October 19, 2017

Nitrogen and Phosphorus Harvesting and Reuse

MWEA – Sustainable Energy Seminar

DONOHUE

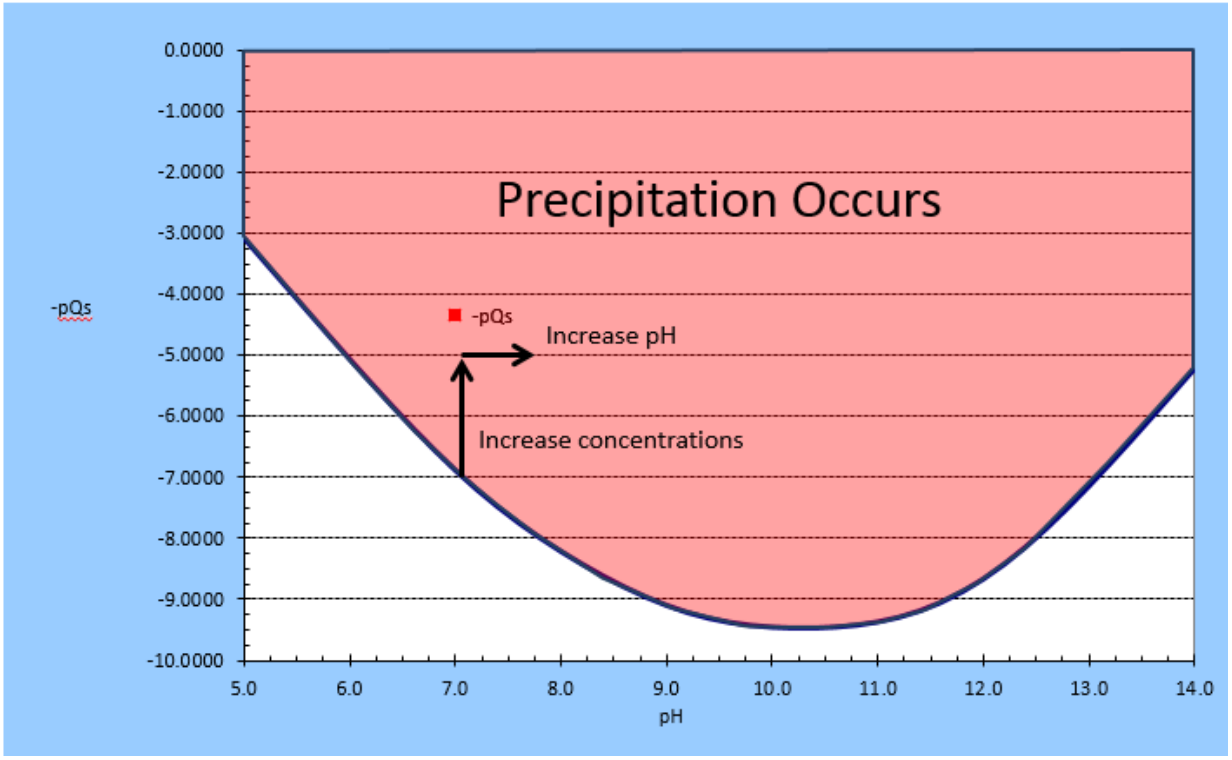
Agenda

- What is struvite and why recover it?
- Technologies for struvite recovery
- AirPrex piloting case studies
- Evaluation and design for St. Cloud, MN

Background

What is Struvite?

- Magnesium-Ammonium-Phosphate – $MgNH_4PO_4*6H_2O$
- Slow release fertilizer



Mg, NH_4 and PO_4 are present in high concentrations in certain flow streams within WWTPs

Why Struvite Recovery?

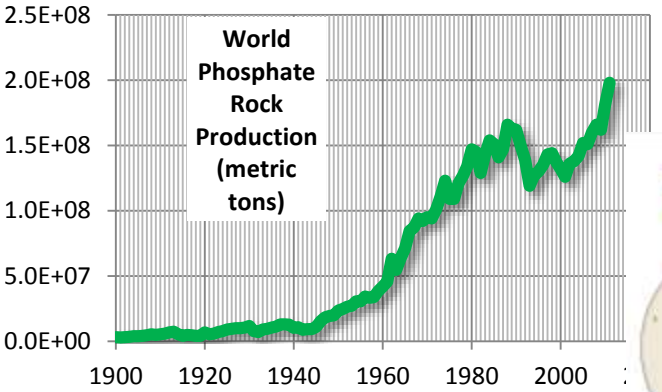
Potential Improvement to Biosolids Dewatering

Prevent Struvite Accumulation Maintenance

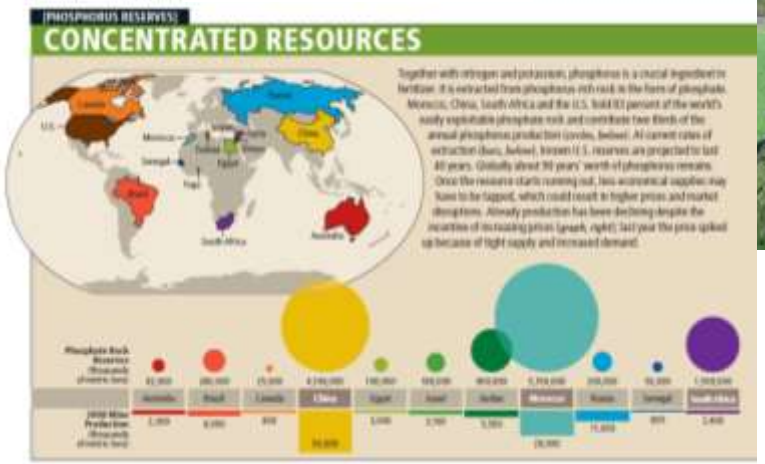
Low WWTP Effluent Phosphorus Limits

Why Struvite Recovery?

