Hazen

NYC Environmental Protection

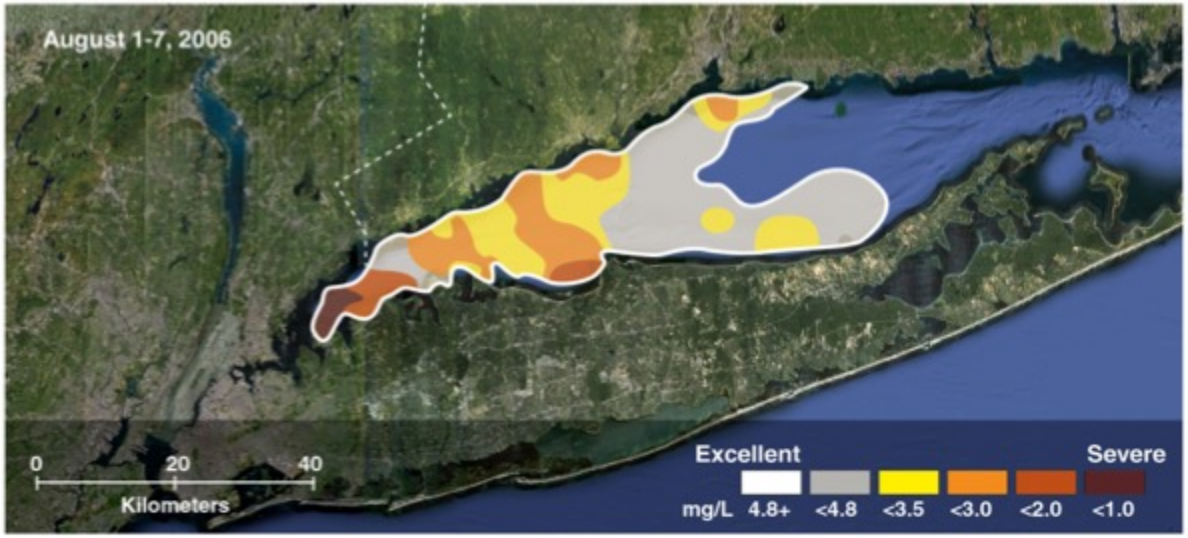
A Novel Testing Approach for BNR Optimization in NYC

Vera Gouchev, P.E.
January 23, 2017
NEWEA 2017 Annual Conference

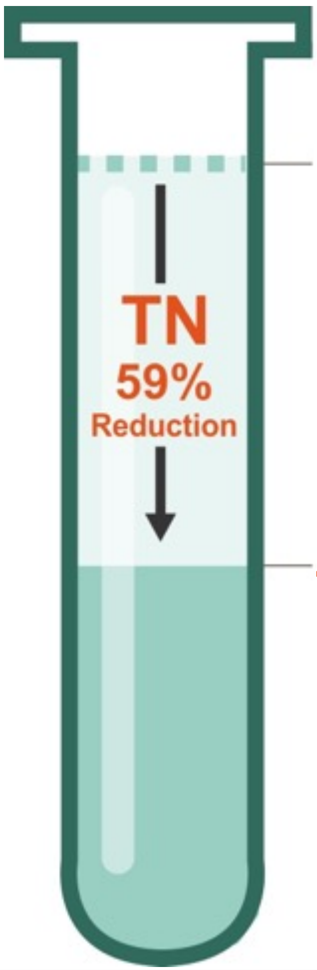
Background to NYC Nitrogen Concerns

- Long Island Sound Study –
  Partnership between USEPA, NY, CT (1988)
- Water Quality Concerns:
  - **Eutrophication** and **Hypoxia**
  - **Nitrogen** identified as causal agent

Dissolved Oxygen in Long Island Sound Bottom Waters



Reduction in Effluent Nitrogen



Reduction from
108,375 lb/d

to
44,325 lb/d

- Phased approach to Nitrogen reduction to achieve an overall reduction in effluent TN of **59%**
- **$1** Billion for Construction of Step-Feed Nite/Denite BNR facilities for 4 wastewater treatment plants (WWTPs) on the Upper East River

Wards Island | **Hunts Point**

Tallman Island | **Bowery Bay**

East River WWTPs

Wards Island
275 MGD

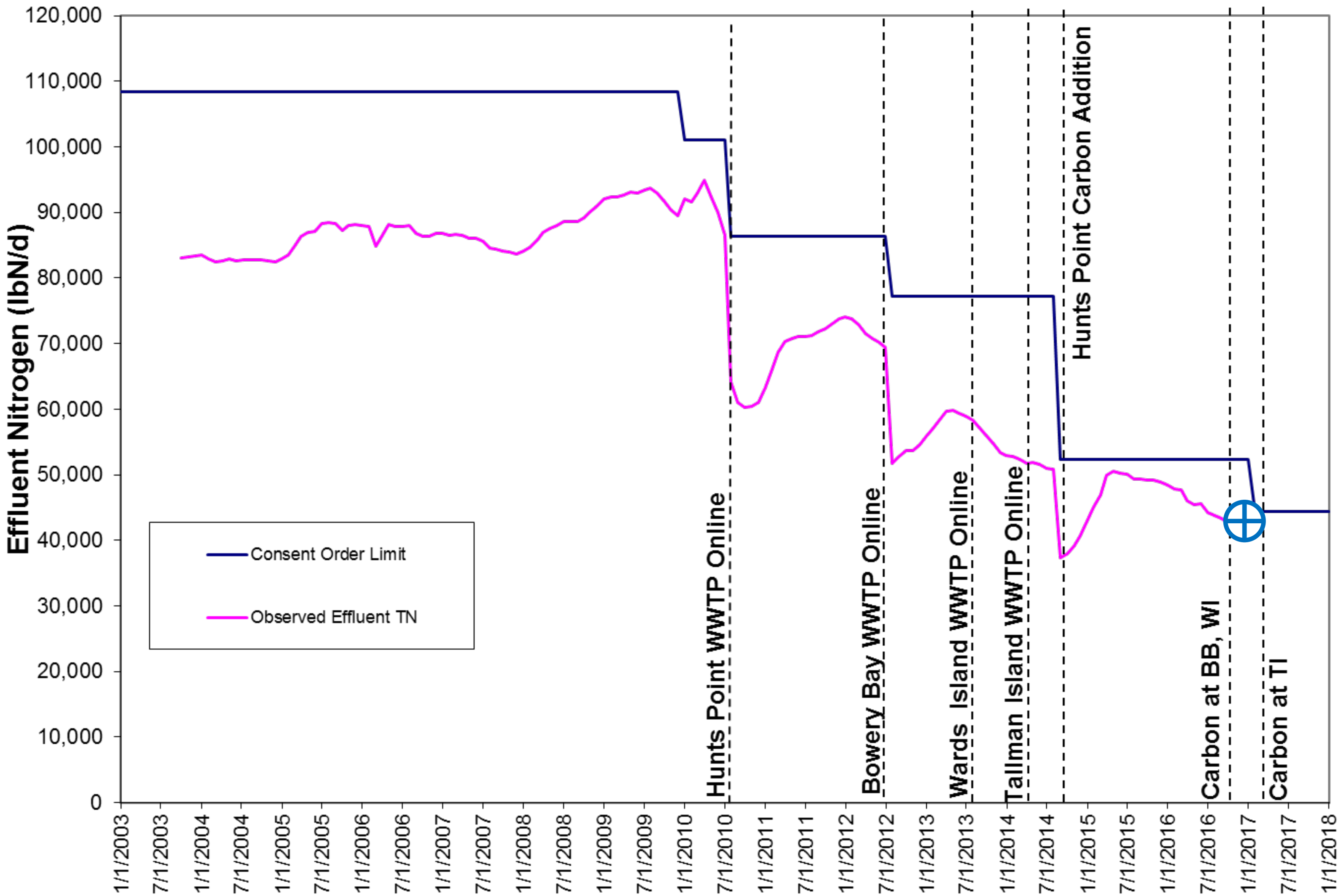
Hunts Point
200 MGD

Tallman Island
80 MGD

Bowery Bay
150 MGD

Hazen

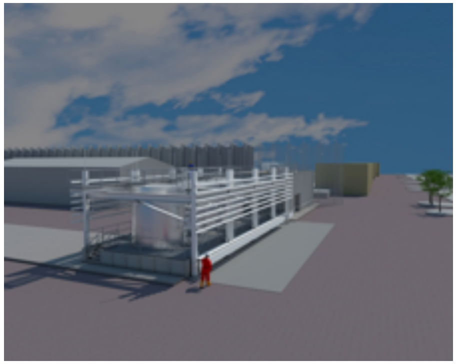
East River TMDL Step-downs



Phase I/Phase II Infrastructure

- Phase I program designed to meet 52,275 pounds per day limit (effective August 2014)
- Additional infrastructure/chemicals necessary to meet ultimate TMDL of 44,375 pounds per day (effective January 1, 2017)
- Phase II requirements:
  - Supplemental Carbon Addition at all UER WWTPs

