The Development of Operational Tools for City-Wide Implementation of BNR in New York City

Sarah Galst, P.E.
Hazen and Sawyer, P.C.

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HAZEN AND SAWYER
Environmental Engineers & Scientists

Outline

- Background to NYC Nitrogen Programs
  - East River
  - Jamaica Bay
- BNR Training
  - SOPs
- Lessons Learned - Case Studies
  - pH
  - DO
  - TSS
    - Flow distribution
    - Wet Weather

Background to NYC Nitrogen Concerns

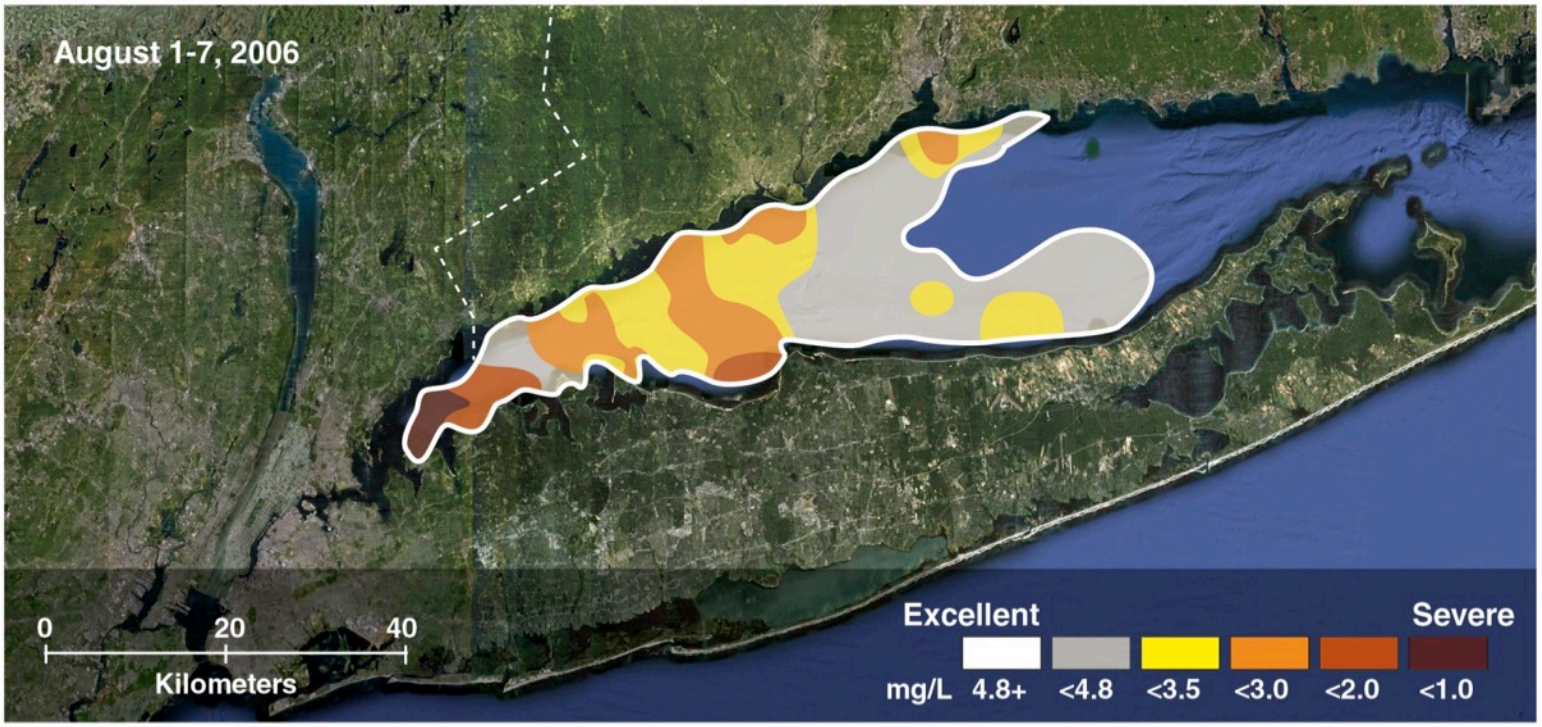
Long Island Sound Study - partnership between USEPA, NY, CT (1988)

Water quality concerns

Eutrophication

Hypoxia - Nitrogen identified as causal agent

Dissolved Oxygen in Long Island Sound Bottom Waters



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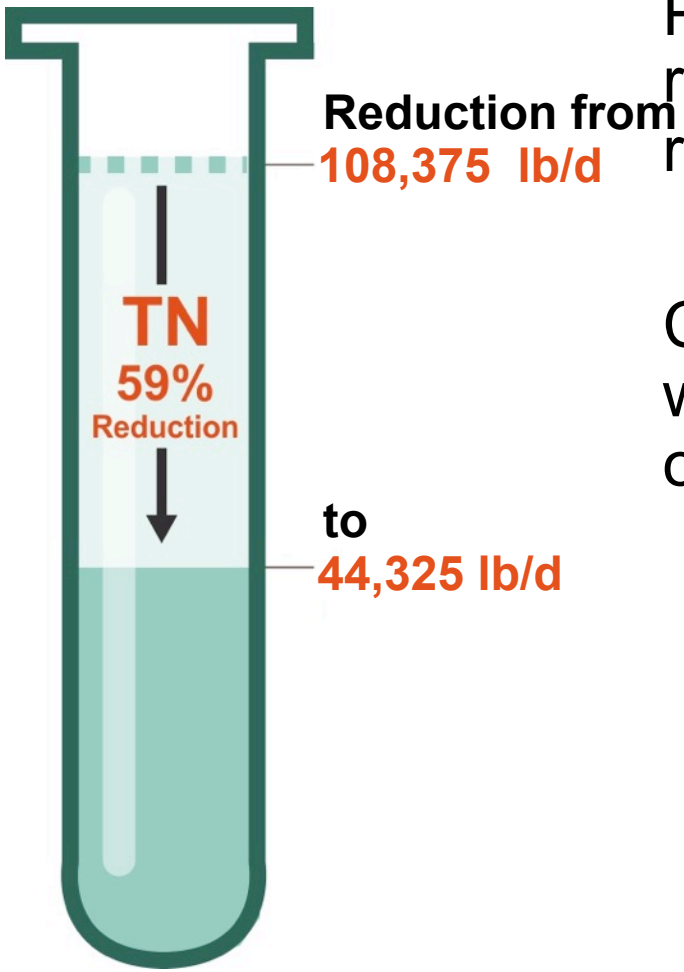


Phased approach to Nitrogen reduction to achieve an overall reduction in effluent TN of **59%**

Construction of BNR facilities for 4 wastewater treatment plants (WWTPs) on the Upper East River

