Environmental Protection

# Sustainable BNR Process Aeration Design and Optimization

# NYC DEP BEDC In-House Design

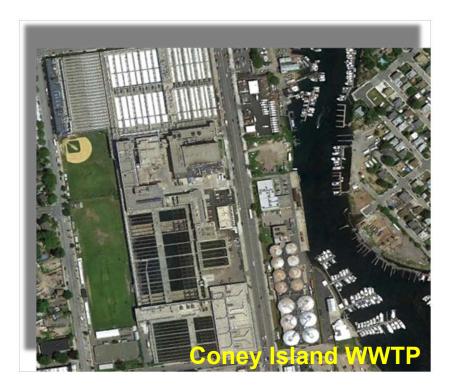
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# Agenda

- 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

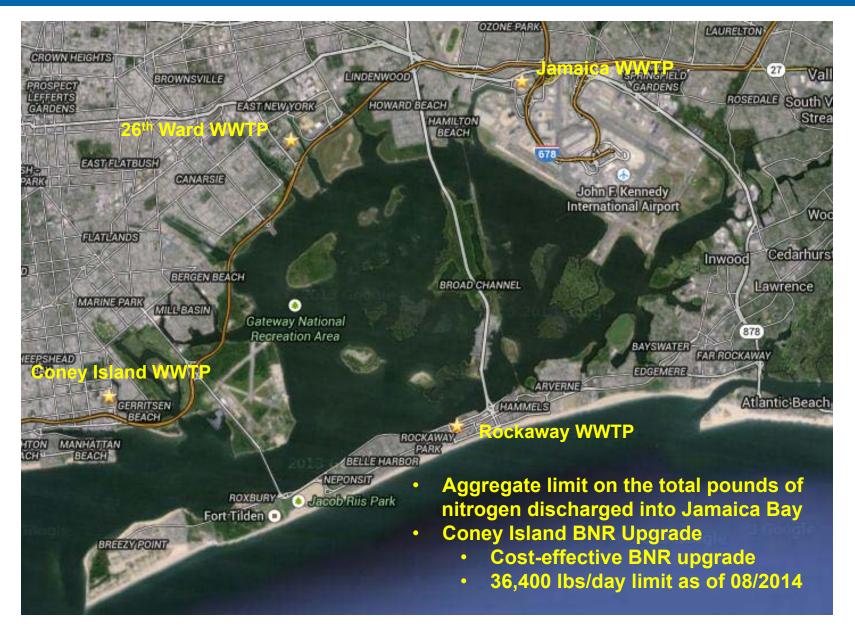


## Jamaica Bay Nitrogen Consent Judgment

BRONX WASHINGTON 63 Manorhaven Carlstadt HEIGHTS 95 Ridgefield Ron Rutherford 120 11 MANHATTAN Washington +THROGGS NECK HARLEM Fairview HUNTS POINT ndhurst [3] Flower North Bergen 17 Great Neck Munse WHITESTONE MANHATTAN Secaucus Great BAY TERRACE Neck Plaza. Union City URPER) EAST SIDE EAST ELMHURST DOUGLASTON-Weehawken FLUSHING ASTORIA BAYSIDE LITTLE NECK 11 MIDTOWN WOODSIDE QUEENS LONG North Nev Höböken ISLAND CITY Jamaica Hyde Par 278 25 WEST VILLAGE 495 POMONOK MEADOWS Jersey City MASPETH 78 REGO PARK GREENPOINT Floral/Rark HILLCREST FOREST HILLS 440 QUEENS VILLAGE New York 25 RIDGEWOOD Fran JAMAIGA Sa Elmont 440 GEENDALE BUSHWICK RICHMOND HILLS 278 478 ST. ALBANS North Valley BEDFORD-STUYVESANT Stream Contraction of the BROOKLYN OZOME PARMAQUE RED HOOK OZONE PARK LAURELTON CROWN HEIGHTS Bayonne GARDENS Walley Stream WINDSOP EAST NEW YORK JERSEY John F. Kennedy International Airport EAST-FLATBUSH ST. GEORGE Hewlett Woodmare TOMPKINSVILLE BOROV GH PARK FLATLANDS BAY/RIDG SILVER LAKE Cedarhurst DYKER HEIGH IS MIDWOOD, BROAD CHANNEL Lawrence MARINE PARK BENSC NHURST SHORE ACRES TODT HILL- LWADSWORTH **Gateway National** BATH BEACH SHEEPSHEAD FAR ROCKAWAY **Recreation Area** BAY/ ARVERNE DONGAN HILLES GRRITSEN Atlantic Beach SOUTH BEACH BEACH ROCKAN BRIGHTON SEA GATE HEACH PARK MIDLAND BEACH ROXBURY OAKWOOD BREEZYPOINT er Ba

