



# **Sustainable BNR Process Aeration Design and Optimization**

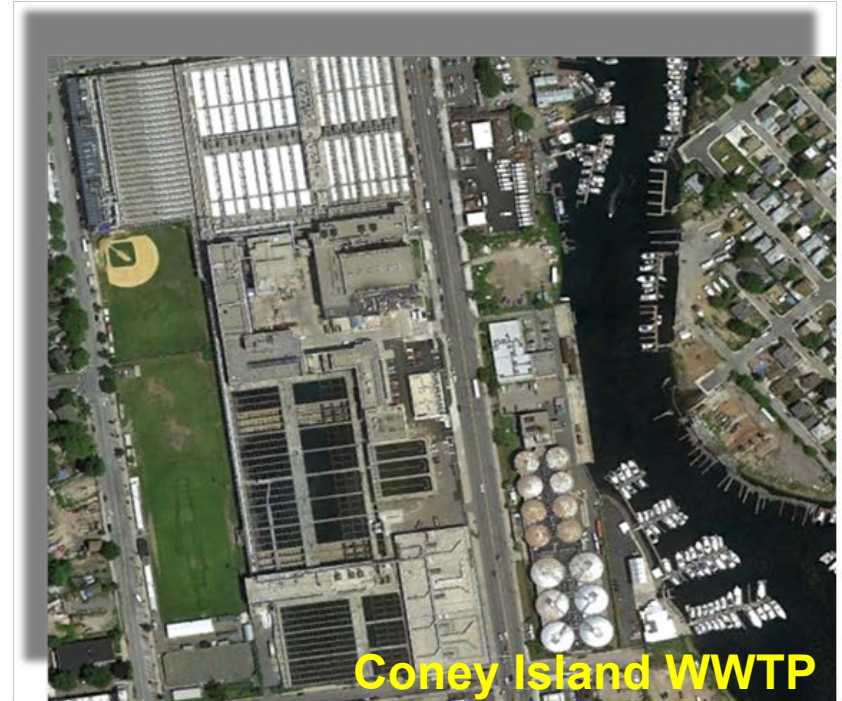
## **NYC DEP BEDC In-House Design**

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Jiren He

# Agenda

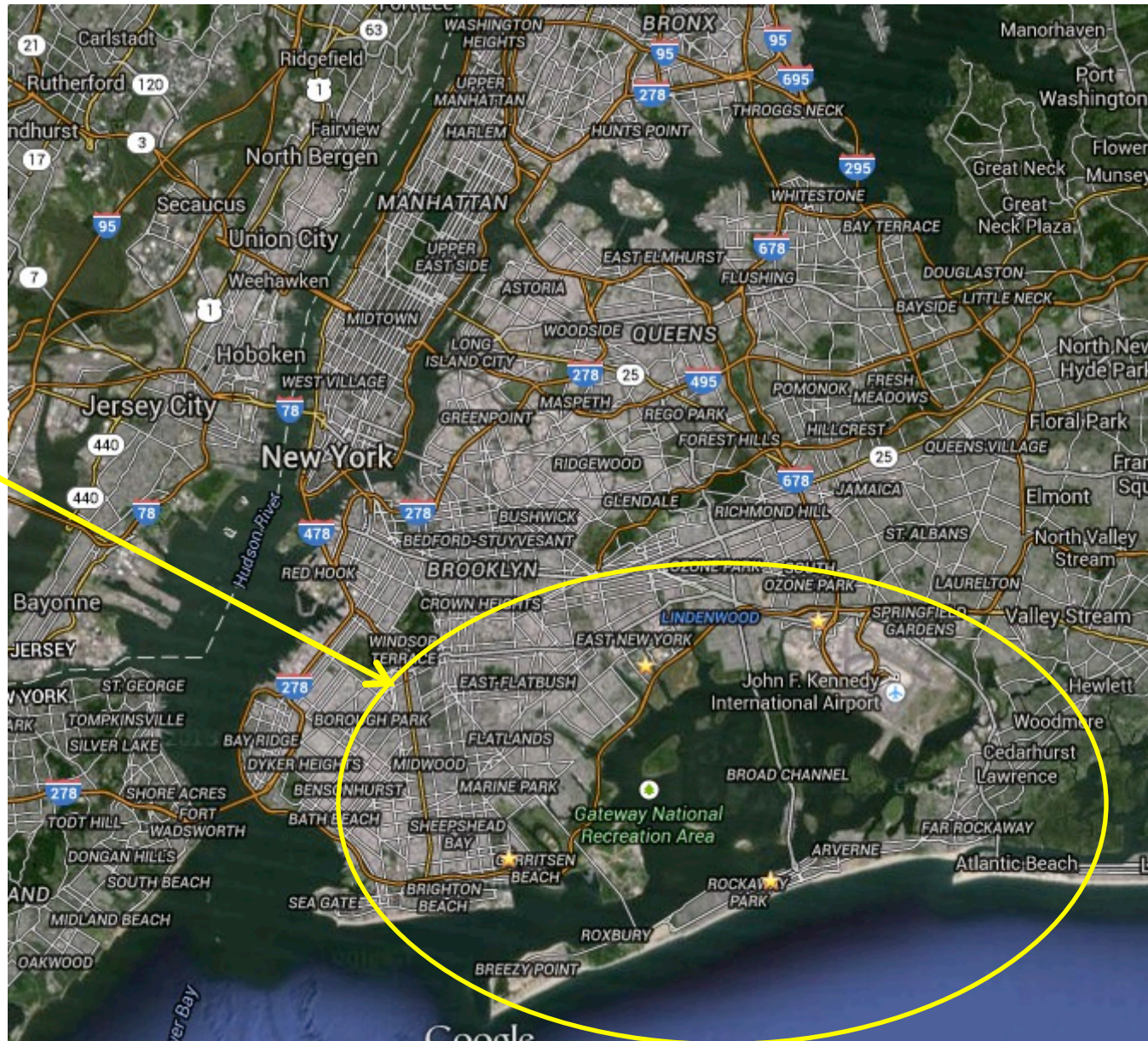
- Jamaica Bay Nitrogen Consent Order
- Brief Overview of Coney Island BNR Upgrade
- NYC WWTP Aeration System Benchmark
- BioWin Modeling
- Process Air Blowers and BNR Process Aeration Requirements
- Process Air Piping
- Diffuser Design
- DO Control
- Channel Mixing
- Questions





