Today's Presenters

Chris Thomson
Kruger Inc.
Cary, NC

Brandy Nussbaum
AnoxKaldnes
Sweden

Glenn Thesing
Kruger Inc.
Cary, NC

2

Presentation Outline

- Sidestream ANITA™ Mox
- Mainstream ANITA™ Mox
- Summary and Questions

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Sidestream ANITA™ Mox

WATER TECHNOLOGIES

4

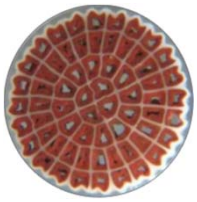
Value of ANITA™ Mox

- With fifteen (15) installations sold for sidestream treatment, ANITA Mox has proven its value:
  - ***Simple***
    - MBBR → Flow In = Flow Out
      - No recycle streams to manage
      - No MLSS or SRT to control
      - No Separate Sludge System Needed
  - ***Robust***
    - Bacteria Retained by Media and Screens
    - Tolerates
      - Variations in Dewatering Schedules and Dewatering Starts/Stops
      - High TSS and Swings in TSS
      - High Polymer Residual
      - High NO_2-N Residual
      - Variability in pH
  - ***Reliable***
    - Process Performance Guarantees
  - ***Flexible Layout***
    - Can be installed in existing tanks

5

Introduction to Deammonification

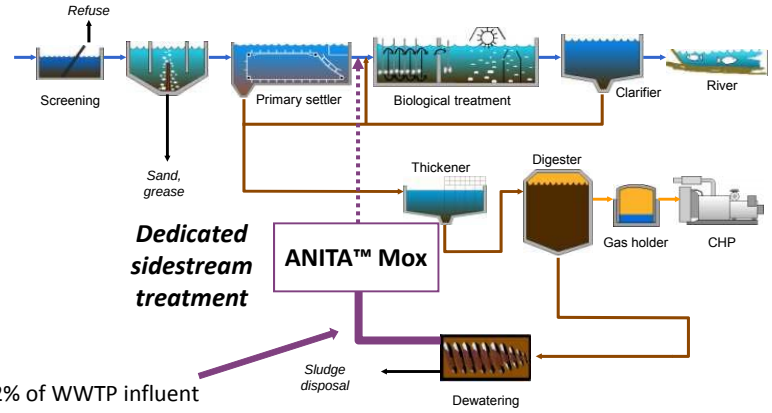
- Deammonification is a “short cut” nitrogen removal process
- Utilizes Anammox = ANaerobic Autotrophic AMMonia OXidizer bacteria
  - *Requires both oxic and anoxic environments*
- Deammonification has achieved industry acceptance as a sidestream treatment technology, treating:
  - *Municipal WWTP – Liquor (centrate, pressate, etc.) from dewatered anaerobic sludge*
  - *Industrial process effluents*
  - *Landfill leachate*



6

Sidestream ANITA™ Mox

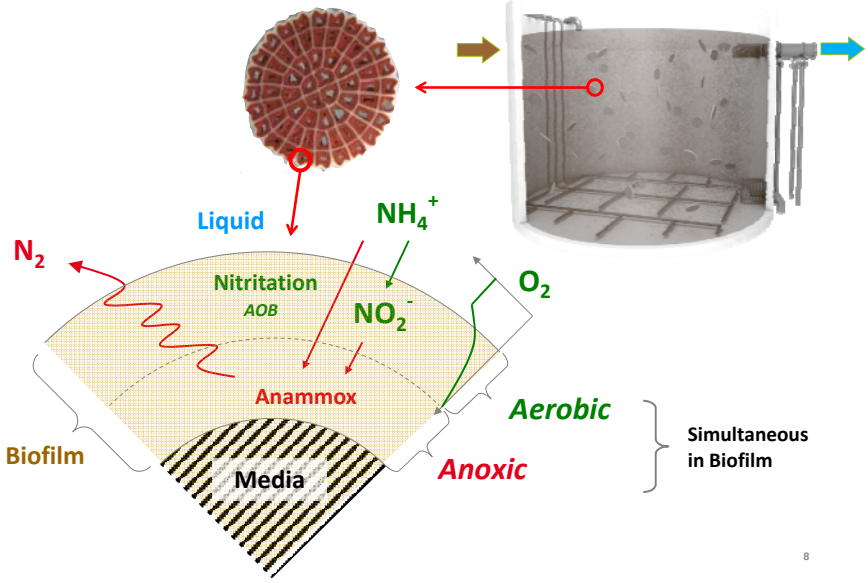
- Reject water from sludge digestion in municipal WWTPs



