Review of Aquatic Life Uses
Analysis of Attainability Preview

Water Quality Advisory Committee

September 13, 2022

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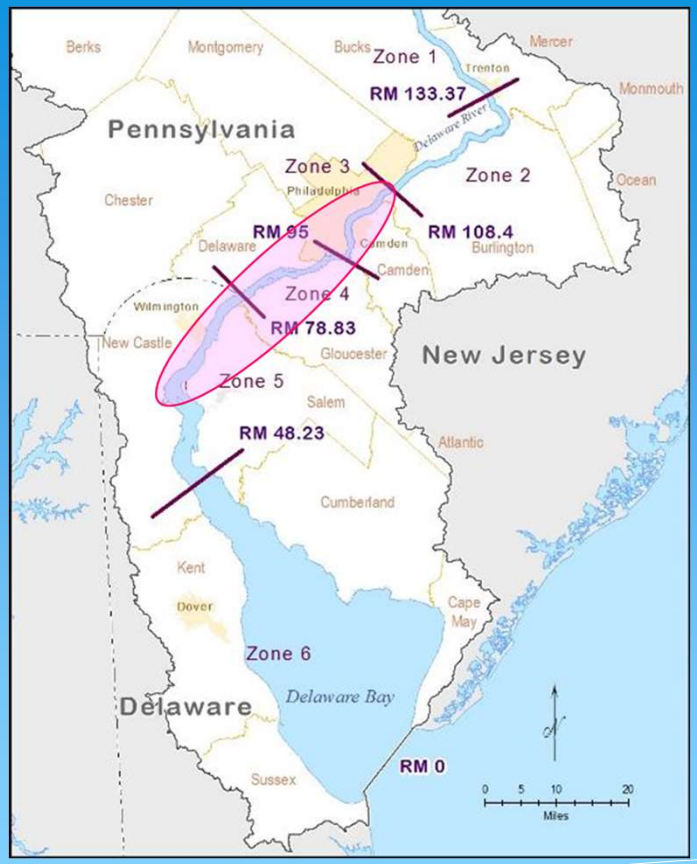

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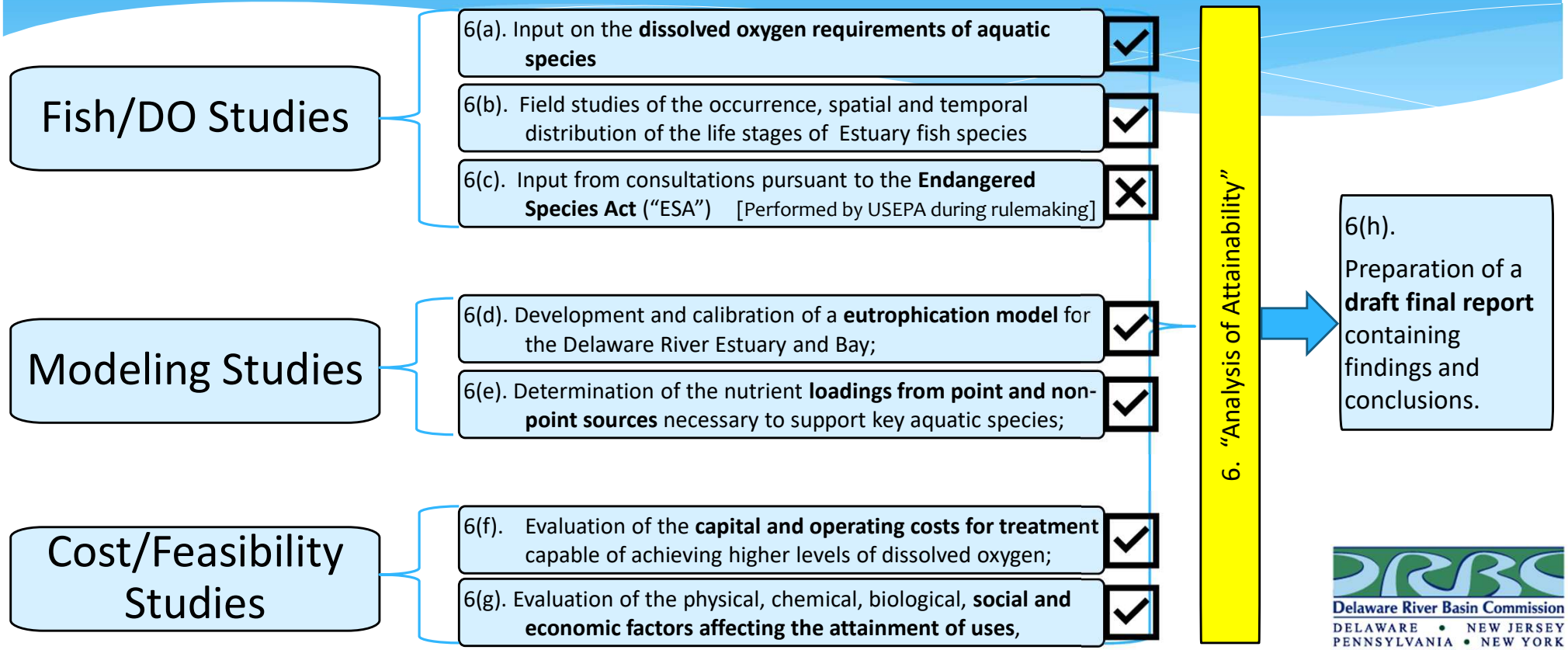
DRBC Resolution 2017-04
Studies Required Before Rulemaking



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What is this "Analysis of Attainability"?

Regulatory basis

- Aquatic life use defined as the degree of propagation associated with a given dissolved oxygen condition

Purpose

- **Highest Attainable Dissolved Oxygen (HADO) condition to be determined based on feasibility, costs, and benefits in the fish maintenance area**

Outcome

- Revised designated use will be the enhanced degree of propagation associated with the HADO condition

Analysis of Attainability

Rulemaking

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Aquatic Life Designated Uses in Current DRBC Regulations since 1967

	Zone	River Mile	Aquatic Life Use	Migratory Fishes	24-hour average D.O. Criteria
	2	108.4 – 133.4	**maintenance** and **propagation** of resident fish and other aquatic life	**passage** of anadromous fish	5.0 mg/l
Urbanized portion of Delaware Estuary	3	95 – 108.4	**maintenance** of resident fish and other aquatic life	**passage** of anadromous fish	3.5 mg/l
	4	78.8 – 95	**maintenance** of resident fish and other aquatic life	**passage** of anadromous fish	3.5 mg/l
	5	70 – 78.8	**maintenance** of resident fish and other aquatic life	**passage** of anadromous fish	3.5 mg/l
		48.2 – 70	**maintenance** and **propagation** of resident fish and other aquatic life	**passage** of anadromous fish	4.5 – 6.0 mg/l
Delaware Bay	6	0 – 48.2	**maintenance** and **propagation** of resident fish and other aquatic life **maintenance** and **propagation** of shellfish	**passage** of anadromous fish	6.0 mg/l

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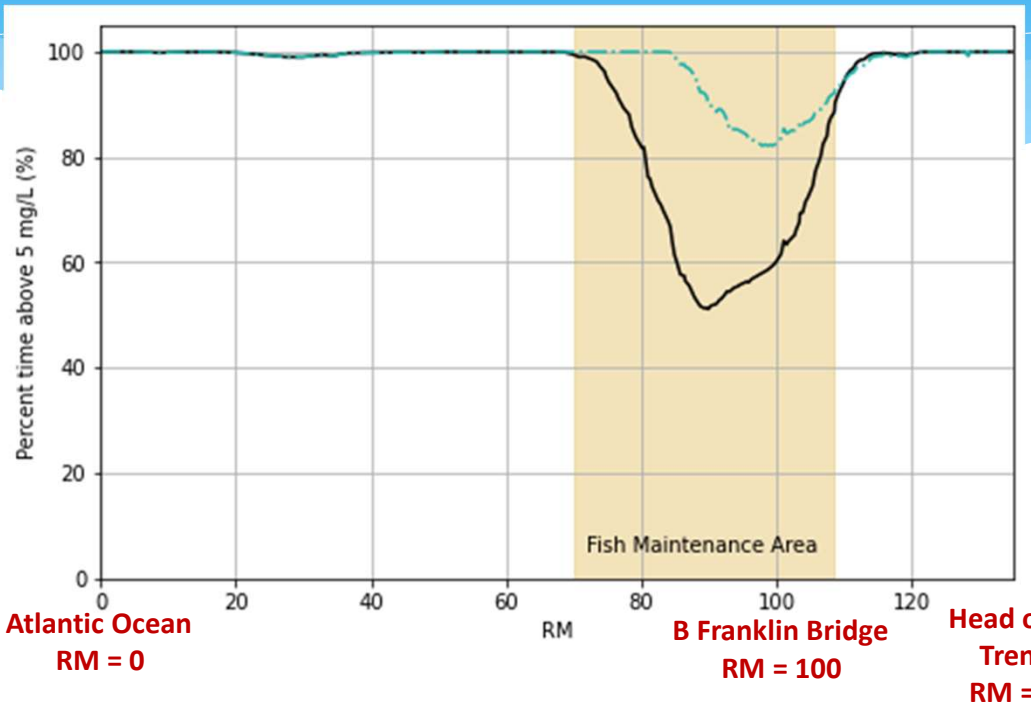
What is the “Fish Maintenance Area”?

- Aquatic life use currently designated for fish maintenance only
- Zone 3, Zone 4, and upper part of Zone 5 (river miles 108.4 to 70)
  - Rest of Zones 2-5 designated for fish maintenance and propagation
- DO criteria of 3.5 mg/L as 24-hr avg
- Urban area – Philadelphia, Camden Wilmington



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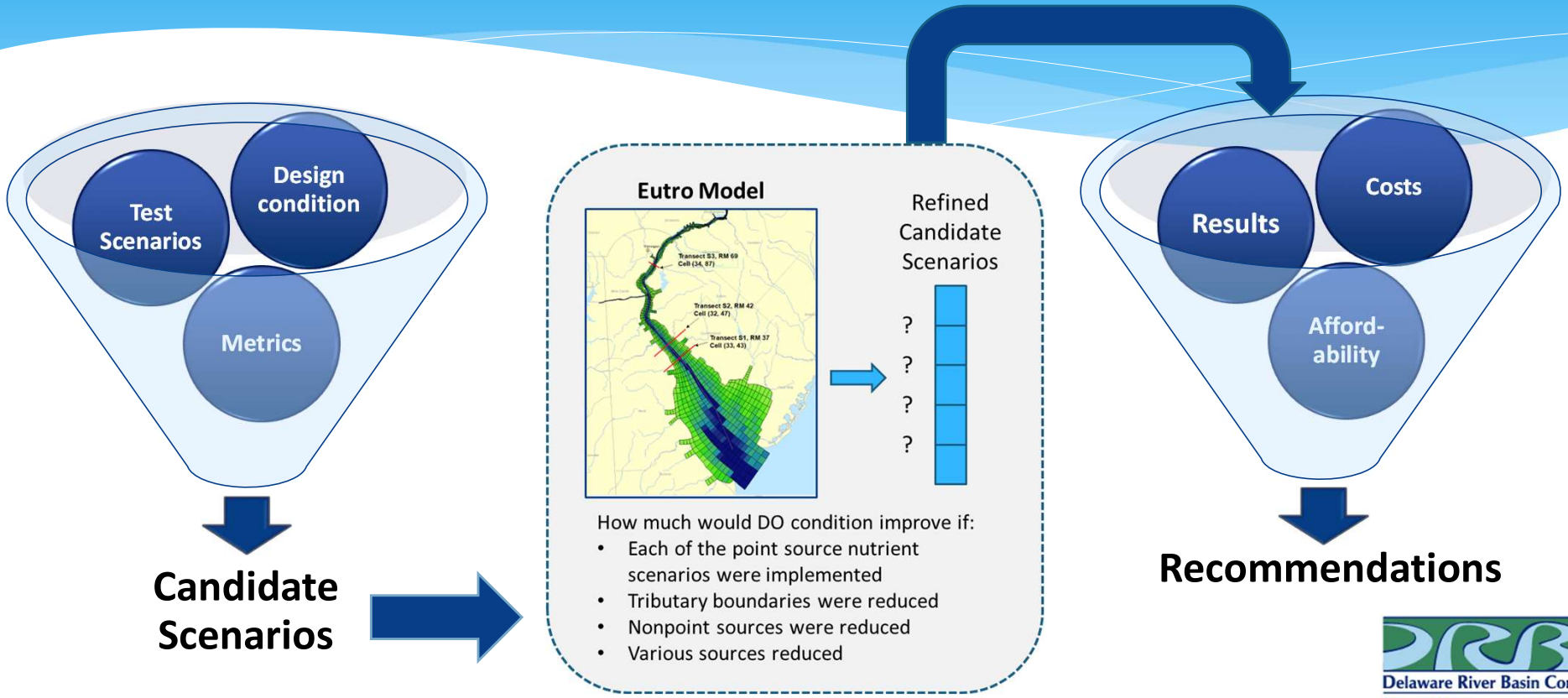
Elements of Analysis of Attainability



