# Optimizing the $A^2/O$ Process at Upper Blackstone to Push the Limit of Technology

CDM Smith


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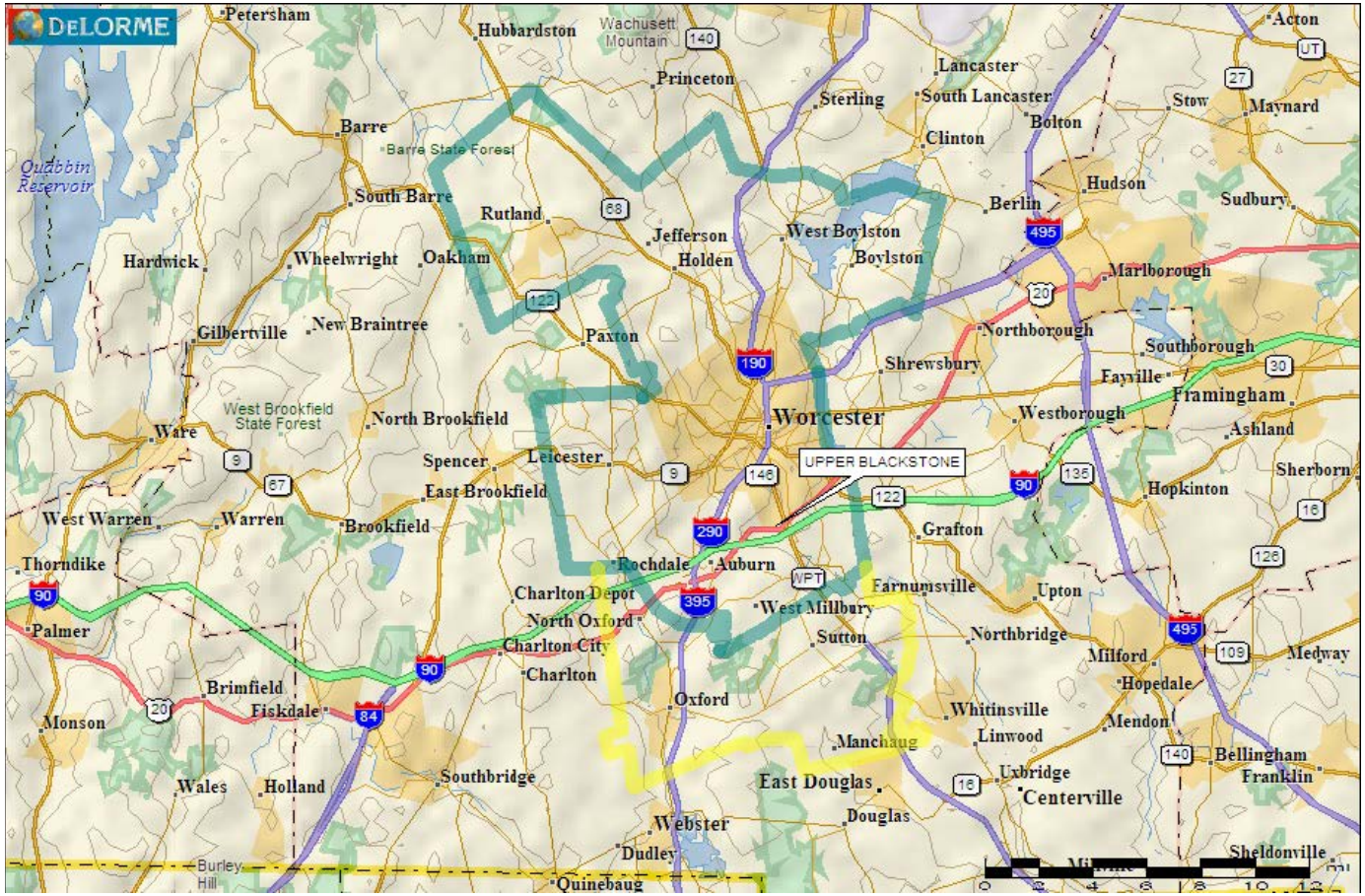
# Outline

- UBWPAD (District) Background
  - Wastewater Treatment Facility (WWTF) Description
  - NPDES Permit Limits
- Overview of Existing $A^2/O$ Process
  - Process configuration
  - Process performance before optimization
- Optimization of Existing $A^2/O$ Process
  - Implement new operational strategies
  - Test process modifications
    - $A^2/O$ with Step Feed
    - Ferric Chloride Addition
- Summary and Next Steps

# UBWPAD Location and Service Area

**Auburn, CVSD, Holden, Millbury, Rutland, West Boylston, Worcester**




**250,000 People, Commercial and Industrial**

# UBWPAD Wastewater Treatment Facility

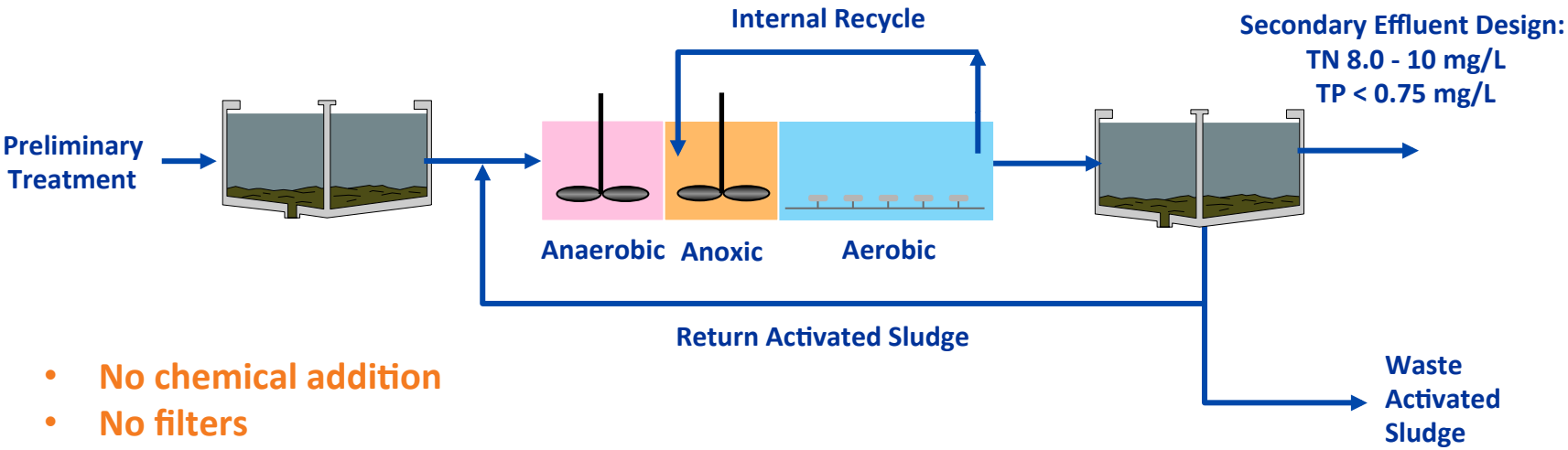
Designed for 45 mgd ADF and 160 mgd peak hour

# Wastewater Treatment Facility NPDES Permit

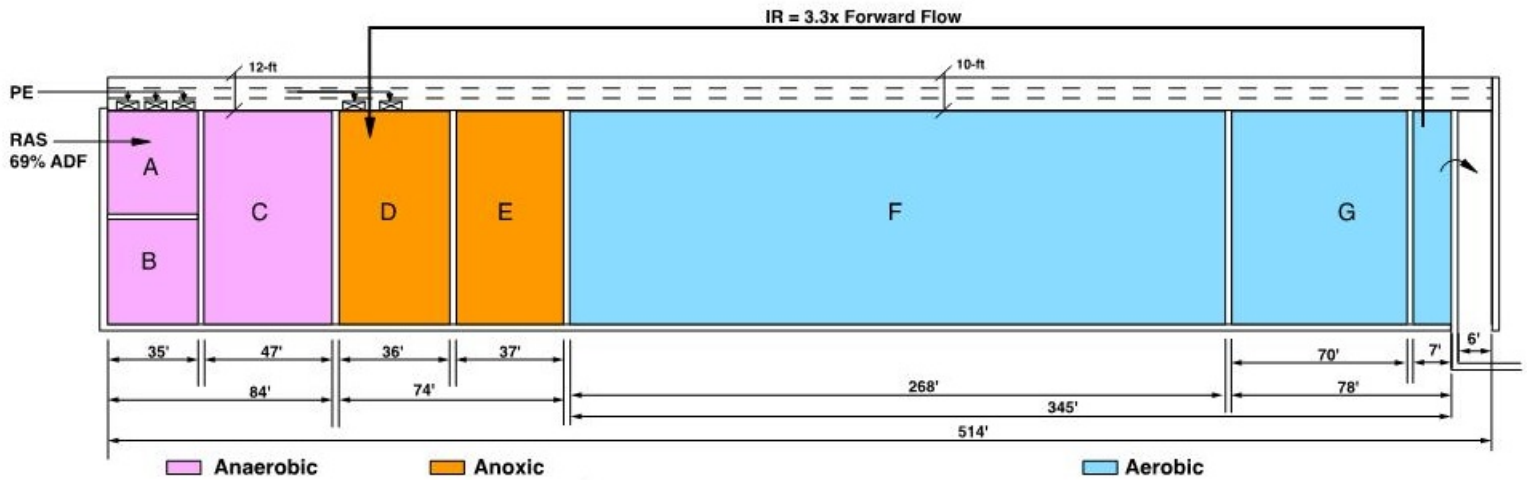
| Constituent | 2001 Permit | 2012 Permit |
|---|---|---|
| CBOD (mg/L) | | |
| Nov – Apr | 25 | 25 |
| Jun – Oct | 10 | 10 |
| TSS (mg/L) | | |
| Nov – Apr | 30 | 30 |
| Jun – Oct | 15 | 15 |
| Total Nitrogen (mg/L) | | |
| Dec – Apr | No Limit | 5 |
| May – Oct | No Limit | No Limit |
| Total Phosphorus (mg/L) | | |
| Apr – Oct | 0.75 | 0.1 |
| Nov – Mar | Report | 1.0 |

- Facility upgraded to meet 2001 permit limits
- Existing facility not able to meet 2012 permit limits consistently
- District testing immediate measures to improve performance
- District studying long-term solutions to meet permit

