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How Low Can You Go? – A Case Study of Low Level Phosphorus Removal Pilot and Full-Scale Testing at the Waukesha WWTP

49th Annual WWOA Conference

Rachel M. Lee, Strand Associates, Inc.
Randy Thater, City of Waukesha

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City of Waukesha

Outline

- Waukesha Plant Background
- Compliance Schedule
- Testing Summaries
  - Multi-Point Chemical Feed
  - BluePRO® Reactive Filtration
  - Full-Scale Hydraulic Stress Testing
  - SorbX-100 Full-Scale Testing
- Conclusions

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Waukesha Plant Background

- 1 mg/L P limit at least since early 1980s due to Illinois Fox River discharge
- c. 1975 tank and feed pumps for pickle liquor retrofitted to 1960s era trickling filter plant
- 1982 upgrade, includes alum tertiary treatment. Separate tertiary ‘coag clarifiers’ following secondary treatment final clarifiers. Dual media filters followed chemical treatment.
- Mid-80s, convert alum to ferric chloride due to inadequate removal

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Waukesha WWTP after 1977-82 upgrade

Includes 1920s, 40s and 60s upgrades

Trickling filter secondary treatment

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Waukesha Plant Background

- 1995 upgrade, plant converted to activated sludge with extended aeration for improved ammonia removal, no bio-P
- Increase filters from 6 to 8 cells
- Alternate feed point at end of aeration basins
- Average effluent TP 2005 – 2013 = 0.22 mg/L

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Waukesha WWTP after 1992-95 upgrade

Conversion to extended aeration activate sludge

1920s, 40s and 60s treatment trains eliminated

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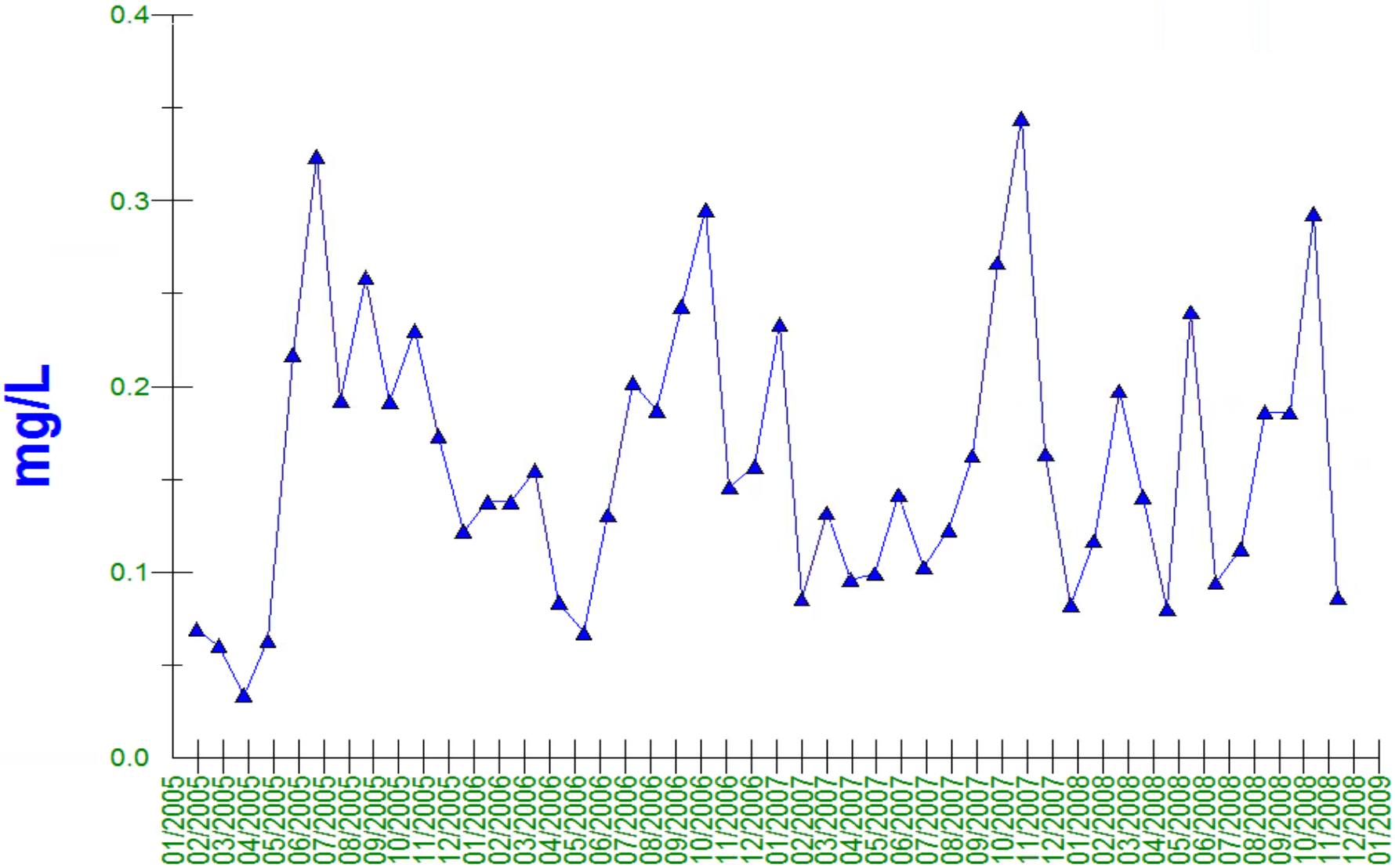