Bay

## Jamaica Bay Nitrogen Consent Judgment



# Coney Island BNR Upgrade

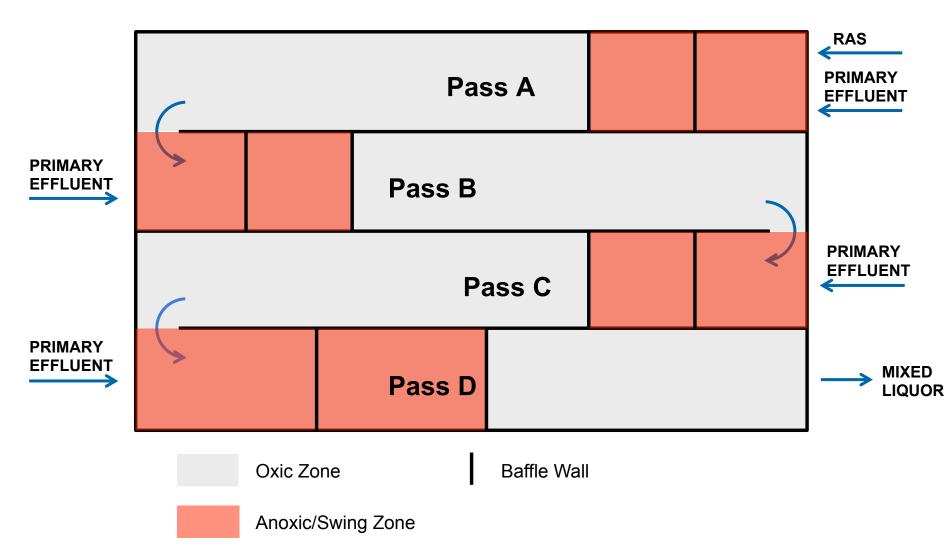


- Treats domestic and combined sewer wastewater
- 110 MGD dry weather flow
- 165 MGD flow through secondary treatment
- 220 MGD wet weather flow
- 4 aeration tanks with a total volume of 16.7 MG

- How do we accomplish Step Feed BNR?
  - Increase SRT
  - Aeration requirements expected to increase to meet nitrification requirements
  - Create anoxic zones for denitrification