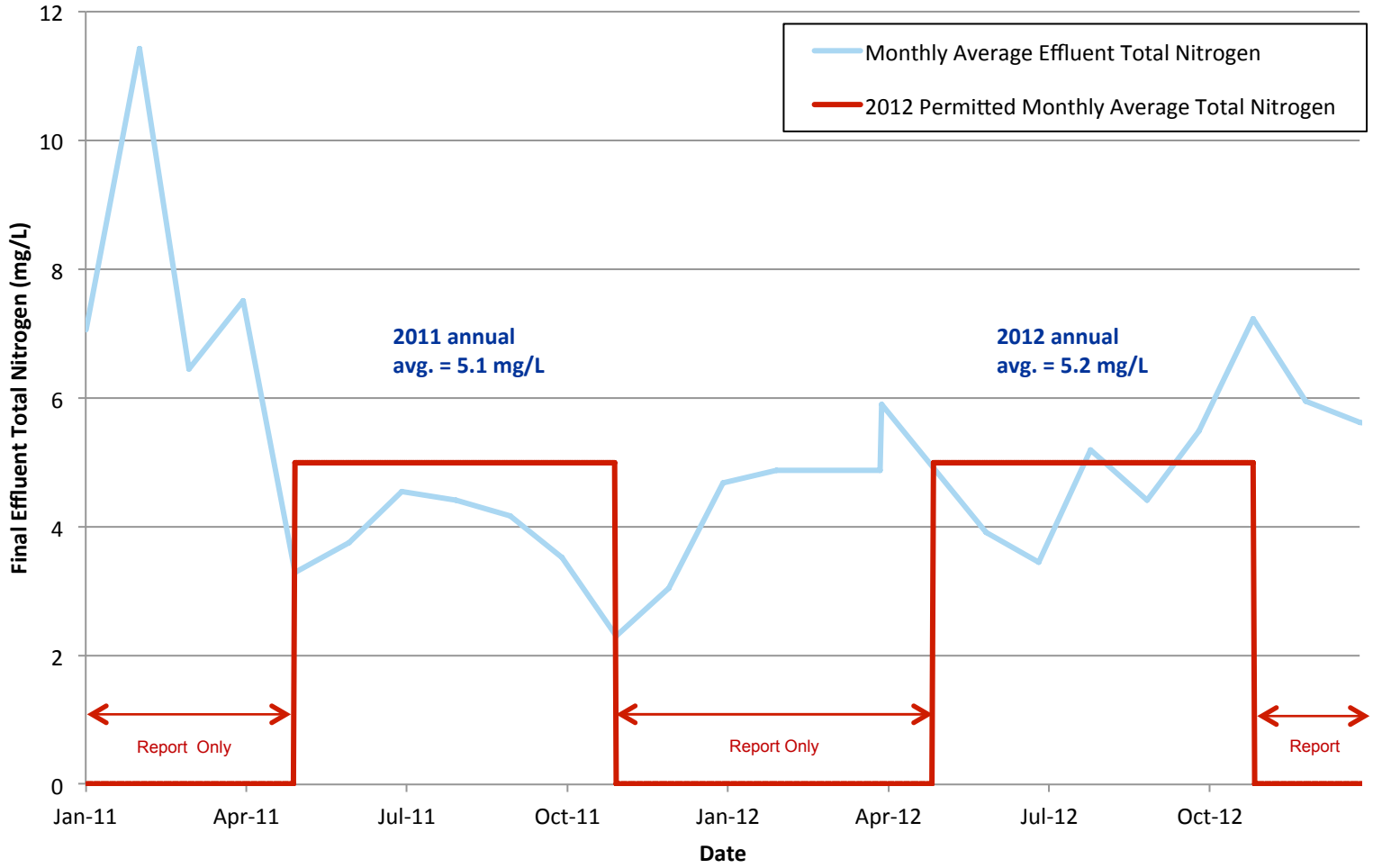
# A²/O Process Configuration



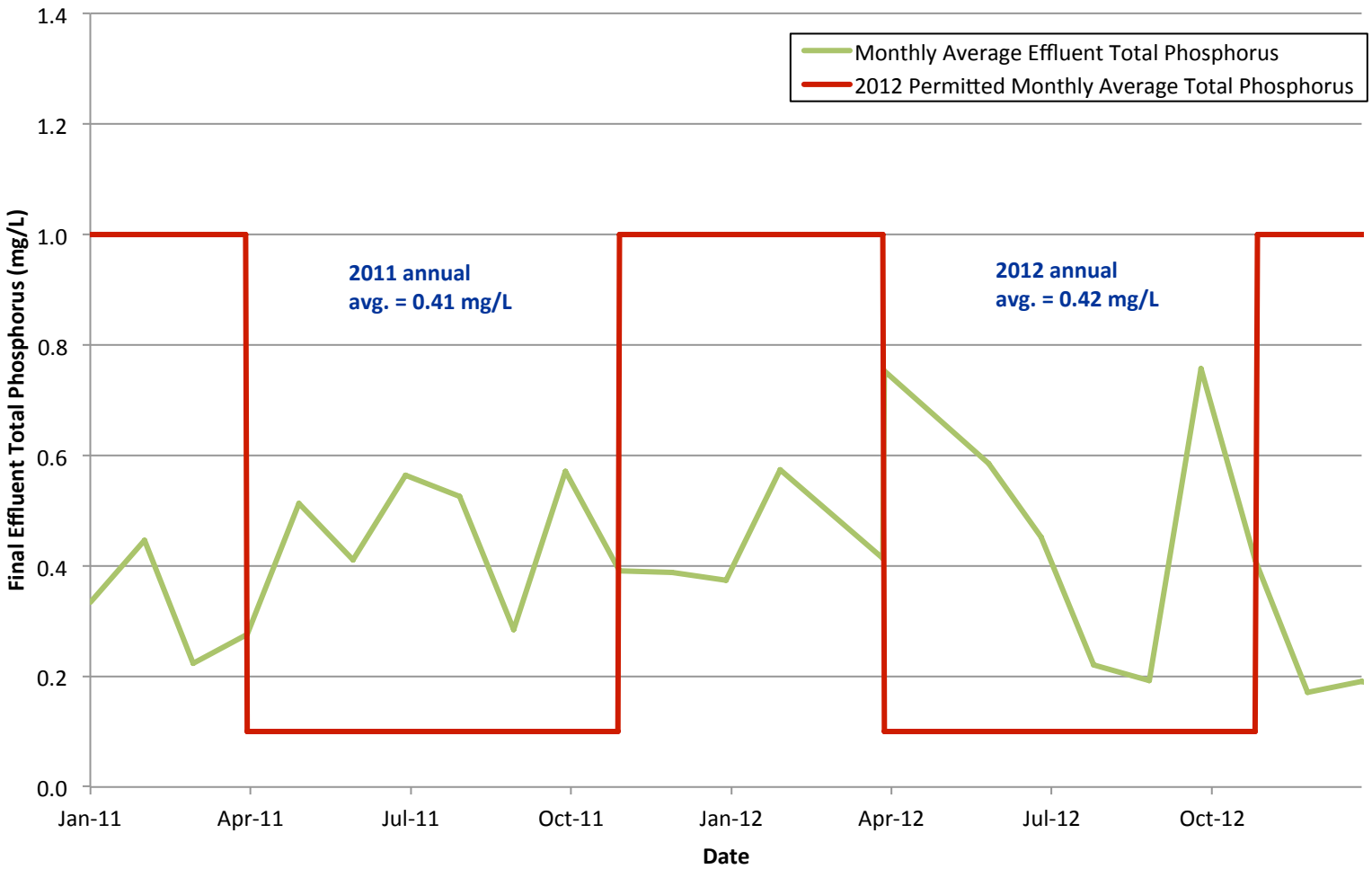

- No chemical addition
- No filters



# Monthly Average Final Effluent TN Concentration versus 2012 Permit Limit



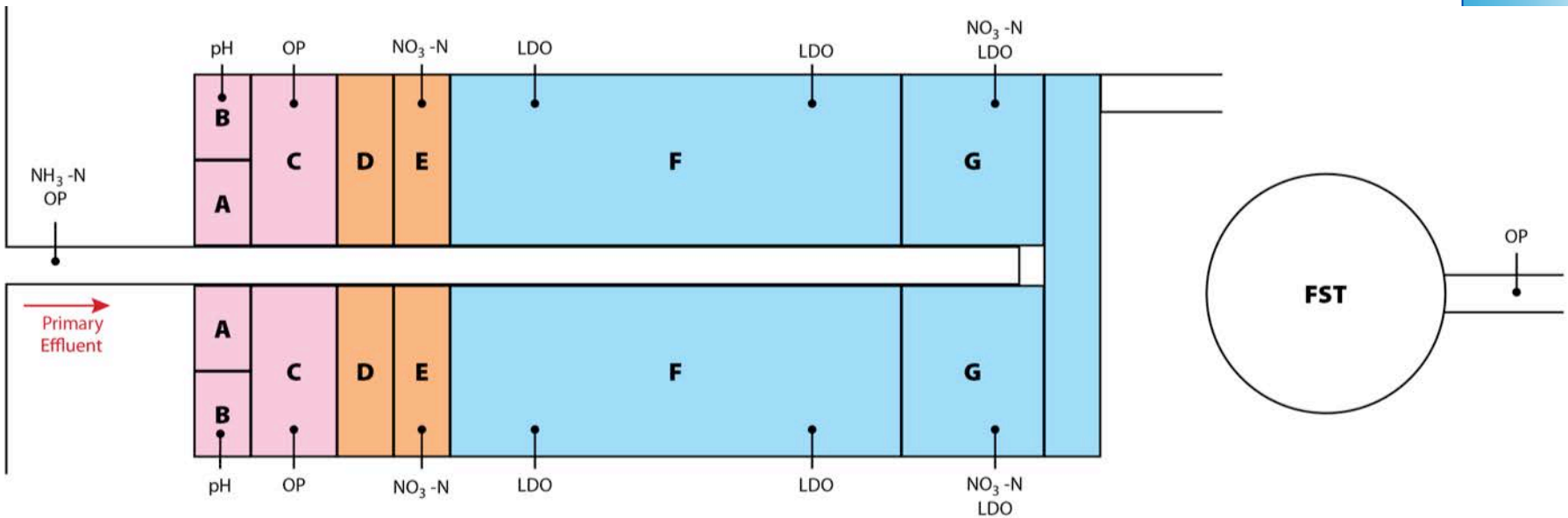
# Monthly Average Final Effluent TP Concentration versus 2012 Permit Limit