- ~1-2% of WWTP influent
- 15-20% of N load
- $N\text{-}NH_4$: 500-1500 mg/L

7

Sidestream ANITA™ Mox



8

Sidestream ANITA™ Mox

- When compared to conventional ammonia removal in the mainstream WWTP
  - *Energy Savings*
    - 60% less O_2 required
  - *Capital Cost Savings*
    - Compact footprint
    - MBBR & IFAS→ small tanks
    - Re-use existing tanks
  - *Operational Ease and Cost Savings*
    - No external carbon needed
    - Reduced sludge production
  - *Robust Process*
    - MBBR & IFAS media protects anammox bacteria

Parameter	ANITA™ Mox	Conventional Nitrogen Removal
Oxygen Requirement (lb O_2 / lb N)	**1.9**	4.6
Methanol Consumption (lb / lb N)	**0**	3.0
Sludge Production (lb VSS / lb N)	**0.1**	0.5 – 1.0

9

Sidestream ANITA™ Mox – MBBR Criteria

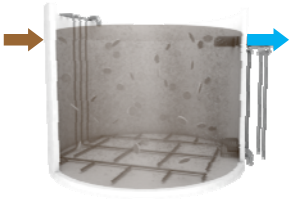
ANITA™ Mox Influent	Optimal	Possible	Challenging
Temperature, °C	20-35	15-20	<15 or >35
Ammonia-N, mg/L	200-2,000	50-200	<50 or >2,000
sbCOD/N ratio	<0.5	0.5-1.0	>1.0
TSS, mg/L (avg.)	<1,000	1,000-2,000	>2,000
Alkalinity, mg/L $CaCO_3$: NH_4-N, mg/L	>5	4-5	<4

* - With ANITA™ Mox only. If conditions are outside of Optimal, Possible or Challenging, treatment is still very likely possible with supplemental treatment.

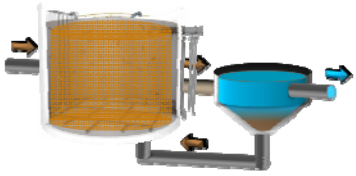
Sidestream ANITA™ Mox

- ANITA Mox Configurations:
  - *Moving Bed Biofilm Reactor (MBBR)*
    - Flow In = Flow Out
    - No Downstream Clarification
    - Biological Treatment in Biofilm
  - *Integrated Fixed Film Activated Sludge (IFAS)*
    - Downstream Clarification and RAS
    - Biological Treatment in Biofilm and Mixed Liquor

MBBR



IFAS



11

Sidestream ANITA™ Mox

- Startup of Systems
  - *Facilities are seeded with seed media (~5%) to jump start the biological process*
  - *Full flow achieved in two (2) to four (4) months typically*
  - *Multiple seed sources available*

12

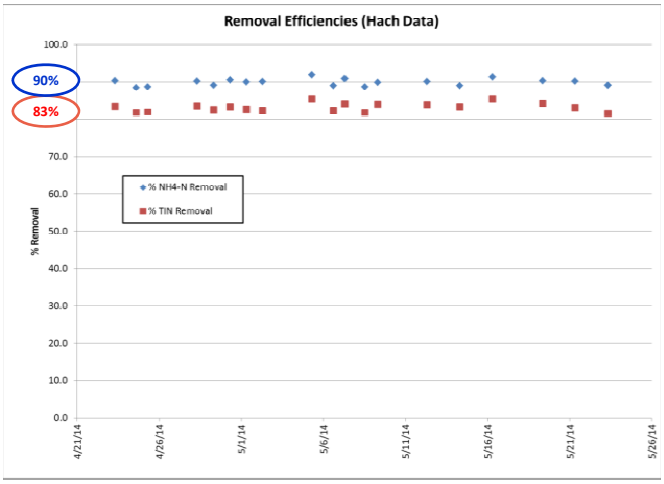
James River Treatment Plant – Newport News, VA

