

# BIOLOGICAL PHOSPHORUS REMOVAL IN OXIDATION DITCH PLANTS



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# Topics

- Traditional Ditch Configurations
- Mechanism of Bio P Removal
- Pollutant Parameters for Bio P
- ORP
- Bio P Ditch Configuration
- Bio P Considerations
- DO Control Settings
- Examples
- Summary

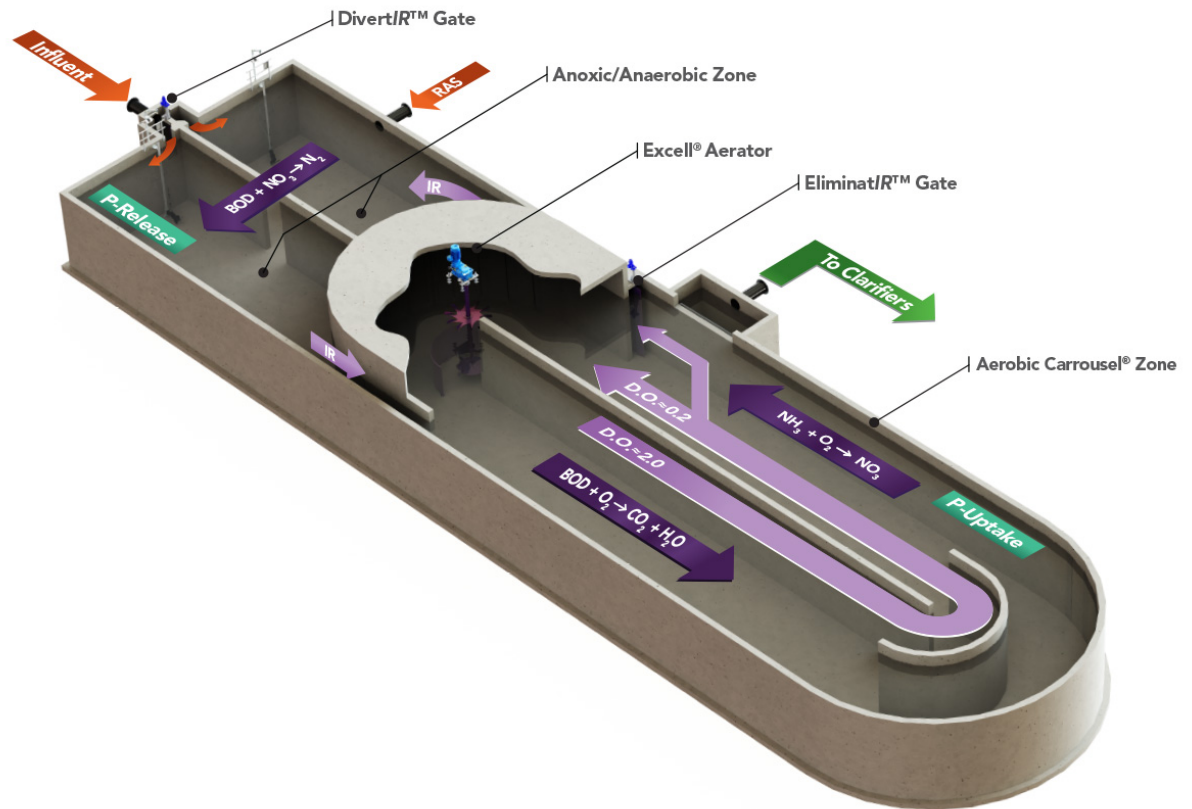
# Traditional Configurations

- Complete Mix
- Tanks in Series
- Extended Aeration
- Single or Multi-Channel
- Mechanical Surface Aeration
- Orbal® Configuration



# Traditional Configurations

- Hybrid Plug Flow  
- Complete Mix
- Specific Selector Zones for P and N Removal



# Traditional Configurations Mechanical Aeration

- Brush
- Disc
- Surface
- Manufacturers
  - Lakeside
  - Envirodyne
  - Evoqua
  - Aeration Industries
  - Other