Wards Island

Hunts Point

Tallman Island

Bowery Bay

4 Upper East River Plants

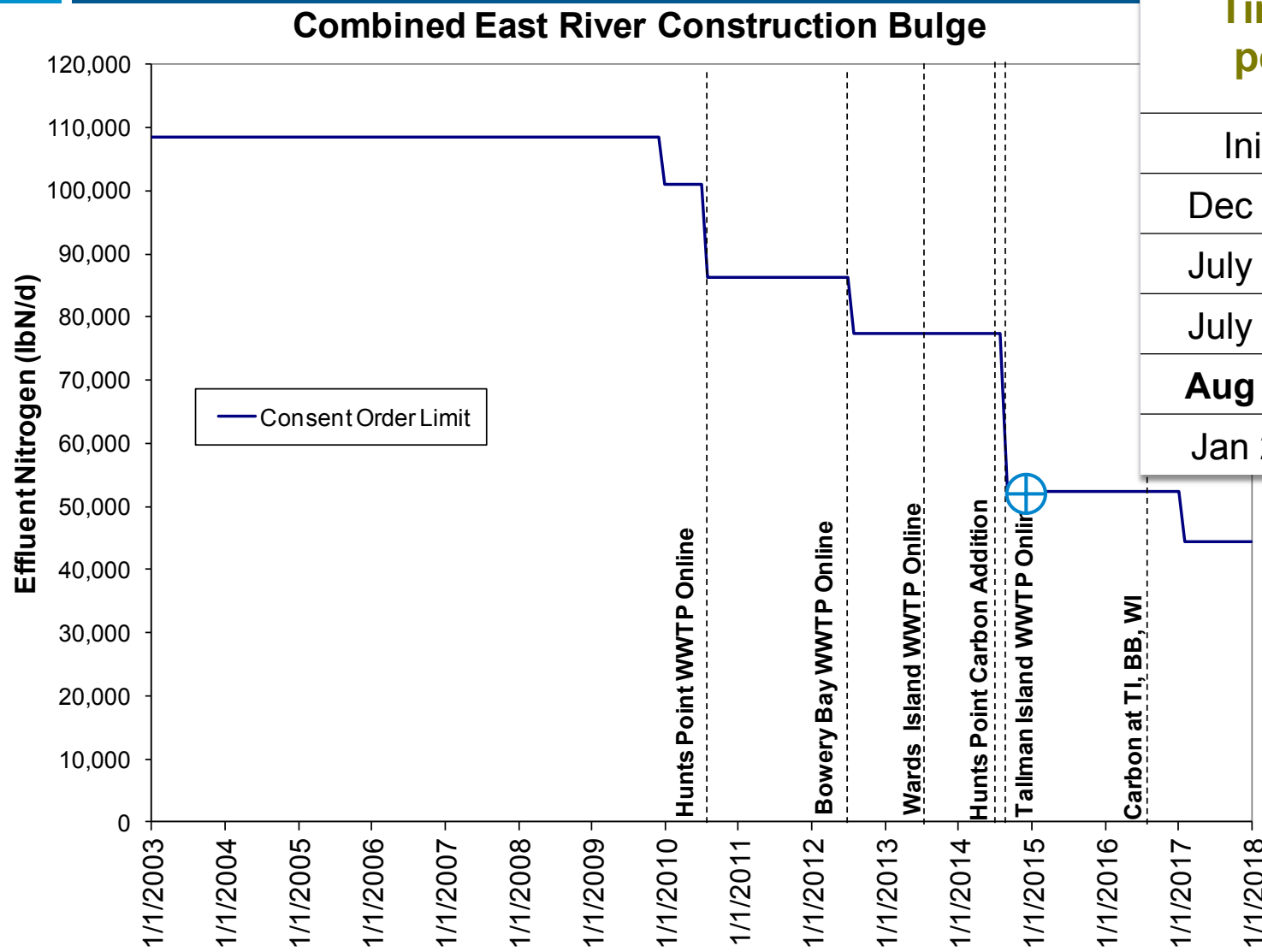
Wards Island
275 mgd

Hunts Point
200 mgd

Tallman Island
80 mgd

Bowery Bay
150 mgd

East River TMDL Step-downs

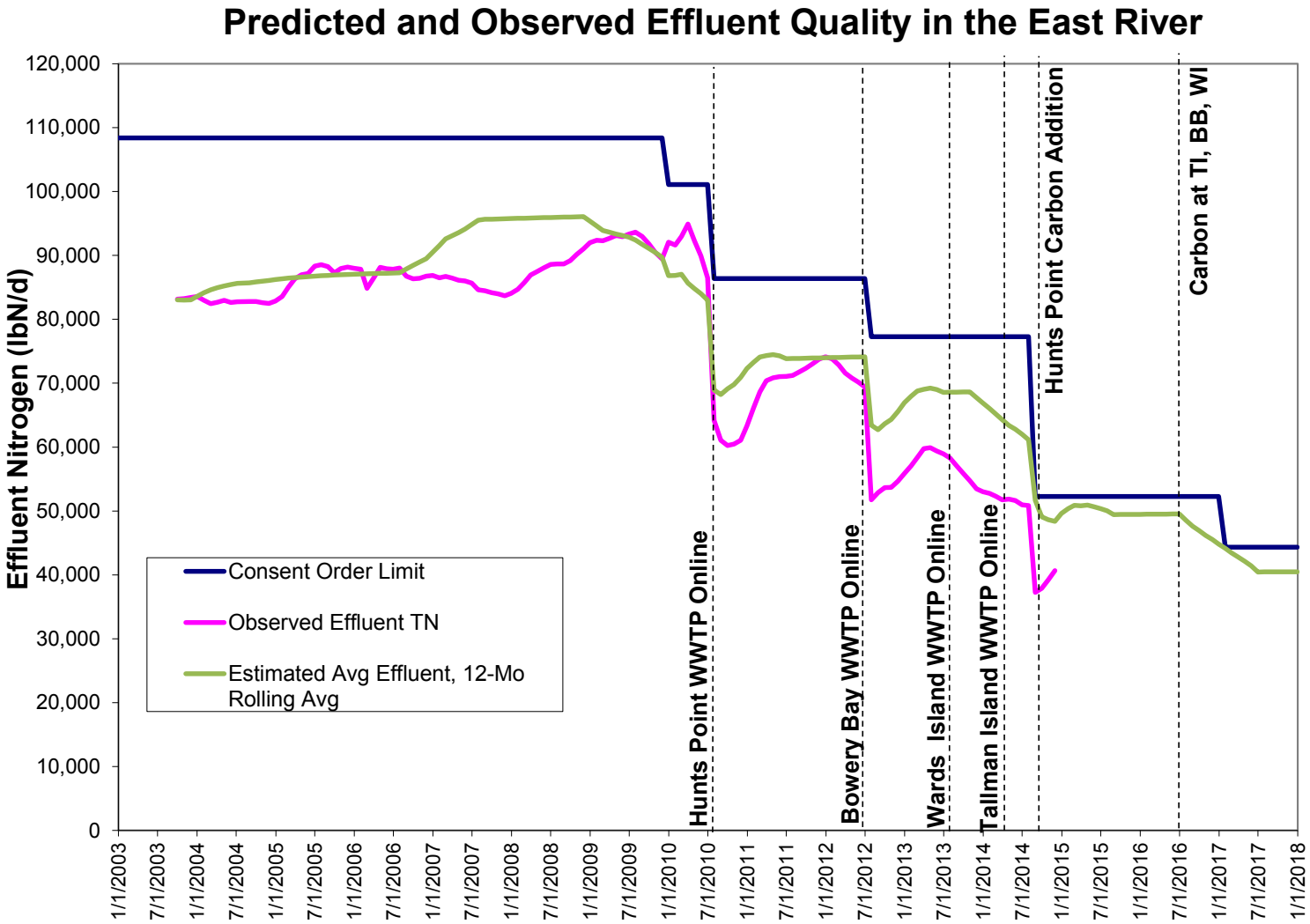


Time period	Eff TN Limit lb/d
Initial	108,375
Dec 2009	101,075
July 2010	86,375
July 2012	77,275
Aug 2014	**52,275**
Jan 2017	44,325

Future East River TN Limits

Step-down date	Limit Stepdown	UER Effluent TN	Contingent Upon
July 2012	77,275	15-16 mg/L	BNR operation of 3 UER WWTPs
August 2014	52,275	9-10 mg/L	BNR Operation of all UER WWTPs, and carbon at one WWTP
January 2017	44,325	7-8 mg/L	All BNR construction Complete AND Carbon addition at 4 UER WWTPs

Ongoing Nitrogen Removal



Nitrogen Removal in Jamaica Bay

Comprehensive Jamaica Bay Water Quality Plan

- Submitted October 2006
- Nitrogen discharges from the four Jamaica Bay (26W, JA, CI, RK) contributes to marshland degradation
- $100 Million of BNR upgrades to reduce Nitrogen discharges

Jamaica Bay WWTPs

26th Ward
85 mgd

Jamaica
100 mgd

Coney Island
110 mgd

Rockaway
45mgd

Implementation to Nitrogen Removal

26th Ward (Level 3) and Jamaica (Level 2+) WWTPs

- ✓ **Completed Level 2 BNR upgrades at 26W**
- ✓ **Completed Carbon addition to SCT**
- ✓ **Completed Jamaica WWTP BNR Operation 2014**
- ✓ Carbon to 26W and Jamaica in 2016

Future BNR upgrades at Rockaway and Coney Island (Level 1)

- ✓ Construction Completion 2019 and 2020

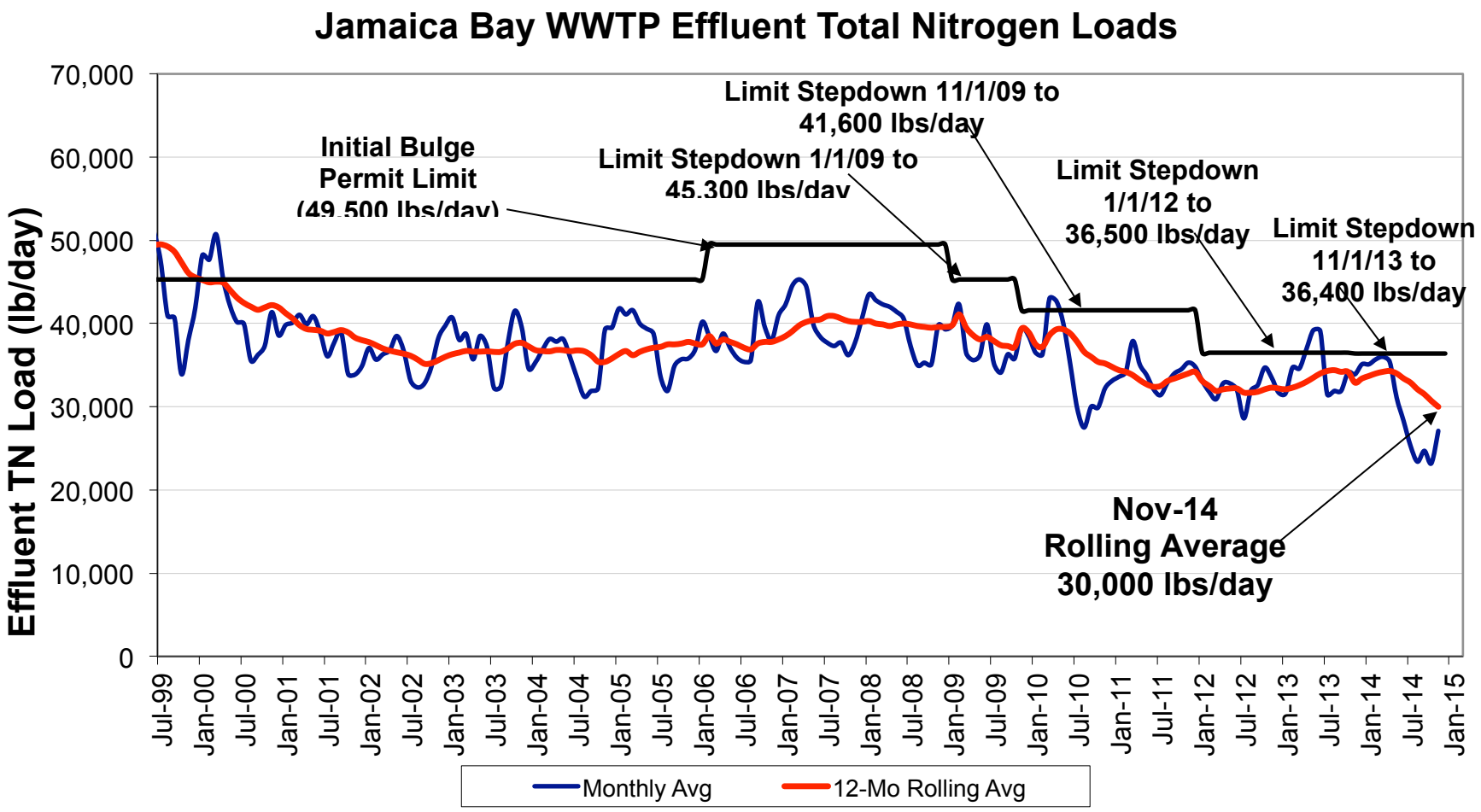
Jamaica Bay Total Nitrogen Limits

Time period	Consent Order Nitrogen Limits (lb/d)
January 1, 2009	45,300
Starting November 2009	41,600
Starting January 2012	36,500
Starting October 2013	36,400
Starting July 2017	TBD
Starting July 2022	TBD

