Hazen

Lessons Learned from Applying Extractive Nutrient Recovery for Managing Phosphorus in Sidestreams and Biosolids

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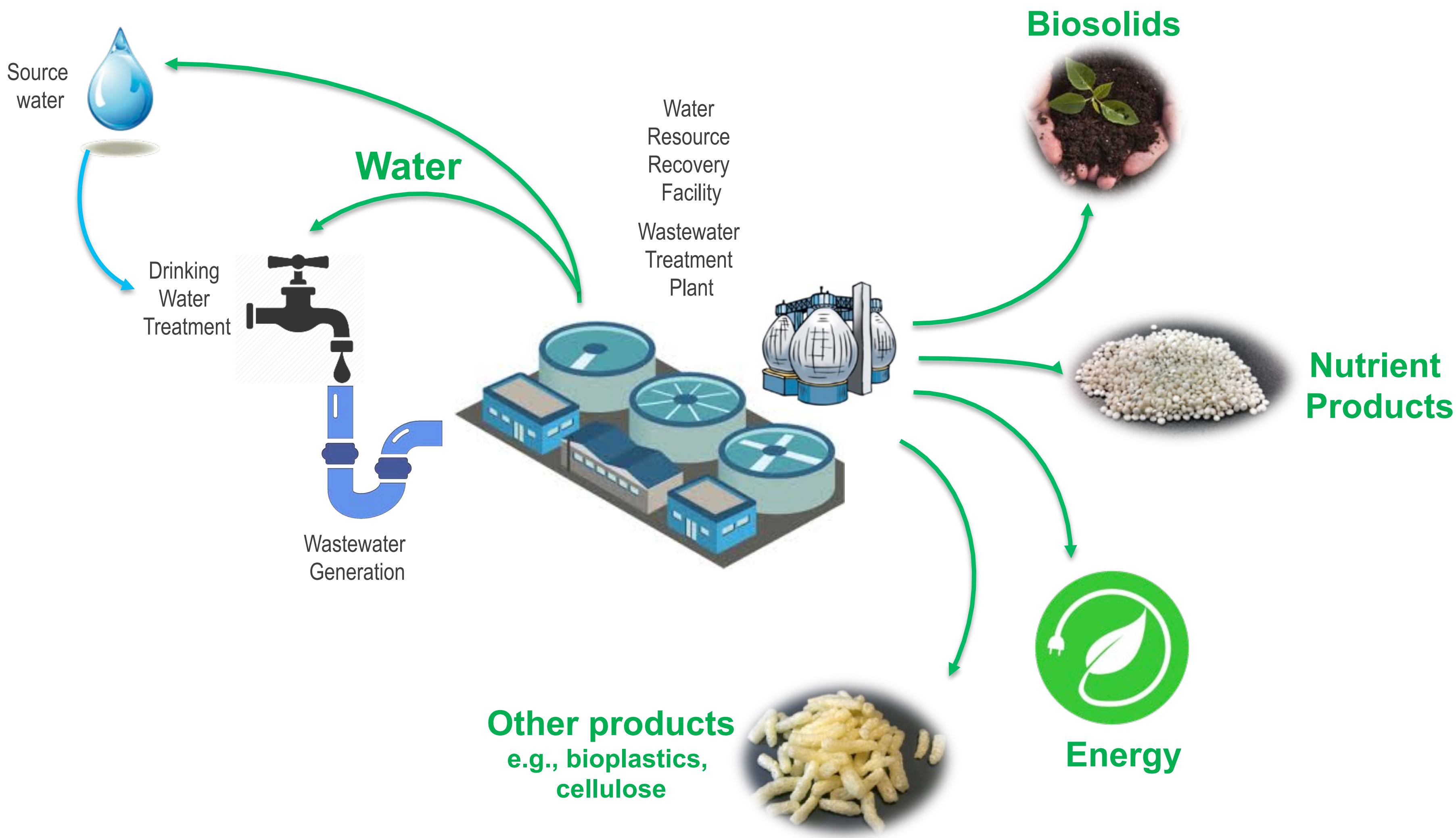
Embracing the new resource management paradigm



Historically, phosphorus was removed from WRRFs in two ways

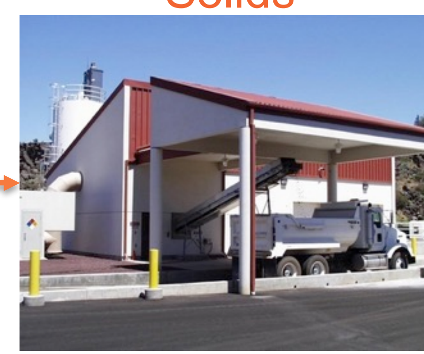
Degree of removal is a function of liquid effluent permit requirements

Phosphorus

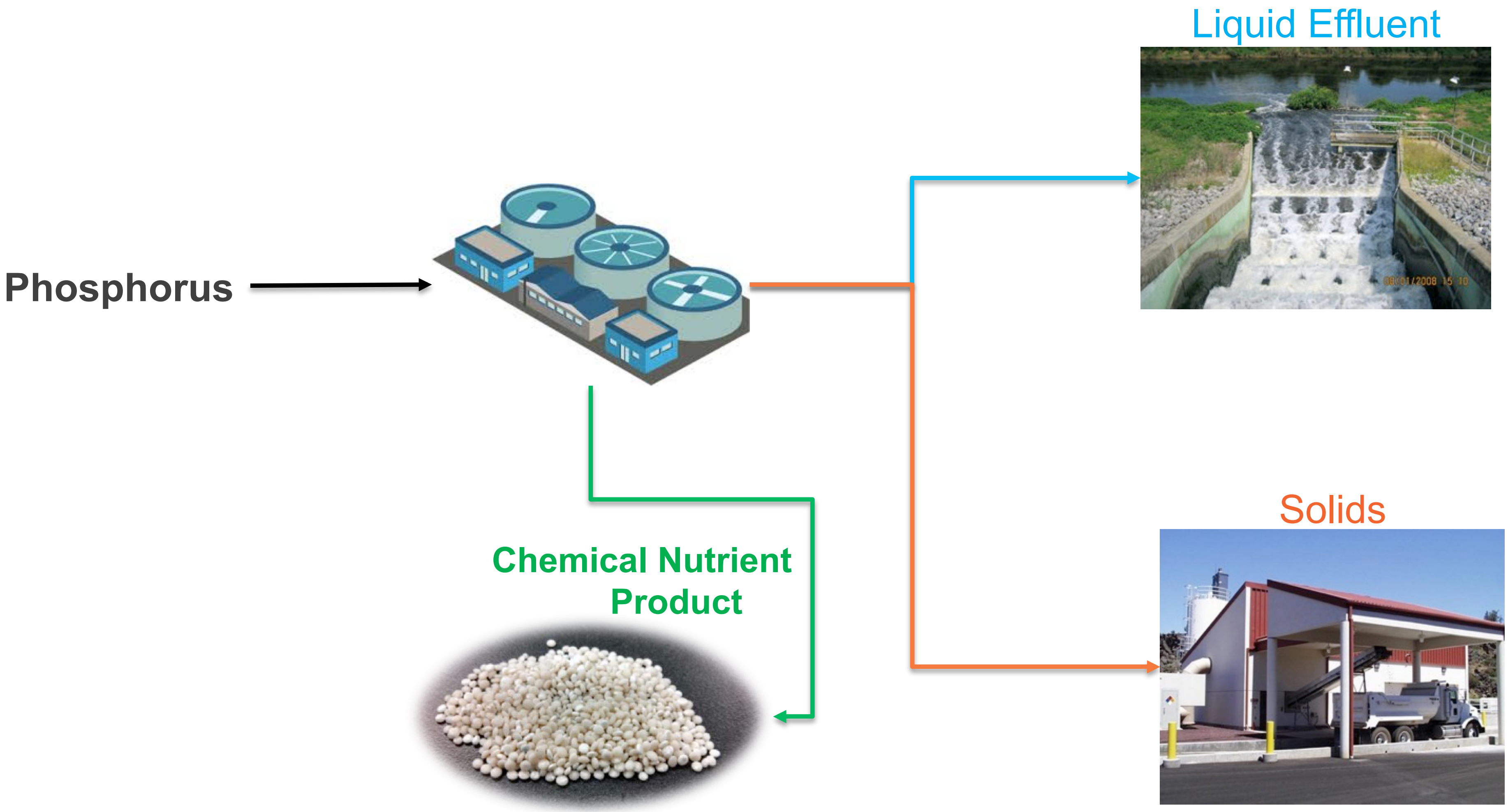
Lower Liq. Effluent = Higher Solids P

Liquid Effluent

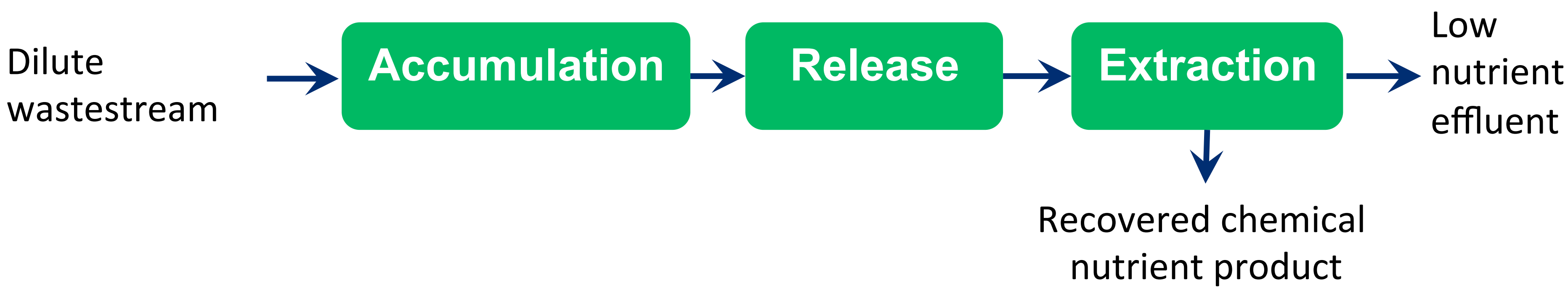
Solids



Extractive nutrient recovery provides an additional outlet for phosphorus



How do we perform extractive nutrient recovery?



