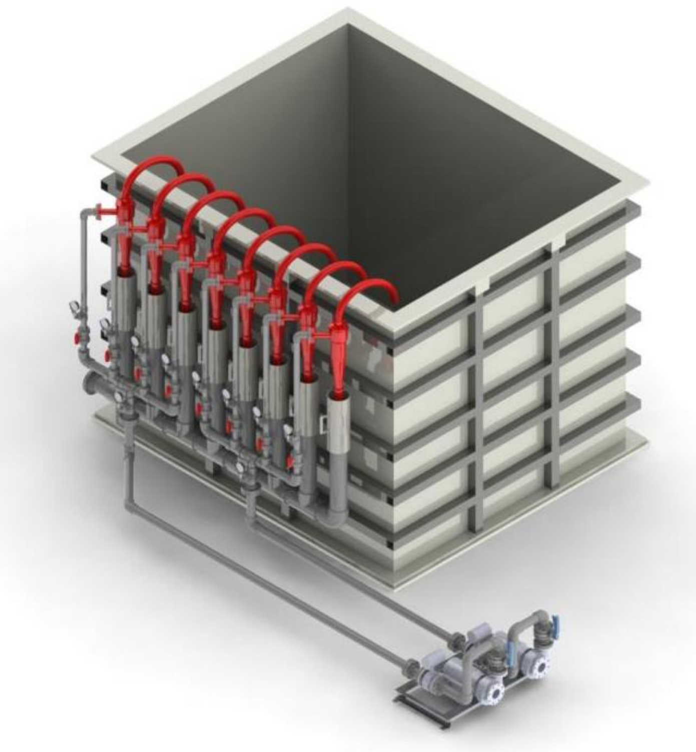
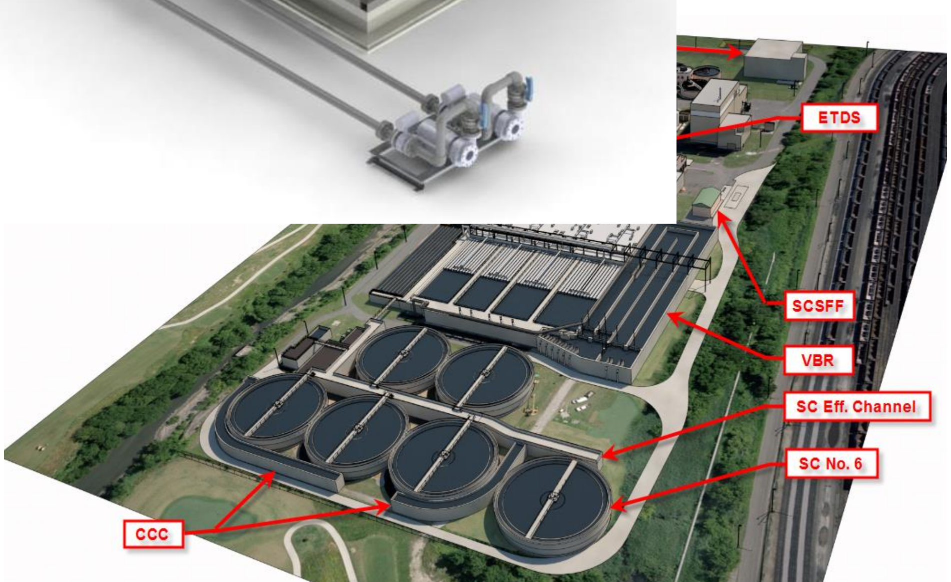
Assessing the Performance of Innovative Technologies for Treatment and Resource Recovery