Future Nitrogen Limits for Jamaica Bay are performance based

95th percentile of one-year of data

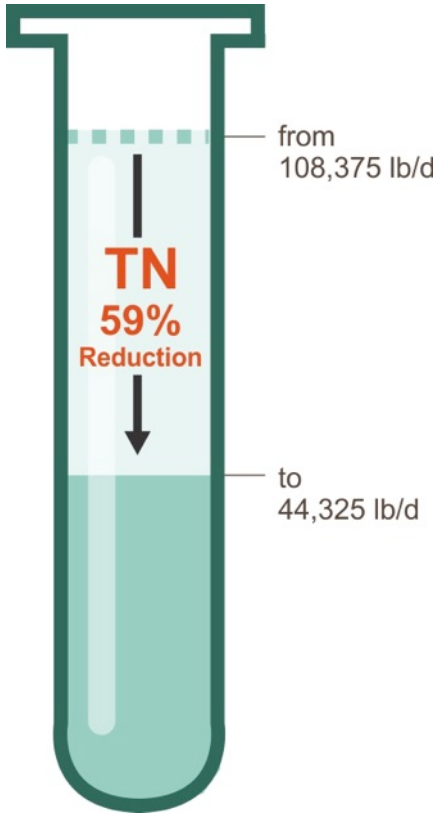
Jamaica Bay Performance



BNR Construction Completing…

- Several construction projects have completed
- BNR operations ongoing

- Operators must now achieve BNR treatment



BNR Training

- Successful BNR operation requires new set of operational tools
  - SRT control
  - DO control
  - Alkalinity/pH control
  - Optimized flow splits
  - Wet weather management
  - Froth/scum removal

- Training sessions provide transition

Typical Training Outline

i. New York Nitrogen Management Program

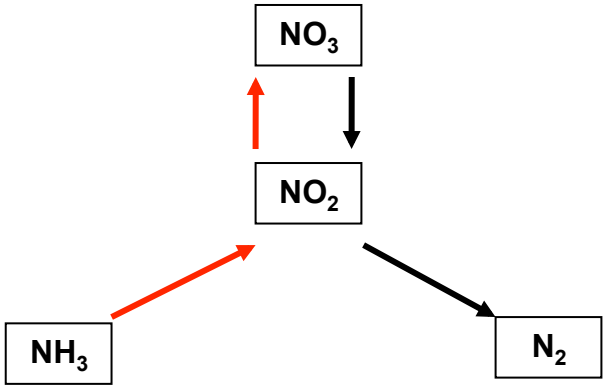
ii. Plant Description and Recent Performance

iii. Nitrification/Denitrification Fundamentals

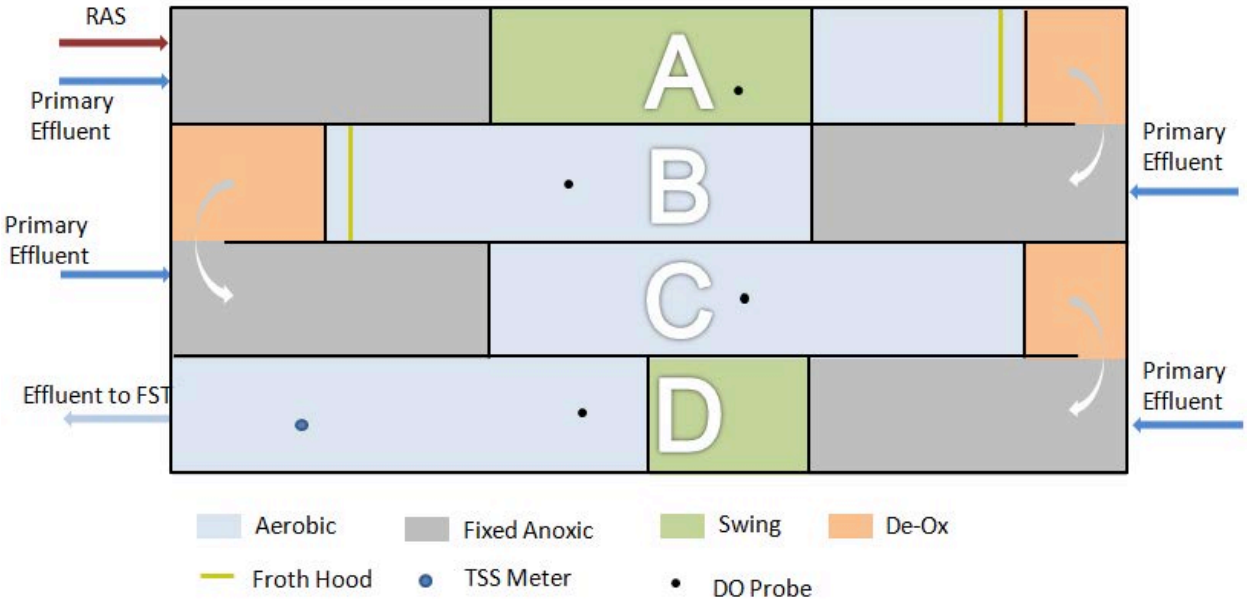
iv. BNR Implementation, Infrastructure, and Operational Aspects

v. SOPs

vi. BNR Lessons Learned



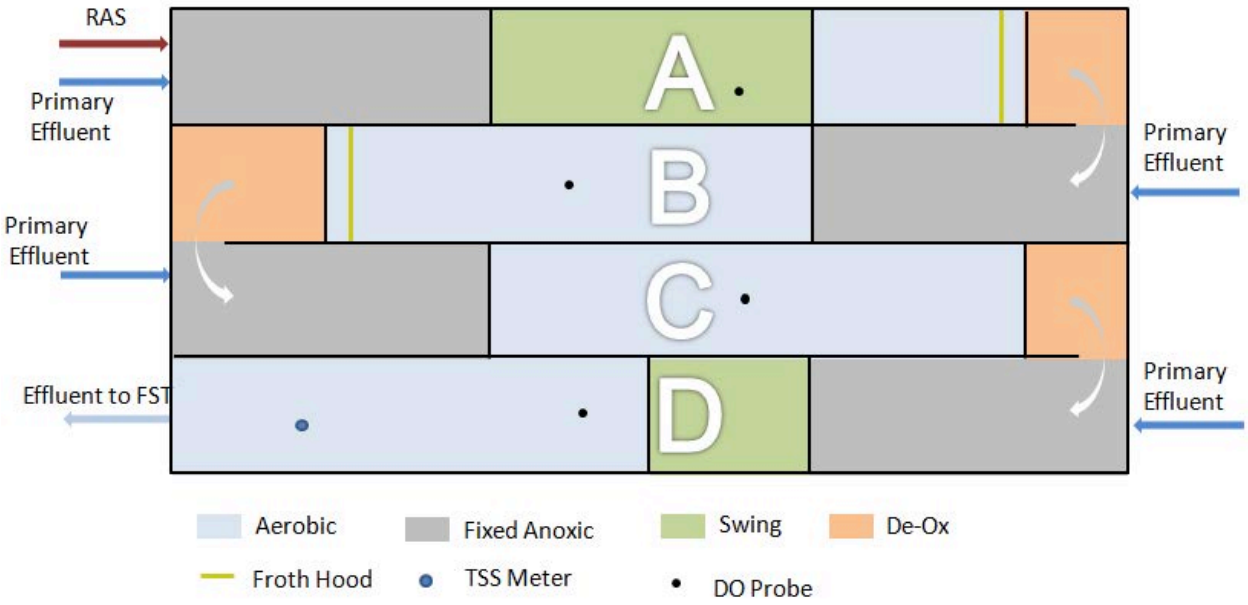
Aeration Tanks

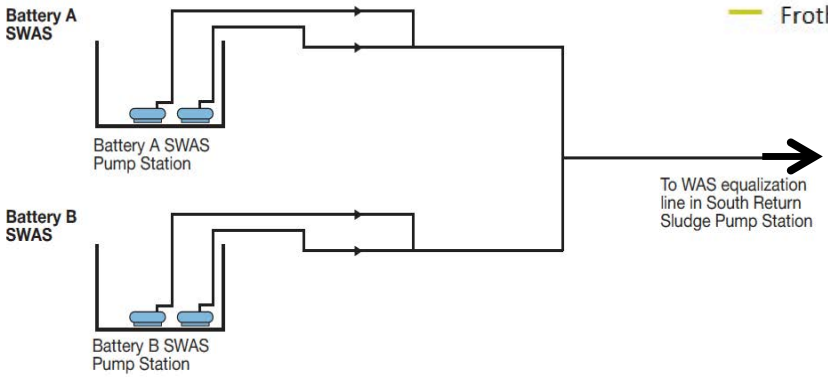


- Zone flexibility
- Seasonal adjustments
- Flow distributions
- Operational Targets

