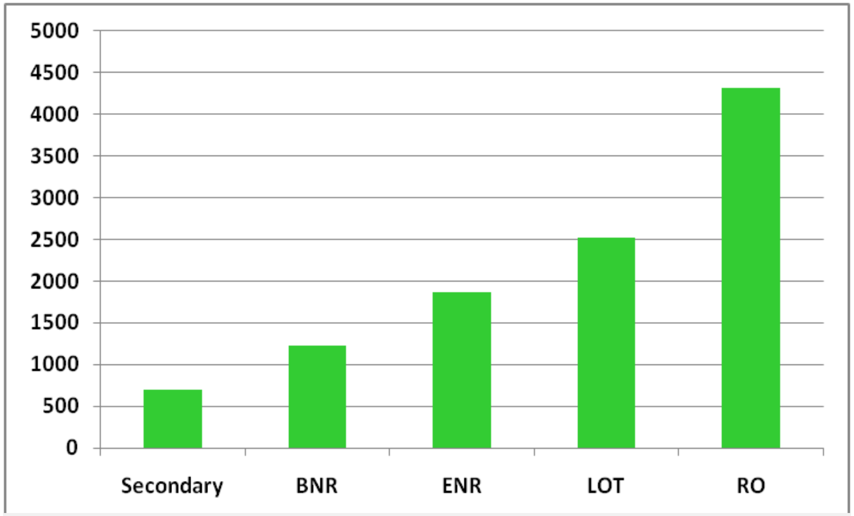
Water Environment Research Foundation (WERF) "*Striking the Balance Between Wastewater Treatment Nutrient Removal and Sustainability*" November 2010

1. *Secondary Treatment (No nutrient removal)*
2. *Biological Nutrient Removal (BNR) TP 1 mg/L TN 8 mg/L*
3. *Enhanced Nutrient Removal (ENR) TP 0.1-0.3 mg/L TN 4-8 mg/L*
4. *Limit of Treatment Technology (LOT) TP <0.1 mg/L TN 3 mg/L*
5. *Reverse Osmosis (RO) TP <0.02 mg/L TN 2 mg/L*

Treatment Costs Escalate Substantially Approaching Technology Limits



Estimated Capital Costs for 10 mgd Capacity (Million $)



Estimated O&M Costs for 10 mgd Capacity ($1,000/yr/10 MG Treated)

Water Environment Research Foundation (WERF) "*Striking the Balance Between Wastewater Treatment Nutrient Removal and Sustainability*" November 2010

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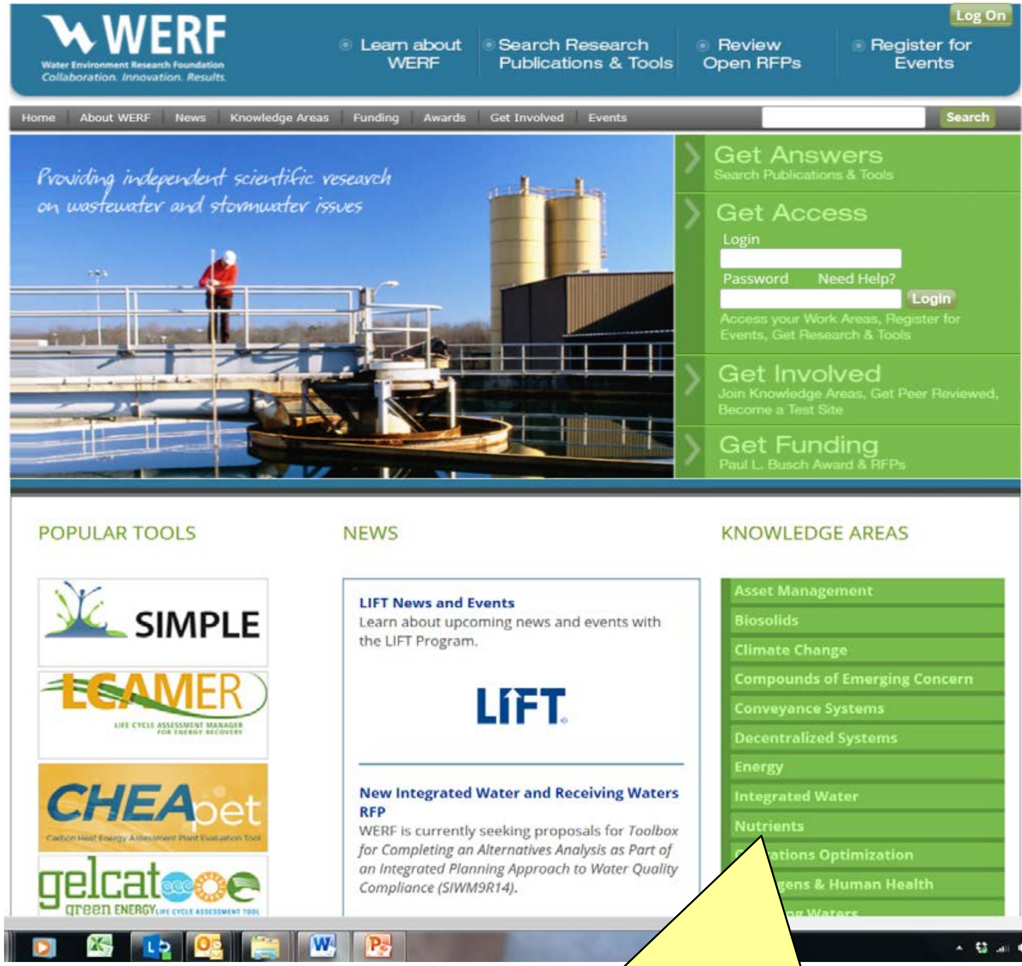
3. Enhanced Nutrient Removal (ENR) TP 0.1-0.3 mg/L TN 4-8 mg/L
4. Limit of Treatment Technology (LOT) TP <0.1 mg/L TN 3 mg/L
5. Reverse Osmosis (RO) TP <0.01 mg/L TN 1 mg/L

Water Environment Research Foundation Nutrient Challenge

www.werf.org

- Original Objectives
  - Provide science-based solutions and recommendations that:
    - (1) support utility decisions to use sustainable wastewater nutrient removal technologies and meet other wastewater treatment goals, and
    - (2) inform regulatory decision making that is moving toward increasingly higher levels of nitrogen and phosphorus removal.



Go to ***KNOWLEDGE AREAS: Nutrients***
>50 completed and ongoing projects

National Nutrient Regulatory Issues

EPA's National Strategy for the Development of Regional Nutrient Criteria, June 1998

State and EPA Roles

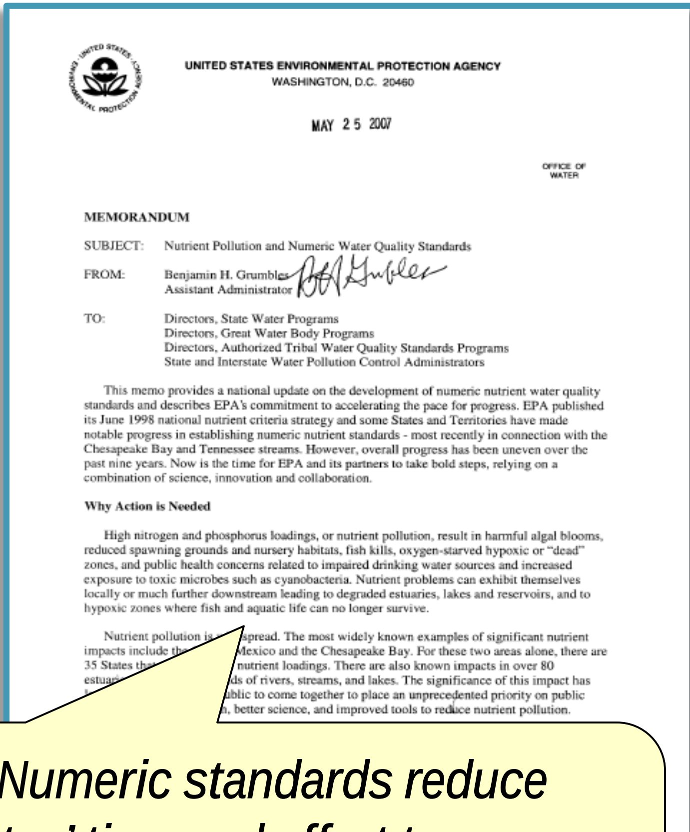
- States to Adopt Nutrient Criteria as Water Quality Standards
- EPA Development of Waterbody-type Guidance
  - Ecoregion Nutrient Criteria

Key Elements

- Use regional and waterbody-type approach for nutrient criteria.
- Development of waterbody-type technical guidance documents
- Establishment of an EPA National Nutrient Team with Regional Nutrient Coordinators
- Development by EPA of nutrient water quality criteria guidance in the form of numerical regional target ranges
  - EPA expects States to use in development of water quality criteria, standards, NPDES permit limits, and total maximum daily loads (TMDLs).
- Monitoring and evaluation of effectiveness

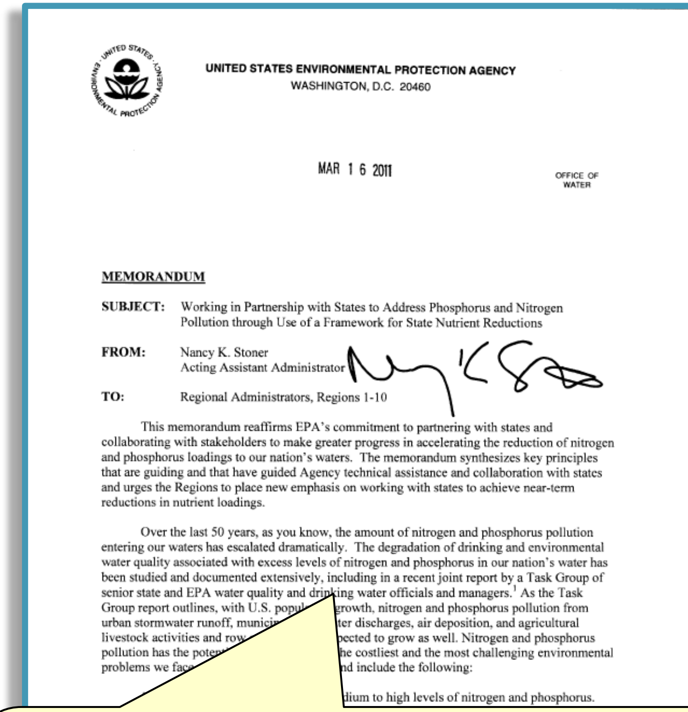
EPA's National Nutrient Strategy

Ben Grumbles' May 25, 2007, Memorandum to States



"…Numeric standards reduce States' time and effort to establish TMDLs and permits to control nutrient levels…"

Nancy Stoner's March 16, 2011 Memorandum to EPA Regional Administrators



"…"It has long been EPA's position that numeric nutrient criteria….are ultimately necessary for effective state programs."

NRDC Petition on Secondary Treatment Standards

- November 27, 2007, NRDC petition for rulemaking
  - EPA has unreasonably delayed publishing information on secondary treatment to remove excess nutrients
  - Nutrient control is properly included within “secondary treatment”

- *NRDC states:*
  - *TP 0.3 mg/l and TN 3 mg/l currently attainable*
  - *TP 1 mg/l and TN 8.0 mg/l attainable only using biological processes*
  - *EPA must assess whether this constitutes “secondary treatment”*

NRDC
THE EARTH'S BEST DEFENSE

NATURAL RESOURCES DEFENSE COUNCIL

November 27, 2007

Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Dear Administrator Johnson,

Enclosed please find a petition, along with attachments, seeking overdue and needed improvements to the Environmental Protection Agency's secondary treatment requirements for wastewater treatment plants.

This petition is filed on behalf of the following groups, many of which are membership organizations that are collectively supported by millions of individuals: the Natural Resources Defense Council, the Environmental Law and Policy Center of the Midwest, the Sierra Club, the Waterkeeper Alliance, the Missouri Coalition for the Environment, Midwest Environmental Advocates, the Prairie Rivers Network, the Iowa Environmental Council, the Minnesota Center for Environmental Advocacy, American Rivers, and the Gulf Restoration Network.

We would welcome the opportunity to discuss the materials presented in this petition with you and your staff.

Should you have any questions about the enclosed materials, please do not hesitate to contact me at (202) 289-2361.

Sincerely,

Jon P. Devine, Jr.
Senior Attorney
Clean Water Project
Natural Resources Defense Council

cc (without attachments):
Benjamin Grumbles, Assistant Administrator for Water (Mail Code 4101M)
Roger R. Martella, Jr., General Counsel (Mail Code 2310A)
James A. Hanlon, Director, Office of Wastewater Management (Mail Code 4201M)

www.nrdc.org 1200 New York Avenue, NW, Suite 400 Washington, DC 20005 TEL 202 289-6868 FAX 202 289-1060 NEW YORK · LOS ANGELES · SAN FRANCISCO

100% Postconsumer Recycled Paper

NRDC Petition on Secondary Treatment Standards Denied

- December 14, 2012 EPA Response
  - EPA Conclusions
  - Nutrients at POTWs Highly Site-Specific
  - Not Suited to Uniform National Rule
  - Not All POTWs Nationwide Need Technology Based Effluent Limits (TBELs) for Nutrients
  - High Costs Nationally
- EPA's Preferred Approach
  - Water Quality Based Provisions of CWA

Technology Based Effluent Limits

Benefits

- Simplicity in Effluent Discharge Permitting
- Select Effluent Limits at Levels Where Compliance is Assured

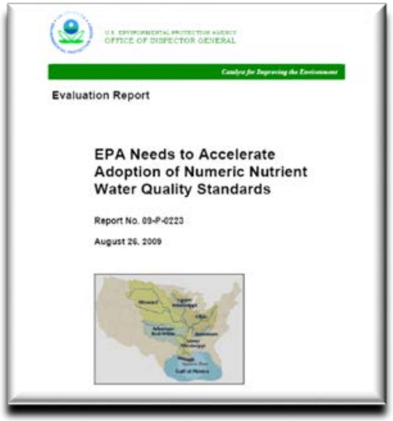
Limitations

- Lacks Direct Linkage with Receiving Water Quality Requirements
- Suggests Uniformity in Limits is Appropriate for all Receiving Waters
  - Contradicted by Site Specific Circumstances that Define the Actual Impact of Nutrients on Individual Waterbodies

Future Water Quality Based Effluent Limits for Nutrients in Ohio?

Gulf of Mexico Load Allocations

- State Goals
  - 2008 Gulf Hypoxia Action Plan
  - Minnesota
    - State Goal 45% Reduction in TN and TP Loads
  - Iowa Nutrient Strategy
    - 45% Reduction in TN and TP Loads
  - Kansas Nutrient Reduction Plan
    - 30% Reduction


U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF INSPECTOR GENERAL

Catalyst for Improving the Environment

Evaluation Report

EPA Needs to Accelerate Adoption of Numeric Nutrient Water Quality Standards

Report No. 09-P-0223

August 26, 2009

- Gulf Restoration Network v. EPA
  - Asked EPA to develop NNCs and TMDL for entire Mississippi and upper Gulf of Mexico
- EPA Office of Inspector General Report August 2009
  - EPA Set Numeric Nutrient Standards
    - Mississippi River and Gulf of Mexico Highlighted

Beyond State Numeric Nutrient Criteria Resulting in New Effluent Limits, Wasteload Allocations from Downstream Waterbodies May Result in Additional Nutrient Reduction Requirements

(Example 1: River Discharge P Limits Combined with Downstream Wasteload Allocation for N)

(Example 2: Downstream P Limits Combined with River Discharge P Limits)



State Nutrient Regulatory Issues

Summary Comparison of Select States Nutrient Discharge Permit Structure and Approach

State	Technology Based Limits	Rulemaking	Informs Permit Structure	Implementation	Variance	Site Specific, Response Variables, etc
Colorado	Yes	Yes	Moving Annual Median	Delayed Implementation	Yes	No
Iowa	Yes	No	12 Month Average	~10 yrs + 10 yrs (Negotiable)	No	Yes & No
Florida	No	Yes	-	-	No	Yes
Maine	No	Yes	-	-	No	Yes
Montana	Yes	Yes	Monthly Ave	Revised Limits 2016	Yes	Yes
Ohio	No	Yes	?	3 Permit Cycles	No	Yes
Wisconsin	Yes	Yes	Moving Annual Mean	4 Permit Cycles	Yes	No

Across the country, the plot thickens…..
as in Iowa

- Des Moines Water Works Notice of Intent to Sue
  - 9 million acres of farmland
  - Drainage tiles that bring nutrients to water bodies
  - Seeks that drainage districts have federal oversight where agriculture is now exempt under CWA
  - Gov Terry Branstad notes, “Des Moines is declaring war on rural Iowa”….and calls the potential action “Un-Iowan”.

Meanwhile in Ohio…

- Framework for Nutrient Standards for Rivers and Streams
  - Wadeable Streams and Rivers
    - Separate Consideration of Large Rivers and Lakes
- Nutrient Technical Advisory Group (TAG)
  - Stakeholder Representation
    - Point Sources, Agriculture, Environmental, Economic
  - Adaptive Management
    - Cost Effective Implementation
    - Avoid Overly Stringent Controls Providing Little or No Water Quality Benefit
    - Build Consensus

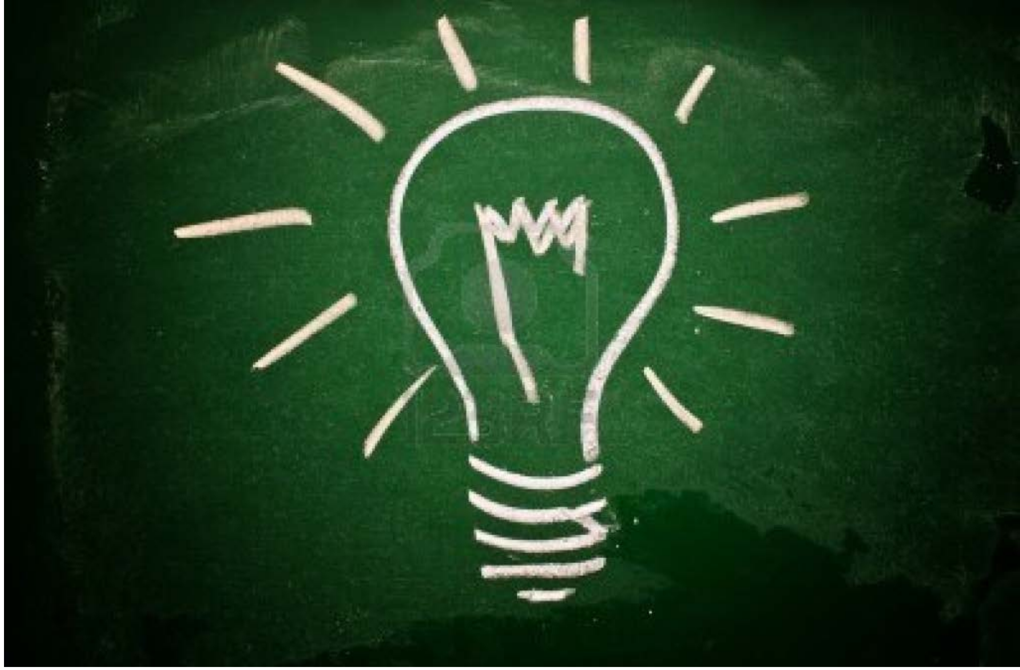
Trophic Index Criterion (TIC) Proposal

<u>Ohio EPA and USEPA Region 5 Developed Composite Index</u>

- Trophic Index Criterion (TIC)
  - Method to Identify Impairment (not a criterion)
- Multi-metric Scoring Index
  - Biological Assemblages
  - Dissolved Oxygen
  - Periphyton
  - Nutrients
- Scoring Designations
  - Acceptable
  - Threatened
  - Impaired
  - Requires Further Assessment
- Limitations

Technical Advisory Group contributions

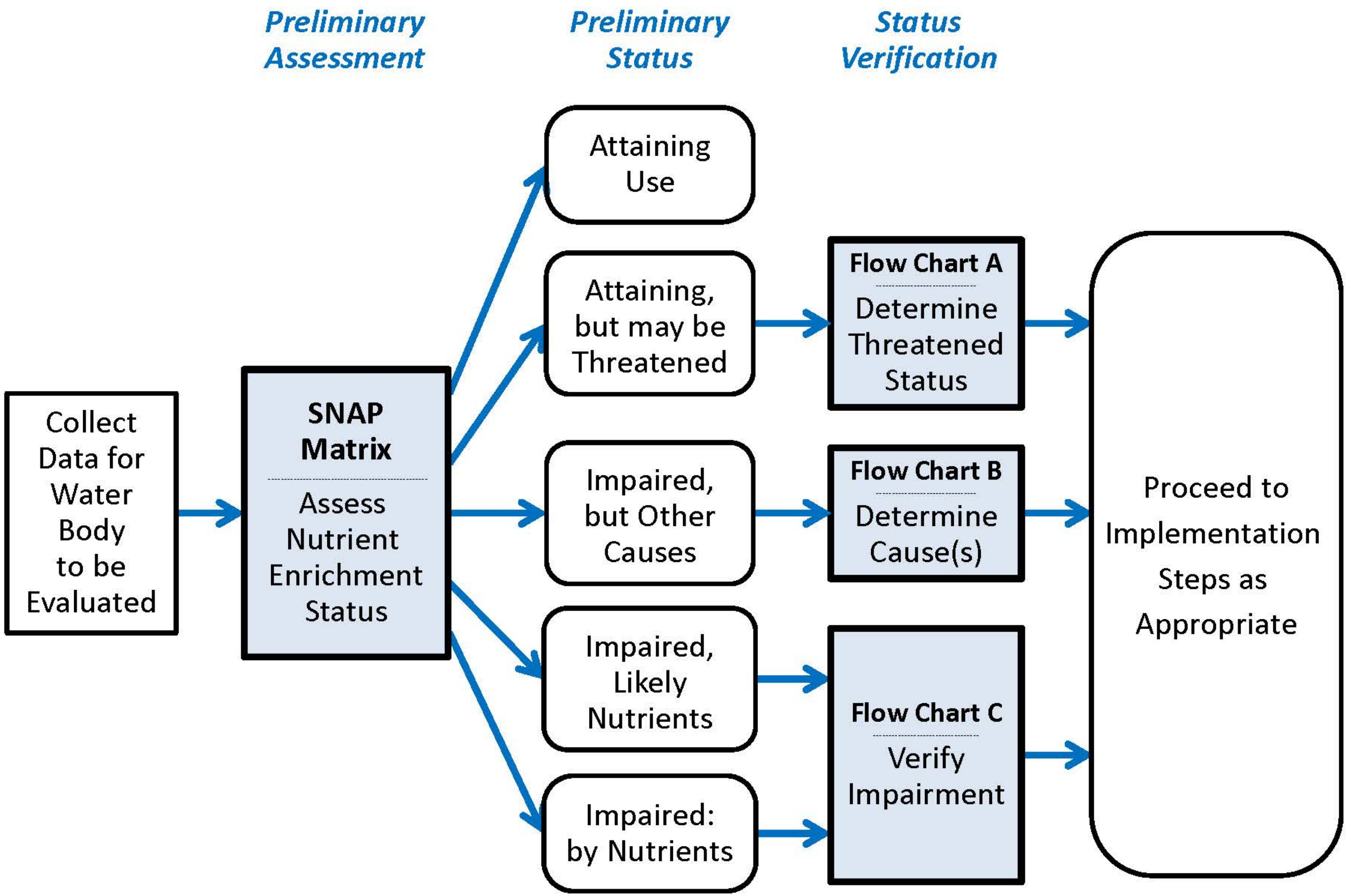
- Nutrient Measurements Rarely Provide a “Bright Line” Dose-Response” Relationship Linked to Use Impairment
- “Biological Health” Best Determined by Multiple Biological Indicators
- Recommended the SNAP
  - Stream Nutrient Assessment Procedure



Ohio Stream Nutrient Assessment Procedure (SNAP)

- Trophic Index Decomposed to Decision Matrix
  - Stepwise Evaluation of Key Indicators
    - Nutrient Concentration Removed
    - 2 Key Response Variables
      - Dissolved Oxygen Swing
      - Benthic Chlorophyll
    - Ohio Biological Water Quality Criteria
      - Biocriteria for Fish and Macroinvertebrates
        - IBI = Index of Biological Integrity
        - MIwb = Modified Index of Well-Being
        - ICI = Invertebrate Community Index
- SNAP Matrix of Trophic Conditions
  1. Attaining and not threatened
  2. Attaining, but may be threatened
  3. Impaired, but cause(s) other than nutrients
  4. Impaired, with nutrients as a likely cause
  5. Impaired, with nutrient enrichment as the cause

Stream Nutrient Assessment Procedure (SNAP)

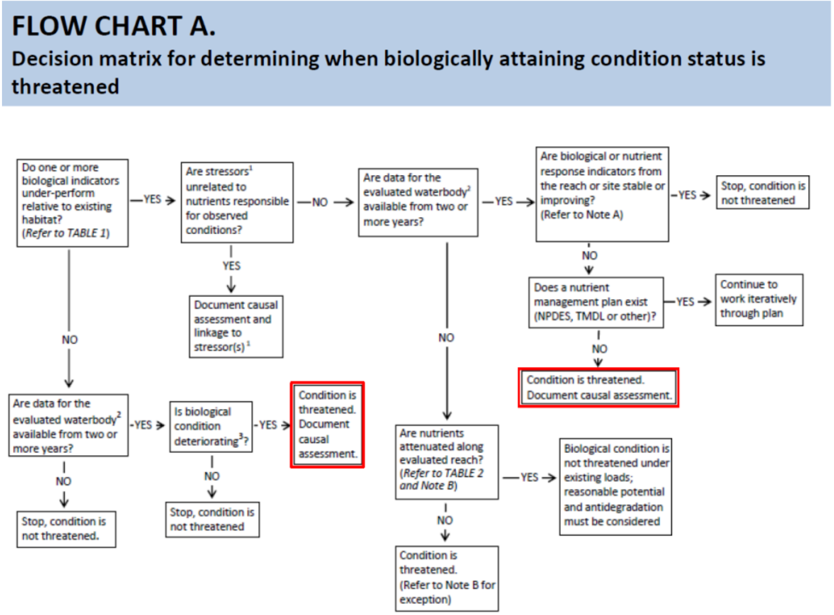


Proposed **Stream Nutrient Assessment Procedure (SNAP)**

<table>
<tr><th>1</th><th>2</th><th>3</th><th colspan="2">4</th></tr>
<tr><th>Biological Criteria</th><th>DO Swing</th><th>Benthic Chlorophyll</th><th colspan="2">Preliminary Assessment: Trophic Condition Status</th></tr>
<tr><td rowspan="4">All indices attaining or non-significant departure</td><td rowspan="2">Normal or low swings (≤6.5 mg/l)</td><td>Low to moderate (≤320 mg/m²)</td><td colspan="2">Attaining use / not threatened</td></tr>
<tr><td>High (>320 mg/m²)</td><td rowspan="3">Attaining use, but may be threatened</td><td rowspan="3">See Flow Chart A</td></tr>
<tr><td rowspan="2">Wide swings (>6.5 mg/l)</td><td>Low (≤182 mg/m²)</td></tr>
<tr><td>Moderate to high (>182 mg/m²)</td></tr>
<tr><td rowspan="4">Non-attaining (one or more indices below non-significant departure)</td><td rowspan="2">Normal or low swings (≤6.5 mg/l)</td><td>Low to moderate (≤320 mg/m²)</td><td>Impaired, but cause(s) other than nutrients</td><td>See Flow Chart B</td></tr>
<tr><td>High (>320 mg/m²)</td><td rowspan="2">Impaired / likely nutrient enriched</td><td rowspan="3">See Flow Chart C</td></tr>
<tr><td rowspan="2">Wide swings (>6.5 mg/l)</td><td>Low (≤182 mg/m²)</td></tr>
<tr><td>Moderate to high (>182 mg/m²)</td><td>Impaired / Nutrient enriched</td></tr>
</table>

SNAP Classification 2: Attaining but may be threatened

- Flow Chart A: for determining when biologically attaining condition status is threatened by nutrients.
  - Biological Criteria are Attaining
  - One or Both DO Swing or Benthic Chl-a are Elevated

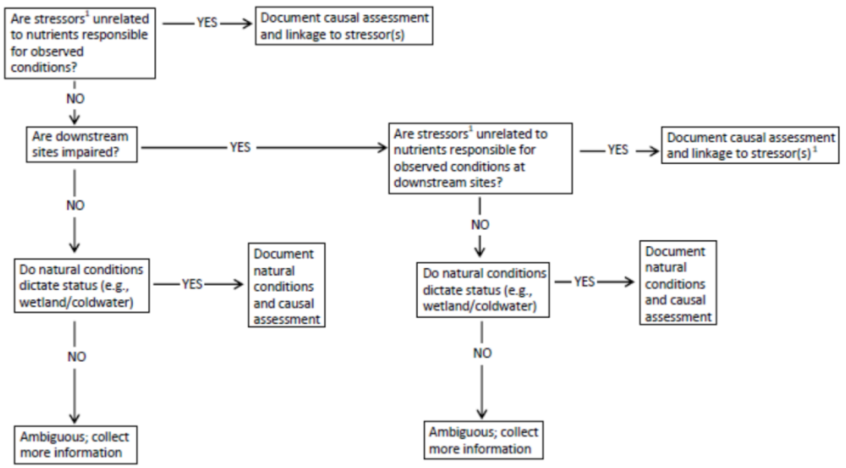


SNAP Classification 3: Impaired by other causes

- Flow Chart B: for determining biological impairment caused by stressors other than nutrients
  - One or more Biological Criteria are non-attaining
  - No Elevated DO Swing or Benthic Chl-a

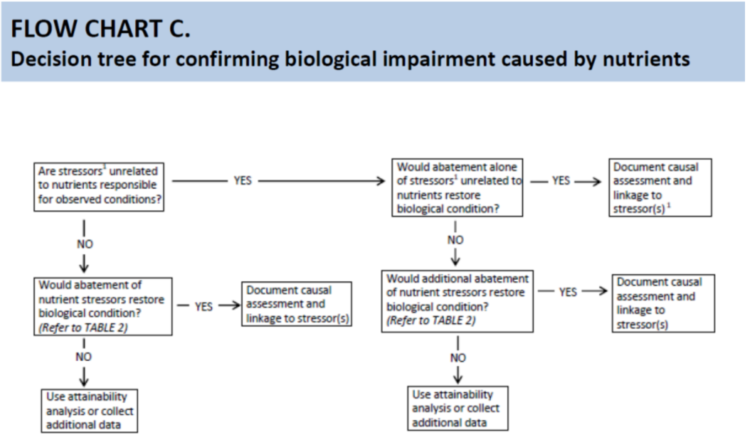
FLOW CHART B.

