

# Upgrading WRRFs for Biological Nutrient Removal

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Don Esping, P.E.

# Agenda

- Permitting and Planning
- BNR Overview
- Case Example
- Innovative Approaches

# Proactive Participation in NPDES Nutrient Permits Can Save \$Millions

## “Traditional” Limits

- Weekly/Monthly

## More Recent

- Annual, 6-month, or Seasonal
- Max day or UOD
- 5-year TN



- Nutrient impacts are seldom responsive to short term variations
- Study of long term statistics on the performance on exemplary nutrient removal plants
- Examples of nutrient permit

# Typical Nutrient Removal Planning Scenarios

Item	Ammonia mgN/L	Total Nitrogen, mgN/L	Total Phosphorus, mgP/L
Nitrification	Varies	--	--
Biological Nutrient Removal	--	<8 to 10	<1.0
Enhanced Nutrient Removal	--	<3 to 4	<0.3
ENR and beyond	--	<2 to 3	<0.05 to 0.1

- **Different Solutions when overlaying permit averaging**

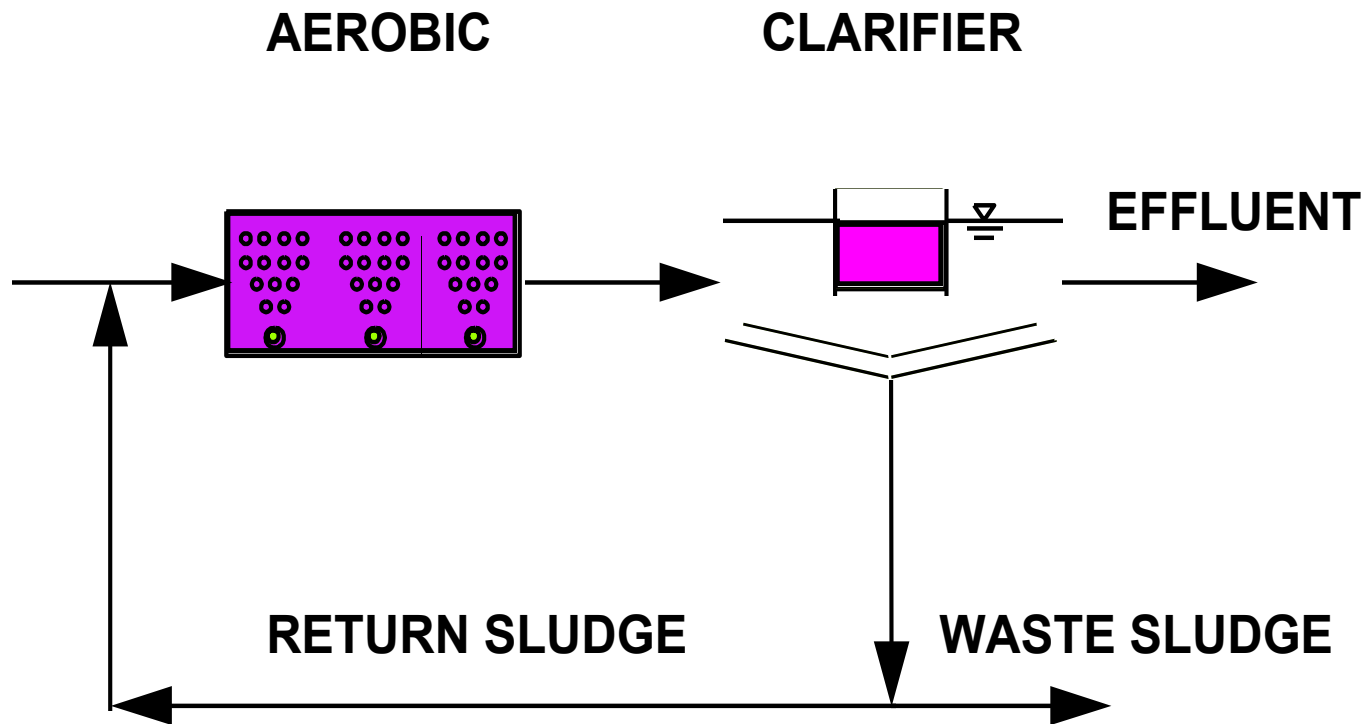
# NEORSD P Removal - Impact of Averaging Period (Easterly 100 mgd)

Averaging Period	Filtration Capacity Required to Achieve 0.3 mg P/L, mgd
30 Day Average	200
90 Day Average	150
180 Day Average	140