- Centrate Characteristics
  - *Q = 0.075 MGD*
  - *NH_3-N = 890 mg/L*
  - *Temperature = 30 °C*
- Retrofit of existing tank
- Startup seeded from Malmö BioFarm
- Plant has existing Hybas™ (IFAS) treatment
- Facility serves as BioFarm

13

James River Treatment Plant – Newport News, VA

- Process Startup Period – 30 Day Performance Test



*Source: Hampton Roads Sanitation District (HRSD)

14

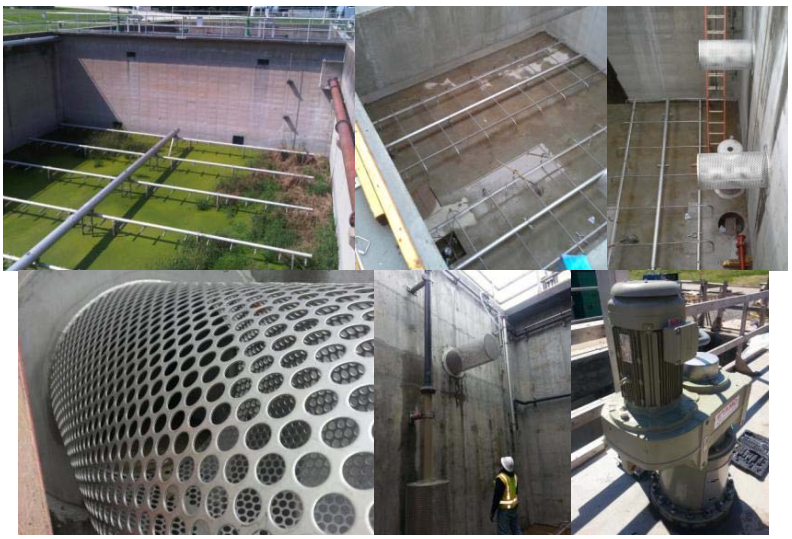
South Durham Water Reclamation Facility – Durham, NC

- Inluent Characteristics
  - *Q = 0.080 MGD*
  - *NH_3-N = 1000 mg/L*
  - *Temperature = 24 °C*
- Retrofit of existing tank
- Startup seeded from James River TP
- Facility will serve as BioFarm

15

South Durham Water Reclamation Facility – Durham, NC

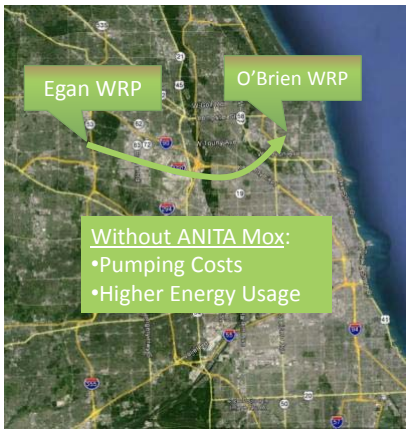
- South Durham WRF Construction:



16

Egan Water Reclamation Plant – Chicago, IL

- Details
  - *Starting in Q3 2016*
  - *Four (4) MBBR Reactors*
  - *Flow = 0.23 MGD*
  - *NH_3-N Load = 1,080 mg/L*
- Project Drivers
  - *Egan WRP currently pumps centrate to the O'Brien WRP*
  - *Energy-efficient method of treating centrate at the Egan WRP*