# Traditional Configurations Mechanical Aeration



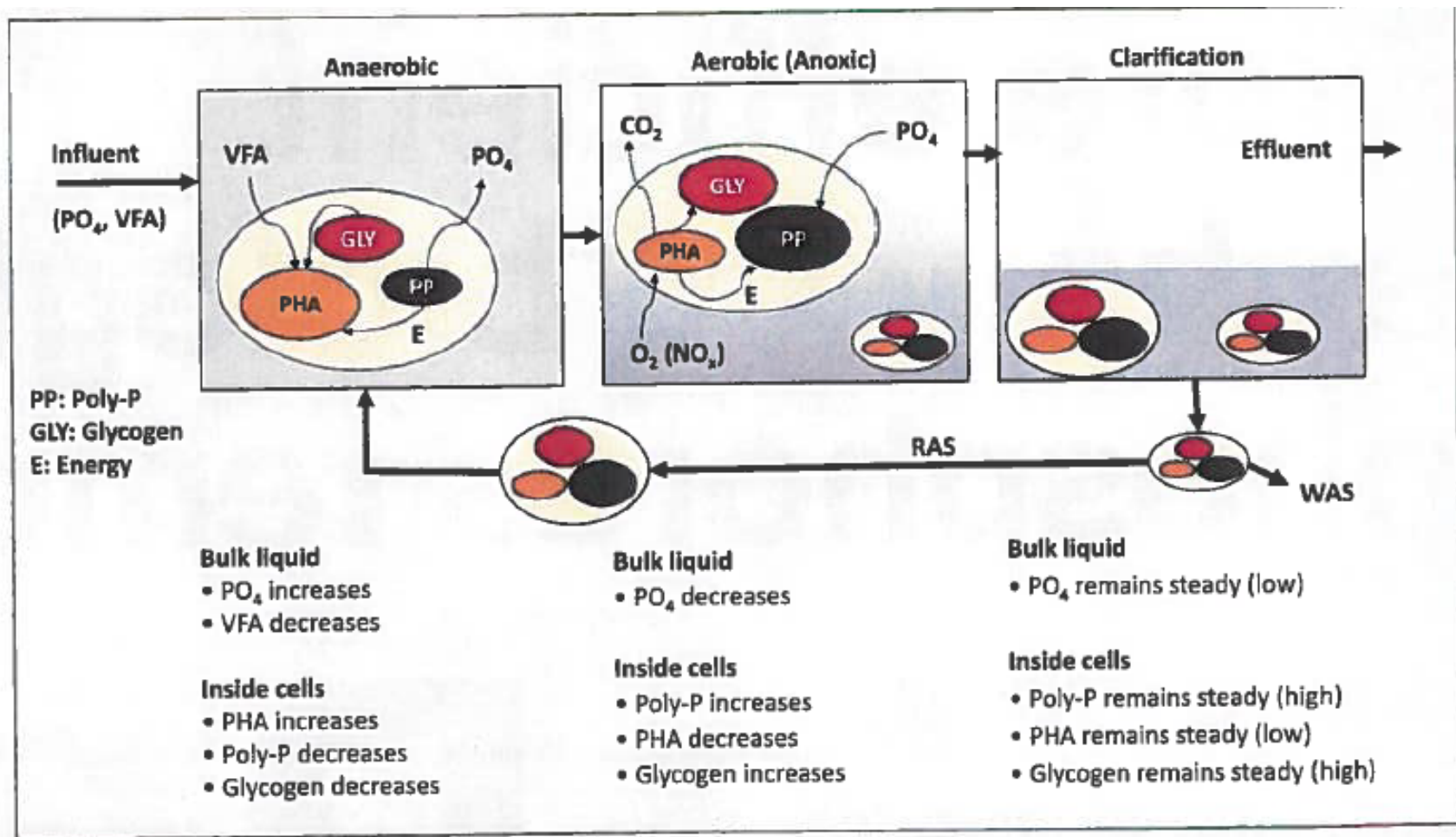
# Traditional Configurations

## Mechanical Aeration

### Limitations

- Bio P Removal, No True Anaerobic Zone
- Tradeoff between Nitrification and Bio P
- Mixing Coupled With Aeration

# Mechanisms of Bio P



Source: WEF

# Pollutant Parameters for Bio P

Substrate Parameter	Substrate-to-TP Ratio
cBOD	25:1
COD	40:1 to 45:1
VFA	4:1 to 16:1
rbCOD	10:1 to 16:1

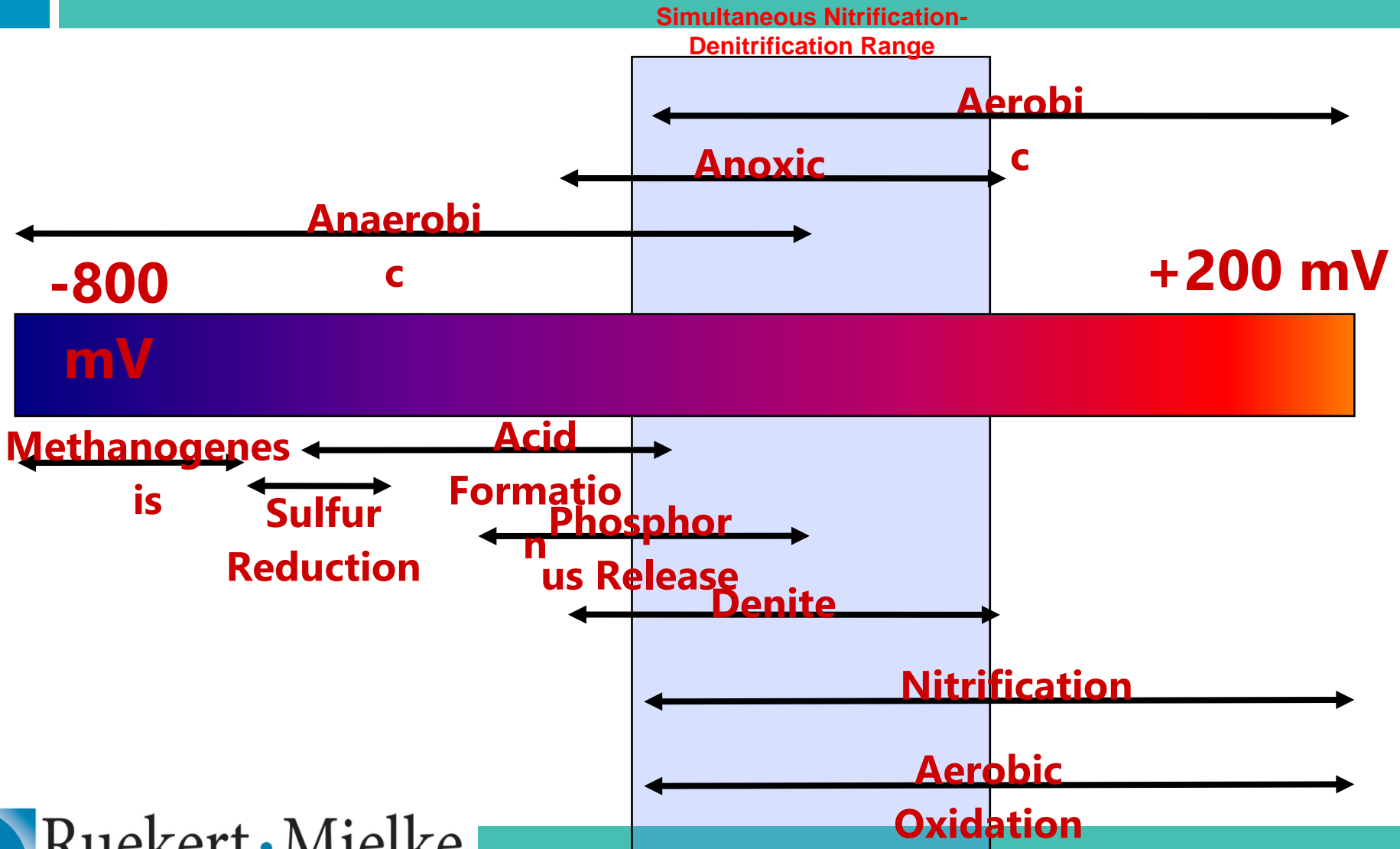
# ORP

- Solution's Capability to Oxidize or Reduce Another Solution
- Oxidize – Lose e
- Reduce – Gain e
- Based on Reference Electrode
  - Salt Bridge