Accumulation step to increase nutrient content

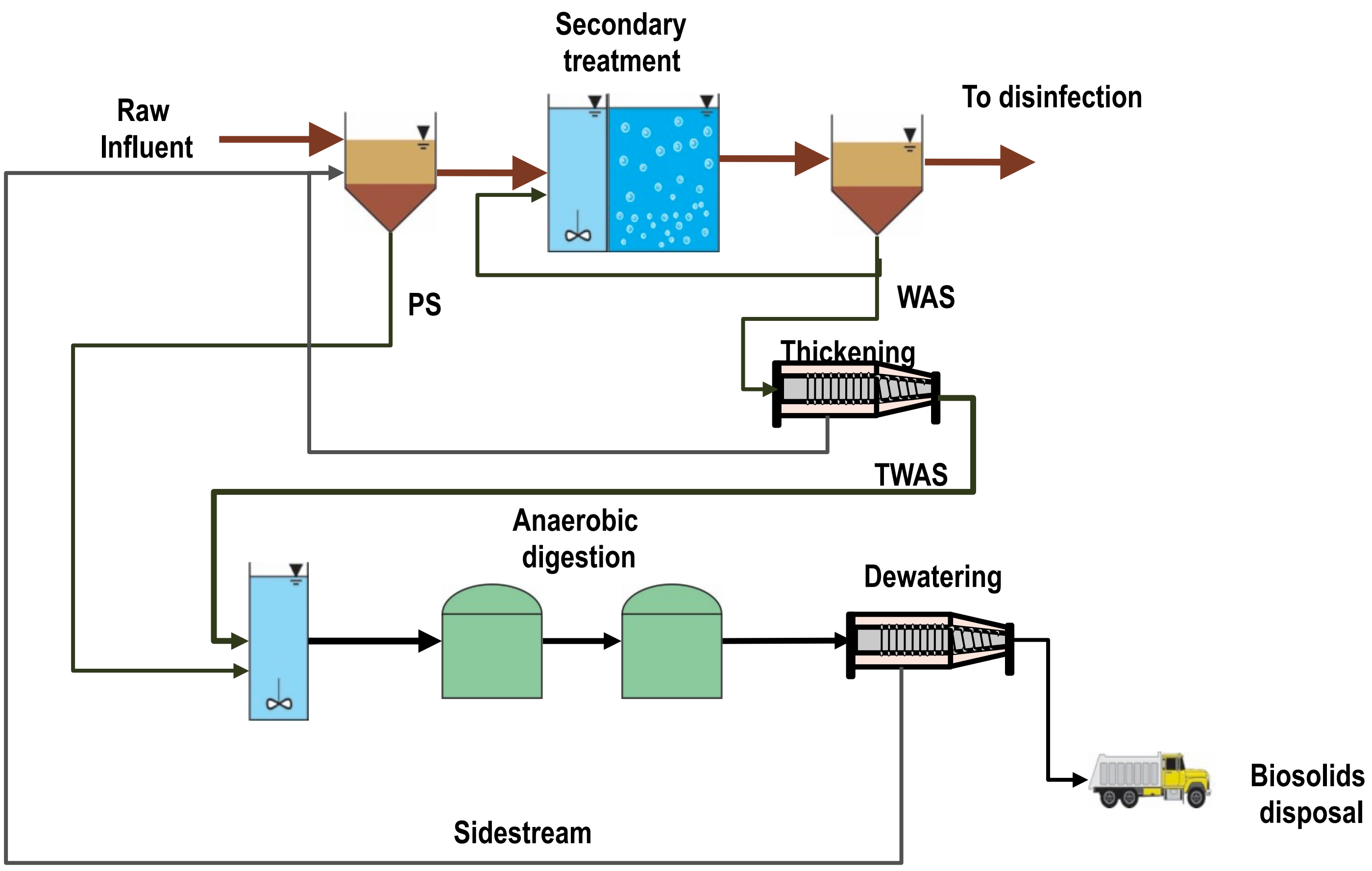
N > 1000 mg N/L and P > 100 mg P/L

Release step to generate low flow and high nutrient stream

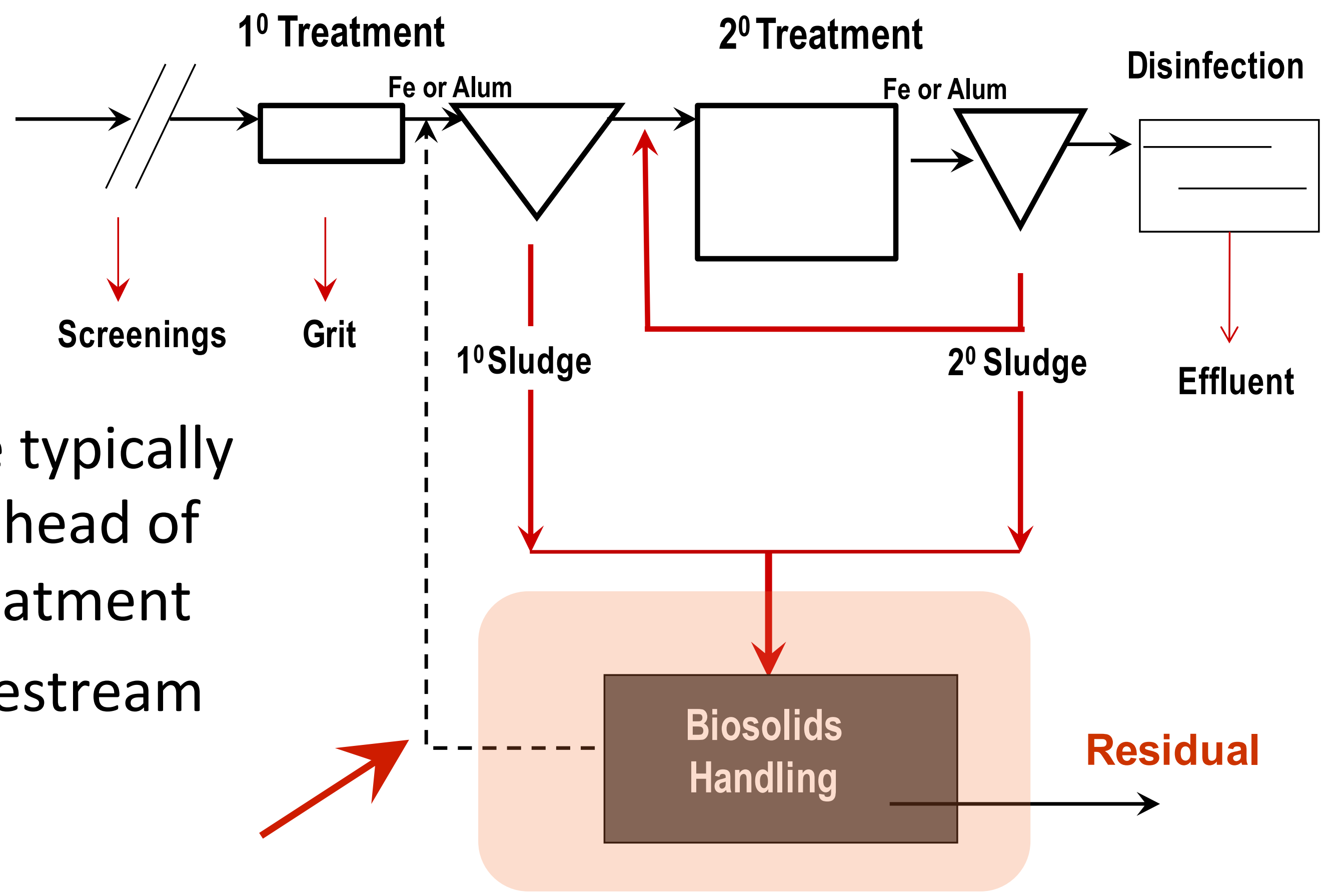
Extraction step produces high nutrient content product

How does this apply to WRRFs?

Consider a common scenario at WRRFs

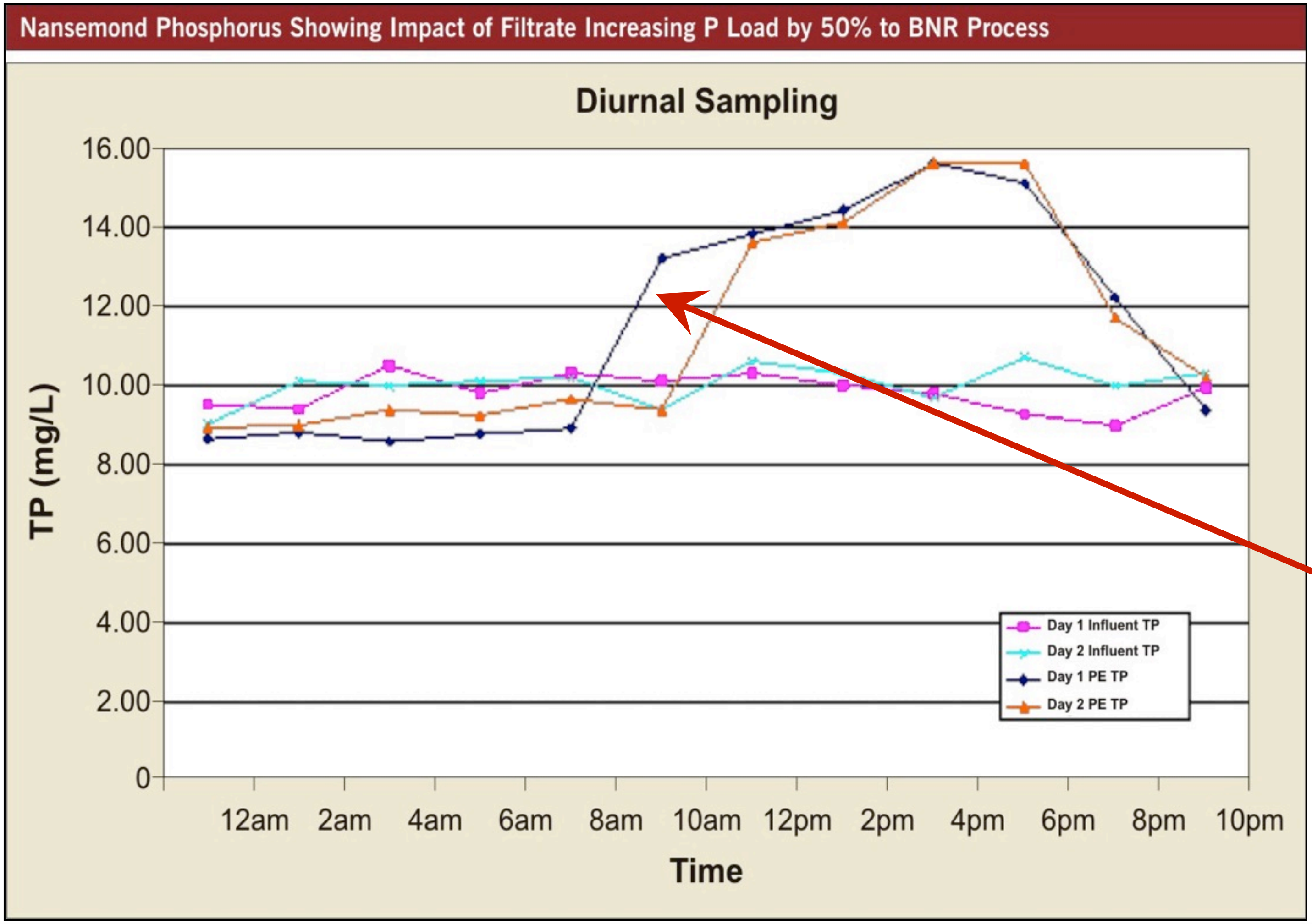


Solids stabilization generates nutrient rich liquid stream



- Sidestreams are typically returned to the head of the plant for treatment
- Examples of sidestream
  - BFP filtrate
  - GBT filtrate
  - Filter backwash
  - Centrate
  - Digester supernatant