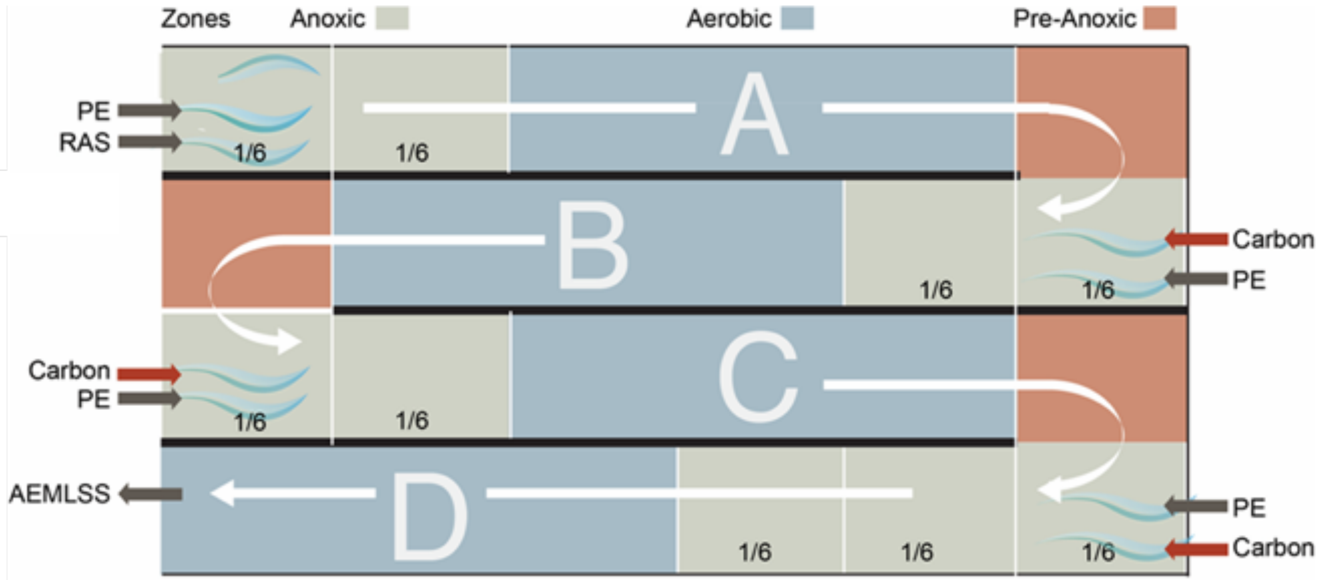
Glycerol



Carbon Addition Facilities

Approach to Implement BNR Technologies

- Step-Feed Nitrification/Denitrification BNR Process
- Upgrades include:
  - Aeration Systems
  - Separate Centrate Treatment (at Dewatering Facilities)
  - RAS/WAS System
  - Chemicals
  - Foam Control

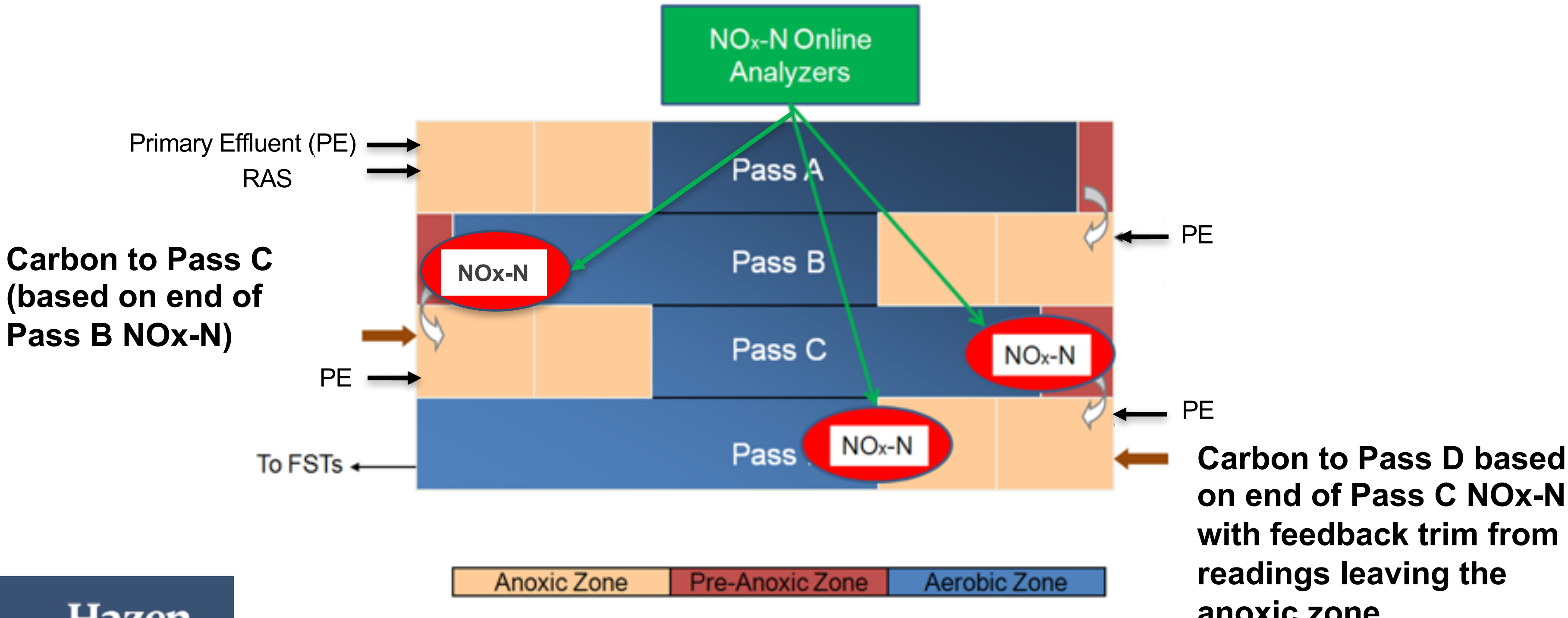


Carbon Addition Facilities

Glycerol Addition Control Strategies

Control Strategies Available:

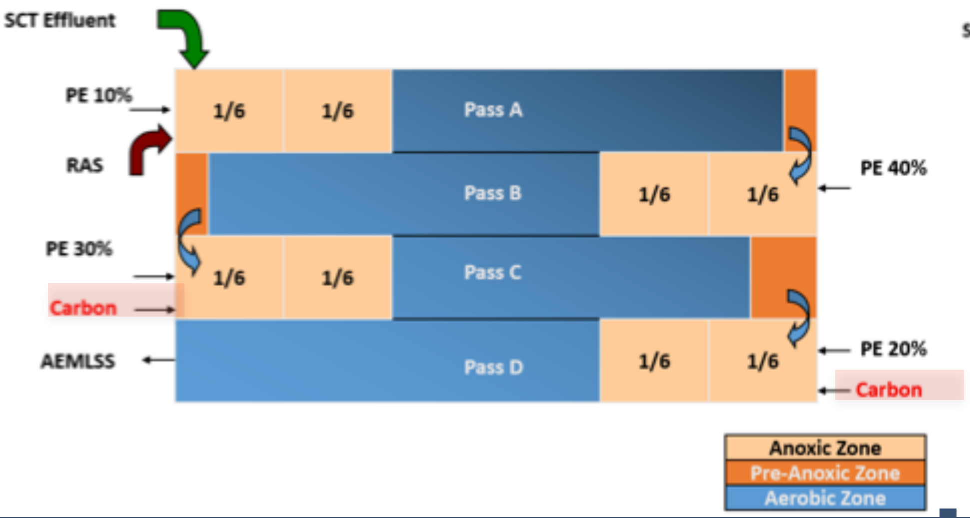
- Manual
- Hourly Inputs
- NO3-N analyzer (Mass paced based NOx-N load entering anoxic zones)