Effluent P monthly average, 2005 - 2008

Maximizing P removal

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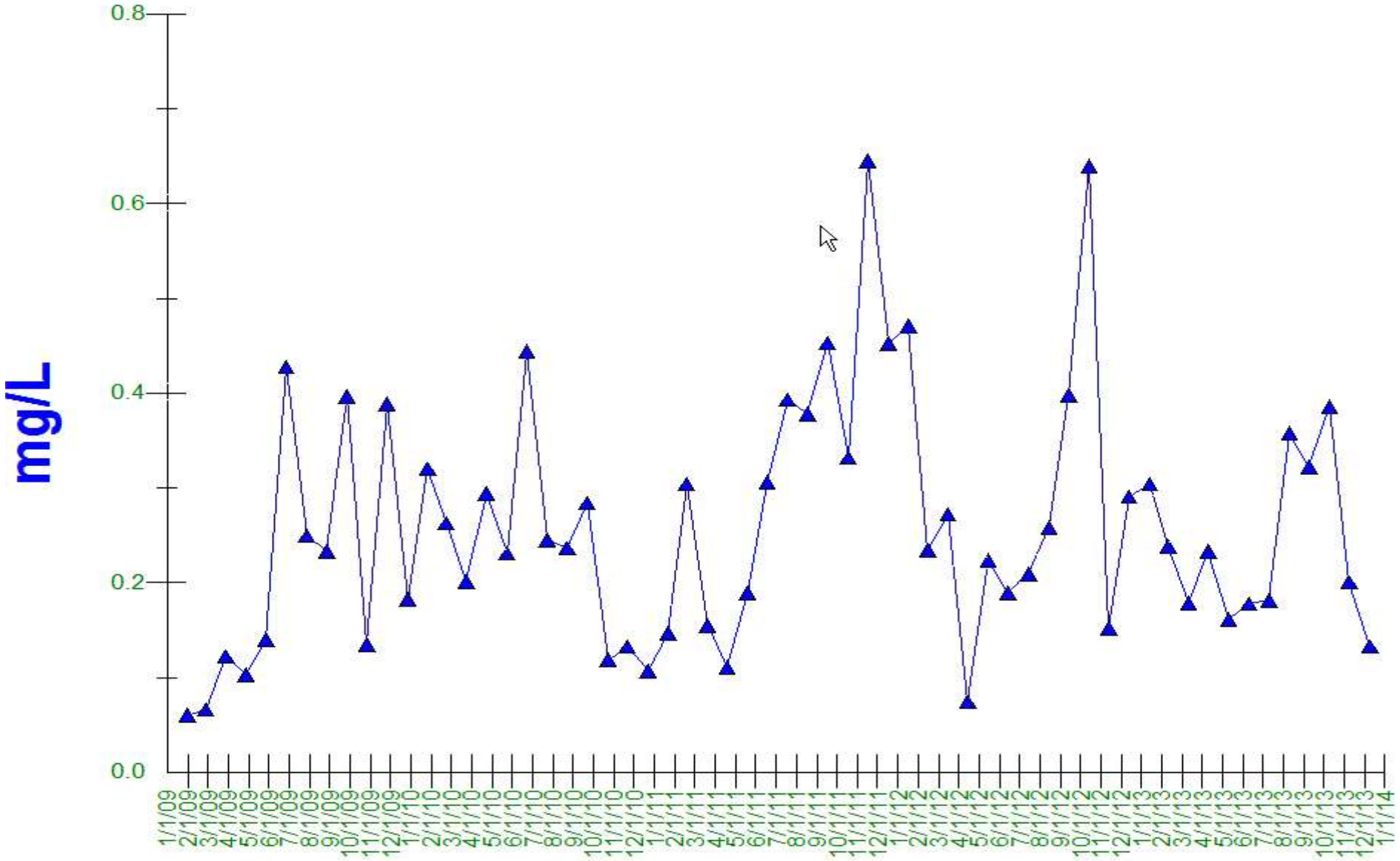

Effluent P monthly average, 2009 - 2013

Save on chemical costs while still conservatively meet limit

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Discharge Permit 2013-2018

- Permit issued 2013 includes compliance schedule for low level P with 0.7 mg/L interim limit
- Final limits to be 0.075 mg/L and 8.76 lbs/day as 6 month averages, 0.225 mg/L monthly average
- Waukesha Water Utility is pursuing Lake Michigan water
- If implemented, WWTP would be required to return water to Great Lakes watershed
- May affect P limits implementation; no variance for new discharge, and possibly lower limits

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Compliance Schedule for Fox River Discharge

Item	Due Date
Permit Effective	6/30/13
Operational Evaluation Report	6/30/14
Study of Feasible Alternatives:	
Start	6/30/14
Status Report	6/30/15
Preliminary Compliance Plan	6/30/16
Final Compliance Plan	6/30/17
Achieve Compliance with WQBEL	6/30/2020