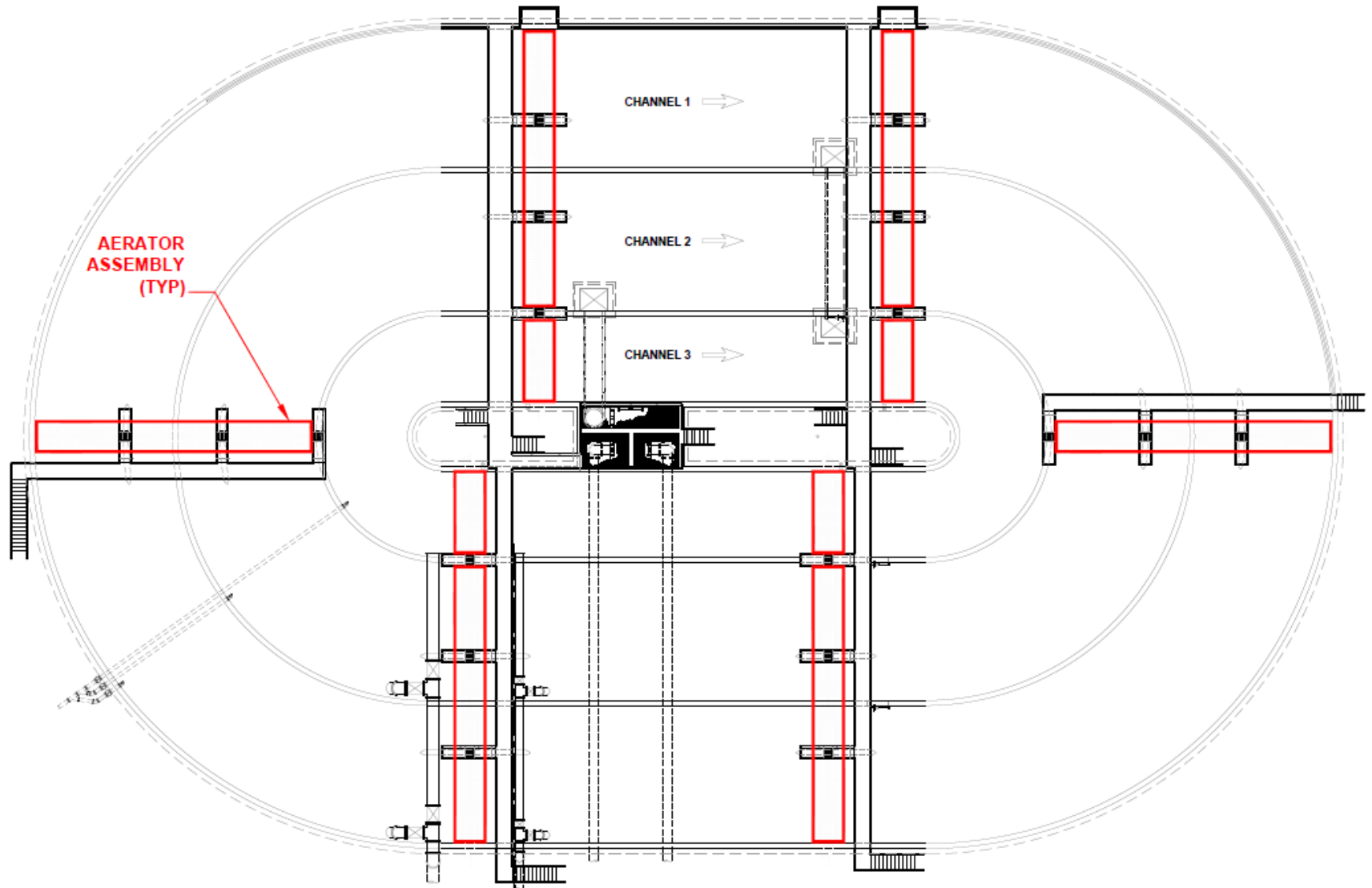
# ORP

- Bio P Release
  - -100 mV to -225 mV
- Bio P Uptake
  - +25 mV to +250 mV
- Nitrification
  - +100 mV to +250 mV
- Denitrification
  - +50 mV to -50mV