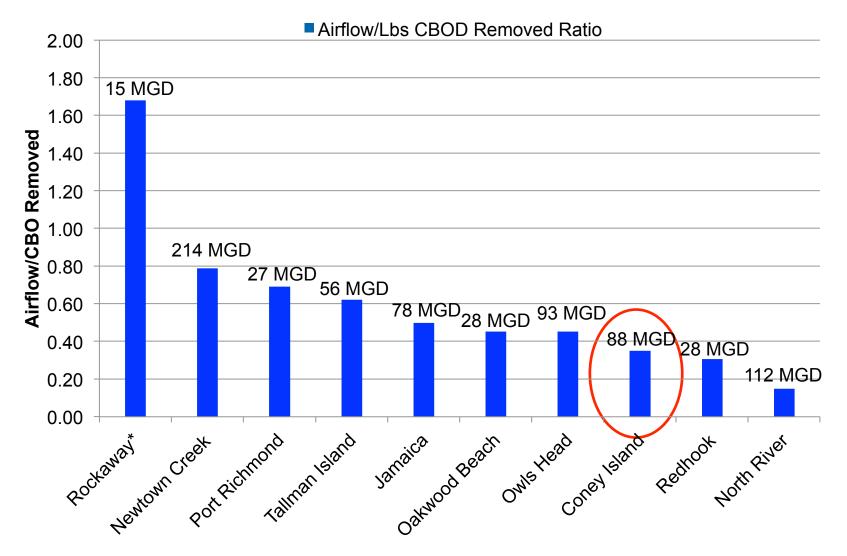
# Coney Island BNR Upgrade

# Anoxic and Oxic Zones



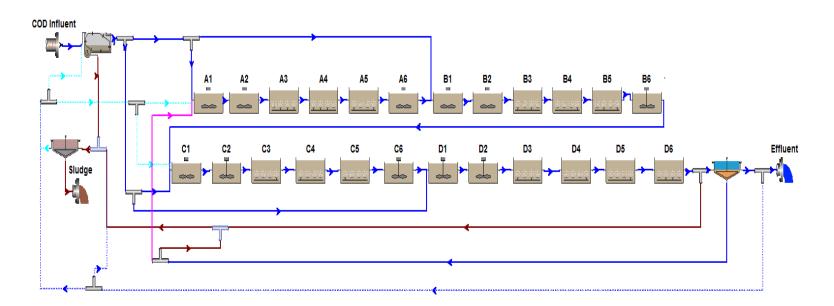
### NYC WWTP Aeration Benchmark

#### 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**



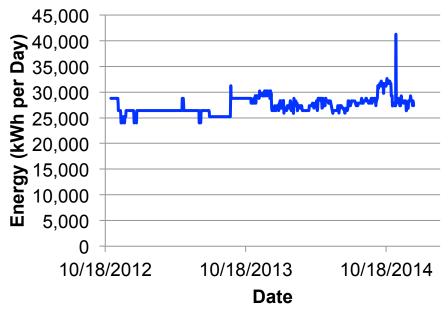
- BioWin was used as a process modeling tool to predict aeration requirements at different loadings and wastewater temperatures
- Model Calibration is important
- Used for aeration system design
  - Optimize operations and equipment at future average conditions
  - Predict treatment results
  - $_{\odot}\,$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

#### **Process Air Blowers**



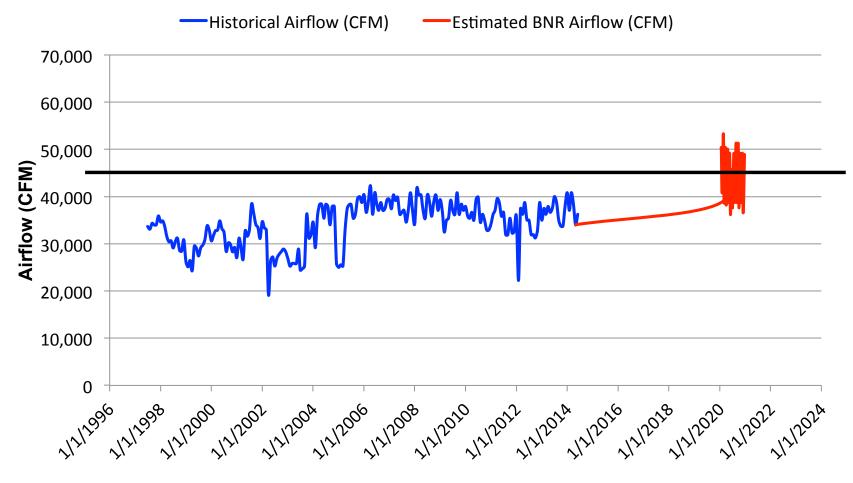
- 4 Dresser-Roots two-stage centrifugal process air blowers rated at 23,800 SCFM at 8psi
- 3 duty and 1 standby
- Maximum Capacity of 71,400
  SCFM at 8psi
- Originally manufactured in 1958 and refurbished in 1990s