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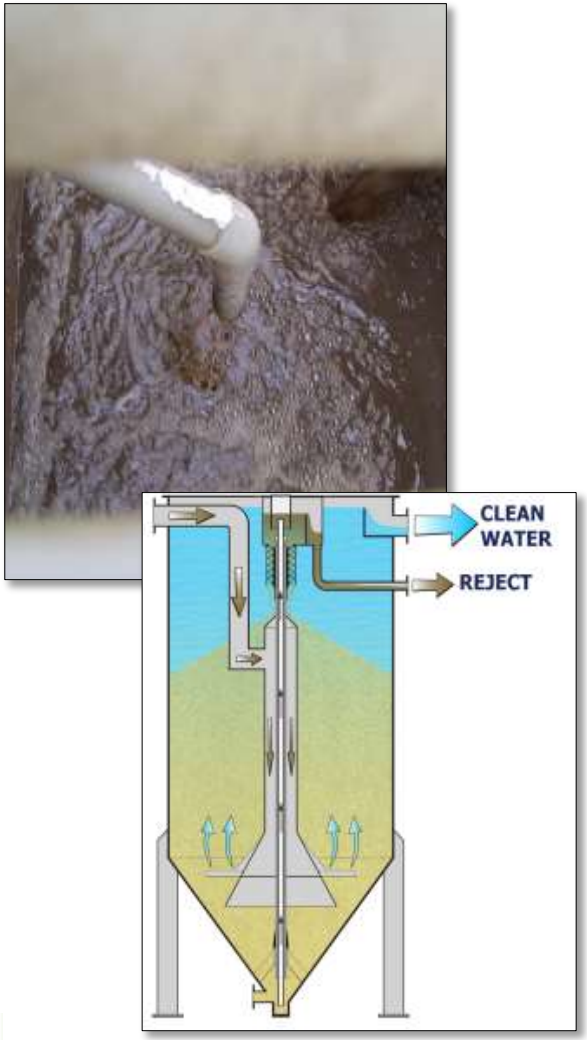
Testing Summaries

Multi-Point Chemical Feed



Reactive Sand Filtration

SorbX-100

Full-Scale Hydraulic Stress Testing

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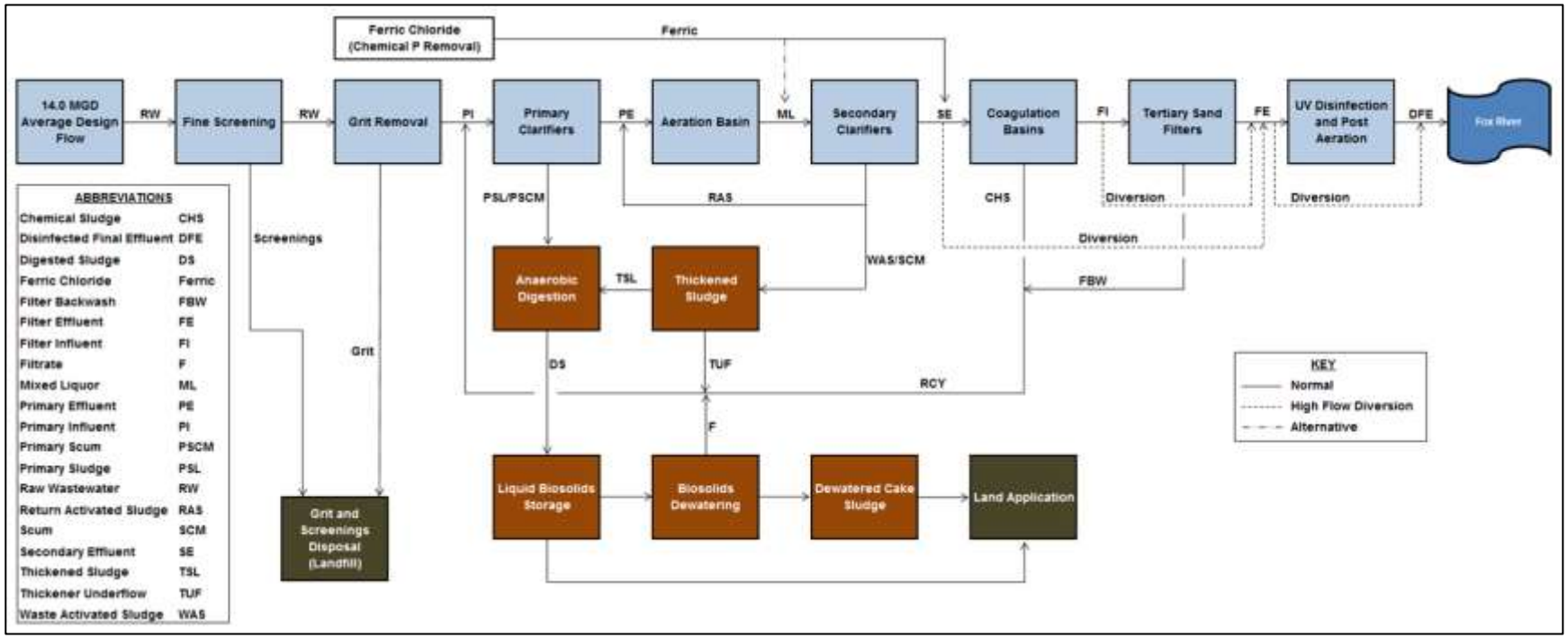
Multi-Point Chemical Feed