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



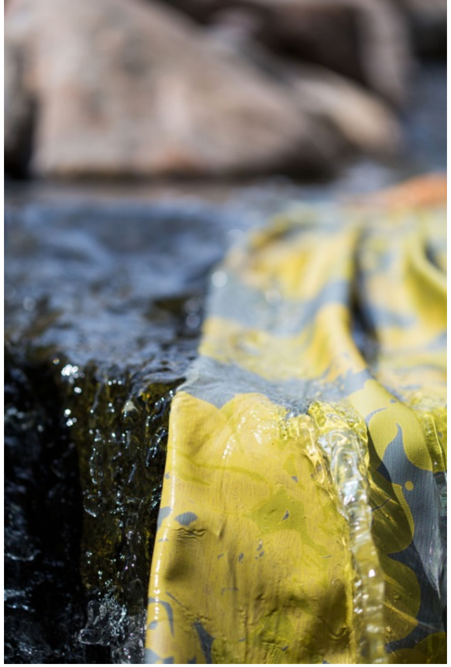
SNAP Classifications 4 and 5: Impaired with nutrients likely or identified

- Flow Chart C: for confirming biological impairment caused by nutrients
  - One or More Biocriteria are Non-attaining
  - DO Swing or Benthic Chl-a is Elevated
  - If Abatement of Nutrient Stressors Does Not Restore Biological Condition?
    - UAA or Collect More Data



In State Rulemaking, Development of Implementation Guidance May Be As Important As Development of the Numeric Nutrient Standards

(Discharge Permitting, Compliance Requirements, Site Specific Conditions, Adaptive Management)


Nutrient Discharge Permitting

Attainable and Protective Nutrient Permits

Preferred	Avoid

Preferred

- Improve Water Quality
  - Effective Nutrient Reduction
  - Linked to Standards or TMDL Wasteload Allocation
- Technically Achievable
  - Low Compliance Risk
- Economical
  - Affordable
- Flexible
  - Supports Watershed Solutions
- Sustainable

Avoid

- Inflexible Permit Structures
  - Unattainable N and P Limits
  - Over-specified Effluent Limits
    - Mass and Concentration
    - Monthly and Weekly Limits for POTWs
  - Immediate Compliance Requirements
- Social and Environmental Impacts
  - Large Increases in Energy, Chemical, Solids, Greenhouse Gas Emissions, etc
  - Marginal Incremental Water Quality Improvements

Clark, D.L. Hunt, G., Kasch, M.S., Lemonds, P.J., Moen, G.M., Neethling, J.B. (2010) “Nutrient Management Regulatory Approaches To Protect Water Quality – Volume 1 Review Of Existing Practices” WERF Nutrient Removal Challenge project NUTR1R06i.

Improving Basis for Nutrient Discharge Permitting

Now

- Treatment Technology Performance
  - Well Documented
- Understanding of Nutrient Speciation
  - Treatment Effectiveness
  - Water Quality Impacts
- State Solutions
  - Near-term Remedies
    - Technology Based Effluent Limits

Developing

- Treatment Technology Advances
- Improved Water Quality Modeling
  - Speciation
  - Nutrient Bioavailability
- Long Term Reconciliation with Water Quality Based Effluent Limits
  - In-stream Targets Lower Than Technology Can Achieve End-of-Pipe
- Bioavailability
- Sustainability

Nutrient Permitting Challenges

Federal Regulations

- 40 CFR 122.45(d) requires that all permit limits be expressed as average monthly limits and average weekly limits for publicly owned treatment works (POTWs) and as both average monthly limits and maximum daily limits for all others, unless impracticable.

Key Issues

- Effluent Variability
  - N and P Variable Even in Best Designed and Operated Facilities
- “Impracticable” Determination
  - Individual Permit Writer’s Interpretation
  - Guidance – 2004 Chesapeake Bay – annual effluent limits acceptable

Example Inconsistency in Permit Limits

Relationship of Weekly to Monthly

Discharger	NPDES Permit Phosphorus Limits		Permit Ratio Weekly/Monthly
	Average Monthly, ug/L (lbs/d)	Average Weekly, ug/L (lbs/d)	
Boise – Lander	70 (8.7)	93 (11.6)	1.33
Boise – West	70 (14)	84 (16.8)	1.2
Caldwell	70 (4.96)	165 (11.7)	2.36
Greenleaf	70 (0.14)	105 (0.21)	1.5
Kuna	70 (1.1)	105 (1.65)	1.5
Notus	70 (0.064)	140 (0.128)	2.0
Sorrento	70 (0.29)	140 (0.58)	2.0

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Key Issues

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- "Impracticable" Determination
  - Individual Permit Writer's Interpretation
  - Guidance – 2004 Chesapeake Bay – annual effluent limits acceptable

S1.B.a Alternate effluent limits for oxygen consuming pollutants demonstrated to be equivalent to DO TMDL baseline effluent limits in S1.A (option 1)

Parameter	Seasonal Limit Applies March 1 to October 31 See notes f and g	
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$)	133.4 pounds/day (lbs/day) average	
Total Phosphorus (as P) March 1 to Oct. 31	3.34 lbs/day average	
Total Ammonia (as NH_3-N)	**Seasonal Limit**	**Maximum Daily Limit**
For "season" of March 1 to March 31	1067.5 lbs/day average	16 mg/L
For "season" of April 1 to May 31	66.7 lbs/day average	16 mg/L
For "season" of June 1 to Sept. 30	16.7 lbs/day average	8 mg/L
For "season" of Oct. 1 to Oct. 31	66.7 lbs/day average	16 mg/L
Parameter	**Average Monthly** [a]	**Average Weekly** [b]
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$), November 1 through February 29	2.0 milligrams/liter (mg/L) 133 pounds/day (lbs/day)	---

Variety of Successful Permit Structures Nationally for Nutrients

- Concentration Only, Mass Only, Both
  - Seasonal Limits
  - Mean or Median
  - Shared Capacity

Location	Total Phosphorus Limits	Comments
Clean Water Services of Washington County, OR	0.100 mg/l	Monthly Median, May 1 to Oct 31 Watershed Permit
Las Vegas, Clark County, Henderson, NV	334 lbs/day (130/174/30 lbs/day)	Mar 1 to Oct 31 Cooperative Agreement to Share for Flexibility
Alexandria, VA	0.18 mg/l and 37 kg/day 0.27 mg/l and 55 kg/day	Monthly Average Weekly Average

Think about the Future: Permit Structure Comparison

<u>Example: Future Effluent Limits Drop from 1 mg/L to 0.5 mg/L</u>

- Concentration Only Limits: Plant Effluent 0.5 mg/L
- Mass Only Limits: Plant Effluent 1 mg/L + Offset/Trade/Reuse

<u>Regulatory Issues</u>

- 40 CFR 122.45(d) requires that all permit limits be expressed as average monthly limits and average weekly limits for publicly owned treatment works (POTWs) and as both average monthly limits and maximum daily limits for all others, unless "impracticable."

Effluent Limits	Technically Attainable		Supports Creative Effluent Management and Watershed Solutions	
	Now	Future	Trading and Offsets	Reuse, Recharge, Restoration, etc (Load Diversions)
Concentration Only	Yes	?	No	No
Concentration and Mass	Yes	?	No	No
Mass Only	Yes	Perhaps	Yes	Yes

Permit Flexibility for Trading, Offsets, Reuse, etc.

Mass Based Effluent Limits

- Straightforward Trades
  - Simple and Clear

S1.B.a Alternate effluent limits for oxygen consuming pollutants demonstrated to be equivalent to DO TMDL baseline effluent limits in S1.A (option 1)

Parameter	Seasonal Limit Applies March 1 to October 31 See notes f and g	
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$)	133.4 pounds/day (lbs/day) average	
Total Phosphorus (as P) March 1 to Oct. 31	3.34 lbs/day average	
Total Ammonia (as NH_3-N)	Seasonal Limit	Maximum Daily Limit
For "season" of March 1 to March 31	1067.5 lbs/day average	16 mg/L
For "season" of April 1 to May 31	66.7 lbs/day average	16 mg/L
For "season" of June 1 to Sept. 30	16.7 lbs/day average	8 mg/L
For "season" of Oct. 1 to Oct. 31	66.7 lbs/day average	16 mg/L
Parameter	Average Monthly [a]	Average Weekly [b]
Carbonaceous Biochemical Oxygen Demand (5-day) ($CBOD_5$), November 1 through February 29	2.0 milligrams/liter (mg/L) 133 pounds/day (lbs/day)	---

Concentration Based Limits

- Requires Calculations

Total Phosphorus[2] **May 1 – Sept 30**	70 µg/L 14 lbs/day	84 µg/L 16.8 lbs/day

Note 2. The permittee may meet the effluent limits for total phosphorus using the Dixie Drain offset. See Part I.B.6.

b) Offset Pounds. For each pound of total phosphorus the West Boise Treatment Facility discharges in excess of 70 µg/L, the Permittee must remove a minimum of 1.5 pounds of total phosphorus at the Dixie Drain Facility. The pounds of total phosphorus the West Boise Treatment Facility discharges in excess of 70 µg/L are calculated as: (Average Monthly Effluent Concentration – 70) × Average Monthly Flow × 8,340 ÷ 1,000

The monthly offset ratio which is defined as the pounds of total phosphorus removed at the Dixie Drain Facility divided by the pounds of total phosphorus the West Boise Treatment Facility discharges in excess of 70 µg/L must be greater than 1.5.

$$\frac{\textit{Pounds Removed Dixie Drain Facilty}}{\textit{Pounds Disharged at West Boise in Excess of 70 } \mu g/L} > 1.5$$

Qualifying Credits and TMDL Load Allocations

- "Because TMDL load allocations (LAs) are not part of DEQ's nonpoint source baseline, the proposed trading policy would allow for generation of trading credits before a nonpoint source LA has been met. *While EPA understands and agrees with DEQ's position that any nutrient reduction benefits the environment, we differ on what constitutes an allowable trading credit.*
- "Generating trading credits before a nonpoint source LA has been met is *problematic because of the relationship between TMDLs and the permitting process."*
- Under its draft Trading Policy, DEQ could issue a permit that allows the permittee *to buy credits from nonpoint sources to meet its permit limits, even though the nonpoint sources have not met their LAs under the TMDL.*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

Ref: 8P-W-WW

JUN 15 2011

George Mathieus, Administrator
Planning, Prevention, and Assistance Division
Department of Environmental Quality
1520 E. Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901

Re: EPA Interpretation of Montana's Draft Nutrient Trading Policy

Dear Mr. Mathieus:

EPA appreciates the opportunity to provide comments on the August 2, 2010 draft nutrient trading policy developed by the Montana Department of Environmental Quality (DEQ). EPA supports the State's efforts to utilize trading as another tool to assist with reducing nutrient loads across Montana, and recognizes the need to provide innovative approaches that help stakeholders achieve cost-effective, near-term nutrient reductions. Throughout 2010, EPA provided informal comments on Montana's draft policy and met with DEQ staff to discuss our concerns. In response to your staff's request, this letter provides additional detail and clarification on EPA's position regarding DEQ's current draft trading policy. Our comments are intended to ensure that DEQ's policy is consistent with the Clean Water Act, EPA's Water Quality Trading Policy (2003) and the technical guidance in EPA's Water Quality Trading Toolkit for Permit Writers (2007). The letter specifically addresses the generation and use of tradable pollution reduction credits in watersheds for which there is a Total Maximum Daily Load (TMDL), and outlines different approaches the State may employ to increase the flexibility of its nutrient trading program.

Credits and Load Allocations in Montana's Trading Policy:

DEQ's draft trading policy outlines the situations in which nonpoint sources may generate credits. On page 3 of the draft policy, DEQ specifies that:

> "A nonpoint source may generate credits by achieving nutrient reductions greater than required by a regulatory requirement applicable to that source. Nonpoint source credits will be based upon a measured or estimated reduction of nutrients adjusted to account for applicable trading ratios. For example, such loads may be calculated by using watershed model delivery ratios that will be applied to edge-of-fields loads or may be calculated by a model used in a Department-approved TMDL."

Nonpoint Source Credits Available Only After TMDL Nonpoint Source Load Allocation Has Been Met

Region 8 EPA Letter to Montana DEQ, June 15, 2011

Model Nutrient NPDES Permit

Features

- Substantial Nutrient Reduction
- Long Averaging Periods
  - Seasonal or Annual Preferred
- Mass Loadings
  - Supports Trading, Offsets, Reuse, etc.
- Include Compliance Schedule
  - Watershed Perspectives
    - Adaptive Management

Benefits

- Water Quality Improvements
- Successful Compliance
- Technically Achievable
- Adaptive Management Opportunities
  - Monitor Receiving Water Response
  - Adapt Treatment Process Over Time
  - Develop Trades and Offsets
  - Quantify and Manage Nonpoint Sources
  - Consider Sustainability

Nutrient Permitting Recommendations

Maintain Watershed Perspective

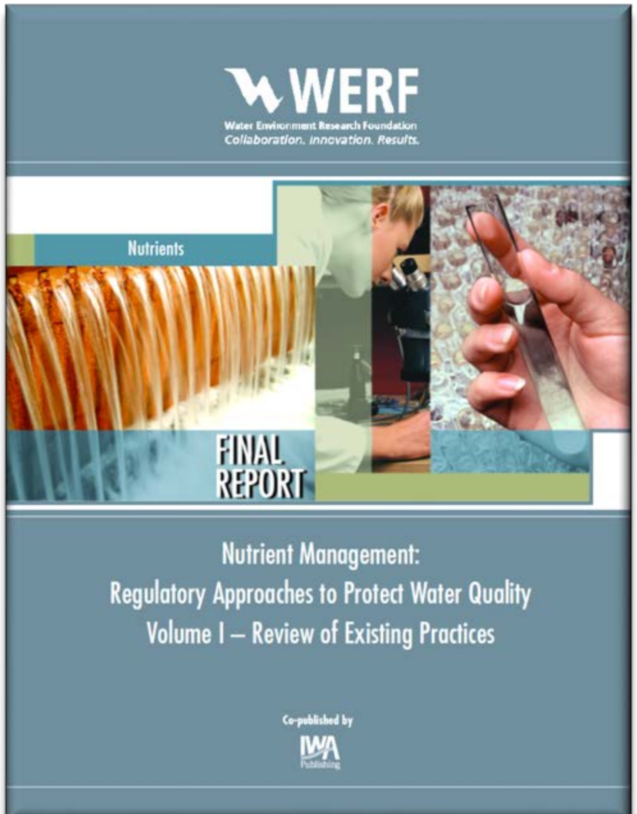
- Early Engagement in Process
  - State Numeric Nutrient Criteria Development
  - Watershed TMDLs
  - Individual Permits
- Technical Input and Support
  - Capabilities of Treatment
  - Effluent Characterization
    - Data
    - Nutrient Speciation
- Long-term Support
  - Lay Foundation for Regulatory "Solutions"
  - Sustained Watershed Perspective
    - Compliance Schedule and Beyond
  - Design Treatment Process for Adaptability

Permit Structure Development

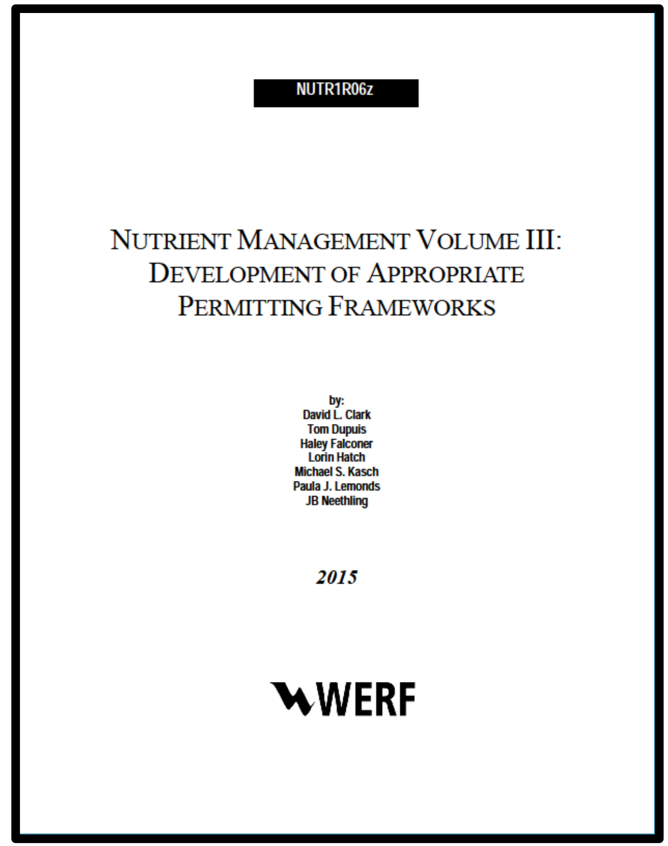
- Dialog with Regulators
  - Permit Writers
- Solution Orientation
  - Technology Exchange
  - Foster Shared Understanding
    - Treatment Capabilities
    - Limitations
- Apply Regulatory "Solutions" When Necessary
  - Avoid Unattainable Effluent Limits
    - Compliance Schedules, Variances, Site Specific Criteria, etc.
- Invest the Time
  - NPDES Renewal Period Alone is Inadequate

Clark, D.L., Hatch, L., Falconer, H.F., Kasch, M.S., Lemonds, P.J., Neethling, J.B. (2015) "Nutrient Management Volume III: Development of Appropriate Permitting Frameworks " WERF Nutrient Removal Challenge project NUTR1R06x

Publications on Water Quality and Nutrient Discharge Permitting



WERF, 2010, _Nutrient Management: Regulatory Approaches to Protect Water Quality, Volume I – Review of Existing Practices,_ NUTR1R06i



DRAFT WERF, 2015, _Nutrient Management Volume III: Development of Appropriate Permitting Frameworks_, NUTR1R06z

Revised Federal Ammonia Criteria

Aquatic Toxicity

Basis for Toxics Water Quality Standards Rulemaking

Toxicity to Aquatic Animals

- Aquatic Life Criteria
  - CWA Section 304(a)
- Relationship Between Pollutants and Effect on *Aquatic Organisms*
  - Acute: Highest One-hour Average Concentration
  - Chronic: Highest 4-day Average Concentration
  - Adjustments
    - pH, Salinity, Temperature, Hardness

Human Health Risk Driven Water Quality Standards

- Protect From Adverse *Human* Health Impacts
  - Long-term Toxics Exposure
    - Consumption of Fish, Shellfish, and Water
  - Exposure Basis
    - Fish Consumption Rate
    - Drinking 2 L/d Water
  - Carcinogens
    - Criteria Based on Risk of 1 Additional Case in 1 Million People (i.e. 10^{-6})

Examples of Toxics Water Quality Standards Rulemaking

Ammonia (Aquatic Life)

- 1999 Federal Criteria
  - Chronic 1.2 mg/L
- Final 2013 Criteria
  - Chronic 0.56 mg/L
- Pending State Rulemaking

PCBs (Human Health)

- Oregon
  - 2011 WQ Std Update 175 g/d
  - *Total PCBs 6.4 pg/l*
- Washington Human Health Water Quality Criterion
  - Fish Consumption Rate 6.5 g/d
  - *Total PCBs 170 pg/l*
- EPA National Recommended Water Quality Criteria (EPA, 2002)
  - Fish Consumption Rate 17.5 g/d
  - *Total PCBs 64 pg/l*
- Spokane Tribe Human Health Water Quality Criterion
  - ~~Fish Consumption Rate 86.3 g/d~~
  - ~~*Total PCBs 3.37 pg/l*~~
  - Fish Consumption Rate 865 g/d
  - *Total PCBs 1.3 pg/l*

Final 2013 Revised Federal Ammonia Criteria

Table 1. Summary Comparison of Ammonia Criteria at pH 7 and Temperature 20^{0}C, and pH 8 and Temperature 25^{0}C

Criterion (Duration)	1999 Criteria Based on Juvenile Salmonids		2009 Draft Revised Criteria Mussels Present		Final 2013 Criteria Single Criteria Mussels Present	
	pH 8.0	pH 7.0, T=20°C	pH 8.0, T=25°C	pH 7.0, T=20°C	pH 8.0, T=25°C	pH 7.0, T=20°C
Acute, mg/L (1-hr average)	5.6	24	2.9	19	2.6	17
Chronic, mg/L (30 day average)	1.2	4.5	0.26	0.91	0.56	1.9

http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/ammonia/index.cfm

Example WWTP NPDES Permit 2014

Chronic Criteria: 0.941 mg/L

Acute Criteria: 3.15 mg/L

Example NPDES Permit and Fact Sheet

AMMONIA LIMITS									
Season	7Q-10 (cfs)	Maximum Effluent Discharge (MGD)	North Platte River pH	North Platte River Temp (C°)	Back-ground Ammonia (mg/L)	Instream Chronic Ammonia Standard (mg/L)	Instream Acute Ammonia Standard (mg/L)	Calculated Effluent Limit (based on acute standard) Ammonia (mg/L)	Calculated Effluent Limit (based on chronic standard), Ammonia (mg/L)
May-Sept	45.82	9.0	8.3	21.5	0.09	0.941	3.15	**13.20**	**3.74**
Oct-April	46.71	9.0	8.2	12	0.15	1.79	3.83	**16.15**	**7.28**

NPDES Permit 2014
Chronic Criteria: 0.941 mg/L
Acute Criteria: 3.15 mg/L

2013 Revised Federal Ammonia Criteria
Chronic Criteria: 0.445 mg/L (- 47%)
Acute Criteria: 1.95 mg/L (- 62%)

???

2013 Criteria (Unionids Absent, Fish Present)
Chronic Criteria: 01.65 mg/L (+75%)
Acute Criteria: 3.2 mg/L (+ 1%)

Final 2013 Ammonia Criteria Published by EPA

- "Aquatic Life Ambient Water Quality Criteria For Ammonia – Freshwater, 2013"
  - 225 pages with 14 appendices
    - Appendix N. Site-Specific Criteria for Ammonia
- "Flexibilities for States Applying EPA's Ammonia Criteria Recommendations"
  - EPA presents a number of flexibilities are available for state consideration including:
    1. Recalculation Procedure for Site-specific Criteria Derivation
    2. Variances
    3. Revisions to Designated Uses
    4. Dilution Allowances
    5. Compliance Schedules

Ammonia Approach

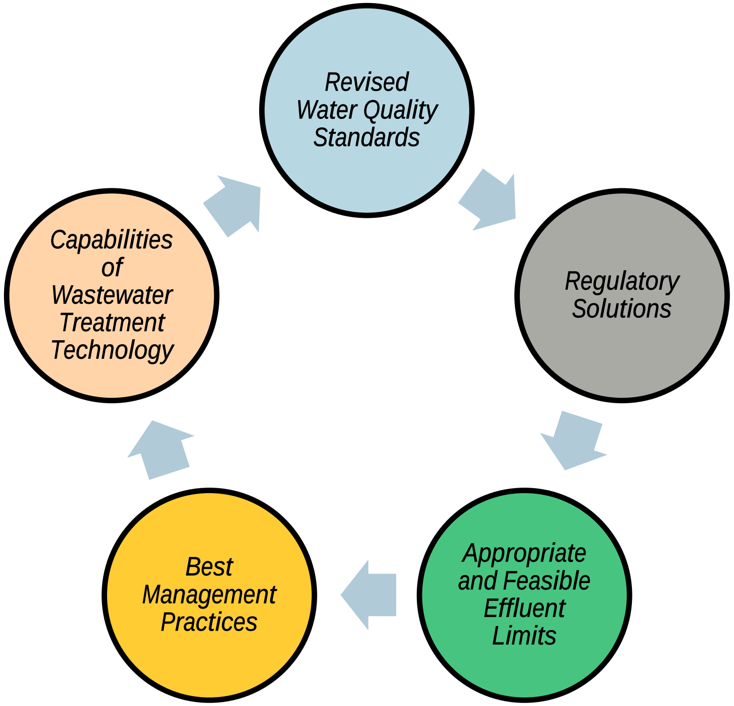
Current Permit	Future Permit Renewals

- Current Effluent Limits
  - *Attainable?*
- Future Reasonable Potential Analysis for Permit Renewal
  - Evaluate Current Plant Performance
    - Evaluate How Permit Limits will Change
      - » *Reasonable Potential Analysis*

- State Rulemaking
  - Revised 2013 Federal Criteria
    - Freshwater Mollusks
  - Engage in Rulemaking Process
- Regulatory Solutions Needed?
  - Consider Mixing Zone and Dilution Analyses
    - Regulatory Mixing Zones
    - Add Diffuser to Increase Dilution?
  - Site Specific Criteria
    - Revised Federal Criteria Provide Flexibility
      - » *Are Sensitive Mussels Present (or should they be)?*

Addressing Potential Ammonia Effluent Limits

- Treatment Technology
  - Evaluate Current Plant Performance
    - Not All Plants are Optimized for Ammonia Removal
  - Evaluate How Permit Limits will Change
    - Reasonable Potential Analysis
- Site Specific Criteria
  - Consider Mixing Zone and Dilution Analyses
  - Revised Federal Criteria Provide Flexibility
    - *Are Sensitive Mussels Present (or should they be)?*



02 Holistic Approaches to Water Quality

So now what?
Take Stock!