Phosphorus Demand



Phosphorus Supply



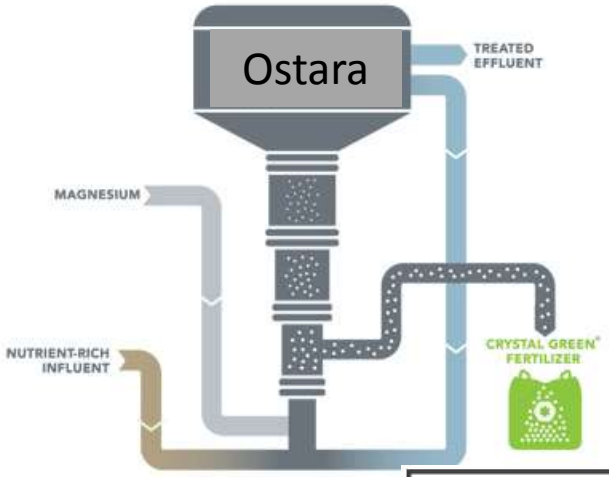
Phosphorus Agronomic Application Rates

Technologies

Struvite Harvesting from Sidestreams

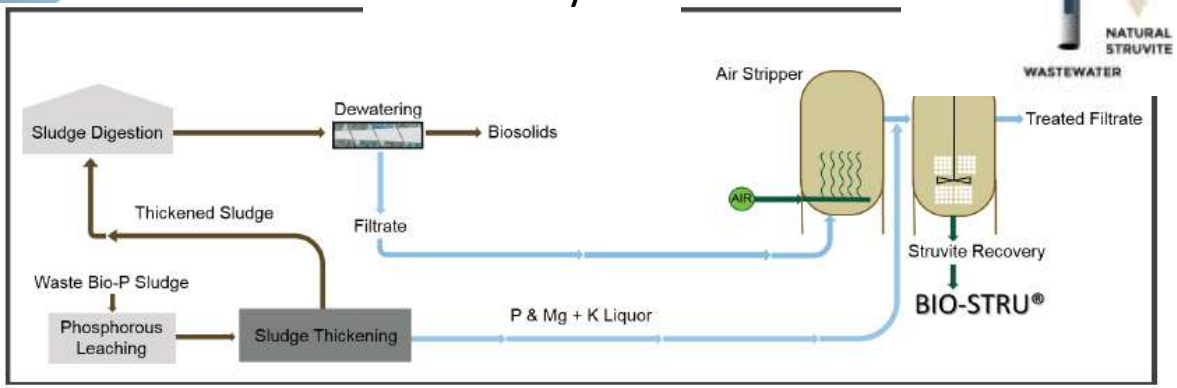
- Ostara, Multiform Harvest, NuReSys
- Forms and removes struvite from sidestreams