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A Few Reminders

Regarding Metrics

- "Critical Propagation Season"
  - May01 – Oct15 (historic low DO periods)
- Predicted DO percentiles by RM
  - 2nd percentile (represents minimum DO)
  - 10th, 25th, and 50th percentiles
- Percent-Over time by RM
  - % of time over 4, 5, 6, 7 mg/L
  - Represents range of DO suitability for fish propagation
- DO Relative Stress Index
  - Considers magnitude, frequency and duration
  - Tool to compare stress to aquatic life (fish)

Costs, Benefits, and Affordability

- Costs
  - Systemwide characterization
  - Based on Kleinfelder cost study
- Benefits
  - Characterized based on DO improvement
- Affordability
  - Evaluates financial burden on ratepayers
  - Facility-specific

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Discussion Items

Identification of discharges that impact DO in Fish Maintenance Area

- Class A' – direct impact in FMA
- Class A – indirect impact in FMA
- Class B – no impact in FMA

Preview of Analysis of Attainability

- AA Scenarios
- Results and recommendations
- Costs and benefits
- Affordability evaluation

Highest Attainable Dissolved Oxygen (preliminary HADO condition)

- Effluent ammonia reduction (AA08) with DO minimum of 4 mg/L
- Implementation of CSO LTCPs
- 10% Reserve Capacity
- Seasonally variable wastewater ammonia concentrations

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Screening of Potential Class A & A' Discharges

based on simulated reductions of individual discharges in 2D

PS Name	Summer NH4 Load (kg/day)	cumulative load %
PWD Southwest	14,354	37%
Camden County MUA	5,241	50%
City of Wilmington	4,807	62%
PWD Southeast	3,626	71%
PWD Northeast	3,535	80%
Gloucester County UA	2,438	87%
Hamilton TWP WPCF	1,634	91%
Delcora	1,014	93%
Lower Bucks County JMA	748	95%
City of Millville STA	495	96%
Trenton SU	411	98%
Morrisville BMA	262	98%
Cumberland County UA	125	99%
Cinnaminson SA	121	99%
Willingboro WPCP*	97	99%
Logan Township MUA	67	99%
Florence Township STP	56	99%
Penns Grove SA	55	100%
Beverly SA	55	100%

1. Summer NH4-N Load

PS Name	% Reduction DO Stress in FMA
PWD Southwest	52%
Camden County MUA	37%
PWD Southeast	25%
PWD Northeast	20%
Gloucester County UA	11%
Hamilton TWP WPCF	2.6%
Lower Bucks County JMA	1.8%
City of Wilmington	1.3%
Trenton SU	1.0%
Morrisville BMA	0.9%
Delcora	0.8%
Cinnaminson SA	0.8%
Florence Township STP	0.3%
Willingboro WPCP*	0.3%
City of Millville STA	0.3%
Penns Grove SA	0.3%
Beverly SA	0.2%
Cumberland County UA	0.0%
Logan Township MUA	0.0%

2. DO Stress Reduction in FMA

PS Name	Weighted DeltaDO Volume (m^3 at Δ1 mg/L)
PWD Southwest	3.16E+08
Camden County MUA	1.38E+08
PWD Southeast	7.92E+07
PWD Northeast	7.80E+07
City of Wilmington	6.98E+07
Hamilton TWP WPCF	5.24E+07
Gloucester County UA	4.45E+07
Lower Bucks County JMA	1.71E+07
Trenton SU	1.10E+07
Morrisville BMA	8.68E+06
Cinnaminson SA	2.69E+06
City of Millville STA	1.95E+06
Delcora	4.73E+04
Florence Township STP	3.87E+01
Willingboro WPCP*	0.00E+00
Penns Grove SA	0.00E+00
Beverly SA	0.00E+00
Cumberland County UA	0.00E+00
Logan Township MUA	0.00E+00

3. Total Volume w/ DO Increase

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Sequential Testing of Ranked Discharges in 3D

- Class A'
  - **Direct** impact on low DO in FMA
  - DO is **sensitive** to ammonia level

  → The biggest low DO response is located *within* the FMA. (The discharge is within the FMA.)

- Class A
  - **Indirect** impact on low DO in FMA
  - DO is **less sensitive** to ammonia level

  → Low DO within the FMA is impacted, but the biggest DO response is located *outside of* the FMA. (The discharge is upstream of the FMA.)

- Class B
  - No measurable impact on low DO in FMA

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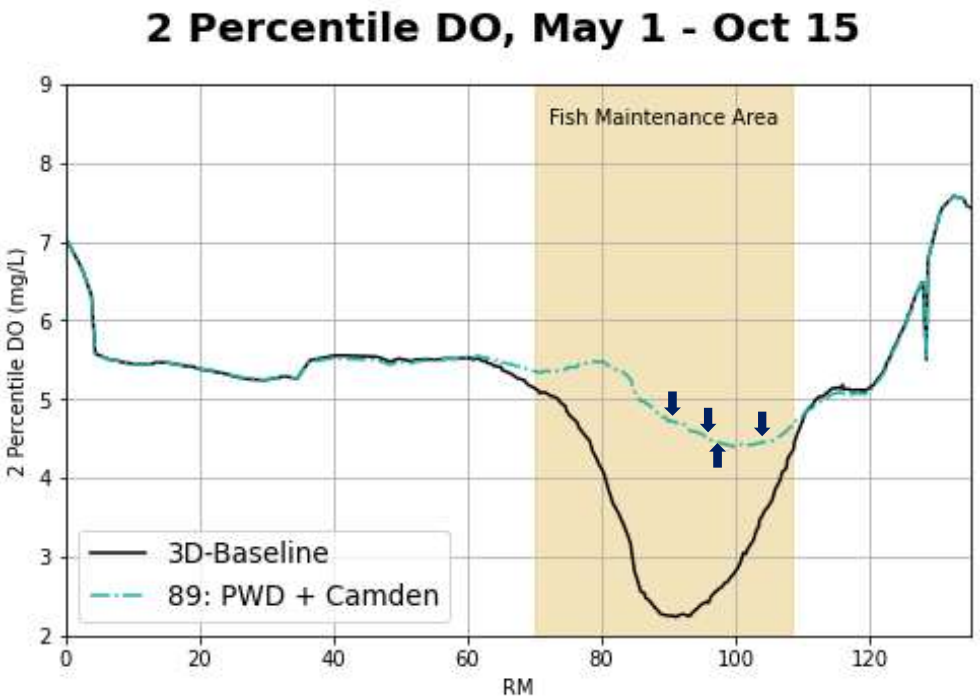
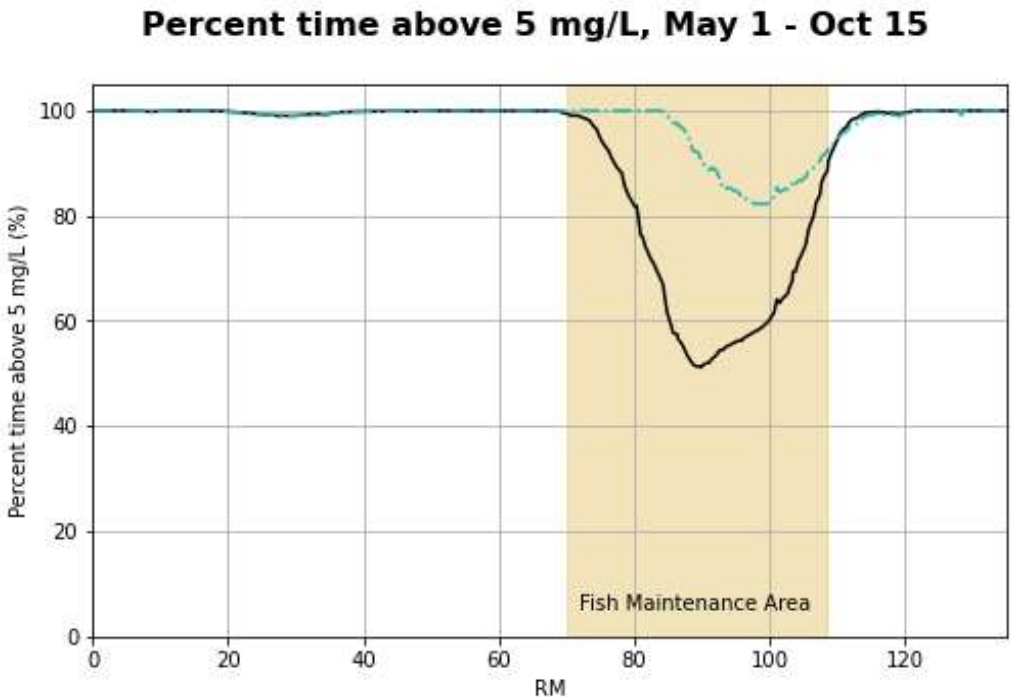
Reducing **PWD** and **CCMUA** to NH4-N = 1.5 mg/L has a significant impact on low DO