# How much better can the process perform?

- *Evaluated current operations*
  - Suitable DO concentrations maintained
  - Nitrate recycle and RAS rates are adjusted to optimize denitrification and EBPR
  - No. of operational aeration tanks adjusted based on season
- *Reviewed historical data and identified new operational strategies to implement*
  - Install additional analyzers for process monitoring and control
  - Operate with a lower and more stable solids retention time
  - Stabilize mixed liquor pH with magnesium hydroxide
- *Modeled potential process modifications, including chemical addition, to determine which should be tested at large scale*

# Install Additional On-line Analyzers for Process Monitoring and Control

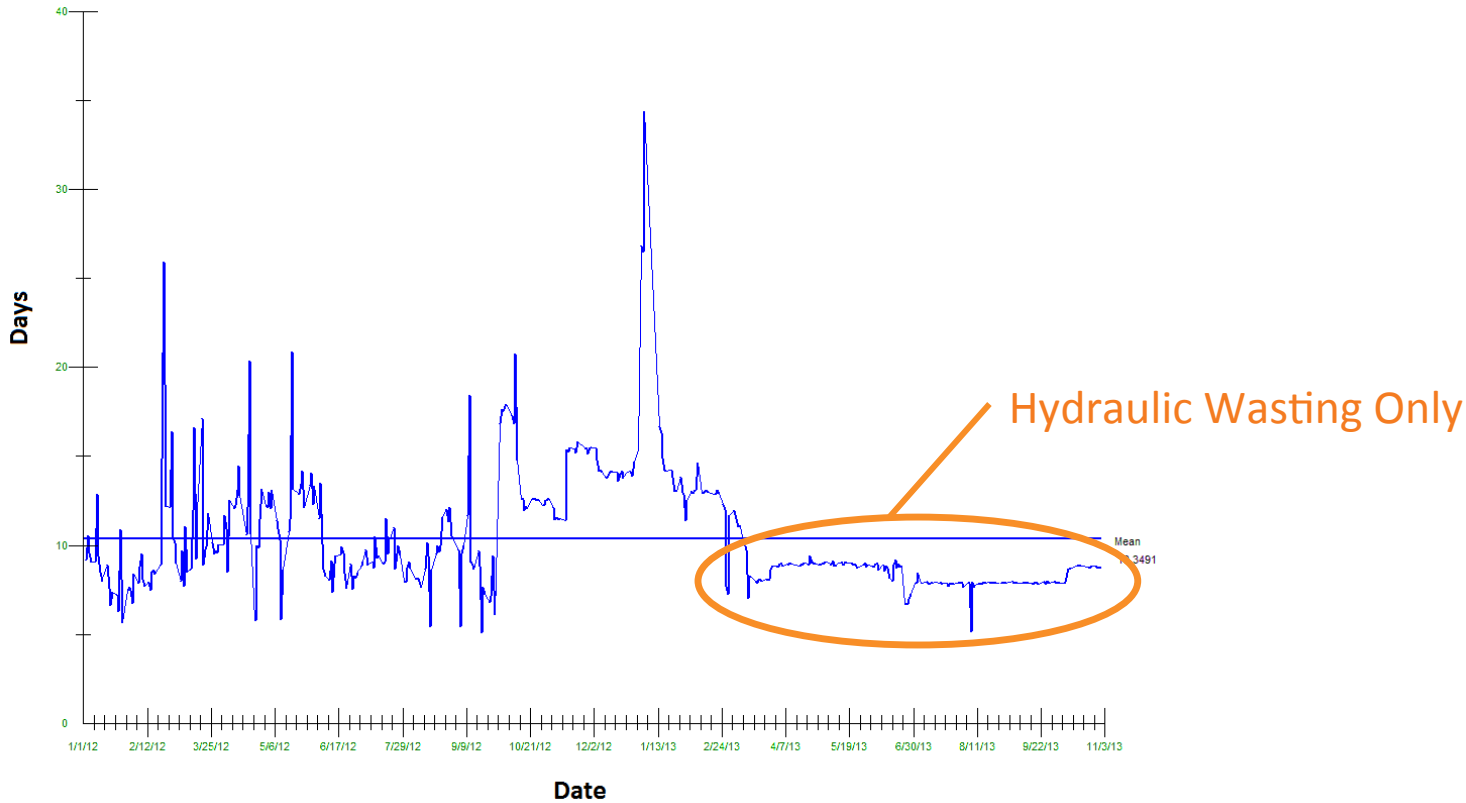




http://www.hach.com

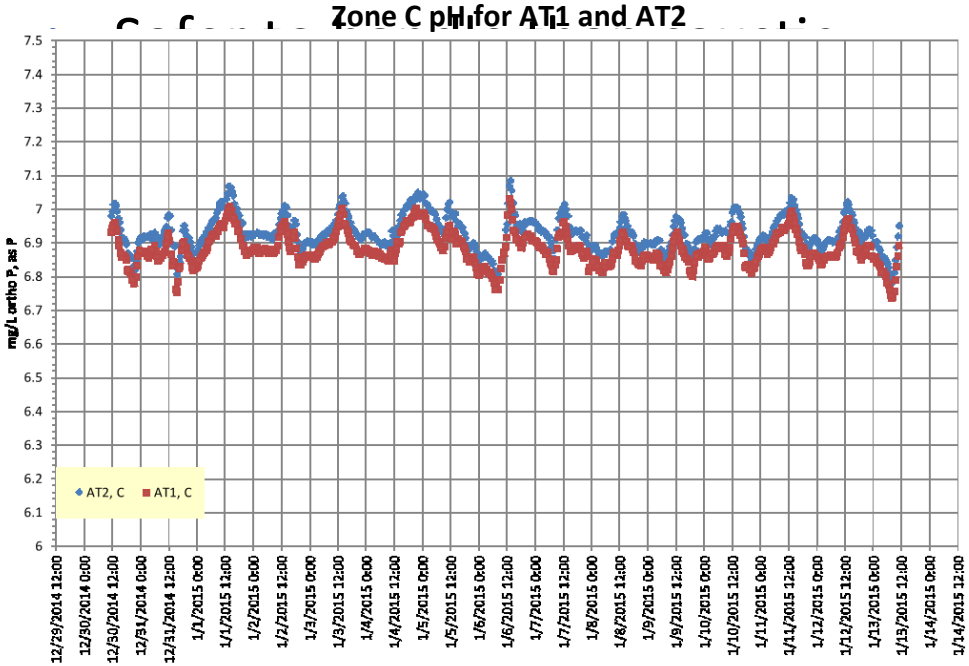
# Reduce and Stabilize Solids Retention Time

- Find balance between nitrification and EBPR needs
- Utilize hydraulic wasting exclusively



# Stabilize Mixed Liquor pH with Magnesium Hydroxide

- Temporary magnesium hydroxide system installed in September 2013
- Maintain pH set point of 6.9-7.0




: it is not yet a permanent



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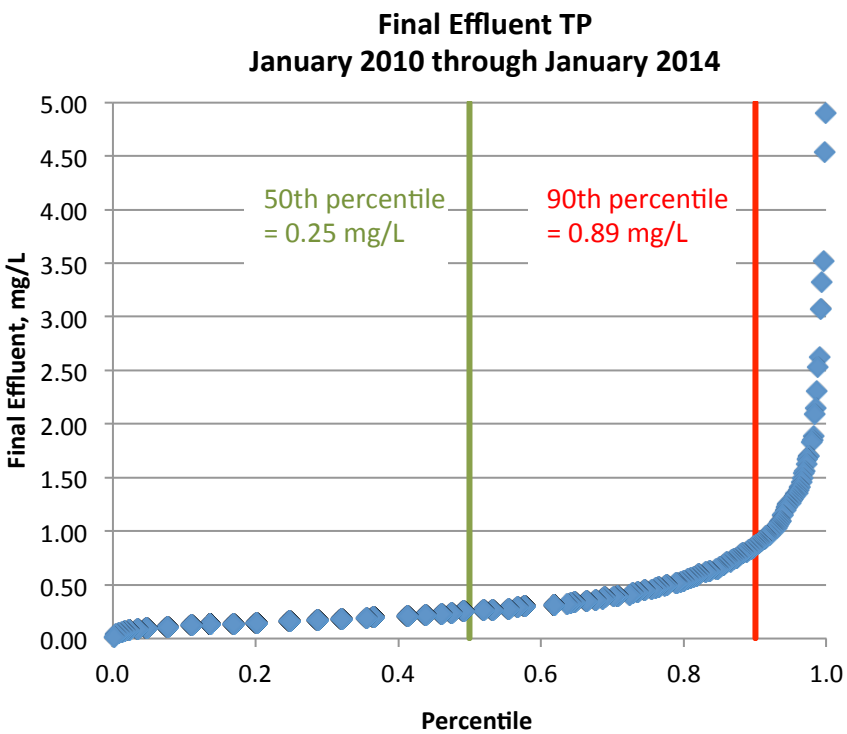
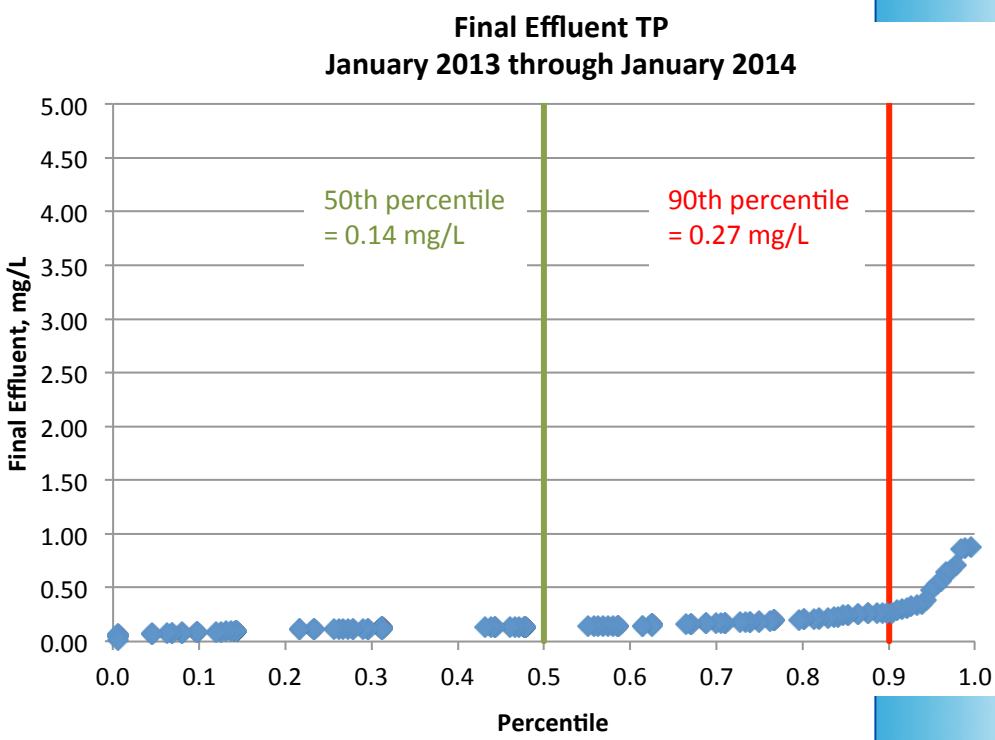
# Results of New Operational Strategies