# BNR Upgrade Overview

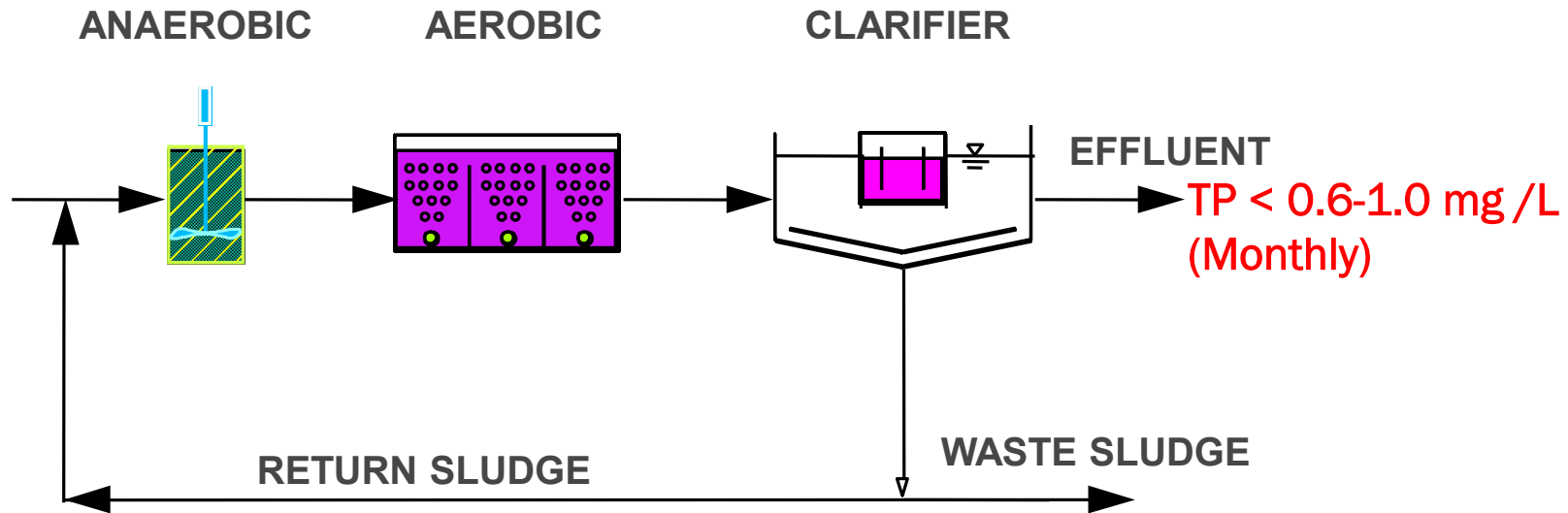
# Nitrifying Activated Sludge Plant

Increase SRT to 7.5 -10 days  
Additional Bioreactor : 2x to 3x



# Adding Bio-P to Nitrification

**Selector:  
15-20% Total Volume**



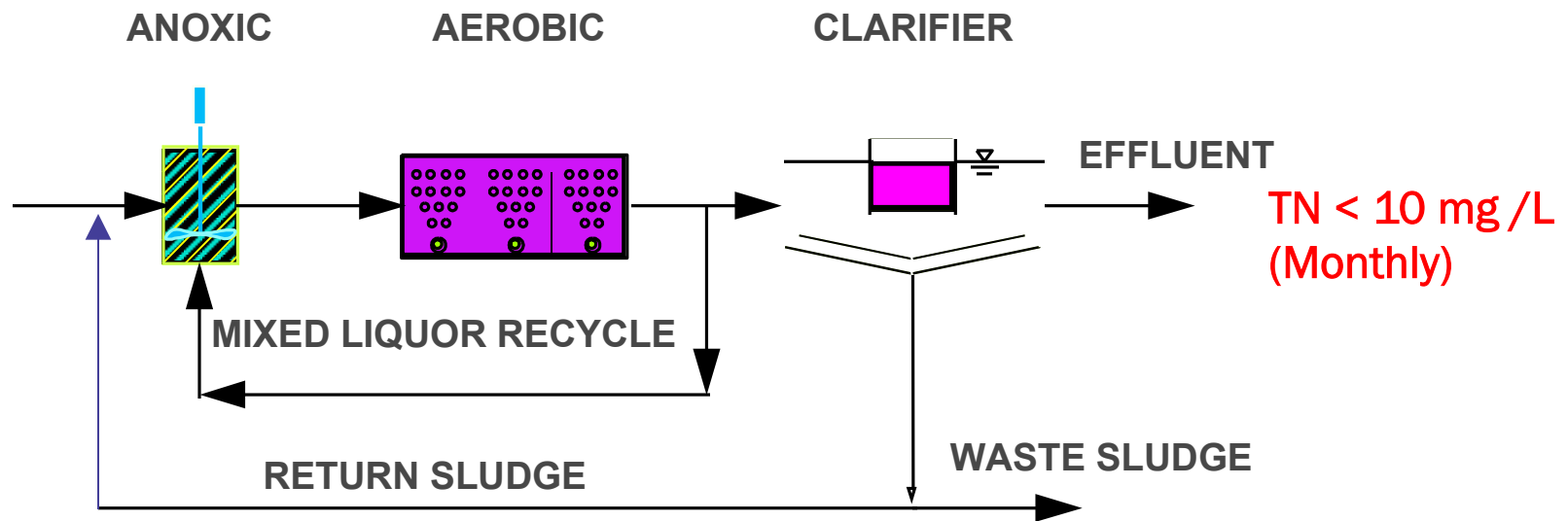
**Struvite Control**

**Capacity Loss  $\approx 0$**



# Total Nitrogen Removal

Anoxic Zone:  
≈ 25 to 30% Total Volume

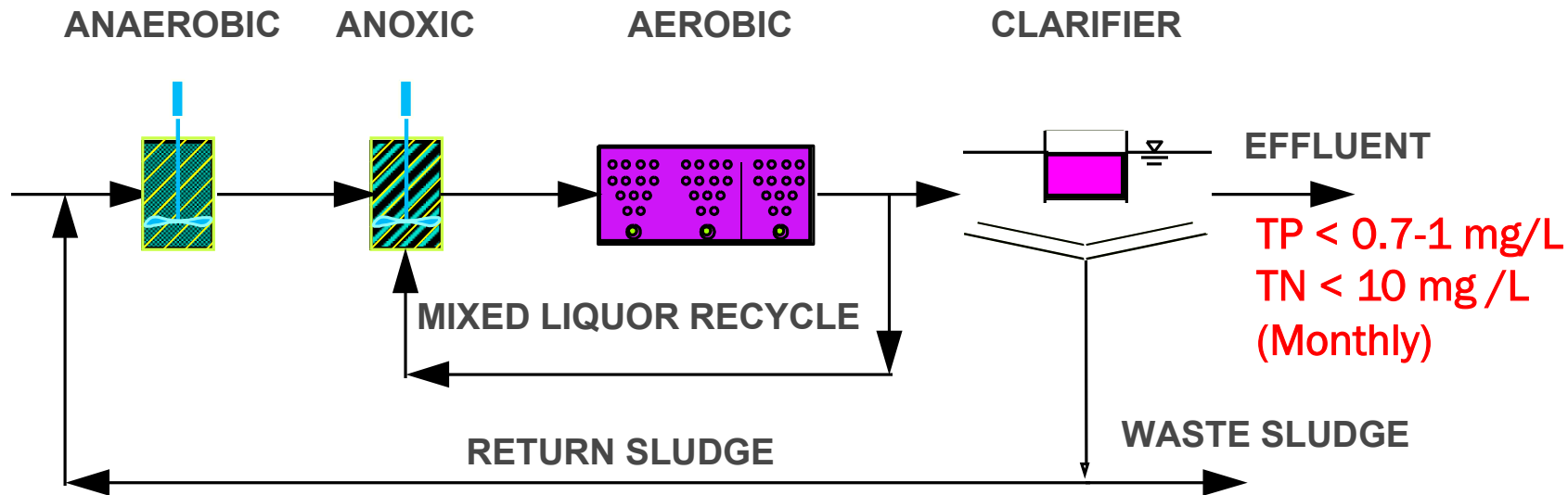