# Jamaica Bay Nitrogen Consent Judgment

Jamaica  
Bay





# Jamaica Bay Nitrogen Consent Judgment



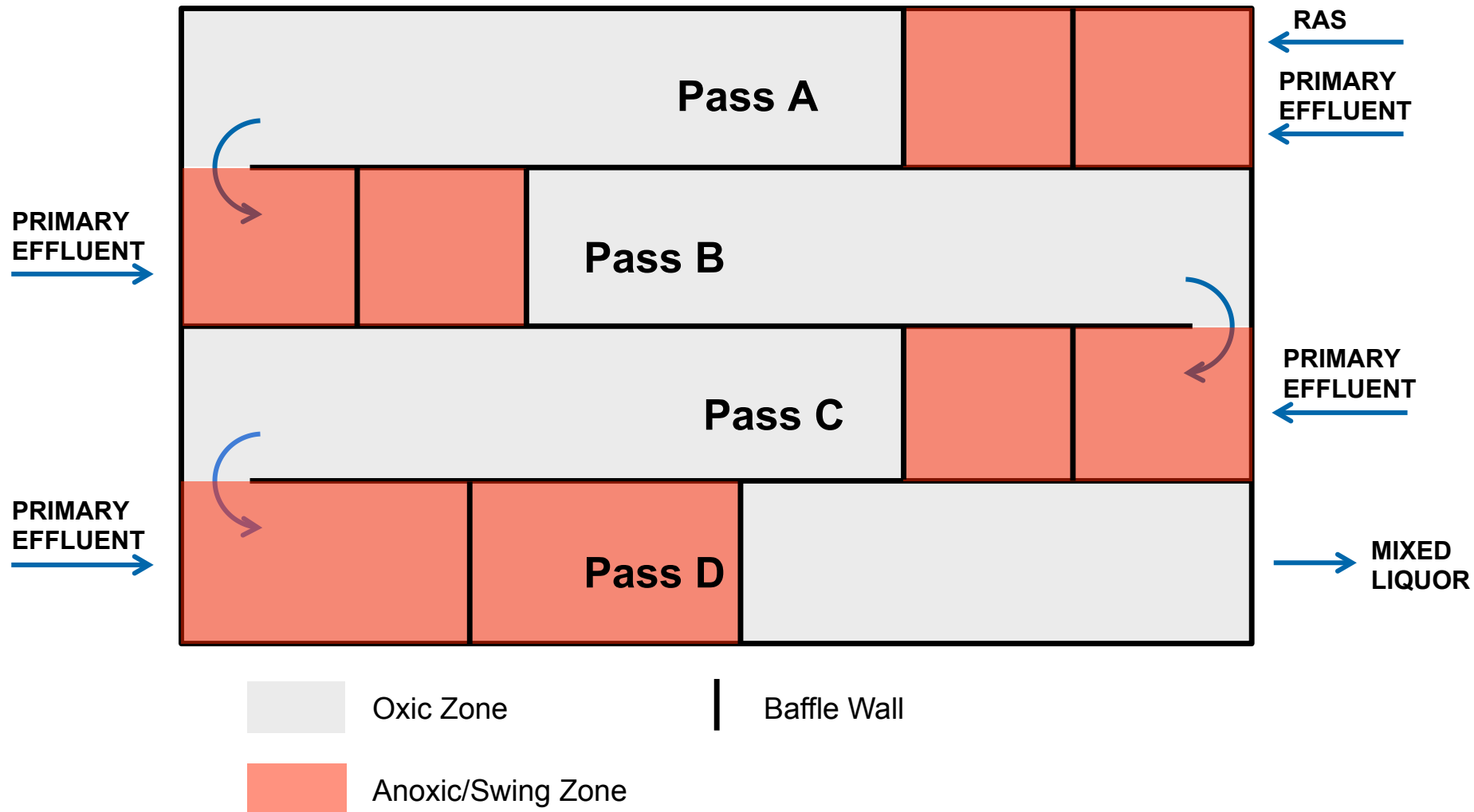
# Coney Island BNR Upgrade



- Treats domestic and combined sewer wastewater
- 110 MGD dry weather flow
- 165 MGD flow through secondary treatment
- 220 MGD wet weather flow
- 4 aeration tanks with a total volume of 16.7 MG
- How do we accomplish Step Feed BNR?
  - Increase SRT
  - Aeration requirements expected to increase to meet nitrification requirements
  - Create anoxic zones for denitrification