17

MBBR Pilot – Sanitation Districts of L.A. County

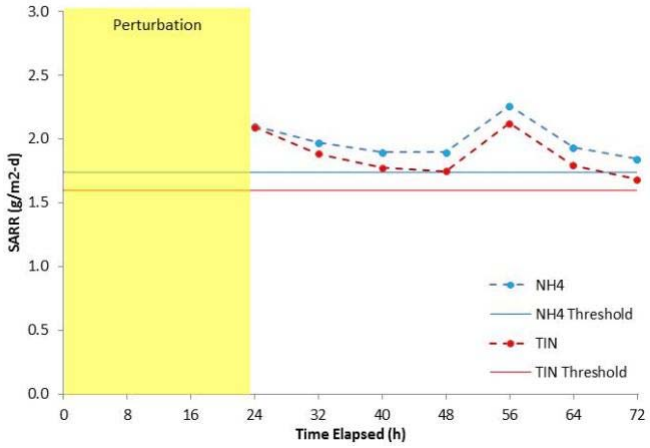
- Joint Water Pollution Control Plant (JWPCP)
  - *Currently no effluent nitrogen limits*
  - *Nitrogen removal may be necessary in the future*
    - Regulatory (MLPA)
    - Reuse demand
  - *Centrate is a nitrogen rich stream*
    - 2% of the hydraulic loading
    - 28% of the N-loading
  - *Targeting centrate for nitrogen removal would reduce the overall process size and cost*

*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County

18

MBBR Pilot – Sanitation Districts of L.A. County

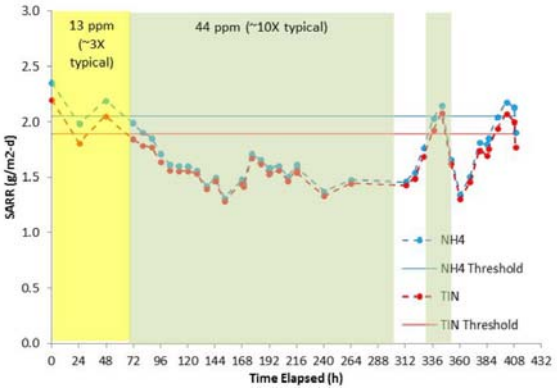
- Simulate a 24-hr Power Outage event



*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County 19

MBBR Pilot – Sanitation Districts of L.A. County

- DMP (Dilute Mannich Polymer) in feed
  - 13 ppm (3X typical dose) e.g., Centrifuge startup condition
  - 44 ppm (10X typical dose) e.g., Worst-case scenario



*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County 20

MBBR Pilot – Sanitation Districts of L.A. County

- Summary of Robustness and Perturbation Testing

Test No.	Scenario	Perturbation Period	Recovery Time
1	Process power outage	24 hr	< 8 hr
2	System underfeed mode 2	24 hr	< 8 hr
3	System overfeed (2X)	24 hr	16 hr
4	Under aeration (No Air)	24 hr	32 hr
5	Over aeration (+23%)	24 hr	< 8 hr
6	Mannich polymer in feed	Various	~24-32 hr

*Source: Pilot-Scale Evaluation of ANITA™ MOX for Centrate Nitrogen Removal at the JWPCP by Sanitation Districts of L.A. County 21

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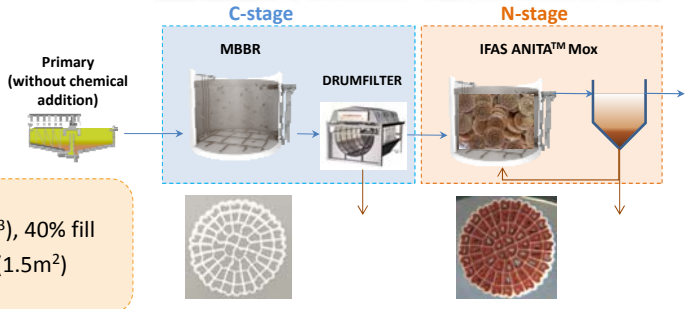
Mainstream ANITA™ Mox