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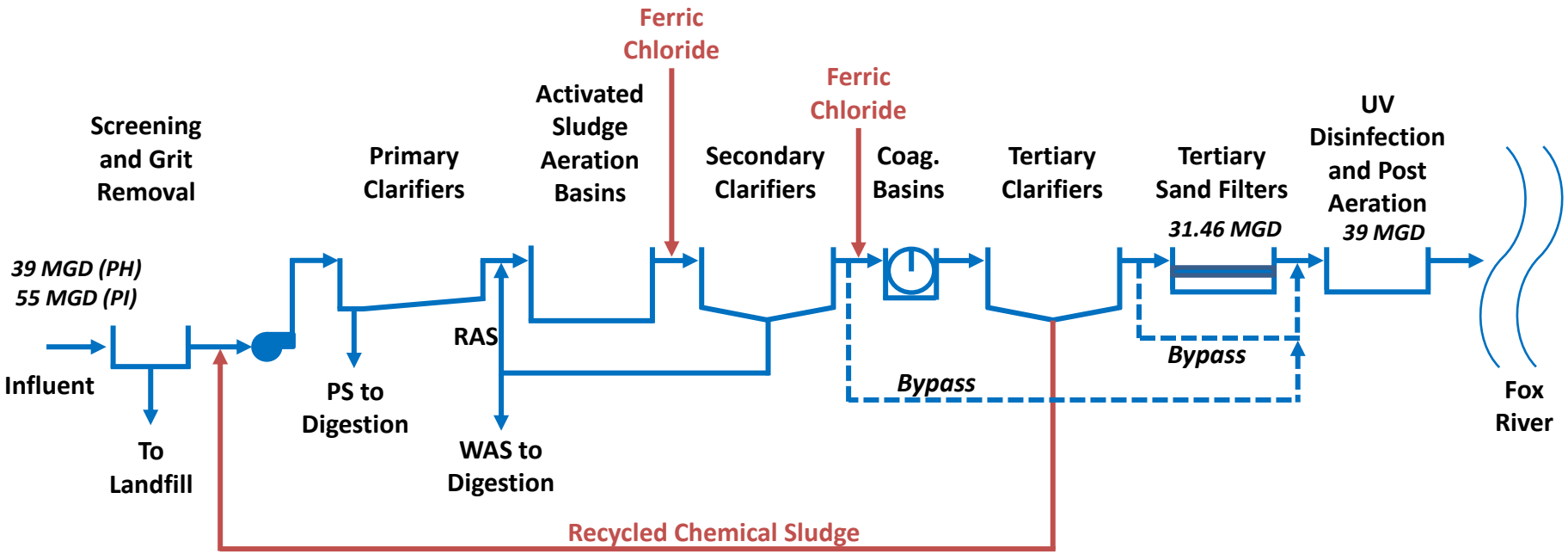

PH = Peak Hourly
PI = Peak Instantaneous

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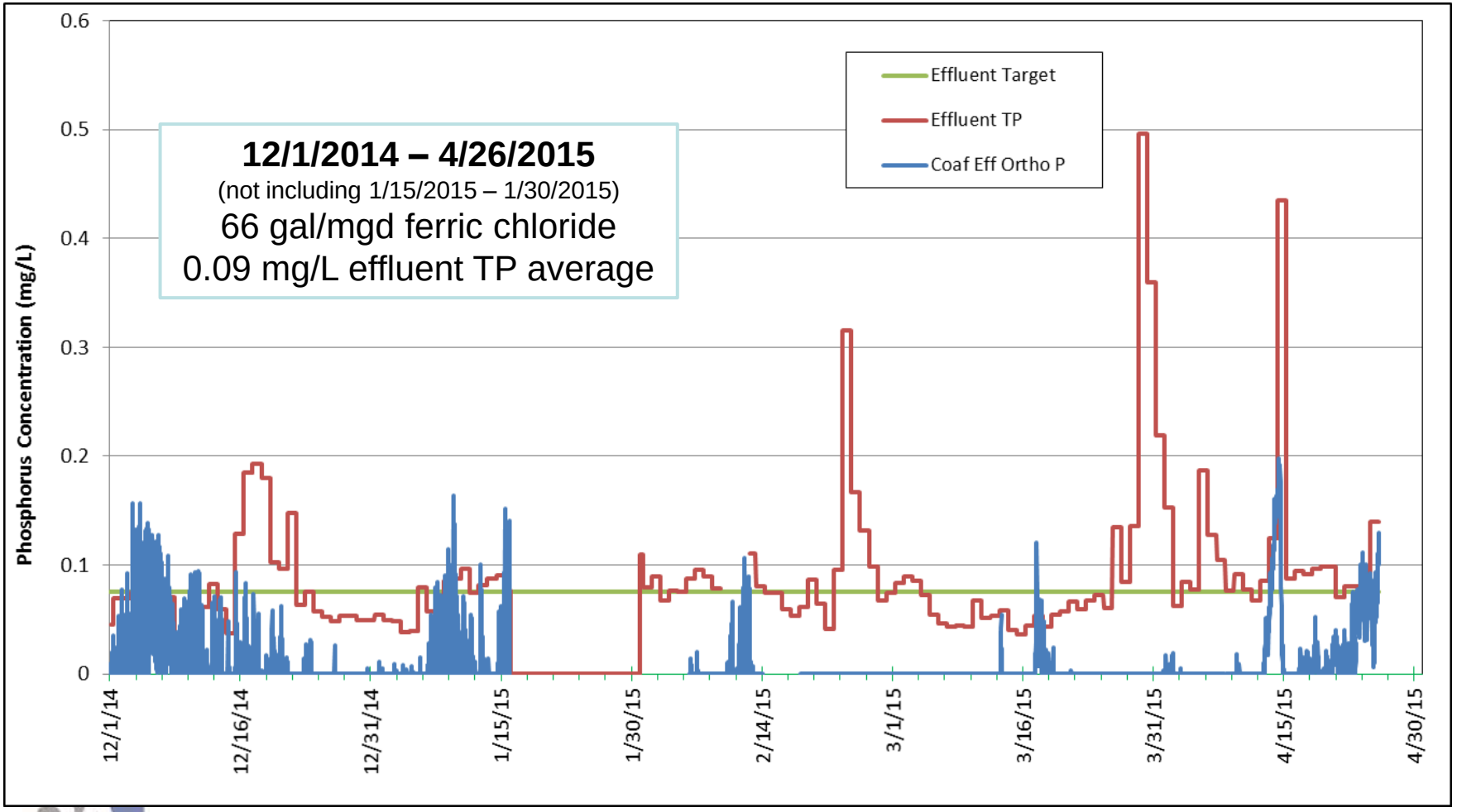
Multi-Point Chemical Feed Proves Successful on Limited Occasions