Sidestream nutrient load can also negatively impact performance of the mainstream plant

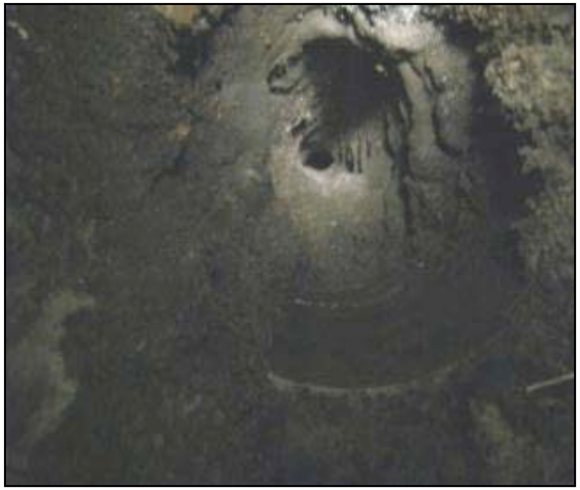


High nutrient recycle loads can upset the mainstream process

Struvite can be a significant maintenance concern with anaerobic digestion

Struvite = Mg + NH_4 + PO_4

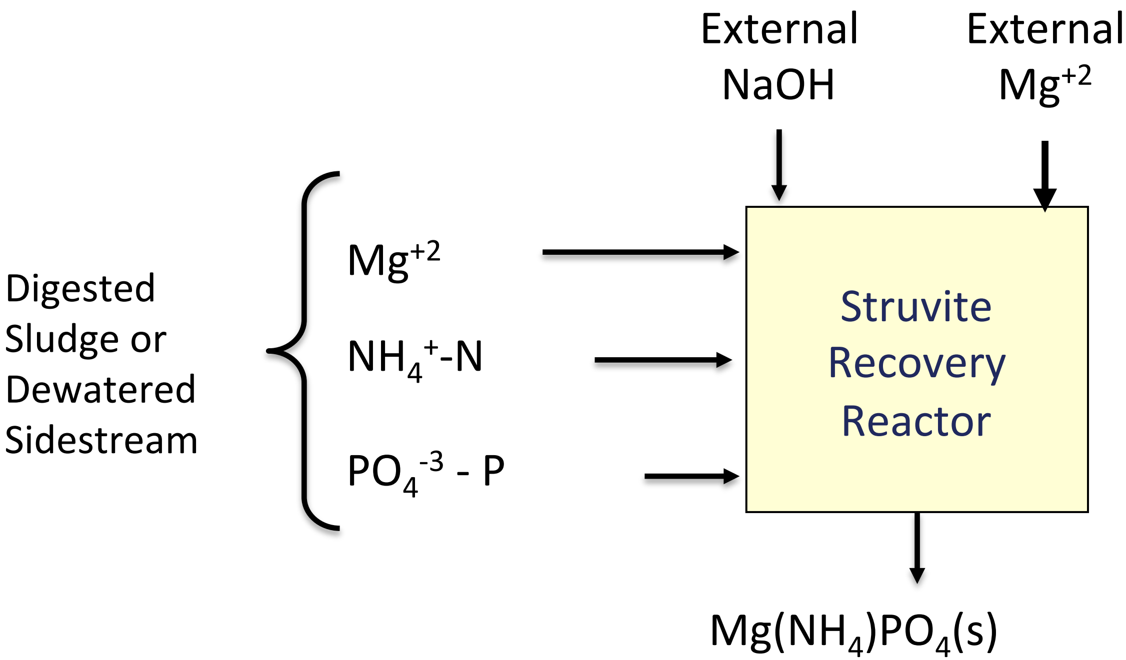
- NH_4 & PO_4 released in digestion
- Typically Mg limited
- Mg addition (i.e. $Mg(OH)_2$) can promote struvite formation



NYC Newtown Creek WWTP

Miami Dade SDWRF

Struvite extraction can transform a nuisance into a valuable resource



$Mg(NH_4)PO_4(s)$ = struvite

- Selectively extract P, N and Mg
- Reduce propensity to scale downstream of process
  - Reduce O&M requirements/chemical dosing requirements

Nansemond Treatment Plant

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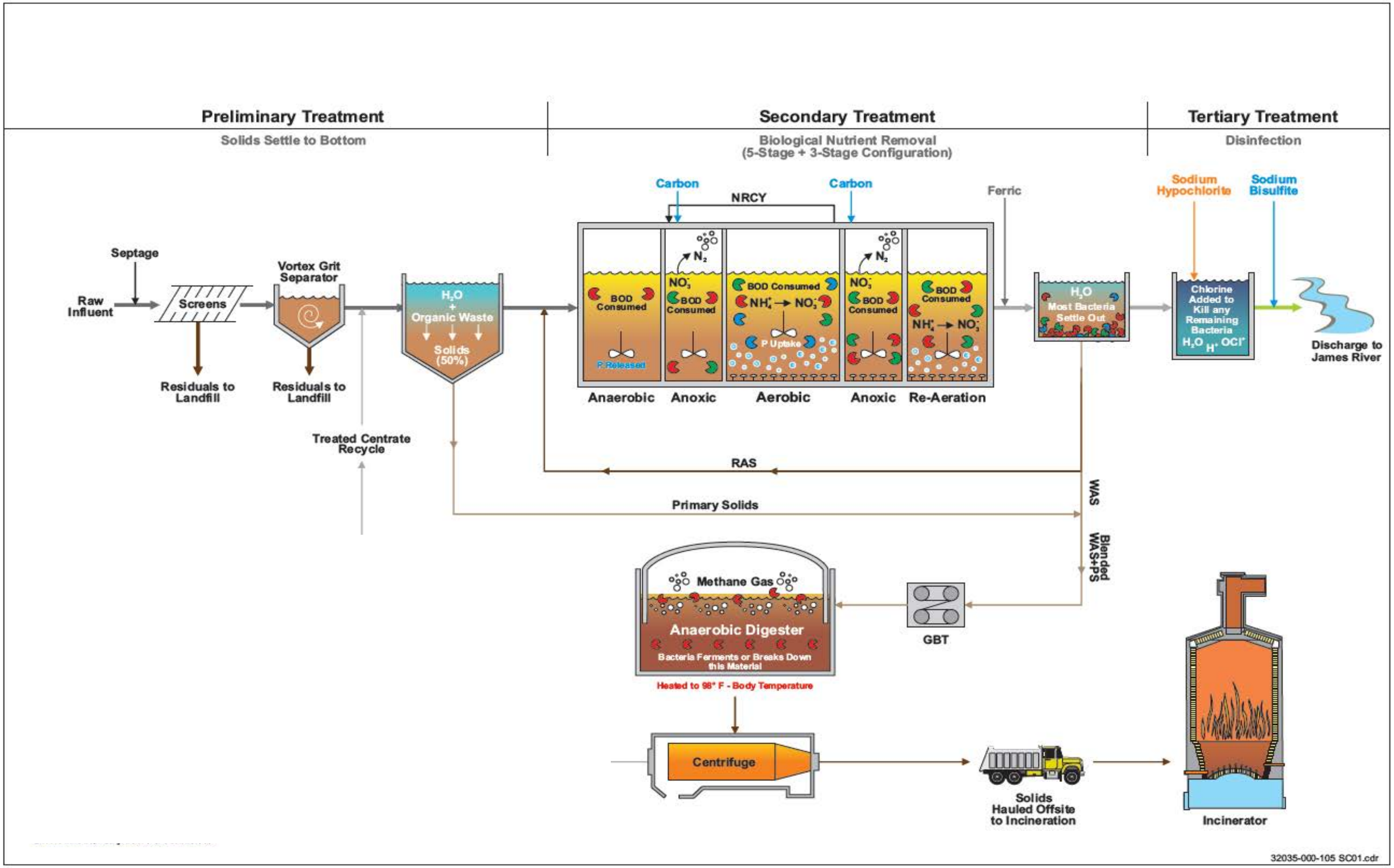
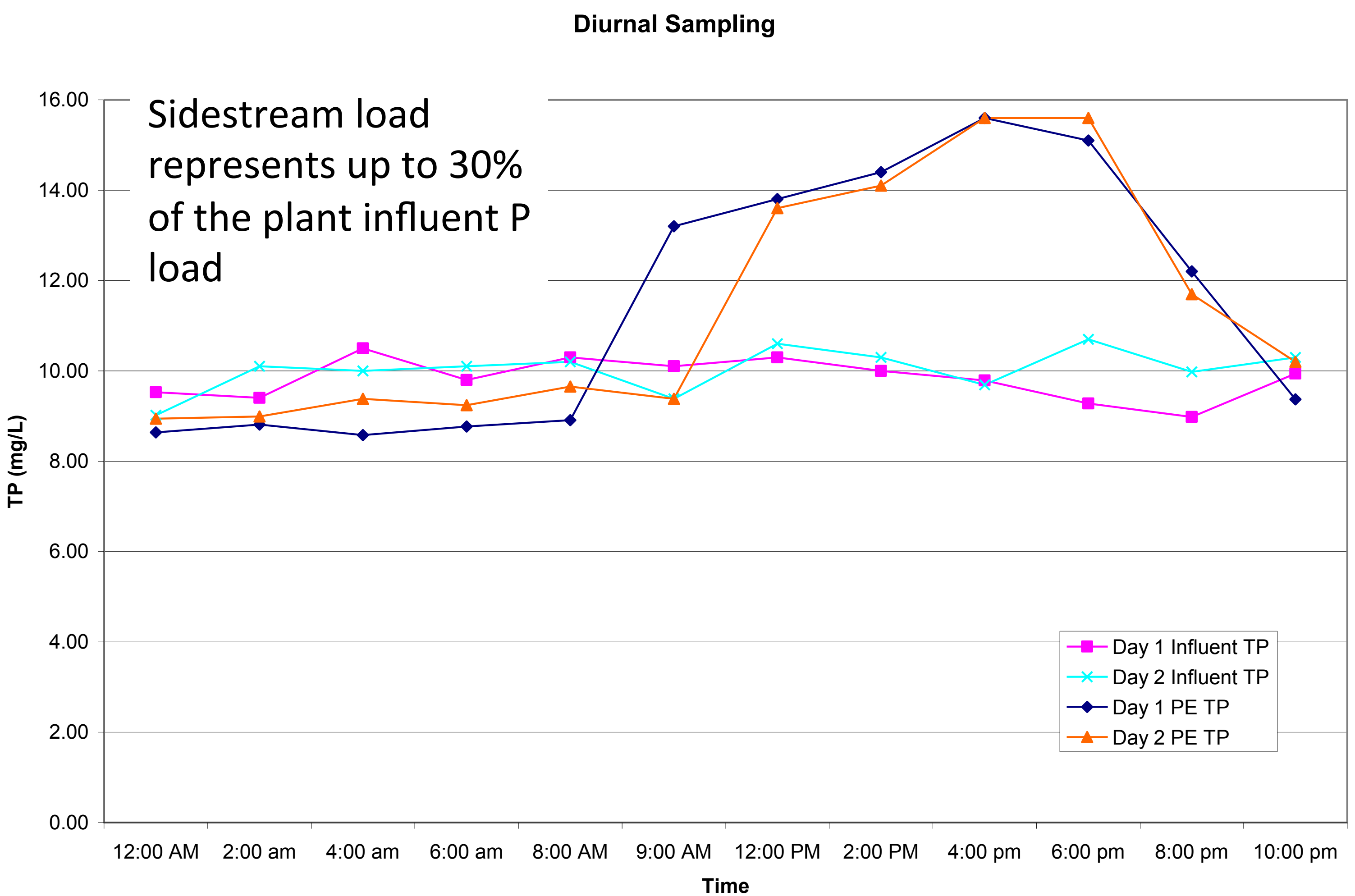
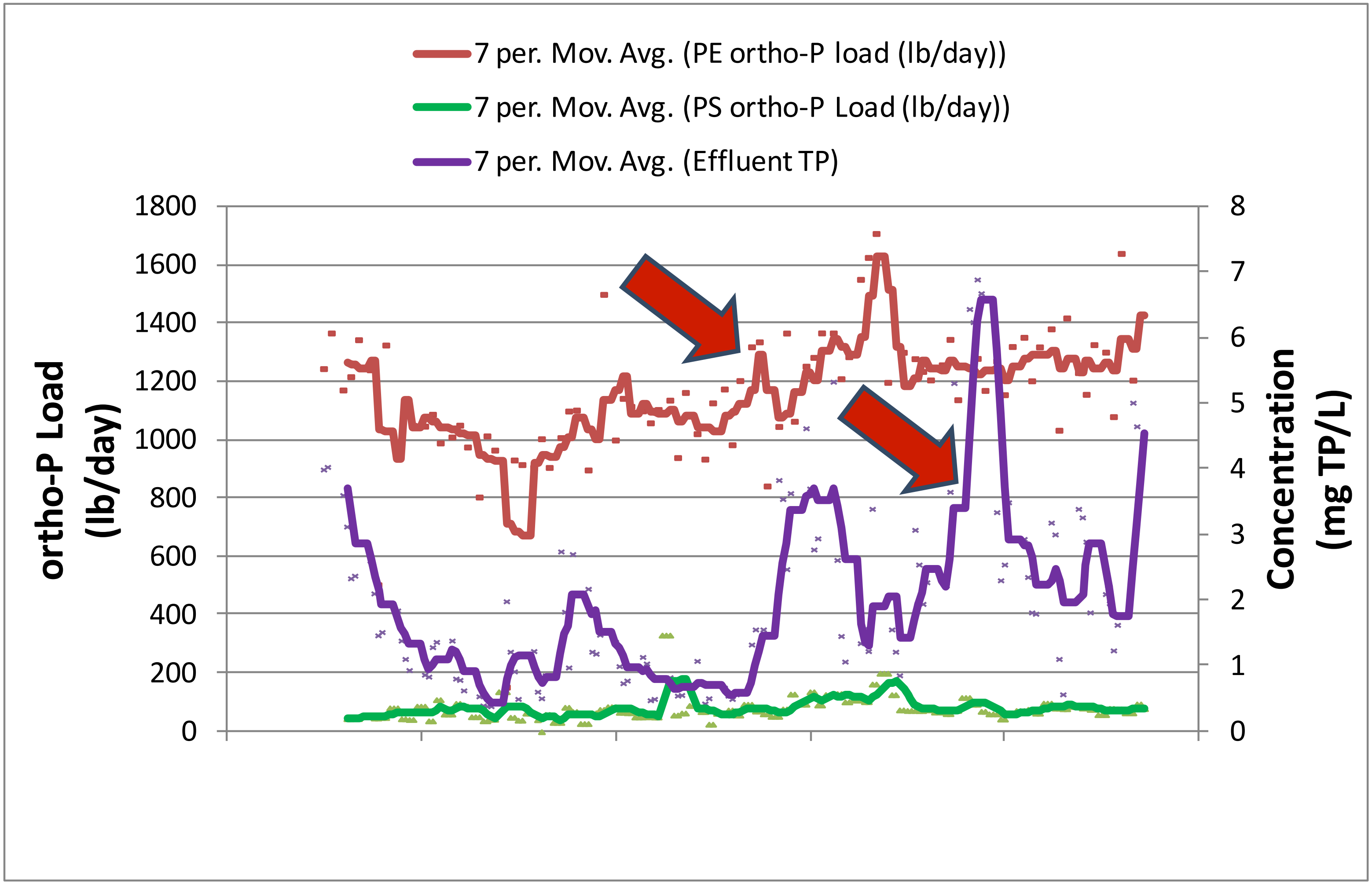
Nansemond WWTP is a 30 MGD facility that employs a 5-stage BNR for N and P removal