WATER TECHNOLOGIES 22

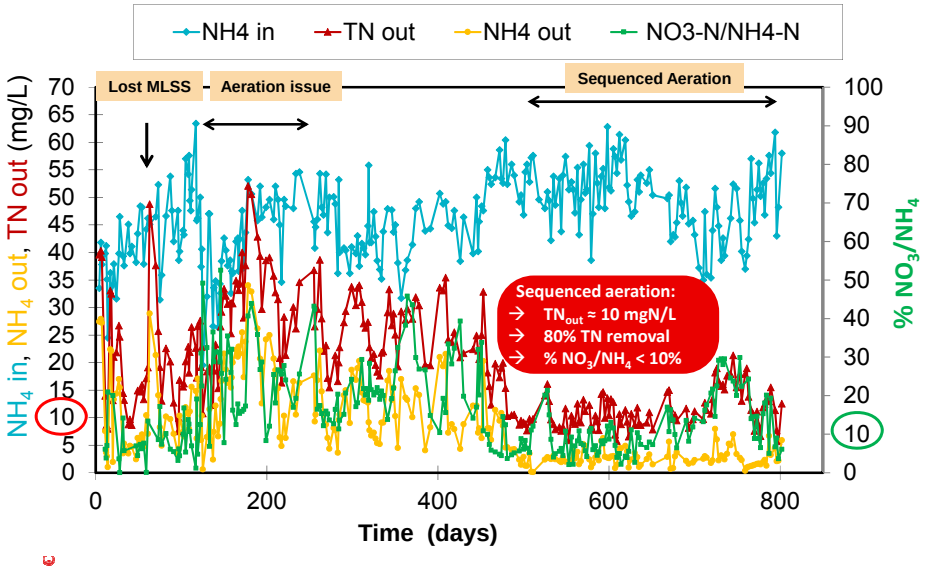
Mainstream ANITA™Mox Pilot – Paris

- **C-stage:**
  - MBBR -> 500 gal (2m³), 30% fill
  - Drumfilter -> 0.4m², 40µm



- **N-stage:**
  - IFAS -> 500 gal (2m³), 40% fill
  - Clarifier -> 400 gal (1.5m²)
  - Temp = 13-23°C

Mainstream ANITA™Mox Pilot – Paris



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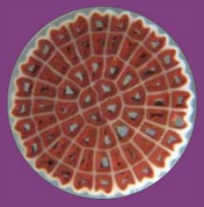
Summary and Questions

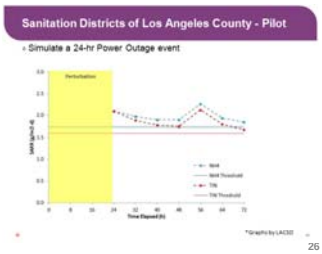


WATER TECHNOLOGIES

25

Summary and Questions

- ANITA Mox has demonstrated excellent value in sidestream deammonification:
  - *Simple*
    - Flow In = Flow Out
  - *Robust*
    - Bacteria Retained by Media and Screens
    - Tolerates Operational and Process Variations
  - *Reliable*
    - Process Performance Guarantees
  - *Flexible Layout*
    - Can be installed in existing tanks at plants seeking efficient NH_3-N and TN removal
- Third party testing has proven ANITA Mox's robustness with regard to a variety of process upsets – important on the dewatering side of the WWTP



26

Summary and Questions

- Kruger, as a subsidiary of Veolia, brings US-based and worldwide expertise, patents, and financial stability to all of our projects.

- Veolia's Mainstream ANITA Mox research is producing stable TN removal in multiple ongoing piloting efforts.

27

Summary and Questions

Chris Thomson, PE (NC and MD)
Kruger Inc.
Director of Product Development
(919) 523-9260
chris.thomson@veolia.com

Brandy Nussbaum
AnoxKaldnes
Sales Manager
+46 46 18 21 66
brandy.nussbaum@anoxkaldnes.com

Glenn Thesing
Kruger Inc.
Process Manager
(919) 653-4555
glenn.thesing@veolia.com

28