Class A' discharges **= Direct impact** on low DO in FMA

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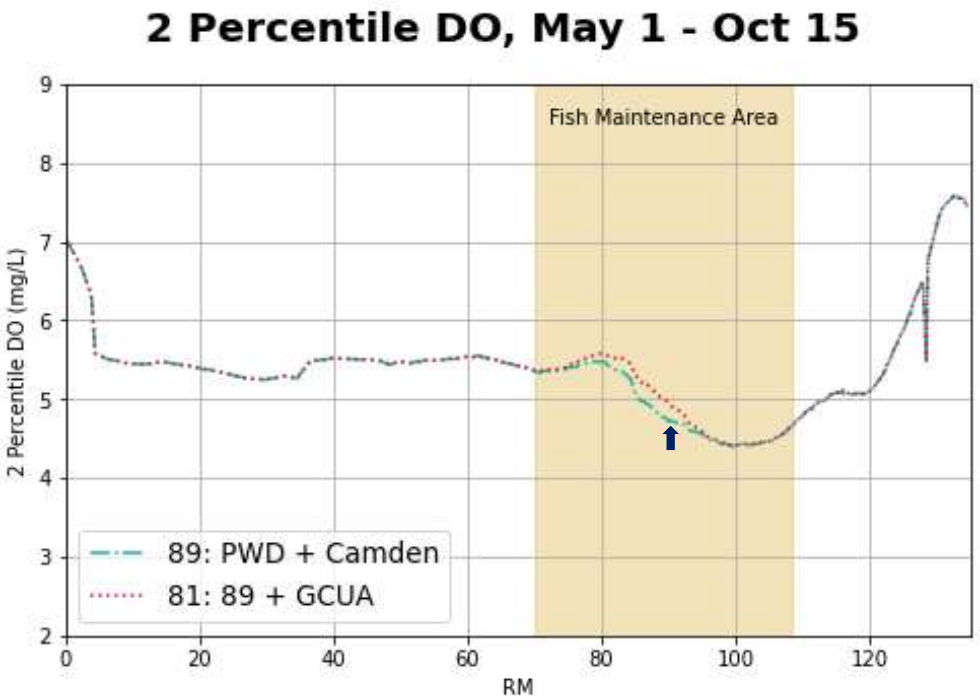
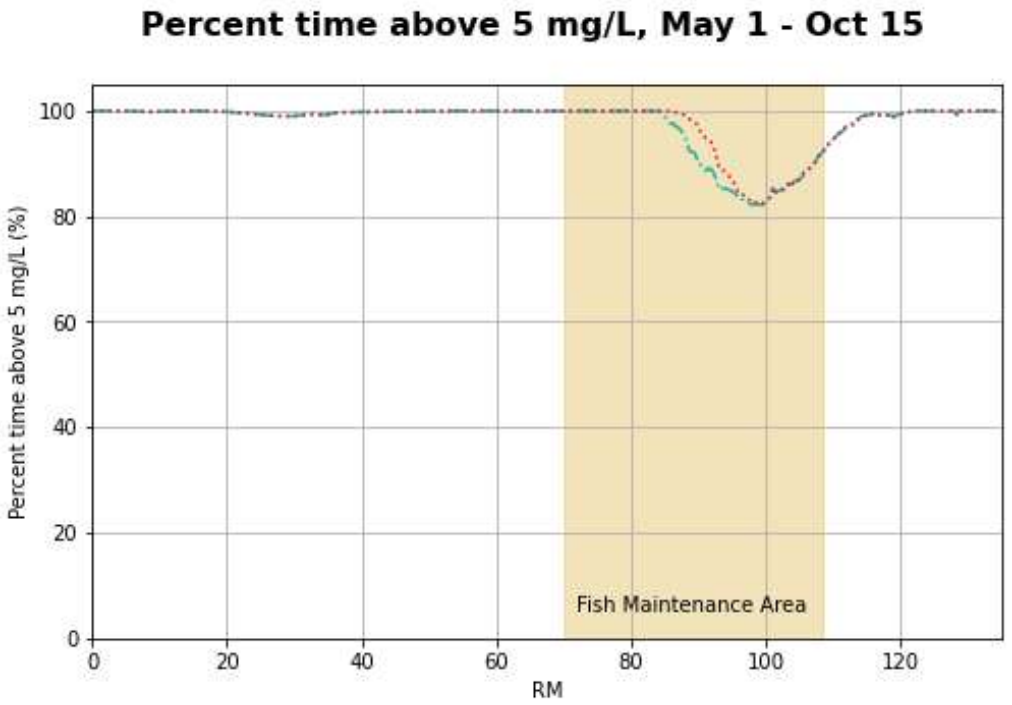
Adding **GCUA** (NH4-N = 1.5 mg/L) has a smaller, but still significant, impact on low DO





Class A' discharges **= Direct impact** on low DO in FMA

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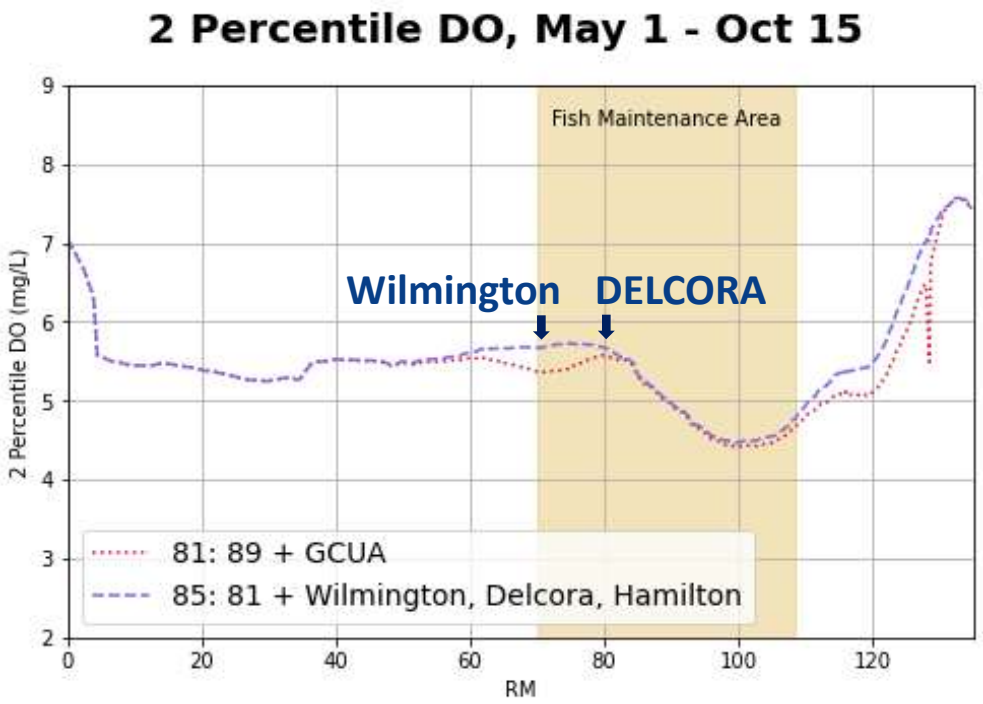
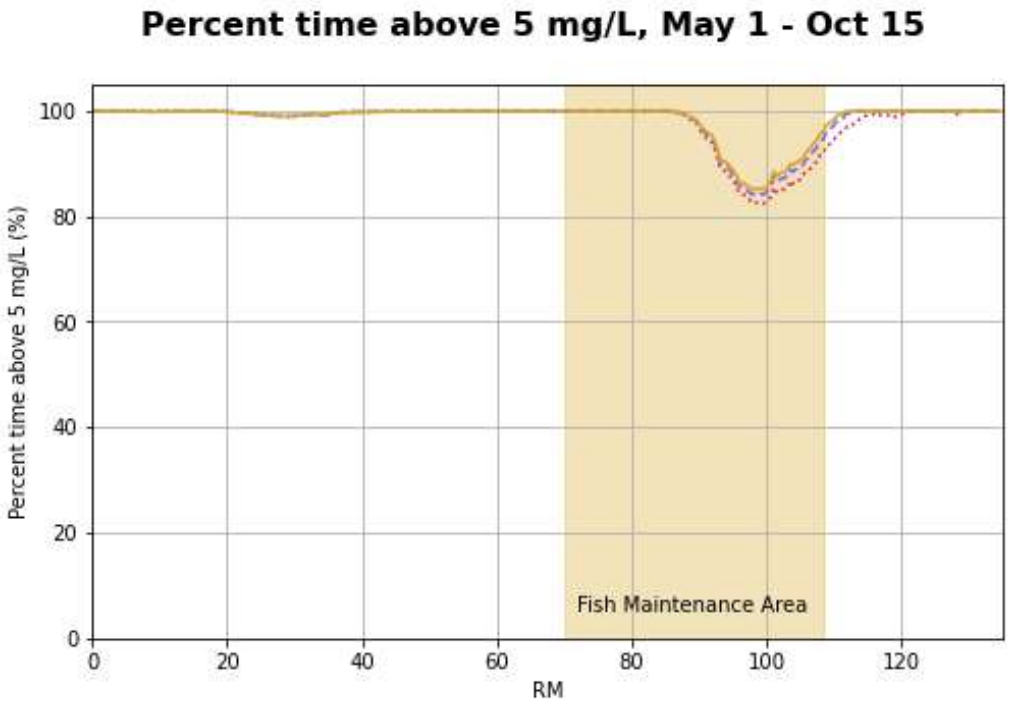
Adding **Wilmington** and **DELCORA** (NH4-N = 1.5 mg/L) has a significant impact on low DO in the FMA





Class A' discharges **= Direct impact** on low DO in FMA

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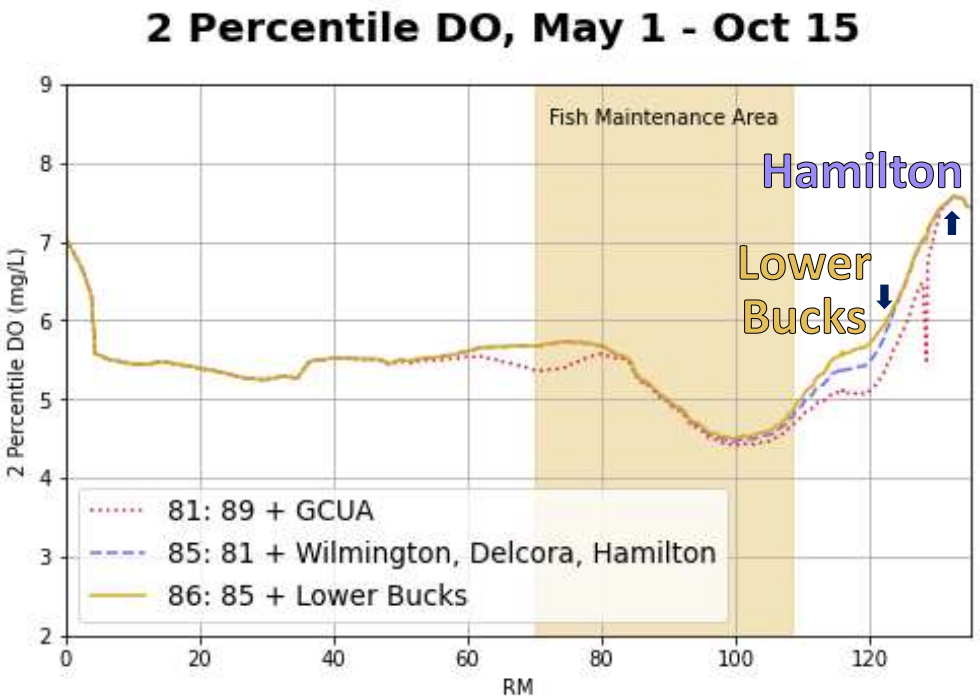
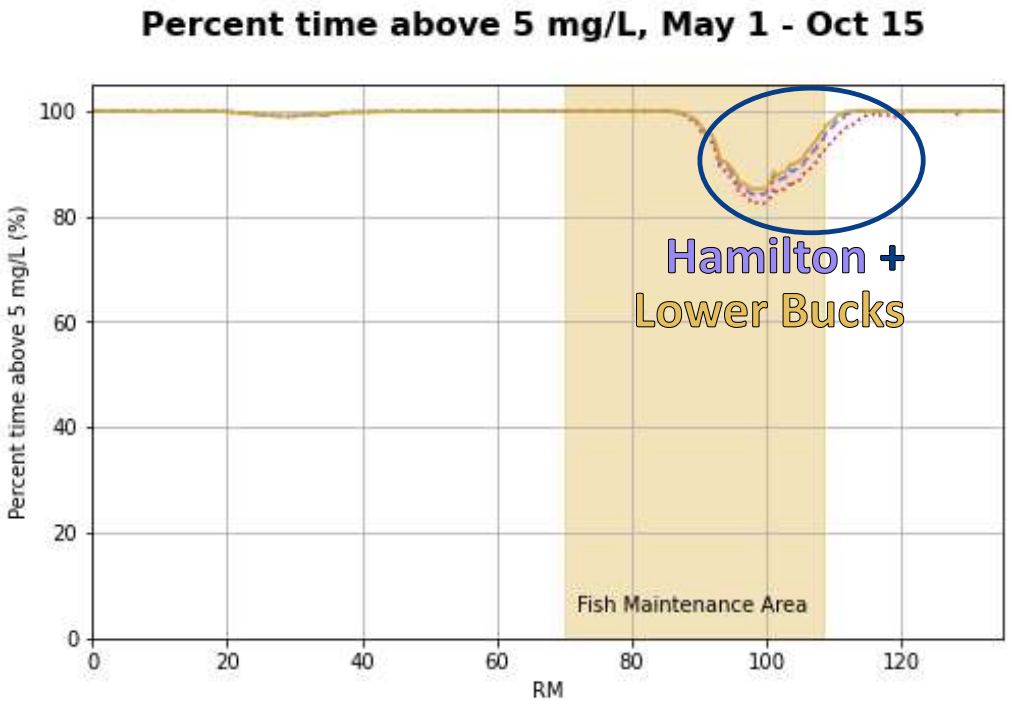
Adding **Hamilton** and **Lower Bucks** (NH4-N = 1.5 mg/L): Impacts to low DO carry downstream into the FMA