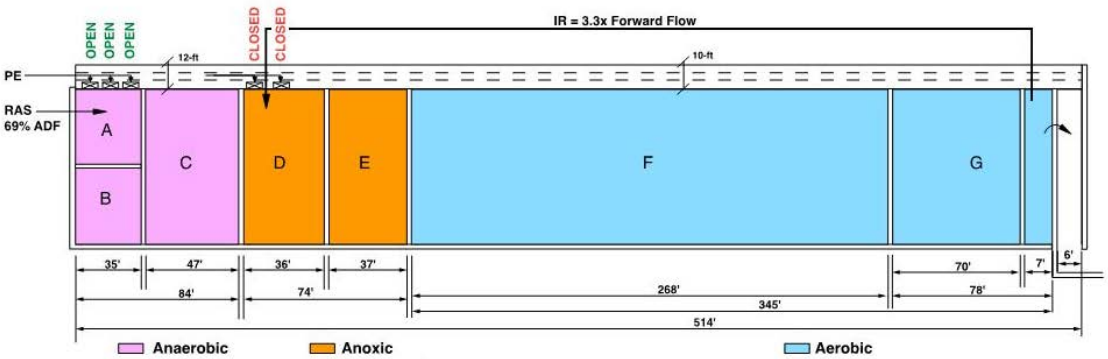


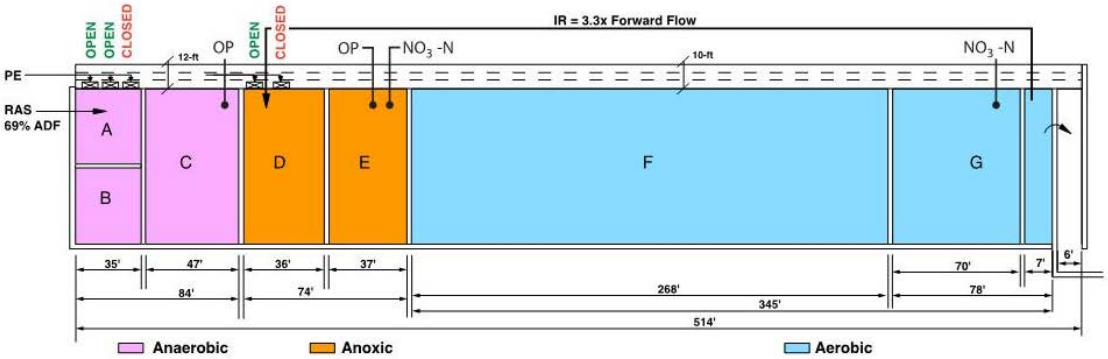

- TP less than 0.3 mg/L every month in 2013
- TP less than 0.2 mg/L in eight out of twelve months

# Step Feed Testing Set-Up

- Commenced on February 13, 2014
- Completed on September 16, 2014
- Goal: Achieve 5 mg/L TN w/o impact on EBPR
- Quarter-scale test at start
- Increased to maximum two-thirds scale