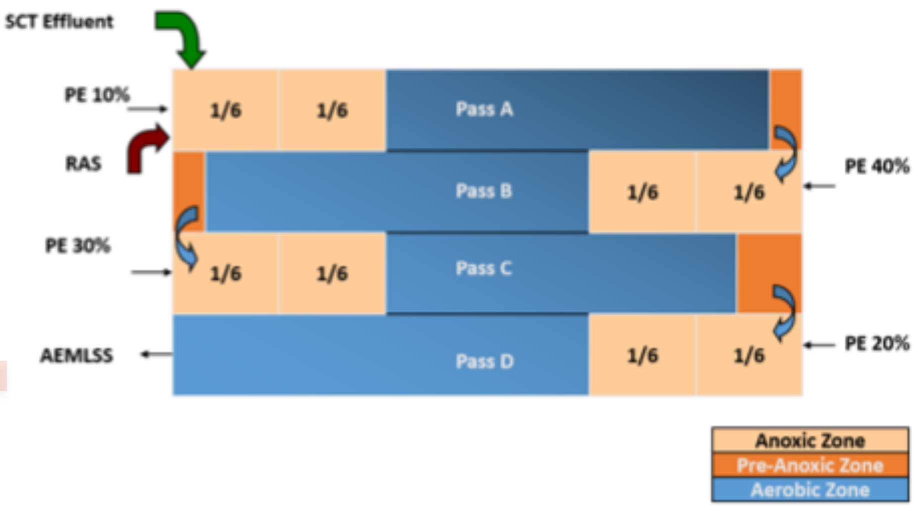
Approach to Carbon Optimization

- Consent Judgment with State requires 'optimization'
- DEP was new at using glycerol in a full-scale step-feed process
- Approach: Control Tank vs. Experimental Tank to quantify impact of carbon

Experimental Tank



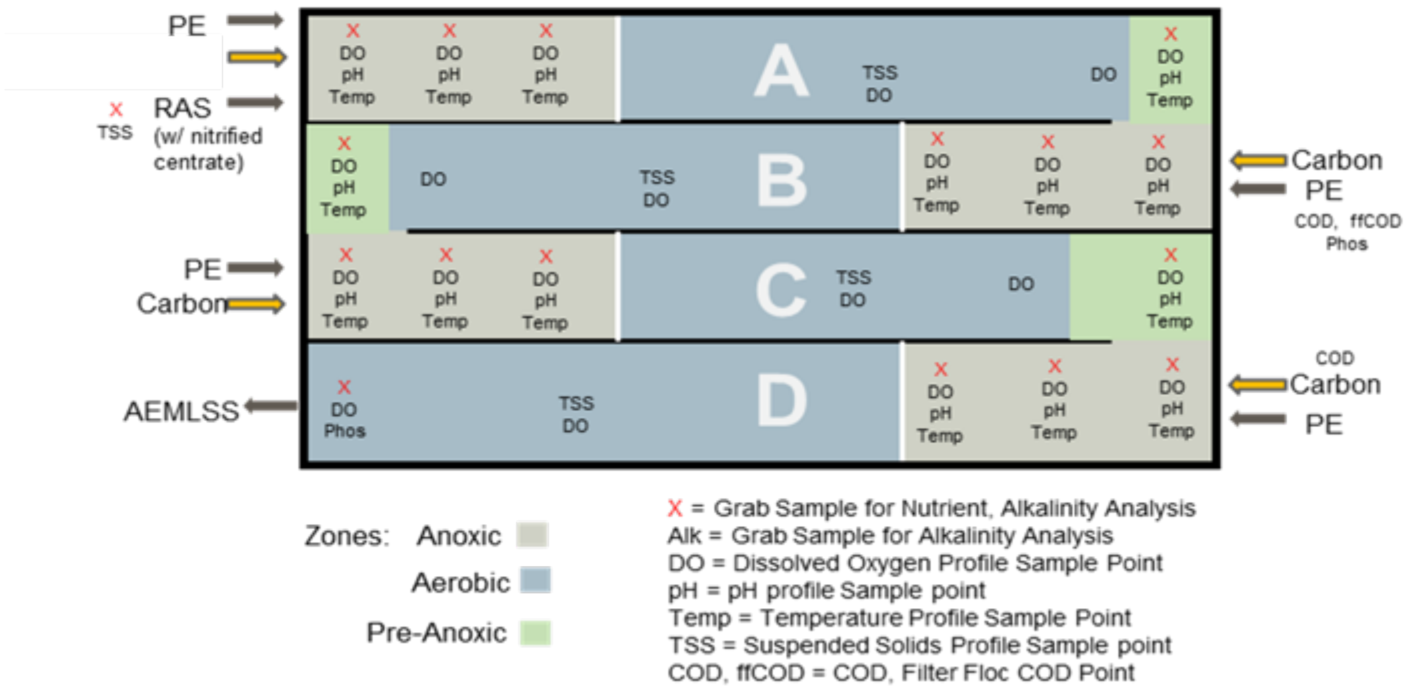
Control Tank



Carbon Optimization Requirements/Goals

- Intensive Sampling Program
  - Weekly Sampling over 6 month period covering Warm and Cold Weather Operation
  - Weekly calls with Plant Staff to test optimization measures (e.g., carbon doses, zone configurations, flow splits)
- Process Model Development
- Development of SOP for Carbon Addition
  - Backup in the event that automated controls are not available
  - Recommendations for typical and stressed operating conditions provided

Intensive Sampling Program



Sampling plan included:

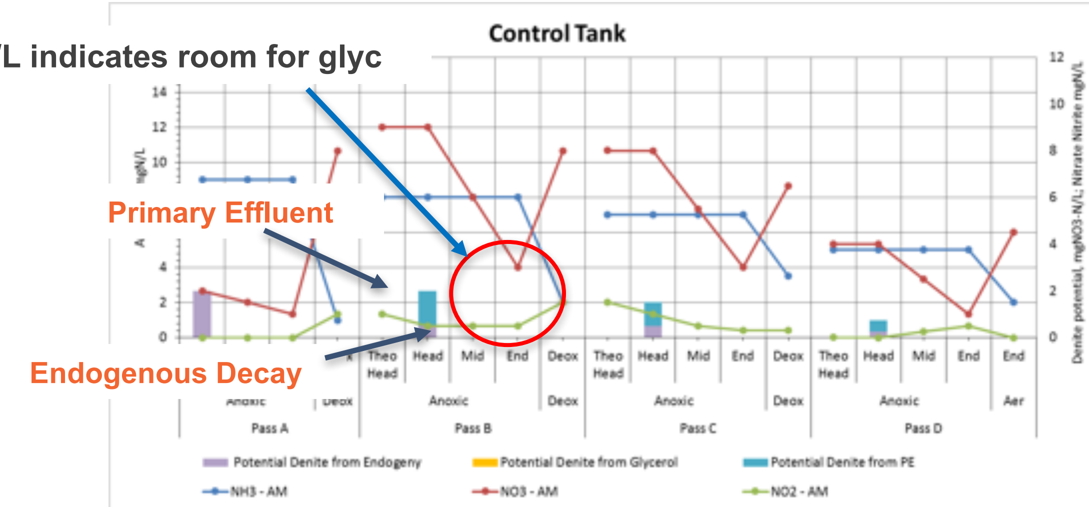
- AM and PM profiling (nutrients, DO, pH, Temp, TSS)
- Test Tank, with glycerol
- Control Tank, no glycerol
- Separate Centrate Treatment (SCT) tank

Intensive Sampling Program

- Diurnal Sampling
  - TSS Profiles
  - Dissolved Oxygen, Temp, and pH Profiles
  - Nitrogen Profiles (NH_3-N, NO_3-N, and NO_2-N)
- Data Analysis
  - Primary Effluent (PE) flow distribution
  - Denitrification Potential via carbon sources (Endogeny, PE, Glycerol
  - Unit flow TIN removal
- Comparison of Test Tank vs. Control Tank to develop glycerol dosing recommendations