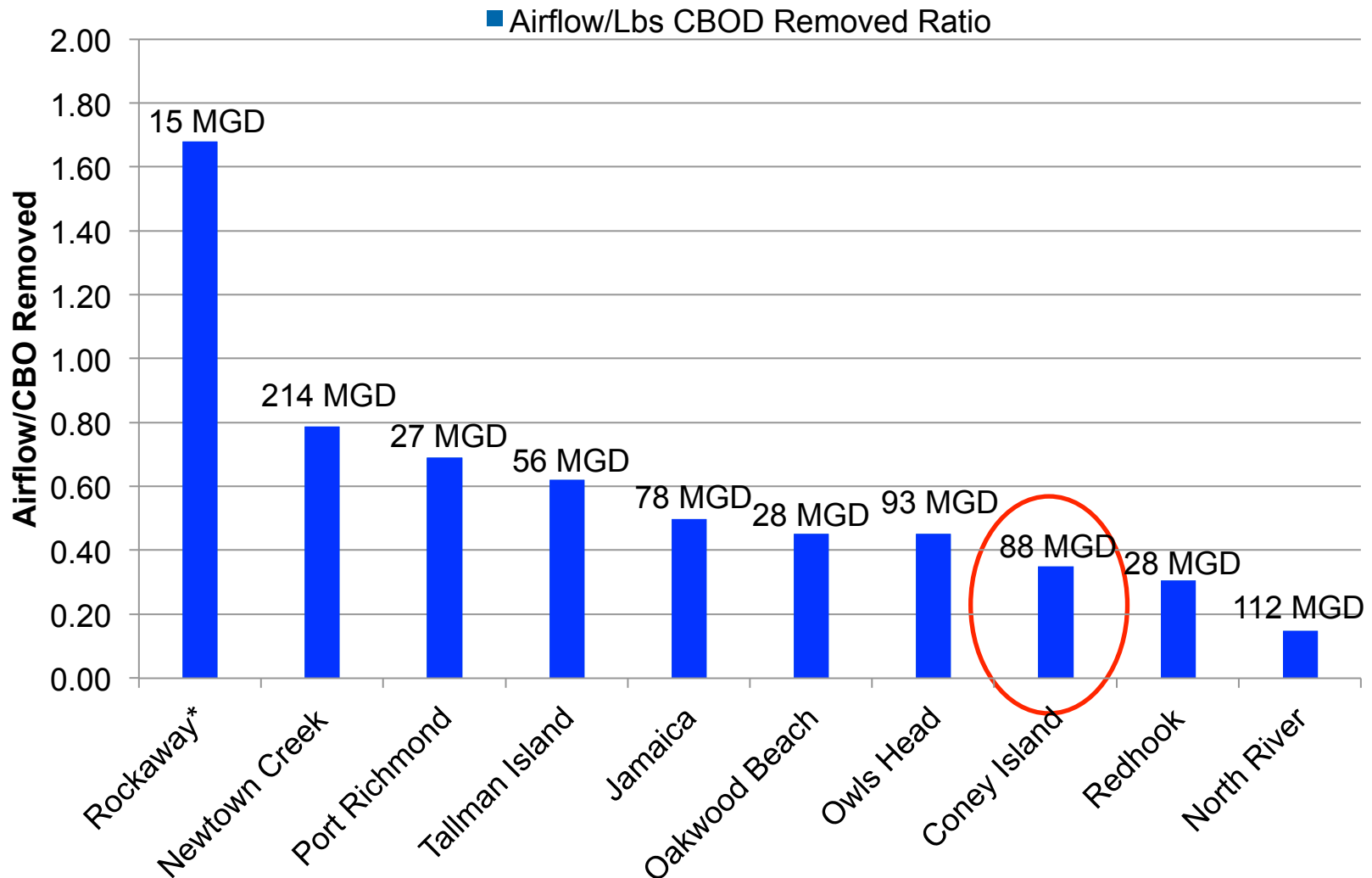
# Coney Island BNR Upgrade

## Anoxic and Oxidic Zones



# NYC WWTP Aeration Benchmark

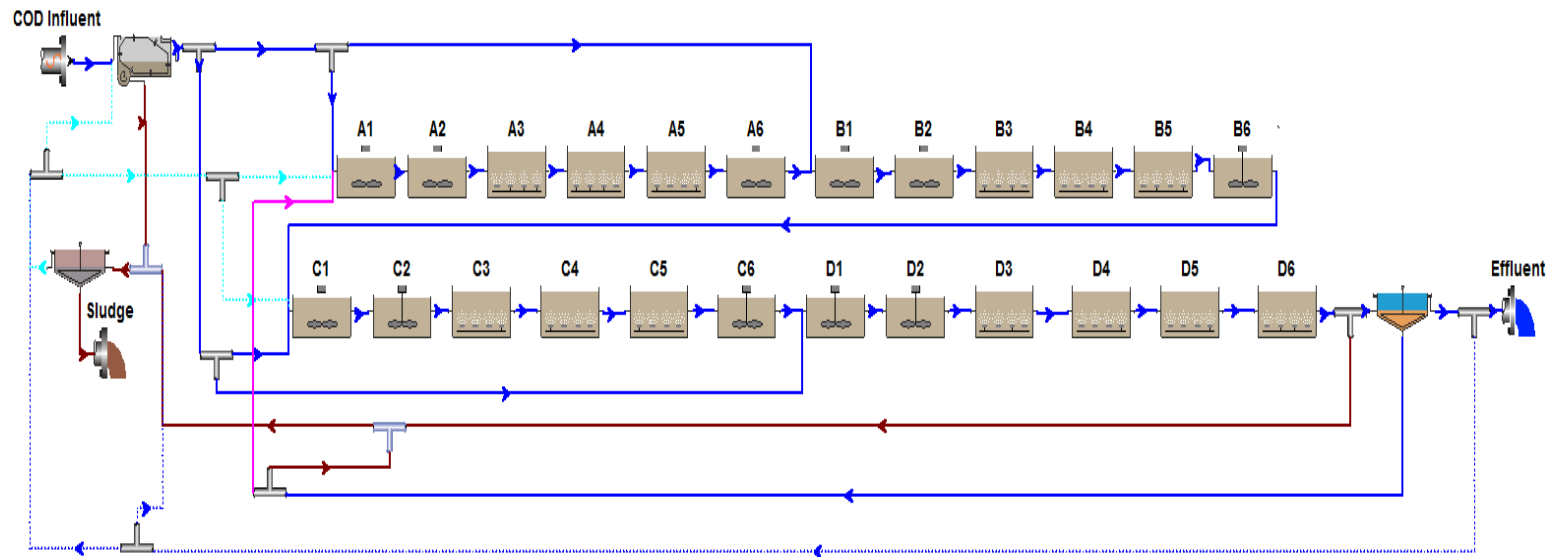
## Airflow per Lbs of CBOD Removed At NYC WWTPs



Data taken from historical plant monthly data from 1/2013 – 12/2013.

\*Rockaway data was taken from 11/2011 – 10/2012

# BioWin Modeling



- BioWin was used as a process modeling tool to predict aeration requirements at different loadings and wastewater temperatures
- Model Calibration is important
- Used for aeration system design
  - Optimize operations and equipment at future average conditions
  - Predict treatment results
  - Stress test BNR operation at maximum month conditions

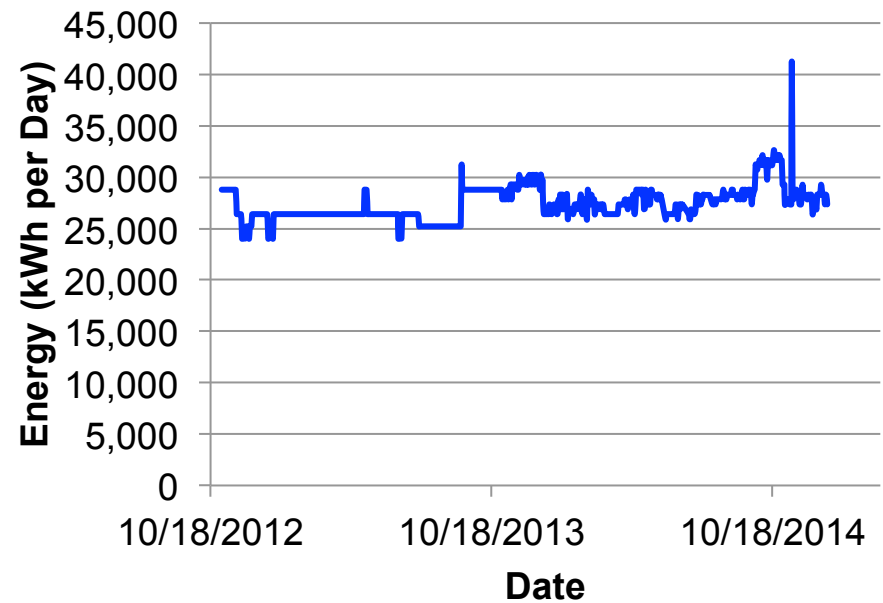


# Process Air Blowers



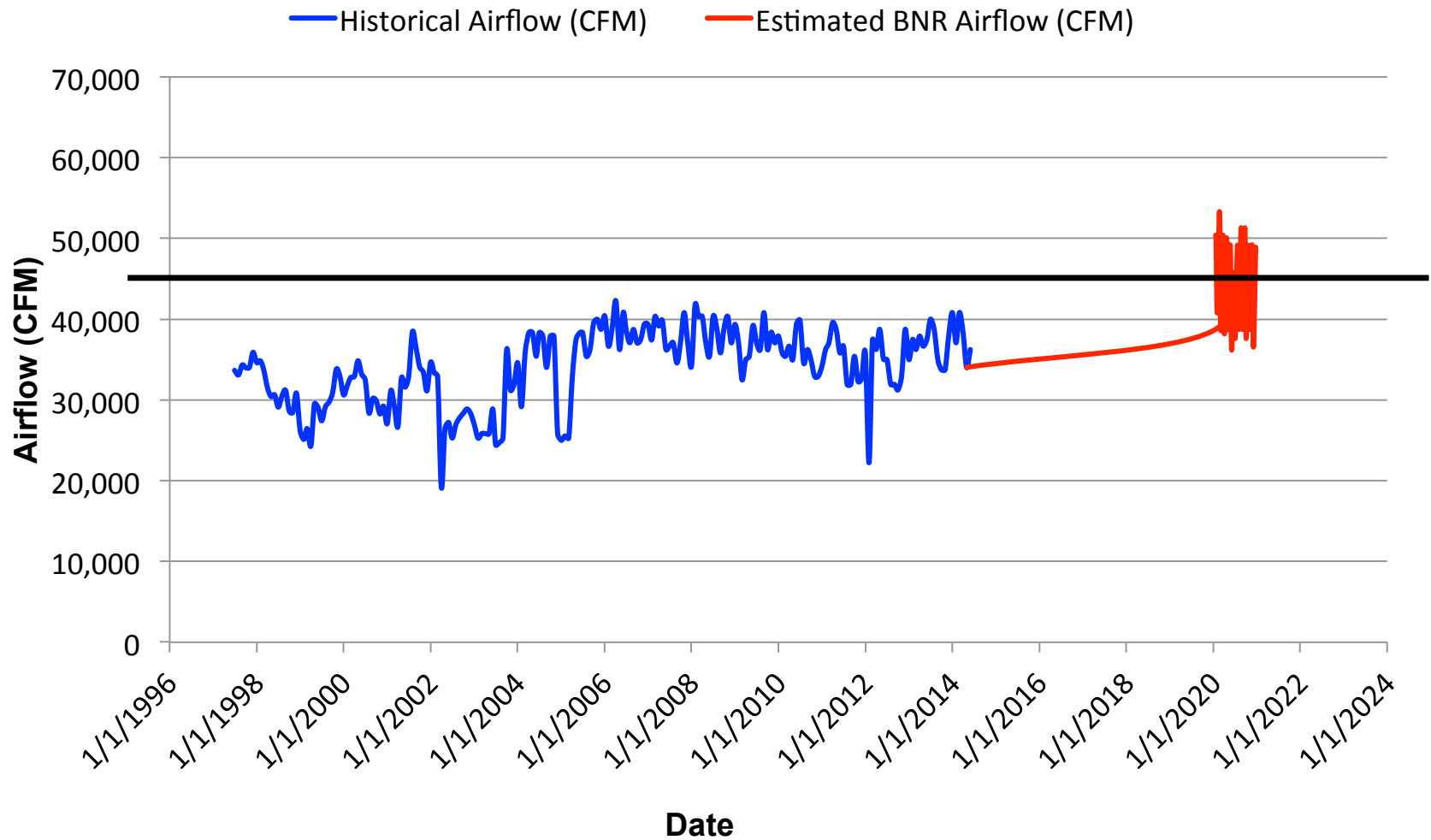
- 4 Dresser-Roots two-stage centrifugal process air blowers rated at 23,800 SCFM at 8psi
- 3 duty and 1 standby
- Maximum Capacity of 71,400 SCFM at 8psi
- Originally manufactured in 1958 and refurbished in 1990s