Sidestream load represents up to 30% of the plant influent P load



High P load negatively impacts TP removal



Two options were considered for sidestream P Treatment at NTP

Ferric addition

- Forms ferric phosphate and ferric hydroxide
- Non-proprietary
- Traditionally used for controlling sidestream P at this plant
- High O&M requirement

Struvite recovery

- Ostara Pearl
- Capital purchase option
  - NTP purchases equipment and receives annual payments from OSTARA

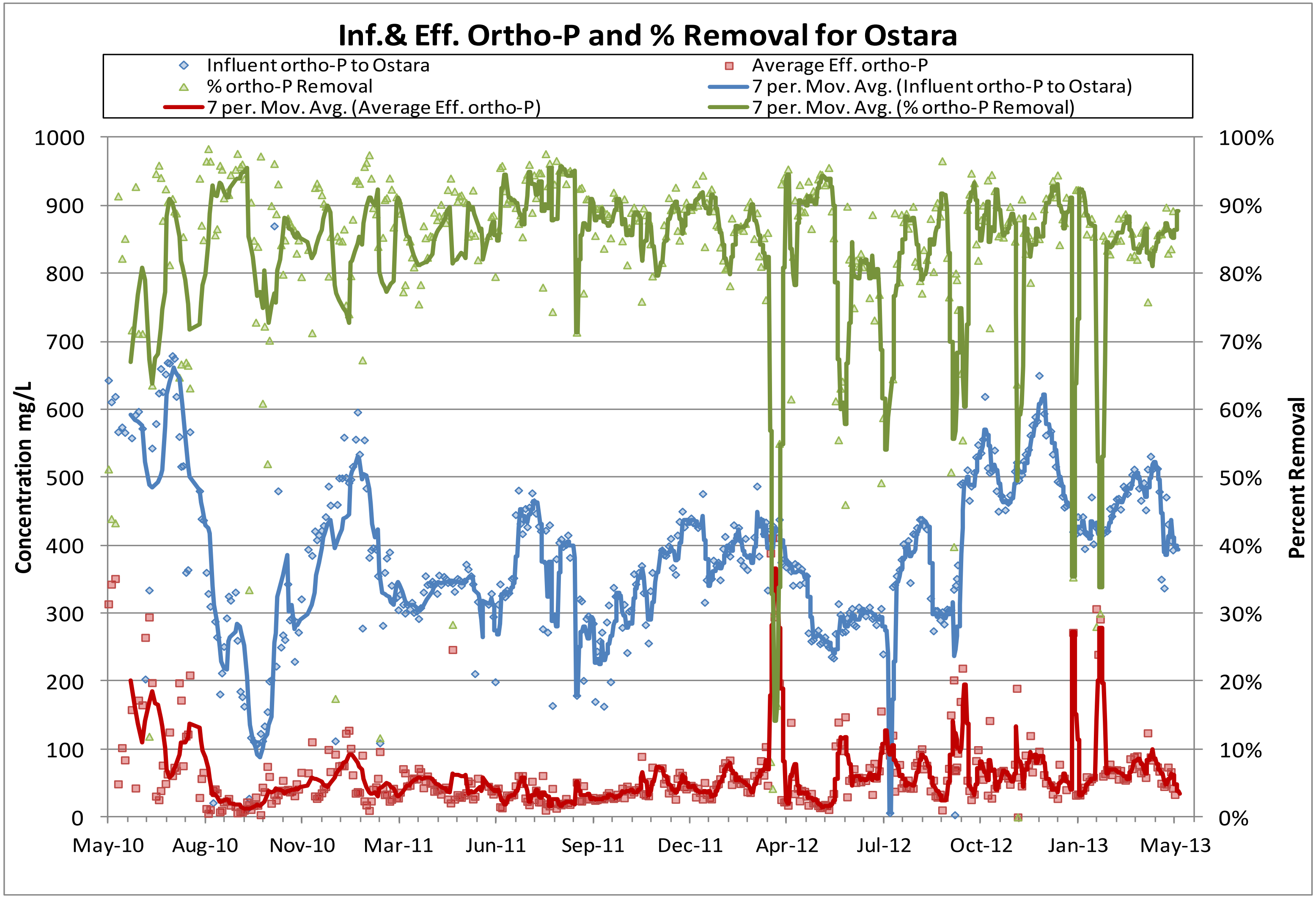
Struvite recovery was most favorable treatment option

Cost Description	Do Nothing	Side Stream Chem Trmt	Ostara
Total Annual Savings	0	0	528,000
Total Annual Operating Costs	(392,000)	(429,000)	(91,000)
Net Annual Costs	(392,000)	(429,000)	437,000
Capital Costs			3,926,000
Net Present Worth @ 10 years	(3,027,000)	(3,313,000)	(552,000)
Net Present Worth @ 20 years	(4,885,000)	(5,346,000)	1,520,000