Solids Inventory Control

- Primary Effluent Flow Distribution
- RAS
- WAS/SWAS

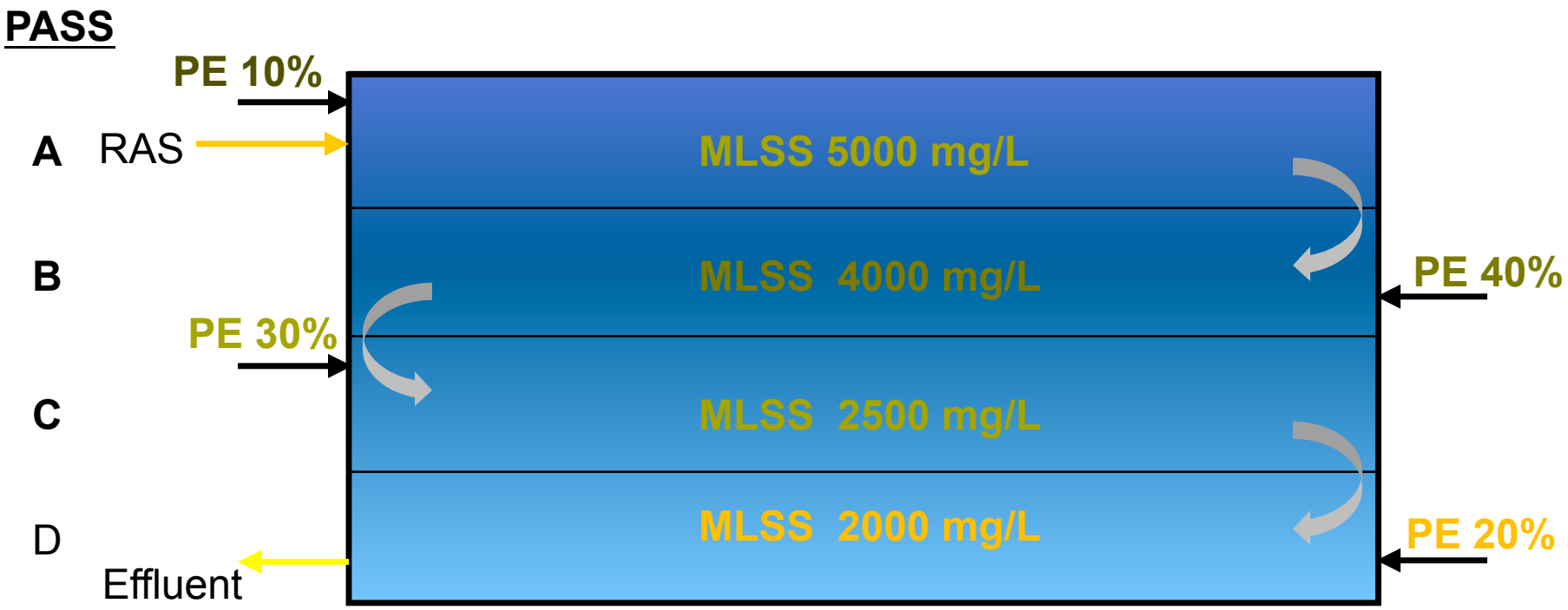




Wet Weather Operations

- Wet weather response to protect nitrifying biomass
  - **Divert excess wet weather flow to downstream passes**, achieving contact stabilization and reducing solids loading on FSTs
  - Maintain solids inventory in the upfront passes, essentially ‘parking’ solids for temporary storage by limiting the PE flow through those passes.

Typical Flow distribution

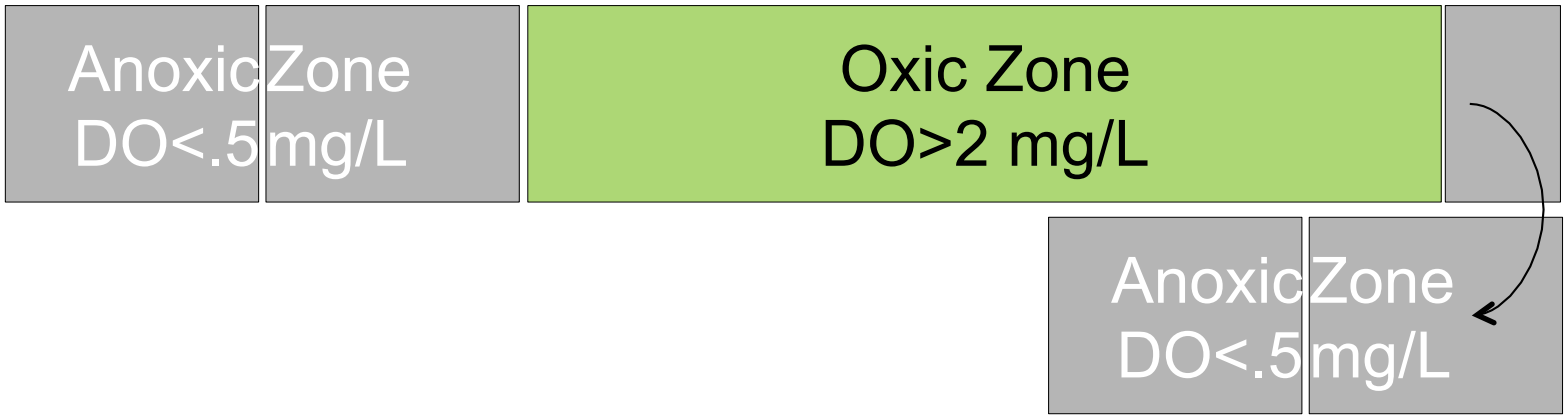


Storm flow – solids parking

Optimal Wet Weather PE flow distribution shown as 0:25:25:50

Aeration

- DO Control System
- DO Targets for Optimal operations



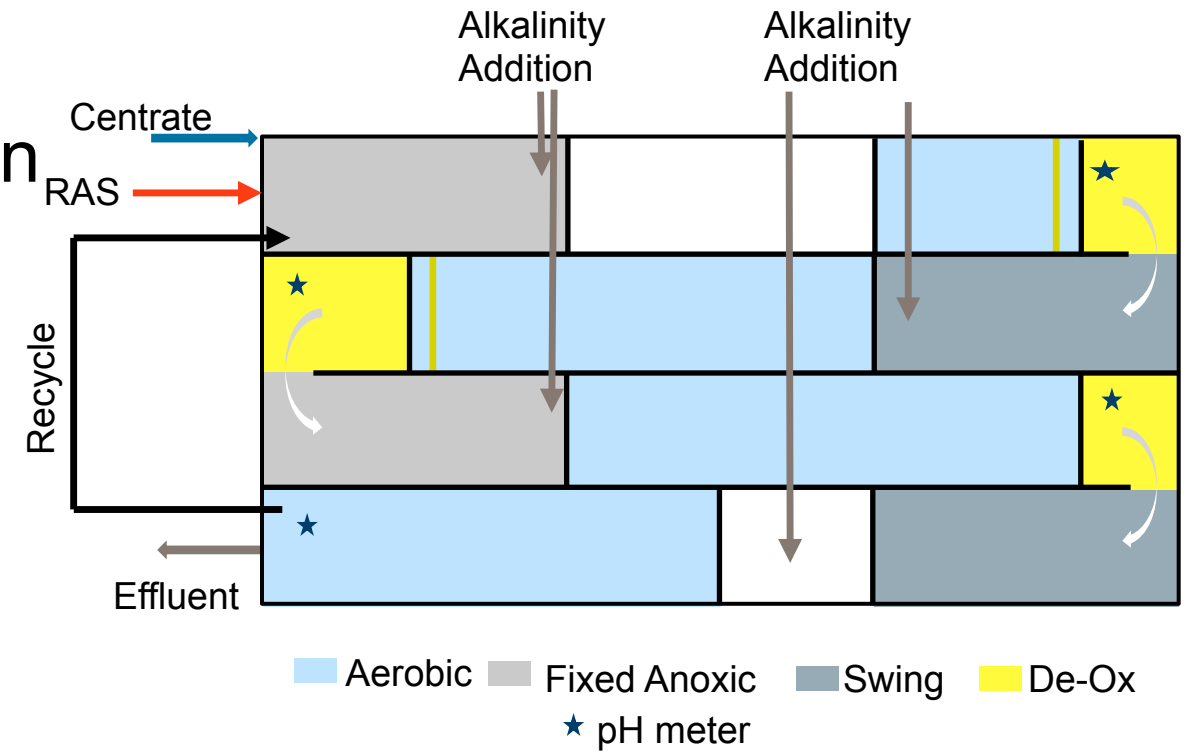
Alkalinity/pH Control

- Installed system
- Target pH
- Seasonal operations

Centrate Treatment

- Separate Centrate Treatment (SCT) operation in dedicated Aeration Tank

- Tank flexibility
- Instrumentation
- Seasonal Operations



Froth Control

- Froth Hoods
- RAS Chlorination
- Polymer
- Surface Wasting
  - % wasting
  - Impact on SRT