Class A discharges = **Indirect** impact on low DO in FMA

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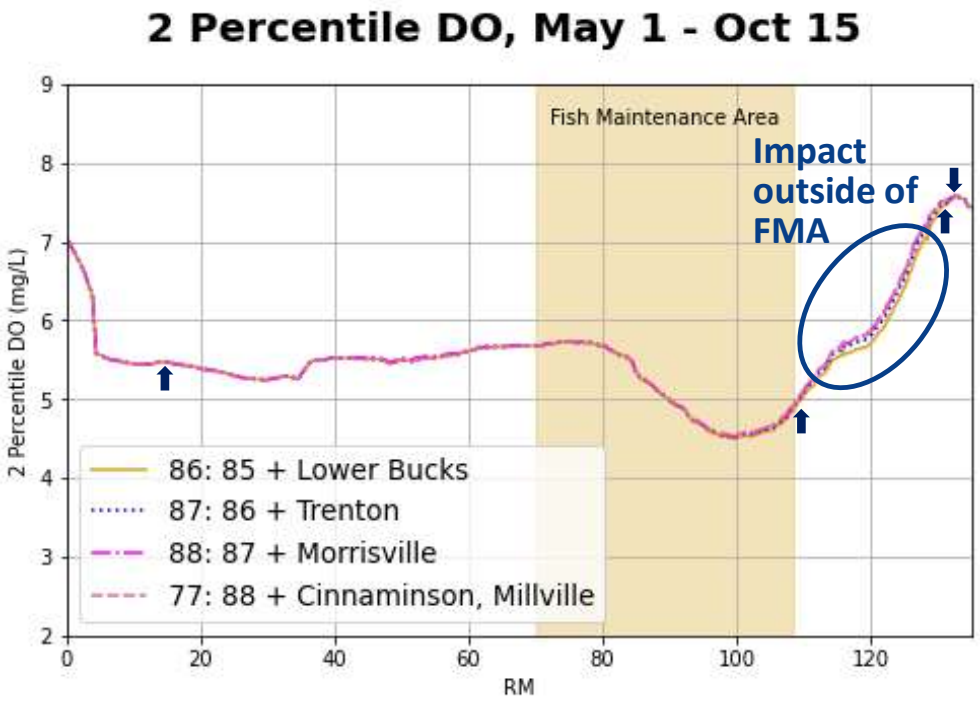
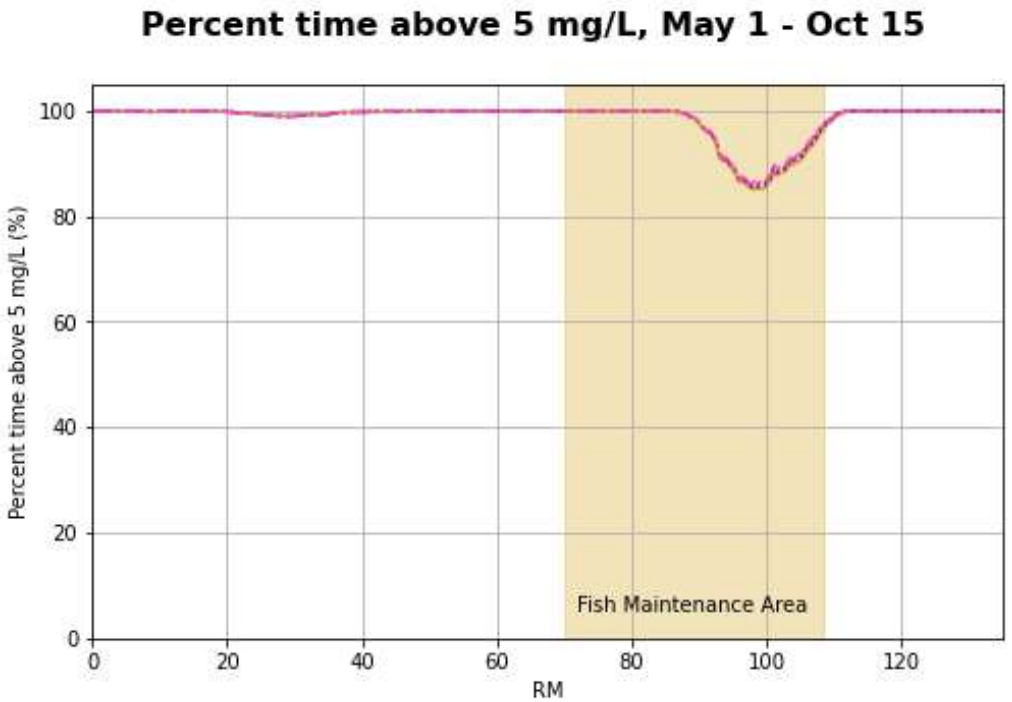
Adding **Trenton, Morrisville, Cinnaminson, Millville**: Impacts to low DO occur only upstream of FMA





Class B discharges **= No measurable impact** on low DO in FMA

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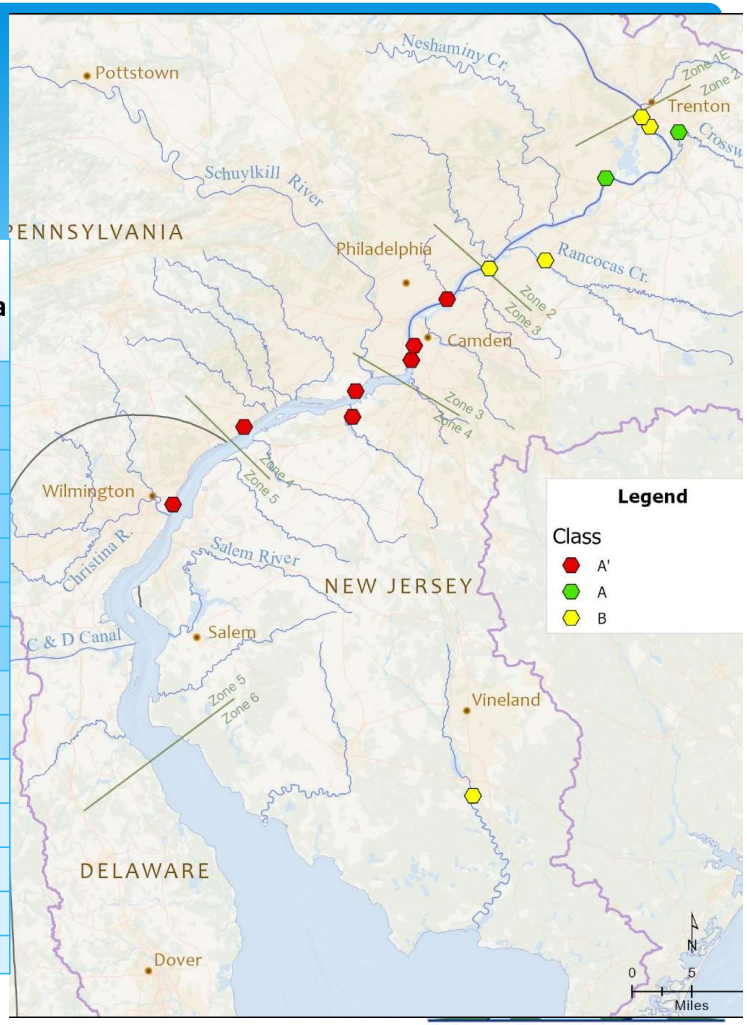
Discharges by Class

Class	Discharge Name	NPDES # Outfall #	ZONE	River Mile	Permitted Flow (MGD)	Effluent Ammonia (mg/L)
A'	PWD Northeast	PA0026689-001	3	103.9	210	4.4
	Camden County MUA	NJ0026182-001A	3	97.9	80	17.3
	PWD Southeast	PA0026662-001	3	96.7	112	8.6
	PWD Southwest	PA0026671-001	4	90.7	200	19.0
	GCUA	NJ0024686-001A	4	89.9	27	23.9
	DELCORA	PA0027103-001	4	80.4	70	3.8
	City of Wilmington	DE0020320-001	5	71.6	134	9.5
A	Hamilton TWP WPCF	NJ0026301-001A	2	128.4	16	27.0
	Lower Bucks County JMA	PA0026468-001	2	121.9	10	19.7
B	Morrisville Borough Municipal Authority	PA0026701-201	2	132.5	7.1	9.7
	Trenton Sewer Utility	NJ0020923-001A	2	131.8	20	5.4
	Willingboro Water Pollution Control Plant	NJ0023361-001A	2	111.4	5.22	1.4
	Cinnaminson Sewerage Authority	NJ0024007-001A	2	108.7	2	16.0
	City of Millville Sewage Treatment Authority	NJ0029467-001A	6	15.2	5	26.2



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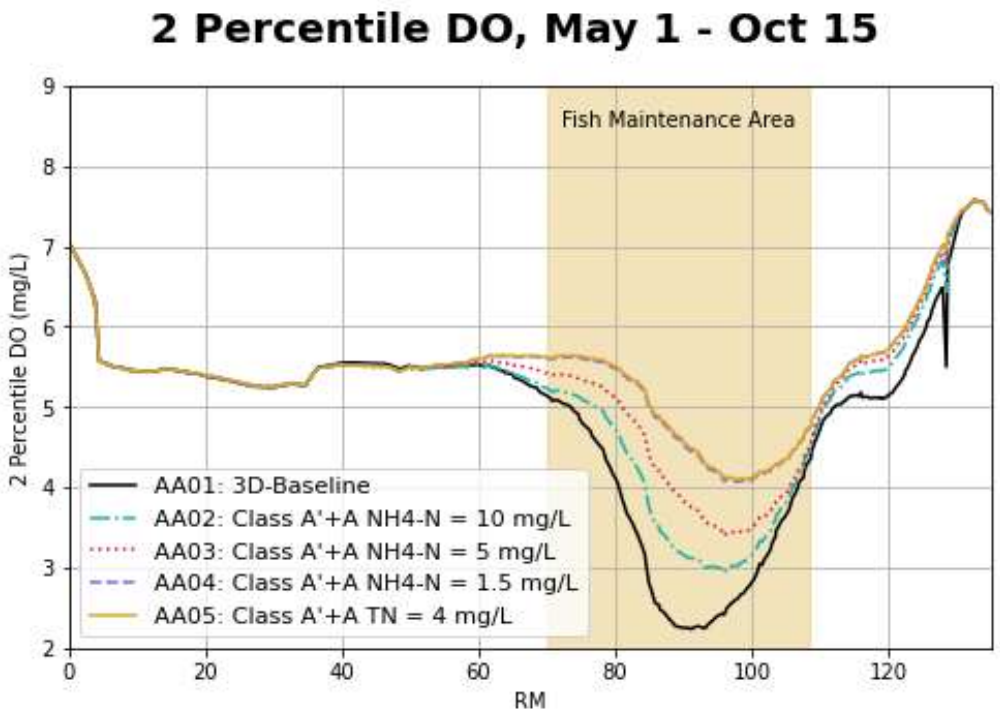
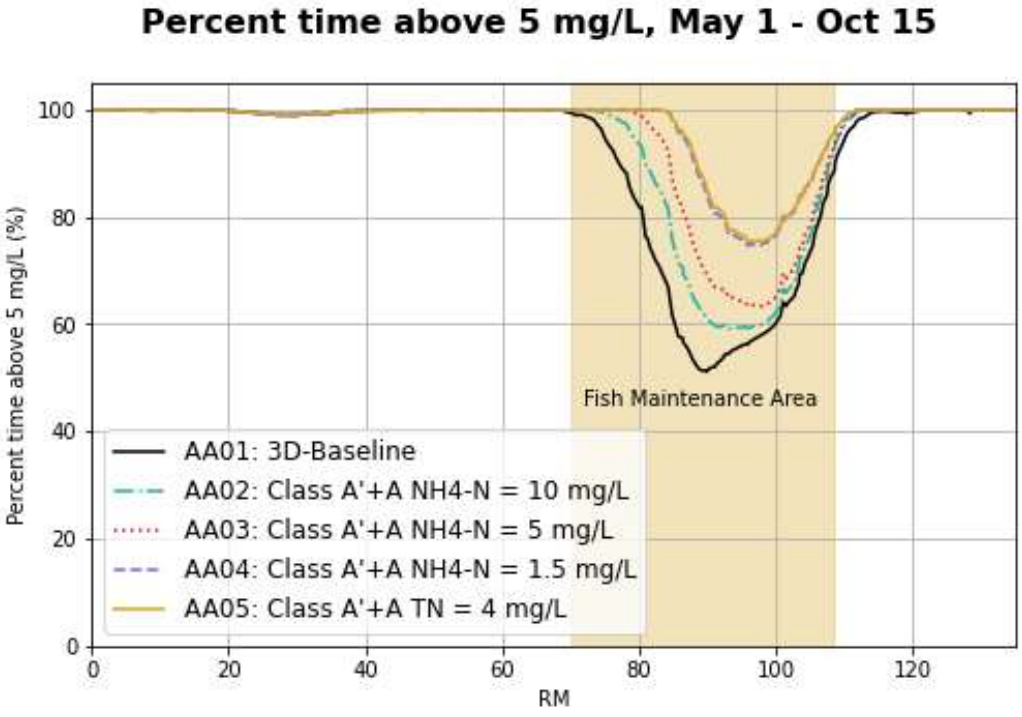
Attainability Analysis Scenarios (3D)