Ostara



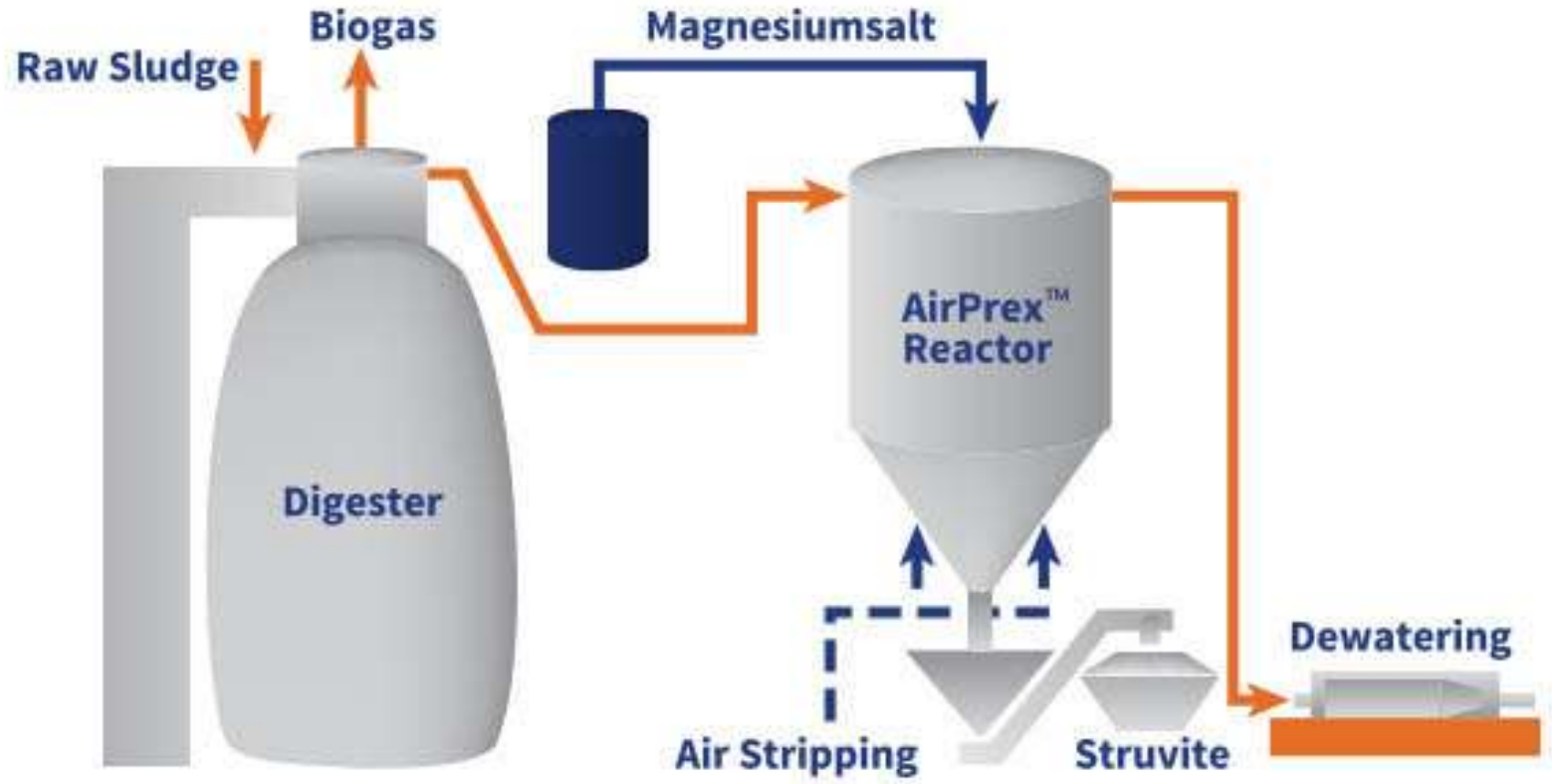
Multiform Harvest, Inc. (MHI)

NuReSys



Struvite Harvesting from Biosolids

- AirPrex, NuReSys
- Forms and removes struvite prior to dewatering



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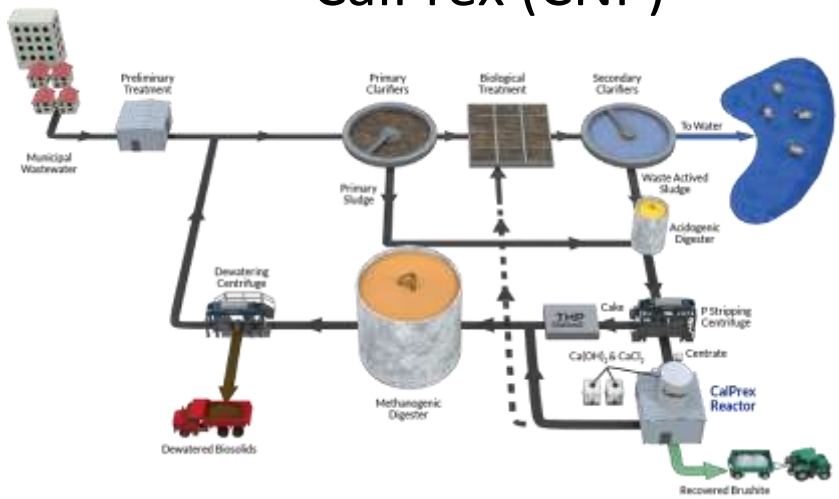
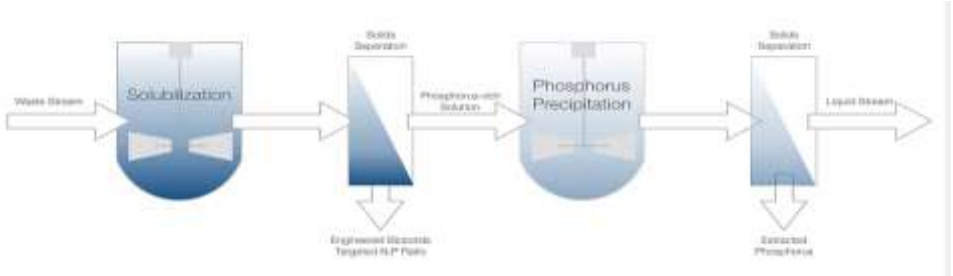
Nutrient Harvesting

- More technologies on the market…

CalPrex (CNP)





- Struvia (Veolia)
- Phosphaq (Paques)
- Crystalactor
- Phosphogreen (Suez)

QuickWash

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Piloting for Improved Biosolids Dewaterability