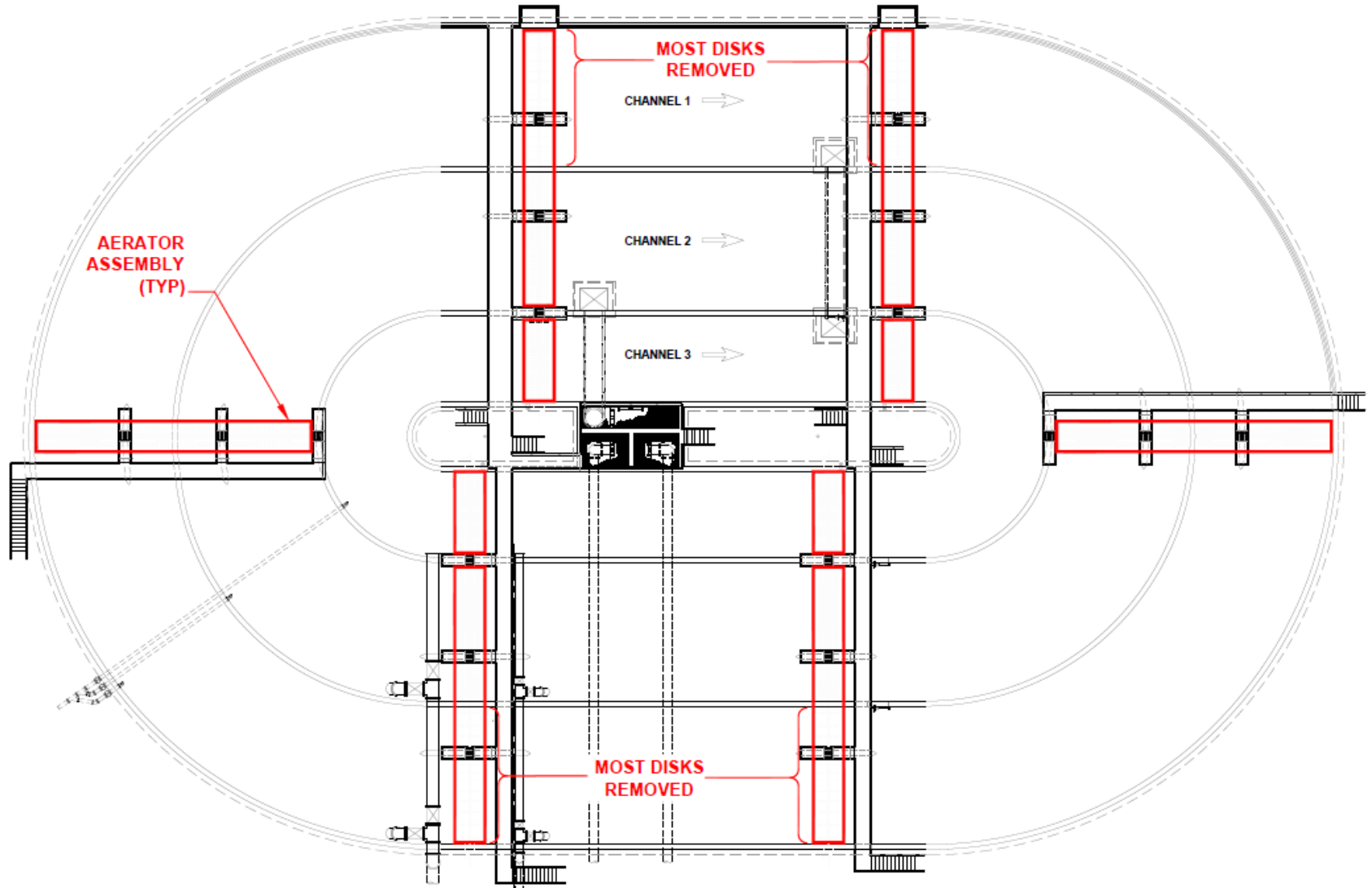
# ORP



# Bio P Configuration - Existing



# Bio P Configuration - Existing



# Bio P Considerations

- Need Some DO for Nitrification
  - ▣ No Bio P, 50 % N Bacteria Outer Channel
  - ▣ Bio P, 25 % N Bacteria Outer Channel
    - Middle Channel More N Work
- Mixing
  - ▣ 0.75 FPS
- Biosolids
  - ▣ Side stream control