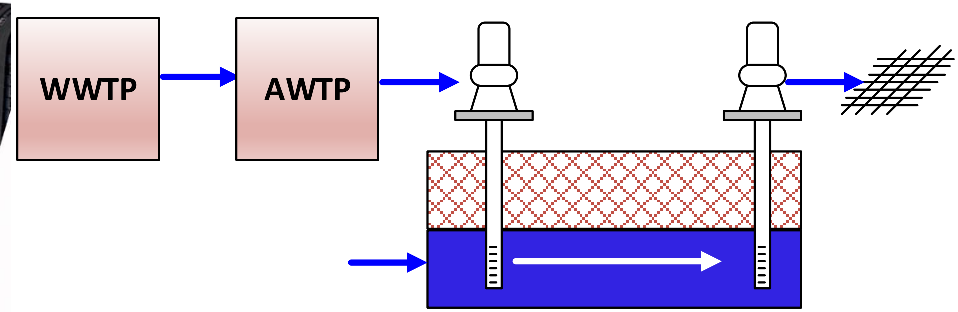


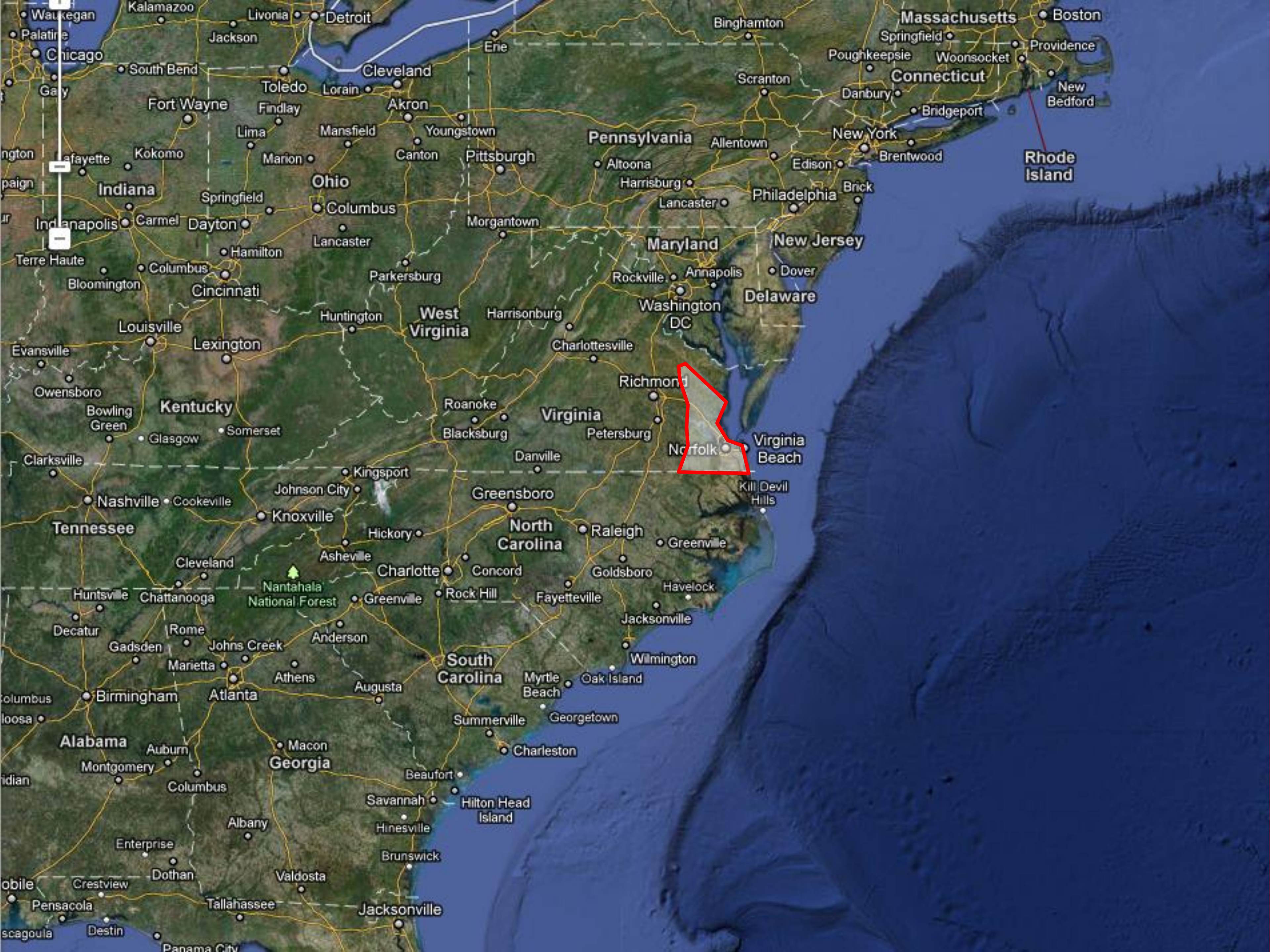
Charles B. Bott, PhD, PE, BCEE

Director of Water Technology and Research

Hampton Roads Sanitation District



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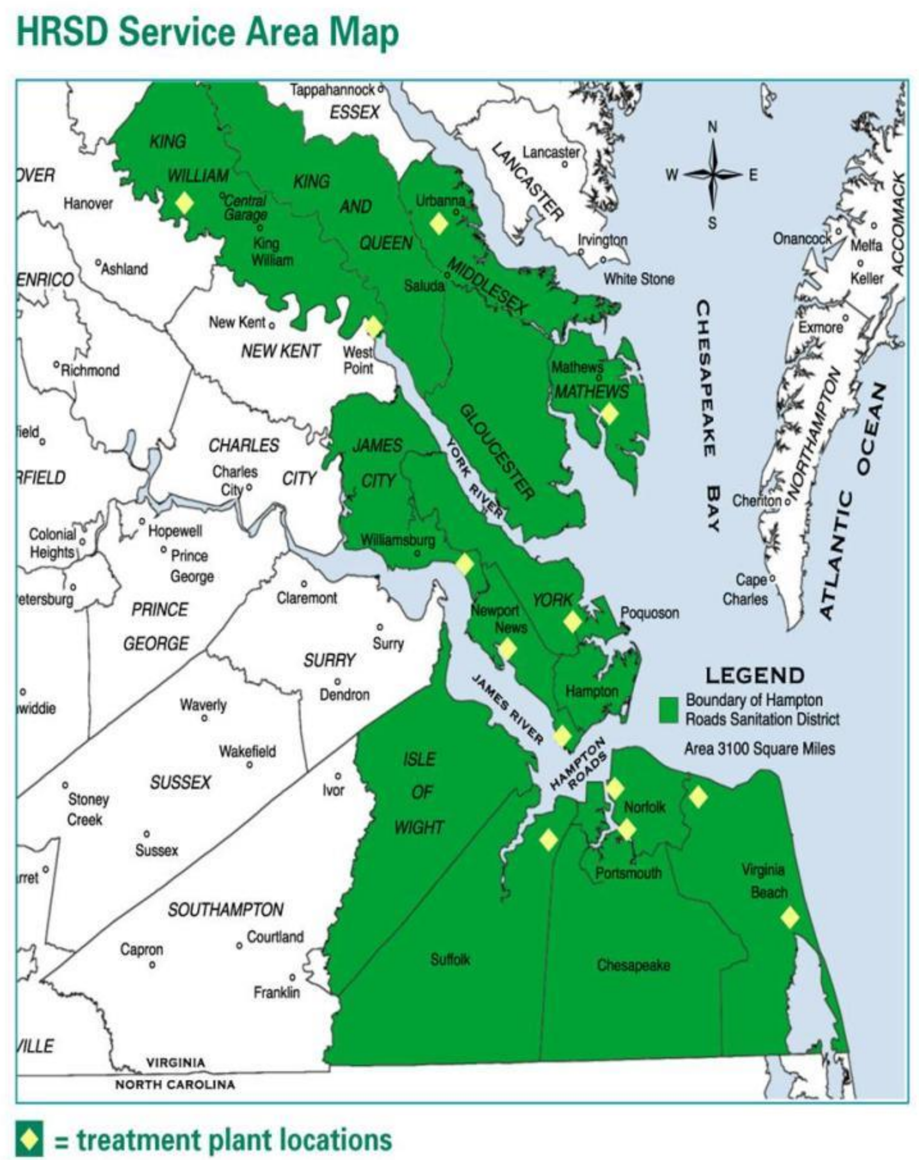
South Bend
Toledo
Cleveland
Connecticut
Scranton
New Bedford
Gary
Lorain
Danbury
Fort Wayne
Findlay
Akron
Bridgeport
Lima
Mansfield
Youngstown
Pennsylvania
Allentown
New York
Kokomo
Marion
Canton
Pittsburgh
Brentwood
Rhode Island
Lafayette
Altoona
Edison
Indiana
Ohio
Harrisburg
Brick
Springfield
Columbus
Lancaster
Philadelphia
Indianapolis
Carmel
Dayton
Morgantown
Maryland
New Jersey
Hamilton
Lancaster
Terre Haute
Columbus
Parkersburg
Rockville
Annapolis
Dover
Bloomington
Cincinnati
Washington DC
Delaware
Huntington
West Virginia
Harrisonburg
Louisville
Lexington
Charlottesville
Evansville
Richmond
Owensboro
Roanoke
Kentucky
Virginia
Bowling Green
Somerset
Blacksburg
Petersburg
Glasgow
Norfolk
Virginia Beach
Danville
Clarksville
Kingsport
Kill Devil Hills
Johnson City
Greensboro
Nashville
Cookeville
Knoxville
North Carolina
Tennessee
Raleigh
Hickory
Greenville
Asheville
Cleveland
Charlotte
Concord
Goldsboro
Nantahala National Forest
Havelock
Huntsville
Chattanooga
Greenville
Rock Hill
Fayetteville
Jacksonville
Decatur
Rome
Anderson
Gadsden
Johns Creek
Wilmington
Marietta
South Carolina
Athens
Myrtle Beach
Oak Island
Augusta
Birmingham
Atlanta
Summerville
Georgetown
Alabama
Auburn
Macon
Charleston
Georgia
Montgomery
Beaufort
Columbus
Savannah
Hilton Head Island
Albany
Hinesville
Enterprise
Brunswick
Dothan
Valdosta
Crestview
Pensacola
Tallahassee
Jacksonville
Destin
Panama City