- Baseline design condition represents protection of existing water quality / uses
- Scenarios differ ONLY in:
  - Effluent concentrations
    - NH4-N, CBOD, NO3-N, and DO were adjusted when baseline (seasonal median) NH4-N > scenario cap
    - Constant value for May through October
  - Which classes were assigned reduced NH4-N
- Other characteristics held the same
  - CSOs unchanged from baseline
  - When effluent NH4-N was reduced, DO set to 2 mg/L or existing permit limit
  - Reserve capacity not included

Scenario	Description
AA01	3D Baseline (Current conditions)
AA02	Class A' + A: Summer NH4-N ≤ 10 mg/L
AA03	Class A' + A: Summer NH4-N ≤ 5.0 mg/L
AA04	Class A' + A: Summer NH4-N = 1.5 mg/L
AA05	Class A' + A: Summer TN ≤ 4.0 mg/L
AA06	All Tier 1: Summer NH4-N = 1.5 mg/L
AA07	Class A' only: Summer NH4-N = 1.5 mg/L
AA08	Class A': Summer NH4-N = 1.5 mg/L; Class A: Summer NH4-N = 5 mg/L
AA10	Class A': Summer NH4-N = 1.5 mg/L; Class A: Summer NH4-N = 10 mg/L

Baseline (AA01) Compared with Scenarios AA02–05
Class A’ & Class A NH4-N ≤ 10, 5, 1.5 & TN ≤ 4 mg/L





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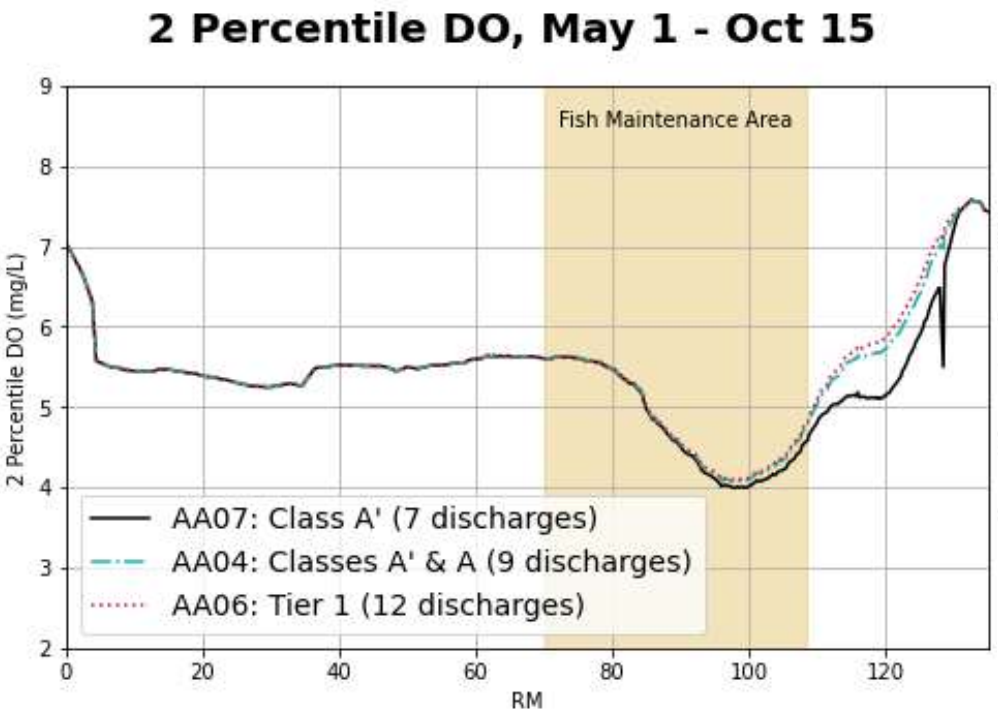
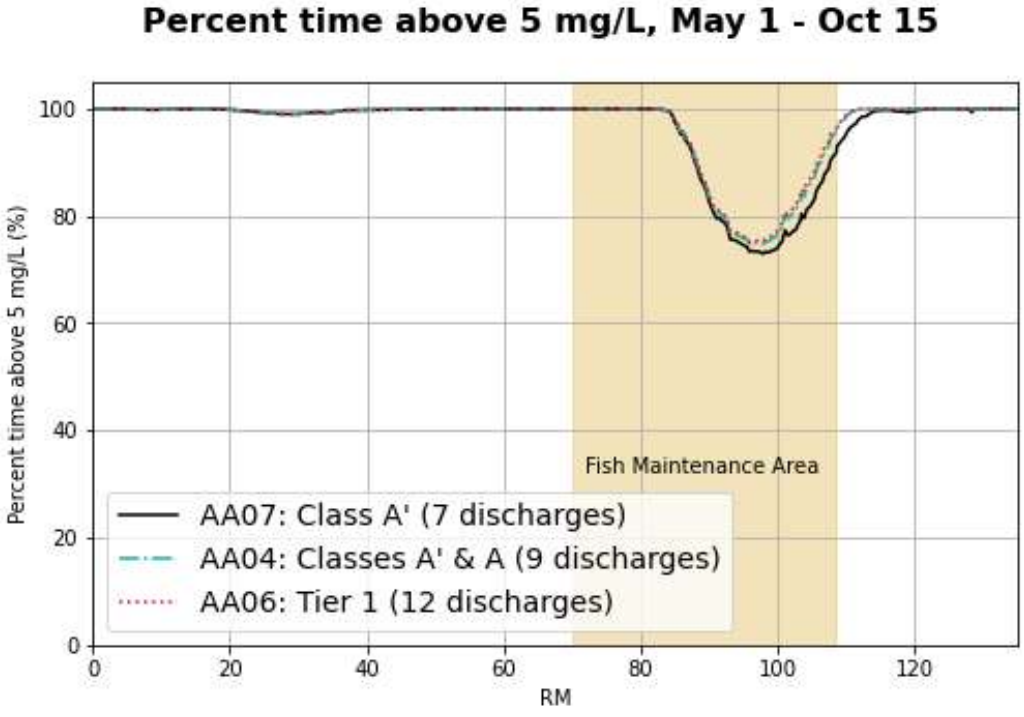
NH4-N = 1.5 mg/L
Class A', Class A'+A, or Tier 1





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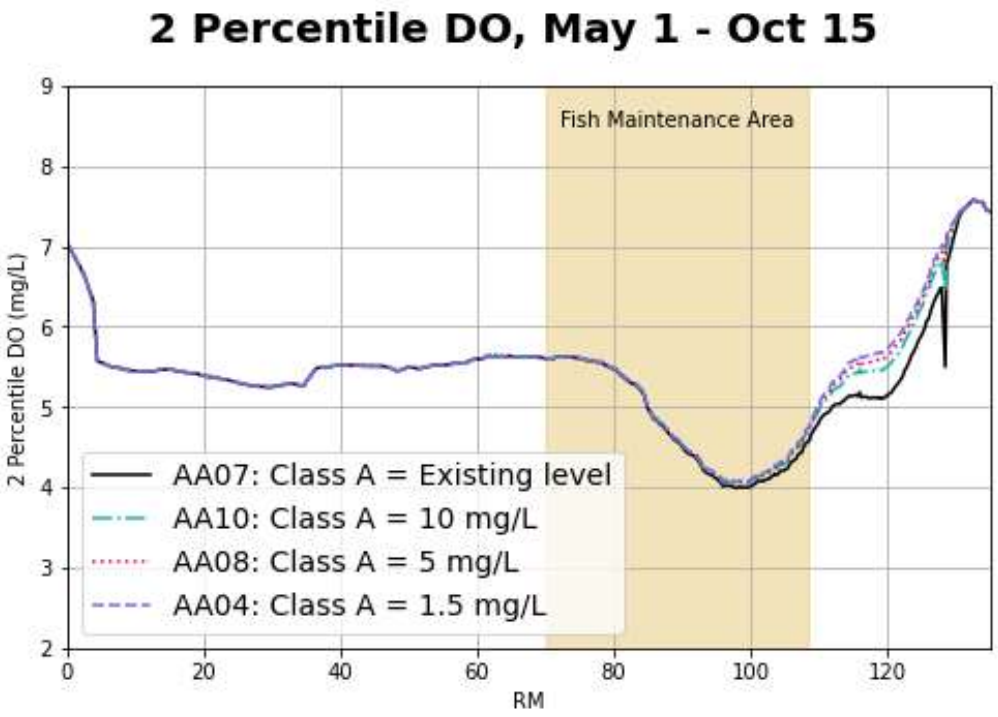
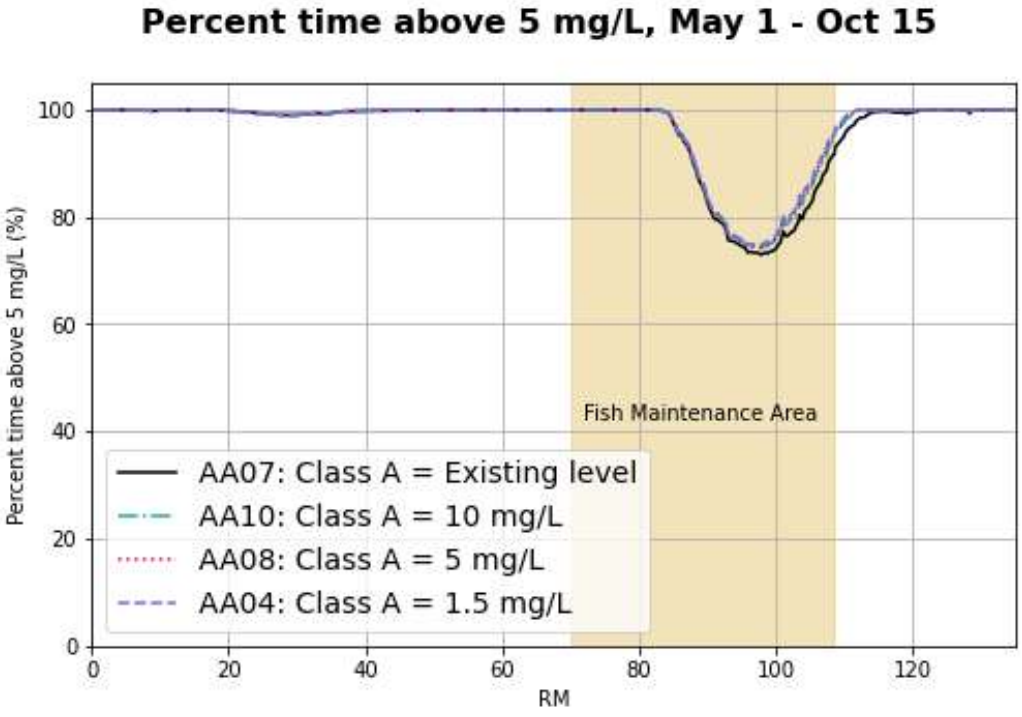
Class A' NH4-N = 1.5 mg/L
Class A NH4-N = Existing level, 10, 5, or 1.5 mg/L