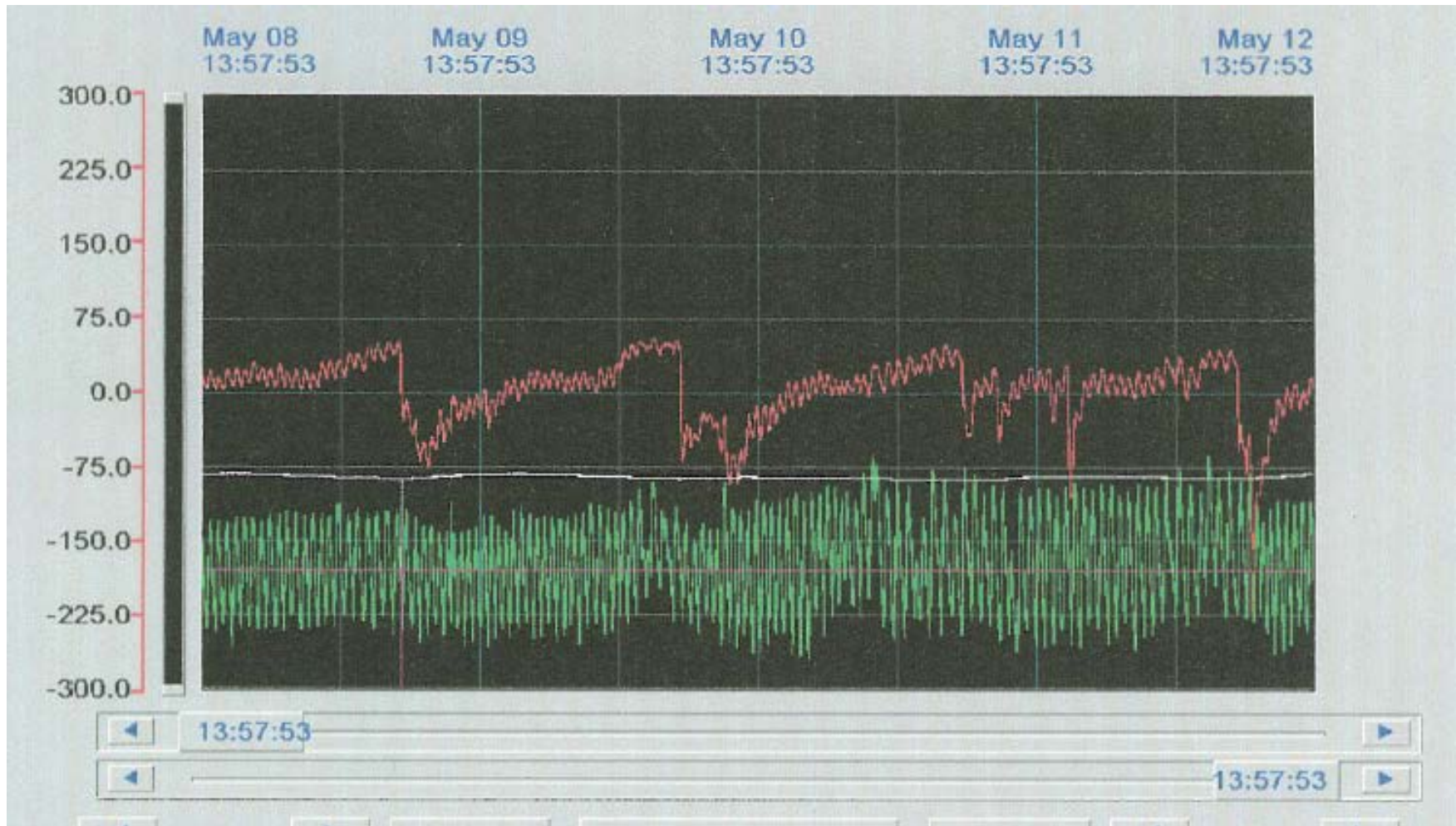
# Control Settings

- Traditional DO Settings
  - Outer – 0 mg/L
  - Middle – 1.0 mg/L
  - Inner – 2.0 mg/L
- Optimized DO Settings
  - Outer Channel – <0 mg/L
  - Middle – 0.4 mg/L
  - Inner – 1.5 mg/L

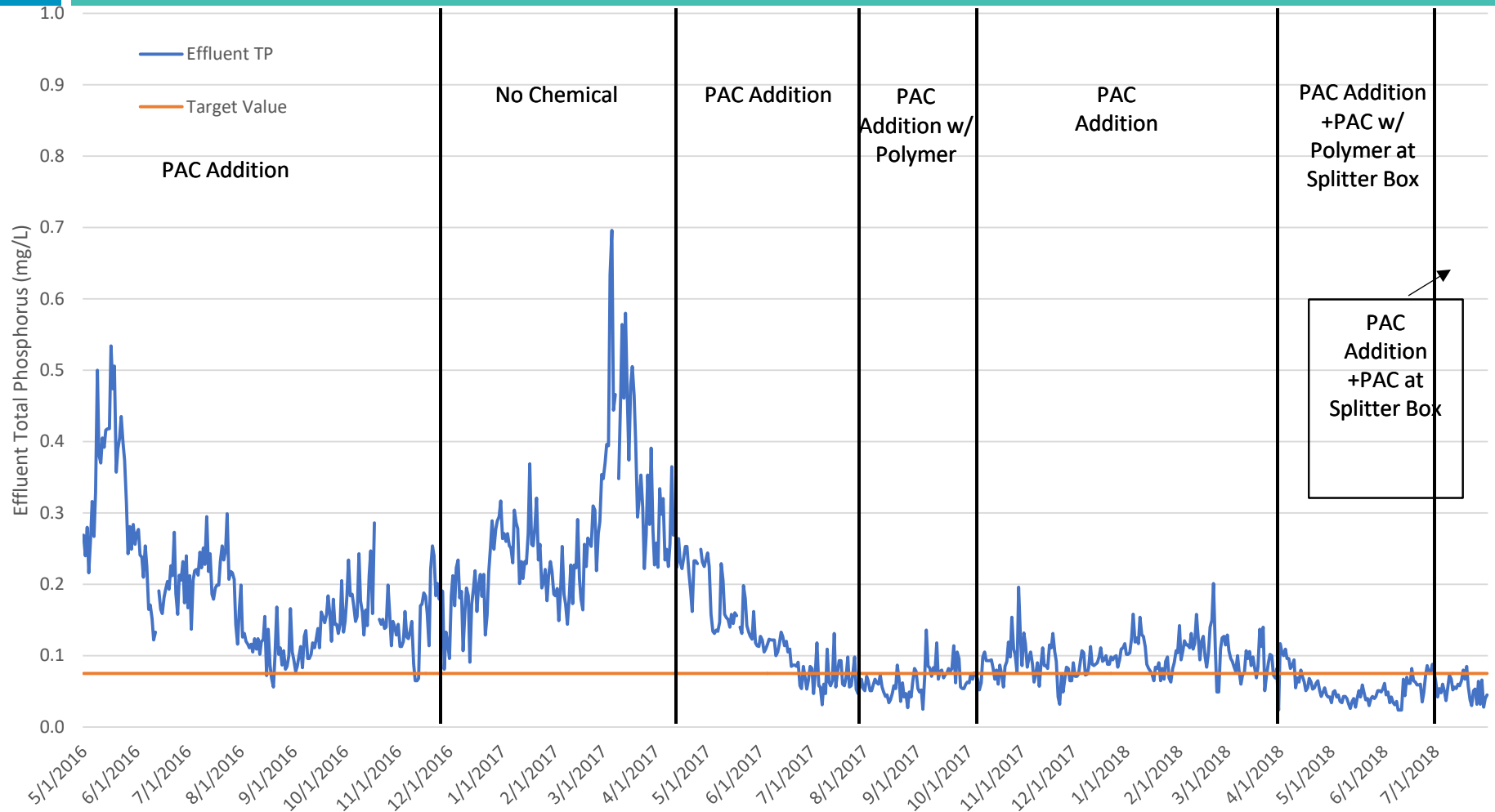
# Examples Slinger, WI

- Orbal Facility, ADF = 0.8 MG
- Removed Outer Discs
- Changed Control Settings
- Installed ORP Probe
- Mixer (In Place of 1 Outer Disc Aerator)
- Influent
  - BOD – 300 mg/L
  - TP – 6 mg/L