Hampton Roads Sanitation District

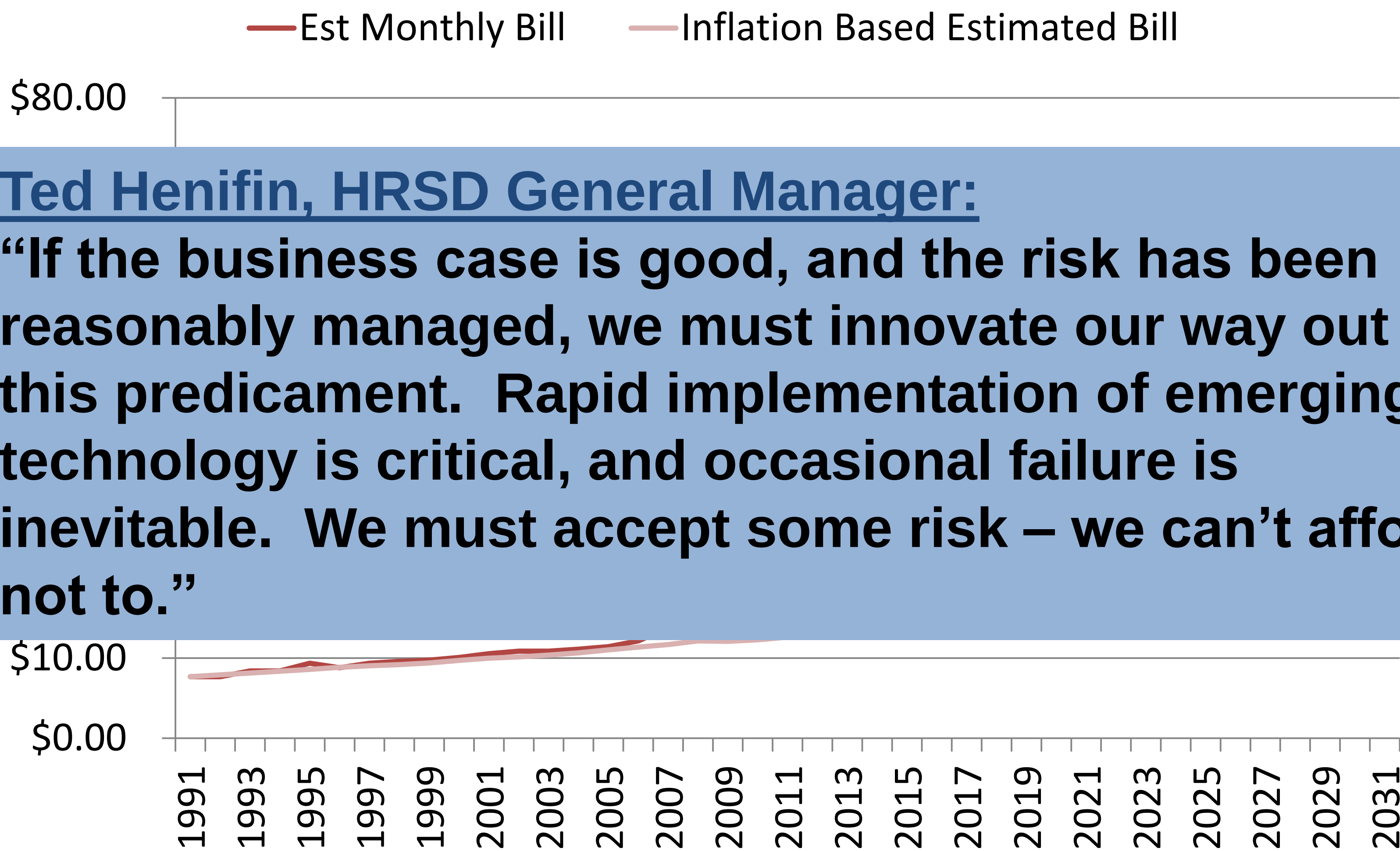
- Created in 1940
- Serves 1.7 million people
- Includes 17 jurisdictions – 3,100 square miles
- 9 major plants, 4 small plants
- Capacity of 249 MGD