Example: Nutrient Profile Analysis

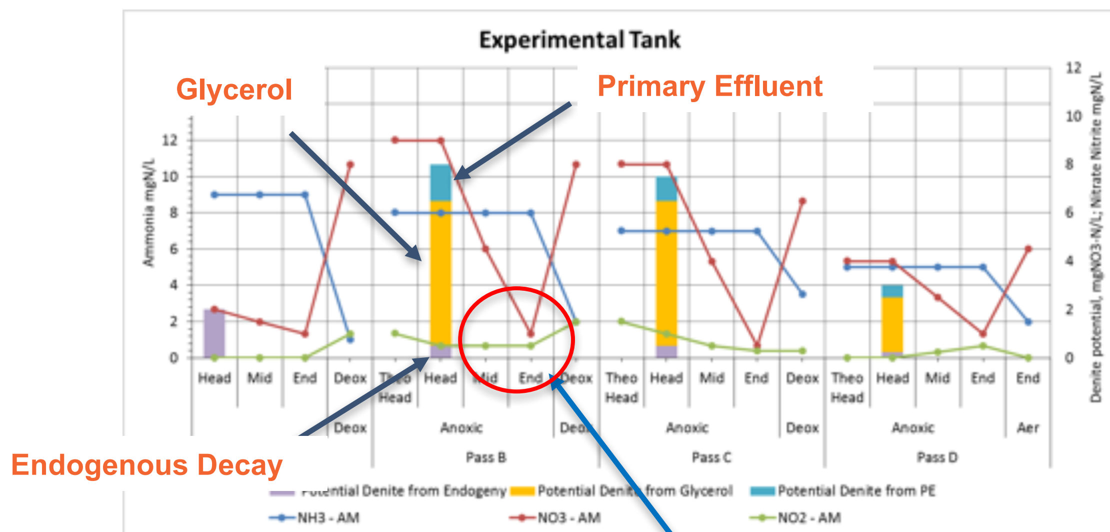
Effluent NOx > 1 mg/L indicates room for glyc



- Nitrogen speciation profile data collected during every sampling event

- ‘Denite potential calcs’ used to determine if glycerol dose/ location are adequate

- Seasonal data collection allowed for glycerol dose and location refinement

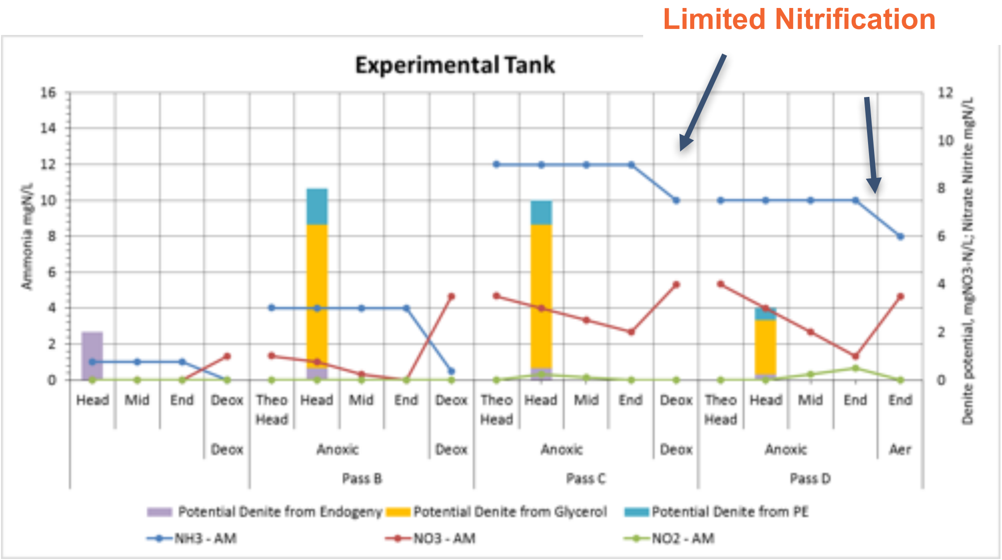


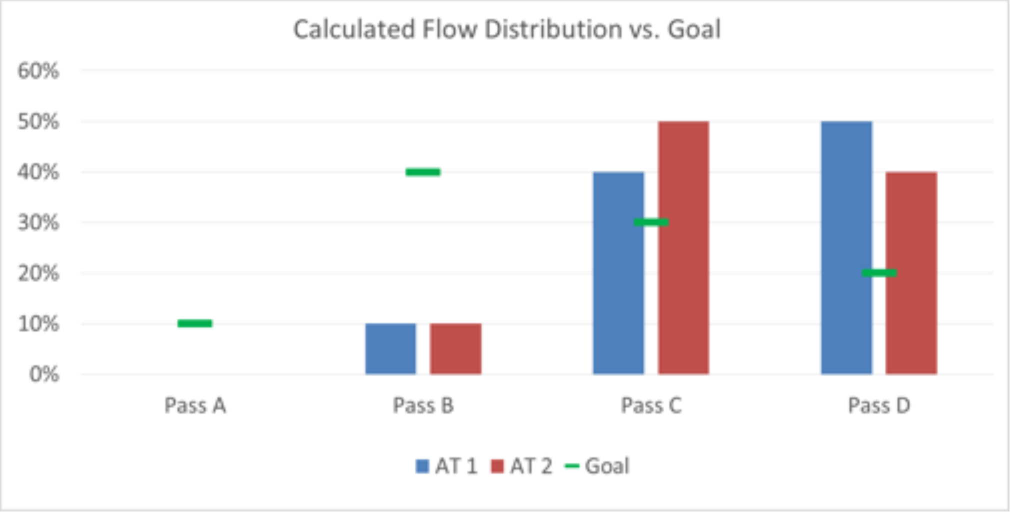
Effluent NOx < 1 mg/L indicates full denite, proper dosage of glyc

Hazen

Example: Impact of PE Flow Distribution

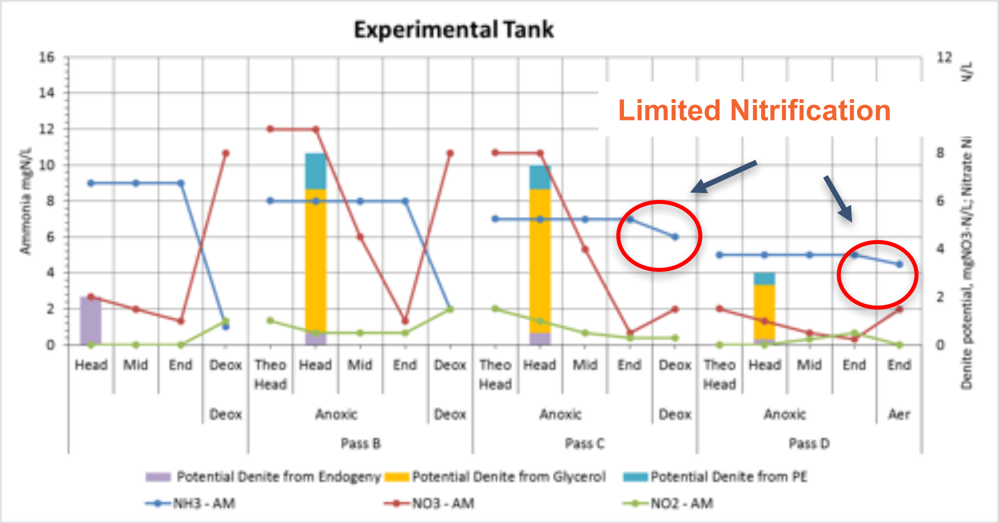
- Nite/Denite performance impacted by PE flow distributions
  - Too much flow → decreased HRT → limited nite/denite
- In this example, Passes C and D are receiving too much flow
  - Limited NO3-N to denitrify in early passes
  - Elevated eff NH3