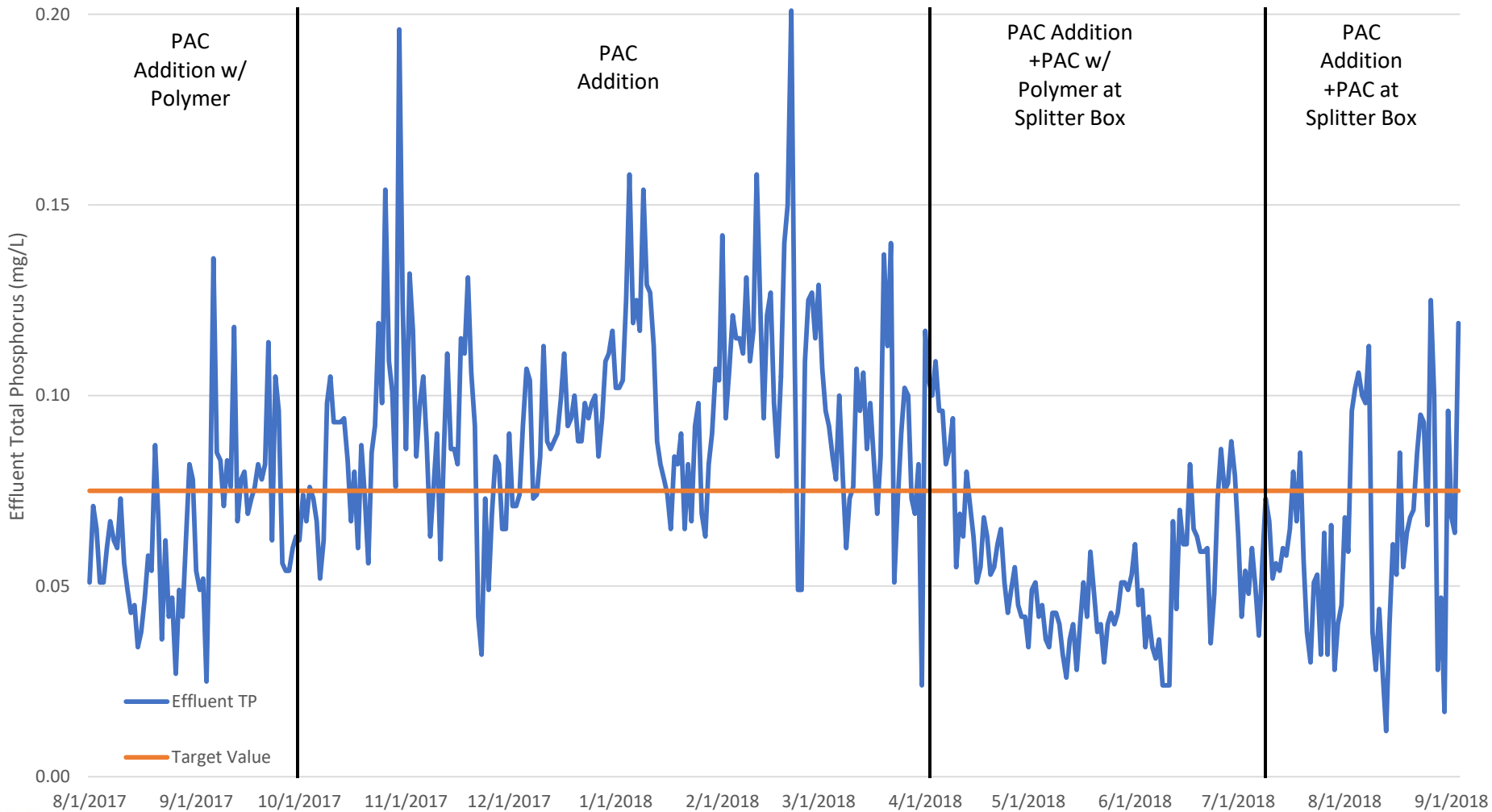
# Examples Slinger, WI



# Examples Slinger, WI



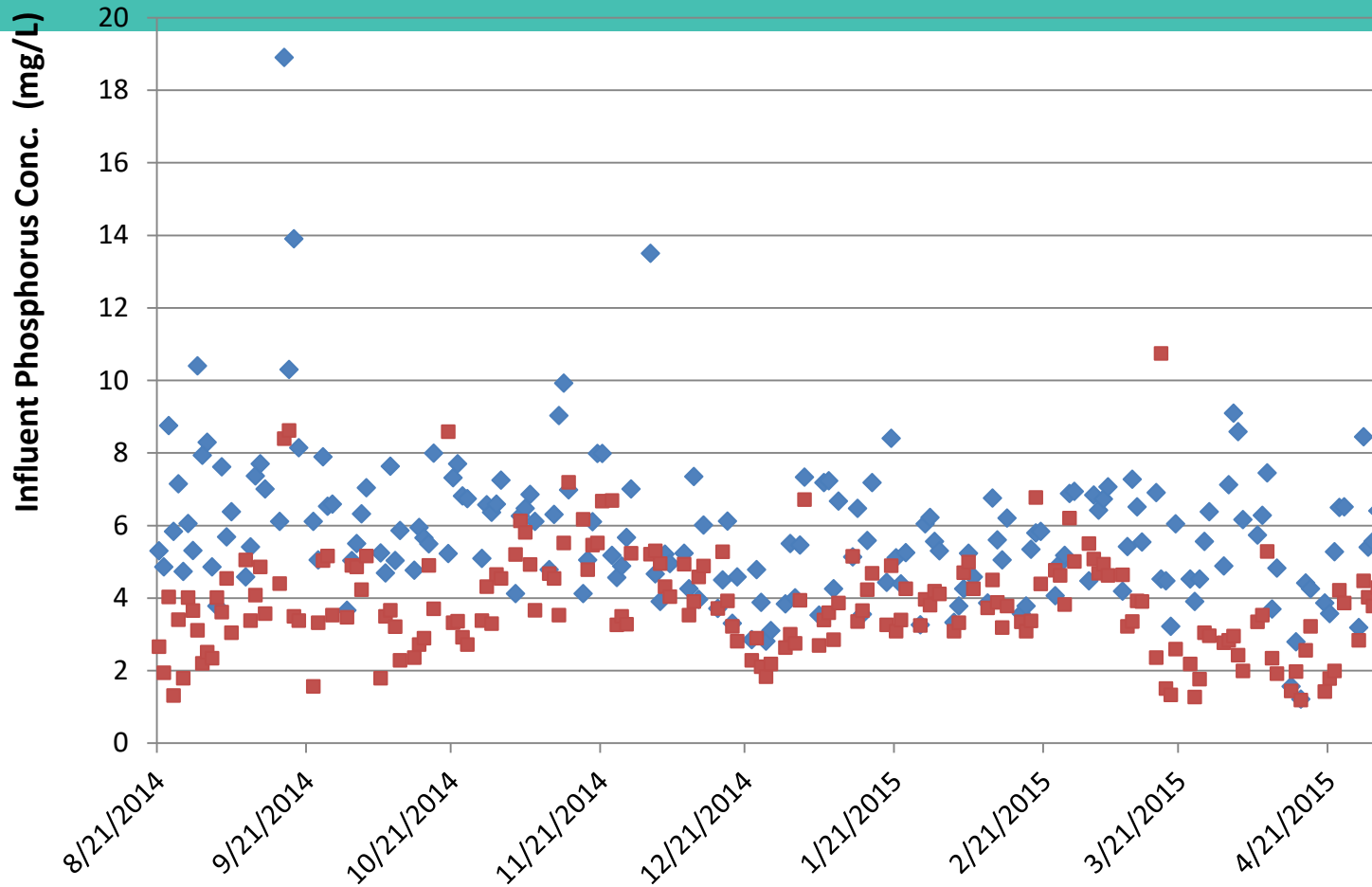
# Examples Slinger, WI



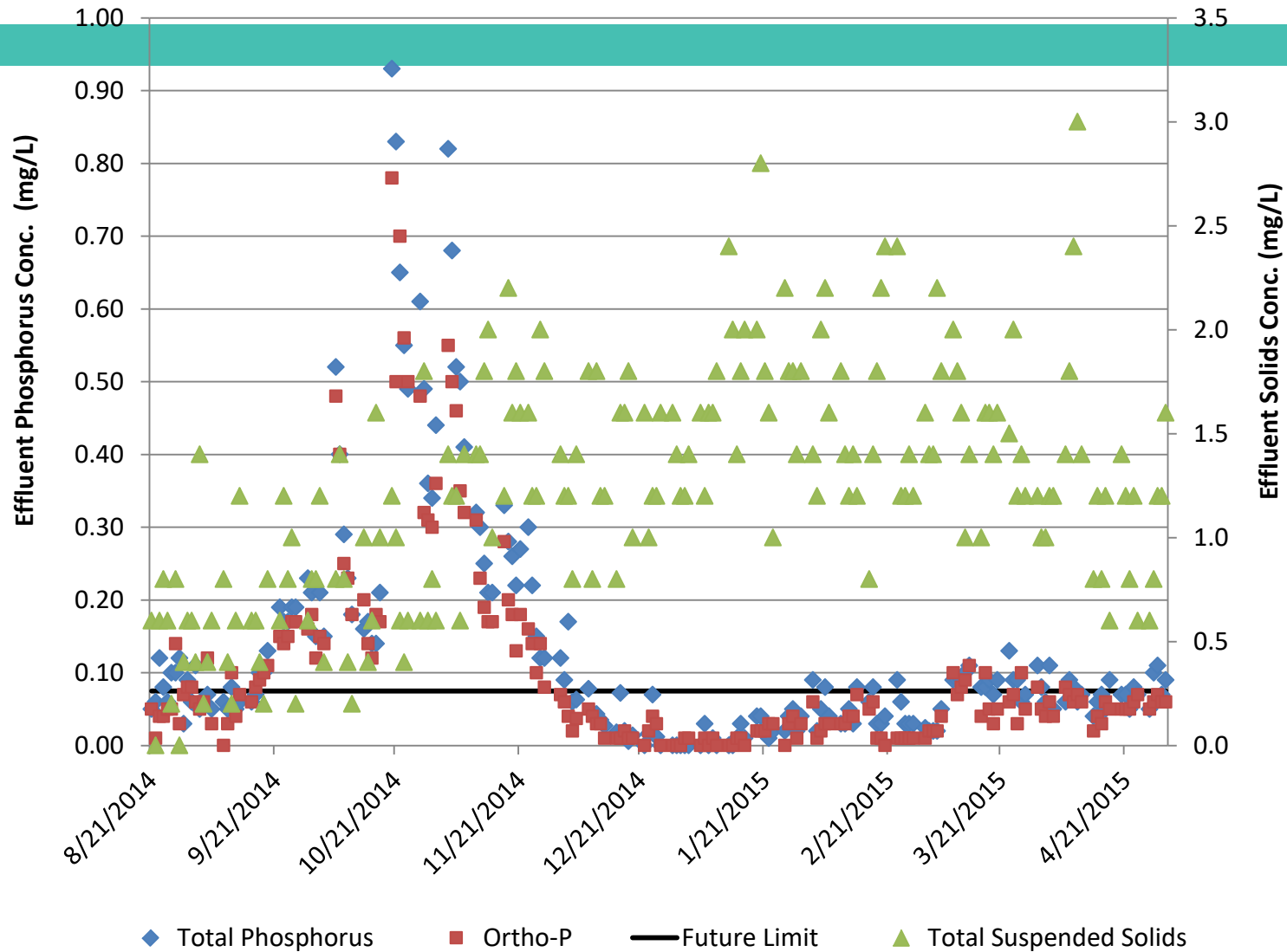
# EXAMPLES HARTFORD, WI

- Orbal Facility, ADF = 2.2 MG
- Disc Aerator VFDs added
- Removed Outer Discs
- Changed Control Settings  
Save \$30,000/Yr.
- Installed ORP Probe
- Changed Coagulant
- Influent
  - BOD – 130 mg/L
  - TP – 7-8 mg/L