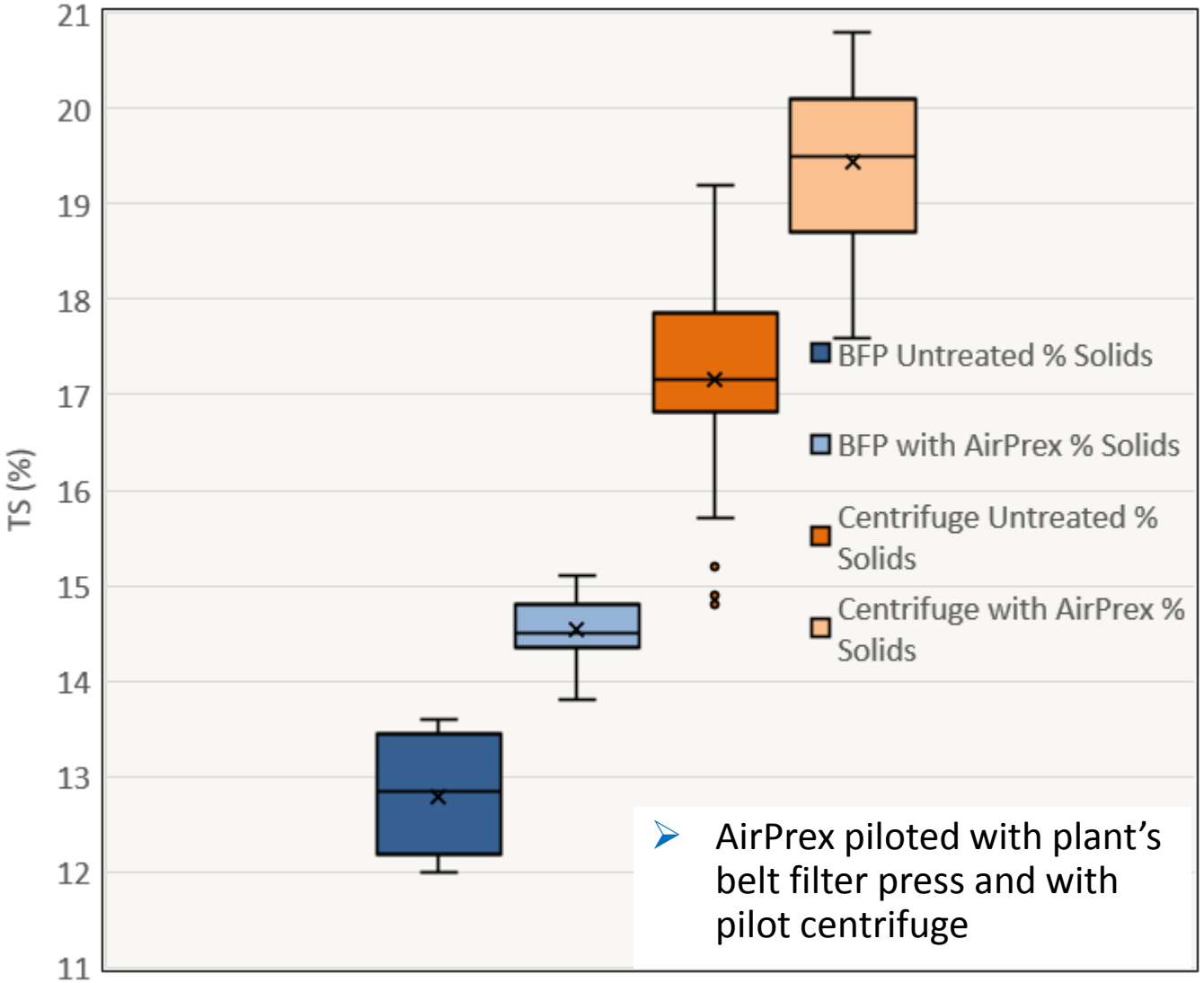
Piloting Case Study
Sun Prairie

- Major plant upgrade with startup in 2007

RBC	Bio-P
Pilot Test = 22% TS	%TS Cake
Full Scale = 18% TS	Currently 12-14%TS

- Theories:
- Bio-P Affects Sludge Extra Polymeric Substance Characteristics (Soluble P Theory, Dr. Kopp)
- Bio-P with Anaerobic Digestion Change Makeup of Multivalent Cations in the Sludge (Divalent Cation Bridging Theory)