**Estimated Blower Energy Consumption (kWh/day)**

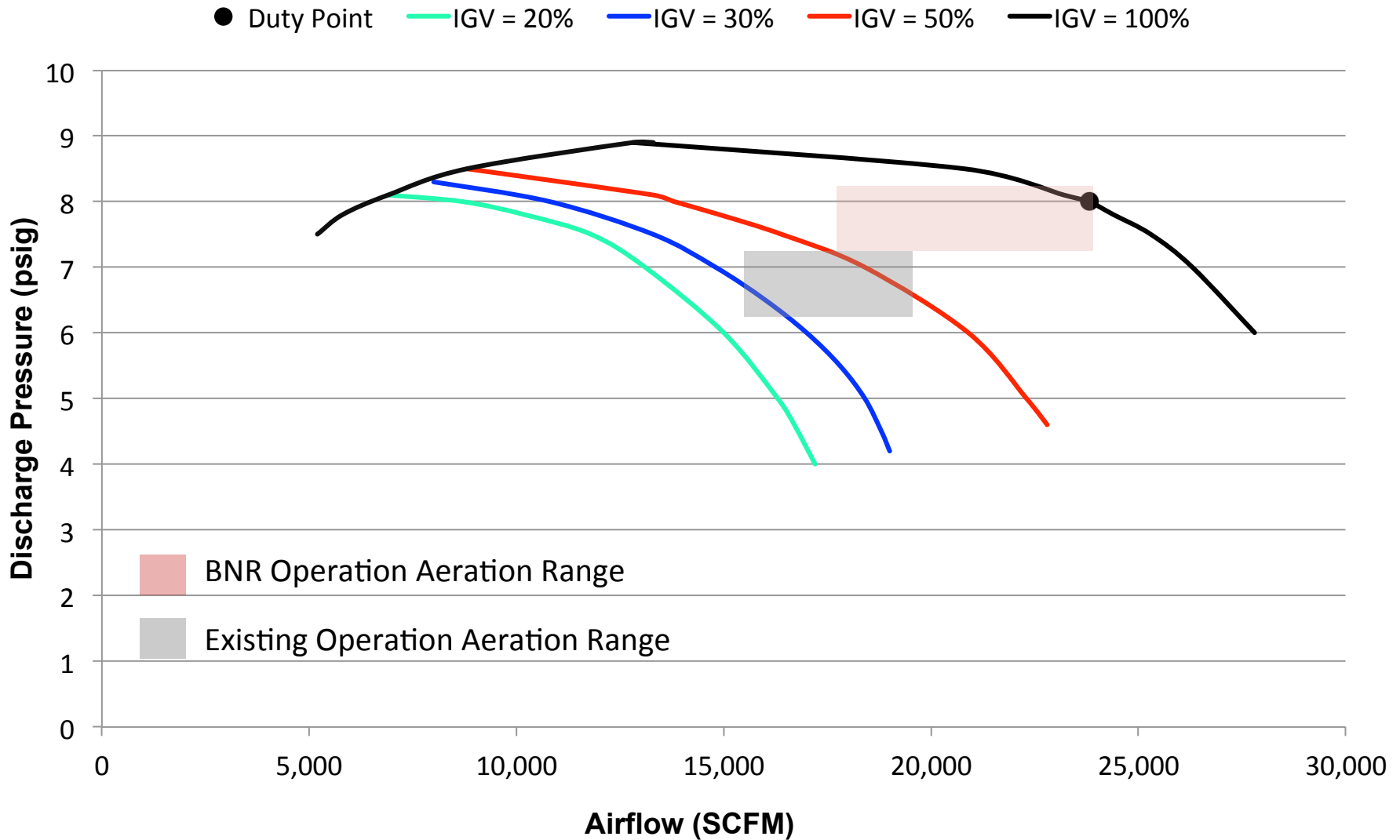


# Coney Island Aeration Requirements

## Coney Island Airflow



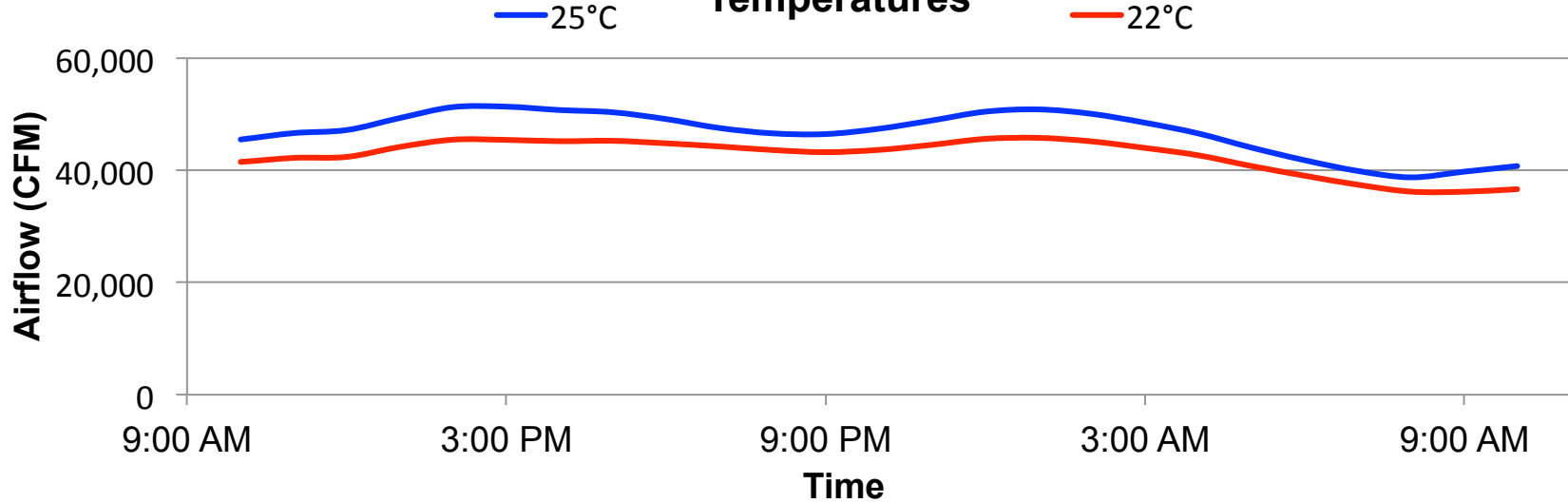
# Blower Efficiency



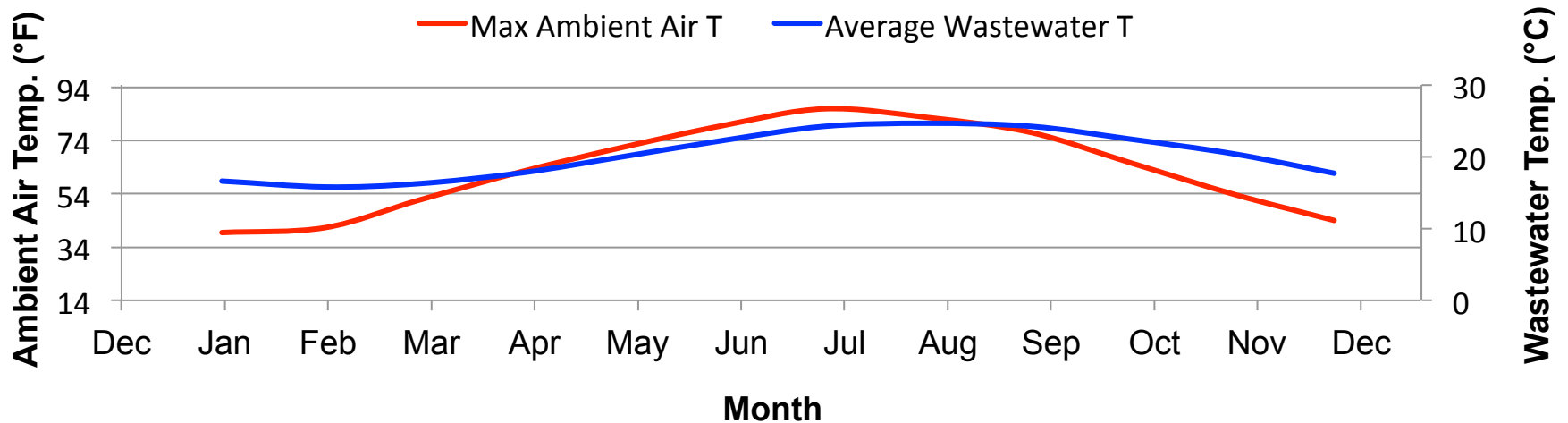


# Temperature Effects on Blower

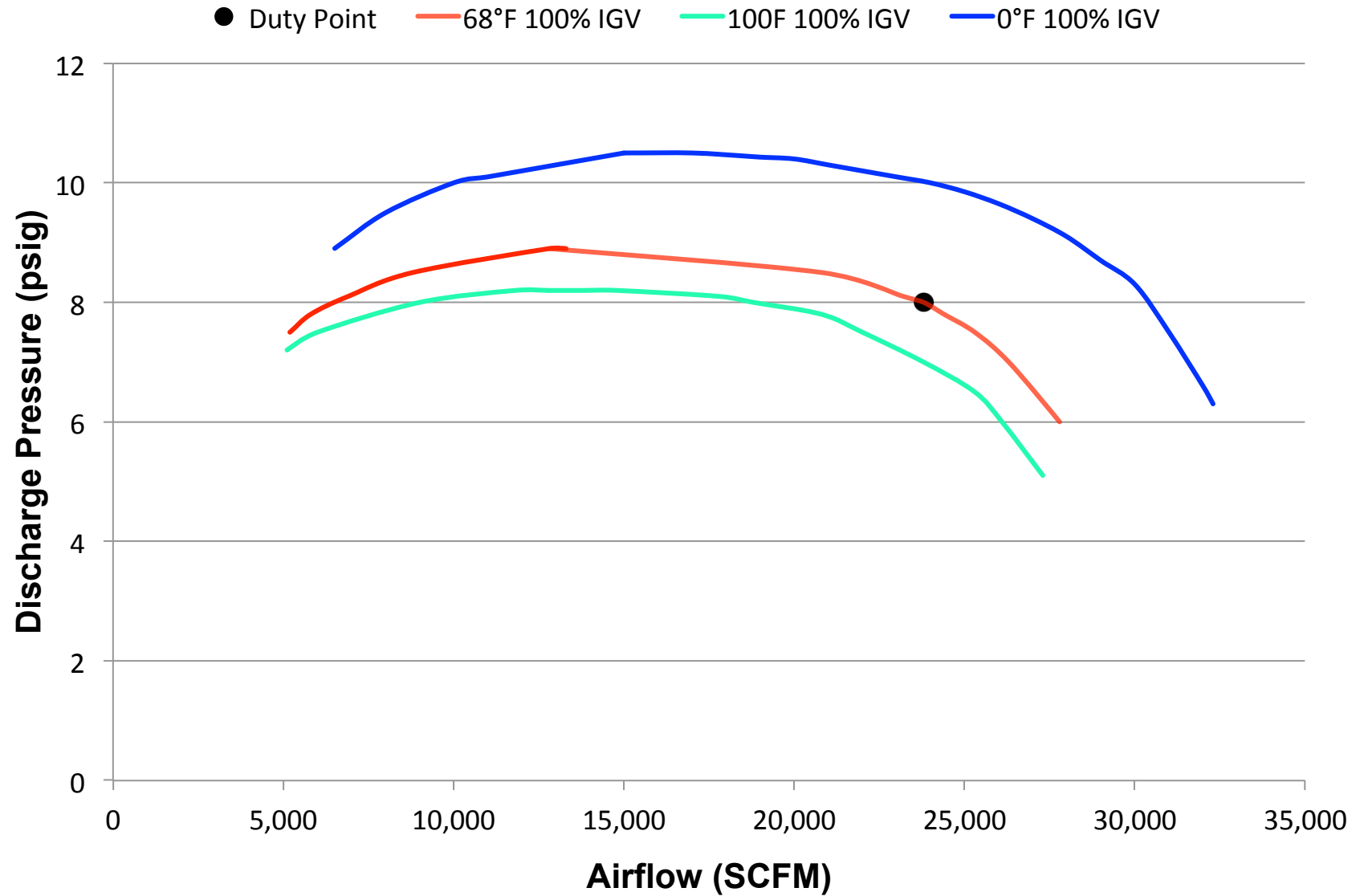
**Future BNR Aeration Requirements at Various Wastewater