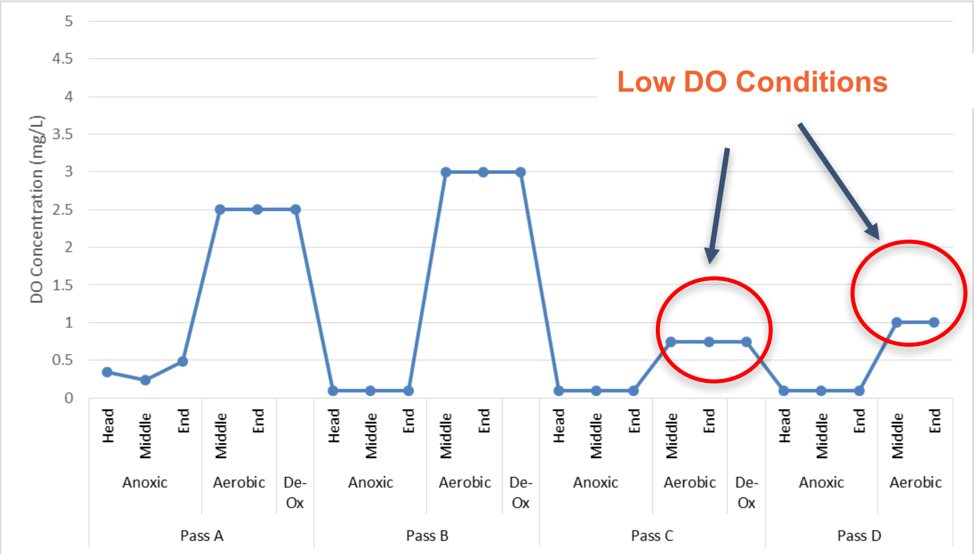




Example: Impact of Dissolved Oxygen

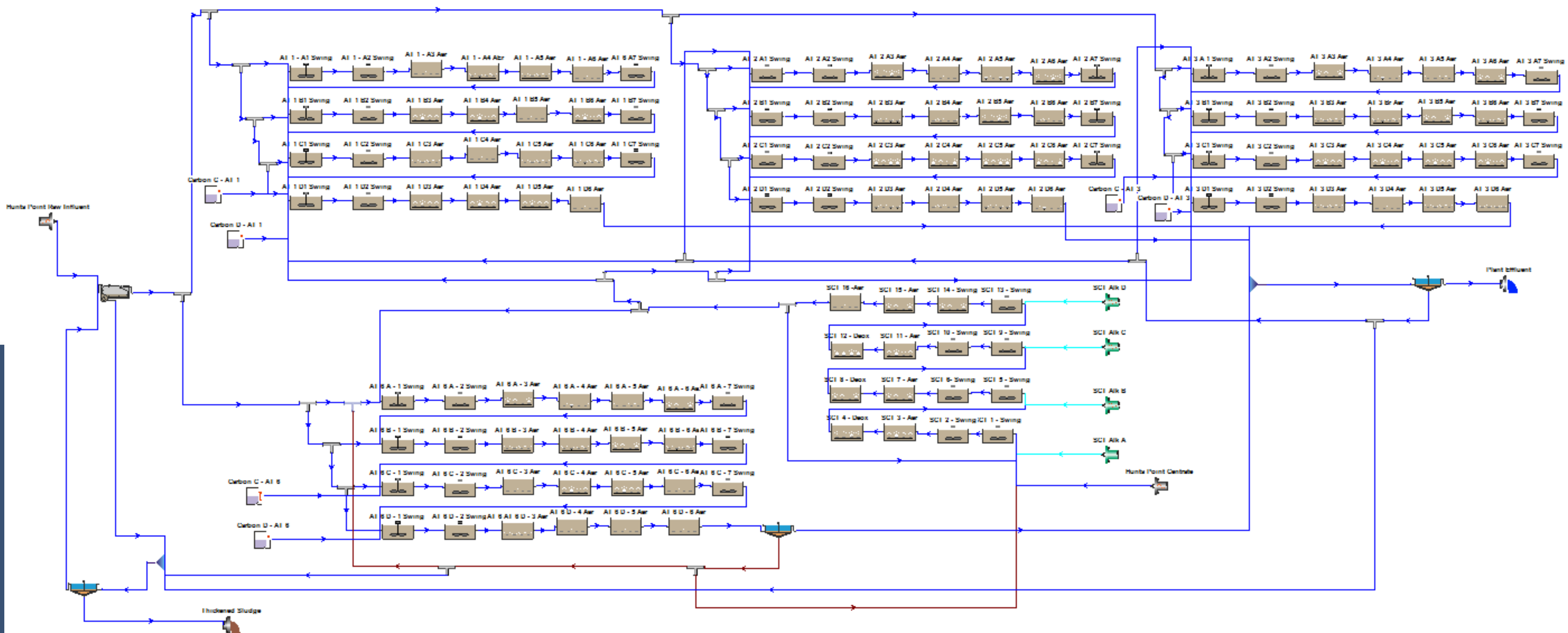
- Ideal DO conditions:
  - Anoxic Zones: < 0.2 mg/L
  - Aerobic Zones: 2-3 mg/L
  - Deox Zones: < 1 mg/L
- In this example, Passes C and D aerobic zone DOs < 1 mg/L





Process Modeling

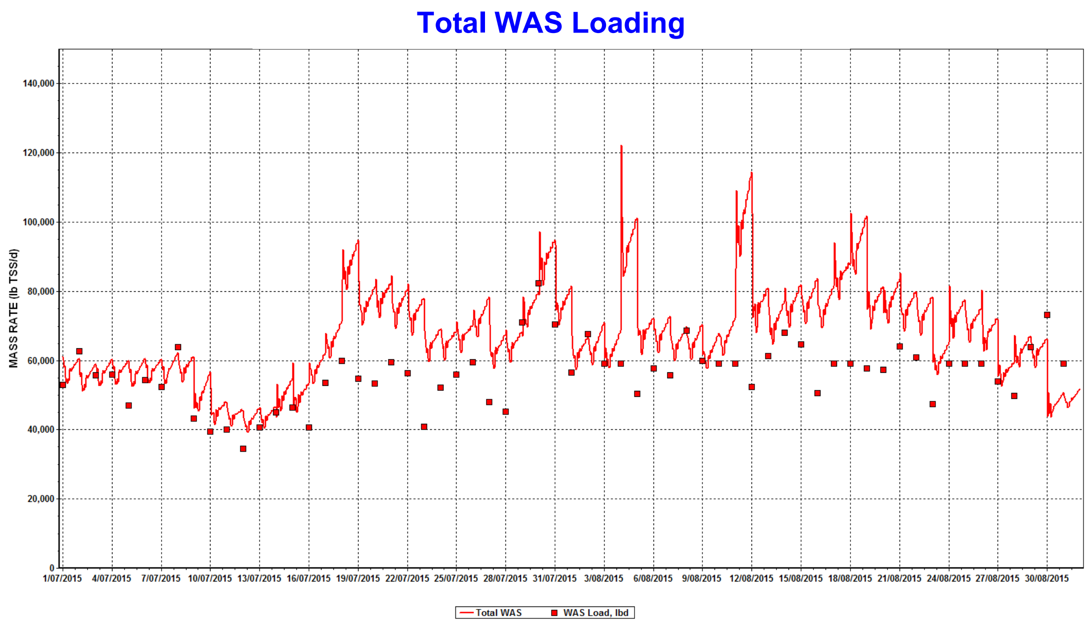
- Detailed sampling data and plant data used to develop Hunts Point Process Model
- Calibrated whole plant model used to develop seasonal glycerol addition strategies

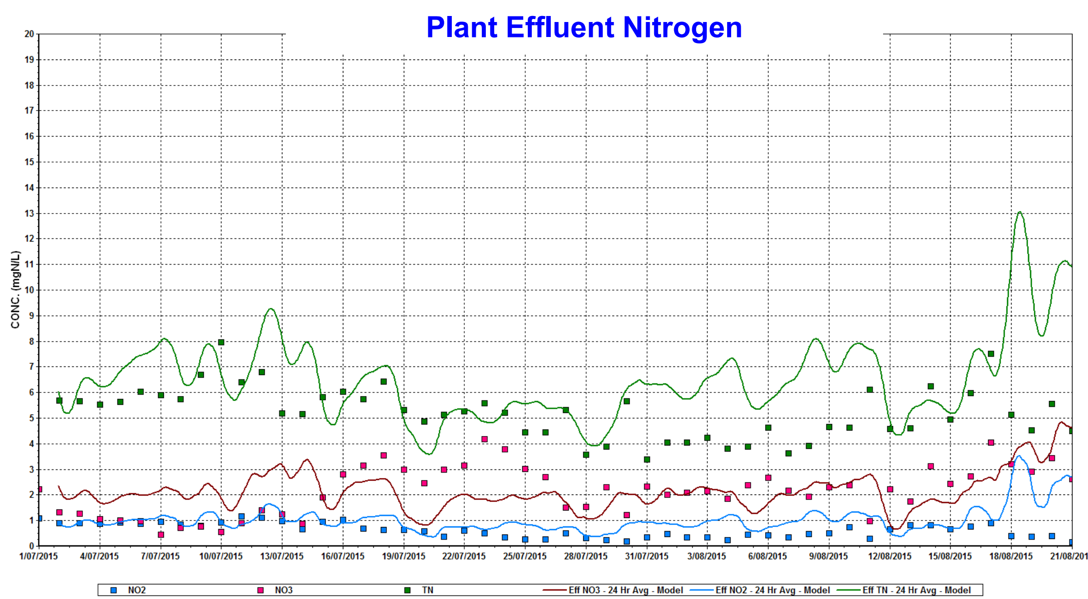


Model Calibration

- Parameters collected from sampling program input into model (DO, MLSS profiles, individual pass glycerol dose)