Full scale struvite recovery facility at NTP

System has produced ~ 1,100 lb struvite/day

The SRF has reduced ortho-P concentrations by approximately 85%



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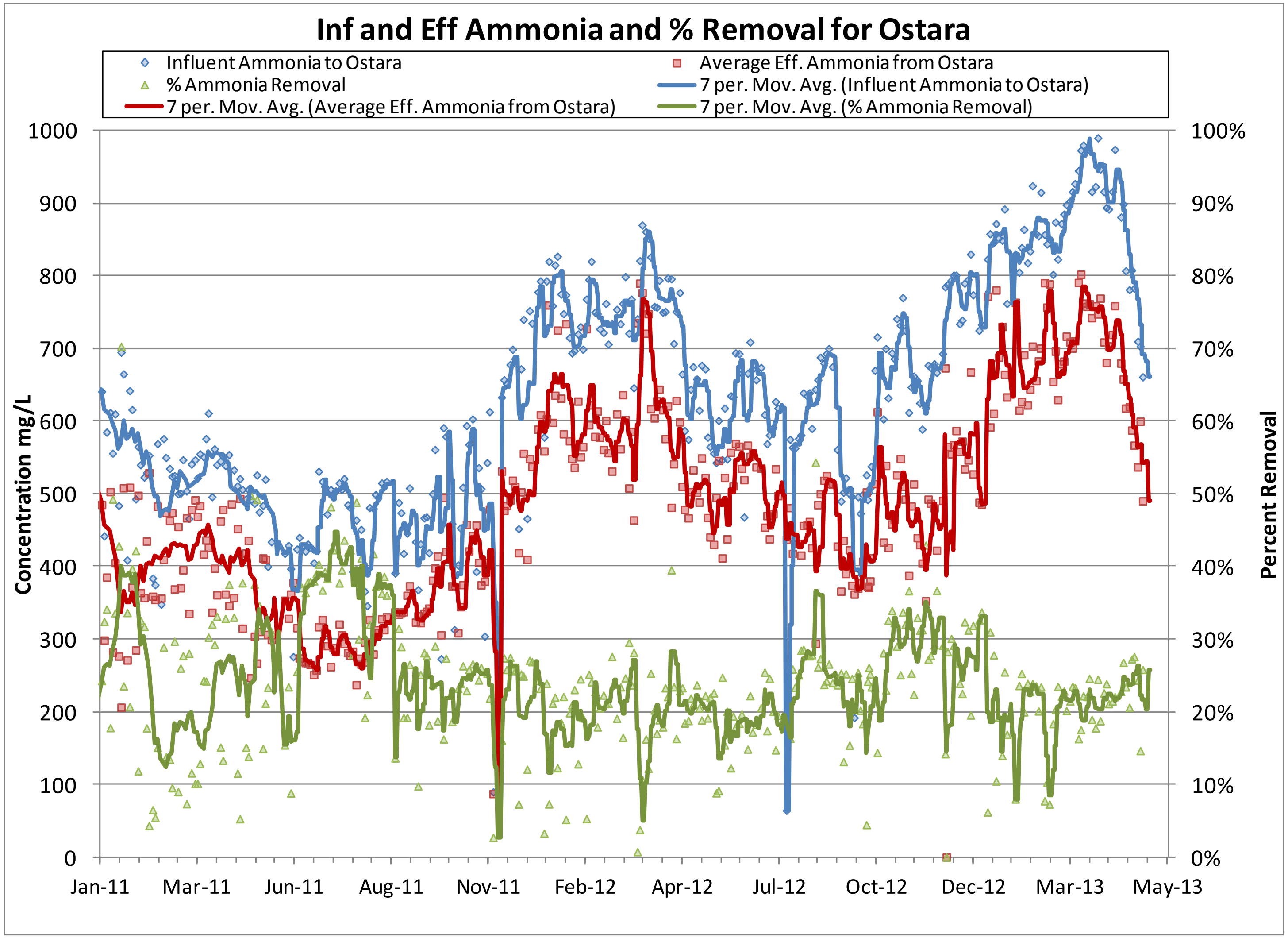
Ammonia removal has averaged 25%



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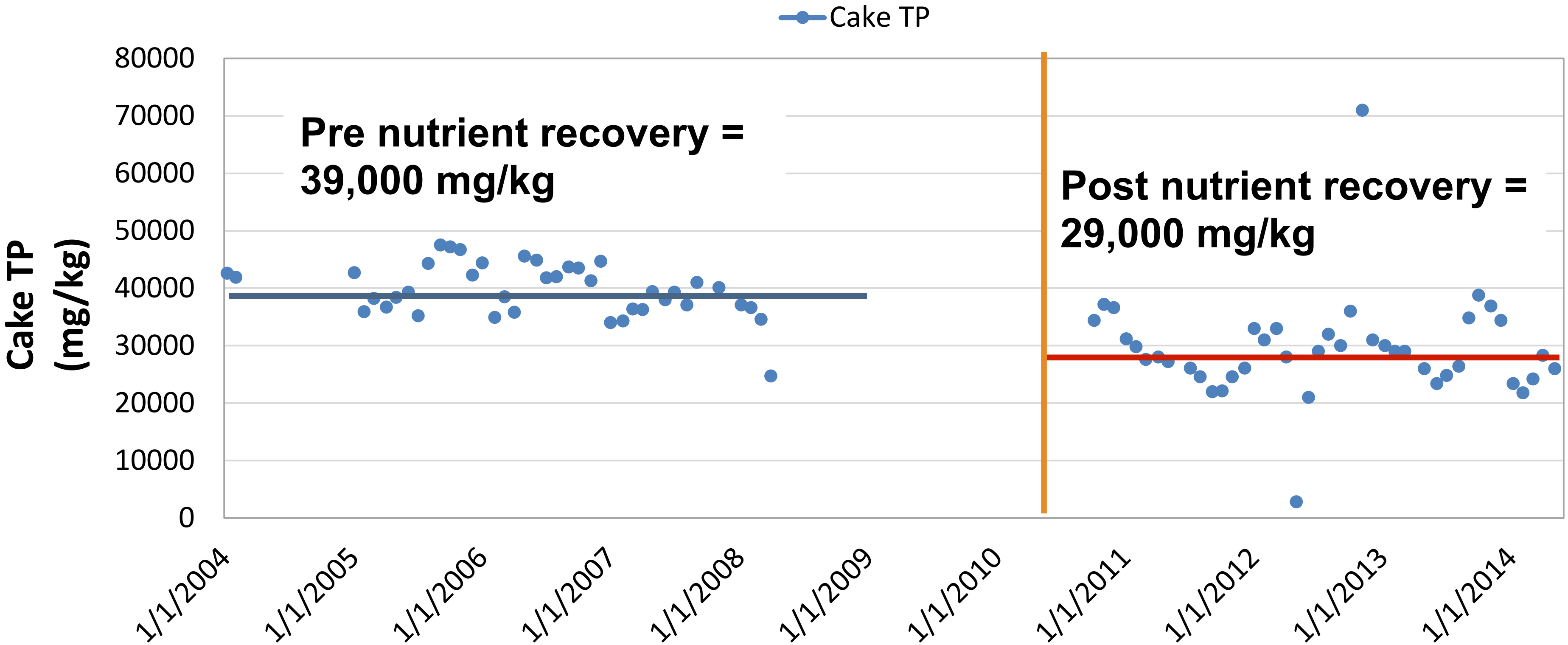
Struvite recovery has reduced the phosphorus content of the biosolids



29% reduction in cake TP content

Lessons Learned from Nansemond Treatment Plant

- Reduced nutrient load (>25% of P and ~ 5% of ammonia) to the main plant
- Dewatering operations/performance directly impact nutrient recovery – solids removal is important
- Optimized bio P removal will result in maximized P recovery
- Nutrient recovery is a viable sidestream treatment strategy

F. Wayne Hill WRC

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F. Wayne Hill Water Reclamation Center

Gwinnett County, GA

60 MGD advanced WWTP

0.08 mg/L TP effluent limit

Bio-P and chemical trim for P-removal

In 2009, F. Wayne Hill Changed from Bioxide to $Mg(OH)_2$ in Collection System for Odor Control

Pros: Eliminated need for ALK addition at plant

Cons: Struvite formation in centrate lines, centrifuges, digester complex

Sludge from 22 mgd Yellow River Bio-P plant coming, which would substantially increase P load in sidestreams and SFP

Struvite taken from centrifuge

Balance - Limit effluent P while minimizing struvite formation

Phosphorus outlets:

- Effluent (Limit TP = 0.08 mg/L)
- Sludge cake (precipitated complex, biomass, struvite)
- Struvite solids from nuisance formation

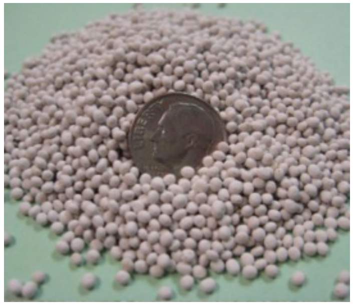
Project Goal: Determine best solution for struvite issue