Temperatures**



**Ambient Air and Wastewater Temperature at Coney Island WWTP**

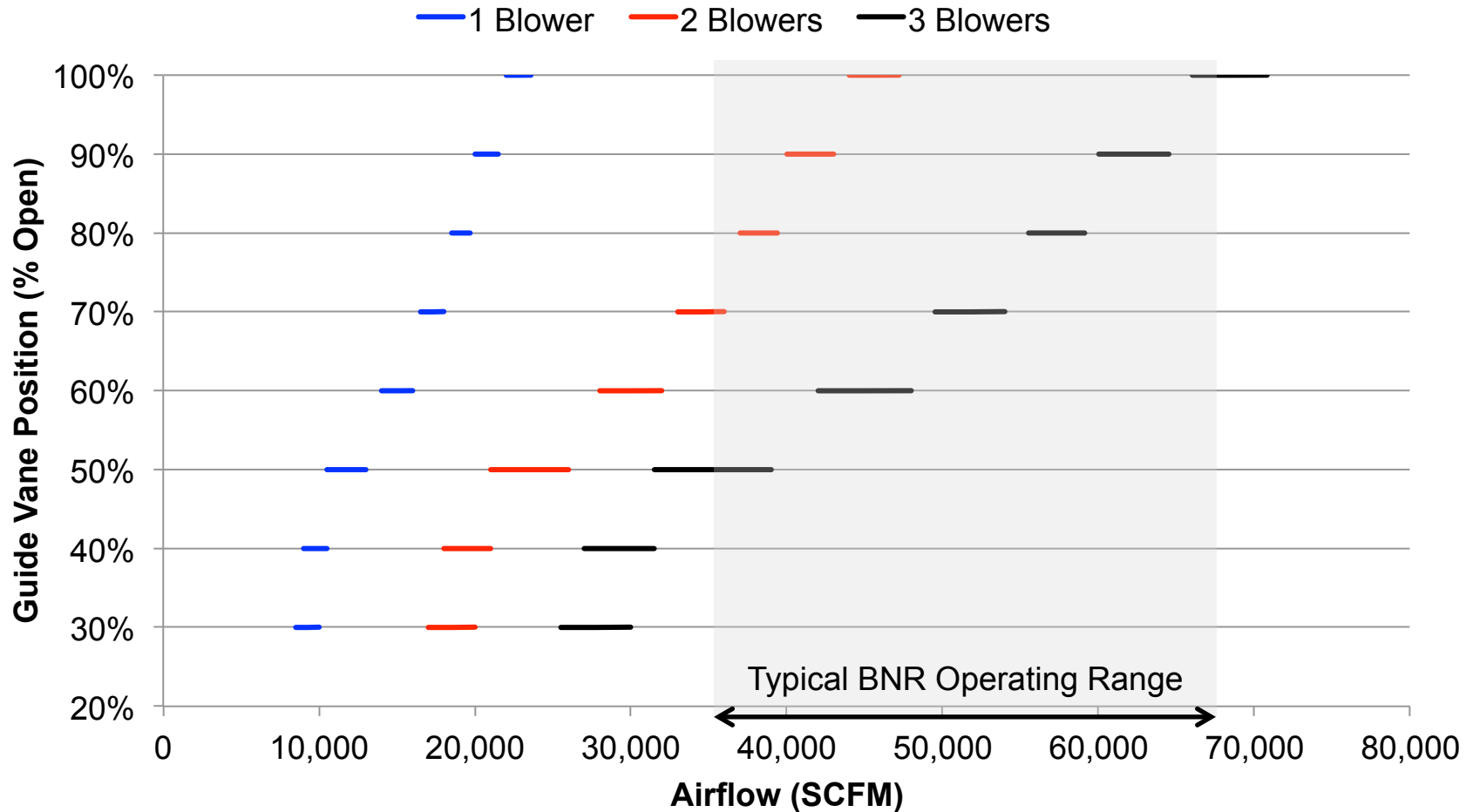


# Temperature Effects on Blower



# Blower Turndown

## Coney Island Blower Capacity



Not having enough turndown uses excess energy and causes dangerous blower surge



# Process Air Piping



- Eliminate pipe leaks
- Check control valve sizing
- Consider decentralized blowers