- Calibration to whole plant provides confidence in SOP model simulations





Standard Operating Procedure (SOP)

Purpose of SOP

- Operational guide in the event of NO3 probe control system malfunctions and/or automated control is unavailable
- Provide set-points for manual carbon addition to the main plant and SCT systems as assurance effluent limit will be met
- Provide operational responses aimed at maintaining over-all plant performance when deviations from the targeted set-points are encountered

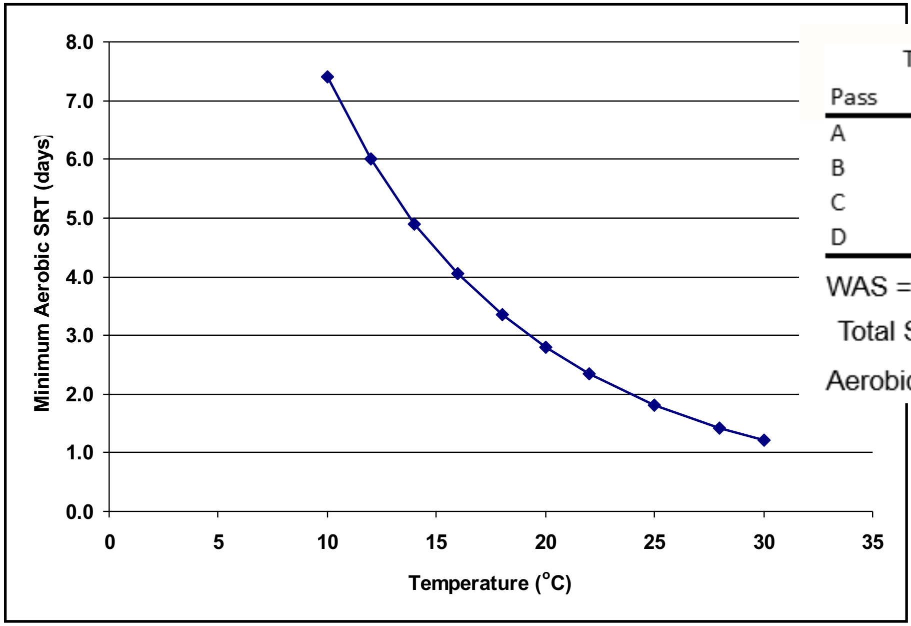
SOP: Main Plant Operational Strategies

Process Control Strategy Elements:

- Nitrification Control
  - Aerobic SRT
  - Aerobic Zone DO Concentrations
  - pH/Alkalinity
- Denitrification Control
  - Anoxic Zone DO Concentrations
  - Supplemental Carbon Dosing Rates and Locations
- Additional BNR Control Elements
  - Wet Weather Operations
  - Aeration tank froth control
  - Effluent disinfection under low/no ammonia conditions

SOP: Main Plant Operational Strategies

- Solids Inventory



Pass	Total Vol (Mgal)	Aerobic Vol (Mgal)	MLSS (mg/L)			MLSS Total (lbs)	MLSS Aerobic (lbs)
A	6.09	3.75	6,200	X	8.34	314,798	194,112
B	6.09	3.75	3,800	X	8.34	192,941	118,972
C	6.09	3.45	2,950	X	8.34	149,783	84,880
D	6.09	4.05	2,500	X	8.34	126,935	84,443
					SUM	784,457	482,406

WAS = 57,920 lb/day

Total SRT = 784,457/57,920 = 13.5 days

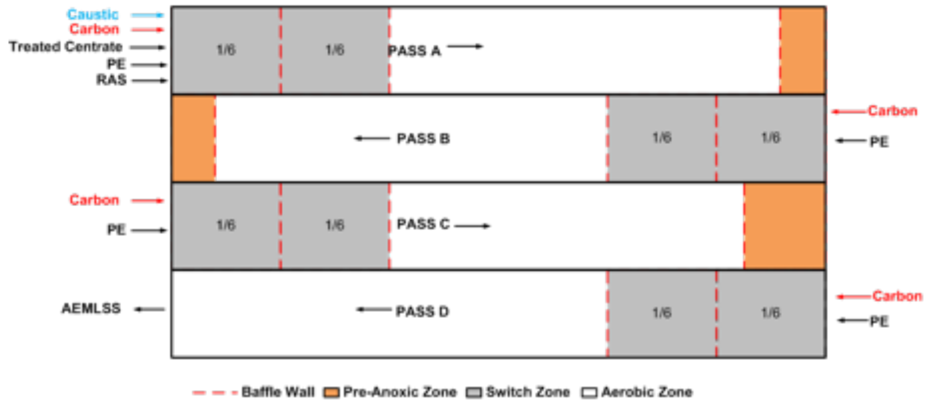
Aerobic SRT = 482,406/57,920 = 8.3 days

- RAS Operation
- Target Primary Effluent flow splits
- WAS and SWAS wasting targets

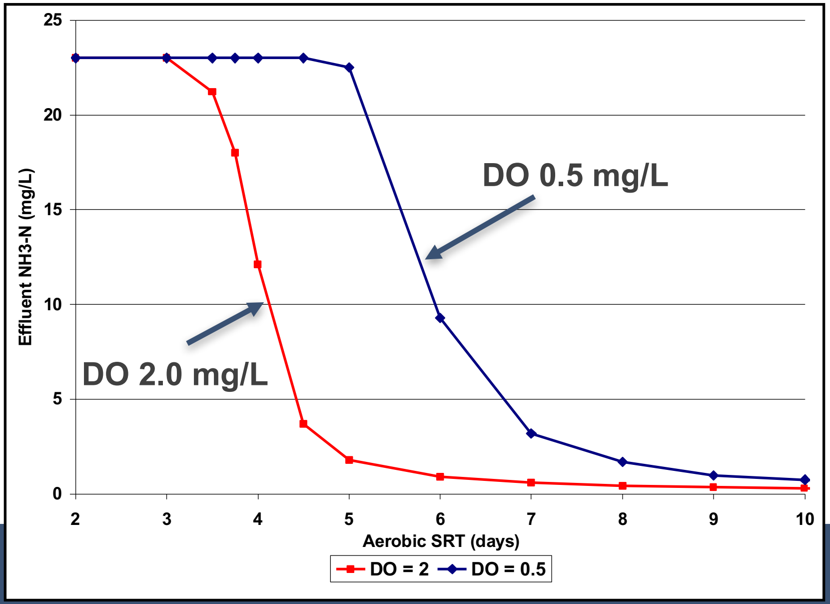
SOP: Main Plant Operational Strategies

Example: Zone Configurations and DO Targets

- Zone Configuration



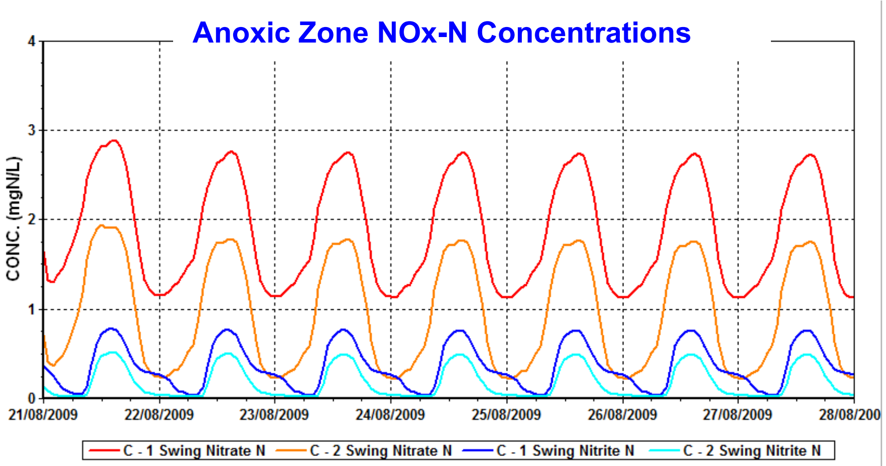
- DO Targets as a Function of Composite Effluent Ammonia-Nitrogen