Capacity Loss ≈ 20%

# Combining TP and TN removal

Selector:  
15-20% Total Volume

Anoxic Zone:  
≈ 30% Total Volume

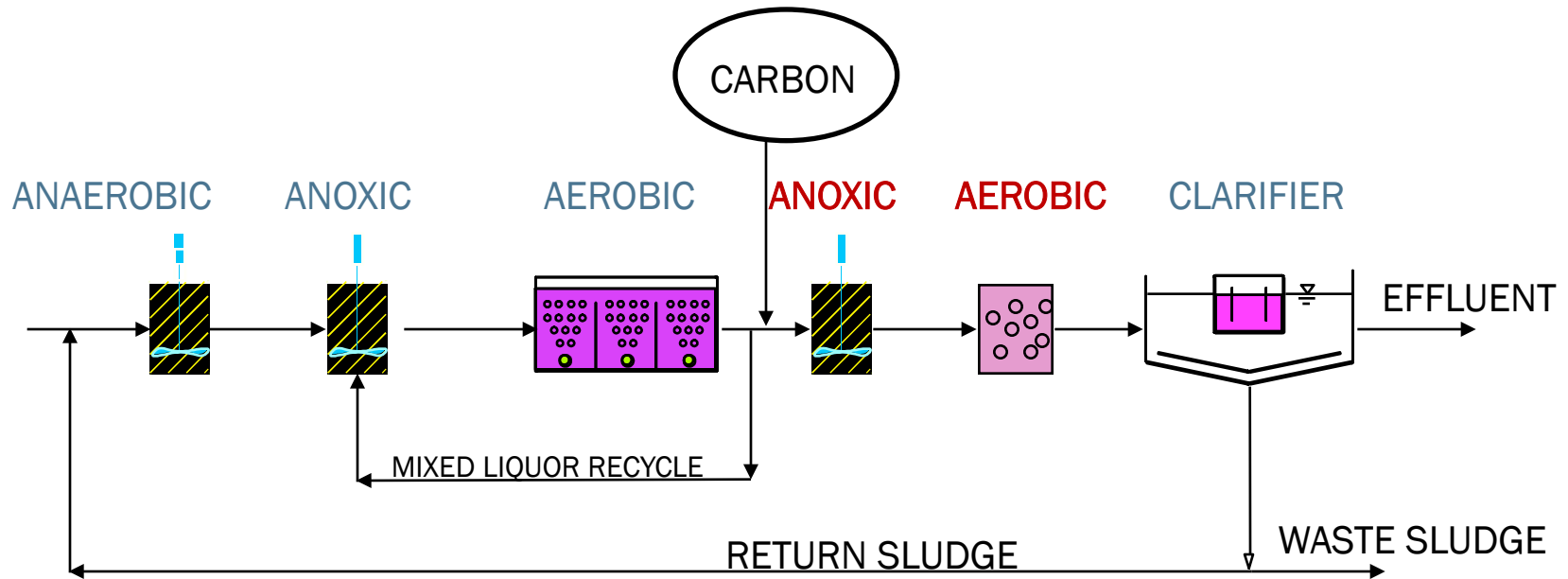


Struvite Control

Capacity Loss ≈ 25-30%

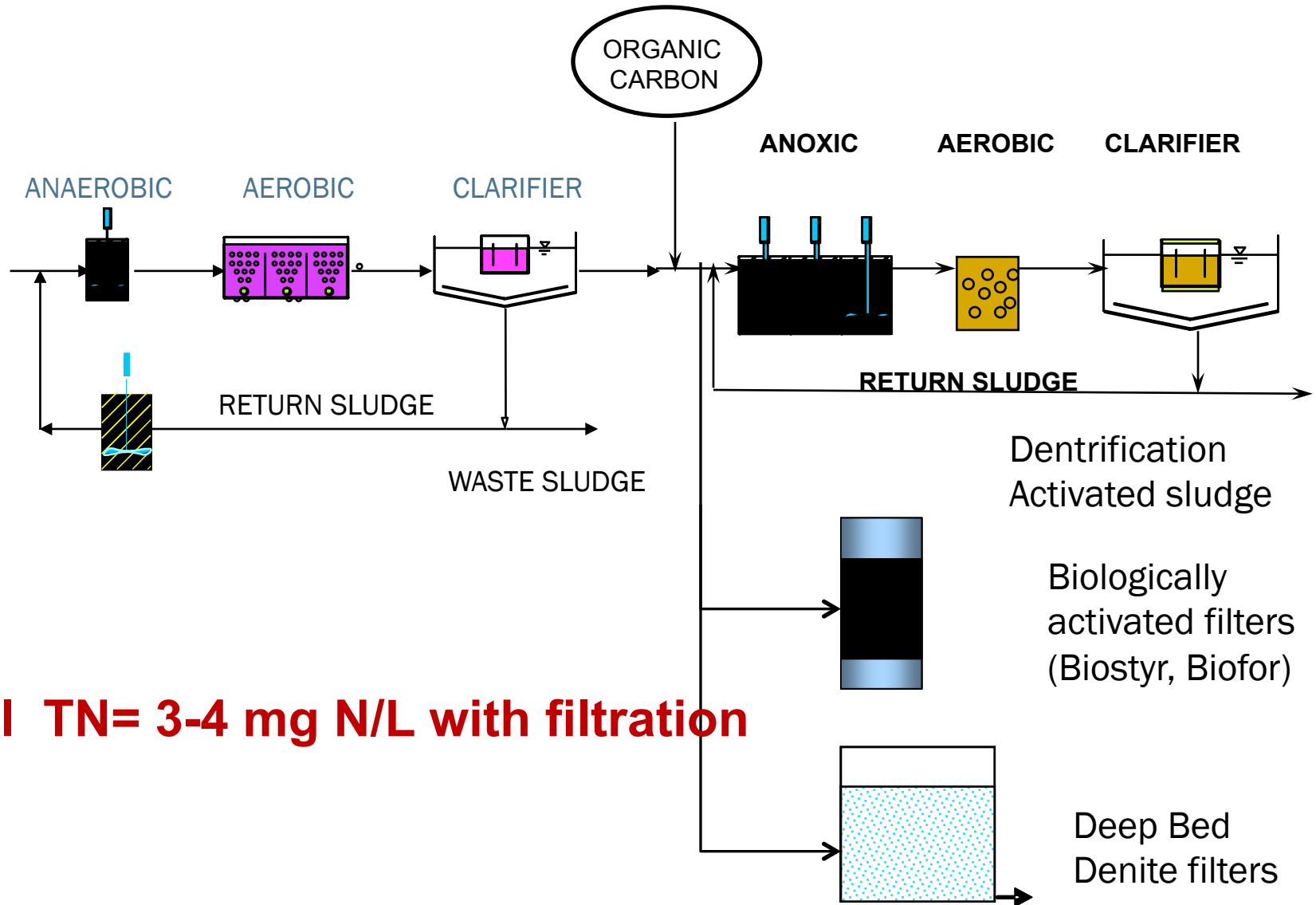
# Reducing TN Further - External Carbon

## 5-Stage Bardenpho Process



**Annual TN= 4 mg N/L with filtration**

# Reducing TN Further - Nitrify First, Denitrify with External Carbon



**Annual TN= 3-4 mg N/L with filtration**

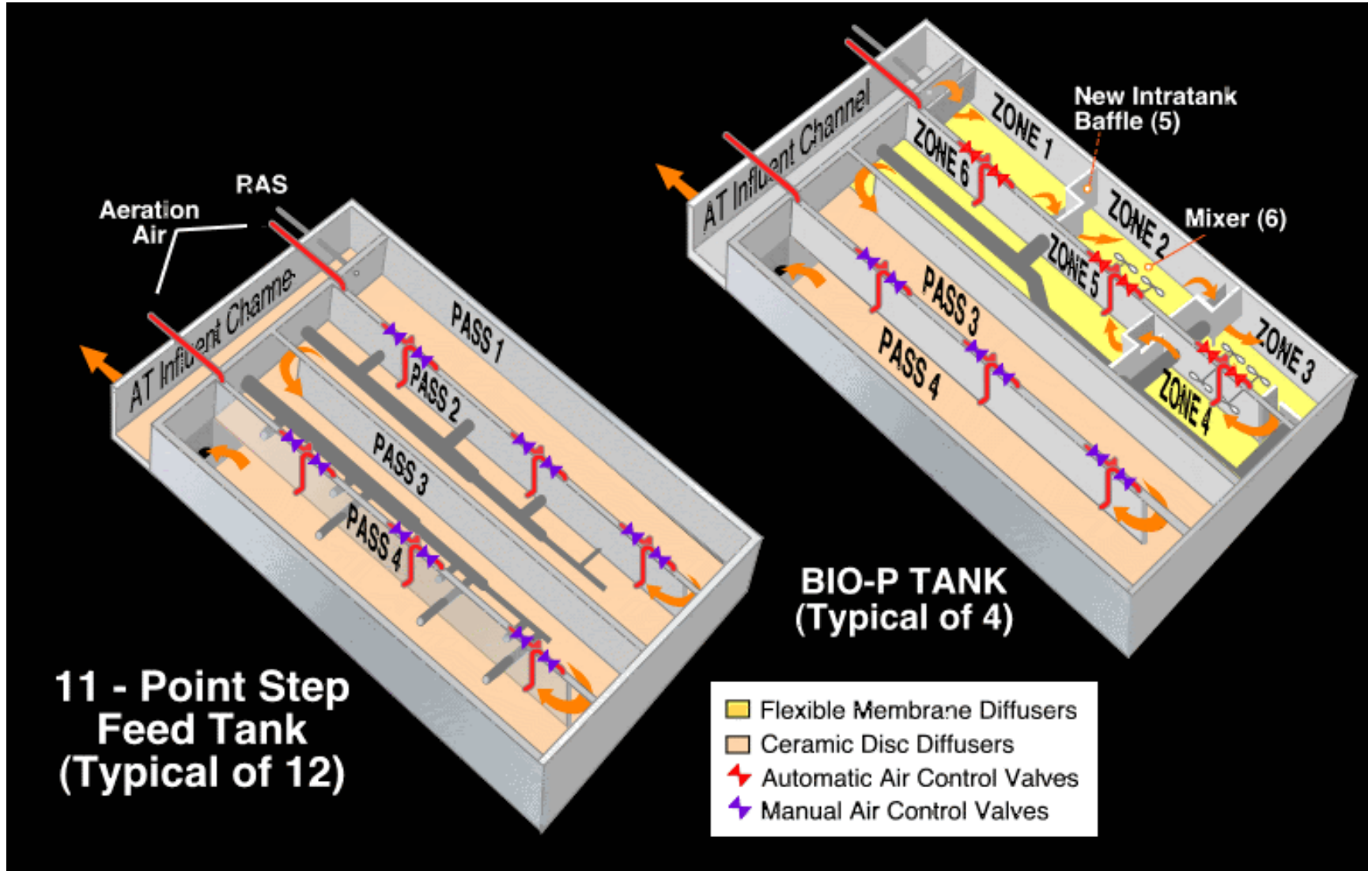