# Diffusers

- Type
  - Coarse Bubble
  - Ceramic Fine Bubble Disk
  - Membrane Fine Bubble Disk
- Alpha and Fouling Factors
- Layout
- Design for average conditions
- Stress test at maximum conditions
- Prevent surge at minimum conditions



*Ceramic Disk Diffusers at  
Coney Island WWTP  
Photo from Sanitaire Diffuser Product  
Brochure*



*Membrane Disk Diffuser  
Photo from Sanitaire Diffuser Product  
Brochure*



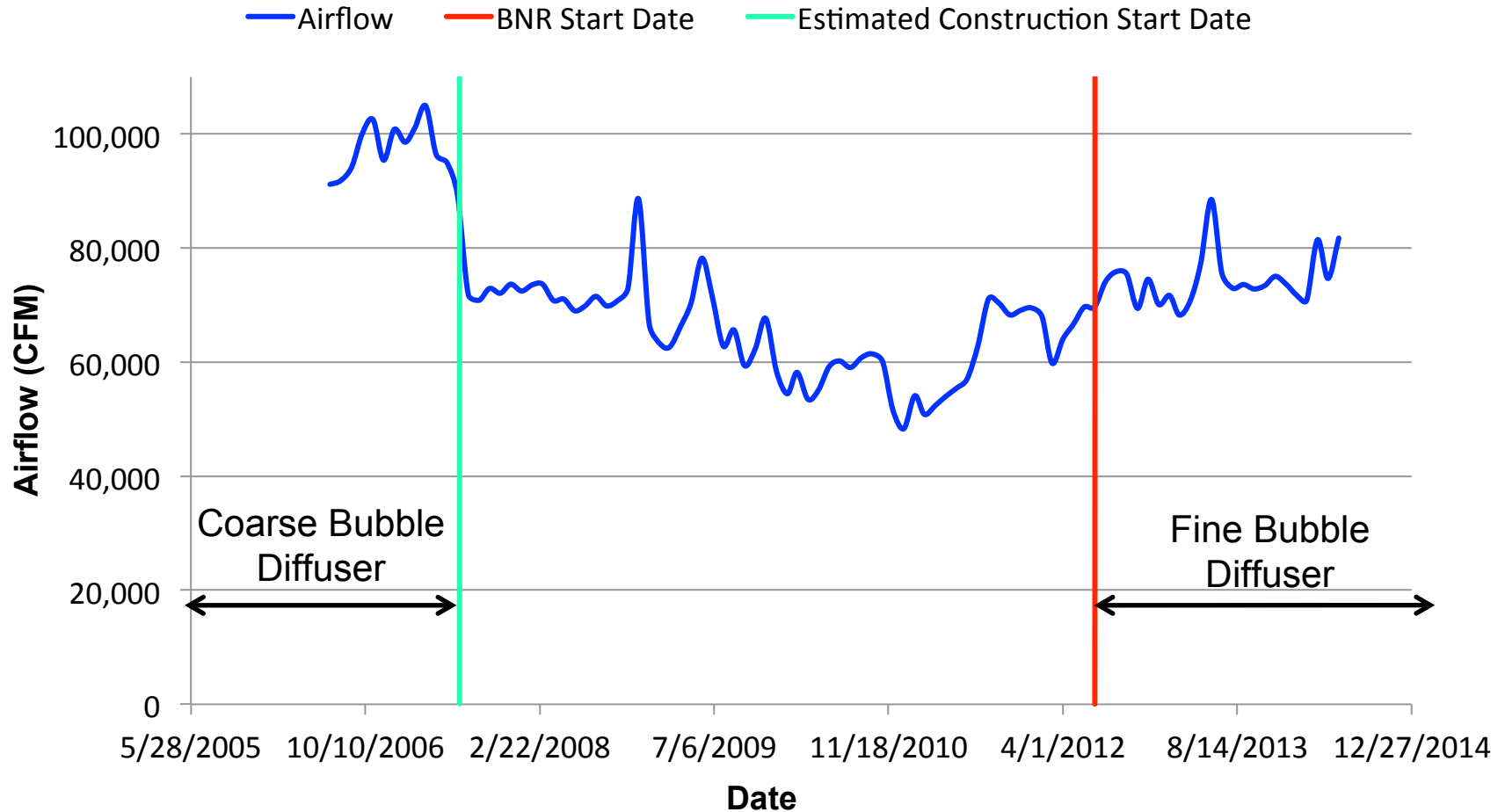
*Coarse Bubble Tube Diffusers at  
Rockaway WWTP*



*Ceramic Dome Diffusers at  
Coney Island WWTP*

# Bowery Bay WWTP Before and After BNR

## Bowery Bay Airflow (CFM)



Negative Net Aeration Requirements after a BNR upgrade. Diffuser efficiency is a key component for optimization.



# Diffuser Fouling

- Earlier Passes have more biofilm accumulation and clogging
- Different  $\alpha F$  factors throughout aeration tanks
- Diffuser fouling increases head losses
- Ceramic Diffusers are more likely to clog