The Challenges for HRSD

- ~$750M in Nutrient Removal Upgrades by 2021
- Biosolids – strong reliance on old Multiple Hearth Incinerators
- ~$2B in Consent Decreed Mandated Upgrades to Reduce Sanitary Sewer Overflows over 20 years
- ~$1B Indirect Potable Reuse Initiative - Aquifer Replenishment at ~120 MGD by 2030

HRSD Rates are Increasing Dramatically



Ted Henifin, HRSD General Manager:

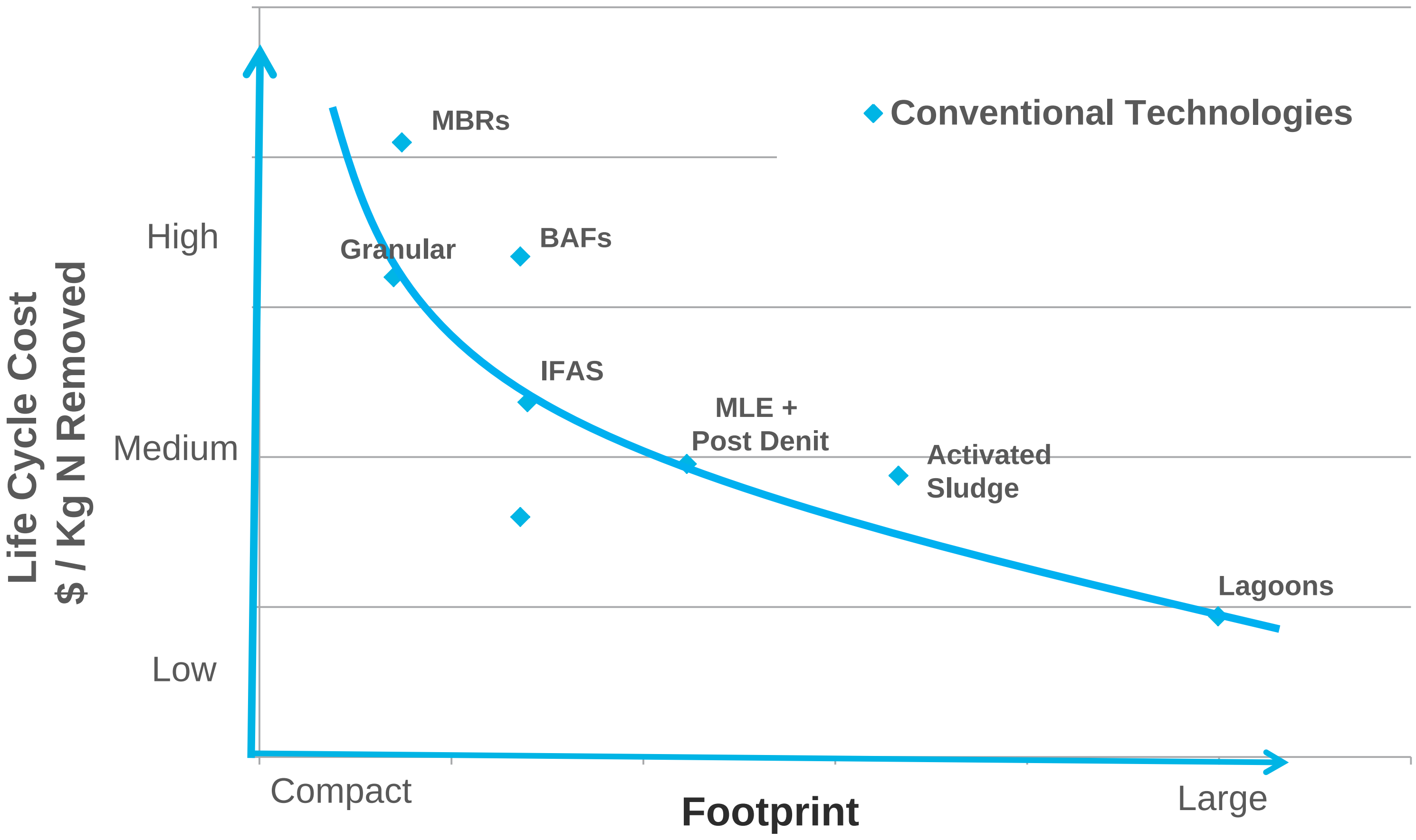
"If the business case is good, and the risk has been reasonably managed, we must innovate our way out of this predicament. Rapid implementation of emerging technology is critical, and occasional failure is inevitable. We must accept some risk – we can't afford not to."