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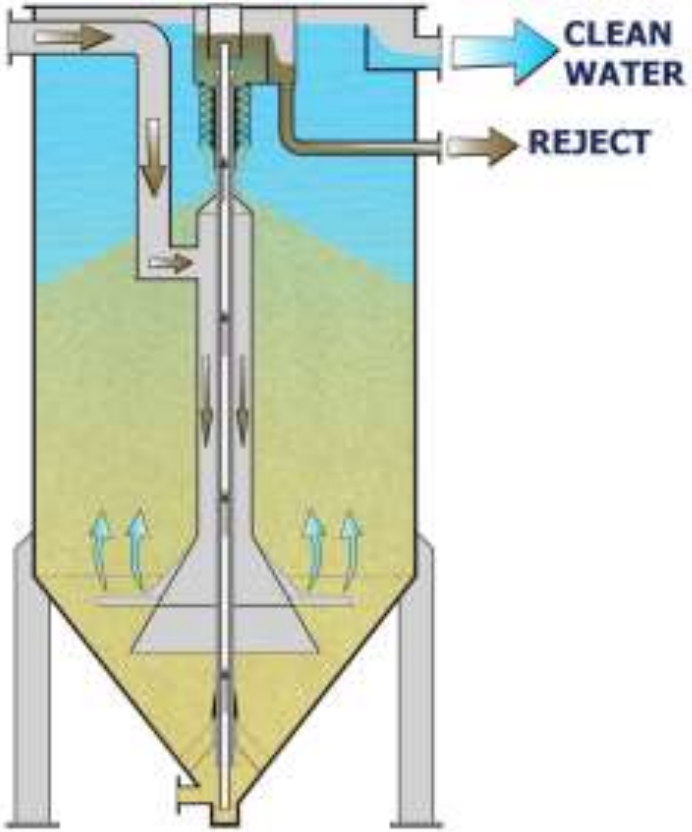
Reactive Filtration Pilot Using BluePro Filters



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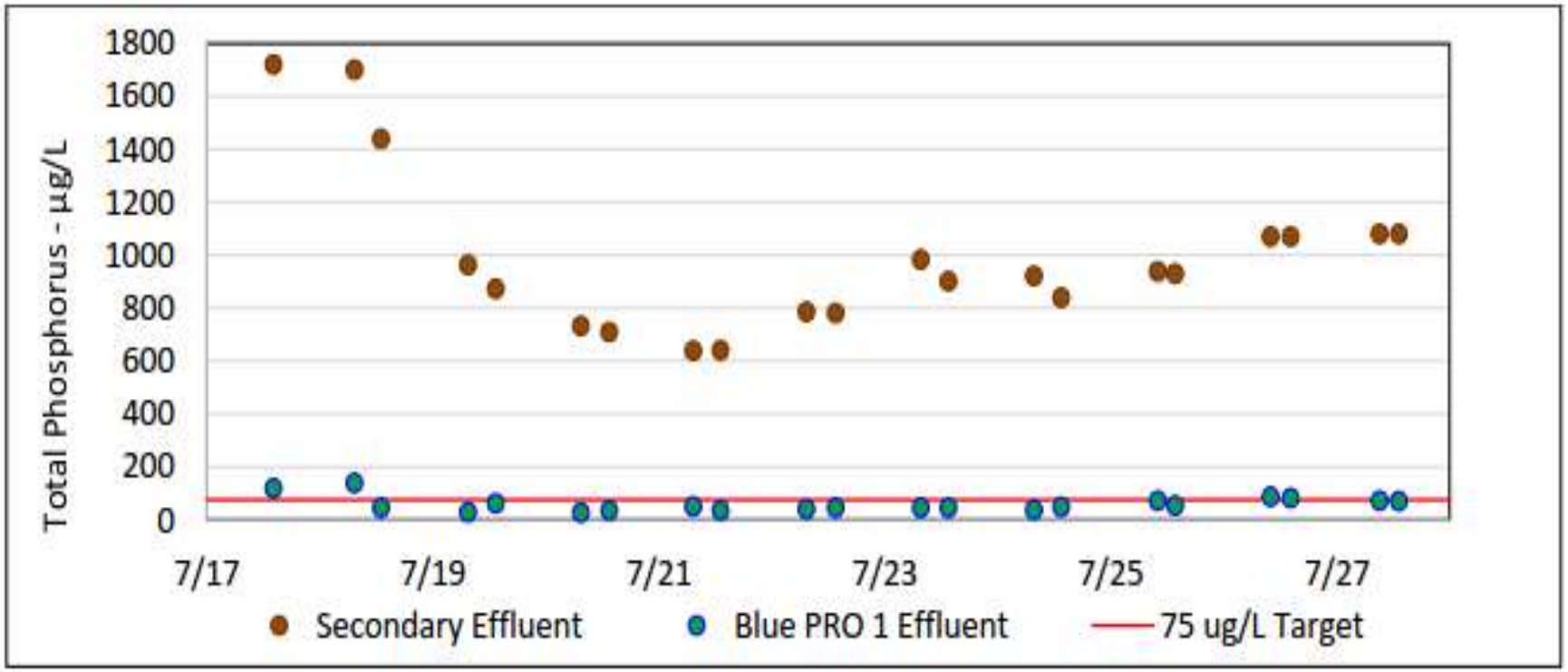
BluePRO Single-Pass Pilot Test Results



Average results consistently met 0.075 mg/L goal.