$A^2/0$: P = 0.75mg/L—TN = 8-10mg/L
Existing Process Mode

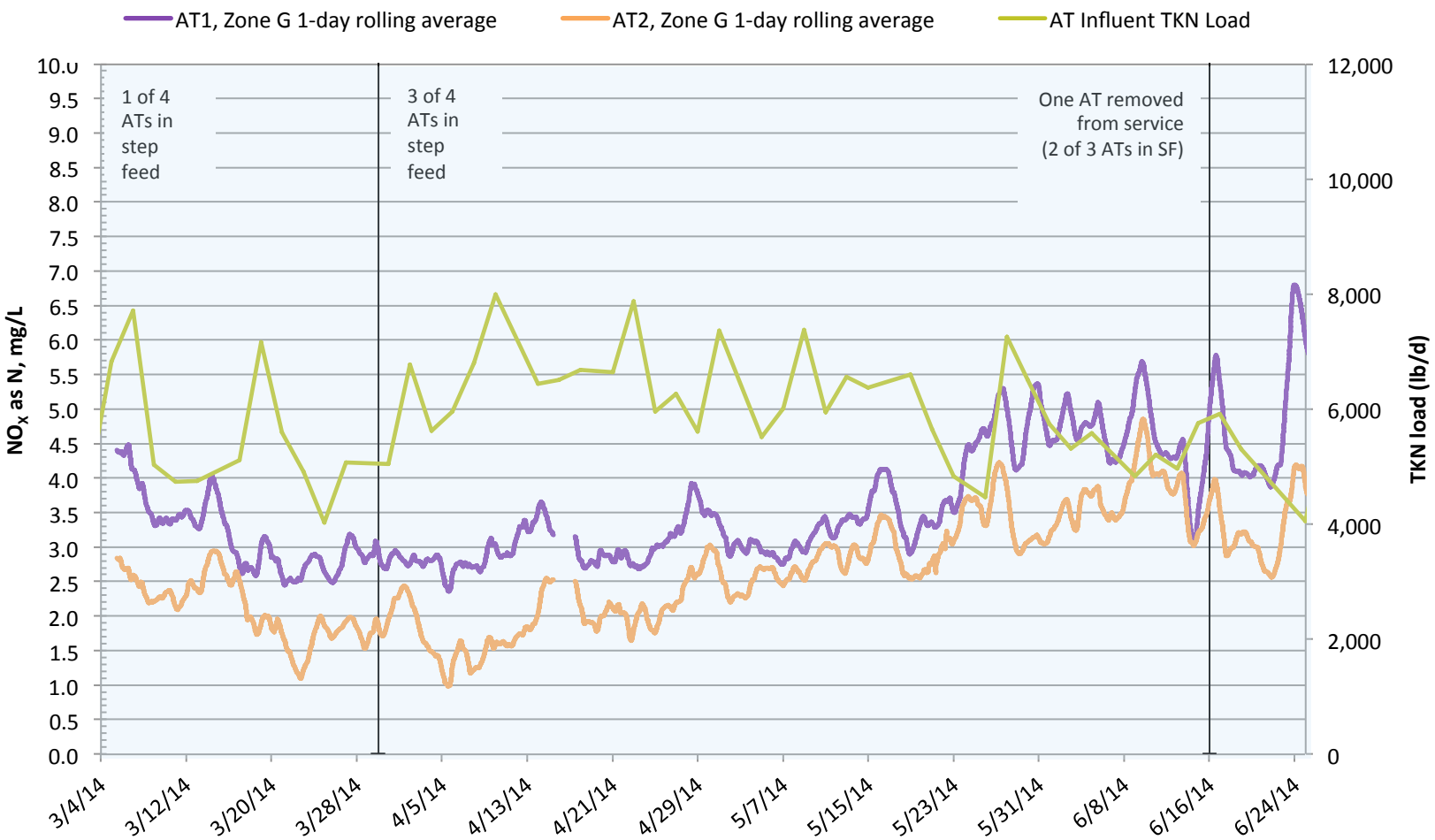



$A^2/0$: Step Feed Mode: Target TN < 5 mg/L

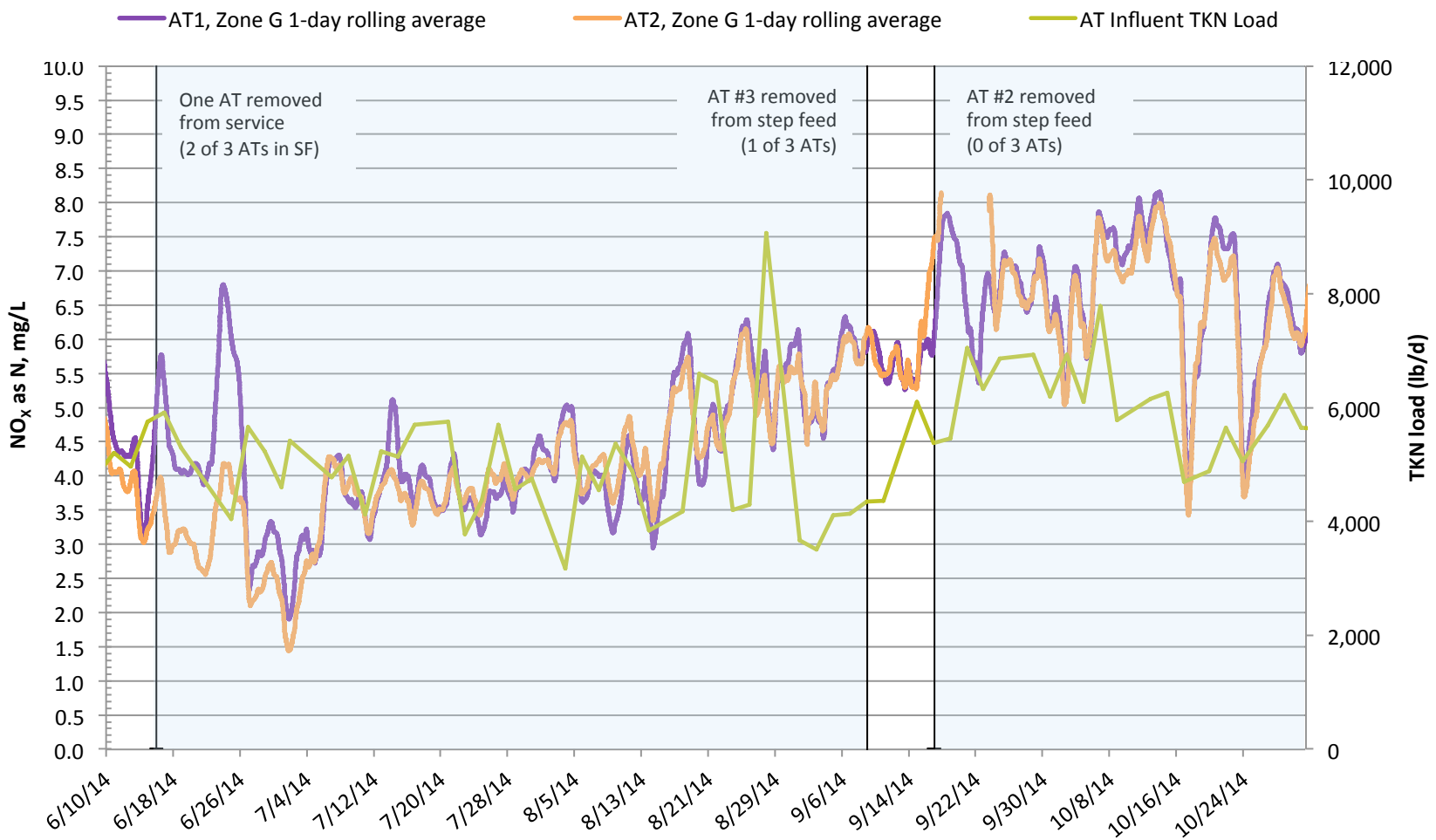
# Step Feed Testing Results

- Average monthly TN < 5 mg/L for 5 out of 7 months
  - Average TN from February to May: 3.6 mg/L
  - Average TN from June to September: 4.8 mg/L
- Minimal impact on EBPR at first, but robustness of EBPR process seems to have been compromised over time
  - Average TP from February to May: 0.16 mg/L
  - Average TP from June to September : 0.50 mg/L
- Step feed benefit diminished with increasing temperatures
- Beneficial tool for wet weather management

# Zone G NOx data with $A^2/O$ Influent TKN Loads Step Feed - March to June 2014



# Zone G NOx data with A²/O Influent TKN Loads Step Feed - June to October 2014



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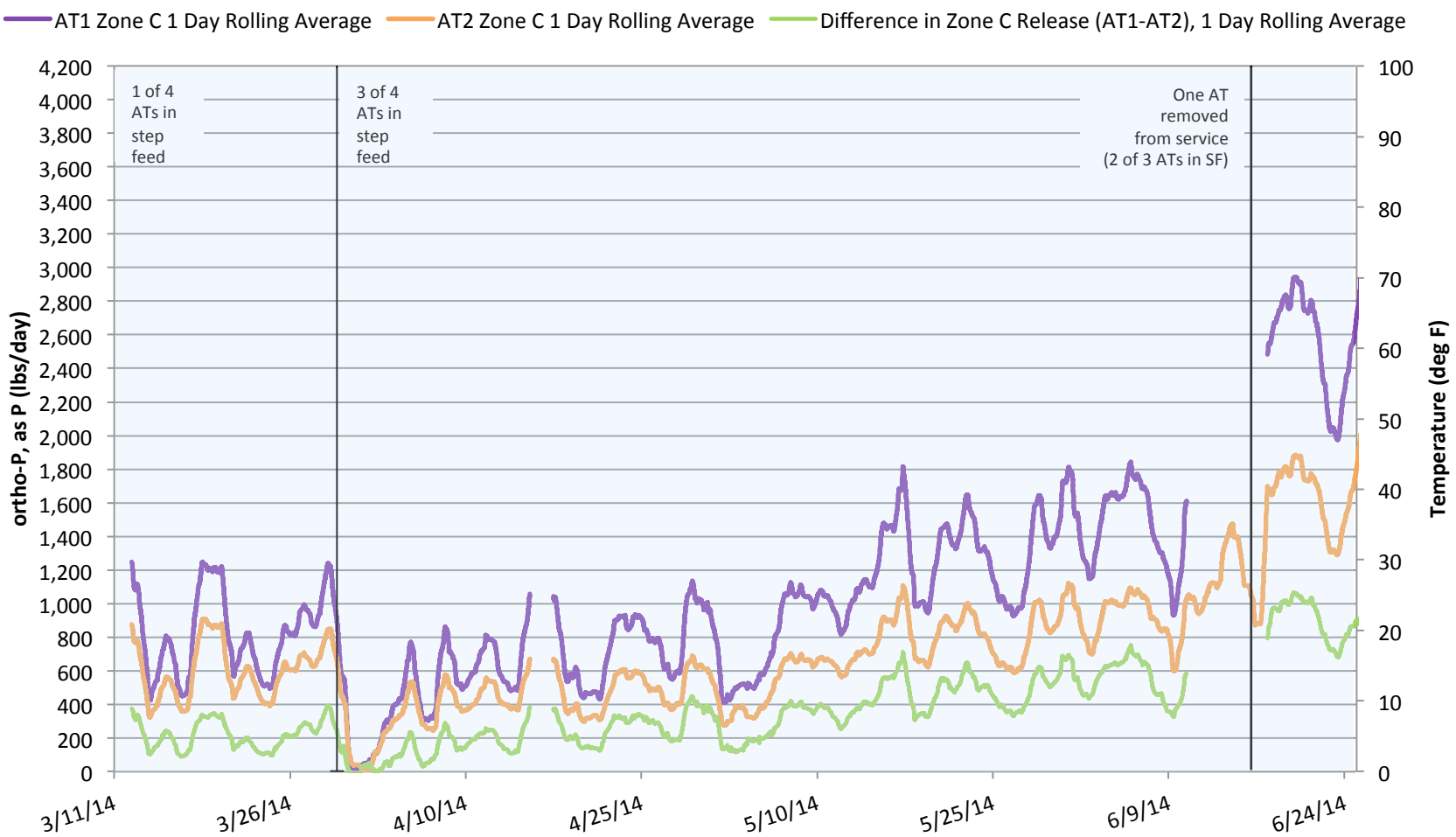
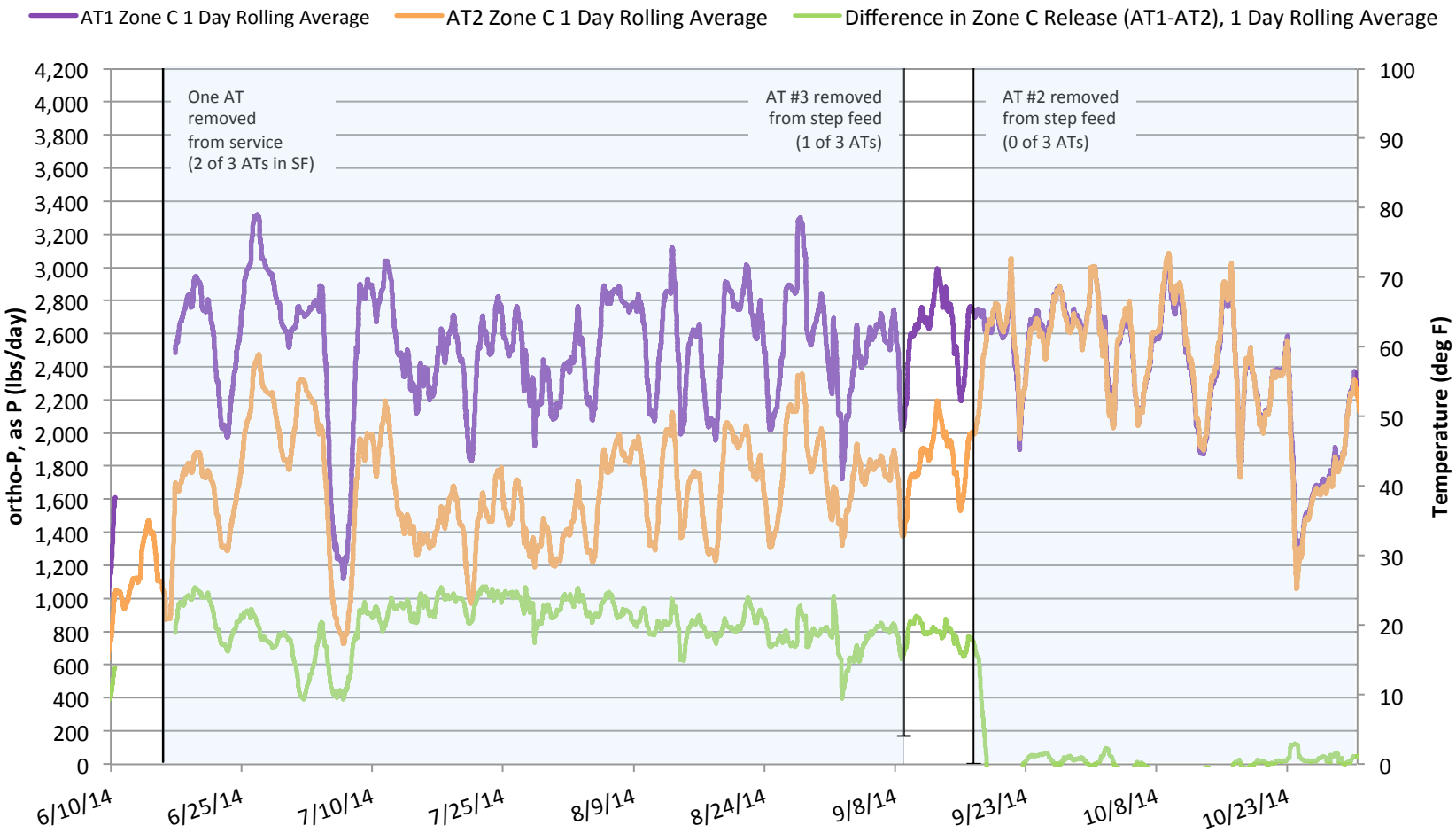
# Zone C Ortho-P Loads with Release Differential Step Feed - March to June 2014