Piloting Case Study
Sun Prairie



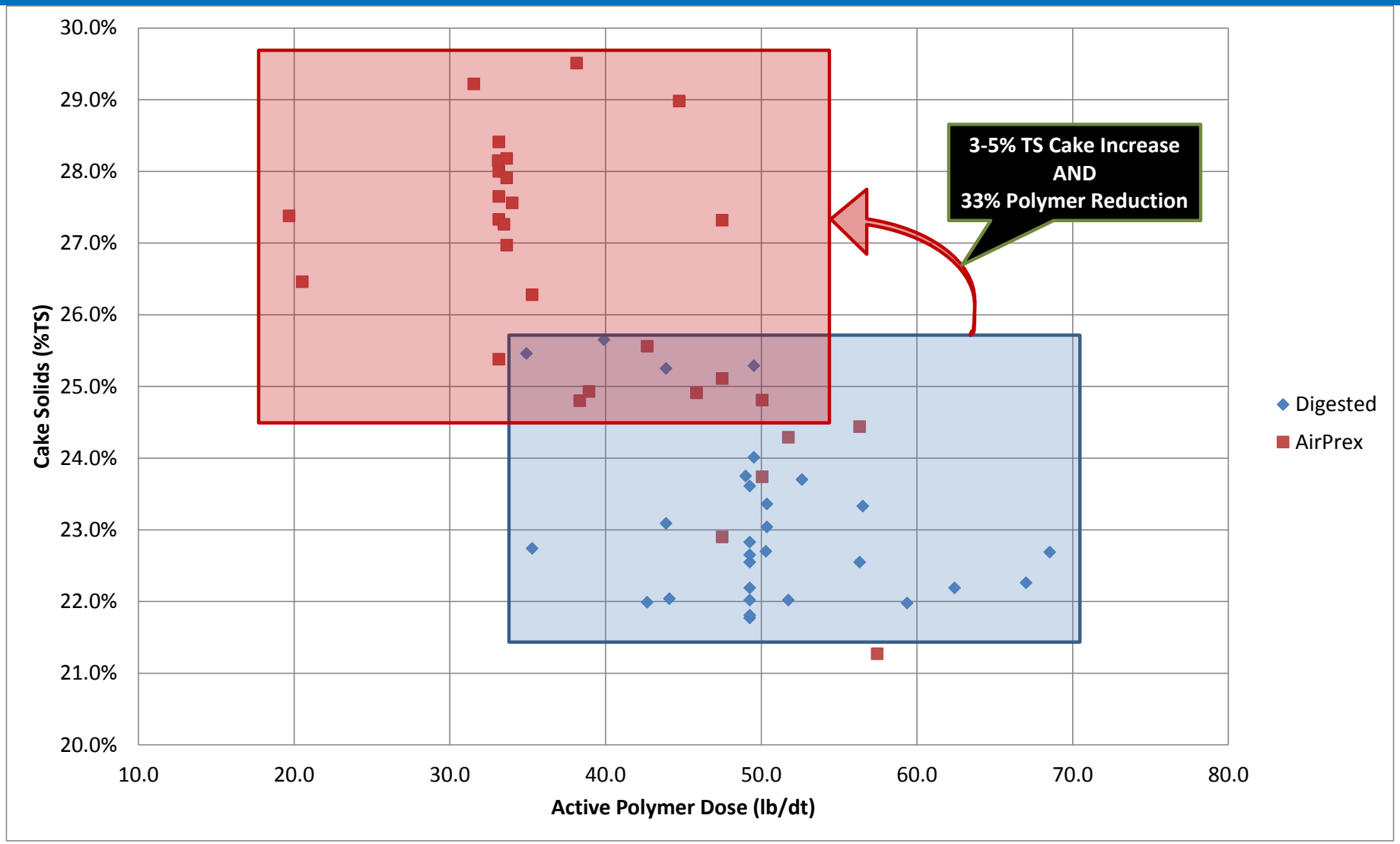
- AirPrex piloted with plant's belt filter press and with pilot centrifuge