Surface Wasting – Bell Weir

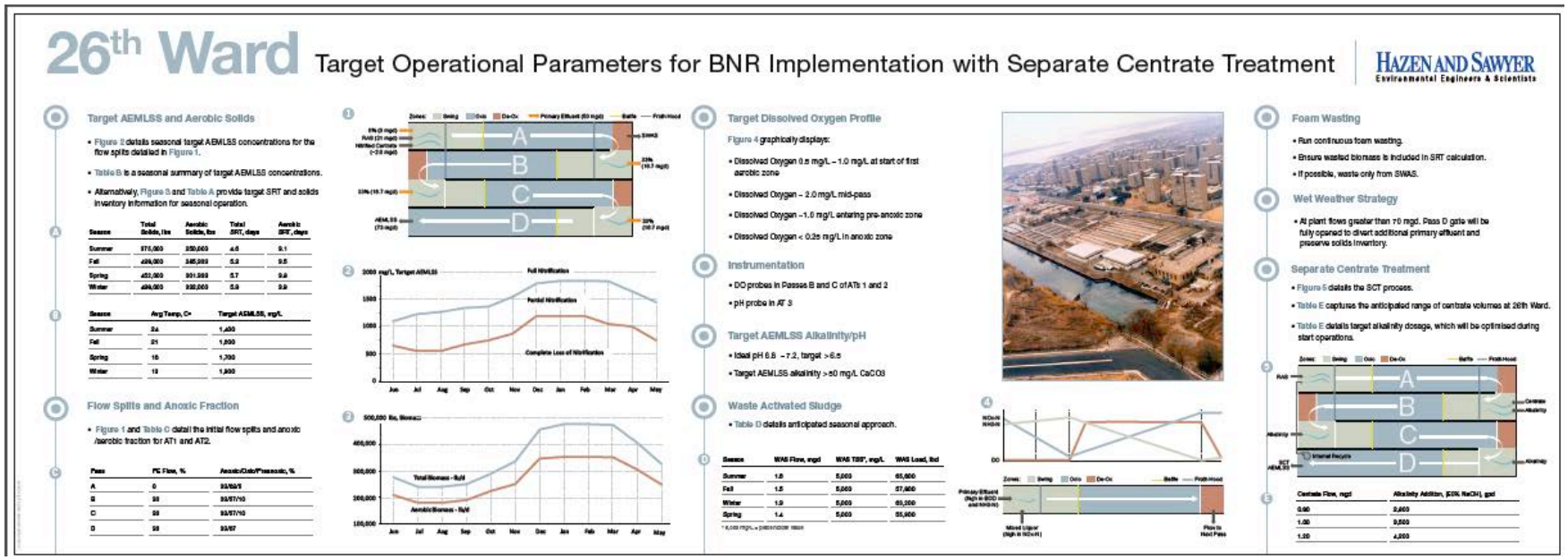
Surface Wasting

Froth Hood

Polymer Addition

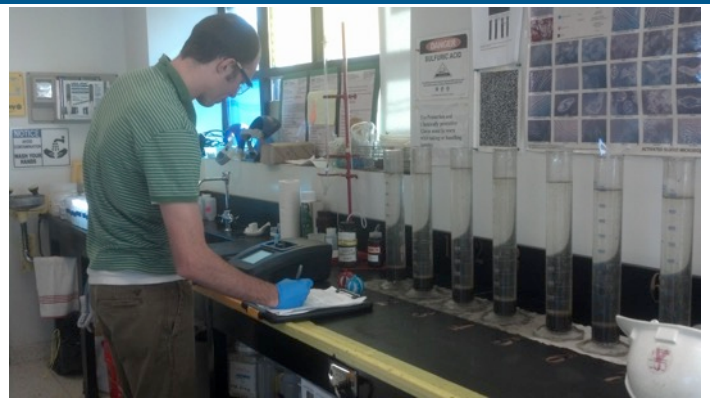
SOPs

- Plant Specific Poster
  - PE flow distributions
  - AEMLSS/Solids Inventory targets
  - Aerobic/anoxic configurations
  - SCT Operation
  - Wet weather operation
  - Froth Control
  - DO targets
  - Alkalinity/pH targets



On-site Assistance

- 6-12 month long sampling program
  - Profiles
    - Nitrogen
    - Solids
    - DO
    - pH
  - Evaluation of Instrumentation
  - Process Optimization
  - Control strategy Adjustment

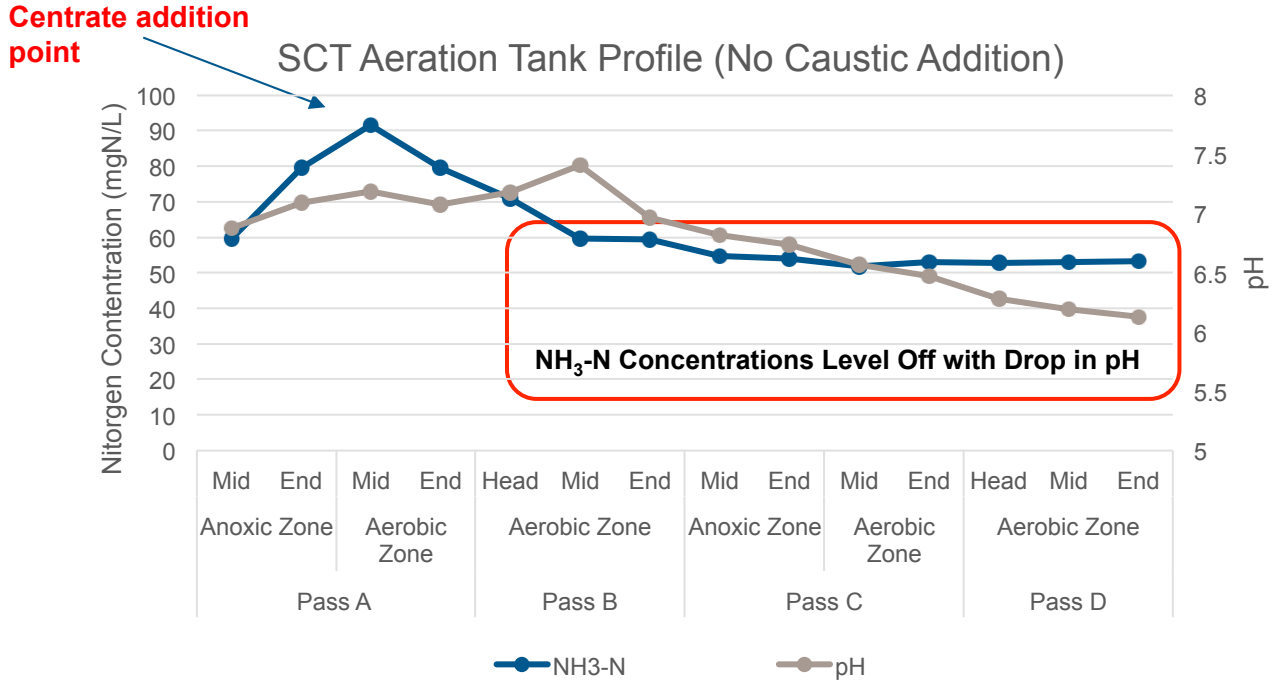


- Provide plant process staff with important information
  - Are SOPs being followed?
  - Are any changes needed to SOPs for optimized future strategies?
  - Assist with achieving overall acceptance by the regulator

Lessons Learned - Wards Island WWTP

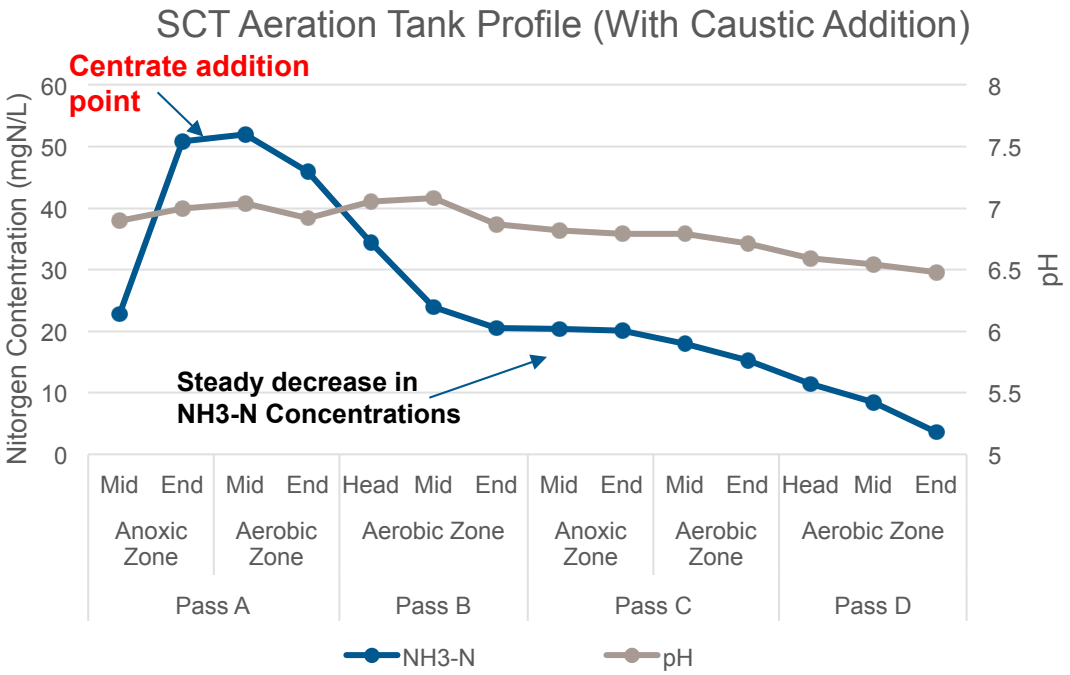
Wards Island – Low pH Conditions

- Routine pH profiles revealed low pH conditions in the Separate Centrate Treatment (SCT) Tank
- Nitrogen 7 Alkalinity profiles showed a leveling off in NH_3-N concentrations at lower pH, indicating nitrification inhibition