# Zone C Ortho-P Loads with Release Differential Step Feed - June to October 2014



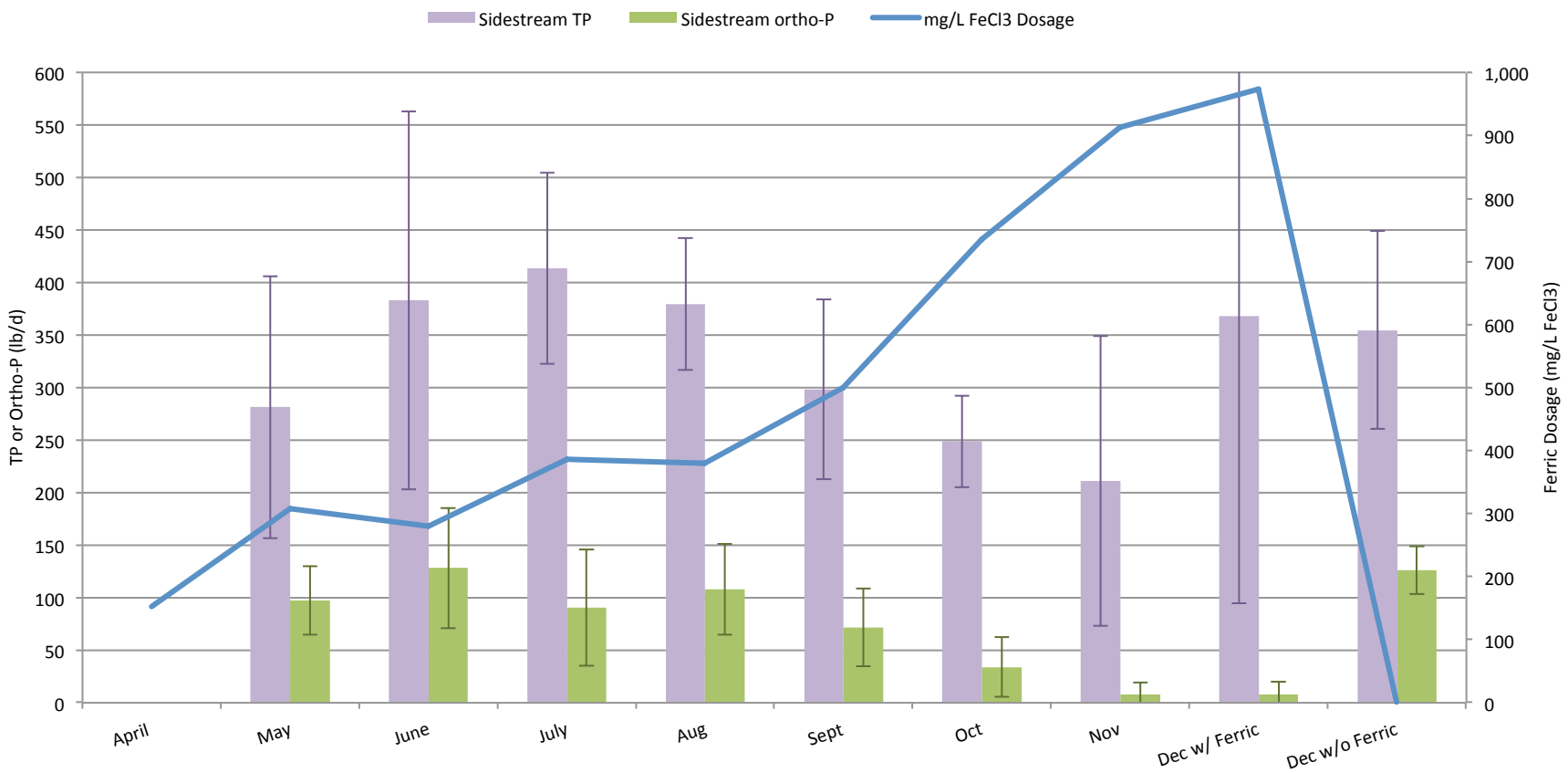
# Ferric Chloride Testing Set-Up

- Commenced on April 14, 2014
- Completed on December 12, 2014
- Feed ferric chloride into belt filter press feed sludge
- Goal: Achieve reduction in TP load returned in sidestream
- Full-scale test

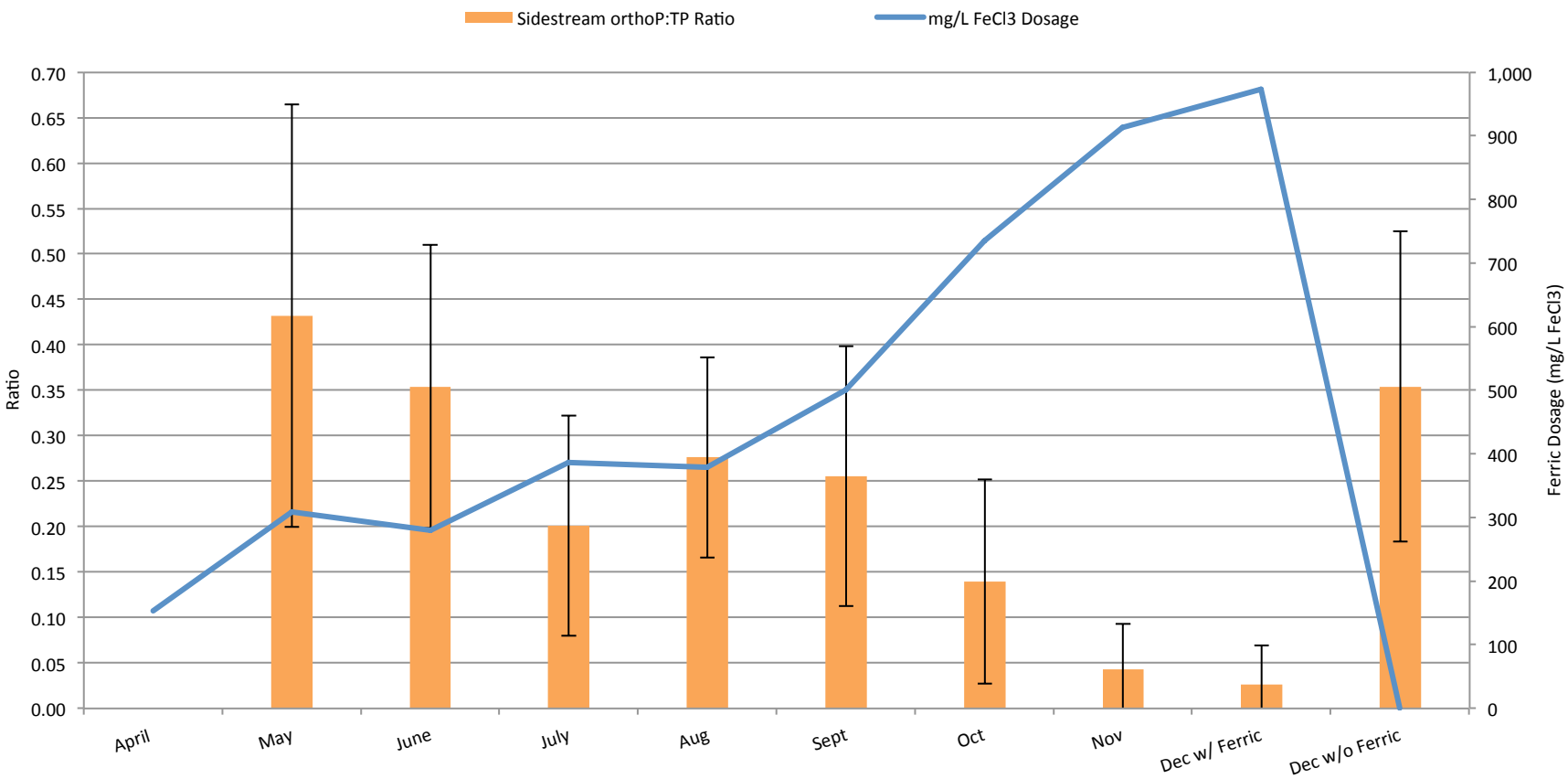
# Ferric Chloride Testing Results

- BFP Feed sludge Ortho-P concentrations
  - Average ranged from 250 to 440 mg/L
  - Daily spikes up to 740 mg/L
- No negative impact on sludge dewaterability with ferric doses up to 1,000 mg/L (or 550 gallons per day)
- Phosphorus reduction during testing
  - Up to 75% in Ortho-P in filtrate
  - Up to 80% in Ortho-P in sidestream
  - Noticeable impact on $A^2/O$ Influent TP and Ortho-P loads