Piloting Case Study
Stevens Point

AirPrex

NuReSys

Piloting Case Study
Stevens Point

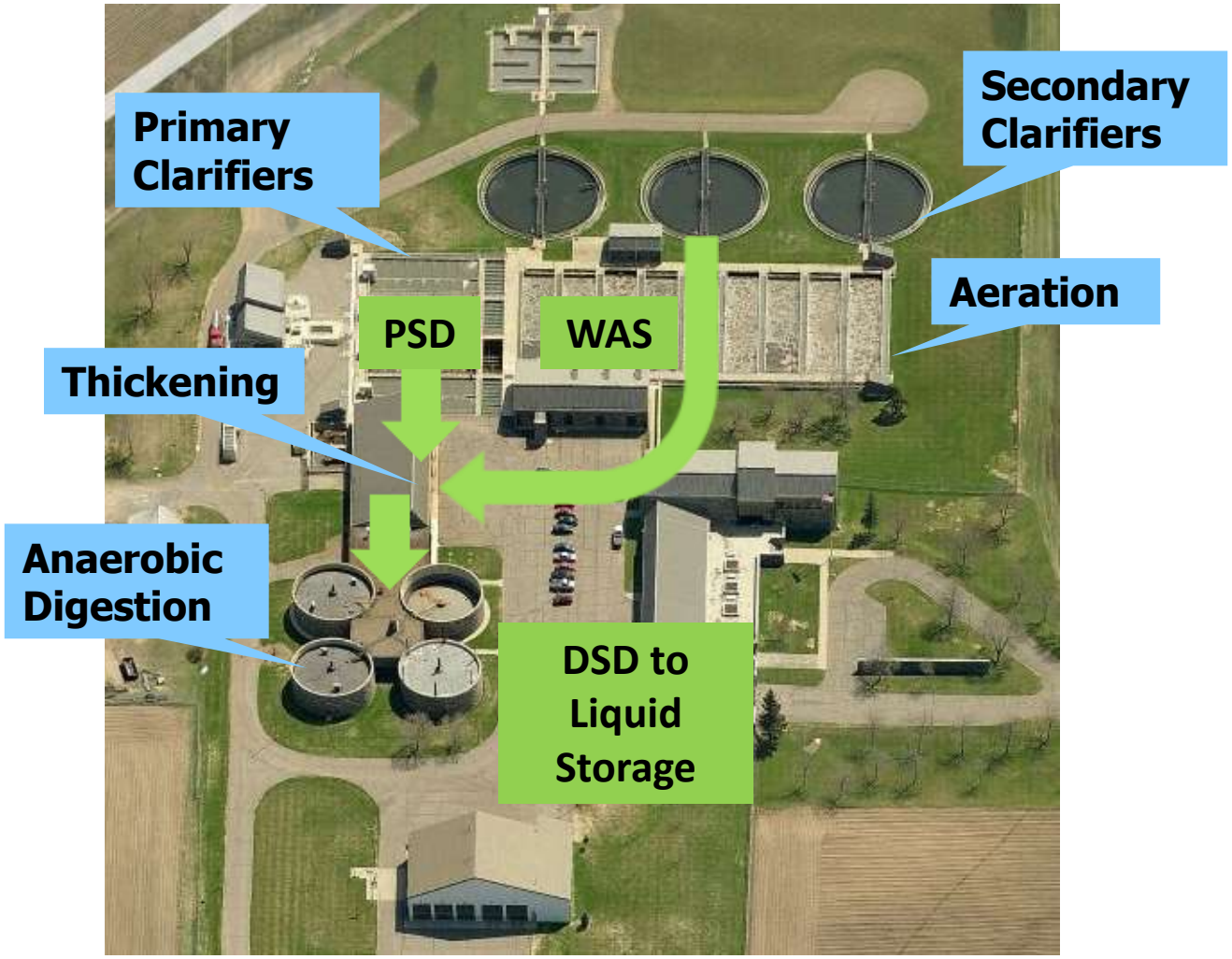


Piloting Summary

- Dewatered Cake Improvement of 2-5% TS
- Decreased Polymer Requirement
- Decreased Sidestream Phosphorus & Nitrogen Loadings
- Decreased Biosolids P Content
  - If sequestered

Site Investigations and Design for St. Cloud, MN

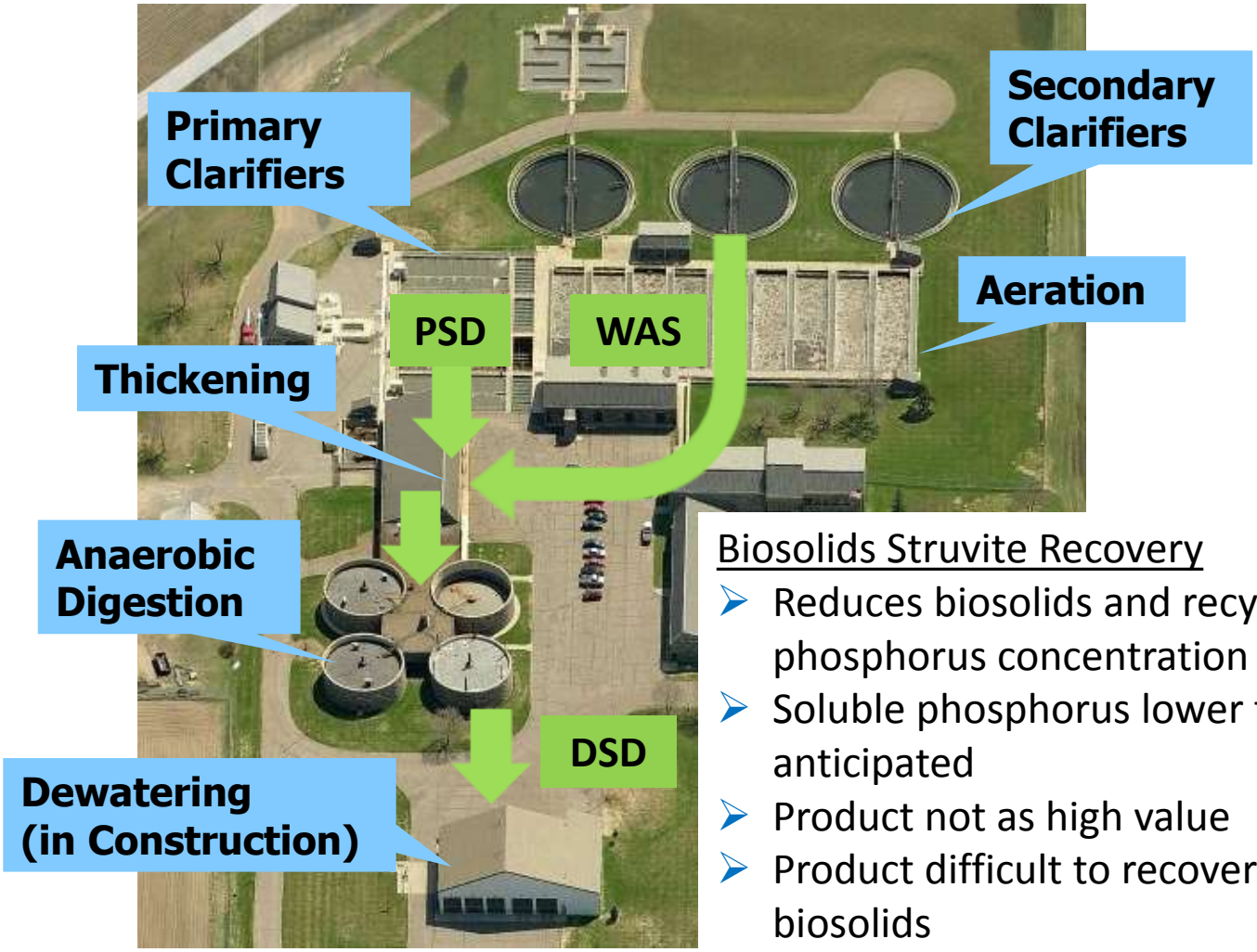
St. Cloud, MN


Primary Clarifiers
Secondary Clarifiers
Aeration
PSD
WAS
Thickening
Anaerobic Digestion
DSD to Liquid Storage