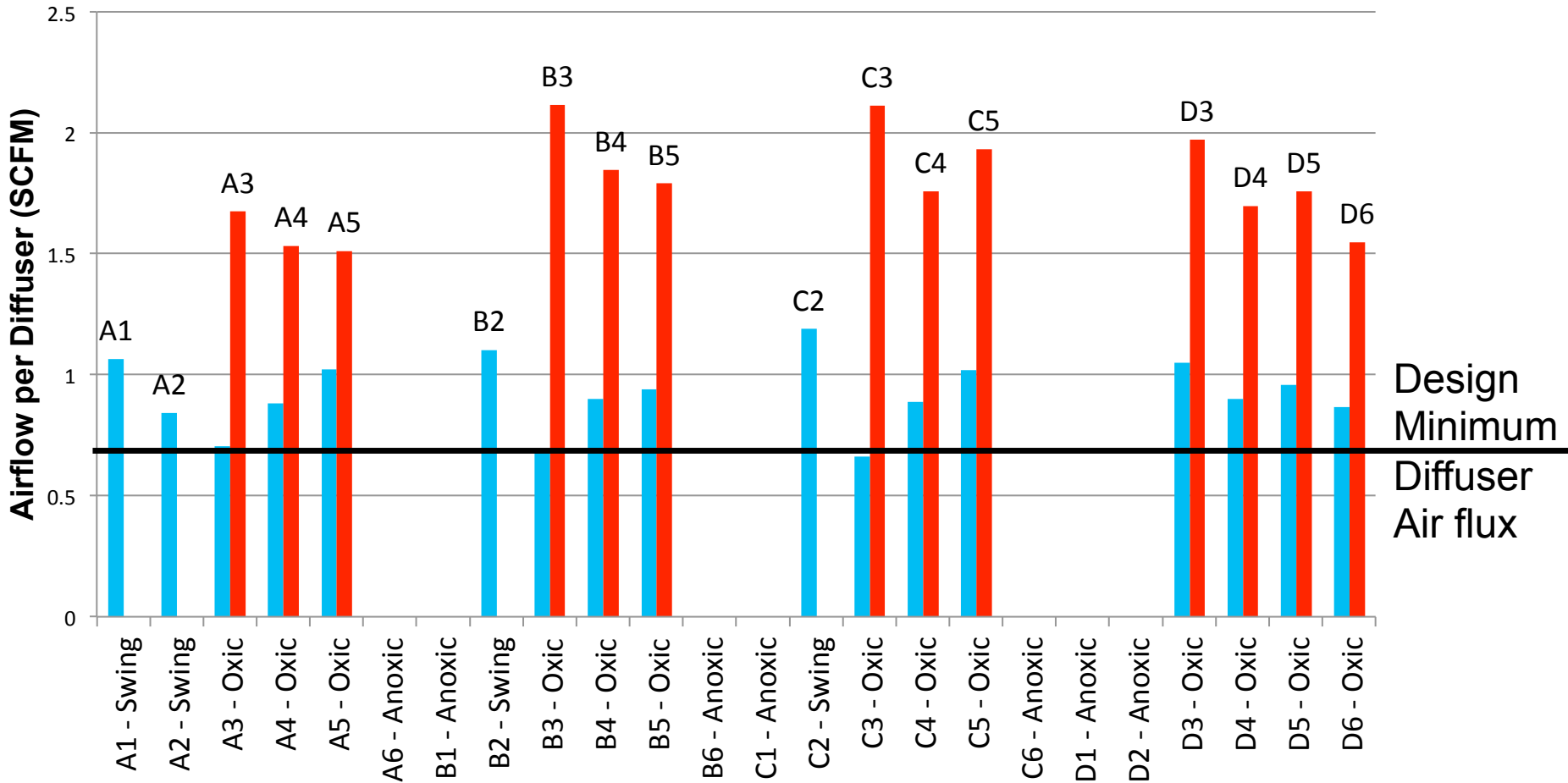


Pass A

# Diffuser Design

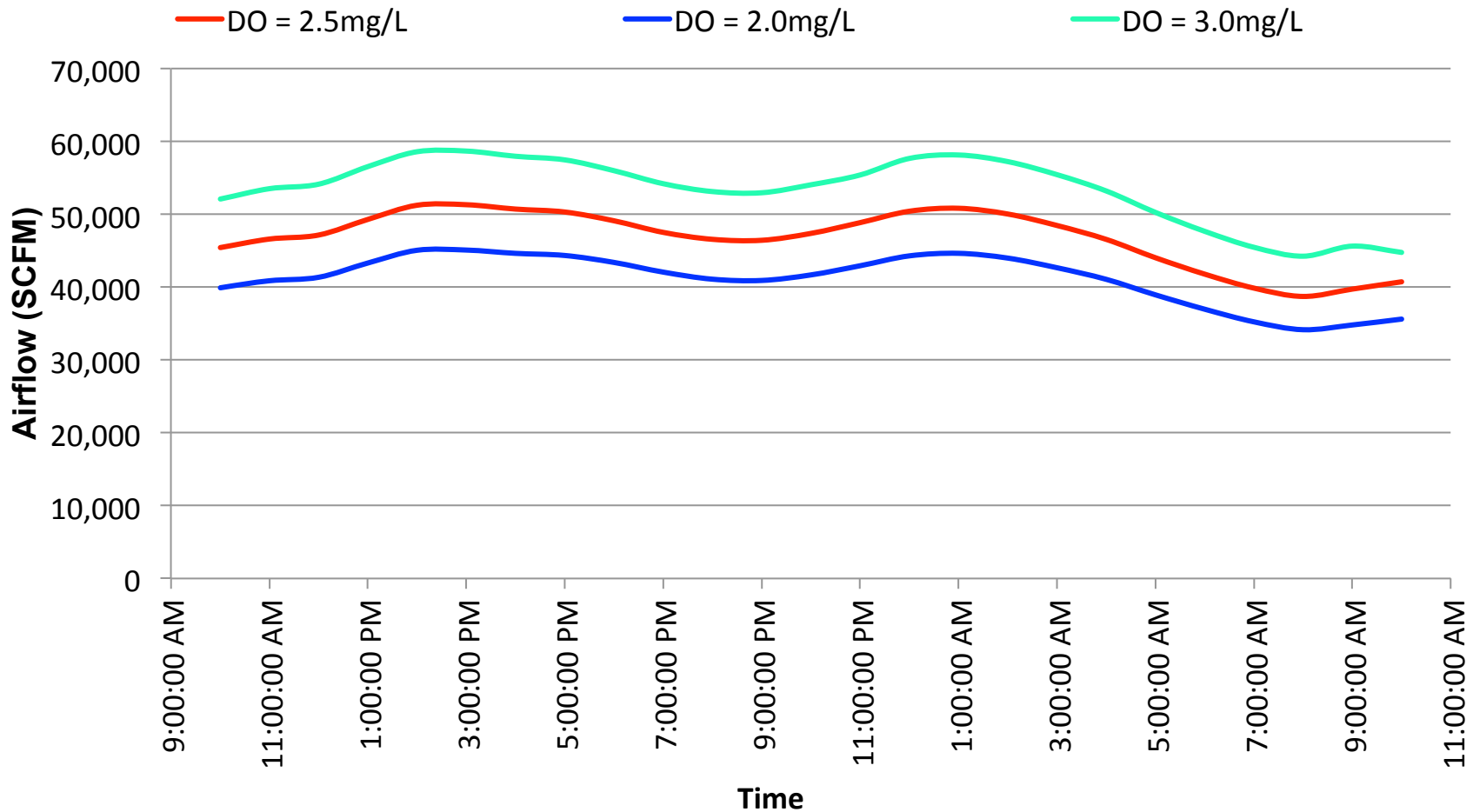
## Air Flux through Diffusers

■ Minimum Air flux at 15° C    ■ Average Air Flux at 20° C



# DO Control

## Coney Island Projected Future Average Airflow Requirements at 25°C



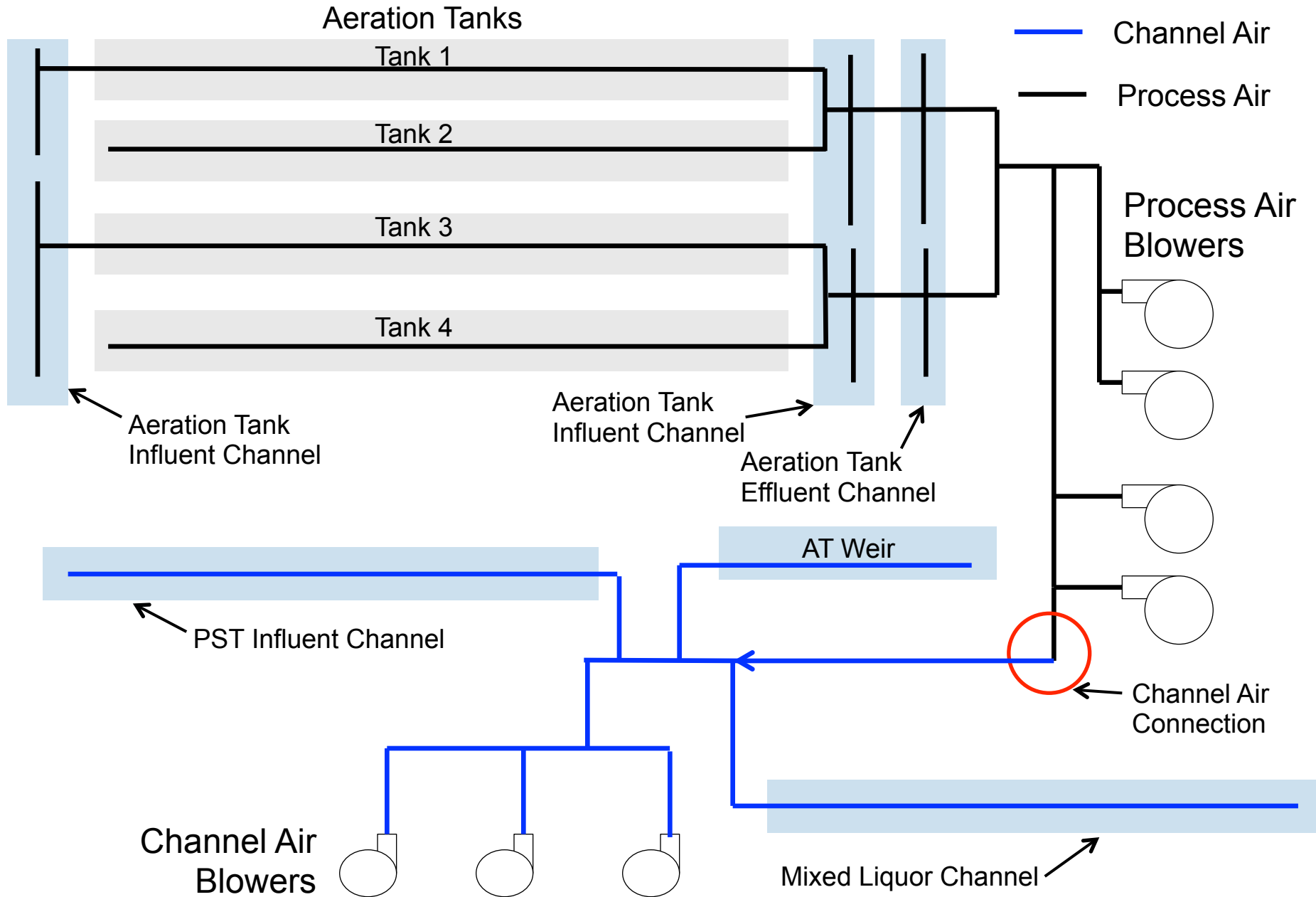
Changing the DO Setpoint by 1mg/L → 10,000 SCFM Increase

# Channel Mixing

- Most channels at NYC plants are mixed using coarse bubble diffusers and process air
- At Coney Island ~10% of process air is used for channel mixing
- Advantages of a separate channel mixing system:
  - Increase capacity for process aeration
  - Reduce denitrification problems
  - Save energy
  - Save \$190,000 operating cost savings per year
  - Operational flexibility