# Case Example – Progression from Nitrification to BNR/ENR

## Step Feed Nitrifying Activated with Seasonal Nitrification Limit

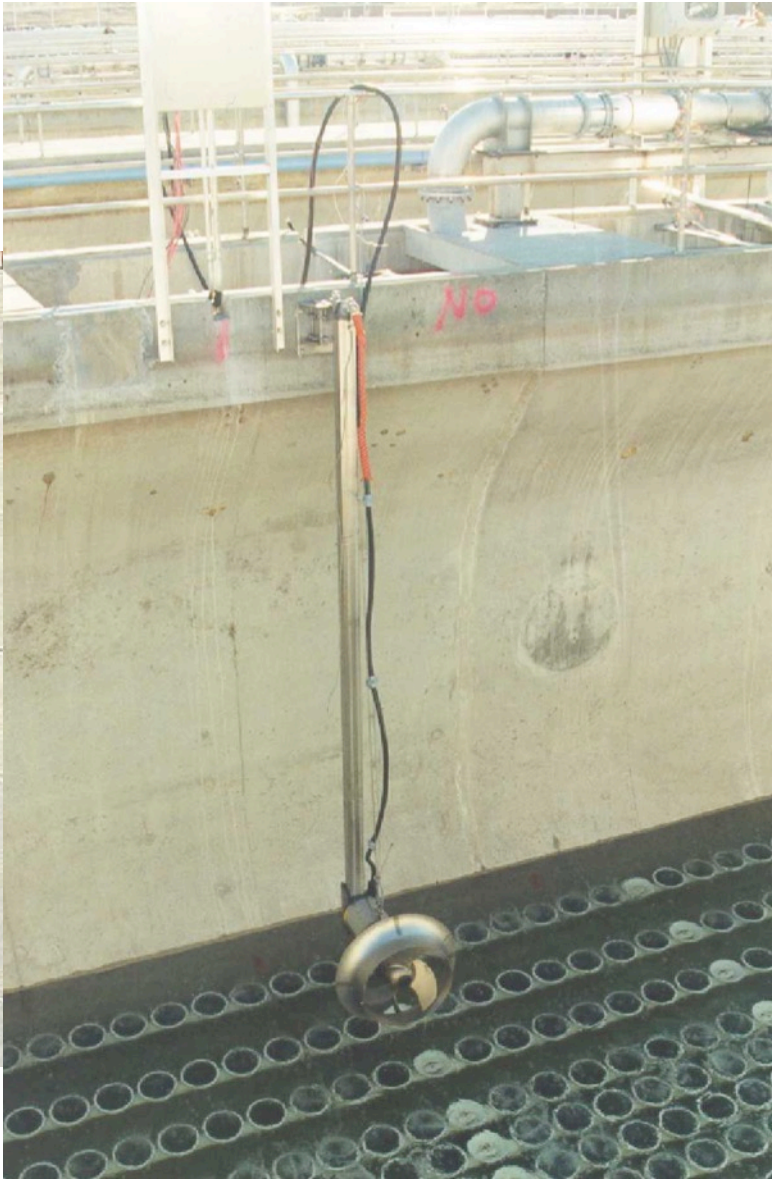
- Summer: 2 mg/L NH<sub>3</sub>-N
  - Winter: 5-15 mg/L NH<sub>3</sub>-N
  - No P limit
- 
- **Phase 1 Improvements**
    - Reduce TP to 1 mg/L
  - **Phase 2 Improvements**
    - TP: 0.3 to 0.1 mg/L
    - TN: 4 to 10 mg N/L