Wards Island– Low pH Conditions

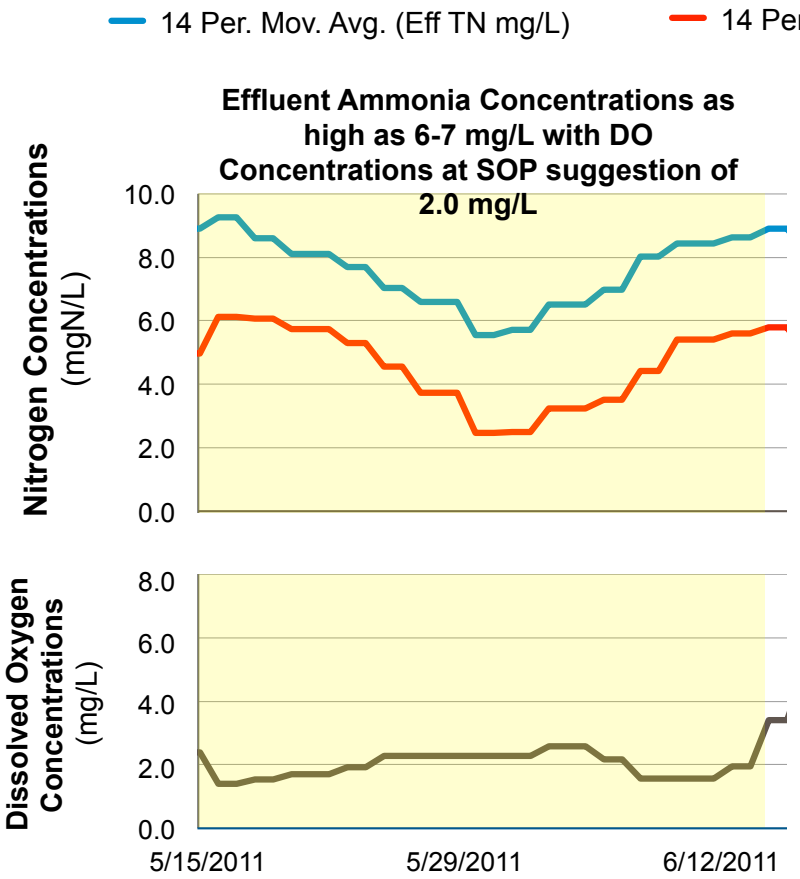
- Plant operators alerted to the low pH conditions in the SCT Tank and the resulting poor nitrification
- Recommended to add supplemental alkalinity
- Resulting Nitrogen profile
  - Improved nitrification performance



Lessons Learned - Battery E at the Wards Island WWTP

Battery E – DO Impact on Nitrification

Accepted DO Concentrations Produce Higher Than Expected Ammonia



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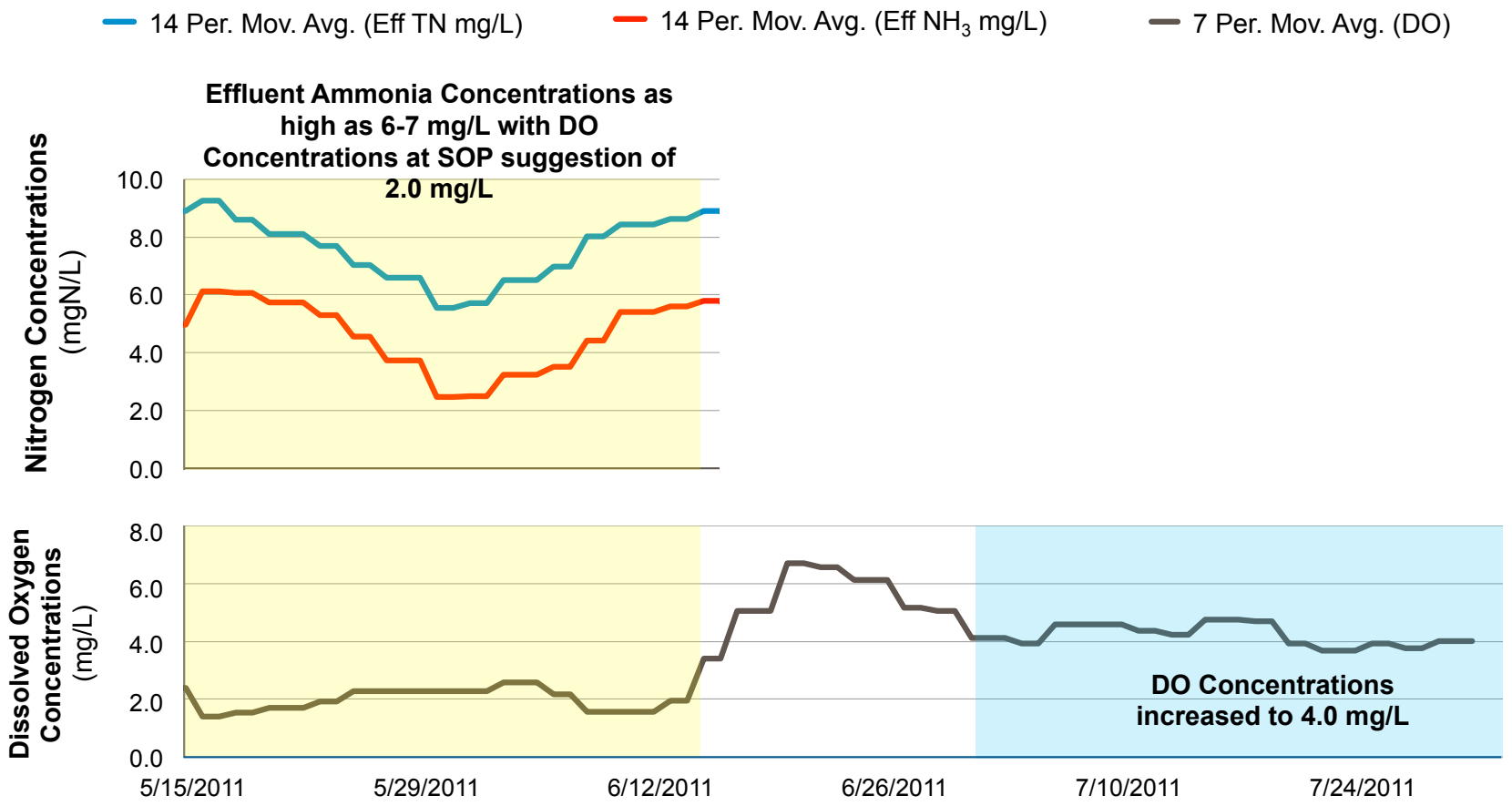

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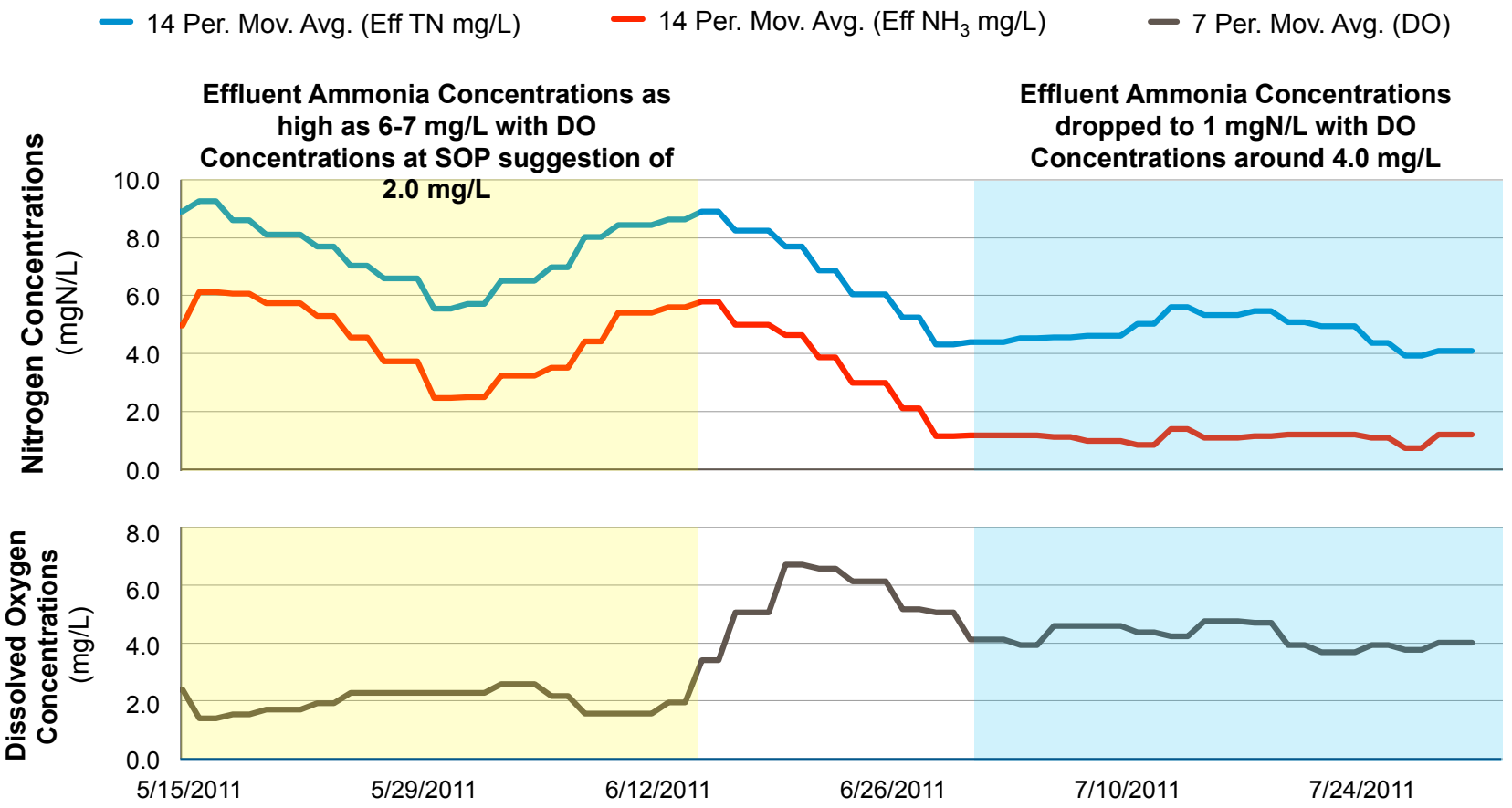