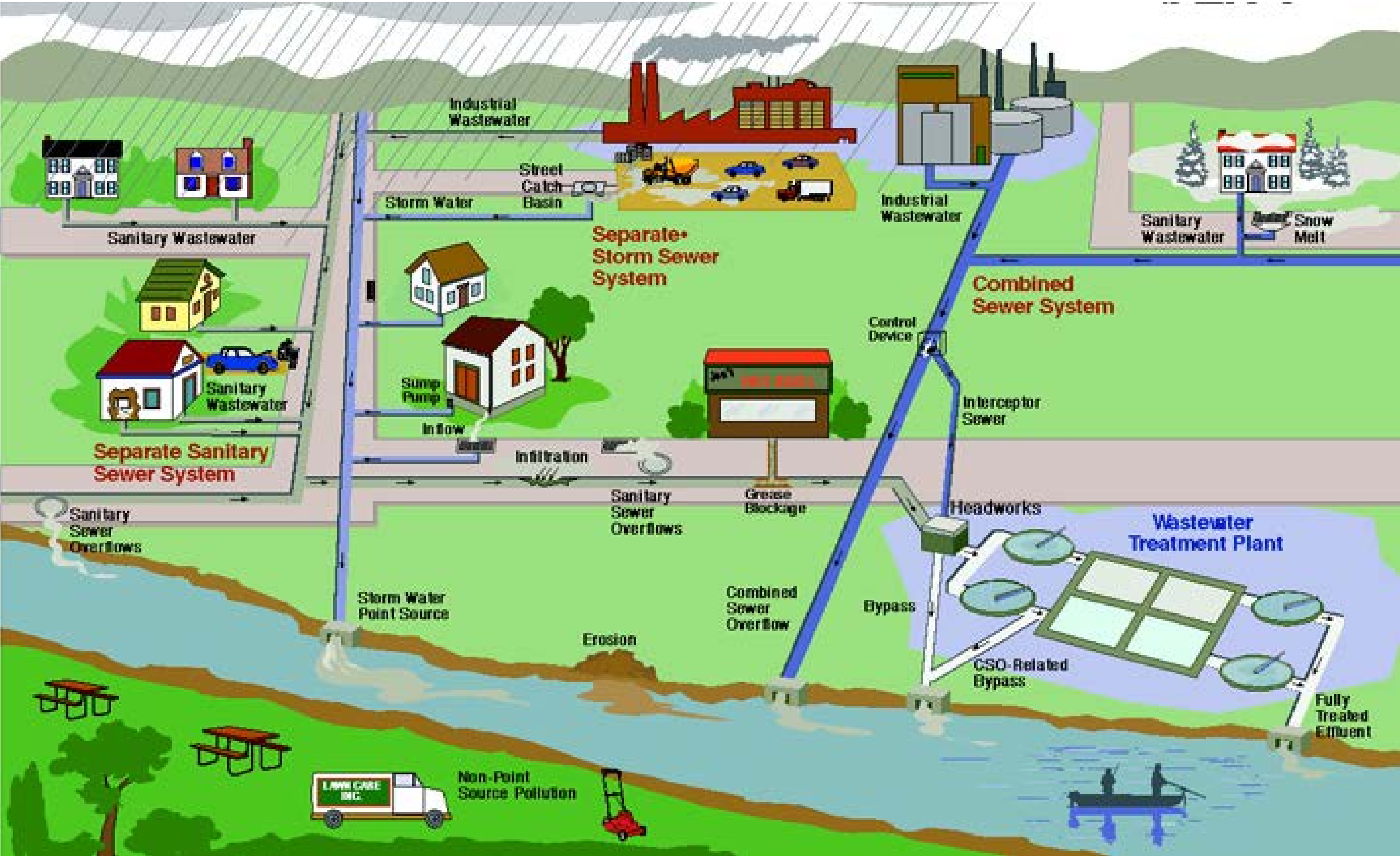
- Goals, desired outcomes
- Available time (permit cycle, TMDL, other)
- Data
- Communication
- Financial considerations
- Know ‘required’ versus ‘available’ actions

Right-sized approach involves…

- Regulatory trends awareness
- Permit writing, permit structure, data management
- Open, collaborative dialogue and data sharing
- Balance (utility management, water quality, aquatic ecosystem, sustainability, affordability)
- Optimization - technology and treatment capability assessments

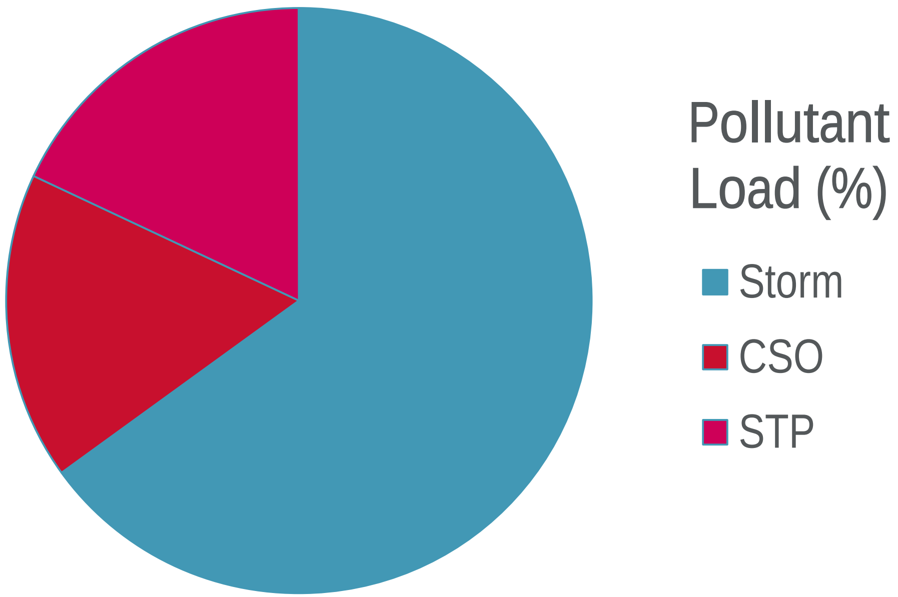
…….…...to proactively chart POTW course for nutrient management in Ohio watersheds.

Improving Water Quality

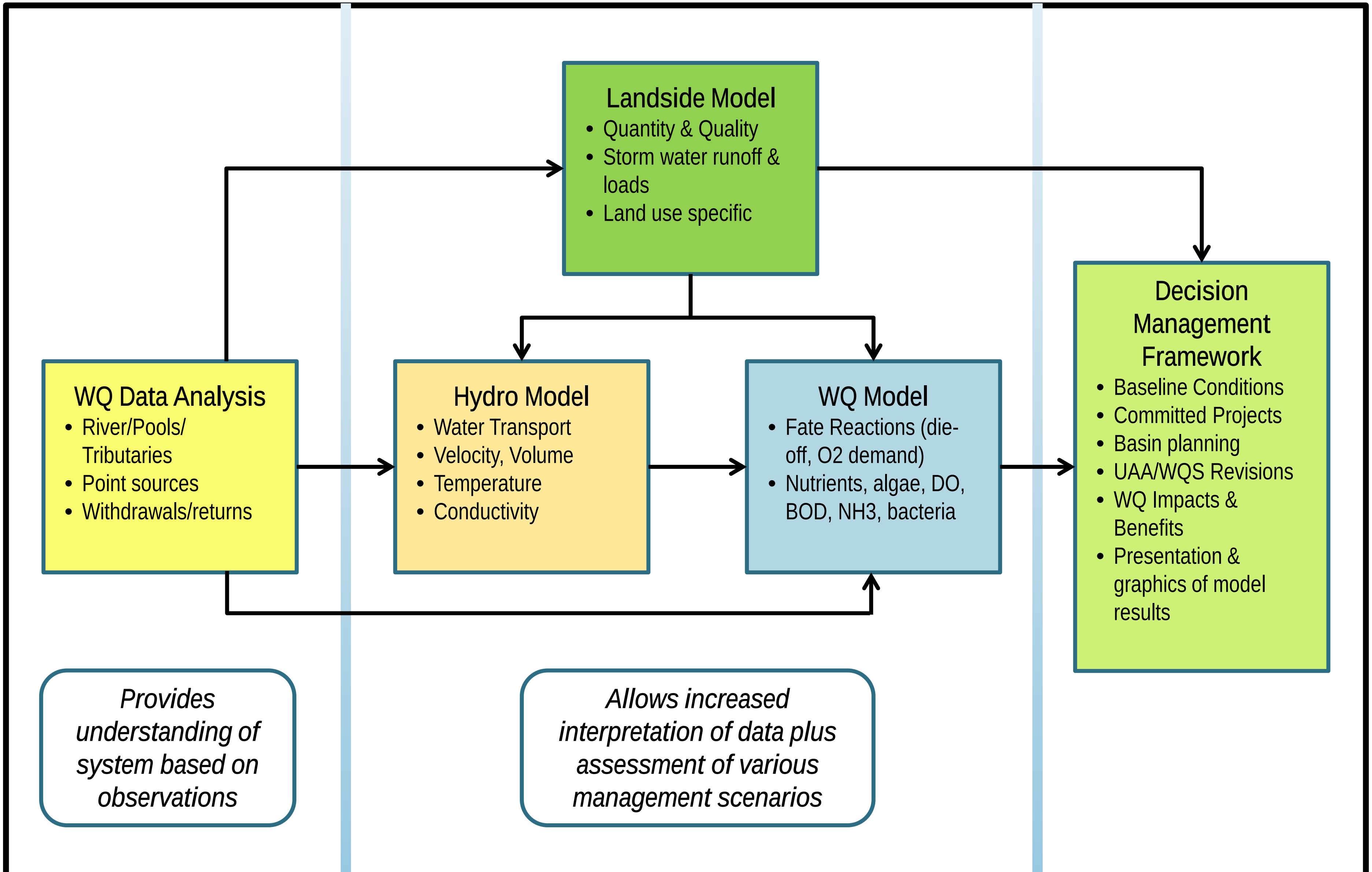


Improving Water Quality

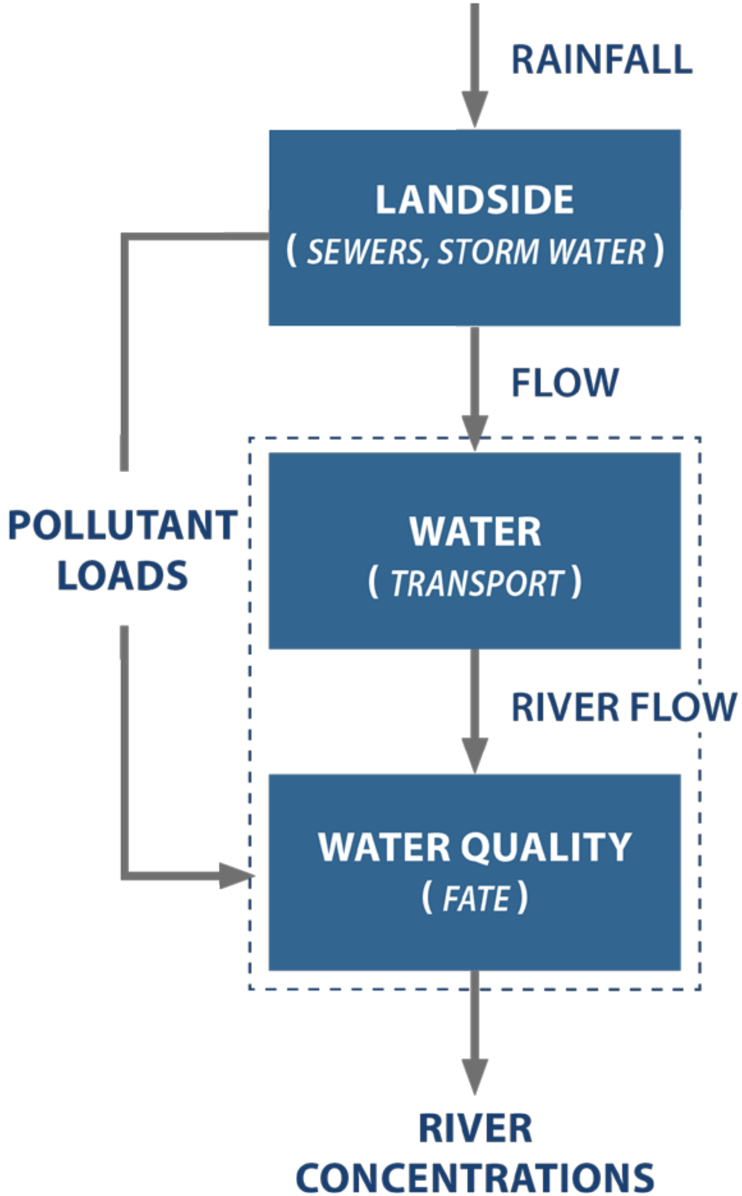
- Water quality impact by source
- Estimate background water quality and attainability
- Decision Framework, Level-of-Service Metrics, Projection Scenarios



Modeling Approach



Model Integration



SWMM | MIKE

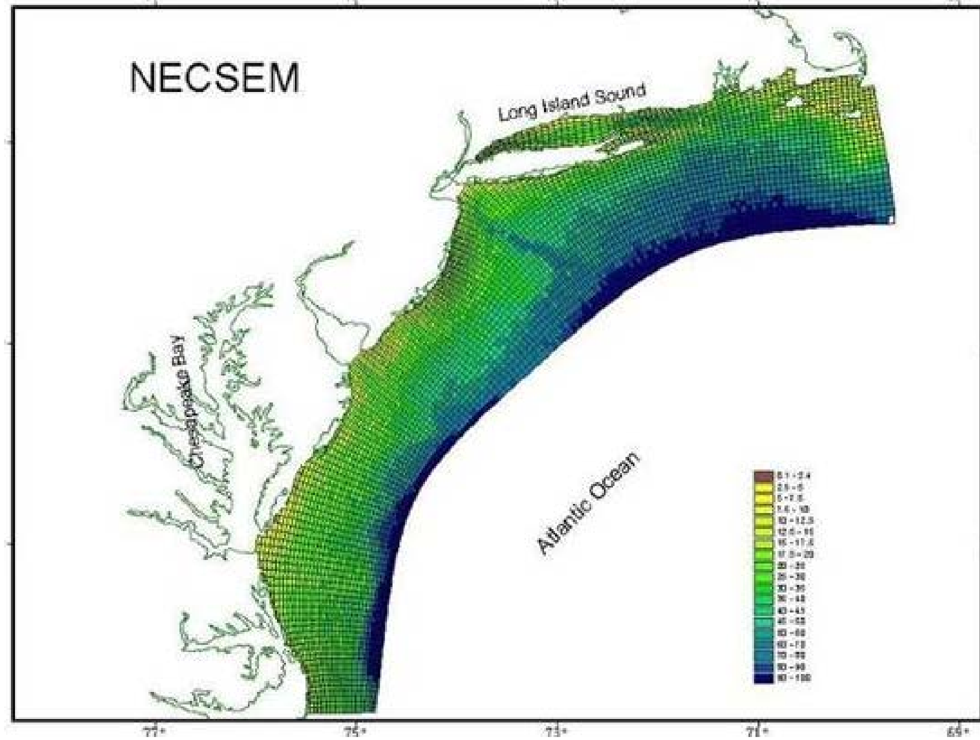
- Rainfall
- Sewer Network

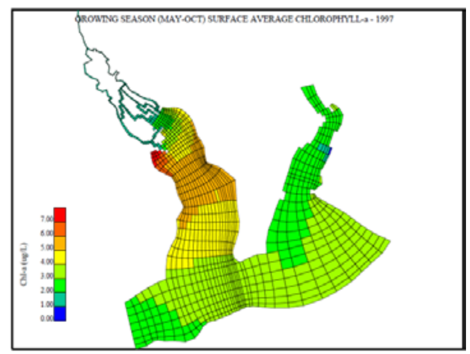
EFDC (*SWMM*)
River Water Movement
(*Flow, Volume, Depth*)

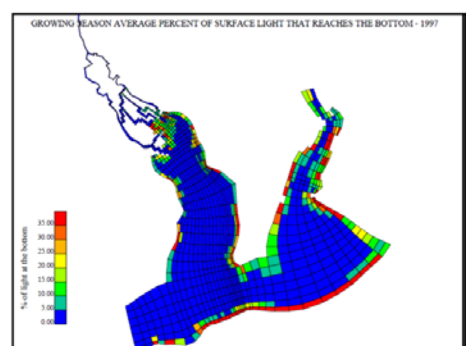
WASP
(*Bacteria, BOD/DO, Nutrients*)

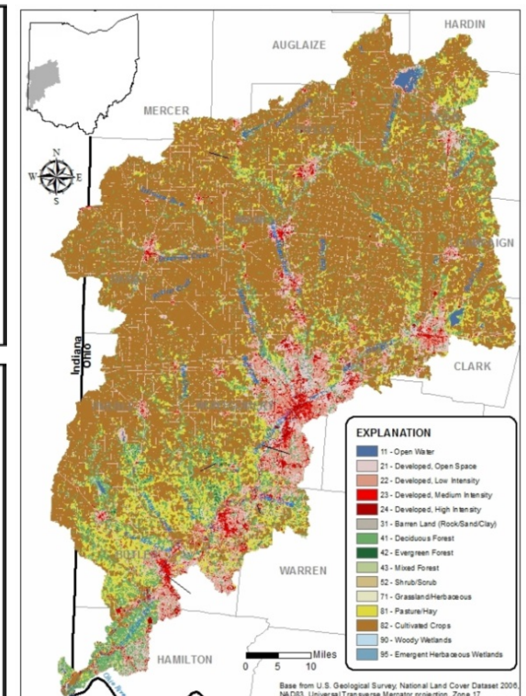
Water Quality Modeling Approach

- Phased Approach
  - Compile/analyze available data
  - ID data gaps/plan to fill
  - Model selection
- Model calibration
- Model projections
  - "Natural background" scenario
  - LOT + best BMPs
  - Knee of curve analysis to find most cost-effective solution
- Model as a tool

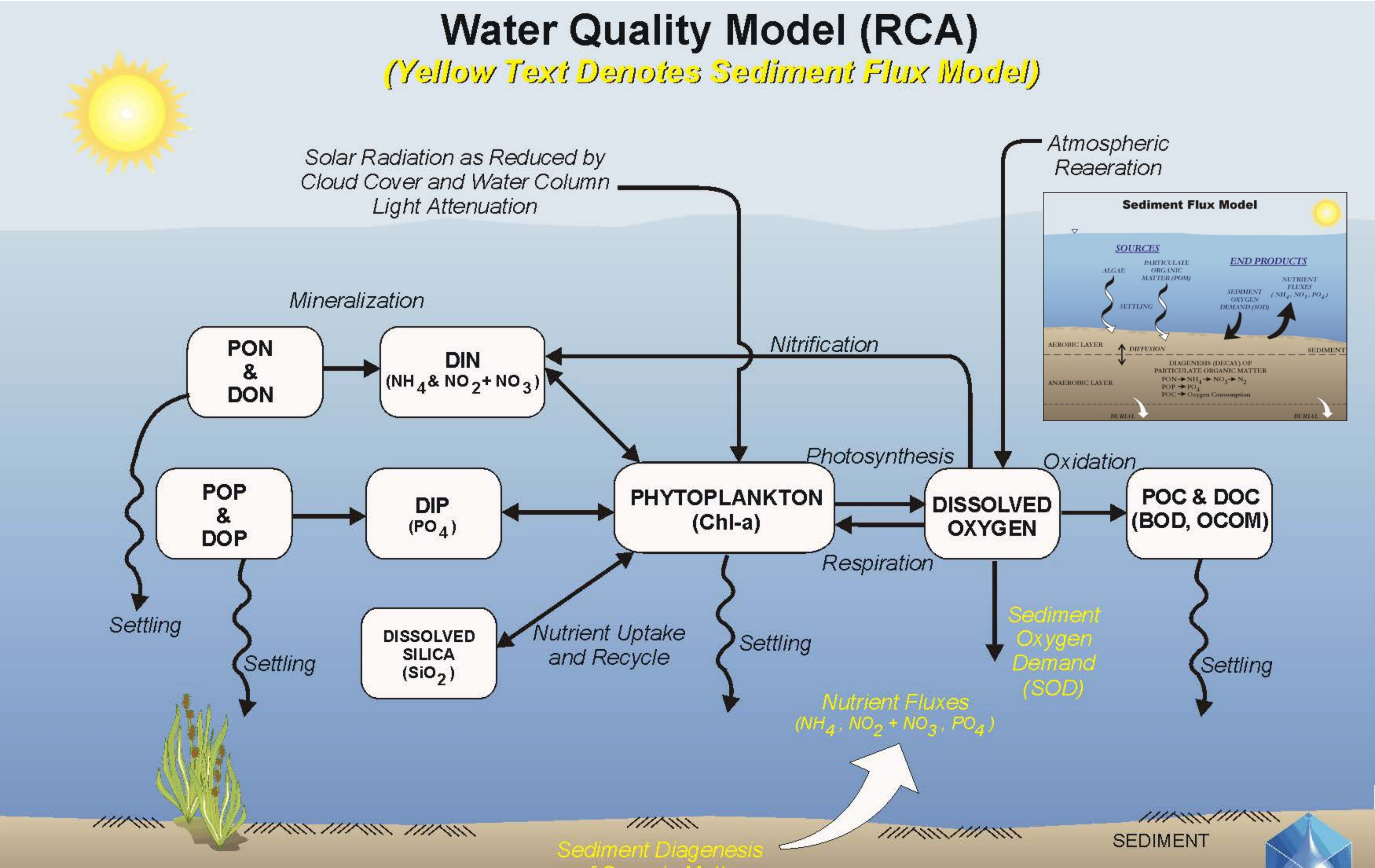






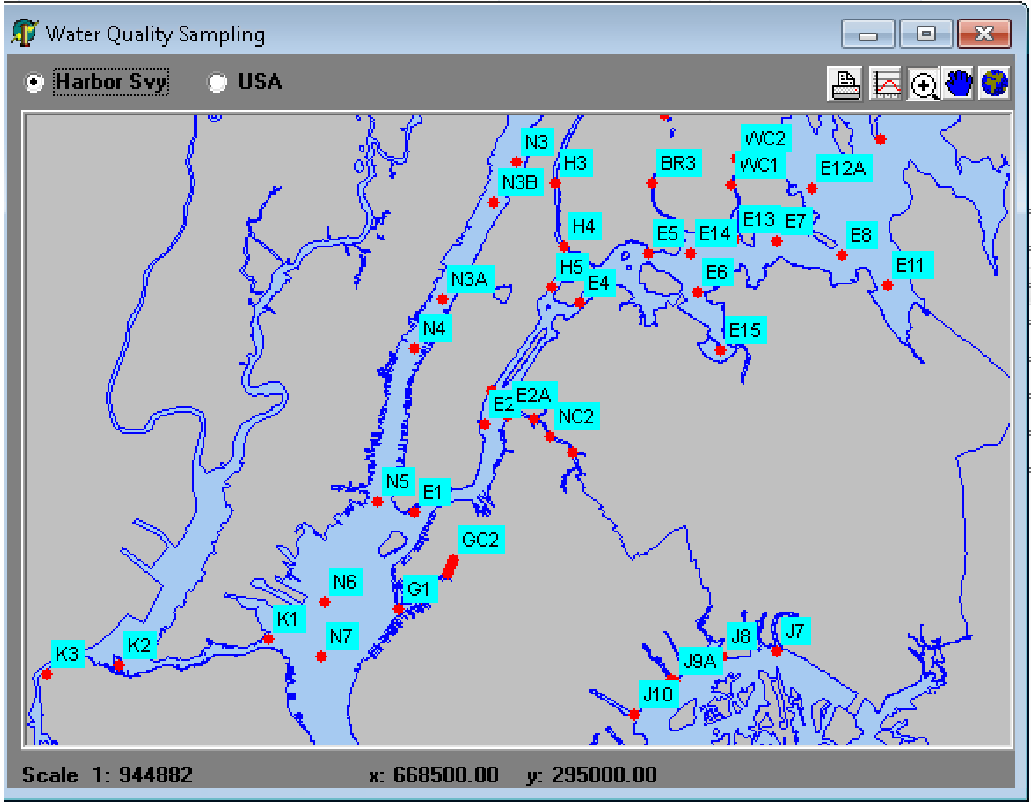


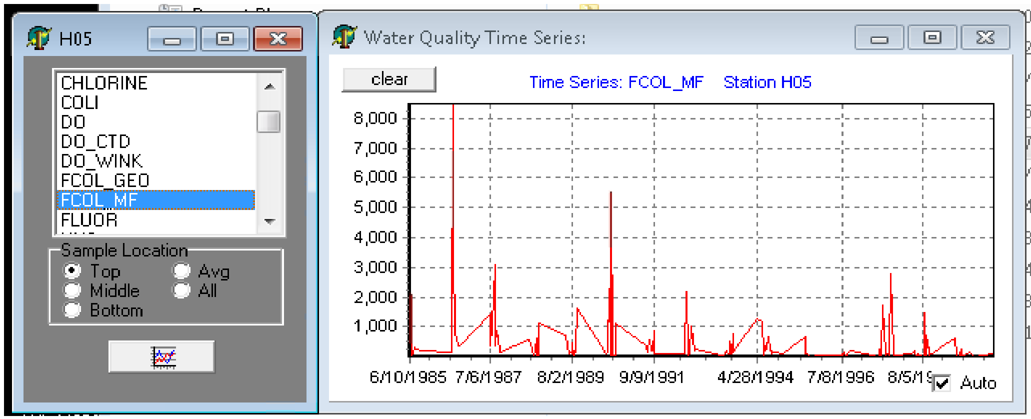
Model Water Quality Kinetics



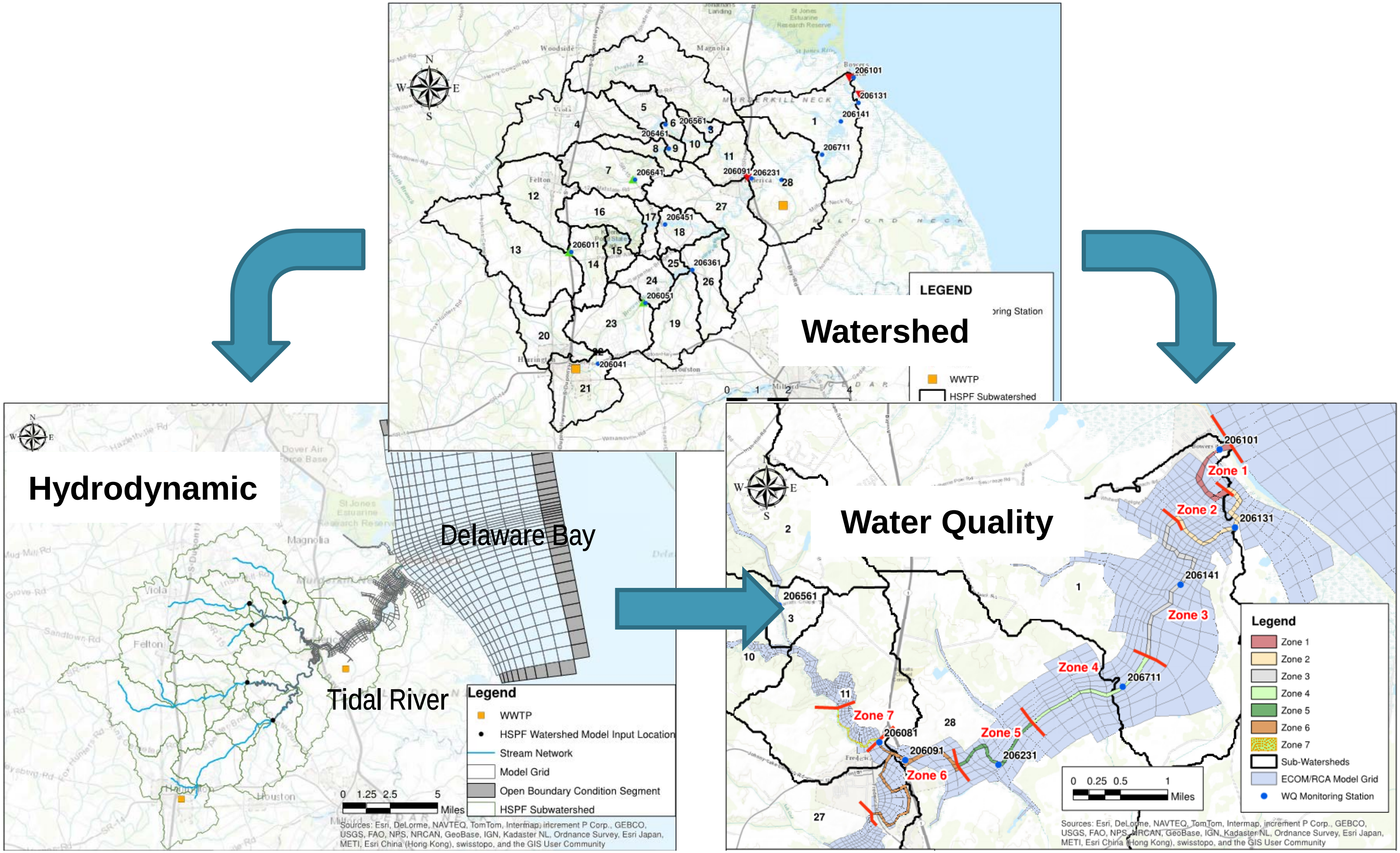
Model Considerations

- Steady-state or dynamic
- Dimensions
- Loading Source Representation
  - Watershed (NPS), Drainage tiles, Internal sediment cycling
- Model Calibration
- Model Projection Scenarios
  - Baseline condition
  - “Natural Background”
  - LOT with BMPs
  - Most cost-effective solution
- Transparency