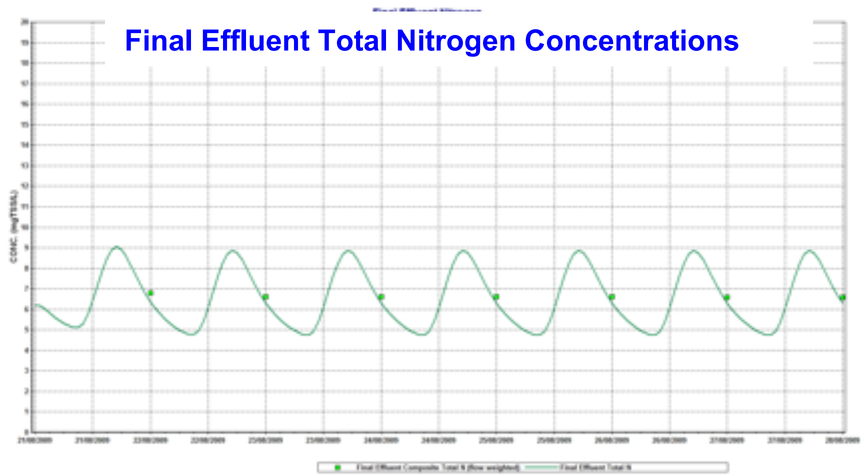


SOP: Main Plant Operational Strategies

Example: Supplemental Carbon Dosing and Dosing Locations

- Calibrated BioWin process model used to develop seasonal glycerol dose rates to the main plant aeration tanks
- Dynamic simulations conducted on a seasonal basis, with and without one aeration tank out of service for maintenance





SOP: Main Plant Operational Strategies

Example: Wet Weather Operations

- Main operations goal during wet weather event = maintain solids inventory, minimize effluent TSS concentrations
- Hunts Point aeration tanks equipped with Pass C bypass gate for Wet Weather flow diversion:
  - Solids inventory is retained and protected in early passes (Pass A & Pass B)
  - Reduces AEMLSS concentrations, resulting in reduced solids loadings to the secondary clarifiers
- Set points for Pass C bypass gate at varying SVI conditions:

SVI	Clarifiers in Operation	Max Allowable AEMLSS at Peak Wet Weather Flow (mgd)	Pass C Flow Wet Weather Flow Gate Opens at (mgd)
80-100	1 OOS Per Battery	2,200	260
100-150	1 OOS Per Battery	2,000	220
150-200	1 OOS Per Battery	1,700	200

SOP: SCT Operational Strategies

Example: SCT Operations

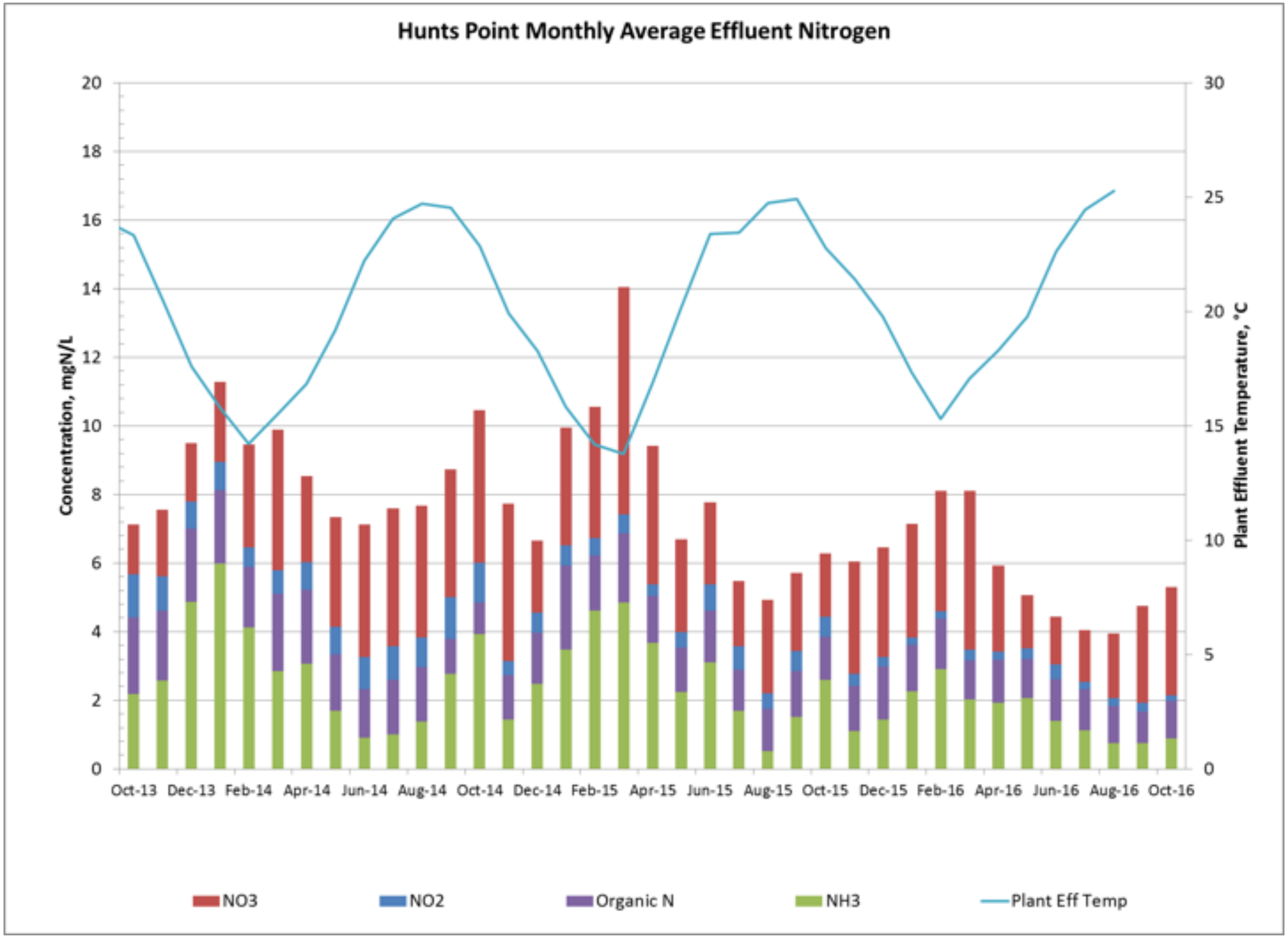
Operation Goals:

- Encourage nitritation (if possible)
- Ammonia Oxidizing Biomass (AOBs) must be selected over Nitrite Oxidizing Biomass (NOBs), which results in high concentrations of nitrite in the SCT effluent
  - Allows for substantial cost savings, by requiring less aeration in the nitrification process, and less readily biodegradable carbon (rbCOD) in the denitrification process

Process Control Strategy Elements:

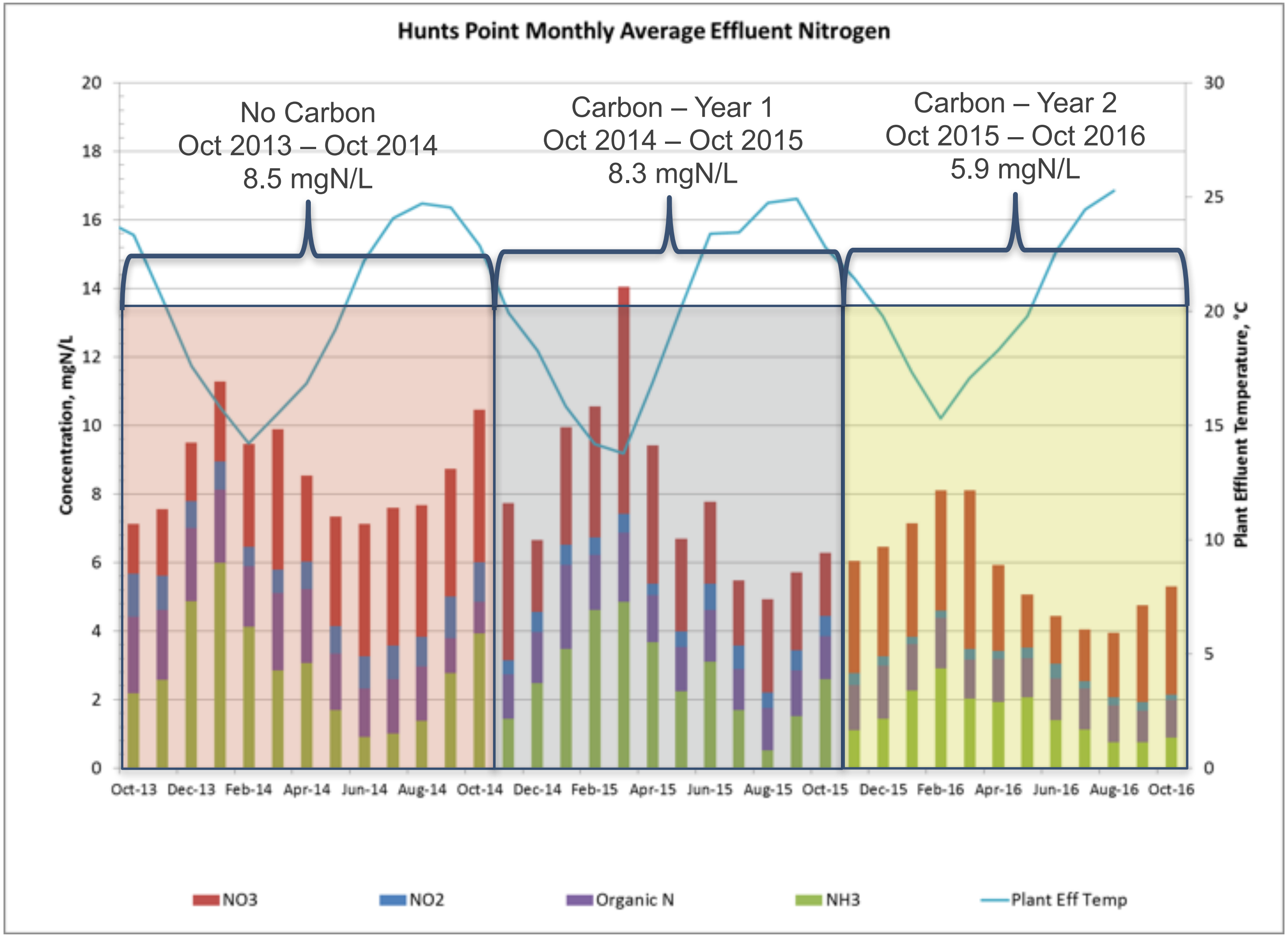
- SCT Internal Recycle Rate
- RAS flow rate
- Dissolved Oxygen Concentrations
- pH/alkalinity including alkalinity addition

Plant Performance



Hazen

Plant Performance



BNR with Carbon Process Guidance Poster

Solids Inventory Targets to Achieve Effluent Ammonia < 2.0 mg/L

Season	WW Temp (°C)	Target Avg MLSS (mg/L)	Target AEMLSS (mg/L)	Total SRT (days)	Aerobic SRT (days)
Summer	23.3	2,700	1,800	10	7.2
Spring	20.8	3,000	2,000	11.6	8.4
Fall	17.4	3,100	2,000	11.8	8.5
Winter	14.7	3,900	2,600	14.5	11.5

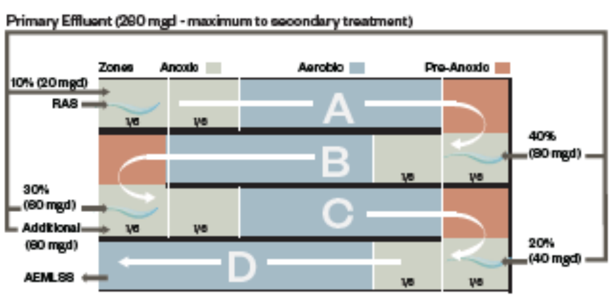
Flow Splits and Oxic/Anoxic Configuration

ALL MAIN AERATION TANKS ONLINE

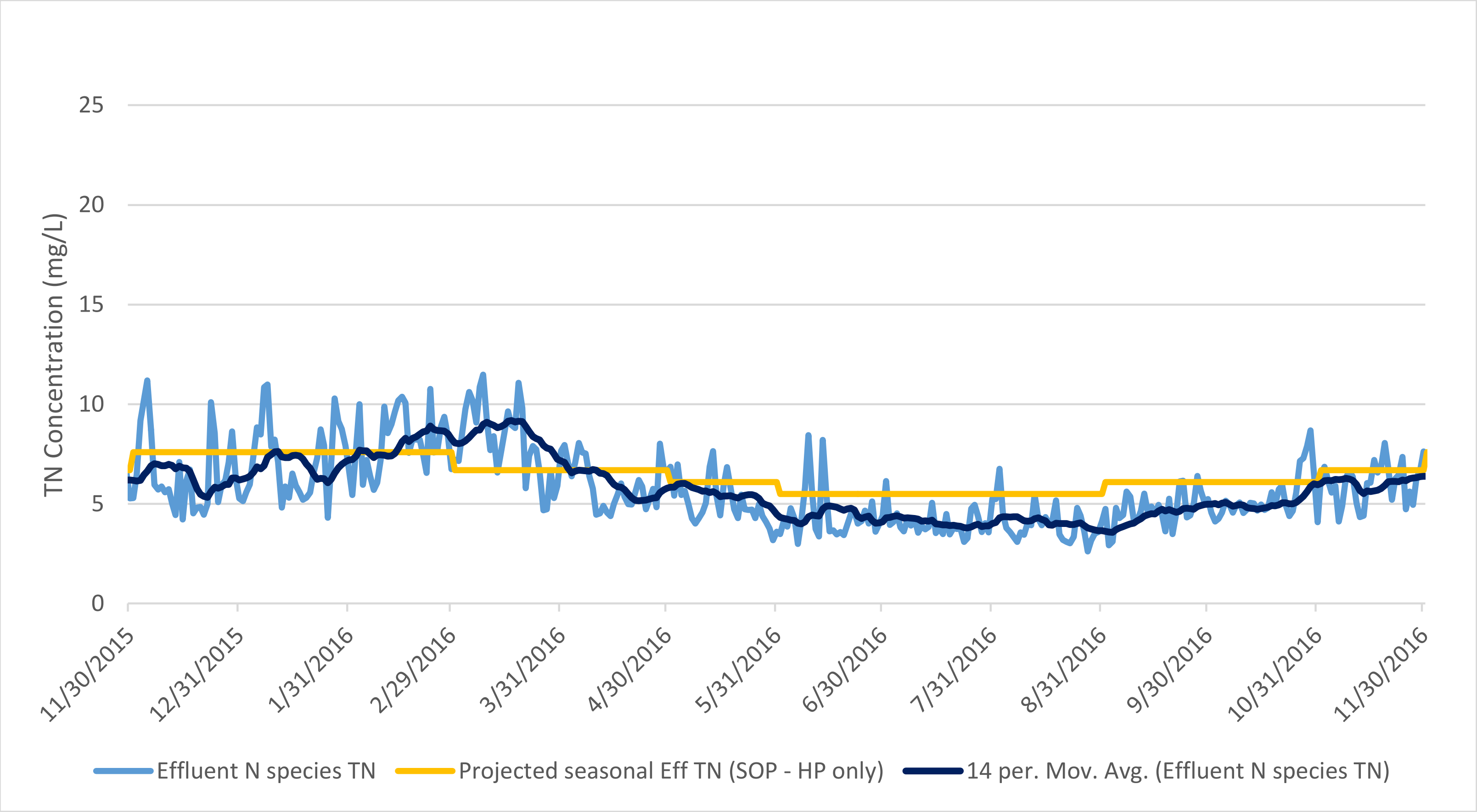
Pass	PE Flow %	Anoxic/Oxic/Preanoxic % Spring/Summer/Fall	Anoxic/Oxic/Preanoxic % Winter
A	10	33/62/5	0/95/5
B	40	33/57/10	33/57/10
C	30	33/57/10	33/57/10
D	20	33/67	33/67

Wet Weather Strategy

- When good settling sludge is observed (i.e., SVI <100 mL/g), the wet weather flow gate in Pass C is activated. Target wet weather flow triggers are dependent on the SVI and current FSTs in service.
- As the SVI increases, the wet weather mode of operation must be initiated at lower flow rates.
- Figures 10 and 11 provide guidance on the flow rate at which the Pass C wet weather gate should be opened under standard operating conditions.
- Turn carbon off



Comparison of Effluent TN to Predicted TN



Acknowledgements

Sarah Galst, Hazen and Sawyer

Mike Lynch, Hazen and Sawyer

Robert Sharp, PhD, Hazen and Sawyer

Laura Grieco, NYCDEP

Millie Soriano, NYCDEP

Peter Pianelli, NYCDEP

Antonio Ho, NYCDEP

Sampling Team – CH2M