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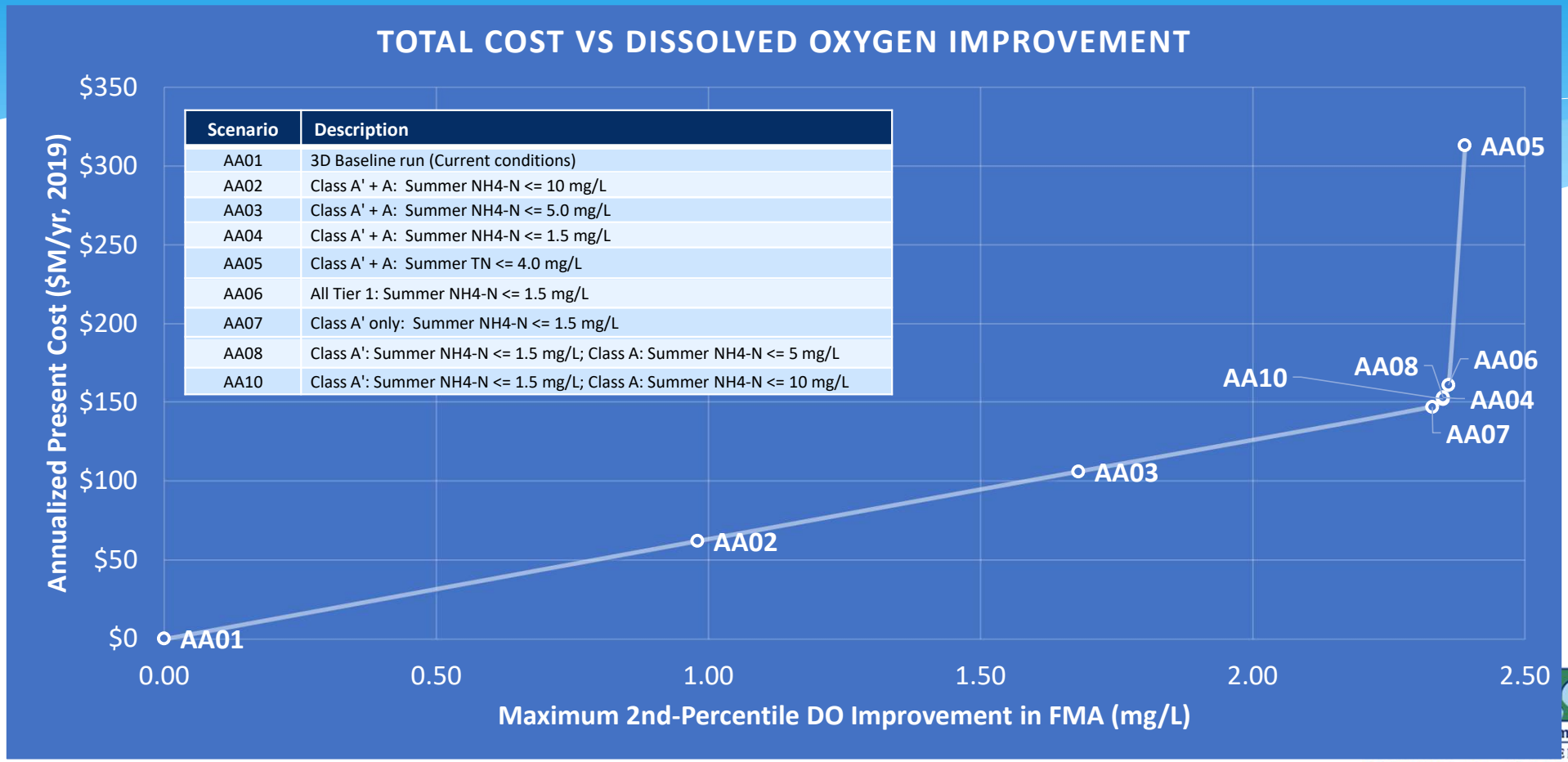
Cost vs DO Improvement Analysis



Scenario	Description
AA01	3D Baseline run (Current conditions)
AA02	Class A' + A: Summer NH4-N <= 10 mg/L
AA03	Class A' + A: Summer NH4-N <= 5.0 mg/L
AA04	Class A' + A: Summer NH4-N <= 1.5 mg/L
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AA06	All Tier 1: Summer NH4-N <= 1.5 mg/L
AA07	Class A' only: Summer NH4-N <= 1.5 mg/L
AA08	Class A': Summer NH4-N <= 1.5 mg/L; Class A: Summer NH4-N <= 5 mg/L
AA10	Class A': Summer NH4-N <= 1.5 mg/L; Class A: Summer NH4-N <= 10 mg/L

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Cost vs DO Improvement

Scenario	Description
AA04	Class A' + A: Summer NH4-N <= 1.5 mg/L
AA06	All Tier 1: Summer NH4-N <= 1.5 mg/L
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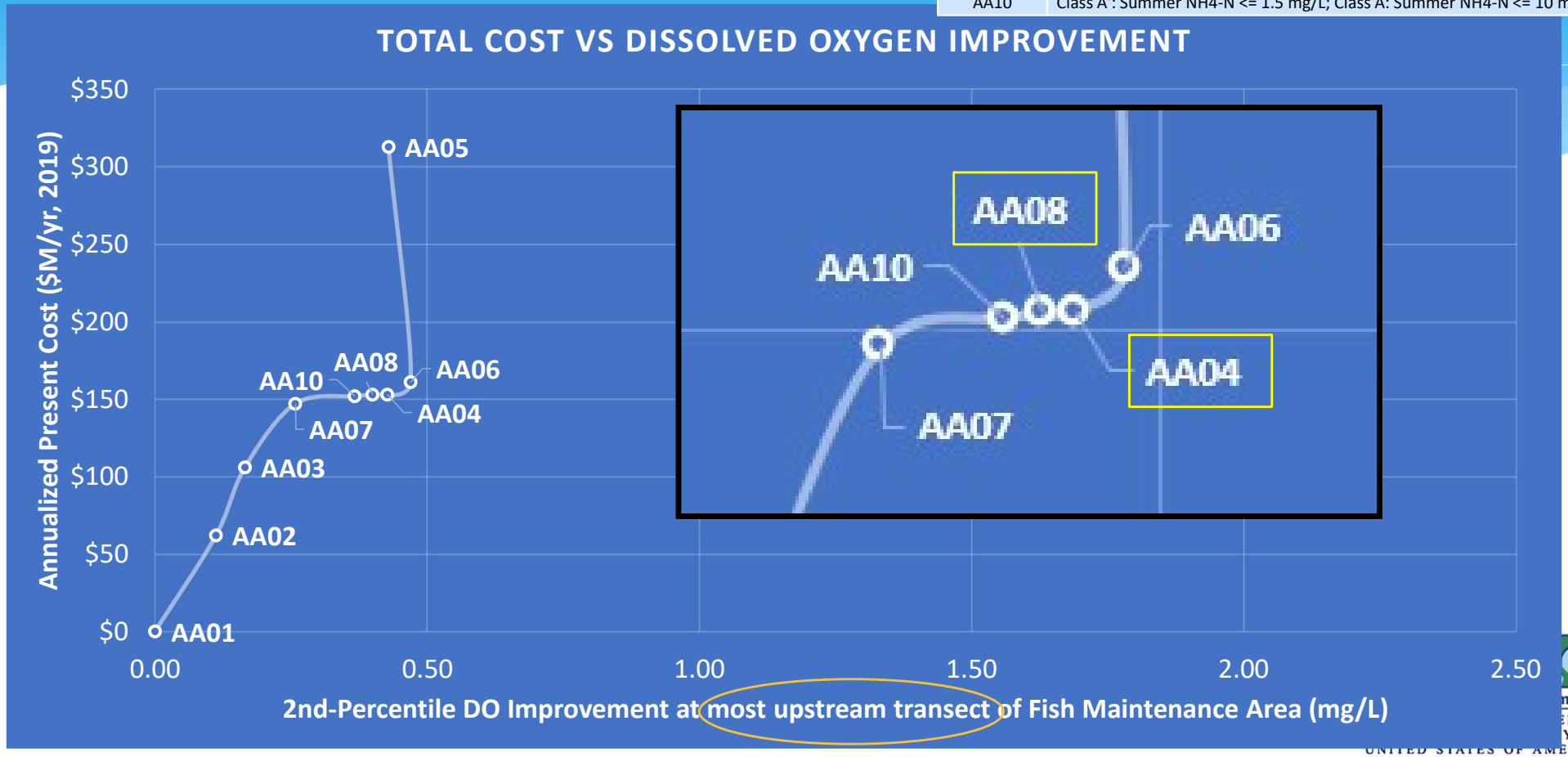

Break
up next … HADO discussion

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Preliminary HADO* Condition (AA15)

*Highest Attainable Dissolved Oxygen

- Scenario AA08
  - 7 Class A' at ammonia = 1.5 mg/L
  - 2 Class A at ammonia = 5 mg/L
  - Effluent DO = 2 mg/L
  - Associated nitrate and CBOD adjustments
- Plus:
  - CSO reductions (based on LTCP)
  - Effluent DO = 4 mg/L for all 9 dischargers
  - Seasonally variable wastewater concentrations
  - 10% Reserve Capacity
- HADO condition expected to support both maintenance and propagation
  - Minimum DO will increase from 2.2 to 4.5 mg/L
  - Significant increase in time over 5, 6, and 7 mg/L

CSO Reductions to reflect LTCP

Post-LTCP (% reduction)	"Typical Year"
PWD	55%
CCMUA	59%
Delcora	51%
Wilmington	0%

Seasonal ammonia variations

Simulated ammonia in May and October	1.5	5.0
5/6 * Scenario in June and Sept	1.25	4.17
4/6 * Scenario in July and August	1.00	3.33
1.5 * Scenario in April	2.25	7.50

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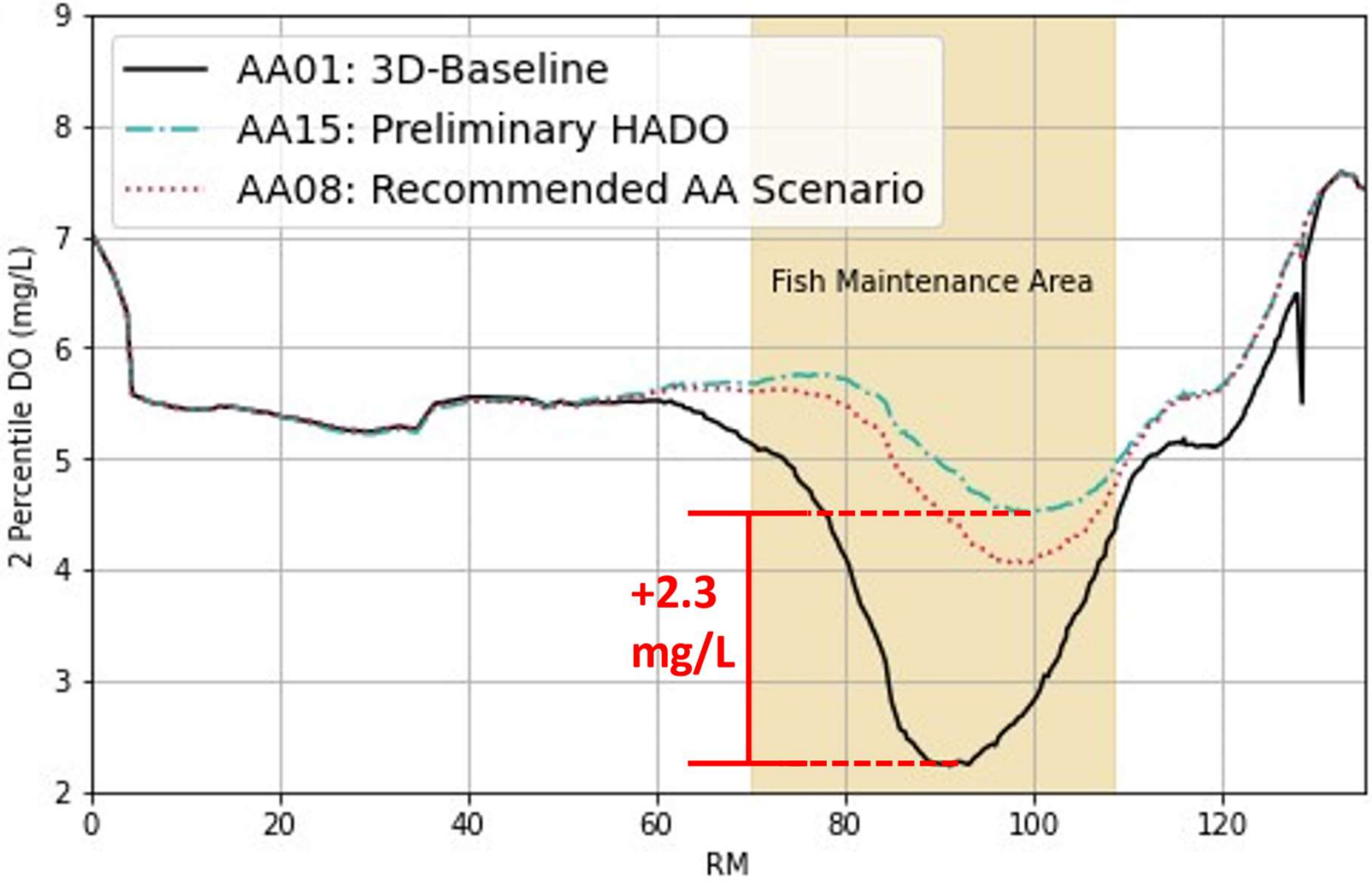
2 Percentile DO, May 1 - Oct 15