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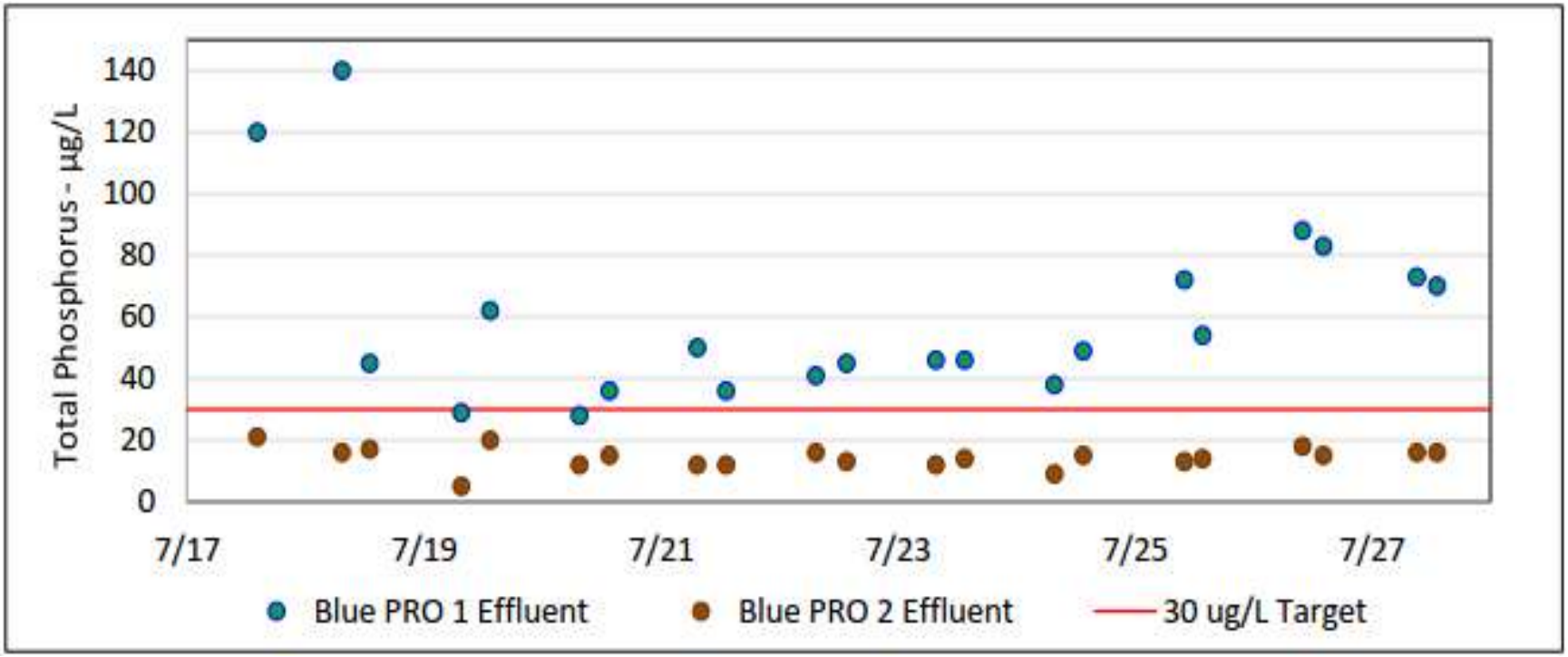
BluePro Two-Pass Pilot Test Results



Two pass system consistently met 0.03 mg/L target effluent Phosphorus.

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Full-Scale Hydraulic Stress Testing to Test Filter Performance

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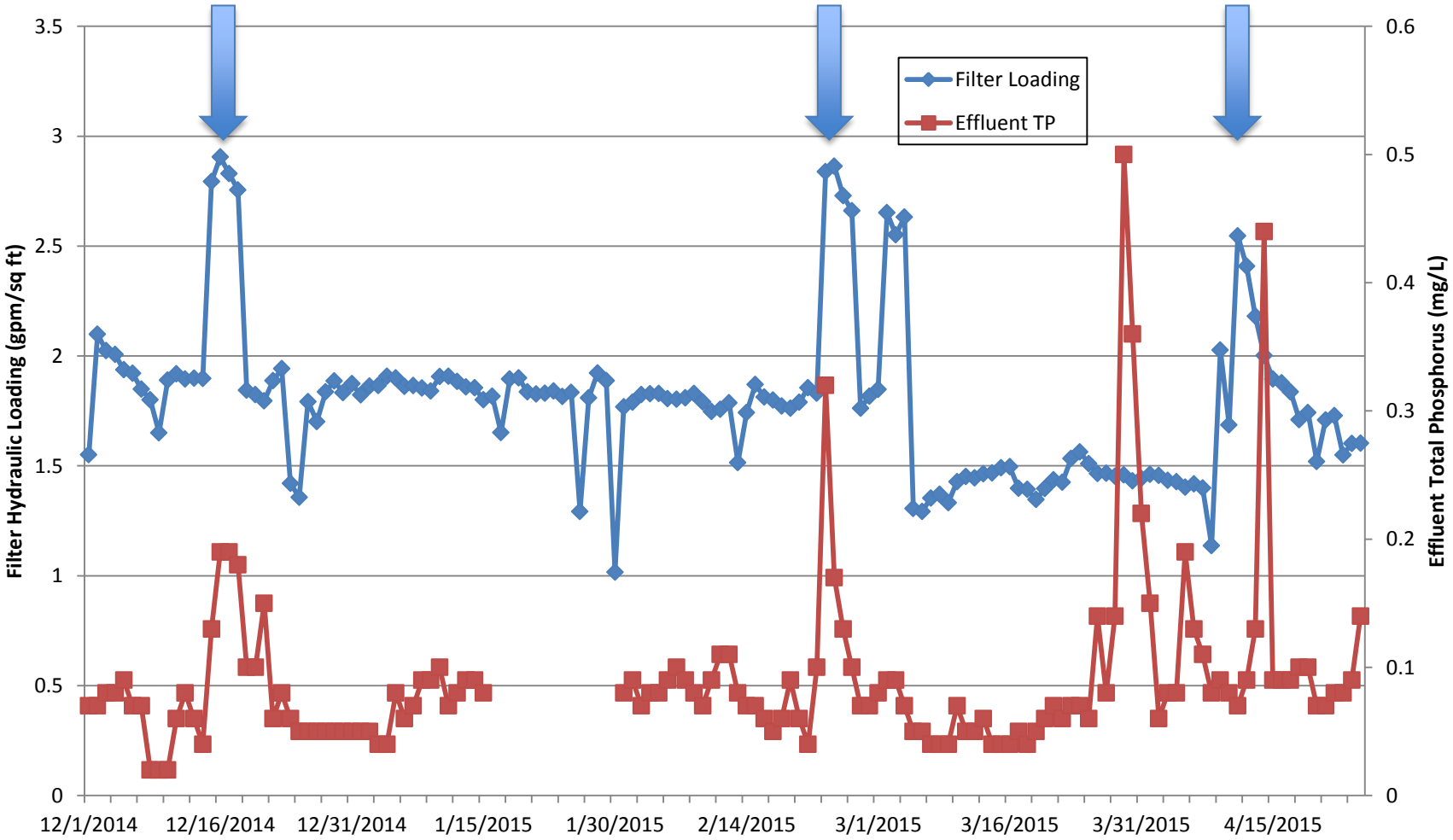
Full-Scale Hydraulic Stress Testing Results