- Nutrient Recovery
- Metal salts

Five options were considered for sidestream P removal from F. Wayne Hill AWRF

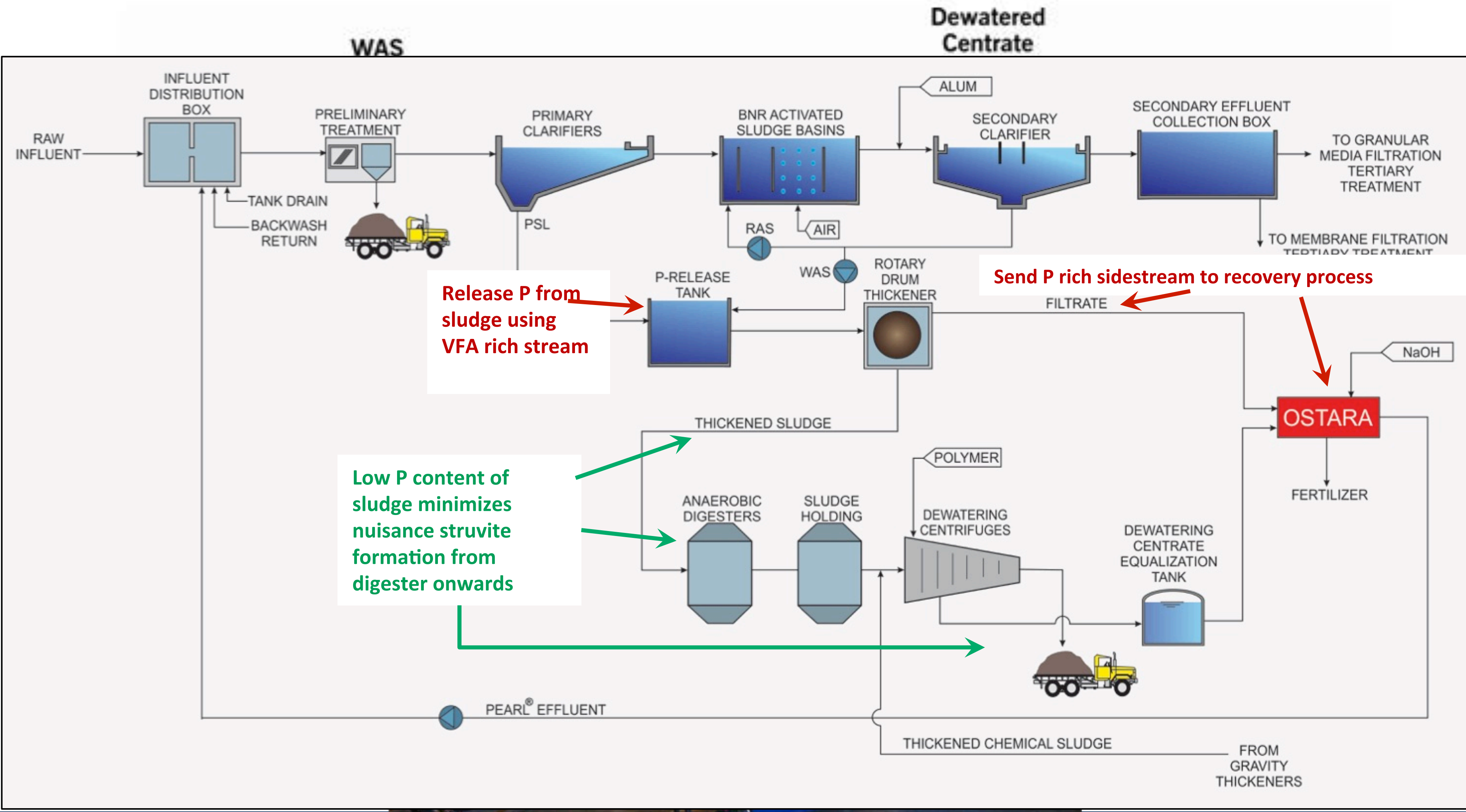
Do Nothing

Ferric addition with and without $Mg(OH)_2$ addition



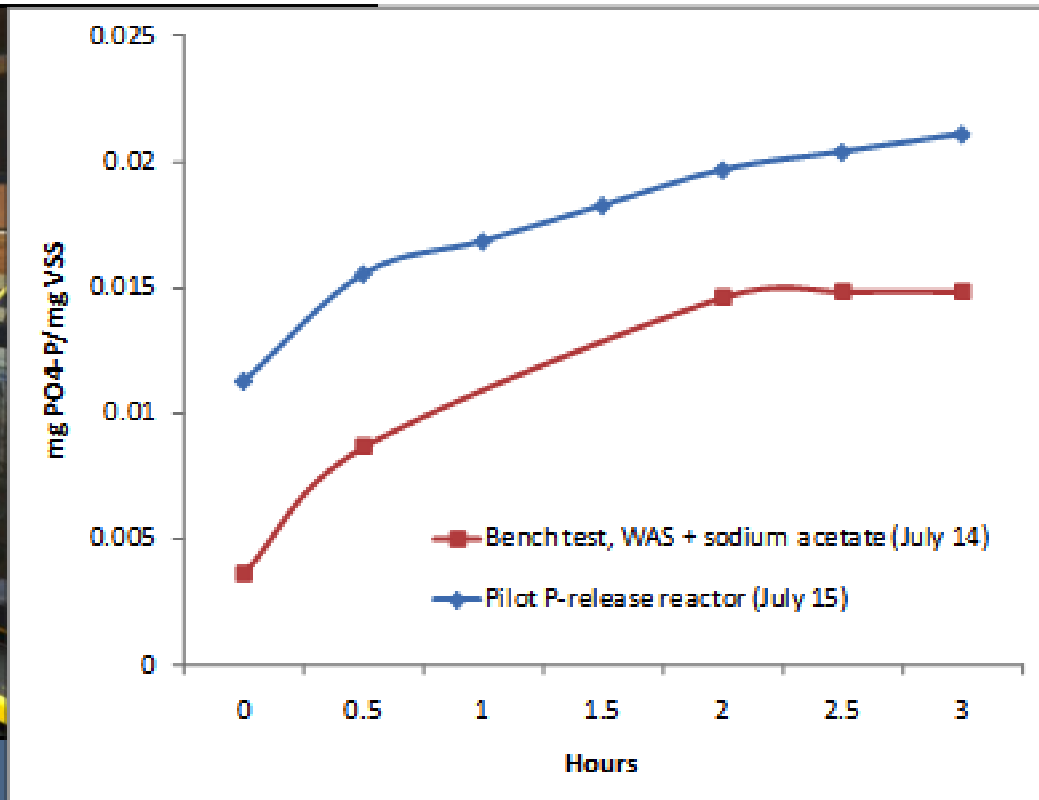
Struvite recovery with and without WASStrip™

WASSTRIP™ concept minimizes nuisance struvite production

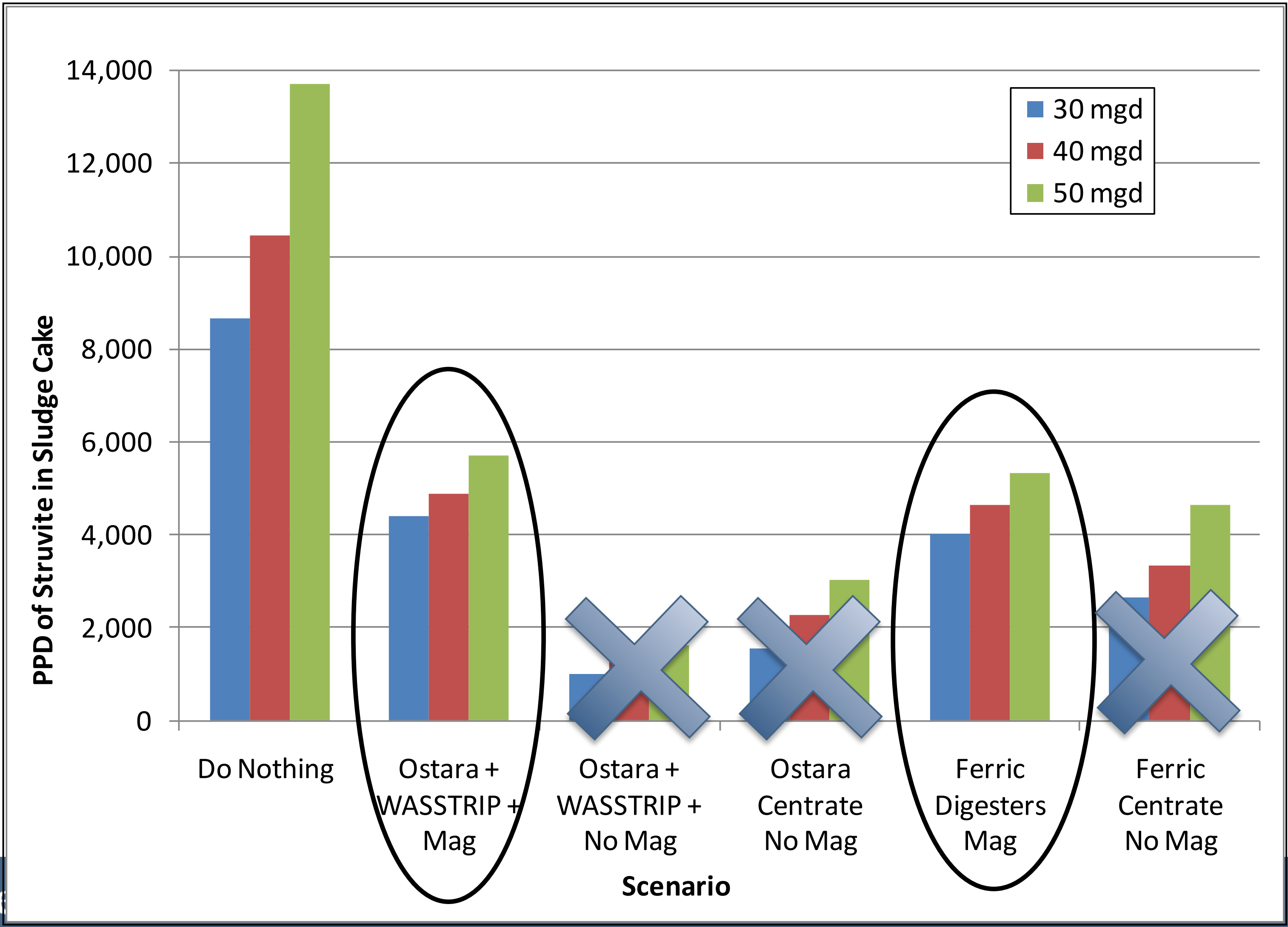


Bench scale testing of the WASSTRIP™ process was performed

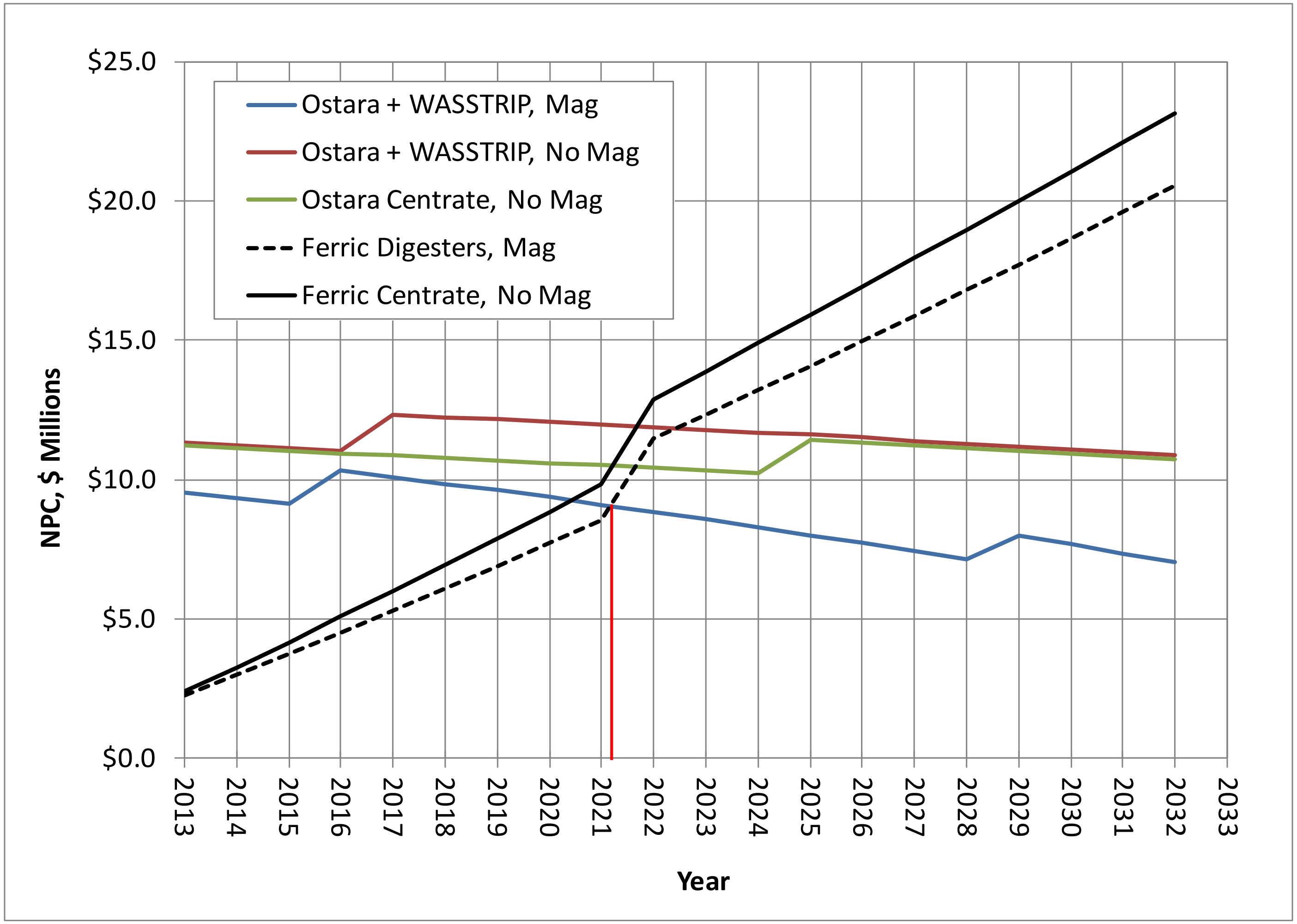
- Determine levels and rates of PO_4 release from WAS
- Optimize parameters to maximize PO_4 release in pilot studies
    - Anaerobic retention time and WAS:PS blend ratio