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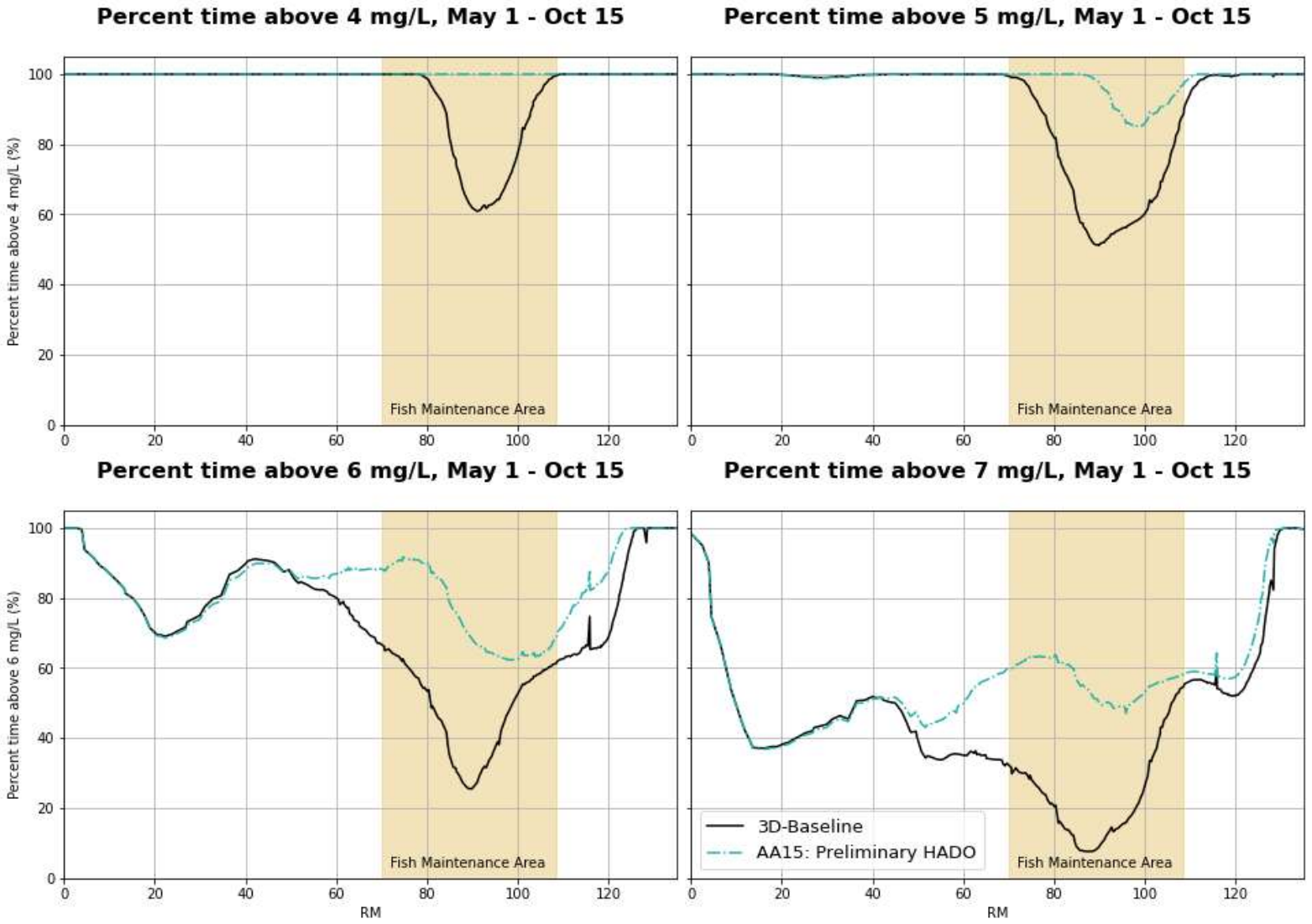

Preliminary HADO* Condition (AA15)

*Highest Attainable Dissolved Oxygen

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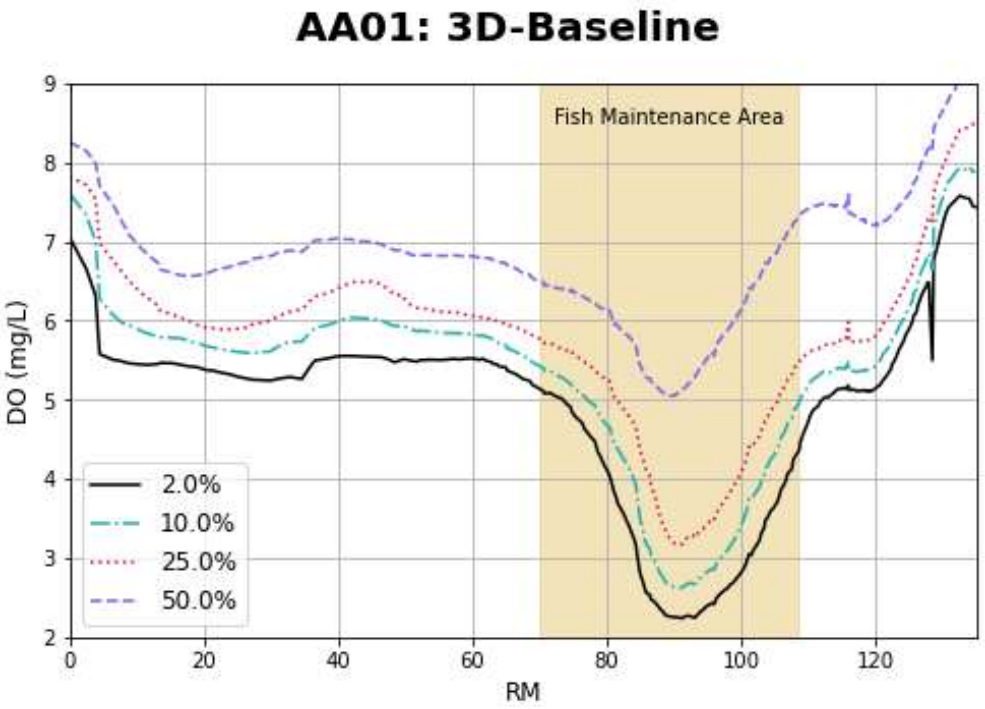

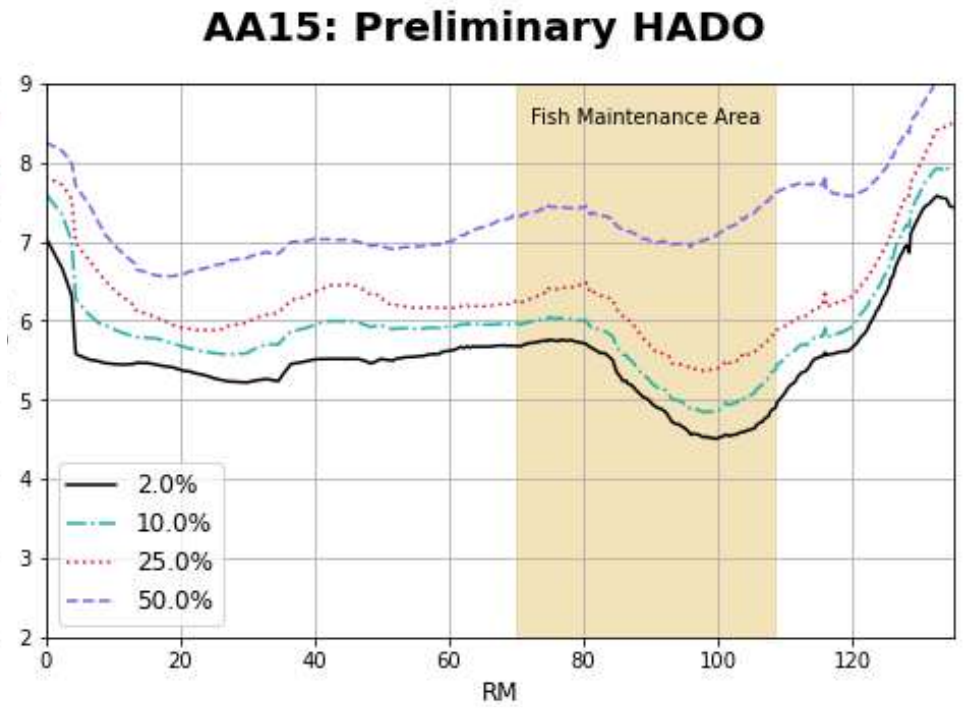

Percentile	Min value in FMA	
	AA01	AA15
2	2.2 mg/L	4.5 mg/L
10	2.6 mg/L	4.8 mg/L
25	3.2 mg/L	5.4 mg/L
50	5.0 mg/L	7.0 mg/L