Technology Implementation at HRSD is Driven by:

- MINIMIZING Resource Utilization:
  - Energy
  - Chemicals
  - Labor (operations, maintenance, instrumentation…)
  - Concrete, footprint, land area

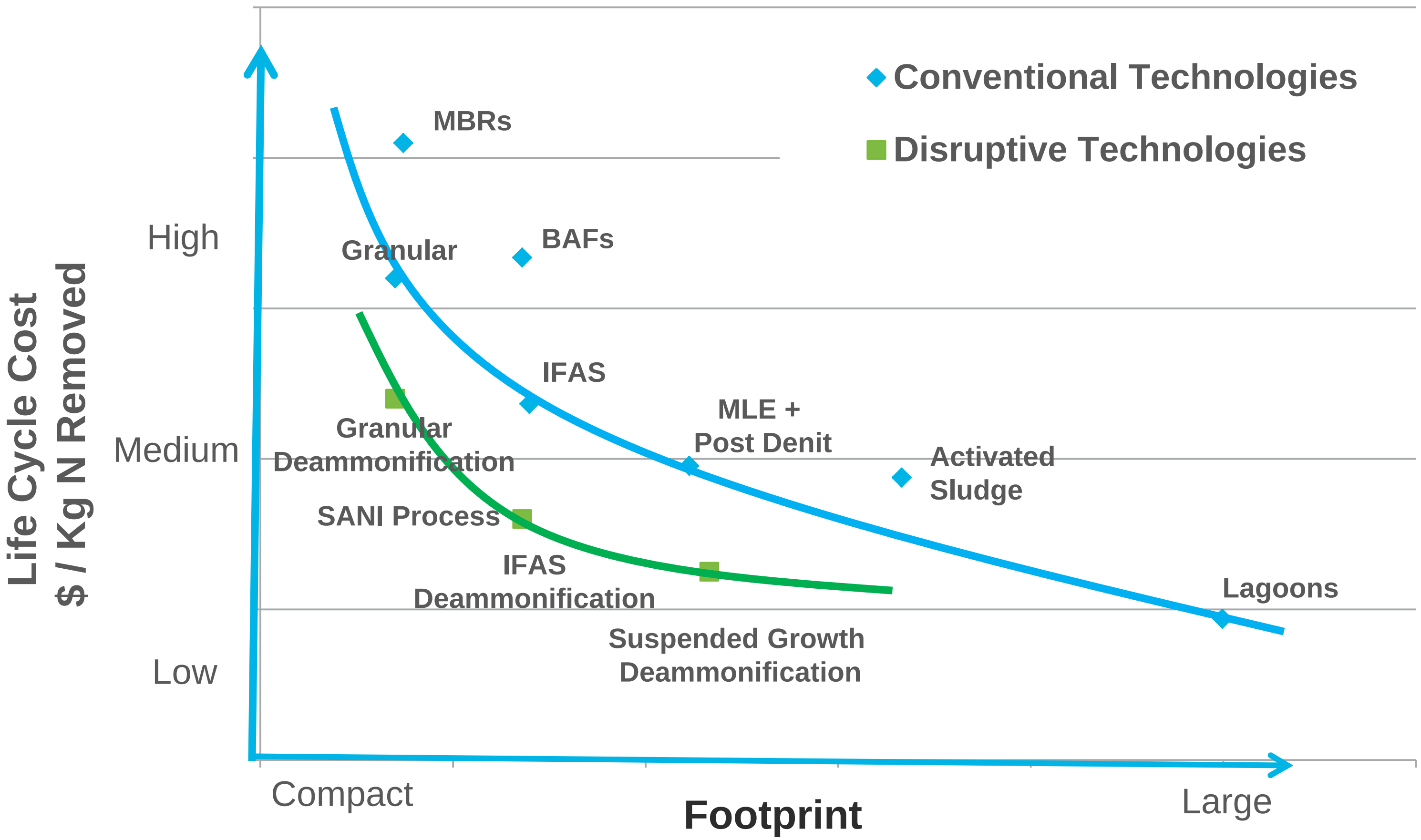
Intensification

Nitrogen Removal Technologies - Conventional



(slide from Beverley Stinson, AECOMM)