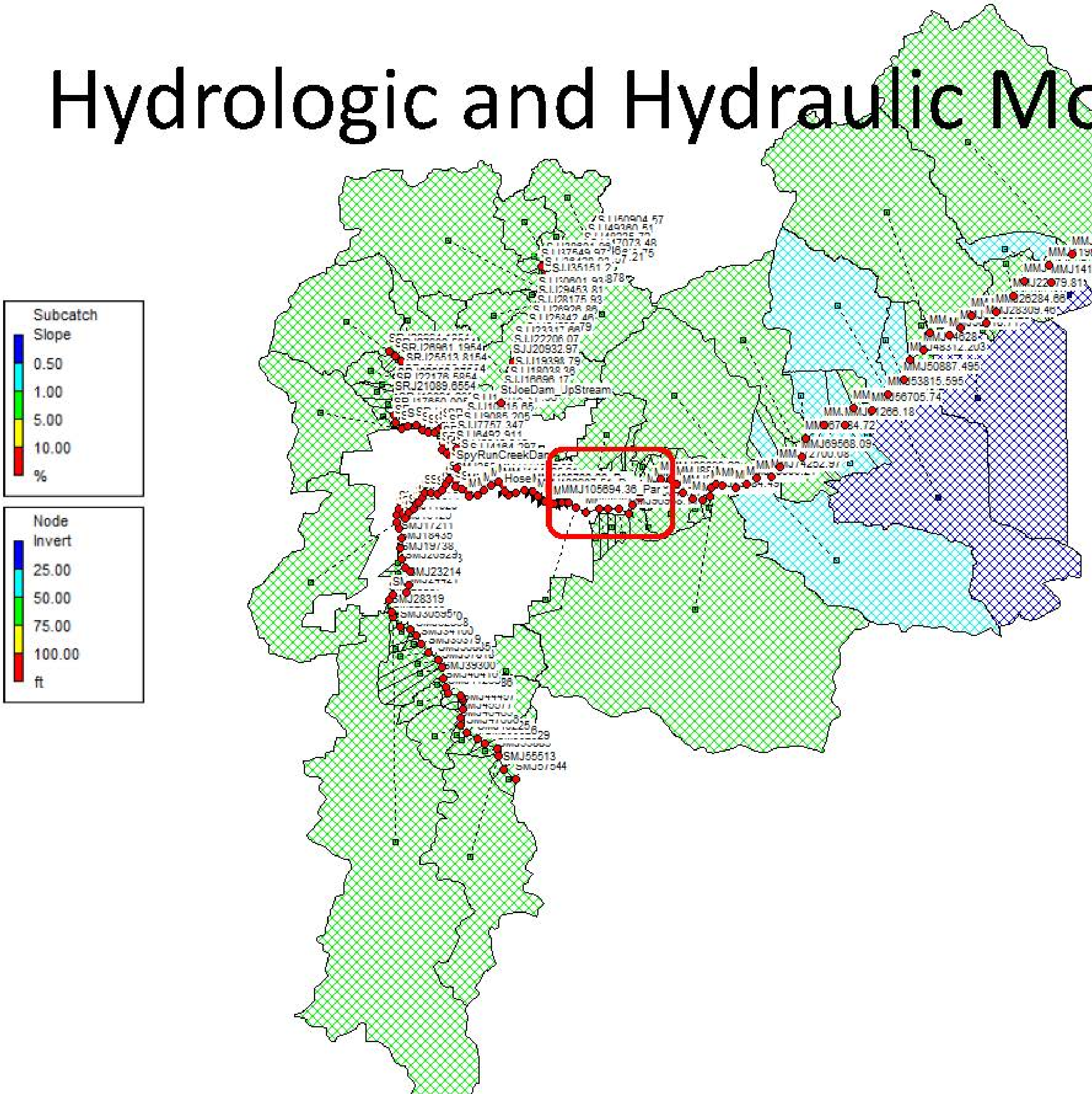




Model Linkage



Hydrologic and Hydraulic Model

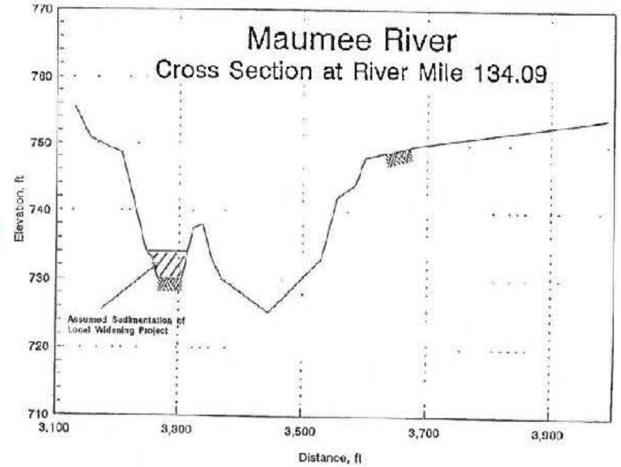


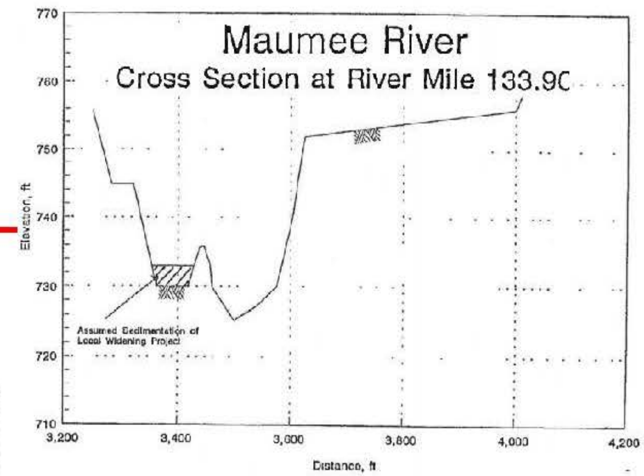
Begin with River segmentation and morphology

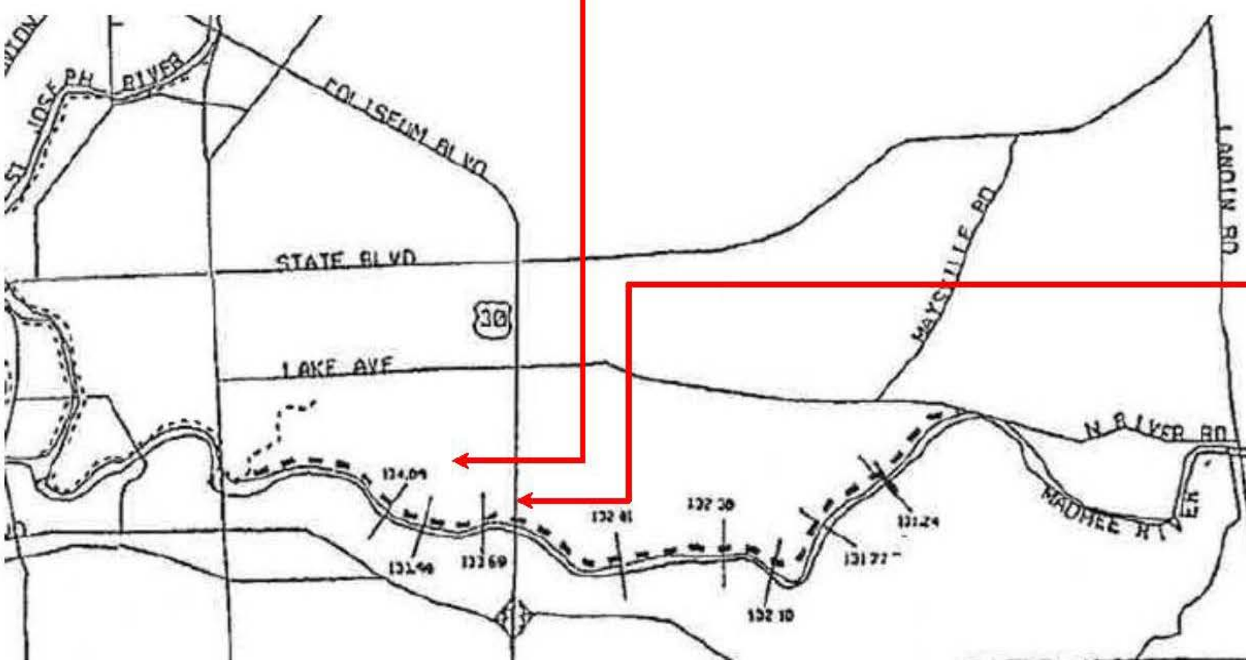
DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231-1027

August 22, 1996

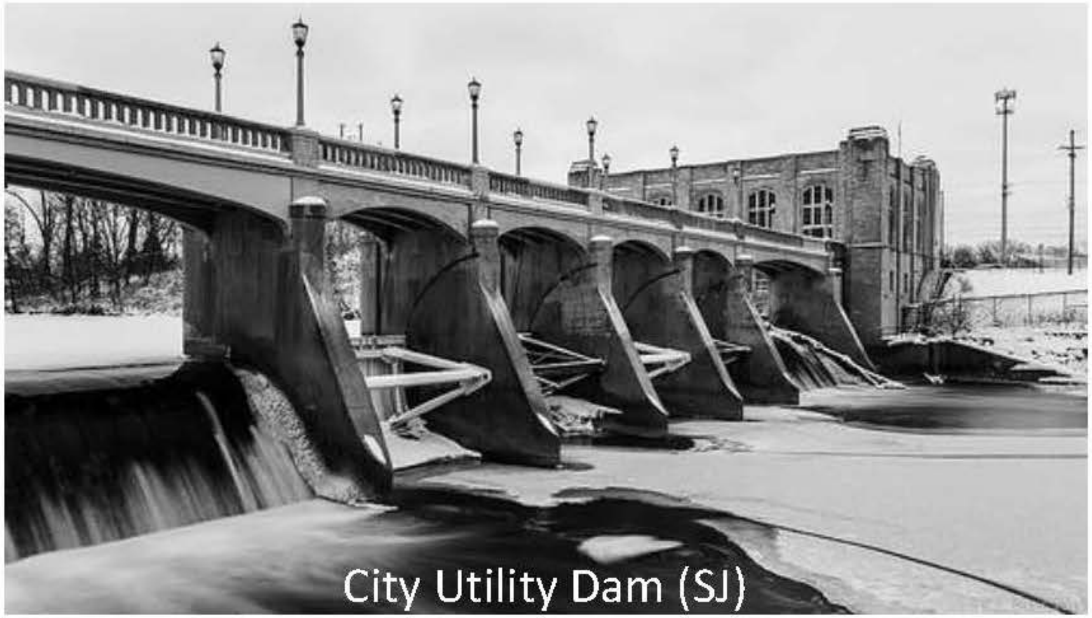
IN REPLY REFER TO
Engineering & Planning Division
Planning Branch



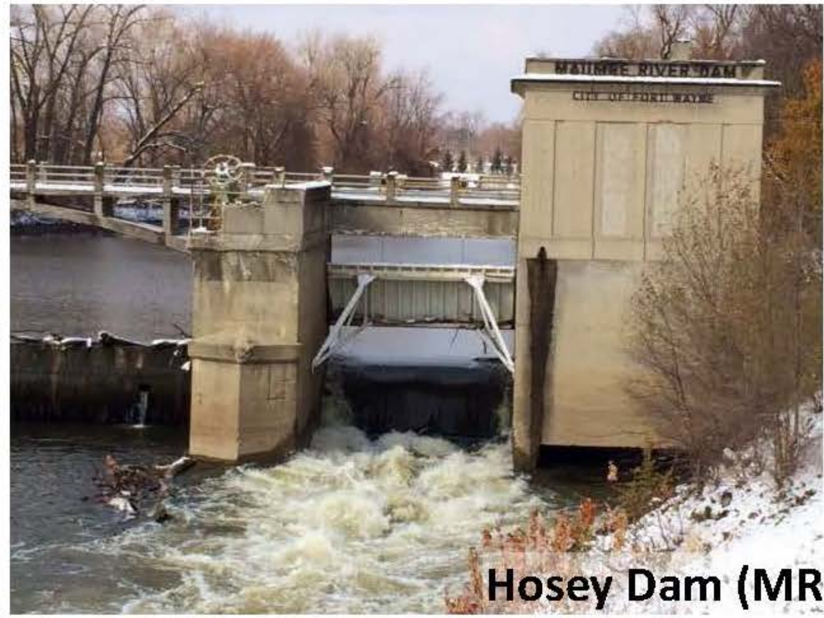




Add known structures



City Utility Dam (SJ)

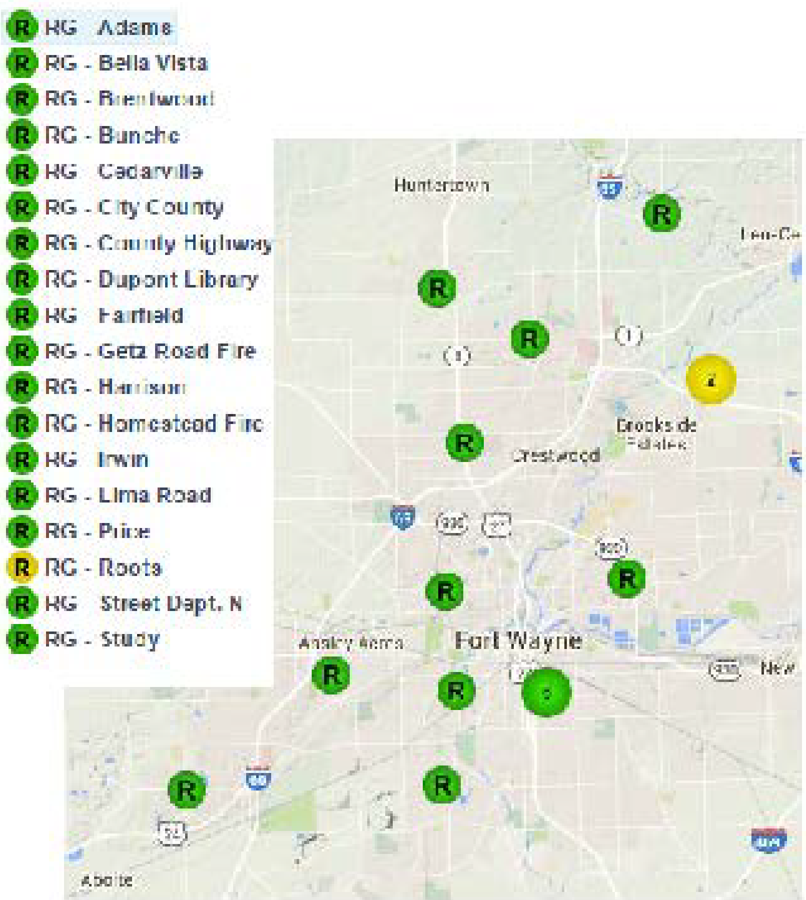


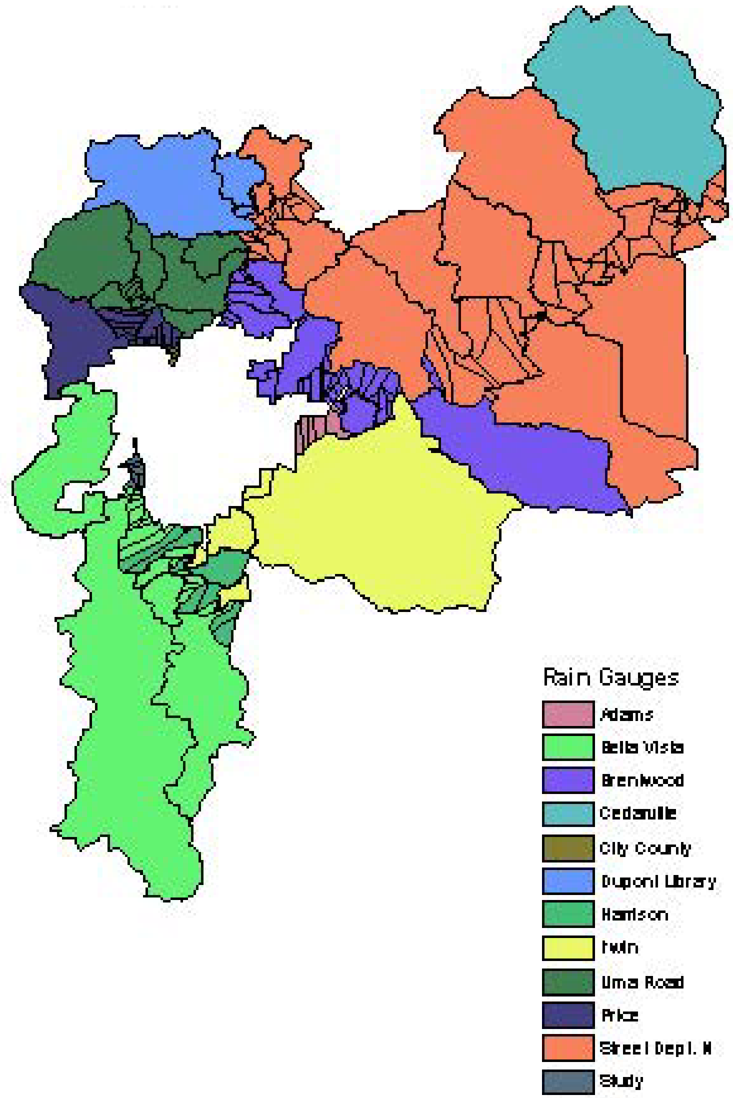
Hosey Dam (MR

Spy Run Creek Weir

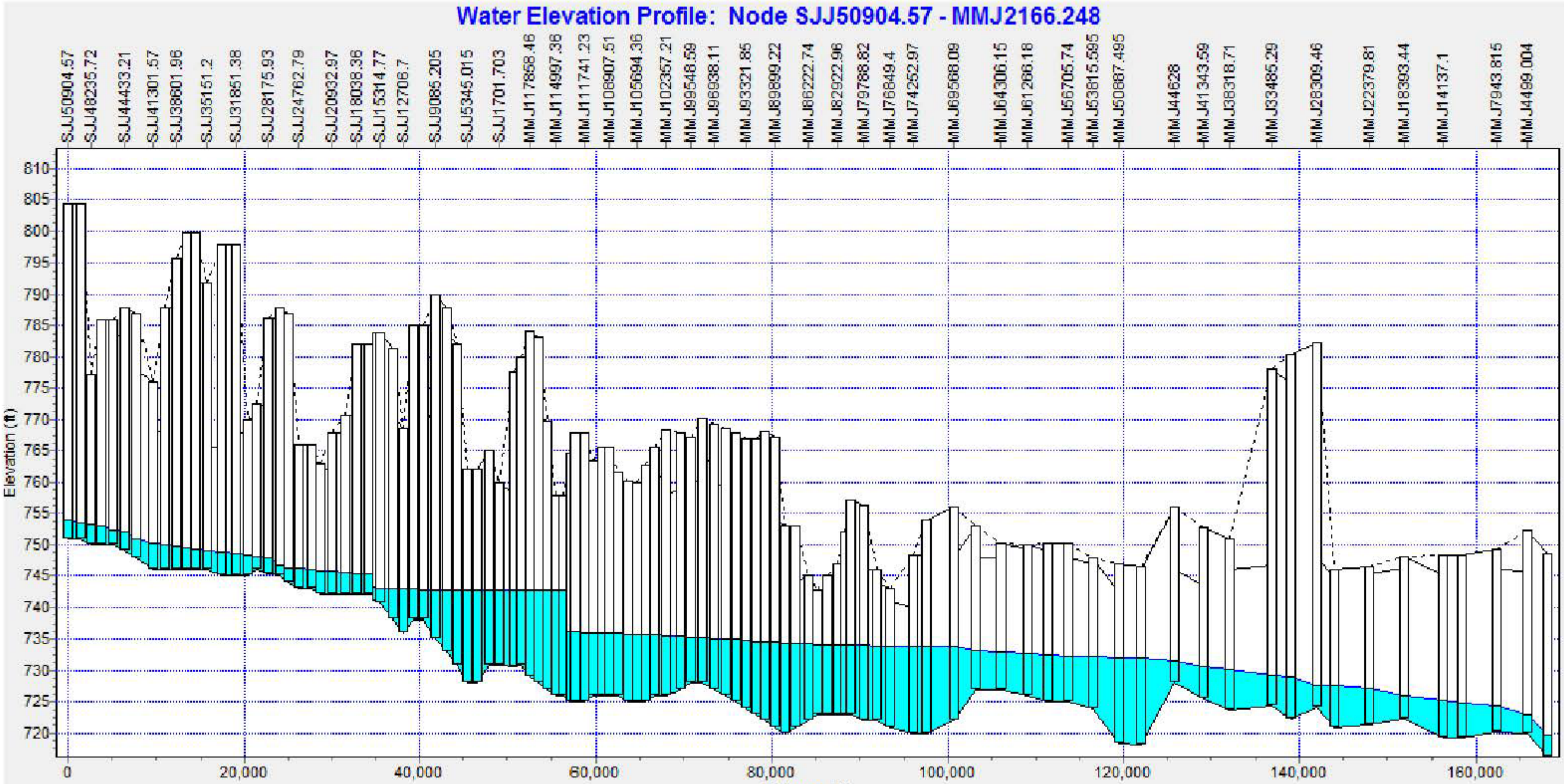
River segmentation: recognize horizontal and vertical stratification