St. Cloud, MN

- Nutrient Removal and Recovery Project
  - Anaerobic digestion improvements
  - Installation of dewatering centrifuge
  - New biosolids cell lysis process
- Primary Goals for nutrient recovery
  - Produce valuable resource
  - Reduce biosolids phosphorus content
  - Reduce phosphorus recycle load

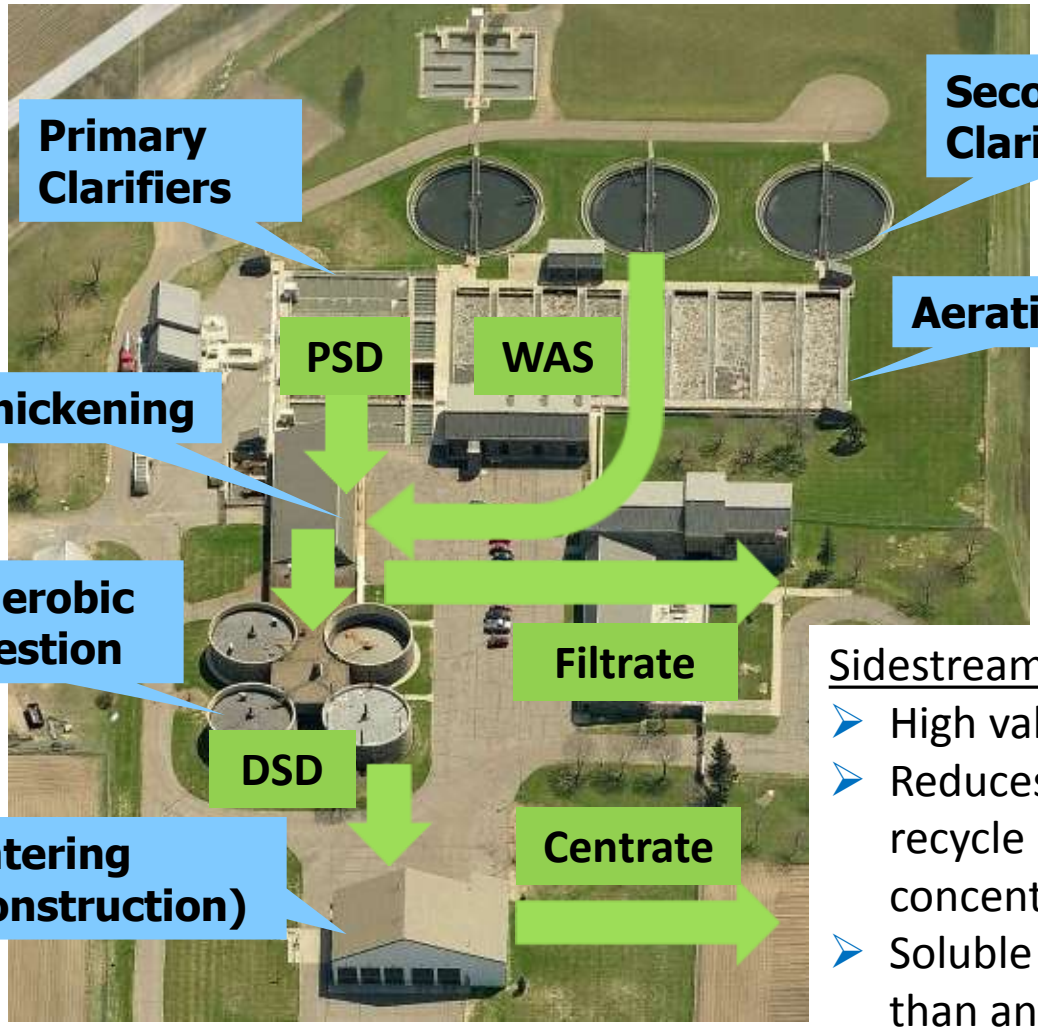
St. Cloud, MN
Biosolids or Sidestream Recovery?



Biosolids Struvite Recovery

- Reduces biosolids and recycle phosphorus concentration
- Soluble phosphorus lower than anticipated
- Product not as high value
- Product difficult to recover from biosolids

St. Cloud, MN
Biosolids or Sidestream Recovery?



Sidestream Struvite Recovery

- High value product
- Reduces biosolids and recycle phosphorus concentration
- Soluble phosphorus lower than anticipated

St. Cloud, MN
Biosolids or Sidestream Recovery?