Lessons Learned - Bowery Bay WWTP

Bowery Bay – Solids Profiles

- Aeration Tank Total Suspended Solids (TSS) Profiles are conducted for many reasons:
  - Monitor solids inventory
    - Is the target solids inventory available?
  - Determine actual Primary Effluent (PE) flow distribution when flow measurement not available
    - Do they line up with target PE flow splits?
  - Quantify plant response to wet weather
    - How does flow distribution change?
    - Are solids maintained or washed out?

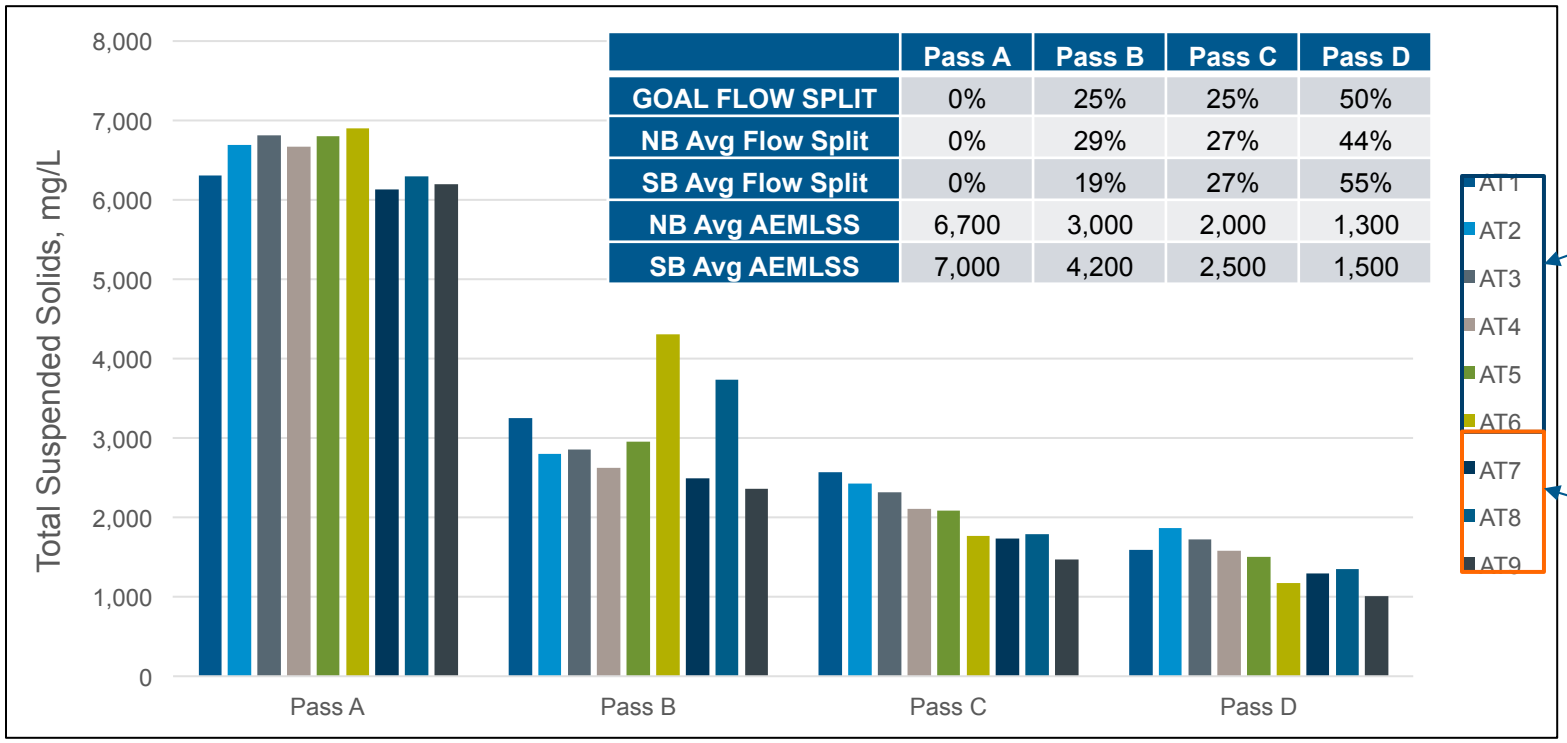
Bowery Bay – PE Flow Distribution

- During Wet Weather, a temporary modified flow distribution is needed to avoid solids washout from the process
  - Shift flow downstream, preserve solids in upfront passes
  - Recommended target Wet Weather PE flow distribution: 0/25/25/50 % to Pass A/B/C/D

- TSS profiles conducted by on-site assistance team during Wet Weather to ensure:
  - Washout of biomass is not occurring
  - Gate settings provide the desired PE distribution

Bowery Bay – Wet Weather Flow Distribution

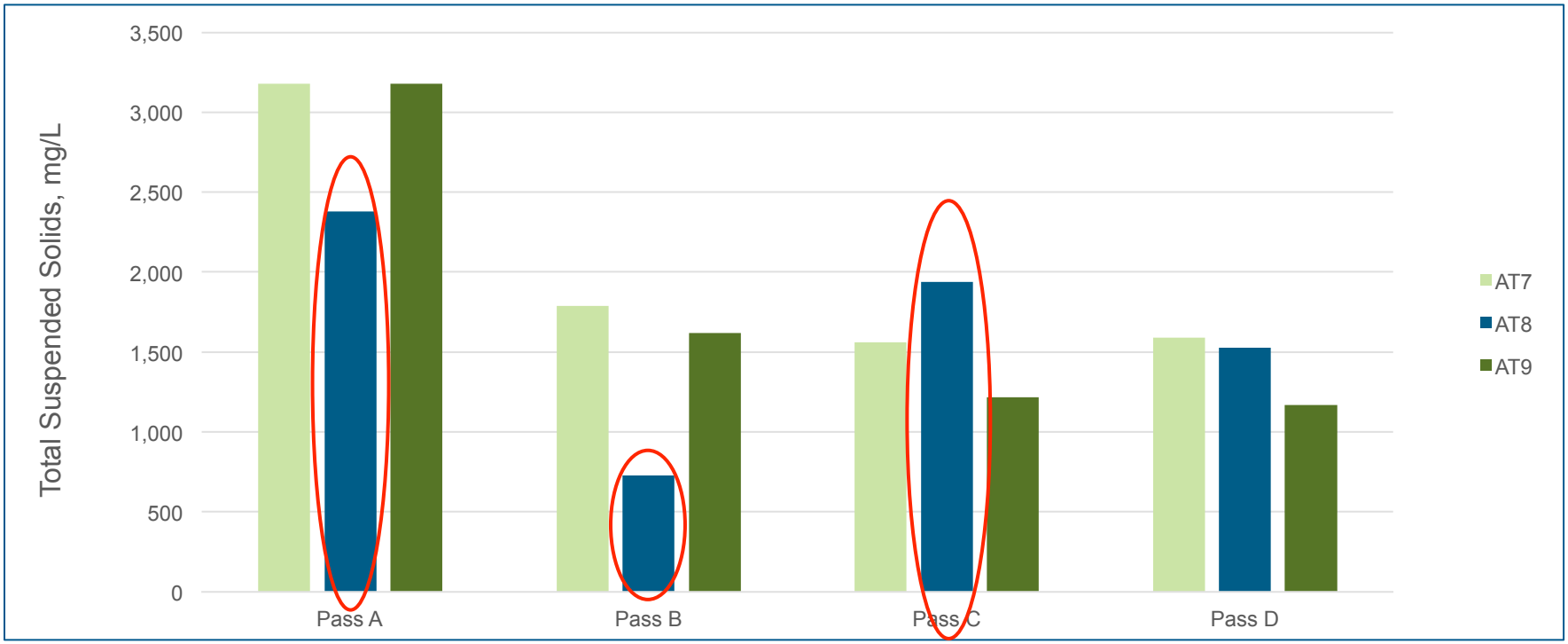
- Bowery Bay
  - 150 MGD DDWF
  - Max of 225 MGD through secondary treatment
- Results from Wet Weather day at BB, plant flows averaged 300 MGD
- TSS profiles showed solids were preserved in early passes; gate settings matched target flow splits