# Bio-P Full Scale Pilot Testing

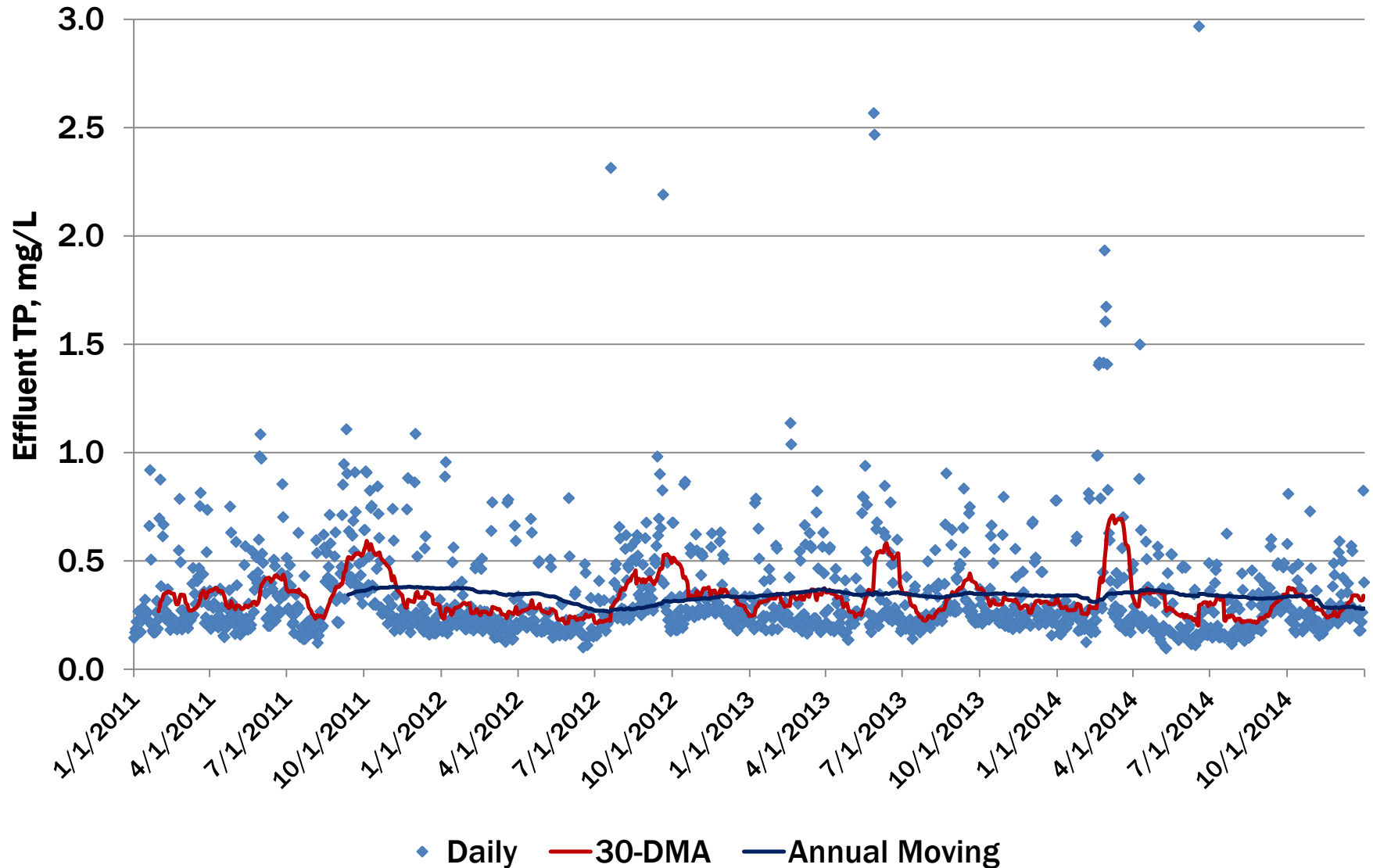


# Full-Scale Pilot Test





# Phase 1 – Reduce TP to 1.0 mg/L



# Phase 2: Reduced Phosphorus Discharges

2A – 0.3 mg/L (Filters)