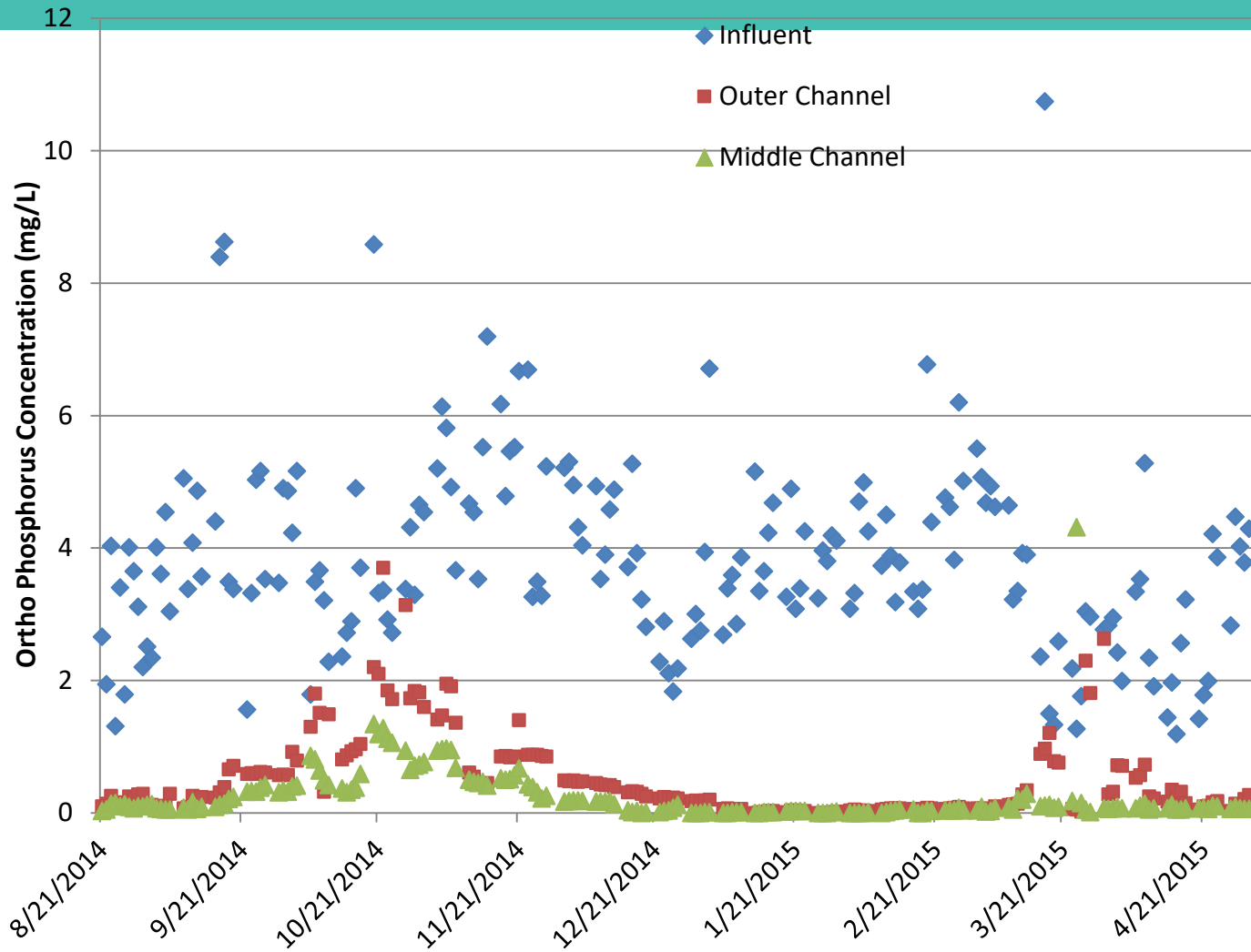
# Examples Hartford, WI



# EXAMPLES Hartford, WI



# Examples Hartford, WI



# EXAMPLES Silver Lake SD, WI

- Orbal Facility, ADF 300,000 gallons
- Reduced O Delivery to Outer Channel
- Confirmed Shift of N –DN from Outer to Middle
- Eff TP = 0.25 mg/L, w/o Chemical
- UW Madison Research
  - PAO P cells
    - High at Inner Channel
    - Low at Outer Channel

Source: Evoqua Water  
Technologies

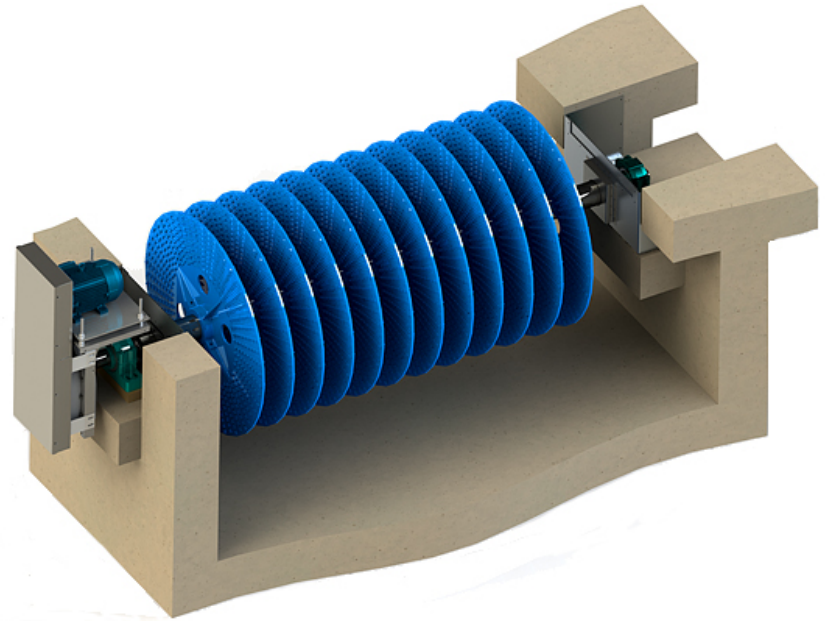
# EXAMPLES McMinnville, OR

- Orbal Facility, ADF = 3.1 MG
- Reduced O Delivery to Outer Channel
  - Similar to Hartford, WI
- Eff TP = 0.2 mg/L, w/o Chemical
- Eff TP = <0.07 mg/L, w/ Alum
- VFAs Not High in Outer Channel
  - Extended HRT

Source: Evoqua Water  
Technologies

# Summary

- Enhancements
  - ORP
  - Removing Outer Discs
  - Optimized Controls
  - VFDs
  - Energy Savings
- True Anaerobic Conditions Not Necessary
- N and Bio P Tradeoff



# Acknowledgements

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- Village of Slinger
- City of Hartford
- Evoqua Water Technologies

# QUESTIONS

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