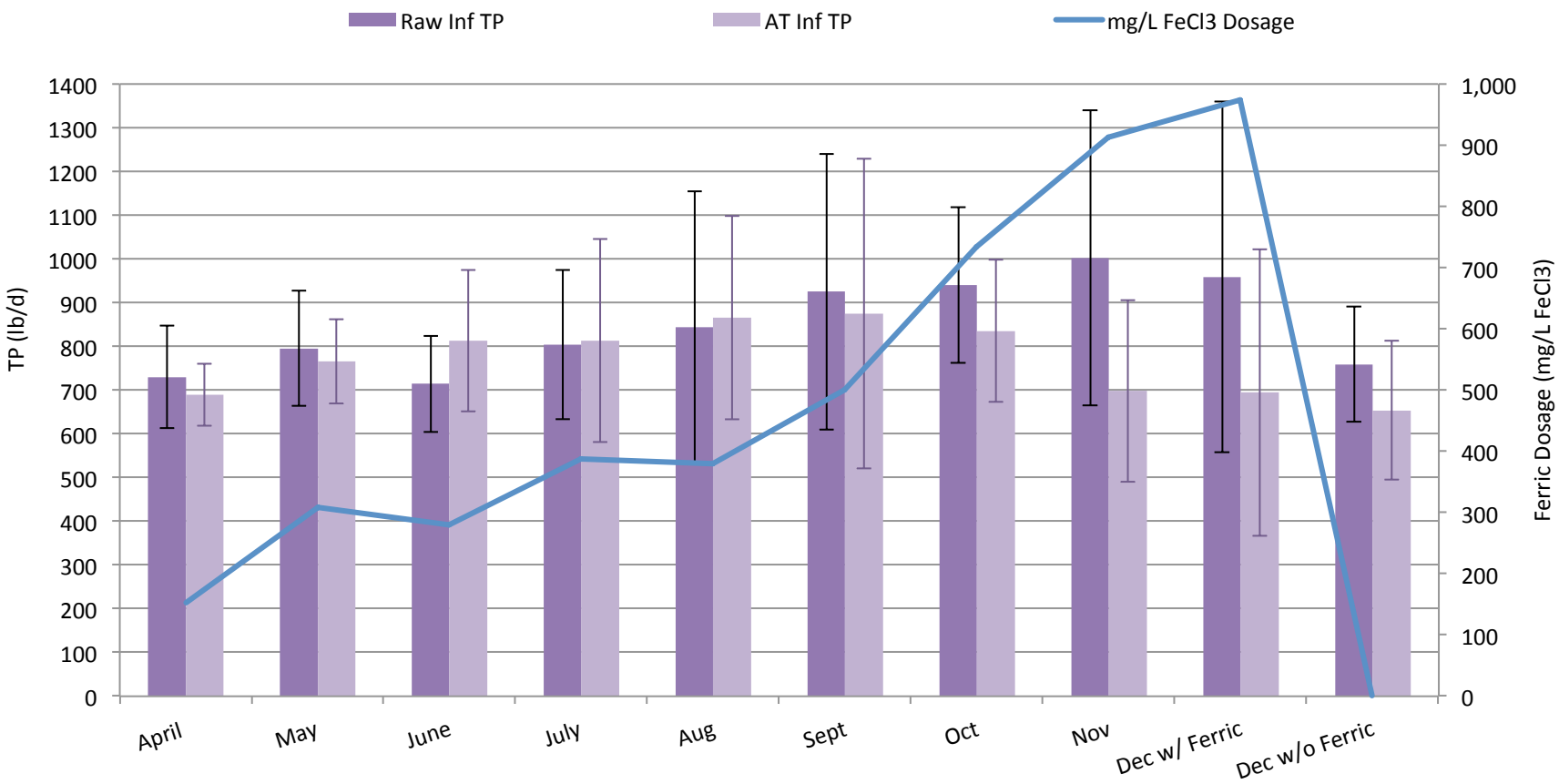
# Phosphorus Loads in Sidestream Compared to Ferric Chloride Dosage



# Ortho-P to TP Ratio in Sidestream Compared to Ferric Chloride Dosage



# TP Load in Raw and $A^2/O$ Influent Compared to Ferric Chloride Dosage



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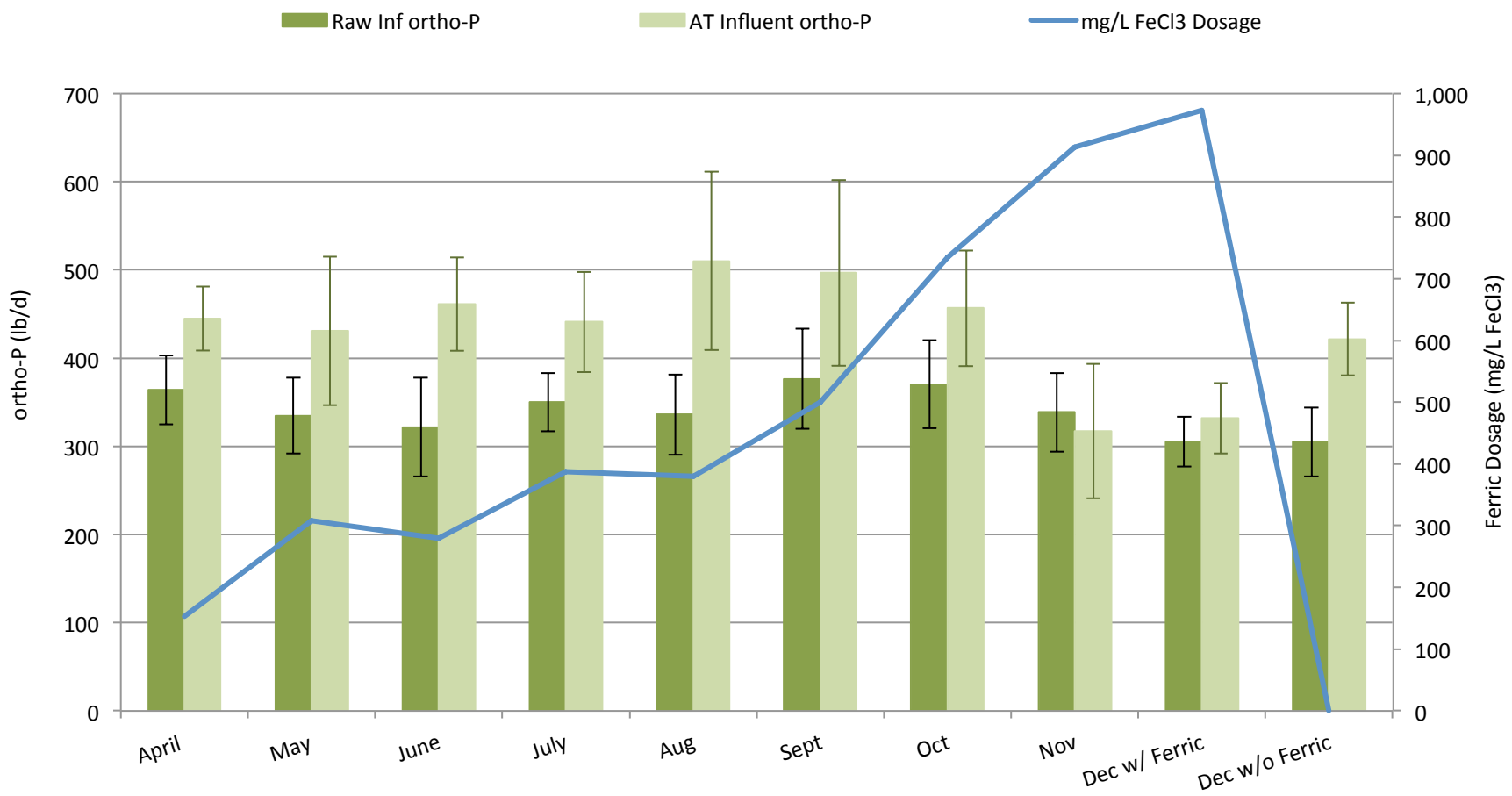
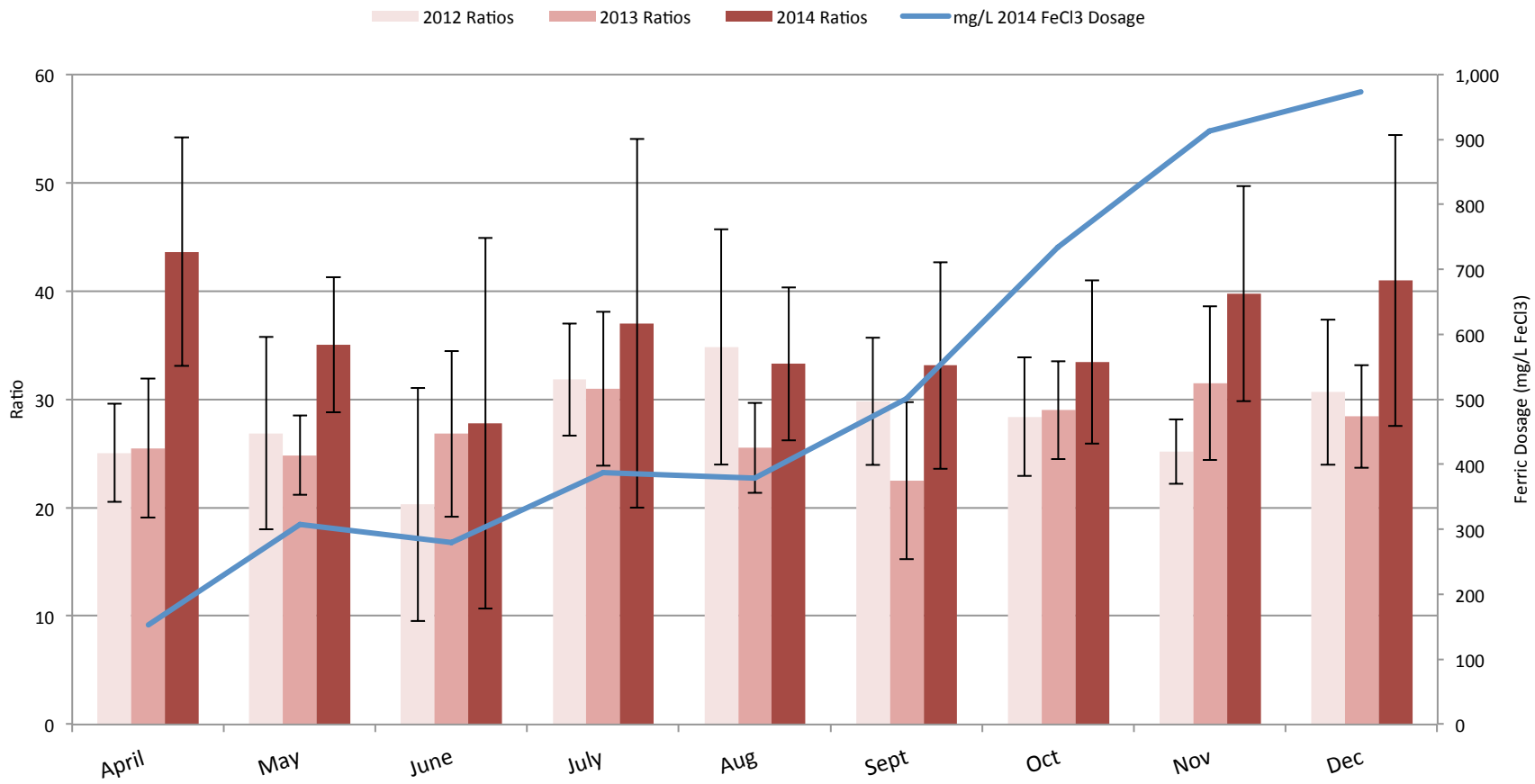