Develop Boundary Conditions, find USGS gauges, make rain gauge assignments

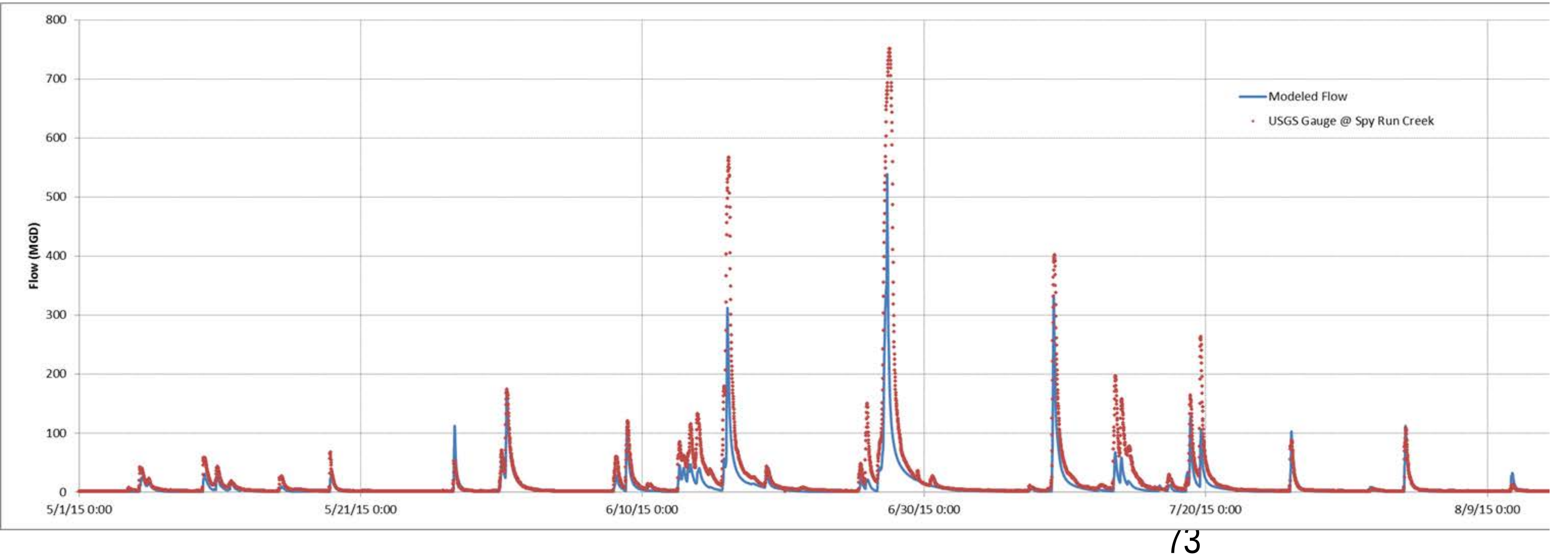




Hydraulic Model Continuity Check

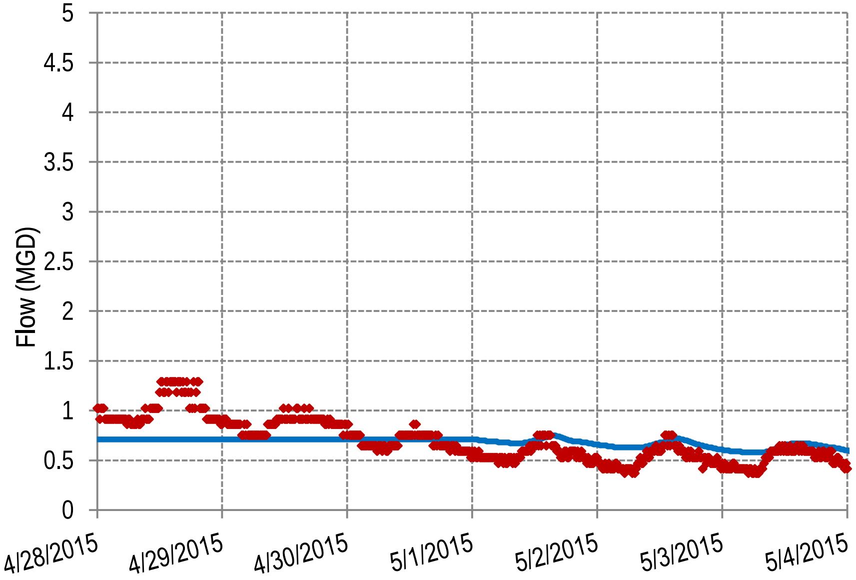


Calibration Process

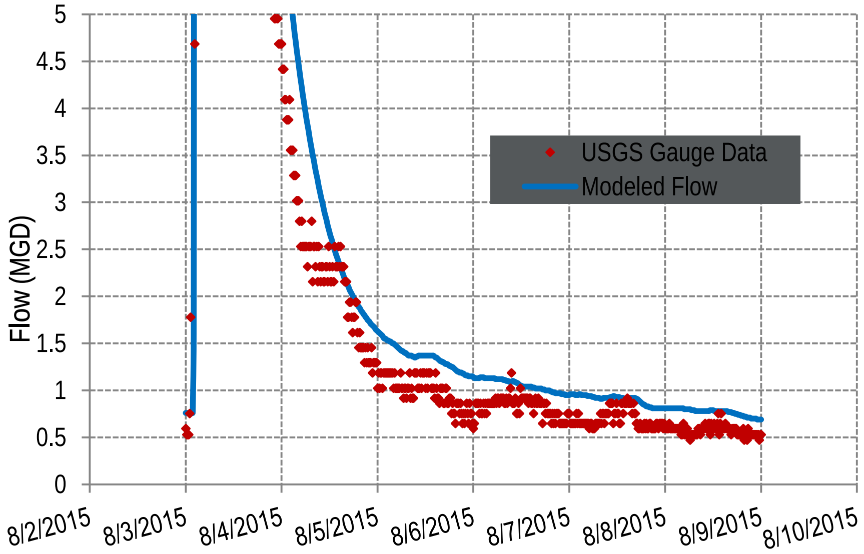


Dry Weather Flow Calibration

Check specific periods

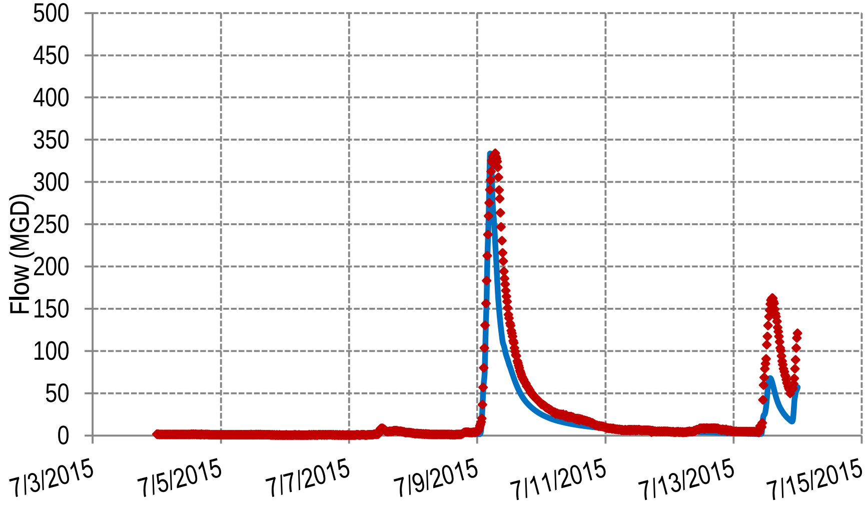


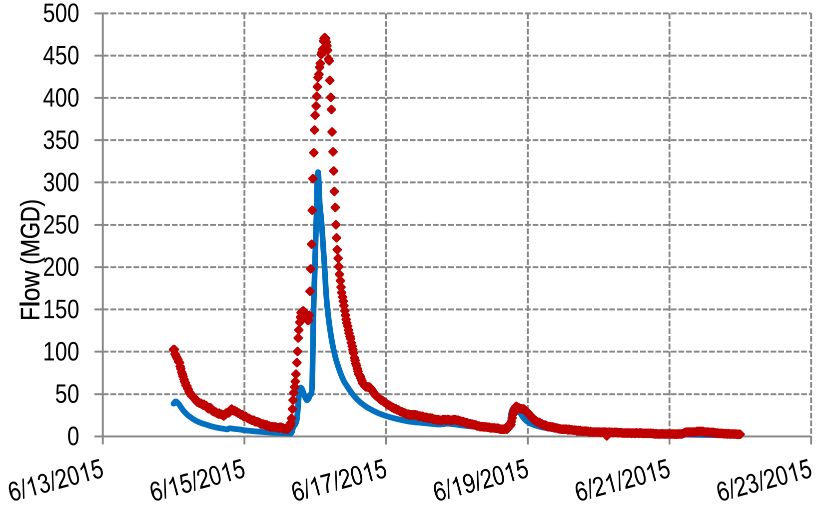
Setting Base Dry-Weather Flows

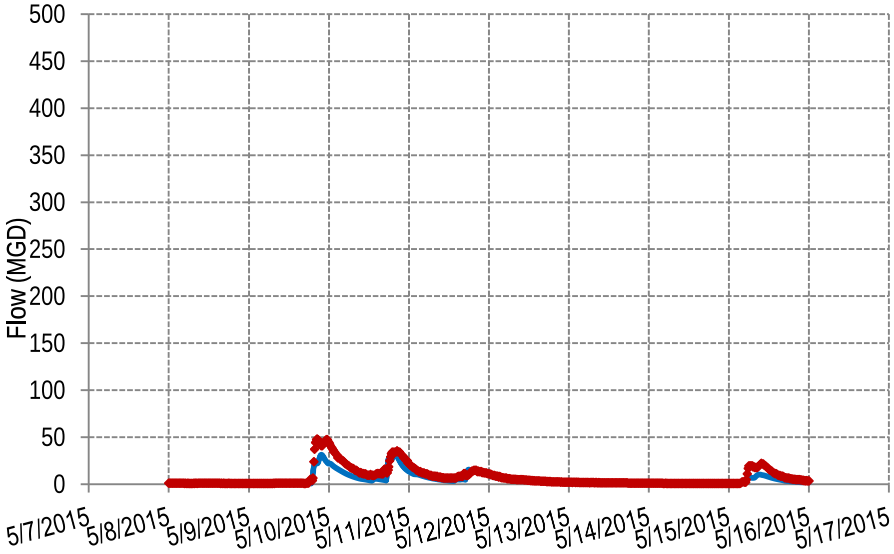


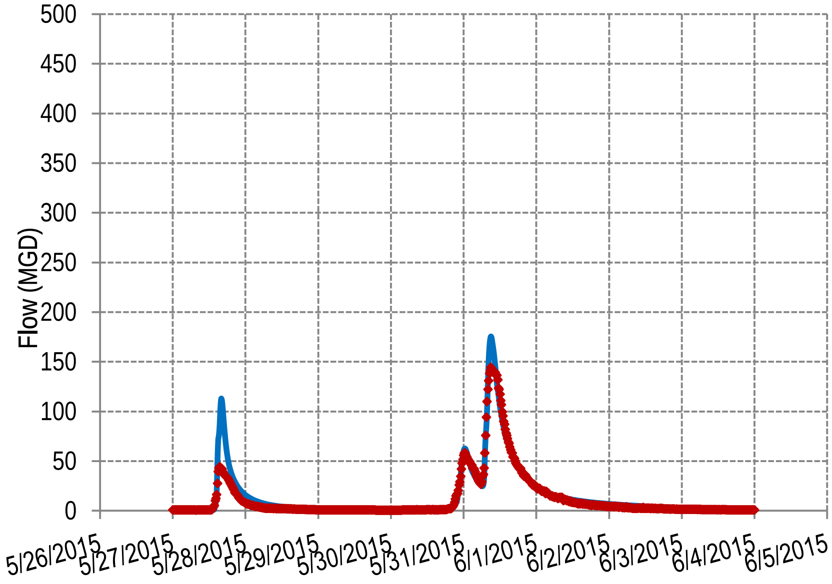
Recovery to Dry Base Flow after Wet Event

Wet Weather Calibration Events



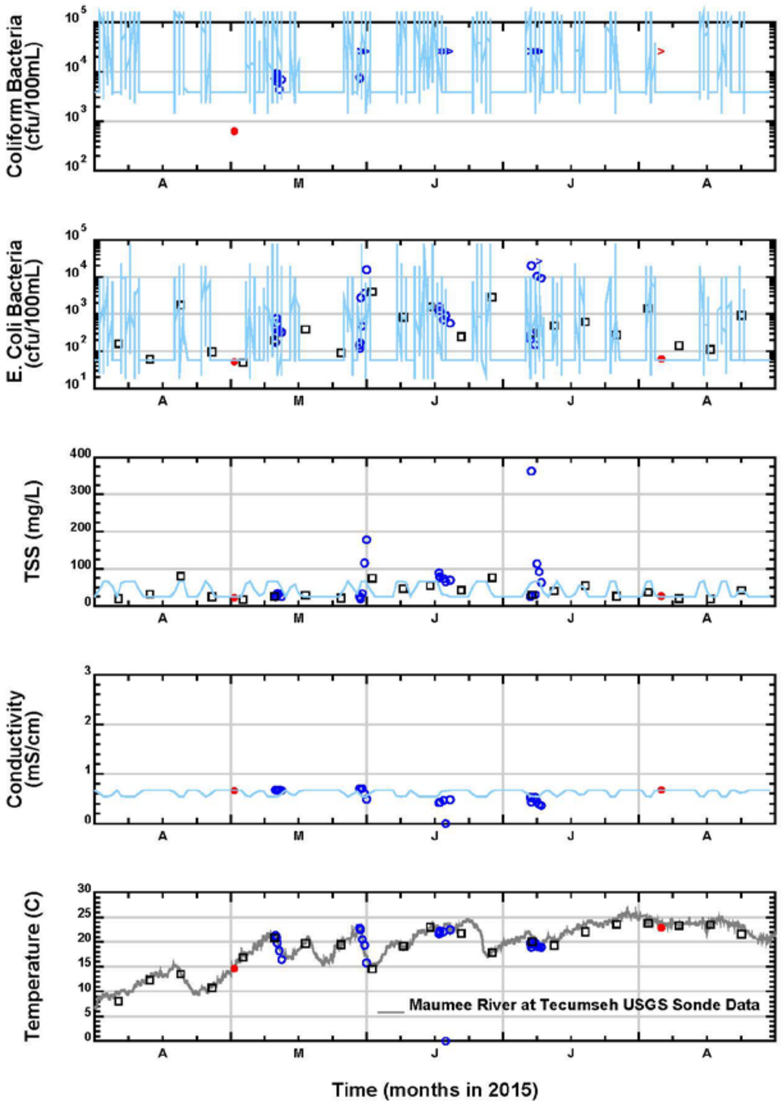






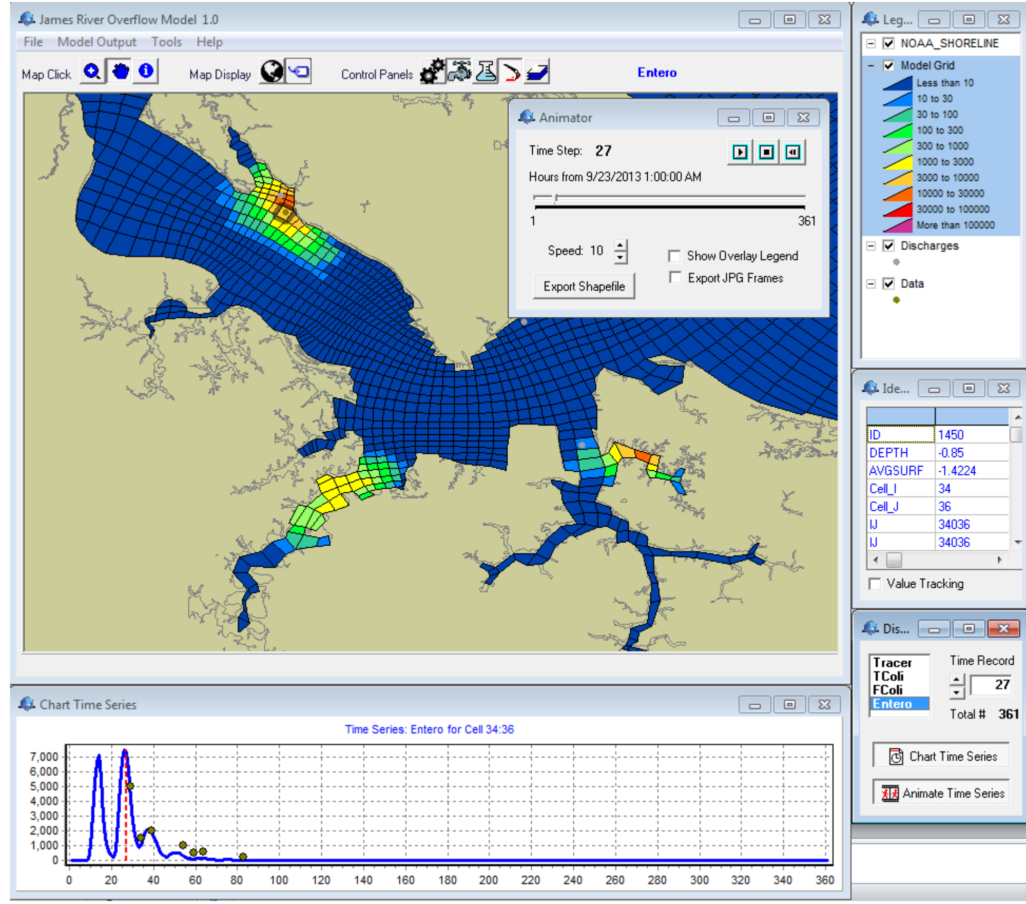
Water Quality

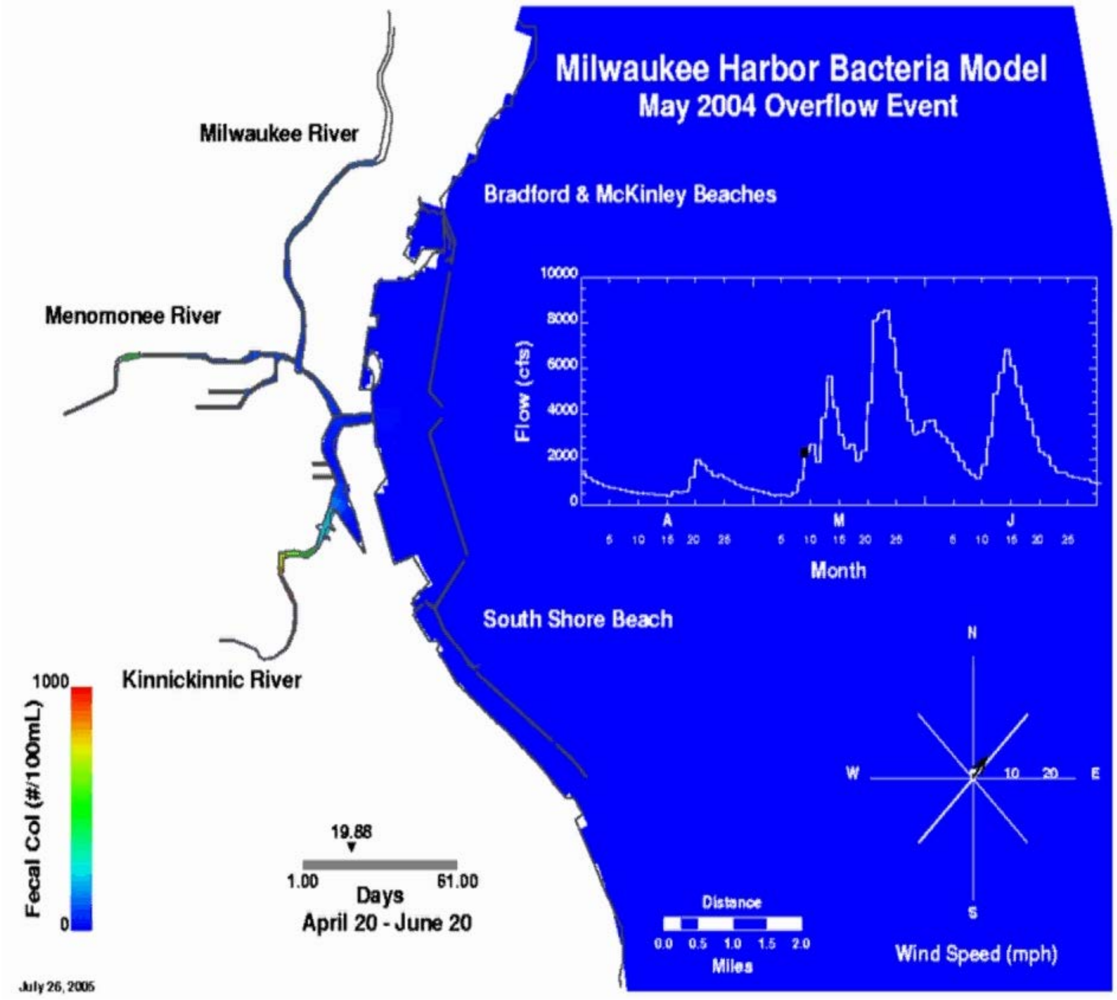
- Boundary conditions
- Outfall and CSO data
- Sampling
- Parameterization of model
- Nutrient die-off rates
- Other factors specific to your watershed



End Product Options

- Data protocol/database (GIS-based)
- Water Quality Model
- Graphical User Interface
- Training





Milwaukee Harbor Bacteria Model
May 2004 Overflow Event
Milwaukee River
Bradford & McKinley Beaches
Menomonee River
Flow (cfs)
Month
South Shore Beach
Kinnickinnic River
Fecal Col (#/100mL)
1000
0
19.88
1.00
61.00
Days
April 20 - June 20
Distance
Miles
Wind Speed (mph)
N
S
W
E
July 26, 2005

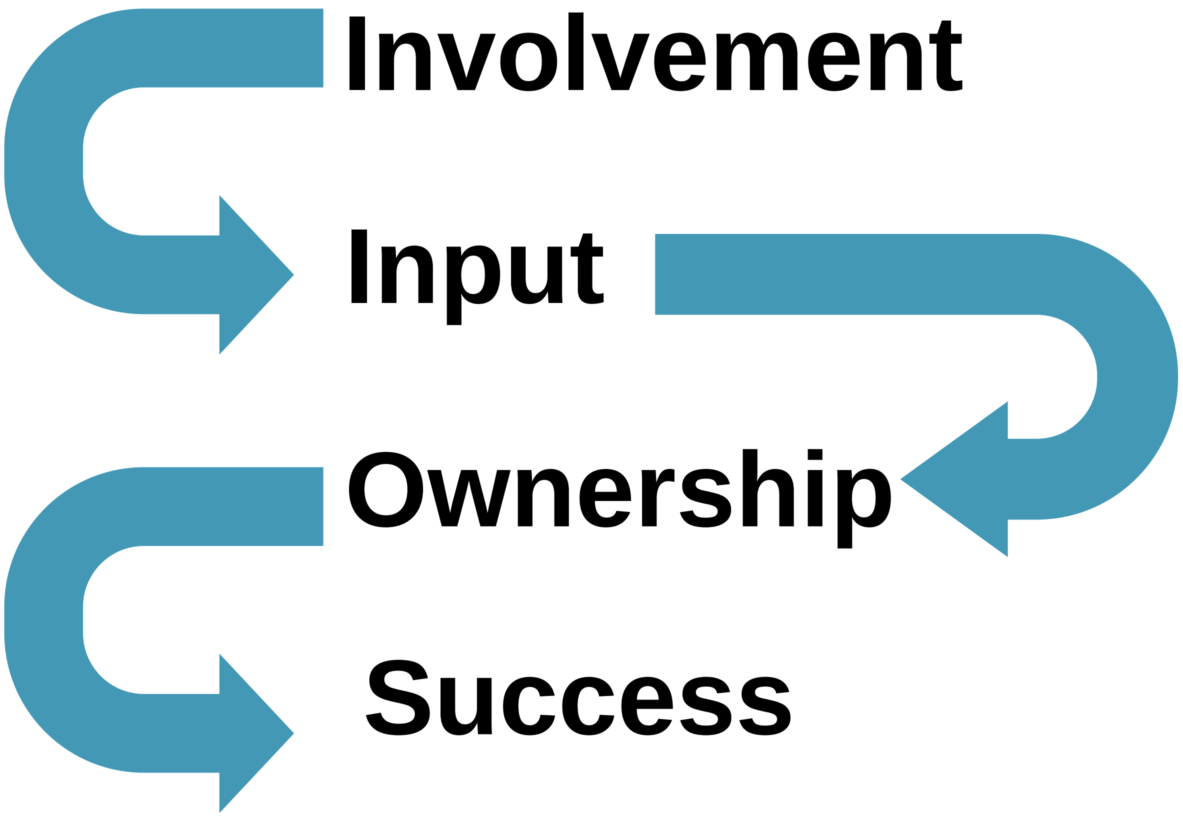
End Product

03

Optimization Techniques

Operators are Key to Short-term and Long-term Nutrient Removal Success

It's **All About** Operators!



Agenda
Optimization Concepts

- Outside the Plant Fence
  - Point Source control
  - Non-point source control and Effluent management (Trading, Reuse)
- Inside the Plant Fence
  - Process changes
    - Sidestream treatment
    - SRT Control
    - Balancing P and N in BNR
    - Recycle Loads
  - Nutrient Recovery
  - Centralized biosolids

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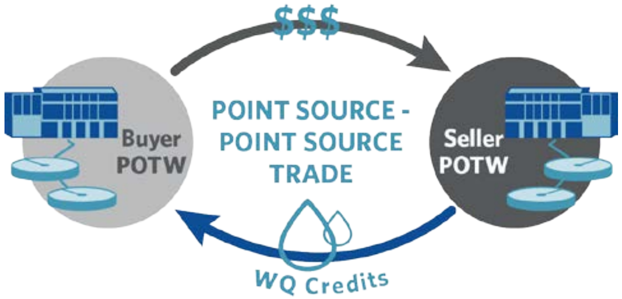
Optimization – Outside the Plant Fence Opportunities

- Compile Existing Information
- Desktop Evaluation



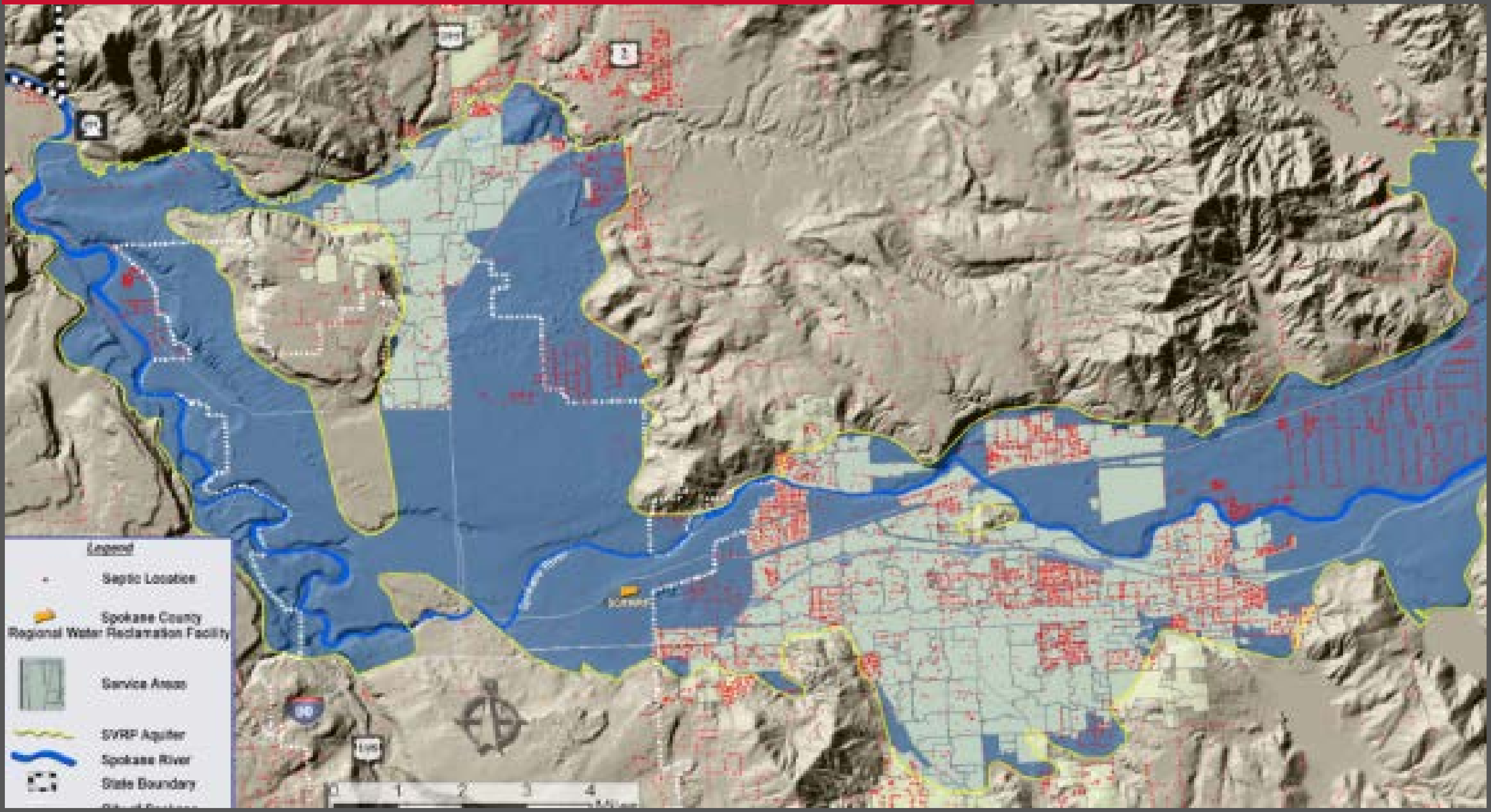
List Options	Desktop Analysis	Prioritize Results	Preliminary Results
Source Control	Area required, acre/tpy	<u>Criteria</u>	Capital Cost
Non-point Sources	Facilities/Rough Cost	Nutrient Reduction	O&M Cost
Effluent Management	Efficiency	Footprint	Unit costs. $/lb
Solids Management	Reliability	Public Benefit	Regional Impacts
Nutrient Recovery	Unit cost, $/lb	Greenhouse Gas	
Effluent Polishing		Sustainability	
		Unit cost, $/lb	

Outside the Fence: Source Control

- Septic system abandonment – no nutrient leaching
- Phosphorous detergent bans
- Urine separation

Providing a Practical Approach to Nutrient Reduction by Other Means

Spokane River Septic System Elimination



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Phosphorus Reduction Through Detergents In Lake Erie Was Initiated in the early 1970s, when the Lake was declared dead

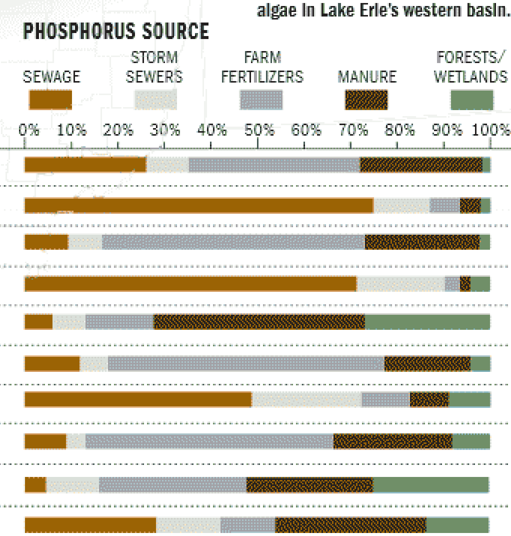
Tracking phosphorus

Ohio officials are seeking federal approval for a plan that would set limits for phosphorus and nitrogen in streams. The limits would be a new tool in efforts to limit blooms of toxic algae that appear in Lake Erie each summer. Estimates for how much phosphorus reaches streams that empty into Lake Erie from farms, sewage-treatment plants and other sources:

This satellite image taken on Oct. 2 shows the bloom of blue-green algae in Lake Erie's western basin.