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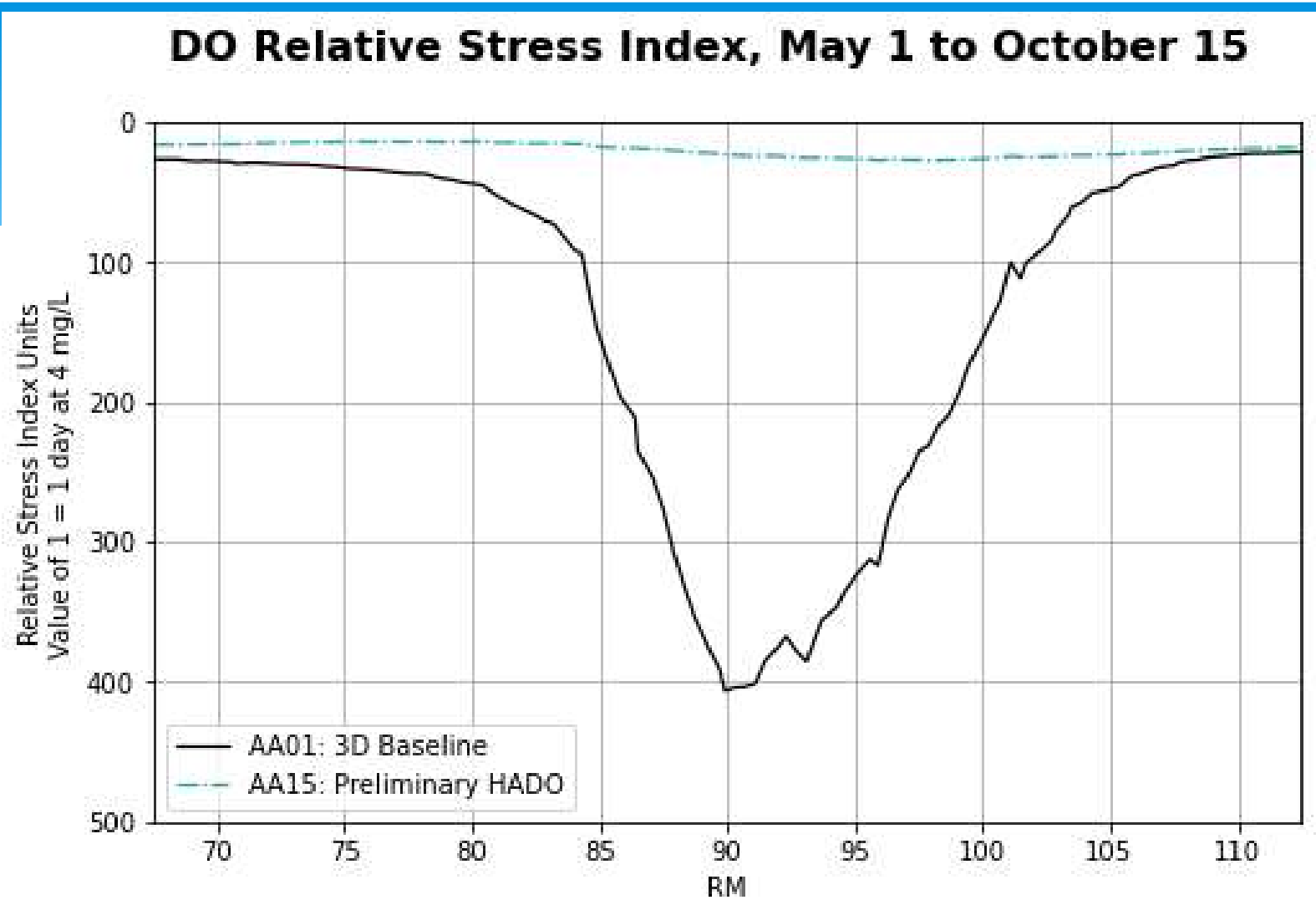

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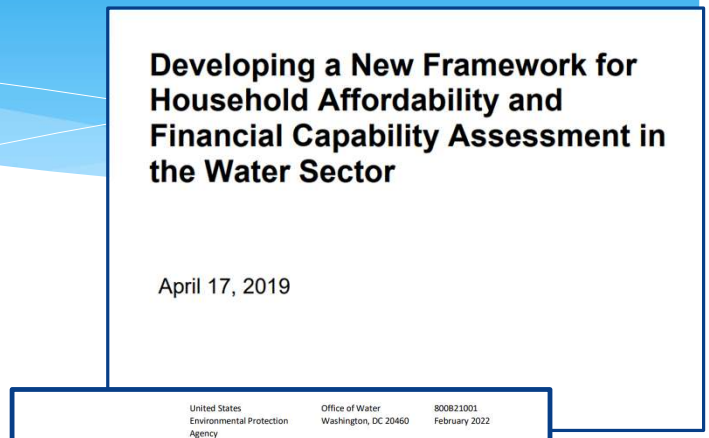
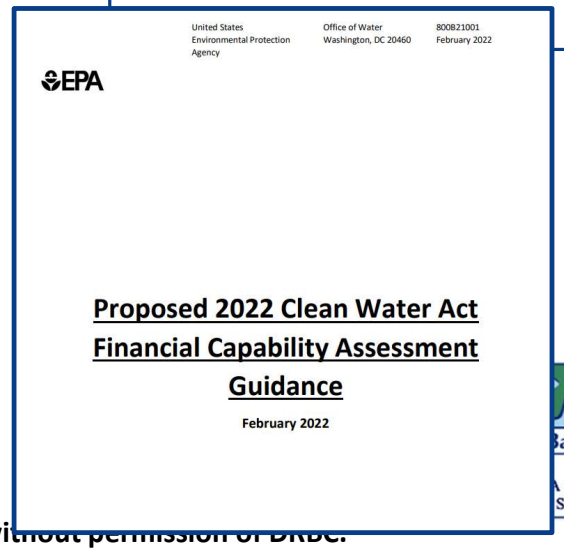
Overview of Affordability Methodology

- Computed metrics from:
  - EPA Financial Capability Assessment Guidance (2022)
  - Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector (AWWA et al.)
- Cost estimates for Tier 1 facilities at 10, 5, 1.5 mg/L Ammonia & 4 mg/L TN from Kleinfelder report
- US Census data tables by tract
- Tech review by Environmental Finance Center, University of Maryland
- Briefed WQAC on 5/18/2022
- Individual utility meetings with PWD, CCMUA, Wilmington, DELCORA
- Draft report as part of Analysis of Attainability package (Sept 30)





Does the scenario indicate a higher affordability burden category than the baseline?

Utility Name	AA02	AA03	AA04	AA05	AA06	AA07	AA08
CCMUA	No	No	No	No	No	No	No
City of Trenton	No	No	No	No	No	No	No
DELCORA	No	No	No	No	No	No	No
GCUA	No	No	No	No	No	No	No
Hamilton Twp WPCF	No	No	No	No	No	No	No
LBCJMA	No	No	No	No	No	No	No
Morrisville	No	No	No	No	Yes	No	No
PWD	No	No	No	Yes	No	No	No
Willingboro WPCF	No	No	No	No	Yes	No	No
Wilmington	No	No	No	No	No	No	No

Summary of Household Affordability (HA) and Residential Indicator (RI) metrics

Utility Name	Metric	AA01	AA02	AA03	AA04	AA05	AA06	AA07	AA08
CCMUA	HA	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
	RI	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
City of Trenton	HA	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden
	RI	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
DELCORA	HA	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
	RI	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
GCUA	HA	Low Burden	Low Burden	Low Burden	Low Burden	Low-Burden	Low Burden	Low Burden	Low Burden
	RI	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Hamilton Twp WPCF	HA	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
	RI	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
LBCJMA	HA	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
	RI	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Morrisville	HA	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
	RI	LOW	LOW	LOW	LOW	LOW	MID-RANGE	LOW	LOW
PWD	HA	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden
	RI	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	HIGH	MID-RANGE	MID-RANGE	MID-RANGE
Willingboro WPCF	HA	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
	RI	LOW	LOW	LOW	LOW	LOW	MID-RANGE	LOW	LOW
Wilmington	HA	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
	RI	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE

Progress Summary

- ✓ Pre-rulemaking studies have been completed as required under Resolution 2017-04
- ✓ A large-scale 3D eutrophication model has been developed, calibrated, and successfully utilized to evaluate potential dissolved oxygen improvement scenarios
  - ➢ Based on state-of-the-art hydrodynamic, water quality, and loading models
- ✓ Extensive analyses performed to identify management scenarios that will achieve the highest attainable DO (HADO) condition
- ✓ Planning level capital and operations costs have been developed
- ✓ Key affordability indicators to characterize the burden to individual discharger service areas have been developed

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Draft Findings

- Factors that can improve DO in the FMA
- Recommended Wastewater Improvements
- Socio-economic evaluation results
- Expected water quality improvement

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Draft Findings
Factors that can improve DO in the FMA

1) Factors that can most improve DO in the FMA
   - "Summer" ammonia loads from specific domestic wastewater treatment plants
2) Factors that can slightly improve DO in the FMA
   - Combined sewer overflows
   - Dissolved oxygen concentration in treated effluent from the largest discharges
3) Factors that cannot measurably improve DO in the FMA
   - Nutrient (carbon, nitrogen, and phosphorus) loads from tributaries (non-tidal inputs)
     - Includes upstream Delaware River at Trenton and Schuylkill River
   - Certain point source discharge loads: carbon; "winter" ammonia; and total nitrogen
     - Discharge of nitrate instead of ammonia does not change the phytoplankton dynamics and maintains same level of DO
   - Direct stormwater and runoff into the Estuary

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Draft Findings
Recommended Wastewater Improvements

1) Ammonia Reductions
   - Targeted reductions from 9 out of the 67 discharges to the Delaware Estuary
     - Ammonia ≤ 1.5 mg/L (7 discharges)
       - PA: Philadelphia Water Dept (3 discharges) and DELCORA
       - NJ: Camden County MUA, Gloucester County UA
       - DE: City of Wilmington
     - Ammonia < 5 mg/L OR 1.5 mg/L (2 discharges)
       - PA: Lower Bucks County JMUA
       - NJ: Hamilton Township
2) Other Conditions
   - Effluent dissolved oxygen
     - Likely recommend ≥ 4 mg/L or 5 mg/L for 6 largest discharges (>50 MGD)
       - DELCORA already has effluent DO limit of 4 mg/L
     - Cost and feasibility study being amended to include DO for these 6 plants
   - Assumes implementation of CSO LTCPs

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Draft Findings
Socio-economic Evaluation Results

1) Cost
   - Estimated annualized present costs for recommended wastewater improvements = $153M /year in 2019 $ (annualized present worth cost + annual O&M)
   - Total Present Worth Cost = $2.6 B in 2019 $
   - Includes capital costs as well as operating and maintenance at the 9 impacted plants
   - Does not include cost to achieve 4 (or 5) mg/L DO in the discharge effluent
     - Costs will be updated following further engineering feasibility and cost analyses
2) Affordability
   - Estimated costs do not change the burden category for either affordability burden metric - Household Affordability (HA) and Residential Indicator (RI) - for the impacted service areas
   - Additional state and federal programs can impact, support, and mitigate affordability
3) Water quality improvements are expected to provide other socio-economic benefits outside the scope of the Resolution 2017-04 studies
   - Commission is expected to accept input on these benefits during the rulemaking phase

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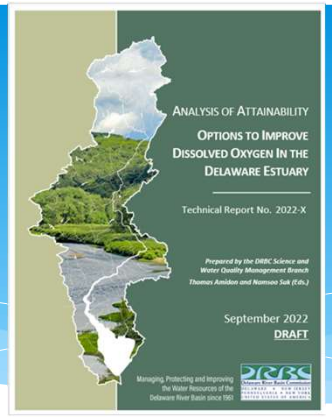
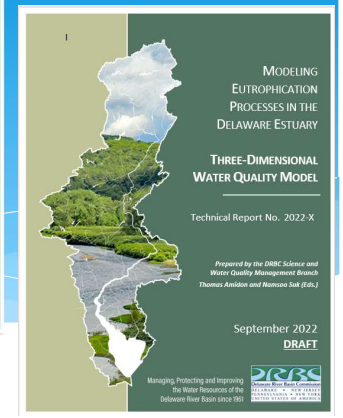
DRAFT FINDINGS
Expected Water Quality Improvement

1) Dissolved oxygen improvement under design condition:
   a) Minimum DO in the FMA will improve by about 2.3 mg/L
   b) Significant DO improvement in FMA both temporally and spatially
2) Inclusion of propagation as a designated use in Zones 3 and 4 and the upper portion of Zone 5 (the "FMA") of the Delaware River Estuary appears to be attainable
3) Consistent with Resolution 2017-04, it is recommended that the Commission:
   a) Initiate rulemaking to revise aquatic life designated use and associated dissolved oxygen criteria; and
   b) Develop an implementation strategy to implement the new criteria to support the enhanced designated use

What's Next





Documentation

- Analysis of Attainability – September 30
  - Draft analysis of attainability report
- Related reports
  - Hydrodynamics model calibration report
    - Draft released to WQAC 12/2021 ; Final ASAP
  - Draft Water quality model calibration report
    - To be issued concurrently with draft AA Report
  - Draft Socioeconomic evaluation study report
    - To be issued concurrently with draft AA Report
  - Linking aquatic life uses with DO conditions
    - 2nd draft to be issued concurrently with draft AA Report or in early October

Next Steps

- Solicit input from WQAC and co-regulators on draft reports
- Implementation Strategy
  - Consideration of alternative permitting
  - Consideration of prioritizing of dischargers
- Initiation of Rulemaking Process
  - WQS development based on Analysis of Attainability (HADO)

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