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



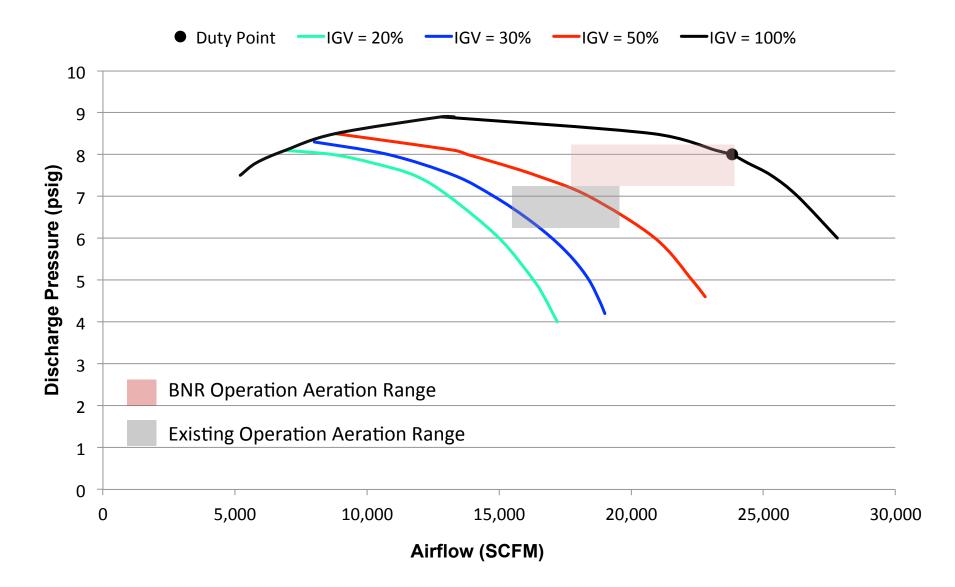
### **Coney Island Aeration Requirements**