TOP PHOSPHORUS RELEASES BY WATERWAY

RANK, WATERWAY	DRAINAGE AREA, SQUARE KILOMETERS	PHOSPHORUS, TONS, 2002*
1. Maumee River	16,948	1,822.5
2. Detroit River**	1,208	1,108.1
3. Sandusky River	3,462	403.6
4. Cuyahoga River	2,091	295.2
5. Cattaraugus Creek	1,449	161.8
6. Huron River	1,078	127.5
7. Rocky River	756	108.2
8. Vermilion River	678	107.2
9. Grand River	1,839	103.8
10. Buffalo Creek	1,167	93.4



*Most-recent data available **The Detroit River estimate is incomplete because it does not include phosphorus from Canada and Lake Huron.
Source: U.S. Geological Survey

TOM BAKER | DISPATCH

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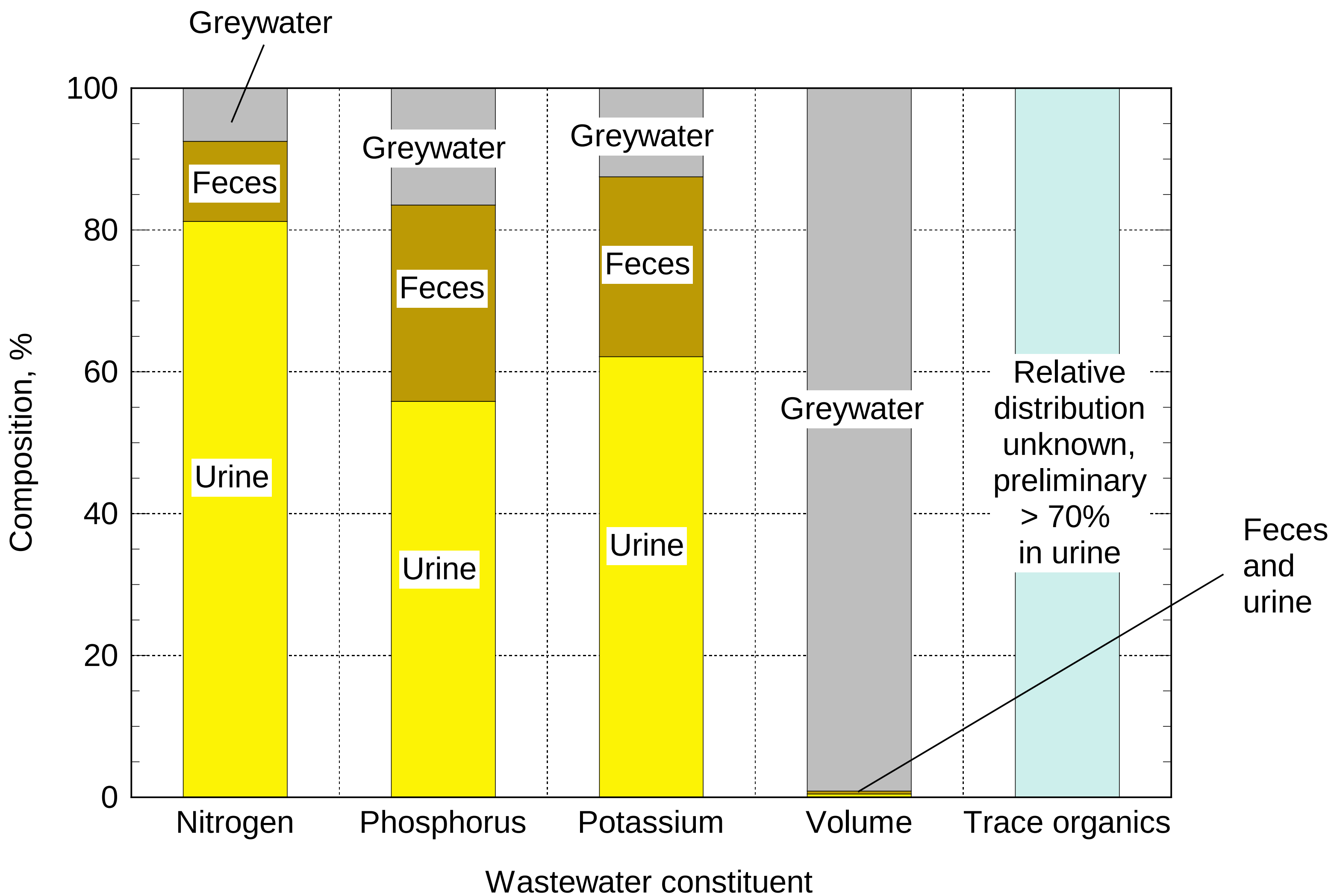
Distribution of Nutrients and Trace Organics in Domestic Wastewater



Source: Jönsson et al.(2000) Recycling Source Separated Human Urine.

New HRSD Operations Center Complex

- Urine will be separated and collected at the HRSD's New Complex and truck it to their Ostara Facility to produce fertilizer
  - 85% P recovery & up to 40% N recovery
- Plumbing code conformance – building permit
  - No valves allowed
  - No small diameter urine piping
- Scale and odor control
- Additional Cost of a no-mix toilet
- Recognition of value of urine separation by HRSD employees
- Toilet cleanliness and odor
- Waterless urinal cleanliness and odor

Courtesy, Dr. Charles Bott, HRSD

Collection and Storage Tanks

- When urine is separated and stored ammonia is hydrolyzed and the pH goes up
- Eliminates or reduces the number of pathogens due to higher temperatures and longer retention times
- Urine is generally considered safe to be used on products which are not consumed raw after a storage time of 6 months at temperatures above 4°C
- Pipes are likely to become clogged when the urea is hydrolyzed due to struvite formation

Urine Storage Tank at Lake Bornsjön in Sweden

Jenssen, et al. (2004) Sustainable Wastewater Management in Urban Areas.

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Inside the Fence/Process Changes:
Cost Effective Means for Nutrient Load Reductions

Nutrient Optimization Examples

No-Cost Strategies

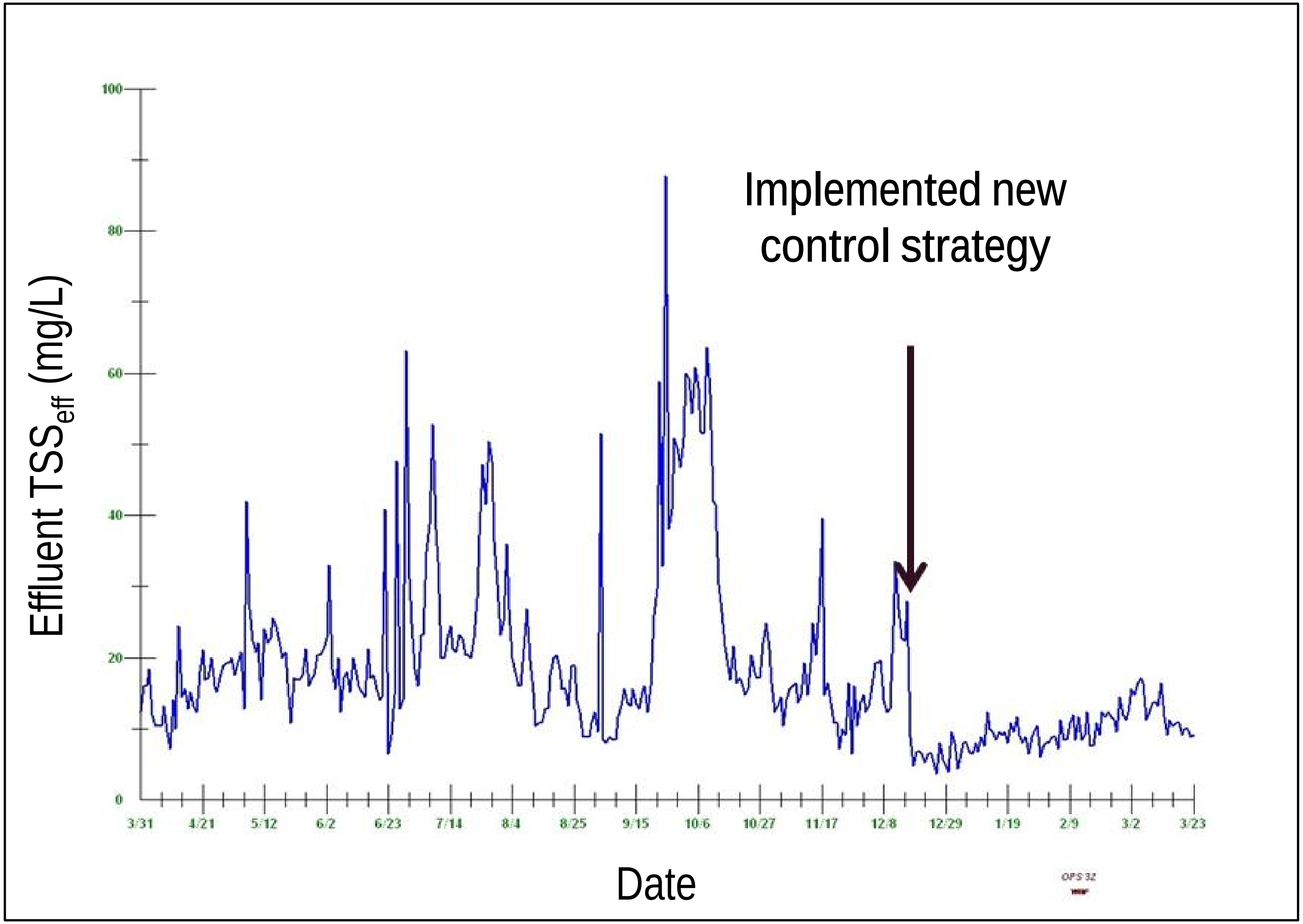
- Use offline tankage to provide additional treatment
- Modify operational mode, such as raising SRT
- Modify blower operating setpoints
- Operate in split treatment mode
- Change to simultaneous nitrification/denitrification operation
- Shut down aeration to create unaerated zones

Low-Cost Strategies

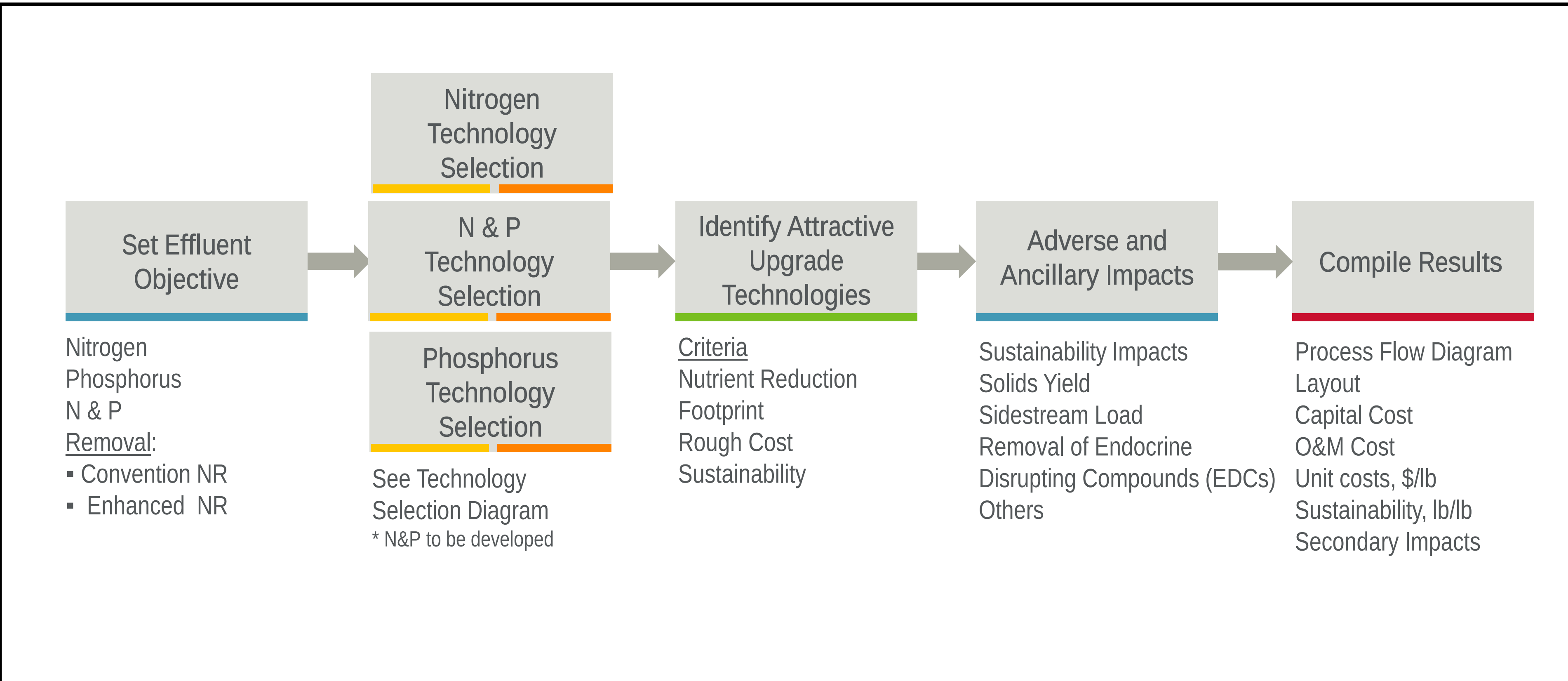
- Add instruments for nutrient removal in ABAC* mode
- Add chemicals for phosphorus removal
- Add chemicals to reduce load, unlock capacity
- Add anoxic and/poor anaerobic zones for BNR
- Add internal recycle for denitrification
- Add mixers for unaerated zones

*Note: * ABAC = Ammonia Based Aeration Control*

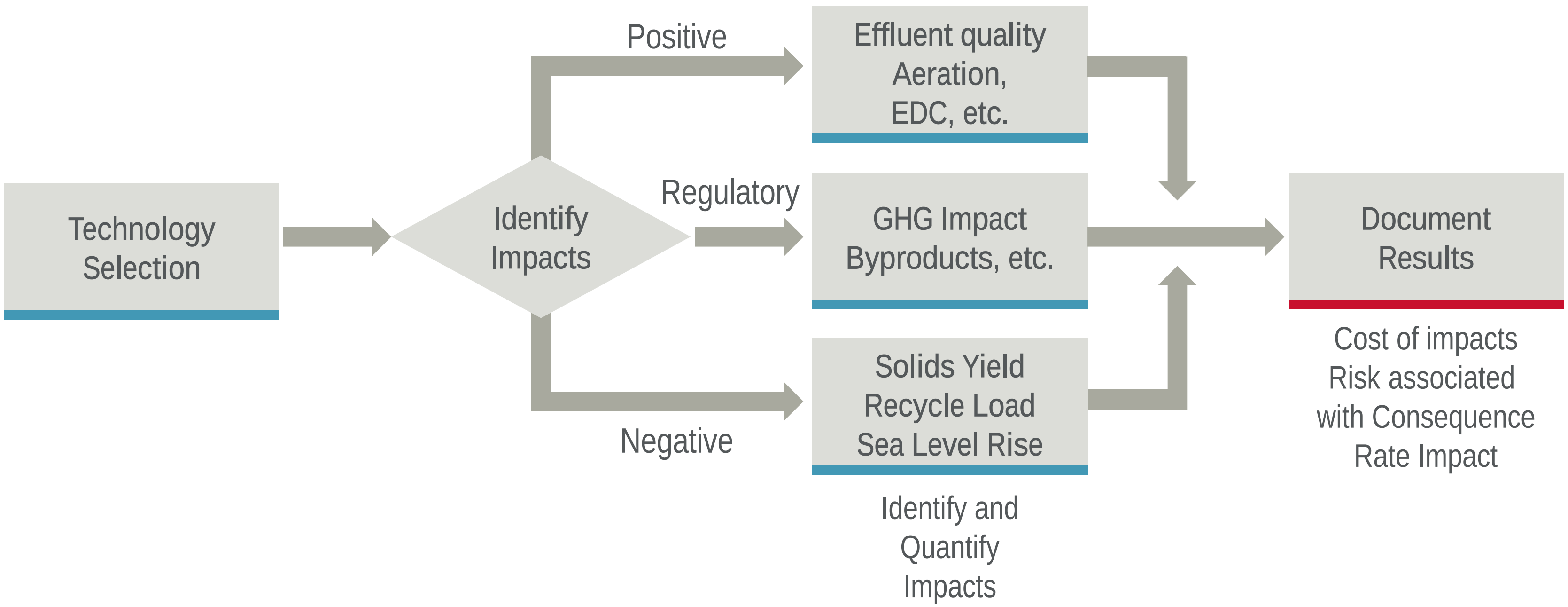
Once Implemented, Process Improvements Will Improve Performance



Process Improvements:
Set objectives but beware adverse/ancillary impacts

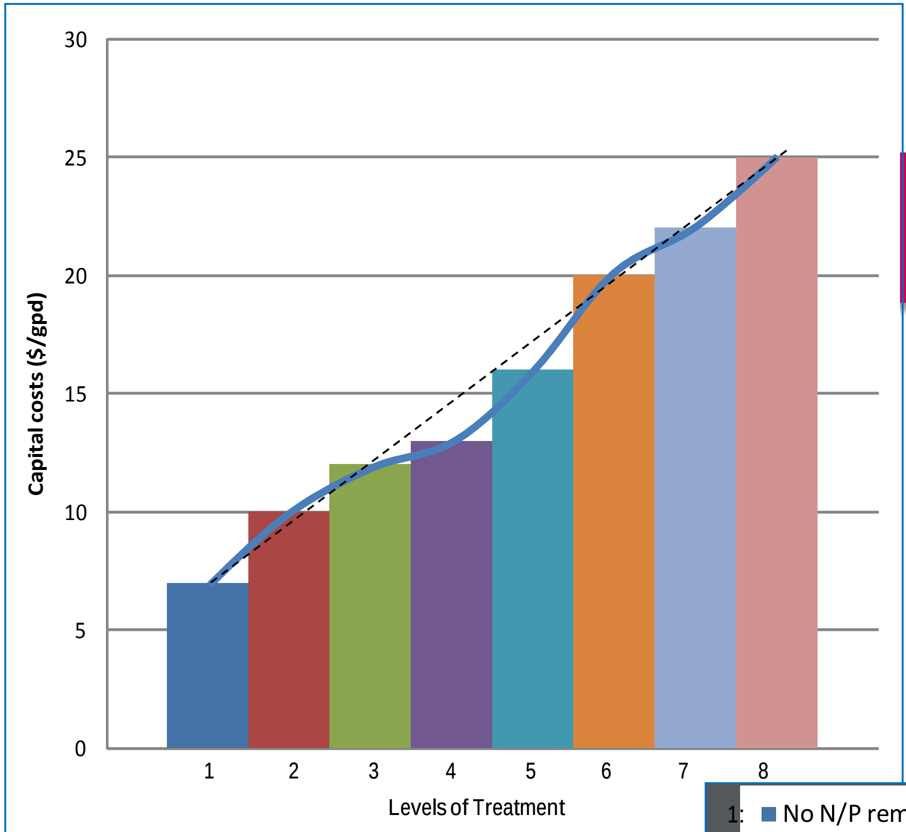


Process Improvements: Evaluating Other Impacts Associated With Each Available Choice

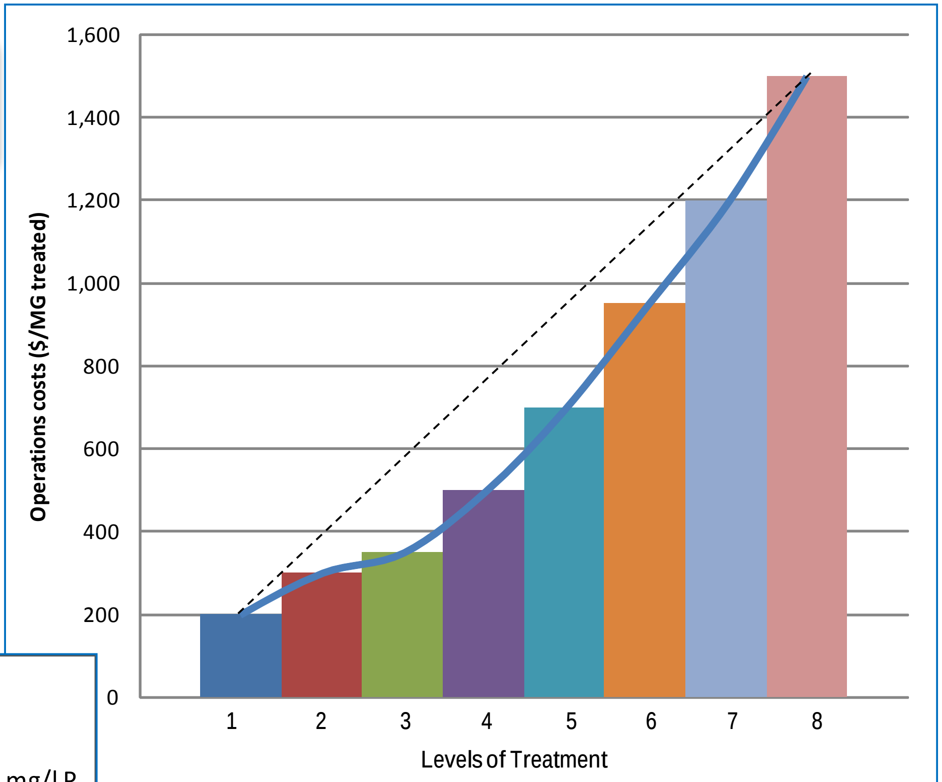


Process Improvements
Assess Operating Costs of Optimization

Operating costs rise exponentially beyond Level 4



Source: Bratby, J., and Jimenez, J. (2011)



1: No N/P removal
2: 8 to 10 mg/l N
3: 8 to 10 mg/l N; 1 mg/l P
4: 6 mg/l N; 0.5 mg/l P
5: 3 mg/l N; 0.1 mg/l P
6: 3 mg/l N; 0.05 mg/l P
7: 2 mg/l N; 0.05 mg/l P
8: 1 mg/l N; 0.05 mg/l P)

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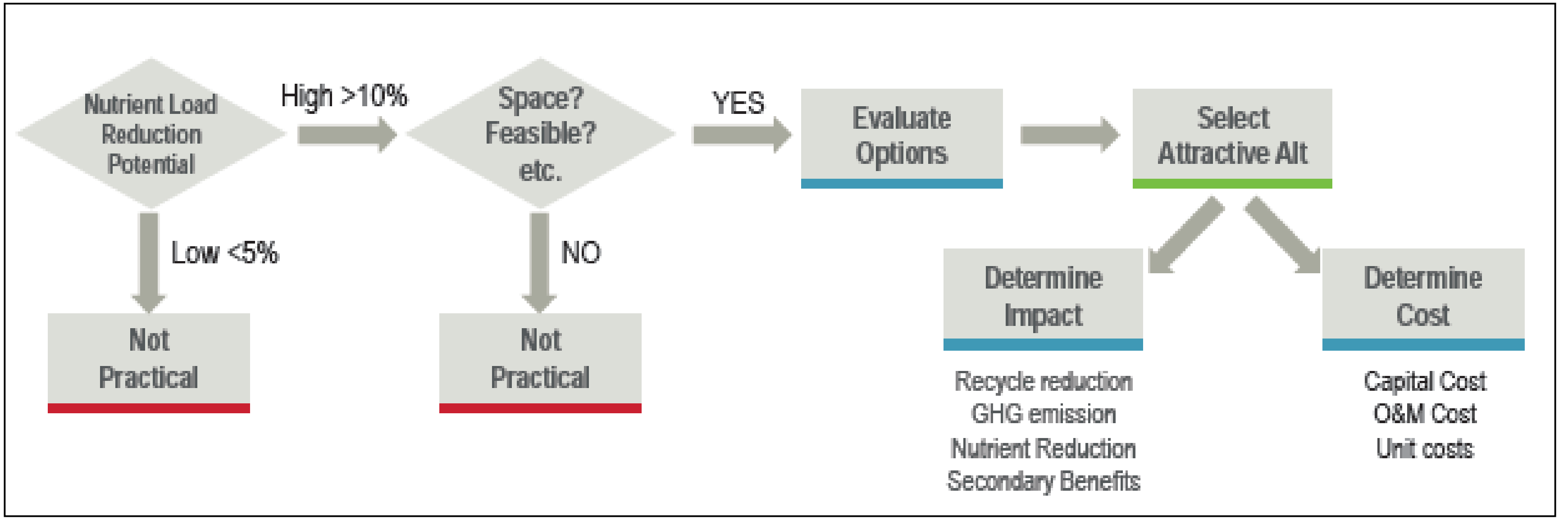
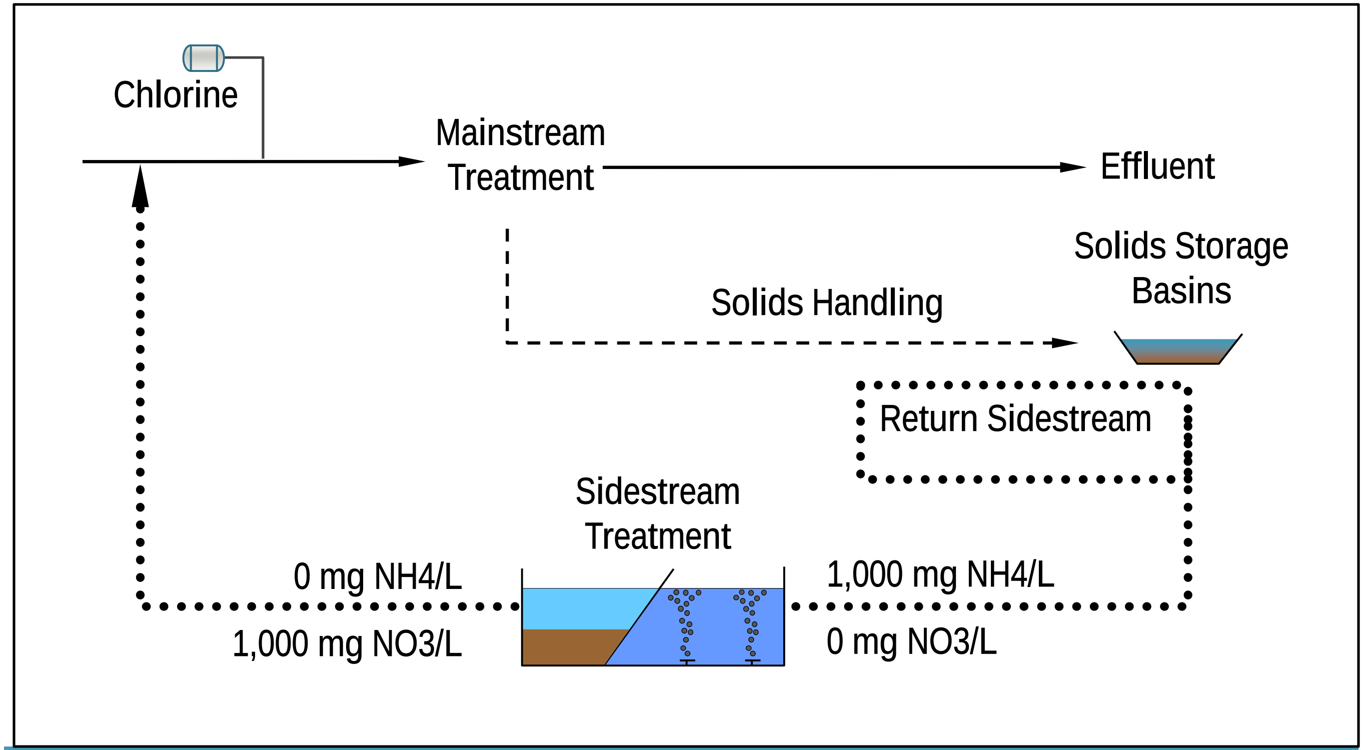
Options Inside the Fence: Sidestream Treatment

- Adaptive management continues with sidestream treatment
- One example of sidestream treatment is sludge processing recycles
- Sidestream is more affordable and requires less energy/chemicals than Mainstream nutrient removal



Sidestream Case Study – Regional Sanitation District



Odor Control at Headworks:

Step 1 → $2NO_3^- + 5HS^- + H_2O = 5S + N_2 + 7OH^-$

Step 2 → $5S + 6NO_3^- + 4OH^- = 5SO_4^{2-} + 3N_2 + 2H_2O$

Sidestream Case Study – Regional Sanitation District

Mainstream vs. Sidestream with DEMON ® Technology

PARAMETER	MAINSTREAM	SIDESTREAM
Unit Cost ($/lb N)	More Expensive ($/lb N) 0.9 - 2.5	Less Expensive ($/lb N) 0.4 - 0.7
Alkalinity Demand	Yes	No
External C Source	Yes	No
Oxygen Demand (lb O2/lb N)	High	Lower
Solids Yield	High	Low
Footprint	Large	Small
Plant Impact During Construction	Major	Minor
Mitigation of Struvite Issues	No	Yes

Removing nutrients at the sidestream is more efficient than at the mainstream.

Options Inside the Fence: SRT Control

- Sludge Age – also called Solids Retention Time – SRT
  - The average “age” of the bacteria (time spent in reactor)
  - Control by how fast you remove the bacteria from the system
- Beware of washout!
  - Sludge age too low
  - Remove the bacteria from the system BEFORE it has had a chance to reproduce
  - Human analogy
    - Reduce average population age to 12 years…
    - Not enough time to mature and reproduce
    - Population decline
    - Ultimately end with zero people!