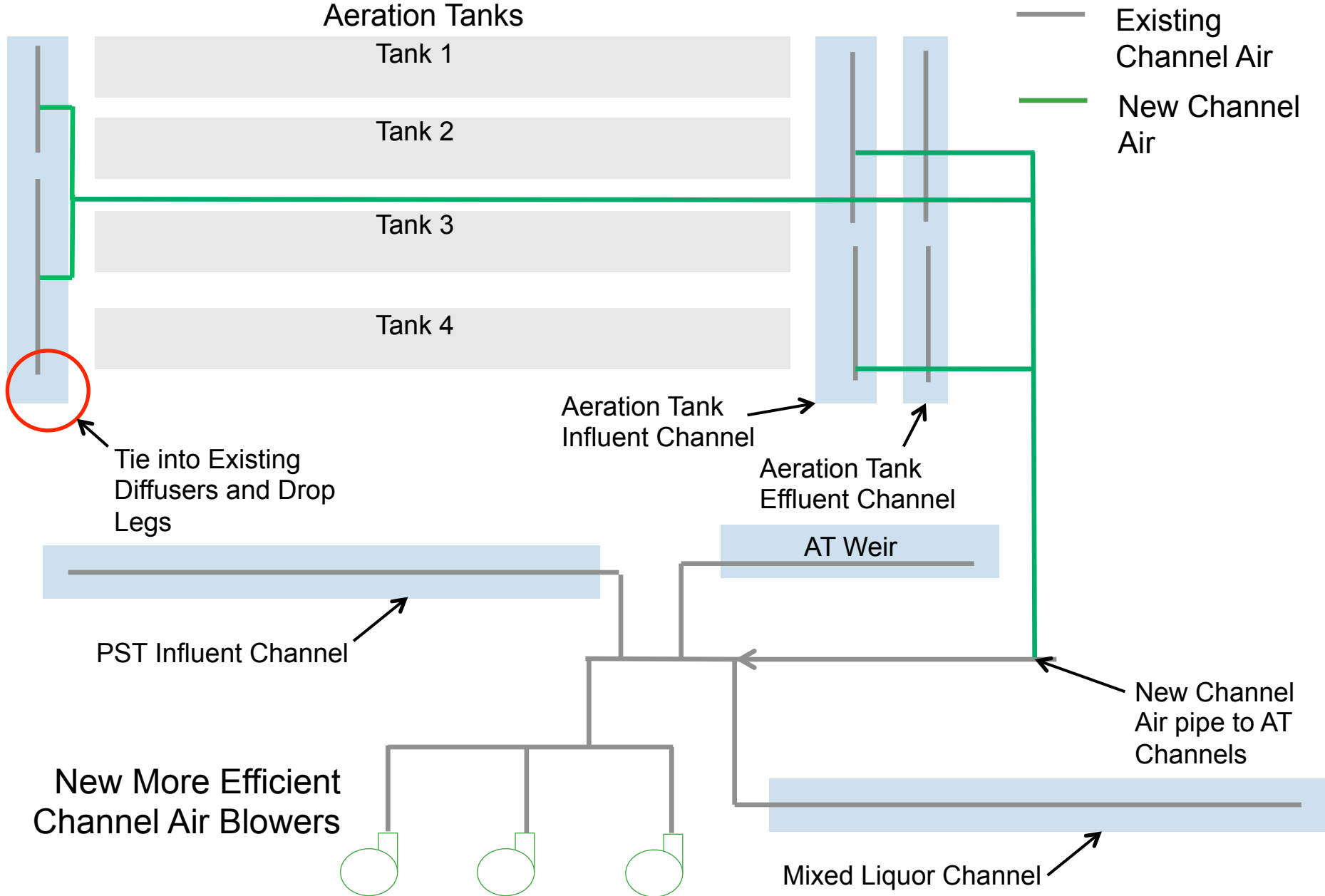


# Existing Channel Aeration System



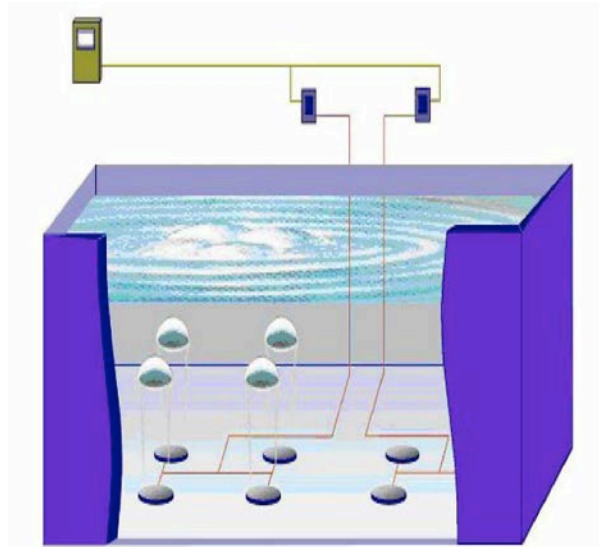


# Channel Aeration System Modifications



# Pulsed Air Channel Mixing

- Significant energy savings
  - Remove coarse bubble diffusers
  - Air supply not required to be continuous
- No moving or mechanical parts
- Low D.O. transfer
- Minimal life-cycle costs
- Channel mixing application has not been tested in NYC WWTPs



*Photos from CCNY report: Evaluation of Anoxic Zone Miners at the Red Hook WPCP, 2007.*

# Summary

- Benchmark Existing Performance
- Model Future Requirements
- Evaluate existing blowers at different loadings and temperatures
- Design diffuser grid to operate efficiently at average conditions
- Evaluate channel mixing alternatives

## Questions?