#### **Coney Island Airflow**



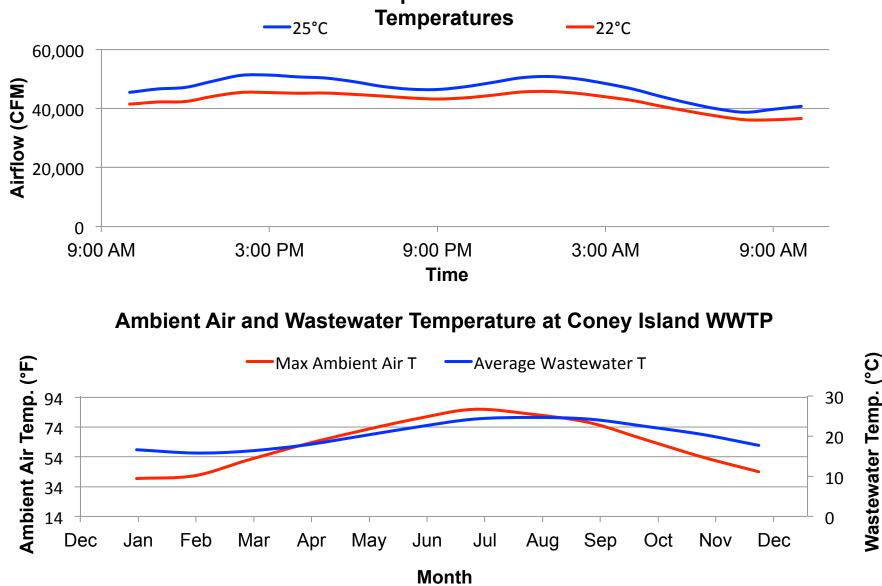
Date

## **Blower Efficiency**

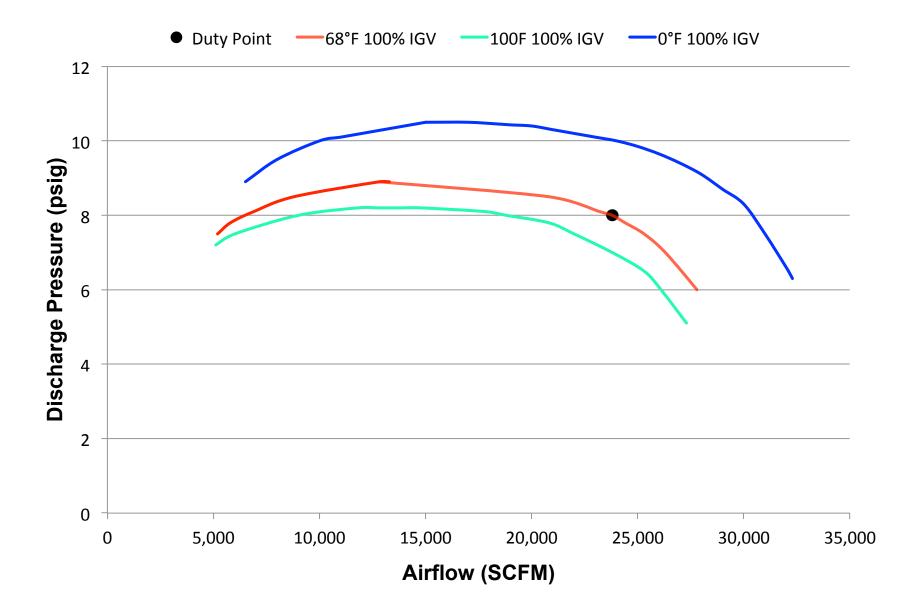


#### **Temperature Effects on Blower**

**Future BNR Aeration Requirements at Various Wastewater** 

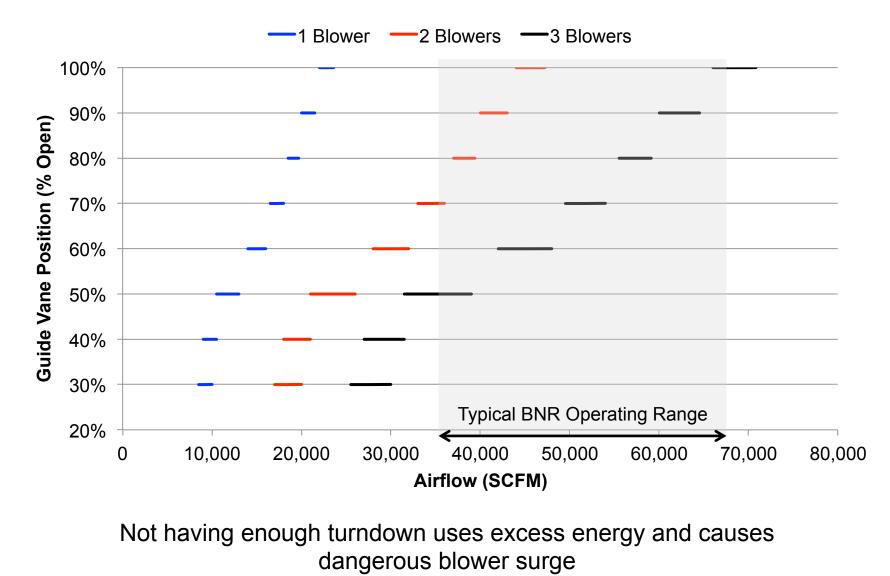


### **Temperature Effects on Blower**



#### **Blower Turndown**

#### **Coney Island Blower Capacity**



## **Process Air Piping**







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

# Diffusers

- Type
  - Coarse Bubble
  - $_{\odot}\,$  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

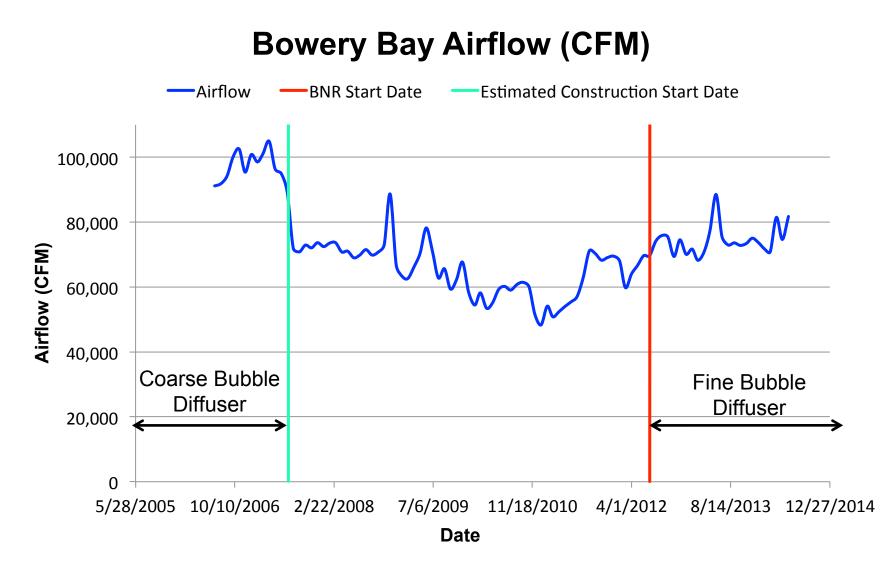


Coarse Bubble Tube Diffusers at Rockaway WWTP



Ceramic Dome Diffusers at Coney Island WWTP

# Bowery Bay WWTP Before and After BNR



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 αF factors throughout aeration tanks
- Diffuser fouling increases head losses
- Ceramic Diffusers are more likely to clog