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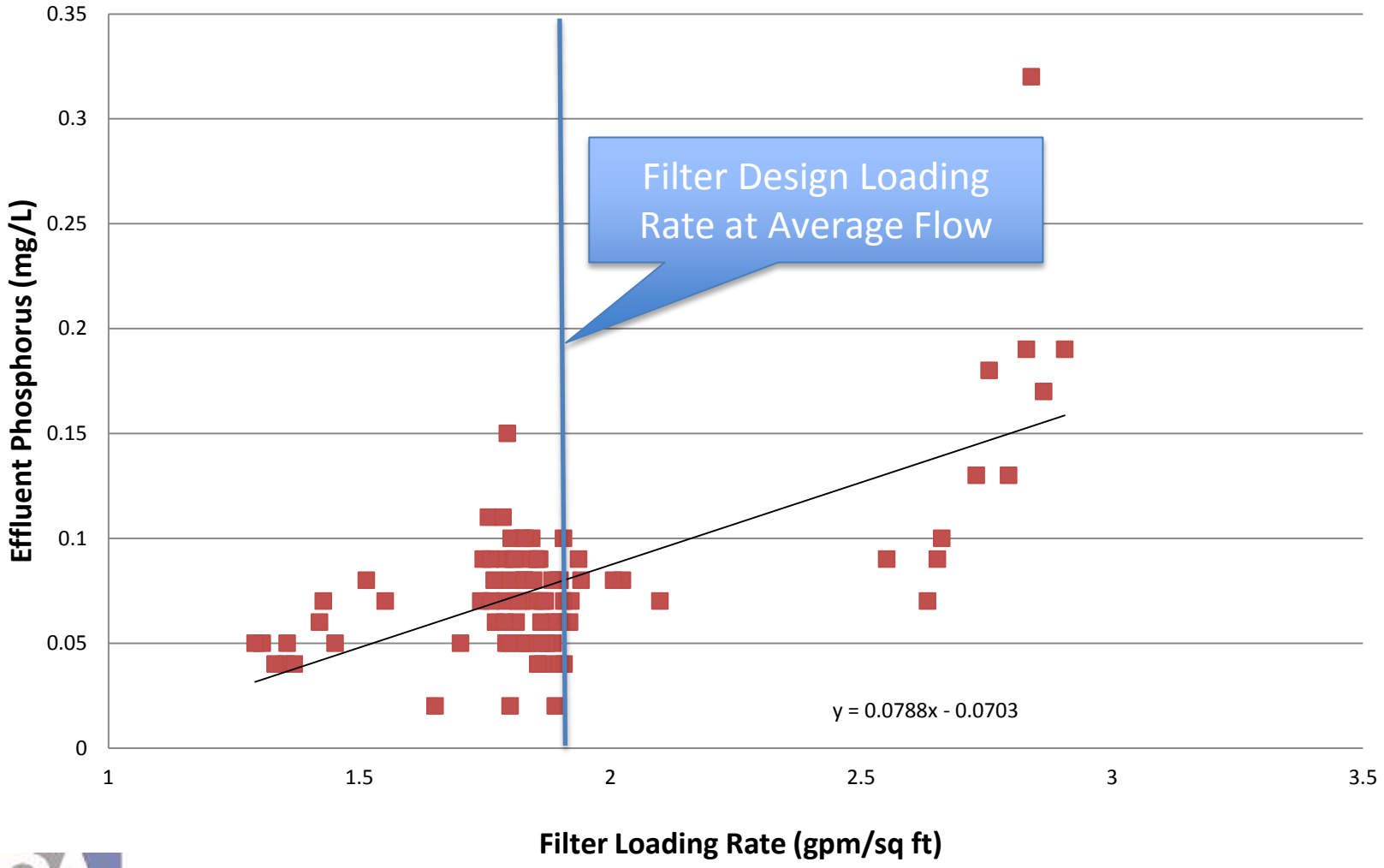
Effluent P Increases with Increased Hydraulic Loading