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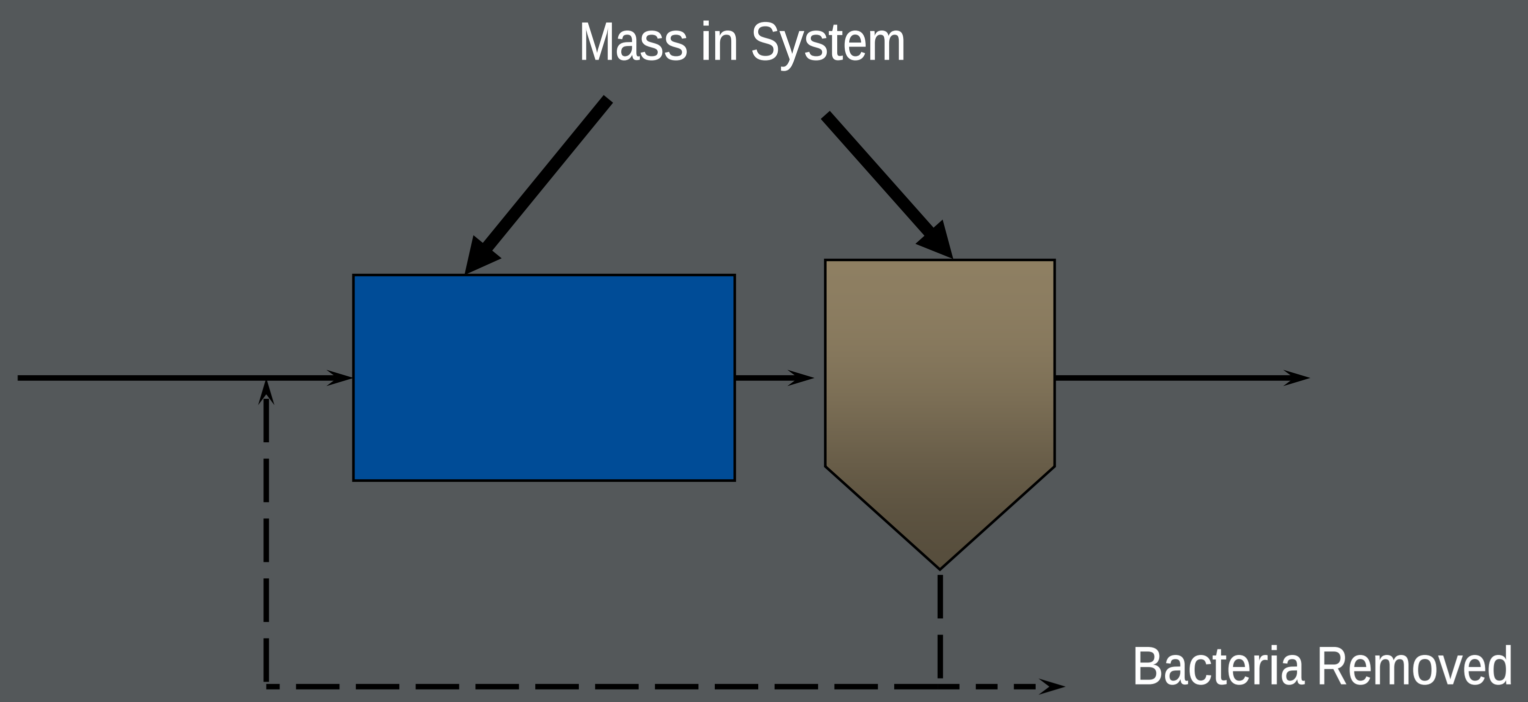
Options Inside the Fence: SRT Control

$$SRT = \frac{\text{Mass in the System}}{\text{Mass removed per day}}$$

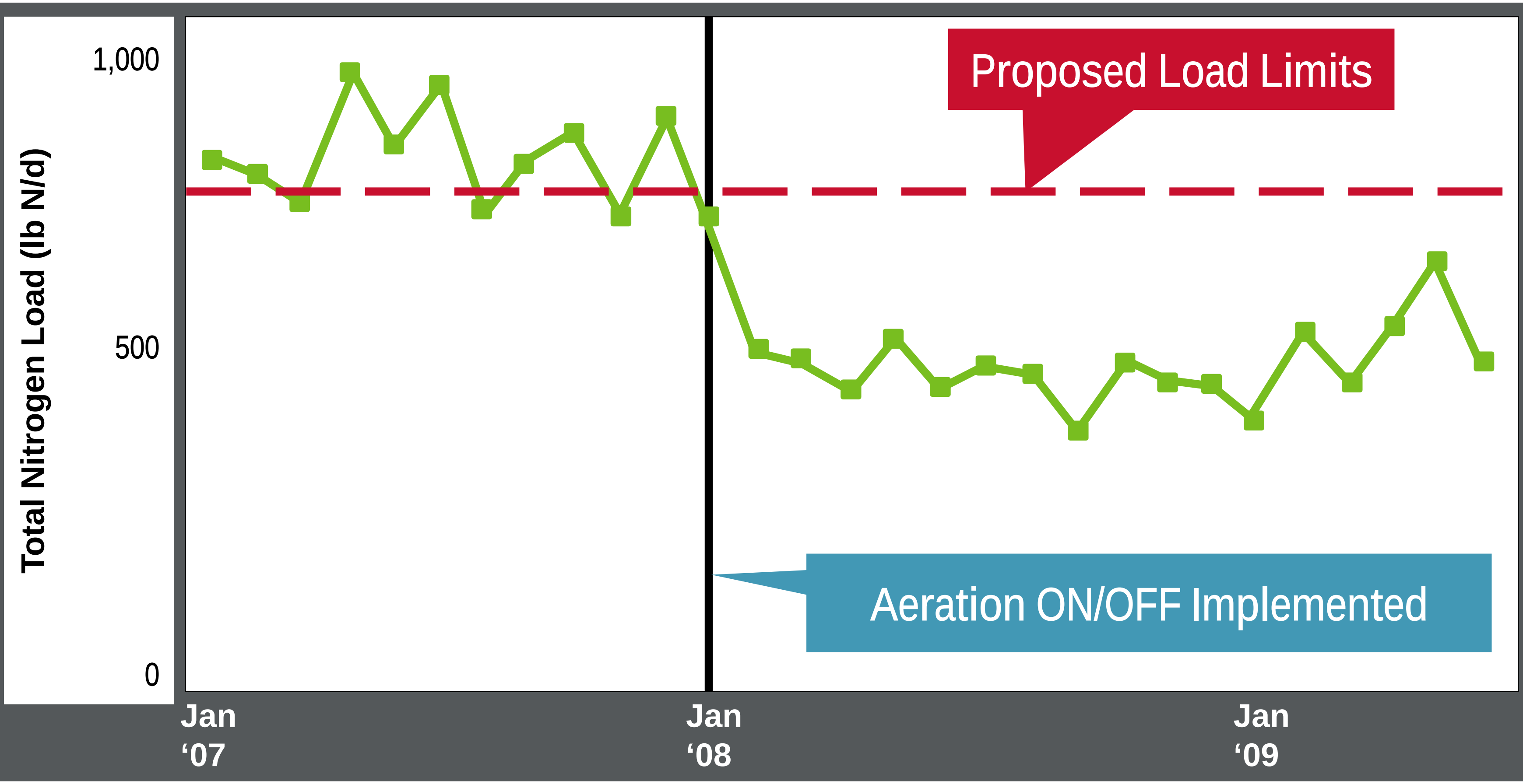


Example Mass in System

	Aeration	Clarifier	Total
MLSS (mg/L)	2,500	500	
Volume (MG)	10	13	
Mass (1000 lb)	208	54	262

- Measure suspended solids concentration (MLSS) – each basin
- Mass in system
  - Mass in each basin = MLSS * Volume * 8.34
  - Add mass up
- SRT = Mass in lb/WAS rate in lb/d

Optimization – Uncover Robust, Cost-Effective Means for Load Reductions



City of Bozeman, MT: Nitrogen Removal without Pouring Concrete
(WEF Gascoigne Medal, 2011)

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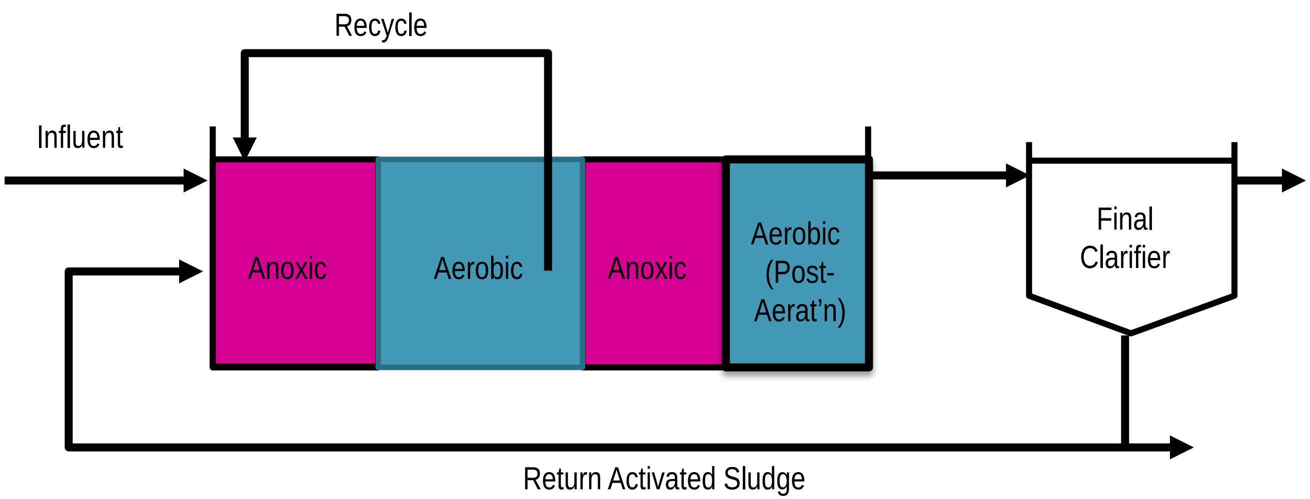
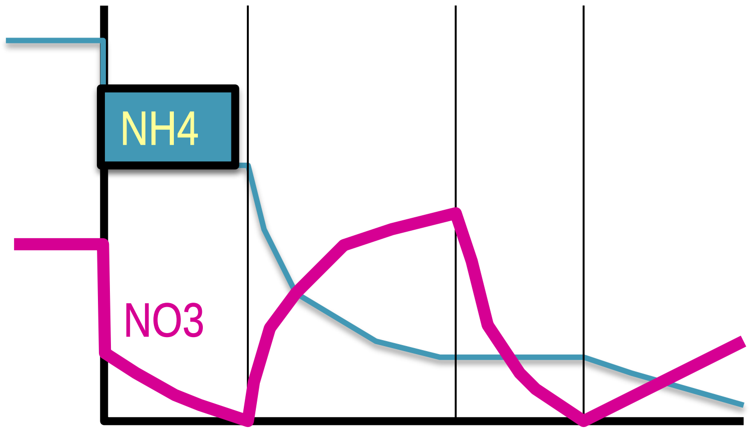
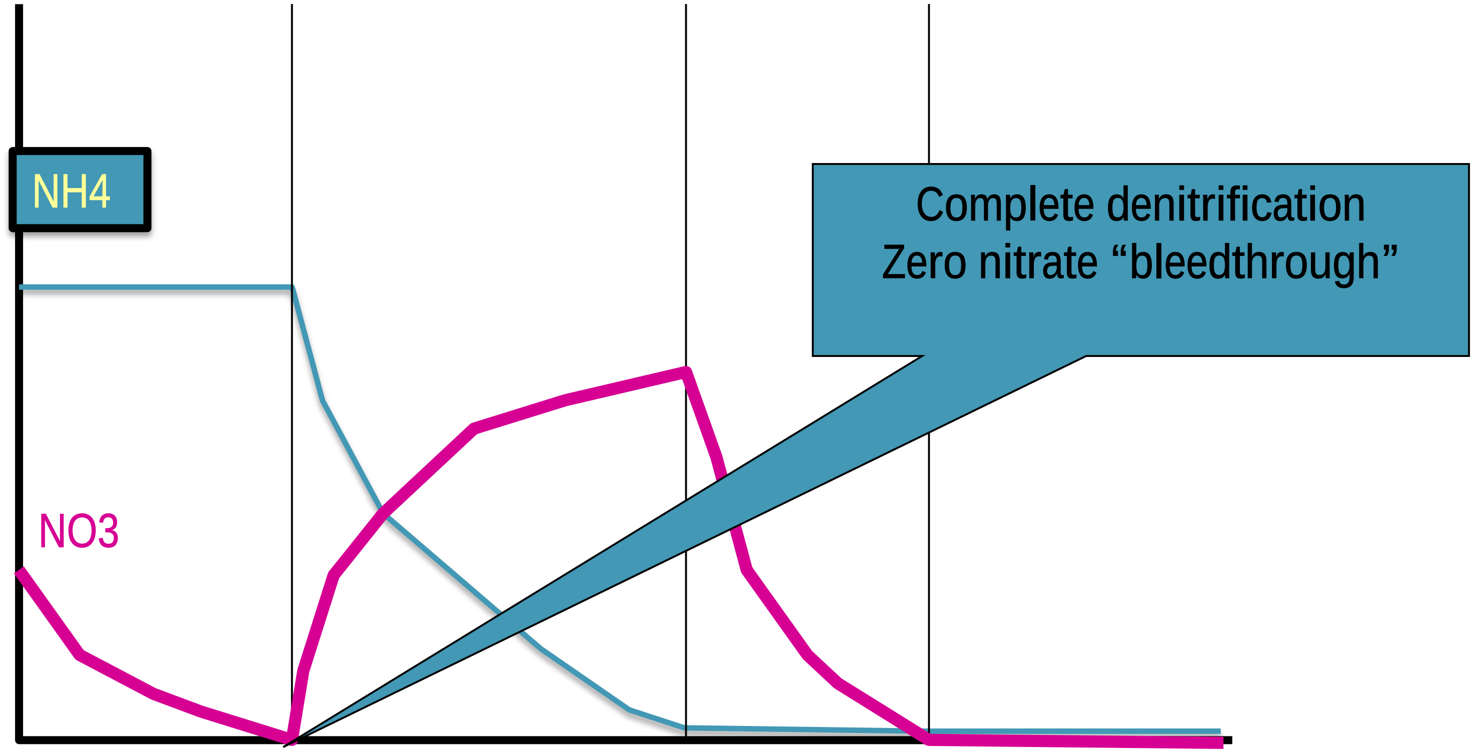
Process Optimization
Balancing Nitrification & Denitrification





Nitrogen Removal Challenges

Balancing Nitrification & Denitrification - Perfect



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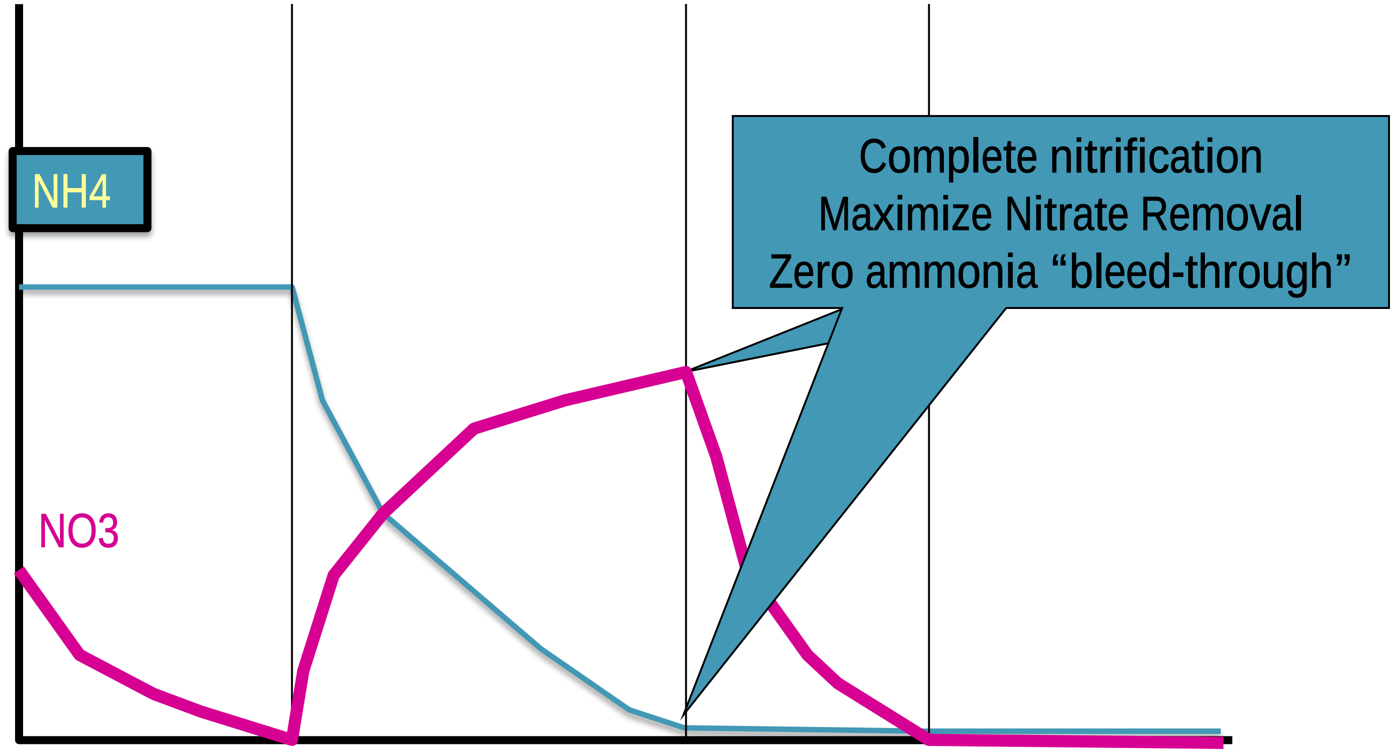

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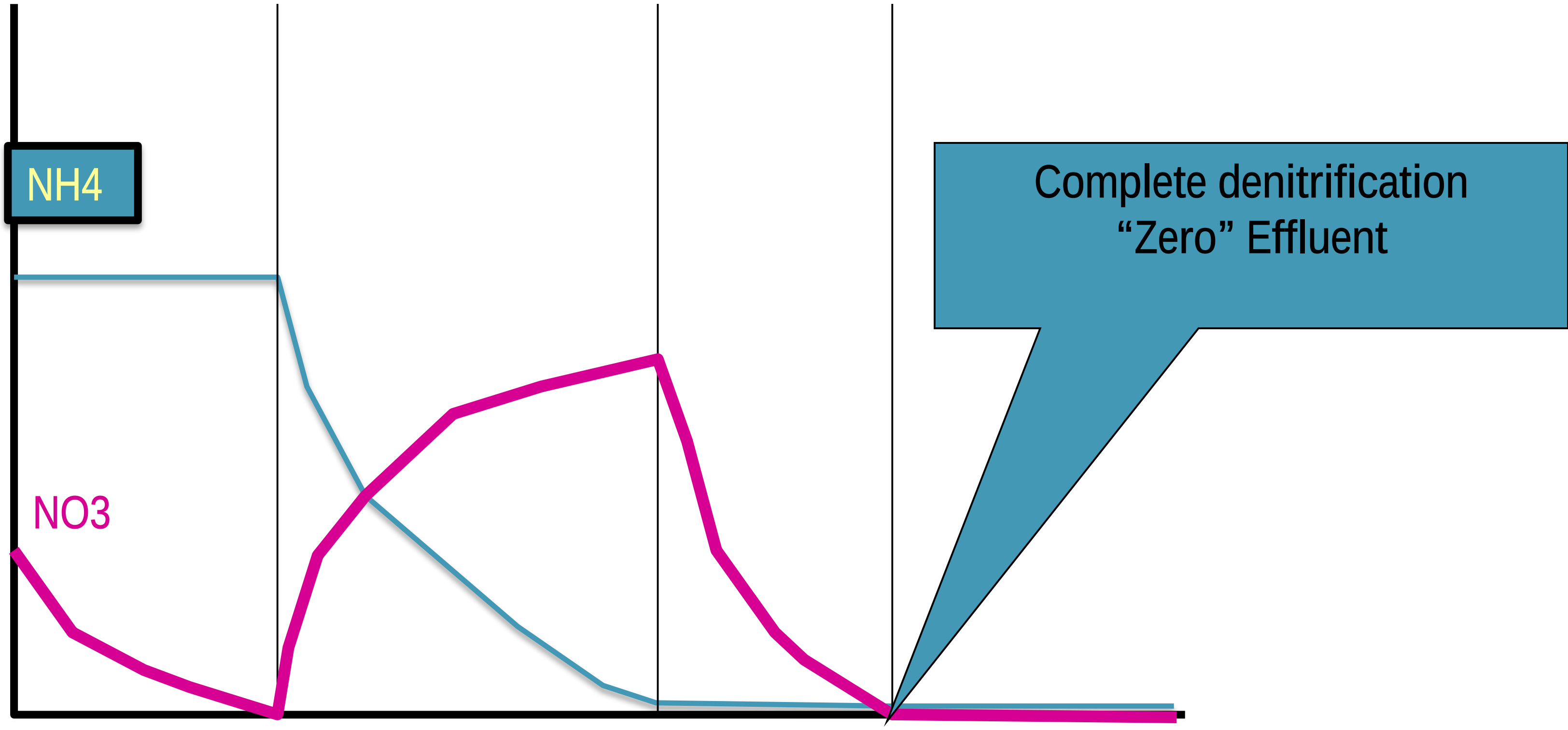
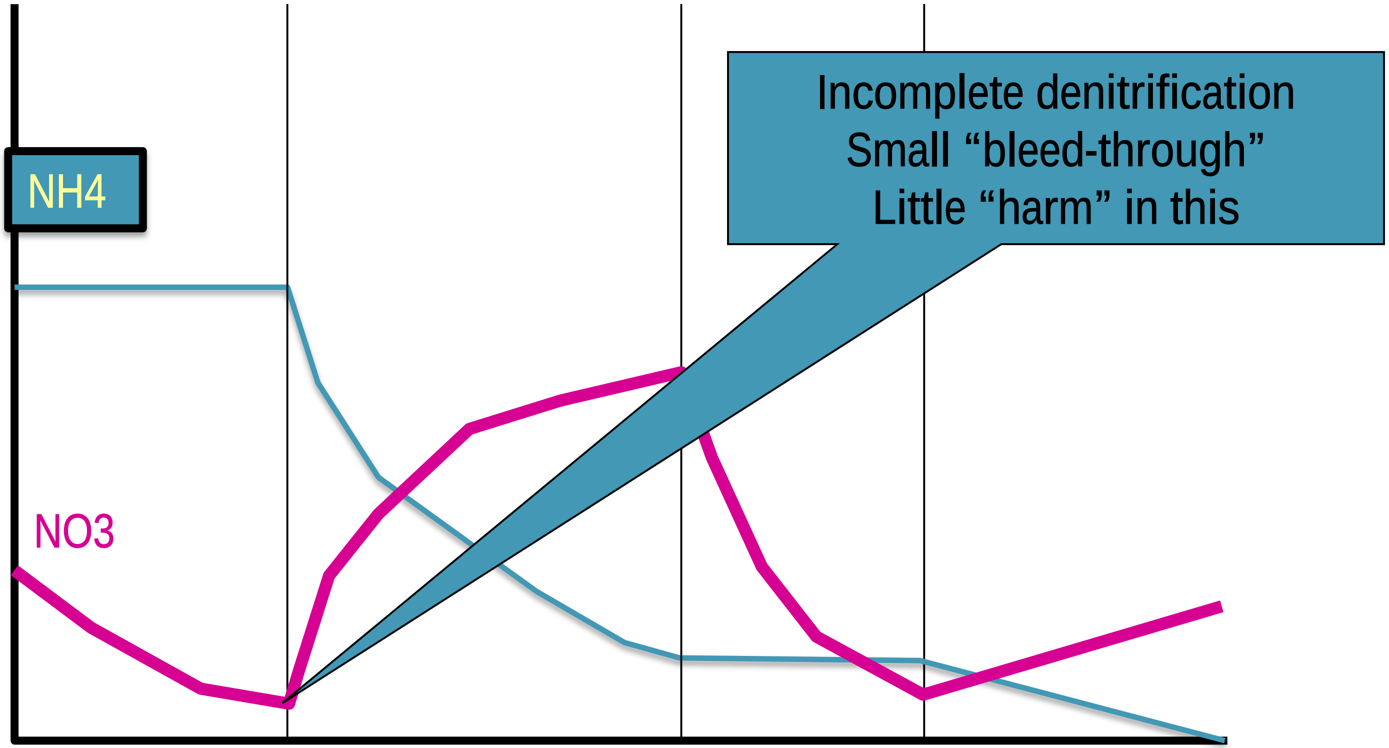


Balancing Nitrification & Denitrification – NH4/NO3 Bleed-through



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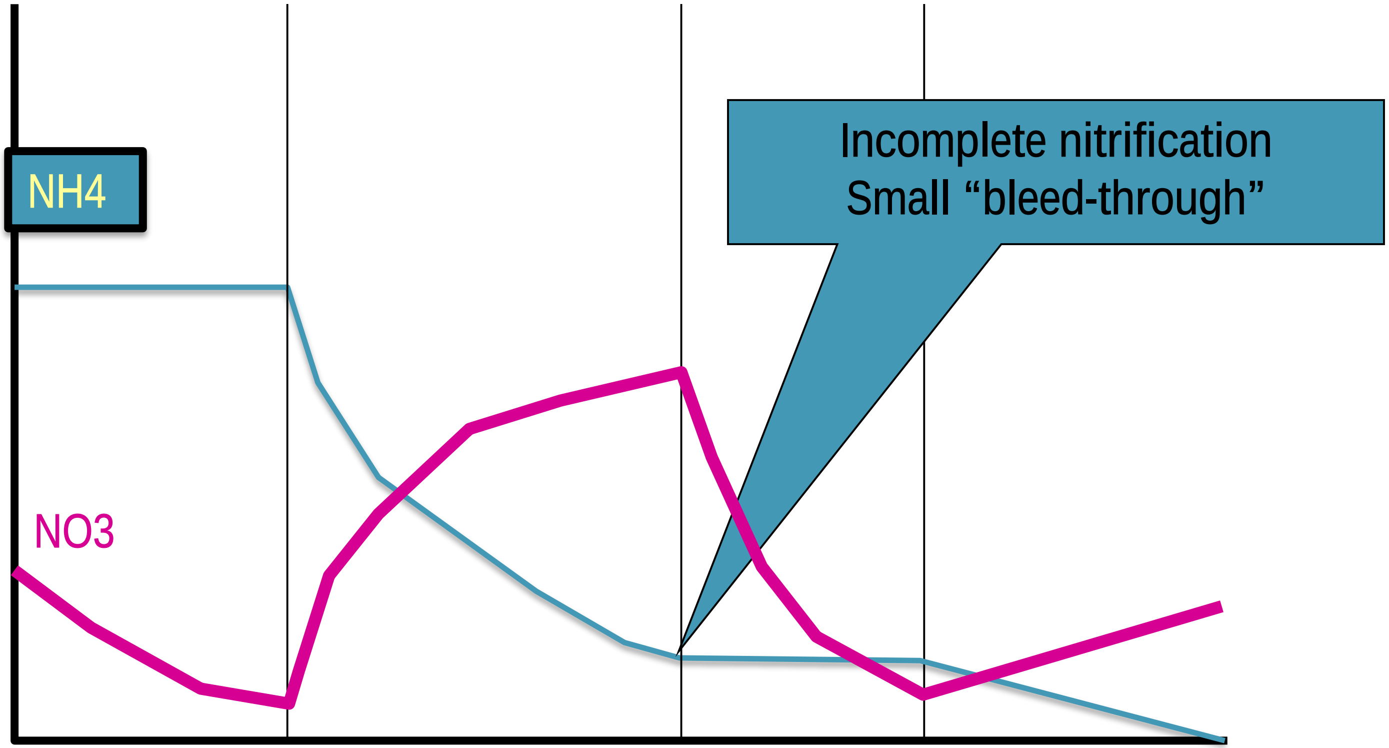