Nitrogen Removal - Intensified



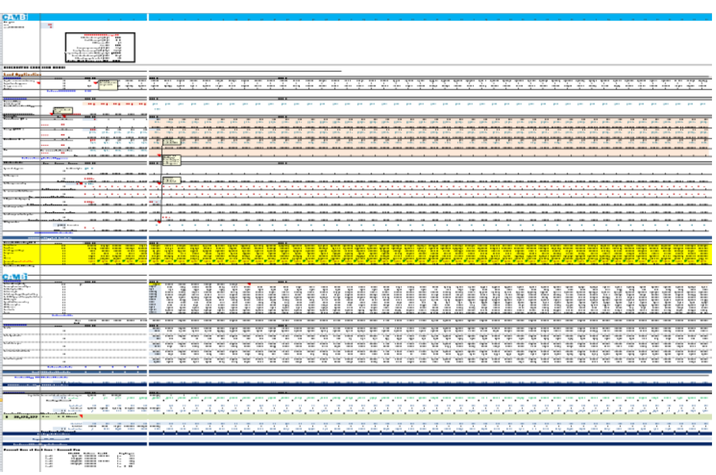
(slide from Beverley Stinson, AECOMM)

New Technology Evaluation

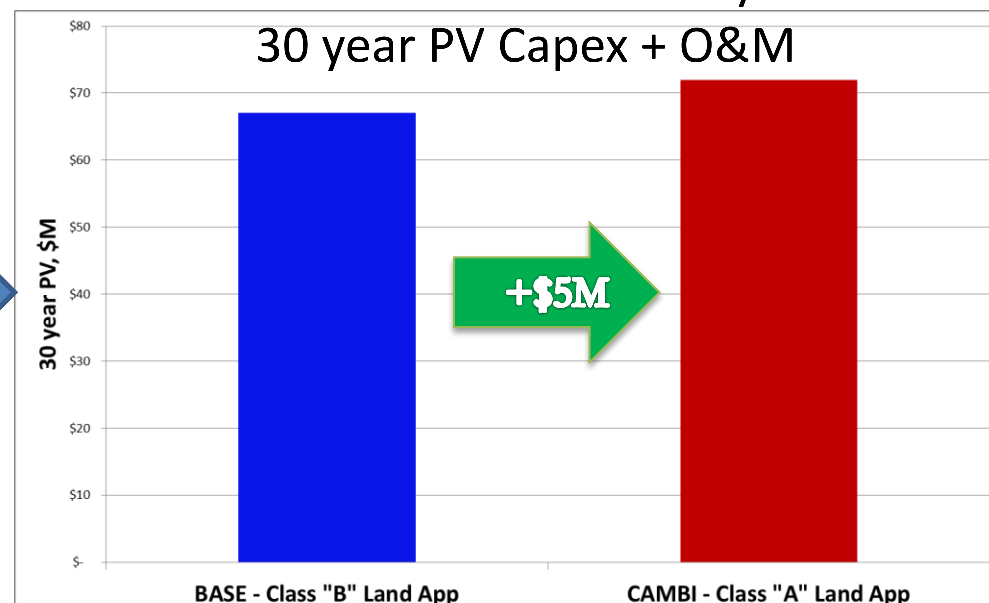
- Business case – must be reasonable for non-regulatory projects   (capital is always limited)
- Travel to see new technologies is critical
- Pilot test, only if needed
- R&D participation manages risk of new technology
- Learn from the experience of others (even outside the US)

Business Case Analysis at HRSD

- Financial modeling
  - Completely in-house
  - Buy-in across departments
  - Team effort between Ops/R&D, Engineering, and Finance
  - Opportunity costs are carefully considered
  - TBL not quantified explicitly but considered
- Jay Bernas, PE, MBA – Director of Finance



CAMBI BCE Summary



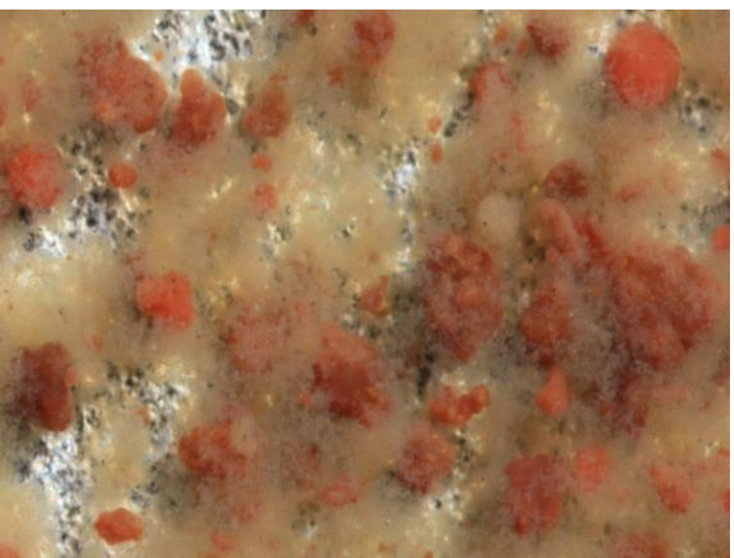
One-Step Sidestream Deammonification

- **SBR + Hydrocyclone Granular Sludge (DEMON)**
  - Strass, Austria
  - World Water Works, Inc.