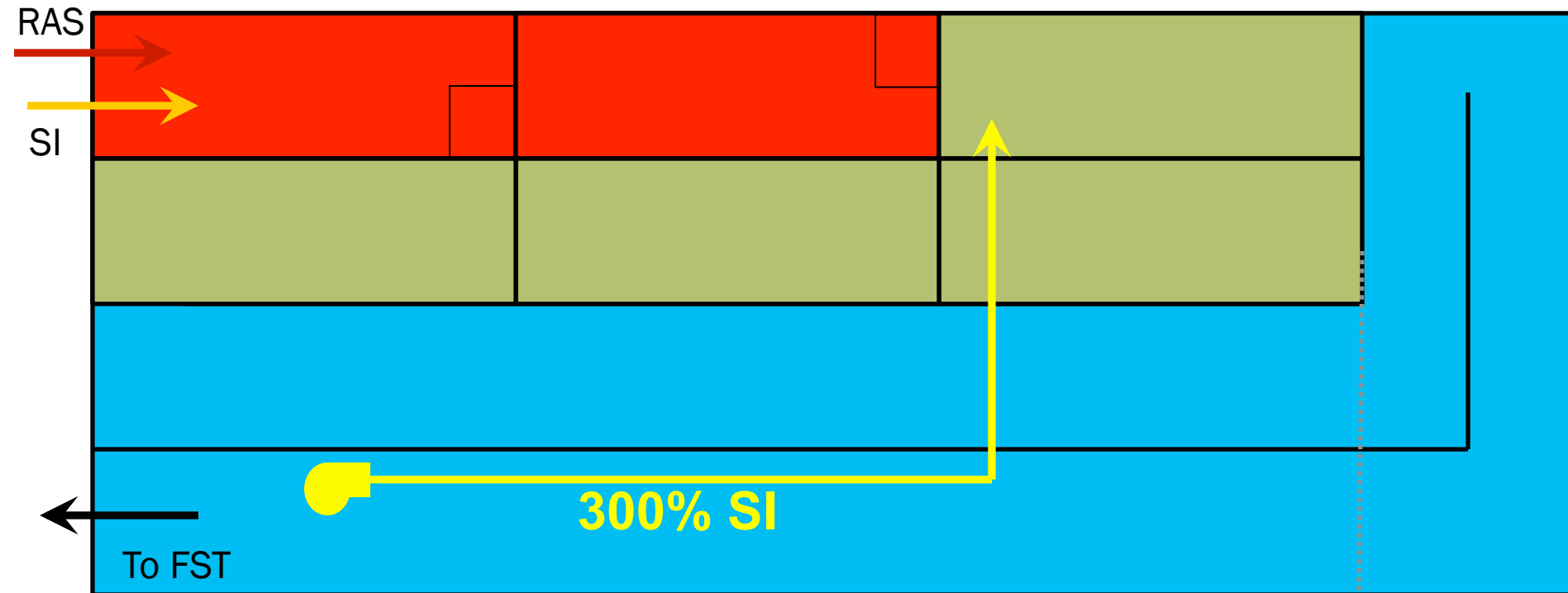
2B – 0.1 mg/L



# Phase 2 – TN Reduction Using Influent Carbon

**Monthly TN= 10 mg N/L**

Anaerobic



# Phase 2 - Influent Carbon for TN Reduction

**Monthly TN= 10 mg N/L**  
**Monthly TP = 1.0 mg/L**



# Phase 2 – Nitrify First, Denitrify with External Carbon

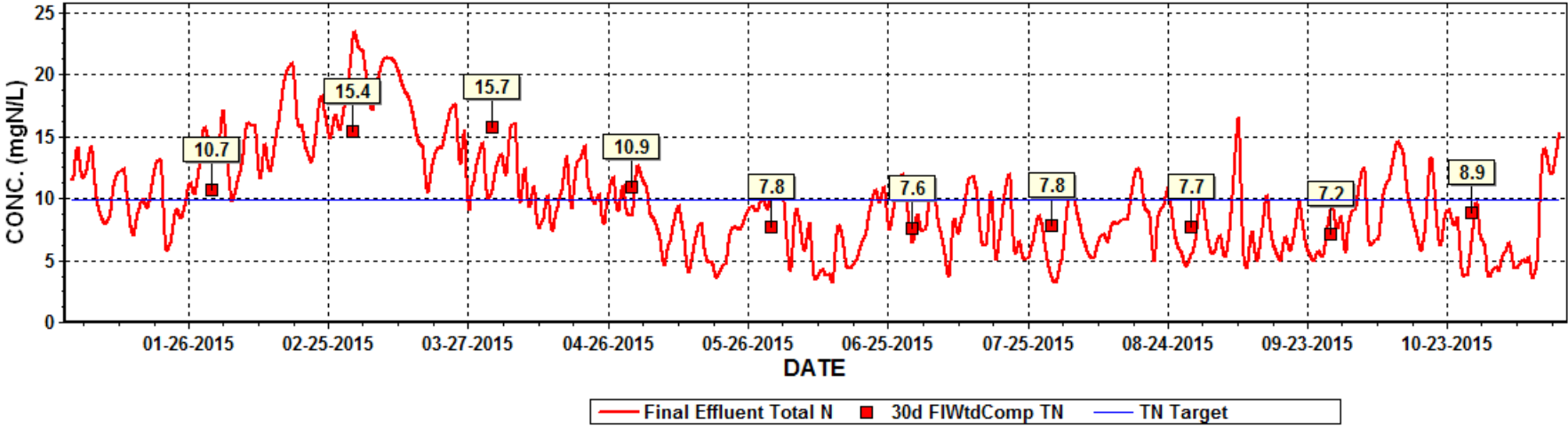
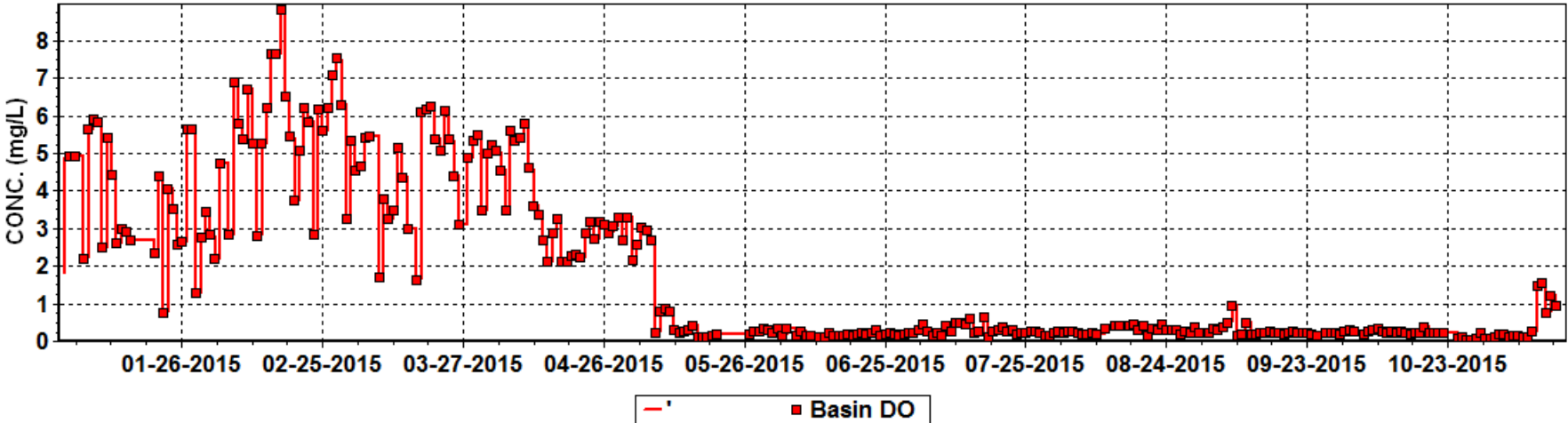
Denite MBBR  
Tert. Clarifiers  
Filtration