- Lower than anticipated soluble phosphorus due to alum in primary sludge
  - Primary sludge and WAS are co-thickened and digested
  - Phosphorus is bound with alum
- Solution: Install WAS phosphorus release process to separate soluble phosphorus prior to thickening

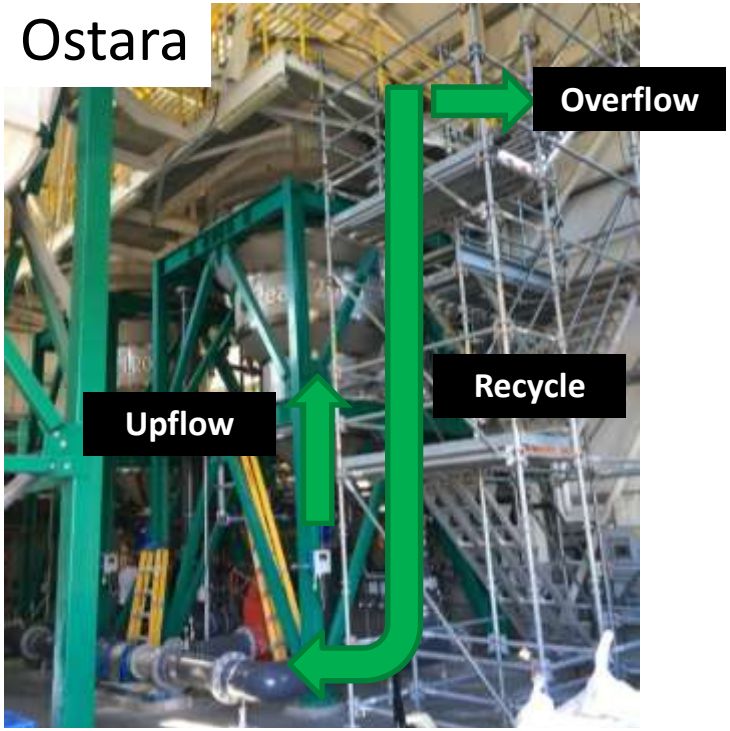
St. Cloud, MN
Biosolids or Sidestream Recovery?

- Sidestream struvite recovery with WAS phosphorus release preferred
  - High value product
  - Maximum struvite production
  - Minimize biosolids phosphorus and recycle phosphorus
- Which sidestream struvite vendor best suits St. Cloud?

Struvite Precipitation

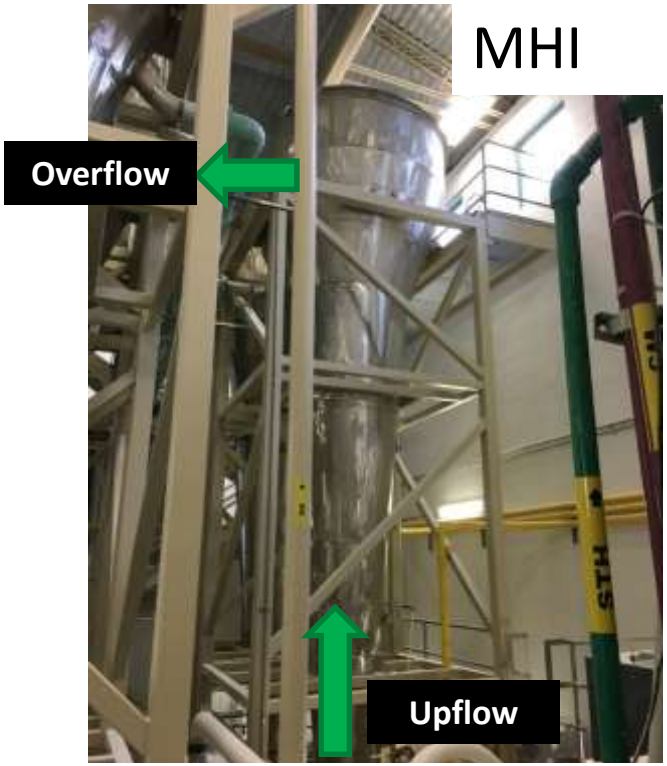
- Donohue visited multiple Ostara and Multiform Harvest installations to obtain detailed information on design, operation and performance

Ostara



Rock Creek Advanced WWTF, Hillsboro, OR

MHI



West Boise WWTF, Boise, ID

Struvite Precipitation

- Influent phosphate concentration, magnesium dosage and pH critical to struvite formation

- Ostara reactor has recycle to enhance production of high value pellets
- Ostara reactor requires periodic reseeding to maintain struvite pellet size

- MHI reactor designed to produce struvite without control over pellet size

Stickney WRP, Chicago Metro Area, IL

Struvite Processing

- Struvite harvested from the reactors is processed and bagged into supersacks
- Ostara package typically includes dewatering, drying, sorting, storage and bagging
- Ostara has offered the City of St. Cloud bulk storage and transport (no sorting required)
- Multiform Harvest package typically includes dewatering, drying (optional) and storage

Nine Springs WWTP, Madison, WI

West Boise WWTF, Boise, ID

Summary

- St. Cloud found advantages and disadvantages to each process
- Request for proposal sent to Ostara and Multiform Harvest
- Vendors were competitively evaluated based on capital and life cycle costs
- Ostara selected and designed, now in construction

Acknowledgement

- WWTP Staff / Researchers
  - John Krug, Lee Graves, Sun Prairie, WI
  - Chris Lefebvre, Stevens Point, WI
  - Brian Schoenecker, St. Cloud, MN
  - Tracy Hodel, St. Cloud, MN
  - Emma Larson, St. Cloud, MN

- Manufacturers
  - Rachel Lee, Ostara
  - Derek Lycke, Ostara
  - Keith Bowers, Multiform Harvest, Inc.
  - Gerhard Forstner, CNP Airprex/Calprex & Centrisys
  - Chuck Wanstram, Schwing Bioset NuReSys

- Donohue Staff
  - Nathan Cassity
  - Eric Lynne


Questions?