	Pass A	Pass B	Pass C	Pass D
GOAL FLOW SPLIT	0%	25%	25%	50%
NB Avg Flow Split	0%	29%	27%	44%
SB Avg Flow Split	0%	19%	27%	55%
NB Avg AEMLSS	6,700	3,000	2,000	1,300
SB Avg AEMLSS	7,000	4,200	2,500	1,500

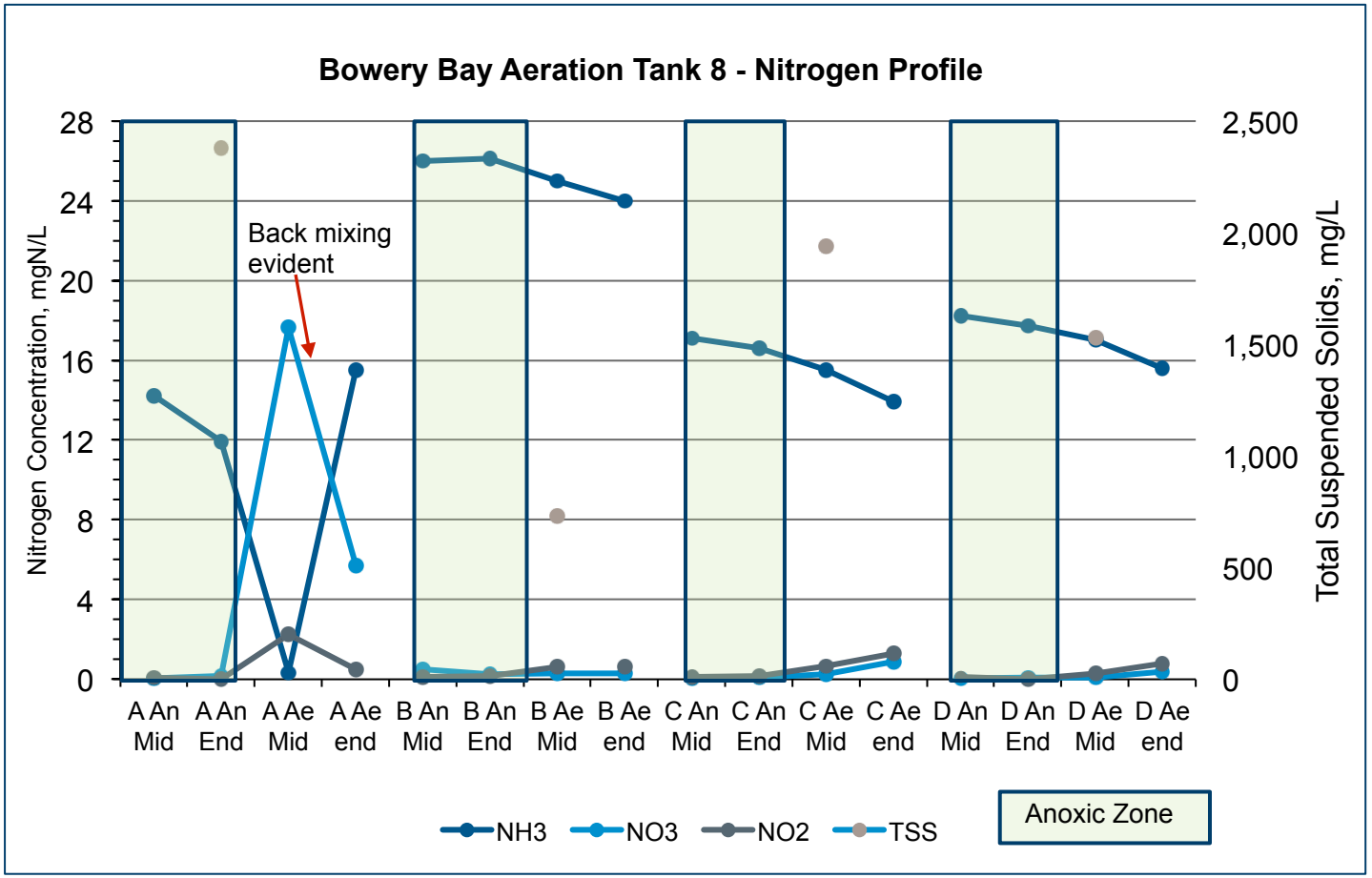
Bowery Bay – Solids Profiles

- TSS profiles on all North Aeration Tanks
- AT8 exhibited strange profile – low solids in A/B, but high solids in C?
  - AT8 PE sluice gate in Pass A open 100% - causing backflow of RAS into PE channel
  - Passes A and C both fed from same channel – RAS escaping into the channel through A gates, and entering Pass C



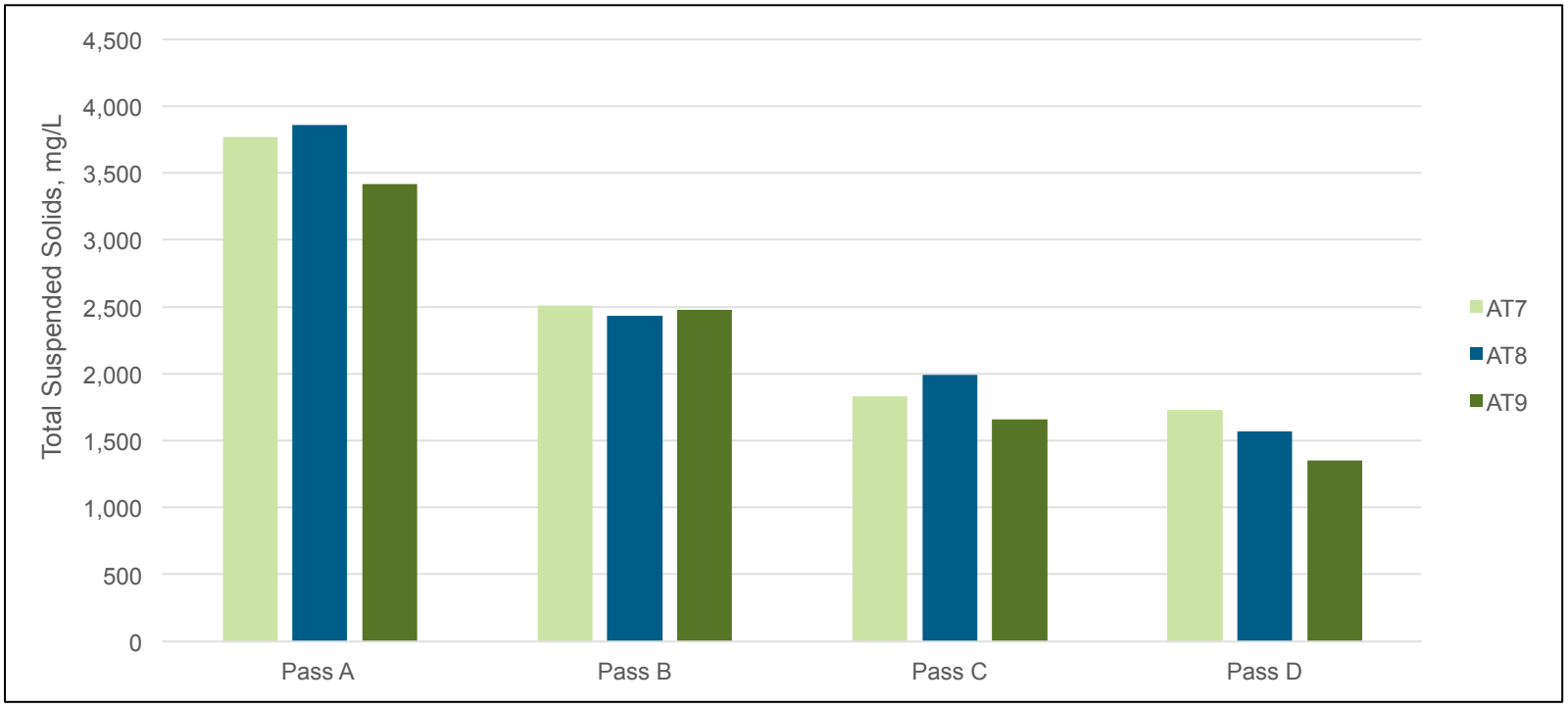
Bowery Bay – Solids Profiles

- Backflow also observed from head of Pass B to the end of Pass A with this hydraulic condition
- Low solids along with a low HRT in the early Passes of AT8 had a significant impact on nitrification performance



Bowery Bay – Solids Profiles

- Plant alerted to flow conditions
- Plant adjusted the PE gate settings to Pass A
- Solids distribution and PE flow splits returned to the recommended operating range



Conclusions

- BNR training provides the information necessary to successfully transition from a traditional BOD and TSS removal facility to a step-feed BNR facility
- Development of SOPs and on-site assistance allows for optimization of processes and adjustment of control strategies
- BNR upgrades essentially completed!
  - No instances of non-compliance
- Carbon addition started in 2014, continuing through 2016

- Acknowledgements
  - New York City Department of Environmental Protection
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    - Michael Lynch,
    - Robert D. Smith
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Questions?

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