- **TP < 0.1 mg/L**
- **TN < 4 or < 10 mg N/L**

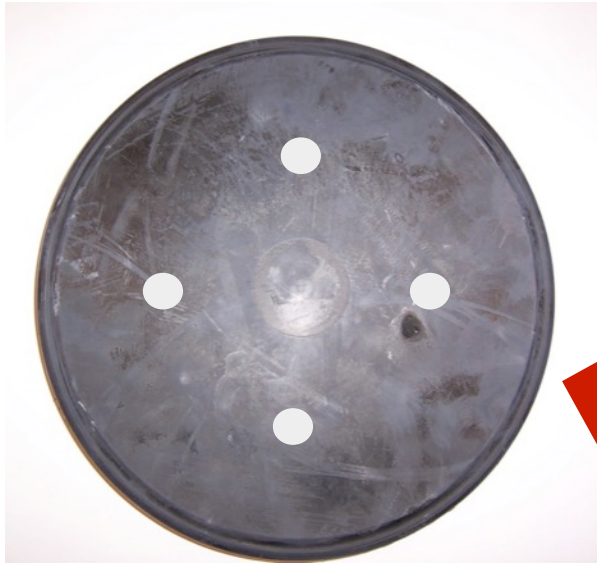


# Innovation - The Time is Now

# Rochester NH Simultaneous Nit-Denit

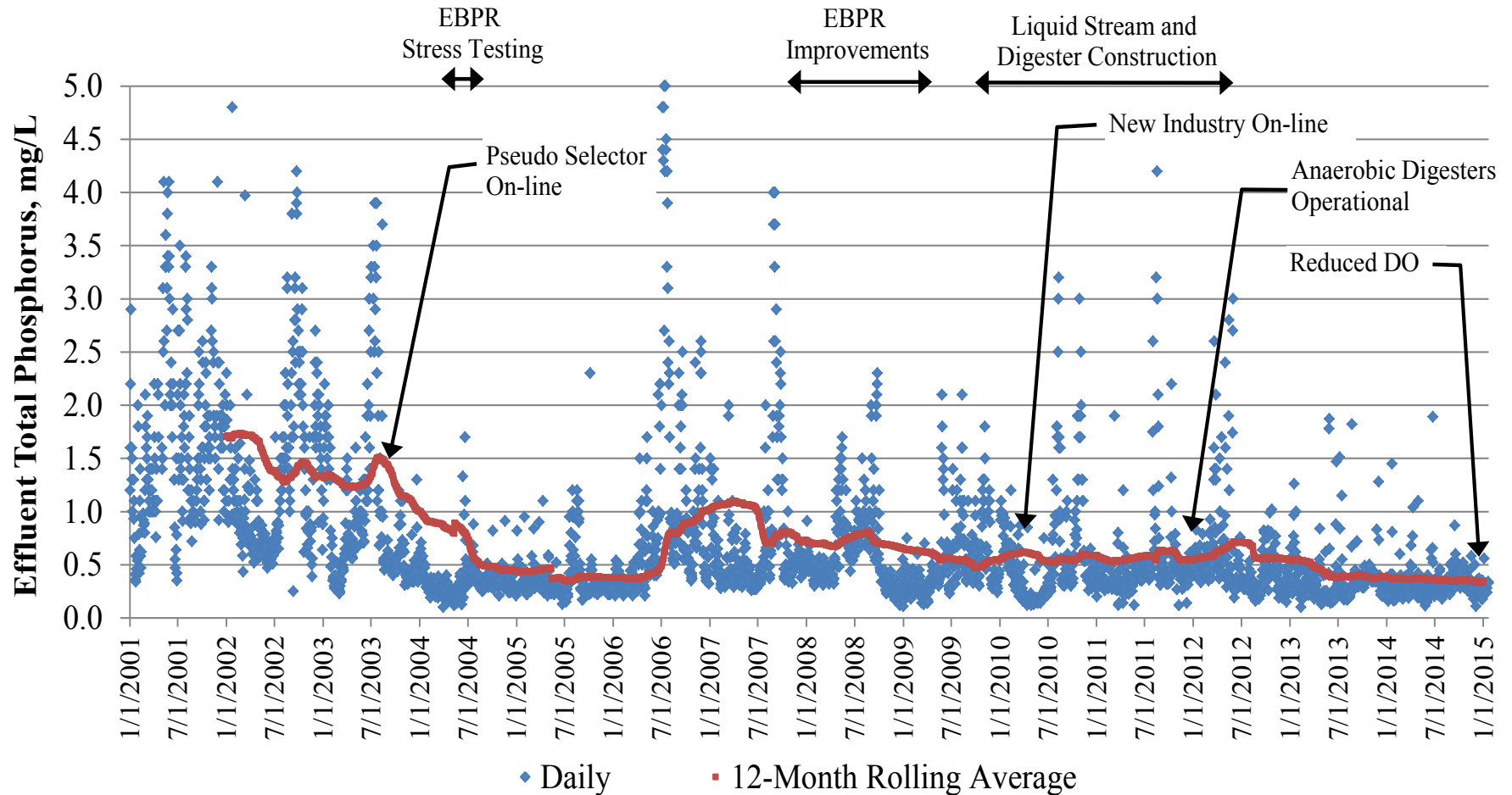


# Air Mixed Selectors

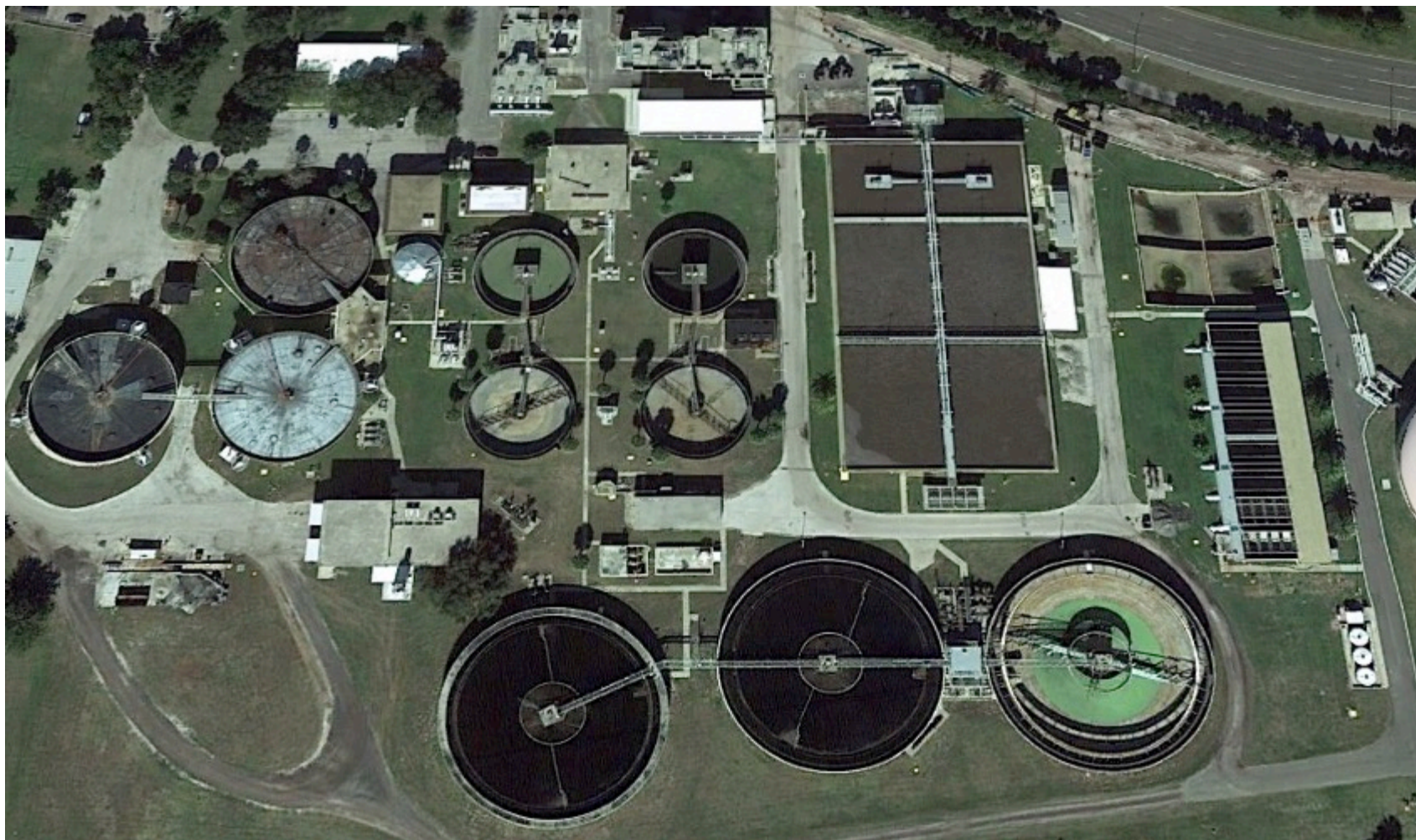




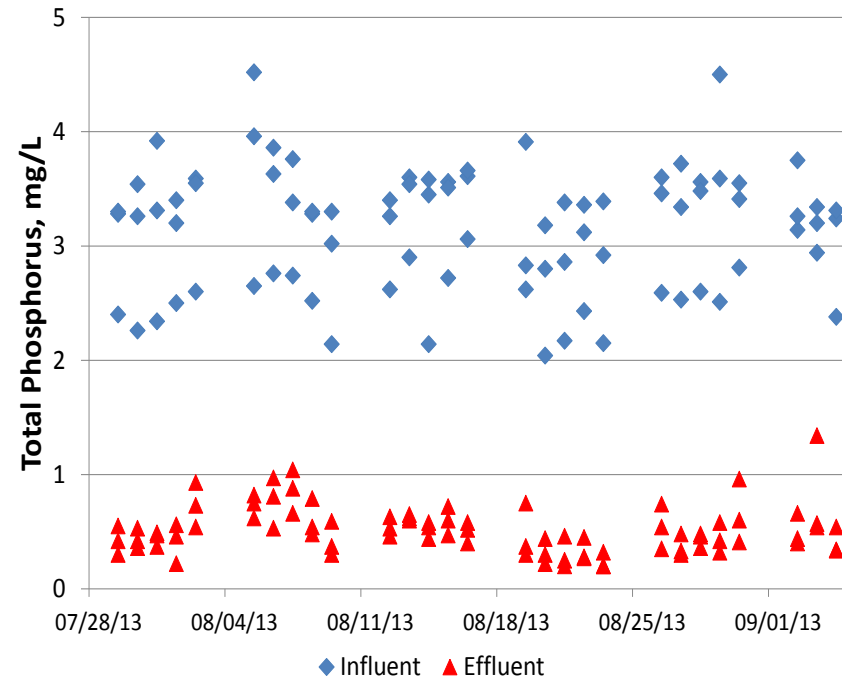
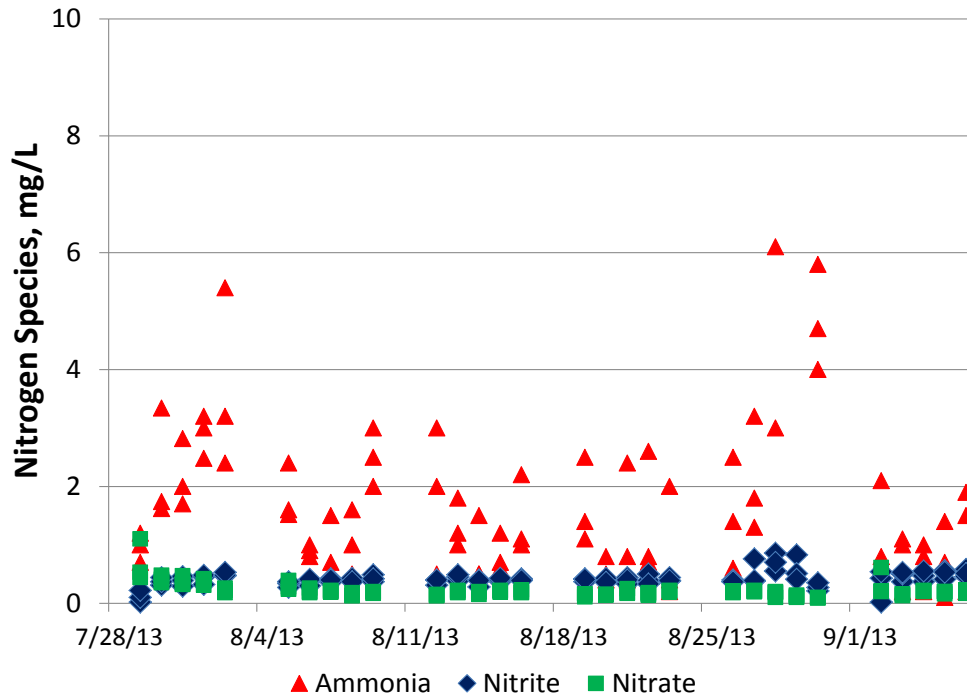
# Air Mixed Selectors



# St Petersburg Southwest Water Reclamation Facility - Nitrite Shunt



# Southwest Water Reclamation Facility - Nitrite Shunt Operations



Aeration Demands Reduced 40- 50%

# Dixie Drain Project Site, Boise ID

September 30, 2015



# Thank you!



**Don Esping, P.E.**

**[DEsping@BrwnCald.com](mailto:DEsping@BrwnCald.com)**



essential ingredients®