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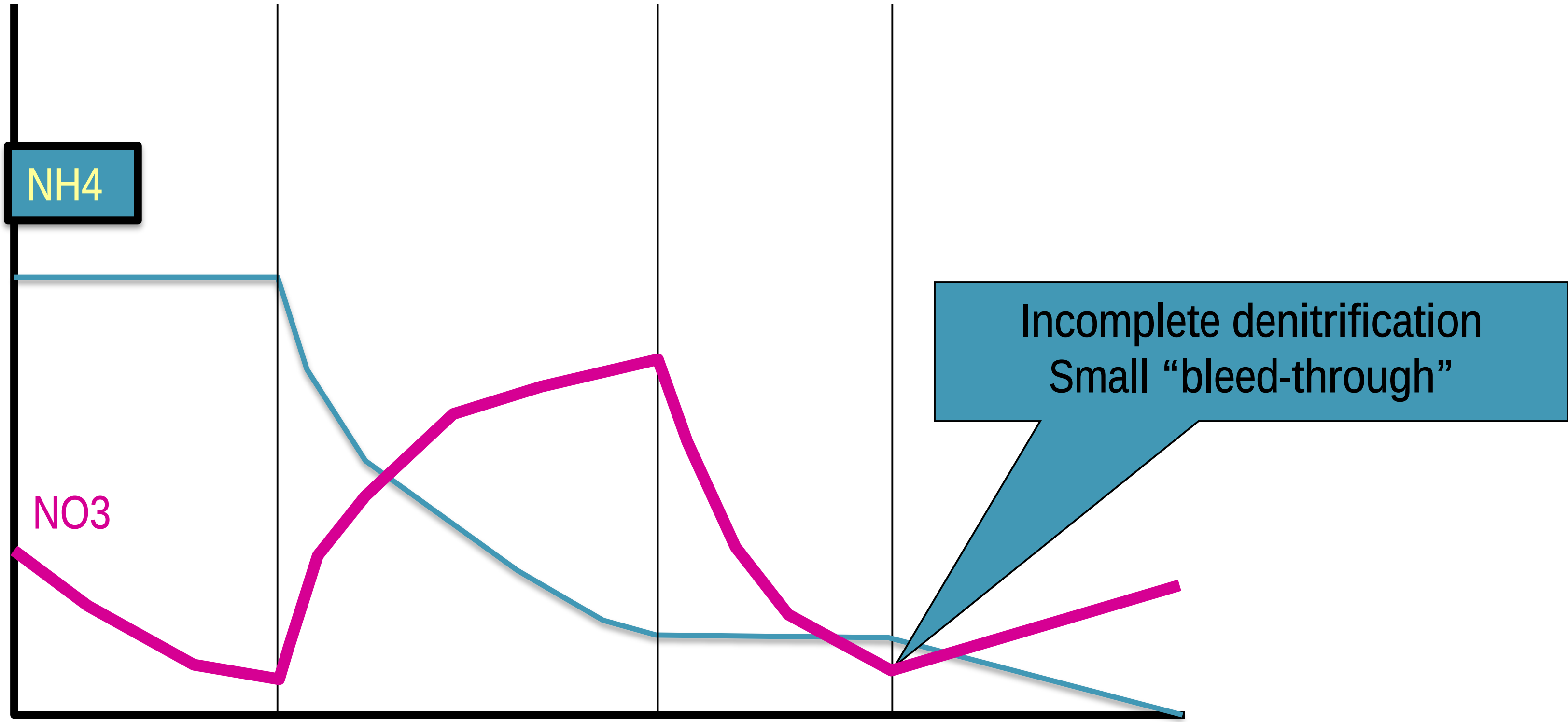

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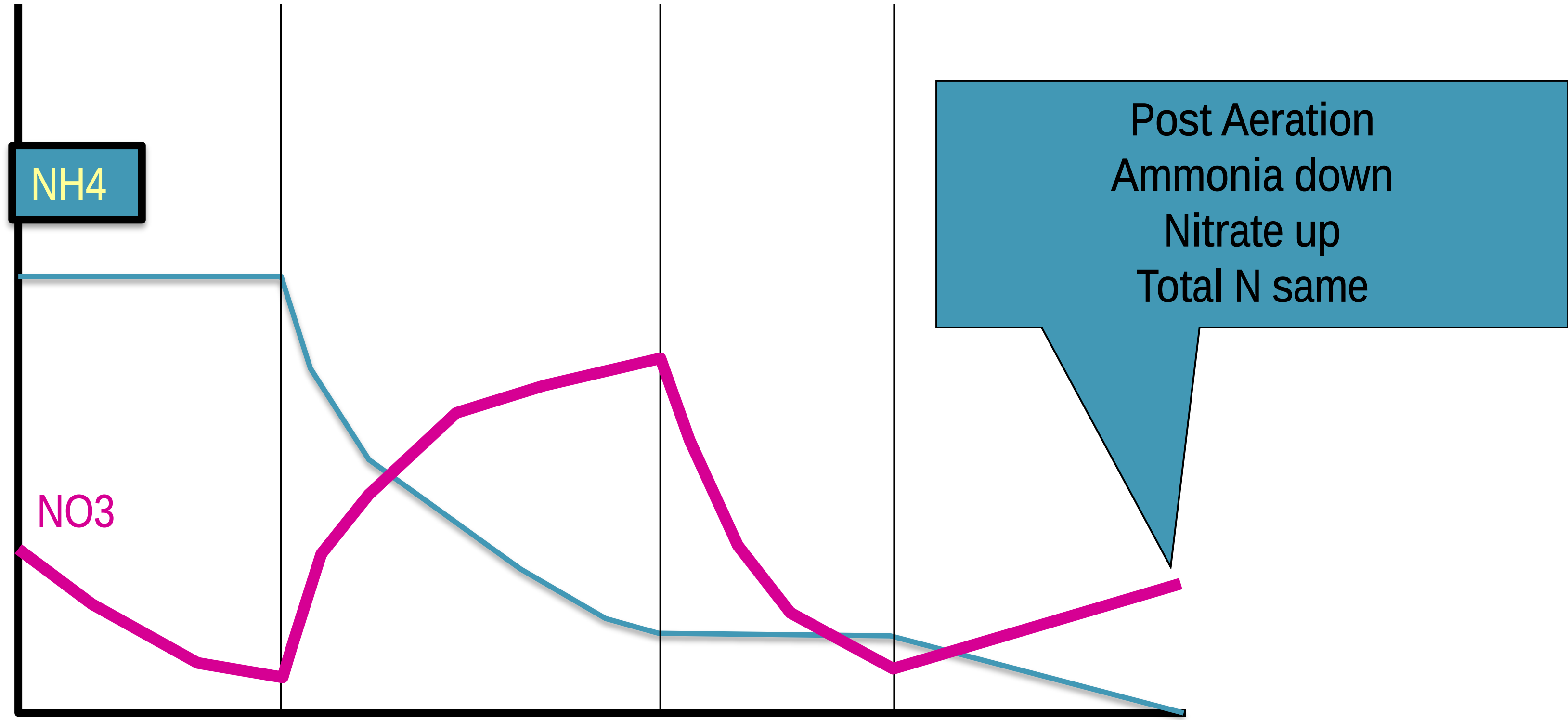

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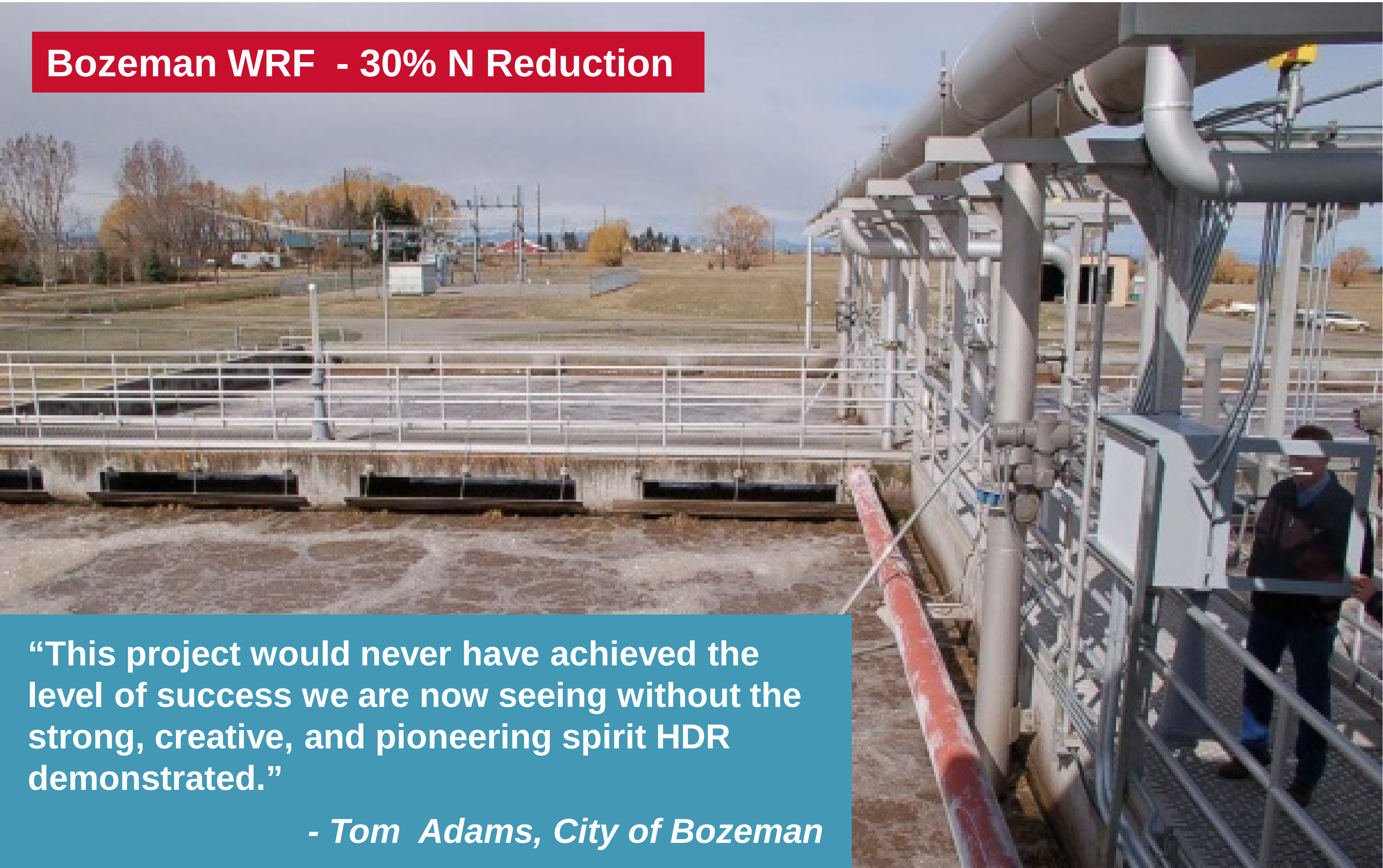
Non-Point Control	Non-Point Source Reduction Program	Residential fertilization lawn/landscape fertilizer restrictions. Agricultural Best Management Practices to reduce nutrient run-off.

Recycle Loads

- Solids Processing
  - Anaerobic digestion Supernatant
  - Sludge Dewatering (Centrate, Filtrate)
  - Other
- Operation schedule
- Management of recycle
  - Load equalization
  - Treatment of return flow

Innovative Methods to Optimize Nutrient Reduction within Existing Tankage



Bozeman WRF - 30% N Reduction

"This project would never have achieved the level of success we are now seeing without the strong, creative, and pioneering spirit HDR demonstrated."

- Tom Adams, City of Bozeman

City of Bozeman, MT

- Significant N reduction without pouring concrete
- Winner of the 2011 Gasgoyne Wastewater Treatment Plant Operational Improvement Medal
- No concrete poured to meet stringent total N requirements

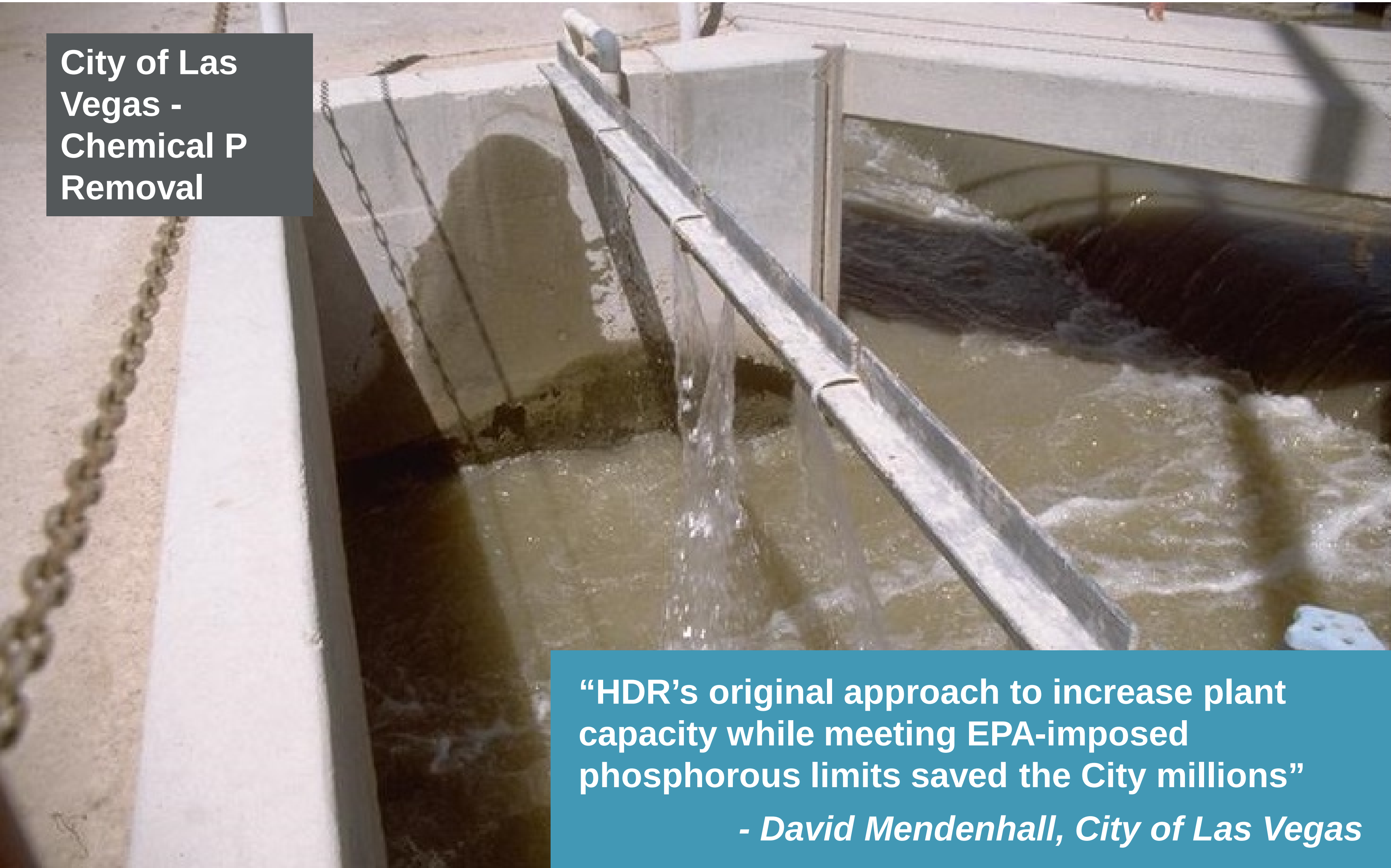
Providing practical methods to optimize nutrient reduction

Innovative Methods to Optimize Nutrient Reduction within Existing Tankage

Innovative Methods to Optimize Nutrient Reduction within Existing Tankage

Orange County Sanitation District

Innovative Methods to Optimize Nutrient Reduction within Existing Tankage



City of Las Vegas - Chemical P Removal

“HDR’s original approach to increase plant capacity while meeting EPA-imposed phosphorous limits saved the City millions”

- David Mendenhall, City of Las Vegas

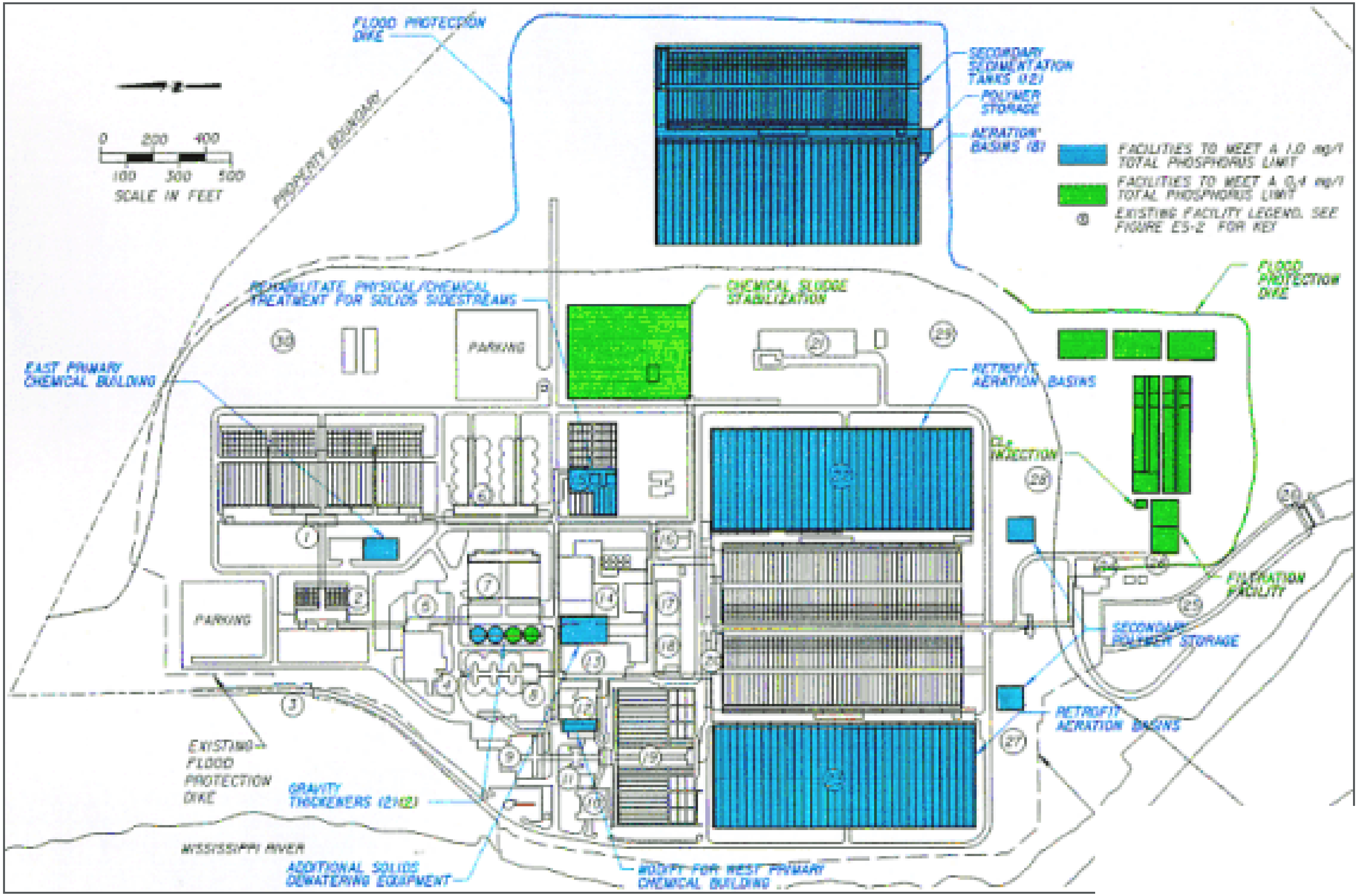
Innovative Methods to Optimize Nutrient Reduction within Existing Tankage

Coeur d’Alene, IA - Nitrifying Tertiary Filter

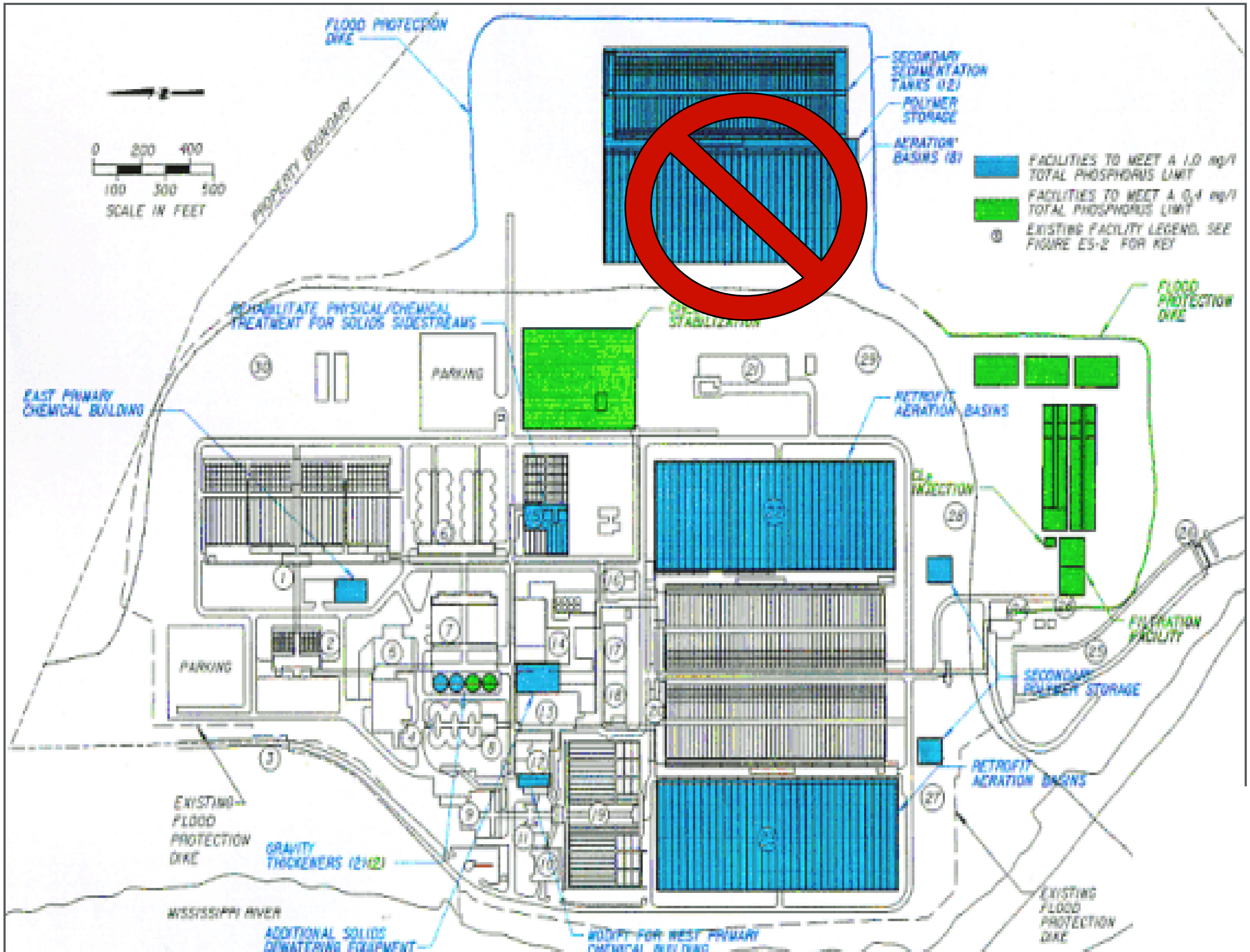
Facility Upgrades – City of Coeur D'Alene, IA

- Provided compliance with the lowest limits in the nation at a modest cost
- HDR's phased approach provided several extra years to capitalize on new cost-saving and process-improving developments

Previous approach required 50 percent expansion in secondary tanks



Science-design approach saved $100 million in construction costs



Agenda
Optimization Concepts

- Outside the Plant Fence
  - Point Source control
  - Non-point source control and Effluent management (Trading, Reuse)
- Inside the Plant Fence
  - Process changes
    - Side-stream treatment
    - SRT Control
    - Balancing P and N in BNR
    - Recycle Loads
  - Nutrient Recovery
  - Centralized biosolids

Now, lets tie this all together.....

NUTRIENT OPTIMIZATION BY OTHER MEANS - INITIAL CONCEPTS BASED ON HDR EXPERIENCE

CATEGORY	CONCEPT	COMMENT
Nutrient Recovery	Sidestream Nitrogen or Phosphorous Recovery	Nitrogen Recovery using the Ammonia Recovery Process (ARP) and/or Phosphorus Recovery using a struvite precipitation technology (e.g., Ostara®)
Effluent Management	Nutrient Trading	Develop an approach for evaluating nutrient trading in SF Bay and identify data gaps. For example, the NNE model does not yet have the sophistication to consider fate/transport of nutrients which is a pre-requisite for evaluating nutrient trading.
Effluent Management	Water Reclamation and Reuse	Perform a desktop analysis that identifies locations that are ripe for recycled water. The Pacific Institute (June 2014) estimates that about 45% of the currently permitted ADWF capacity of BACWA plants is available for recycling.
Effluent Management	Bio-Available Phosphorous	This policy issue addresses whether discharge permits should only focus on bio-available phosphorus. If yes, the ability for POTWs to reliably meet future phosphorus limits increases.
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Providing a Holistic View of Treatment Plant Solutions

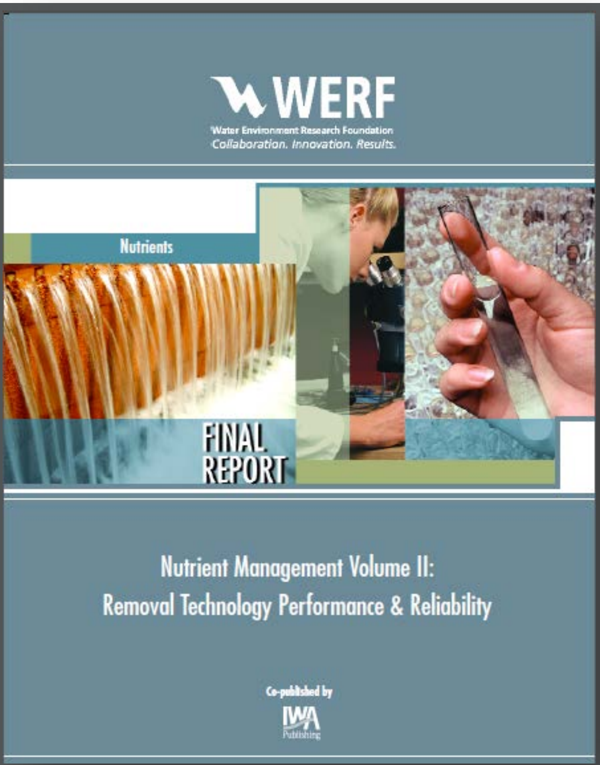
RegionalSan Ammonia Reduction Treatability Study

Nitrifying SBR
Reduce NH4 load

Nitrate Production
Odor Control

Deammonification
Low Cost NH4 Reduction

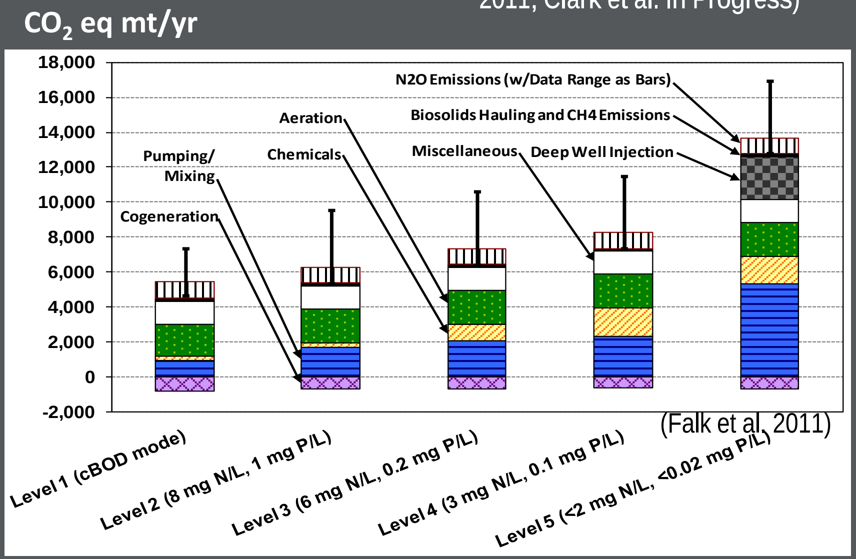
Providing Credible Support for Permit Negotiations



Nutrient Management:

- Regulatory Permit Structure
- Removal Technology Performance & Reliability
- Regulatory Approaches to Protect Water Quality

(Clark et al. 2010; Bott & Parker, 2011; Clark et al. In Progress)



WERF - Evaluated the impact of nutrient removal on GHG emissions

"Dave Clark has been terrific to work with! He sees the big picture and understands how to get to that goal."

- Ruth Watkins, Tri-State Water Quality Council, ID

"HDR/Dave Clark has represented our interests with exceptional skill..."

- Mr. Jim Hansz, City of Kalispell, MT

Plant Optimization, Water Quality, and Regulatory Strategy

Dave Clark, Jennifer A. Frommer, Rich Atoulikian | HDR Engineering, Inc.

Plant Operations and Lab Analysis Workshop

October 21, 2015

HDR