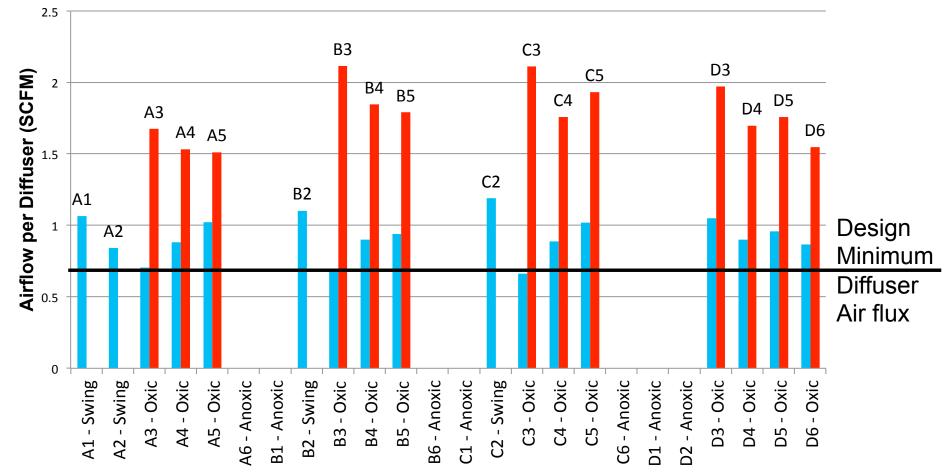


## **Diffuser** Design

#### **Air Flux through Diffusers**

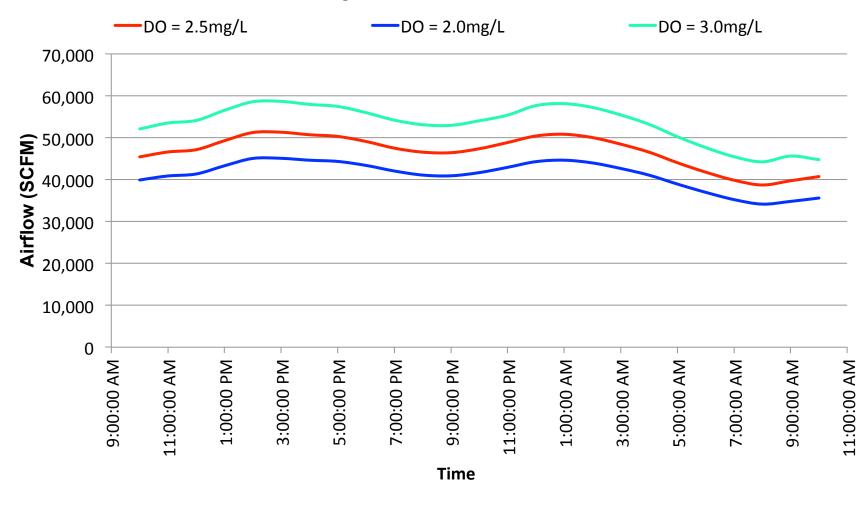
Minimum Air flux at 15° C

Average Air Flux at 20° C



#### **DO Control**

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



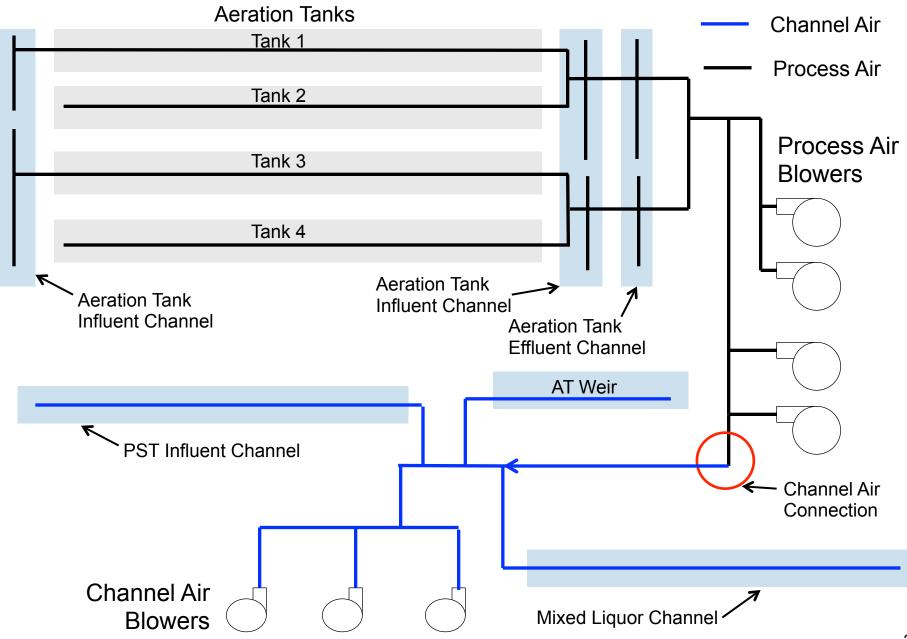
Changing the DO Setpoint by  $1mg/L \rightarrow 10,000$  SCFM Increase

# **Channel Mixing**

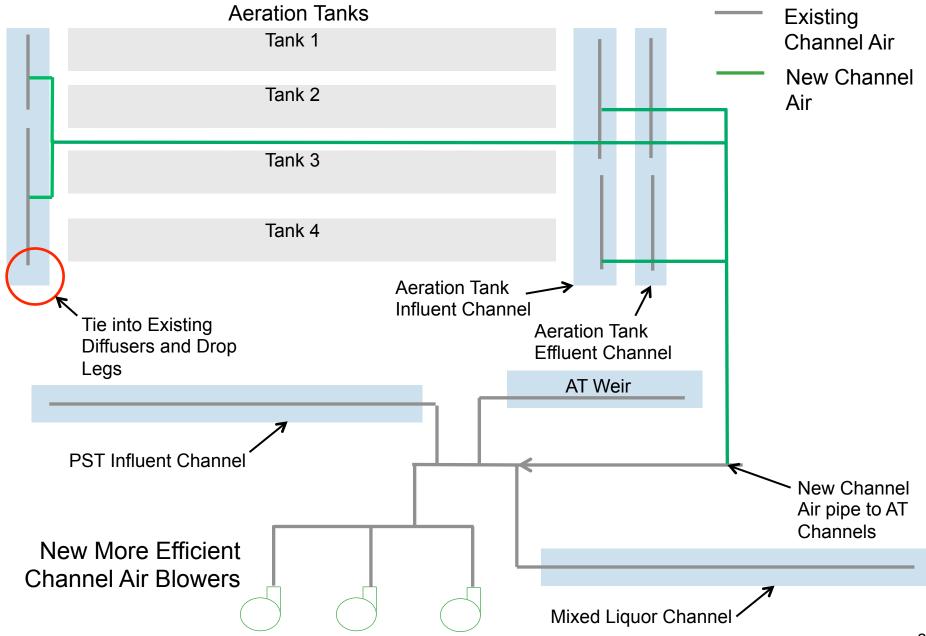
- Most channels at NYC plants are mixed using coarse bubble diffusers and process air
- At Coney Island ~10% of process air is used for channel mixing
- Advantages of a separate channel mixing system:
  - Increase capacity for process aeration
  - $\circ$  Reduce denitrification problems
  - $\circ$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



# **Existing Channel Aeration System**

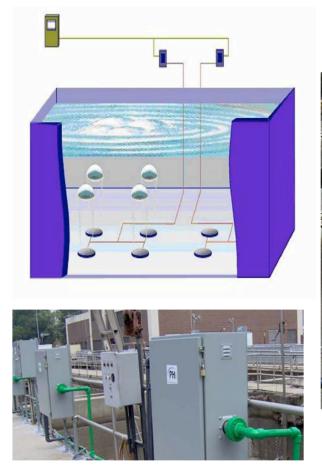


# **Channel Aeration System Modifications**



# **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?**