P recovery provides equivalent struvite reduction compared with the ferric addition option

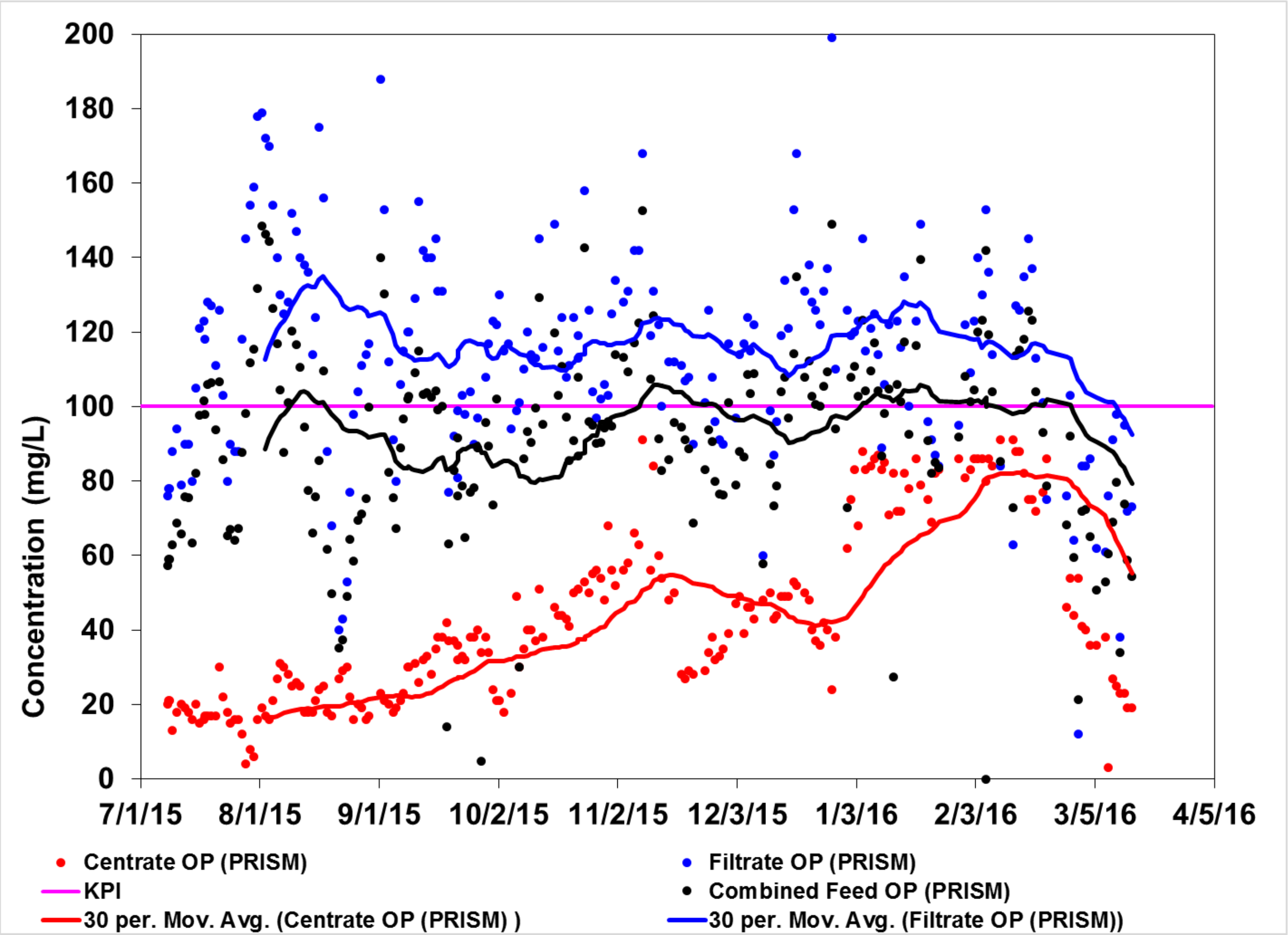


Struvite recovery + WASSTRIP has lowest net present cost and 8-Year Payback

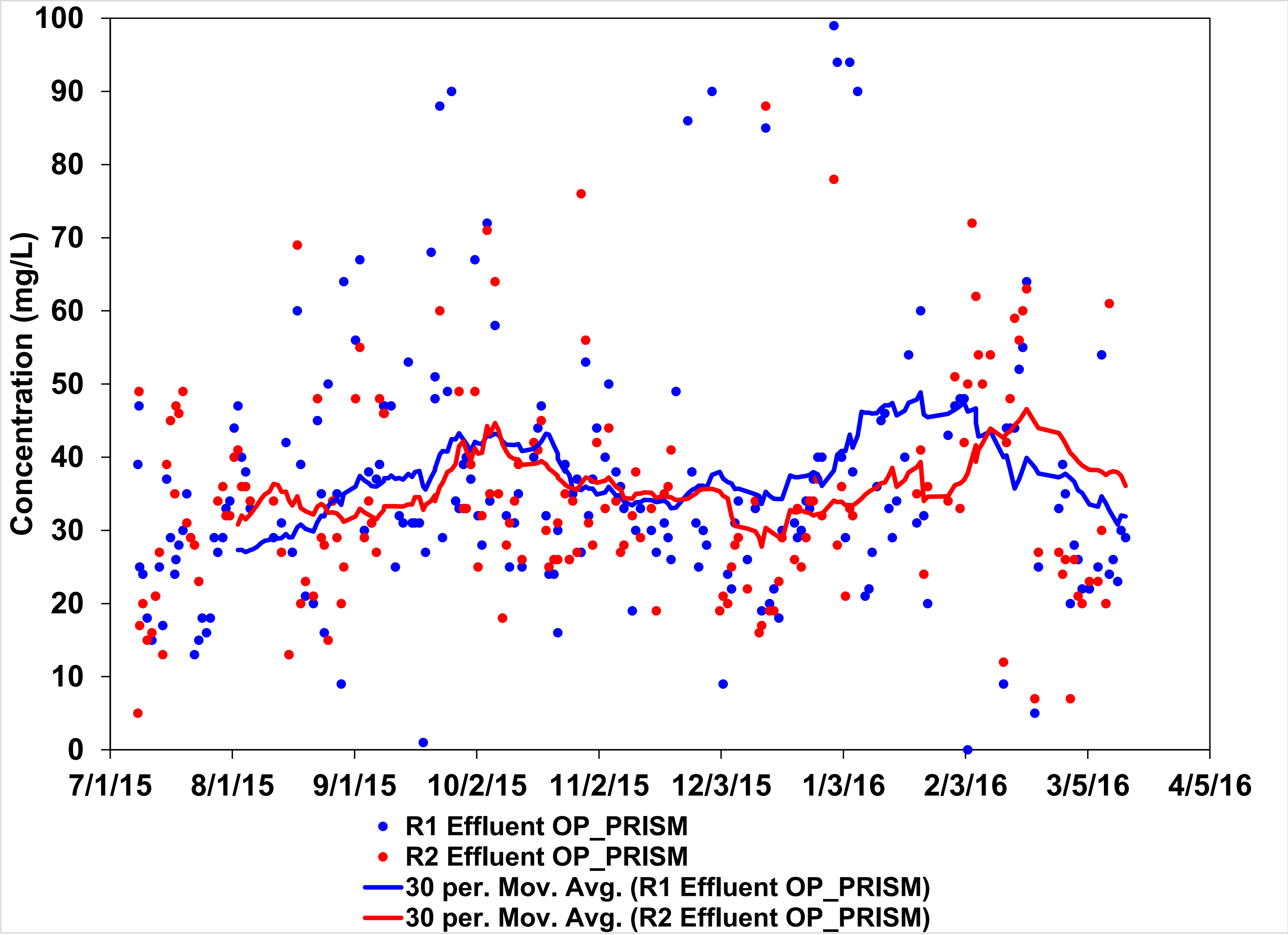


Full-Scale Facility Has Been In Operation Since 2015

Ostara feed – Orthophosphate

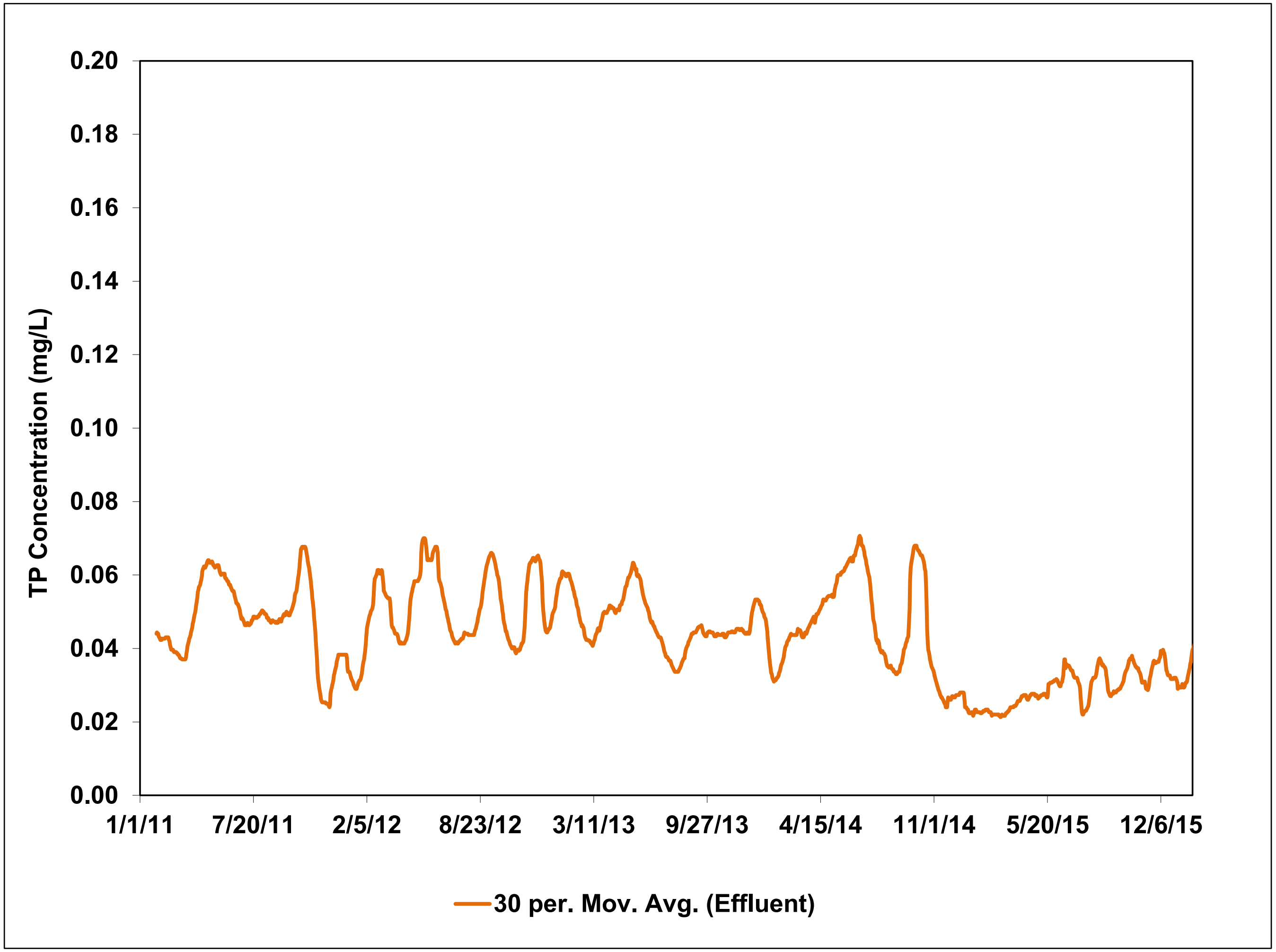


Ostara effluent – Orthophosphate

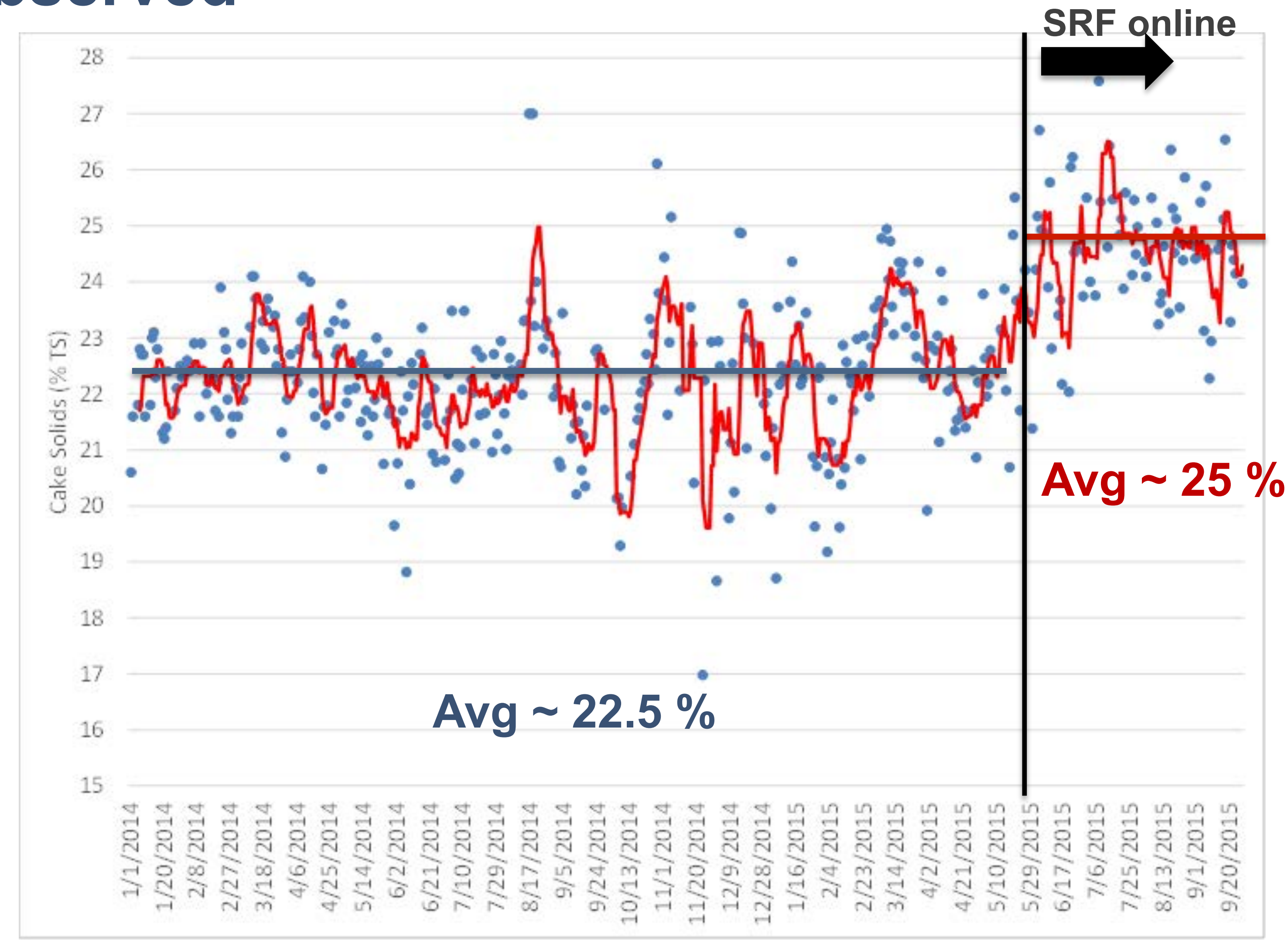


Plant Effluent

Lower, more stable effluent TP



Cake TSS content improvements have been observed

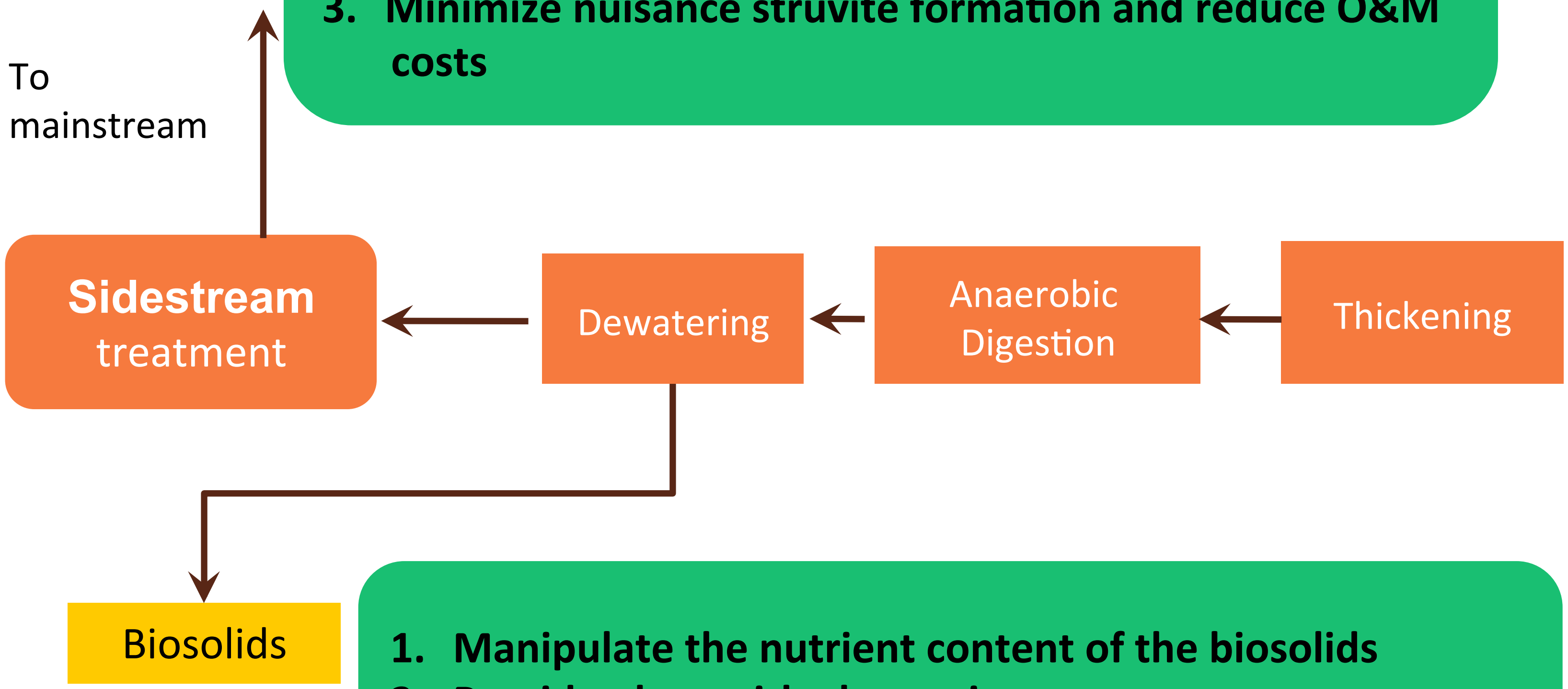


Lessons Learned from F. Wayne Hill WRC & WASSTRIP™

- Mitigate nuisance struvite formation
- Minimized need for ferric addition
- Reduced sludge production
  - Decreased P content of biosolids
- Possible benefits to dewatering
  - Study underway to confirm

Benefits of Nutrient Recovery

1. Reduce energy and chemical consumption in the mainstream process
2. Provide factor of safety for mainstream nutrient removal process
3. Minimize nuisance struvite formation and reduce O&M costs



1. Manipulate the nutrient content of the biosolids
2. Provide plant with alternative revenue stream
3. Regain digester capacity

Logistics of Implementation

- Equalization and solids pre-treatment are critical
- Locate struvite recovery facility as close to dewatering facilities and equalization tank as possible.
- Avoid traps and use long turn elbows
- Incorporate acid flushing of lines and provide flush connections on all pipe runs.
- Provide duplicate piping and pumps to minimize downtime during maintenance

Questions and Contact Information

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