# cBOD to TP Ratio in $A^2/O$ Influent Compared to Ferric Chloride Dosage



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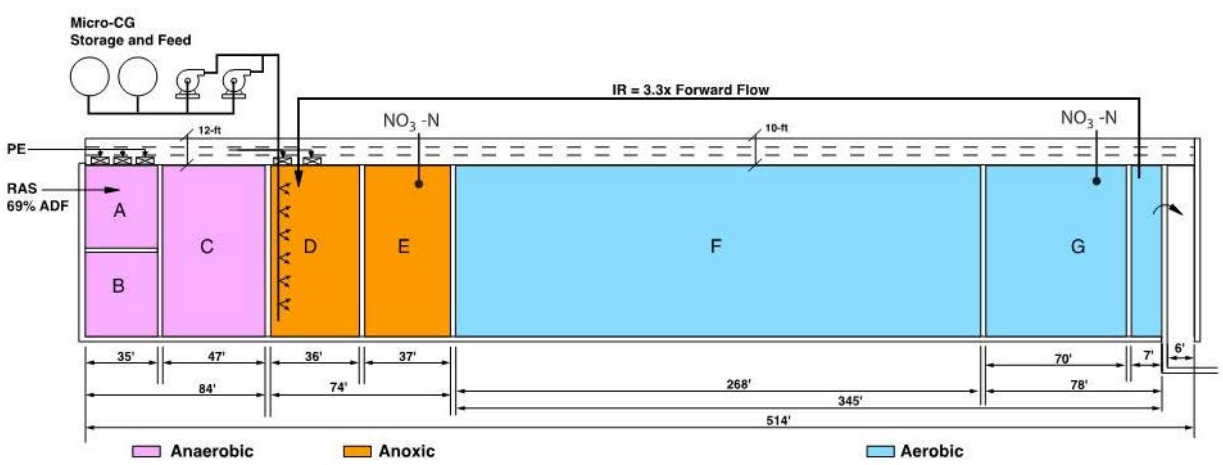
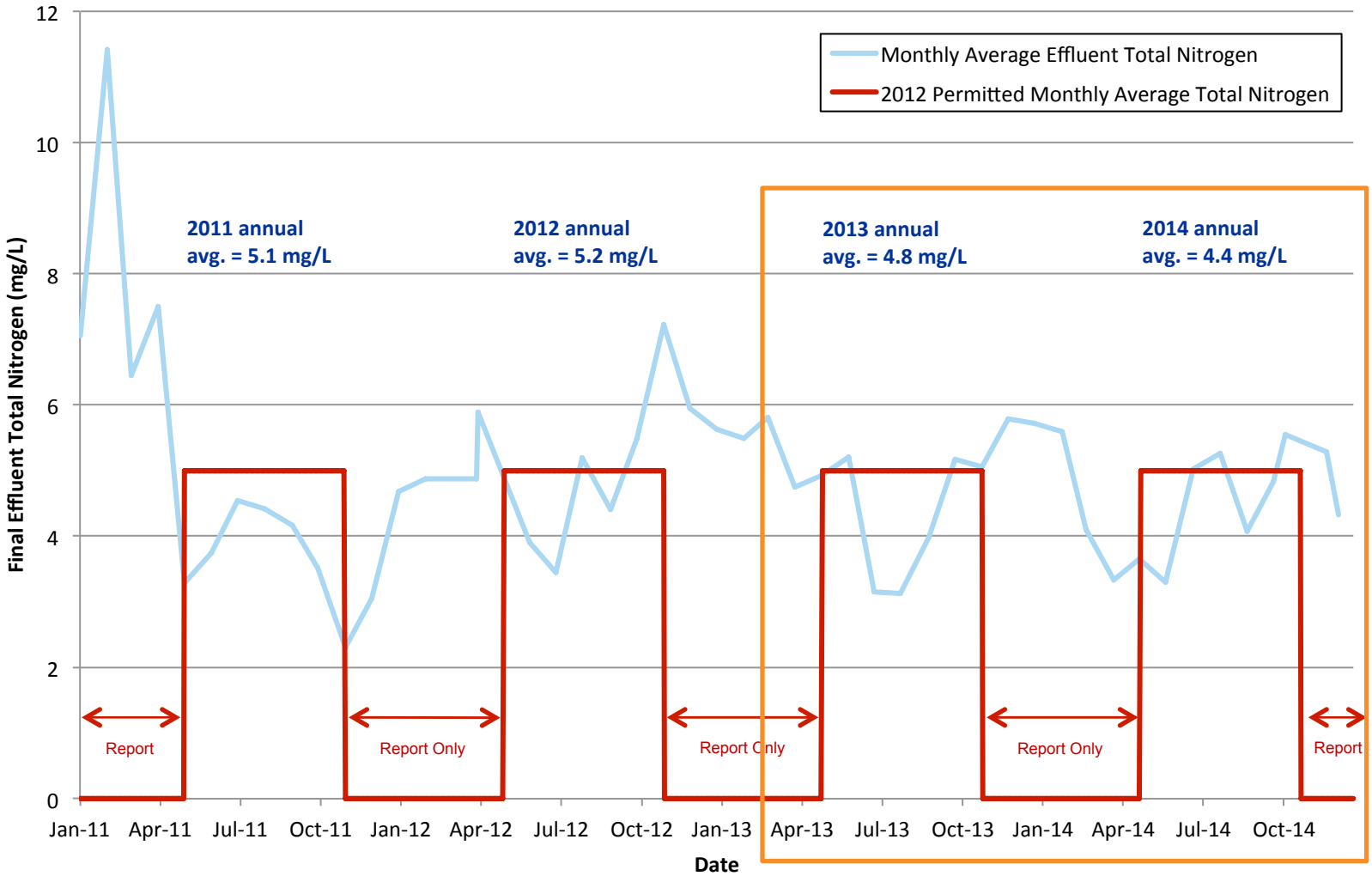
# $A^2/O$ with Carbon Addition Set-Up

- Start in March 2015
- Add supplemental carbon to anoxic zone and to anaerobic zone
- Goals: Achieve 5 mg/L TN and Improve EBPR performance
- Quarter-scale
- 10-week duration (minimum)




$A^2/0$: With Carbon Addition to Anoxic Zone: Target TN < 5 mg/L

# Monthly Average Final Effluent TN Concentration versus 2012 Permit Limit



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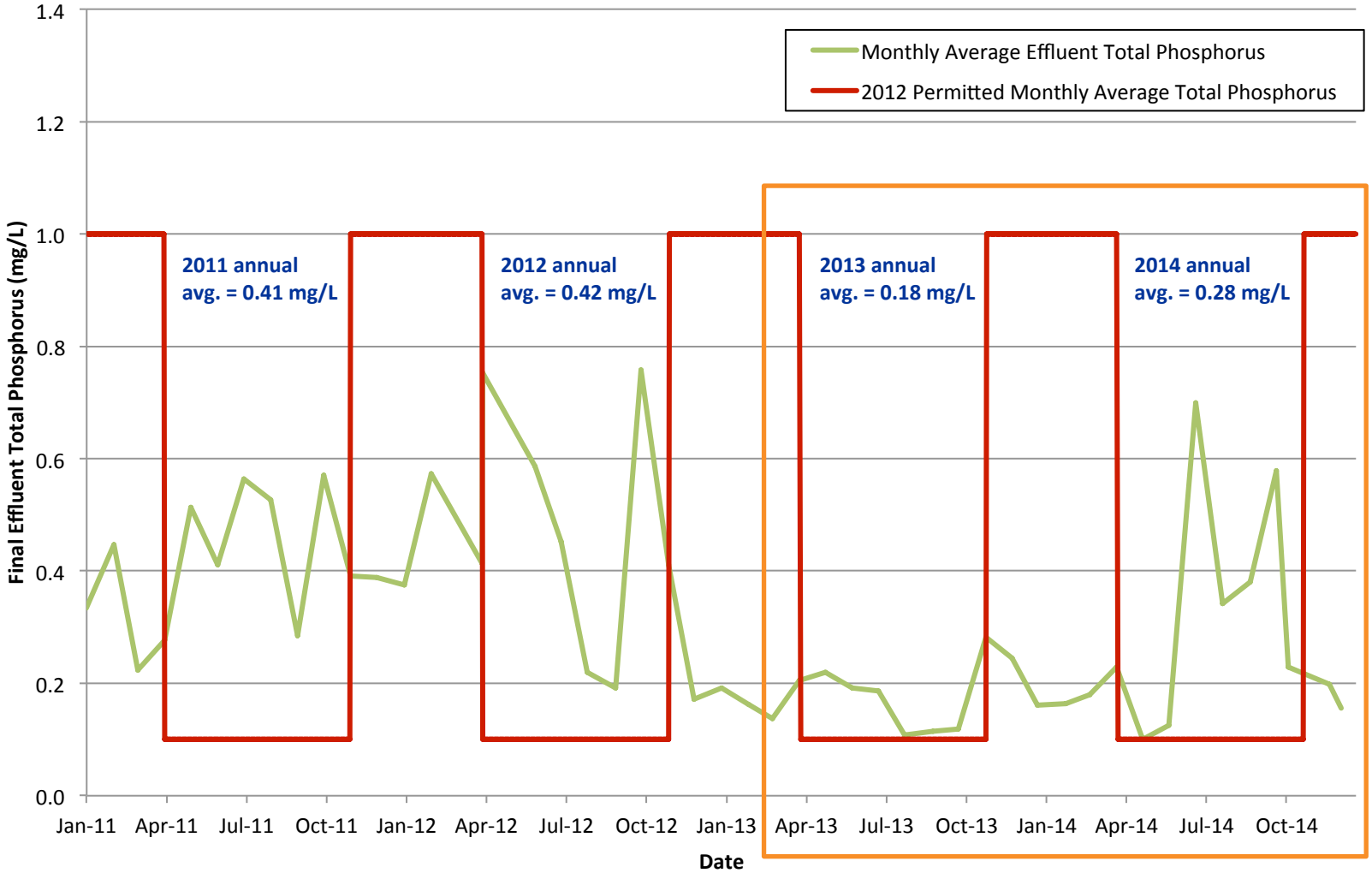

# Summary

- $A^2/O$ process is performing extremely well… pushing the limit of this technology
- The operational strategies implemented in 2013 (SRT control and magnesium hydroxide) provided process stability which enhanced $A^2/O$ performance
- The process modifications tested in 2014 demonstrated some additional benefit under certain conditions

# Next Steps

- Determine how best to integrate the process modifications to further optimize $A^2/O$ performance
  - Overcome periodic process shortfalls
  - Enhance process stability and performance year-round

- Determine most cost-effective solution to meet 2012 NPDES permit limits for nutrients in the long-term

# Questions?


**Many thanks to the District staff for all their help and hard work!**