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SorbX-100

- Mixed rare earth chloride
- 31% - 35% w/w
- Strong attraction to phosphorus
- Reduce amount needed
- Generate less chemical sludge
- Higher pH with less corrosive impact

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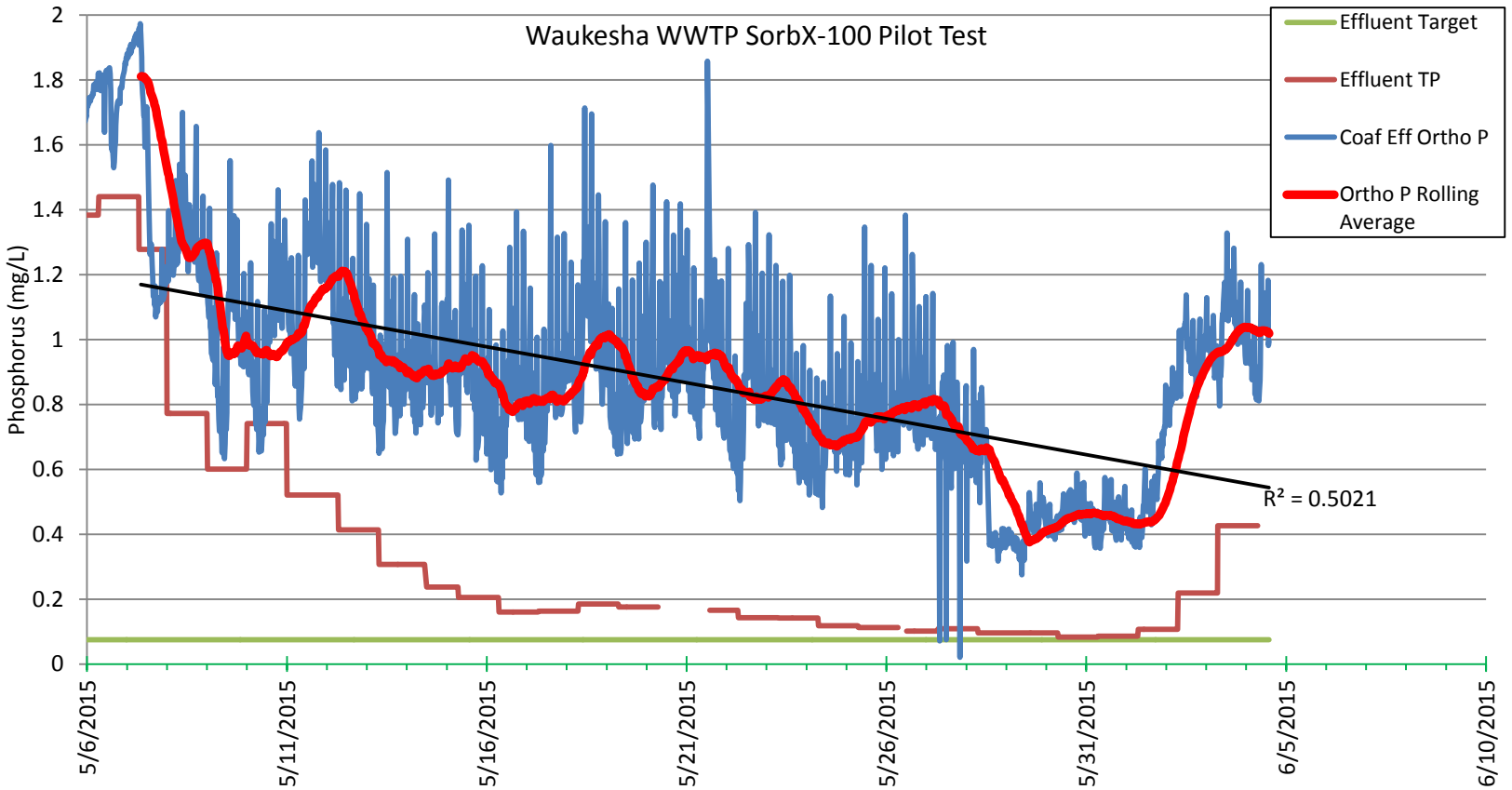
SorbX-100 Full-Scale Test

- Discontinued all coagulant for 2 weeks prior to starting test.
- Started dosing SorbX-100 to the tertiary clarifiers on 5/7/15
- Continued with only SorbX-100 for 2 weeks.
- Initial feed at 225 gpd, increased to 300 gpd, then 330 gpd 5/11
- Started dual-chemical feed (SorbX-100 to tertiary clarifiers and ferric chloride to mixed liquor) on 5/21/15.
- Started feed at 165 gpd Sorb-X and 275 gpd ferric
- Increased to 165/325 on 6/9/15, then to 190/370 on 6/16/15
- Ended test 6/23/15.

SorbX-100 Significantly Reduced Effluent P



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Conclusions

- Multi-point chemical feed can meet the future effluent limit; however, filtration capacity is insufficient for long-term compliance. SNRP must be reasonably low.
- Reactive filtration can meet the future effluent limit of 0.075 mg/L in a single-pass. It could meet a goal of 0.03 mg/L in a two-pass configuration.
- Full-scale hydraulic stress-testing proved limited hydraulic capacity in the sand filters.
- SorbX-100 did not perform better than ferric chloride in full-scale tests.

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Next Steps

- Upcoming ballasted filtration pilot test using ACTIFLO.
- Continued evaluation of various alternatives to meet effluent limits.
- Several viable alternatives still available.

- Win = alternative with best fit for facility needs and economic (capital, operating, and biosolids disposal) constraints while providing regulatory compliance.

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