- **Upflow Granular Sludge (CANON/ANAMMOX)**
  - Olburgen, Netherlands
  - Paques (NL)

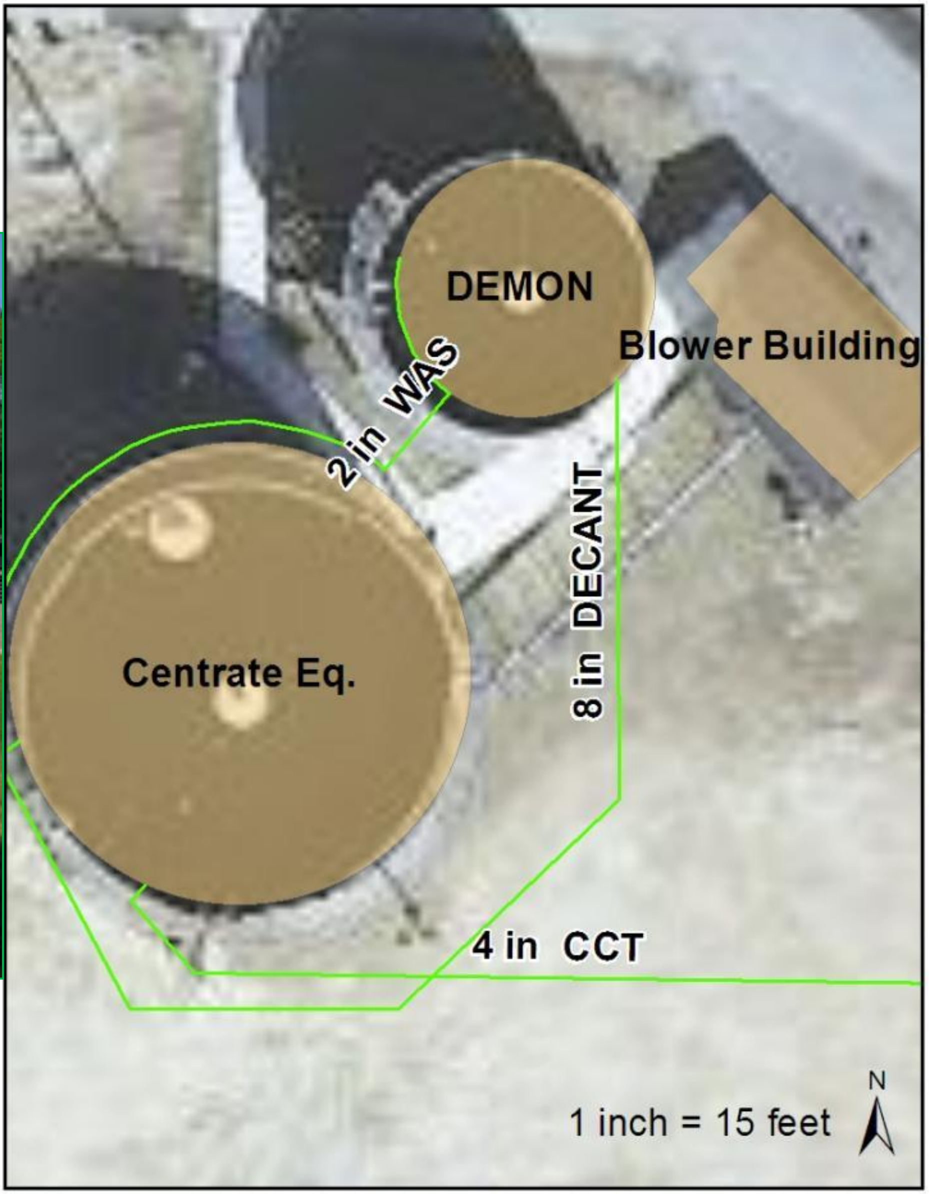
Partial Nitritation and Anammox - combined in a single reactor

- **Biofilm process (MBBR-style)**
  - ANITA Mox – Malmo, Sweden
    - AnoxKaldnes – Kruger - Veolia
  - Deammon -- Hattingen, Germany & Stockholm
    - Purac



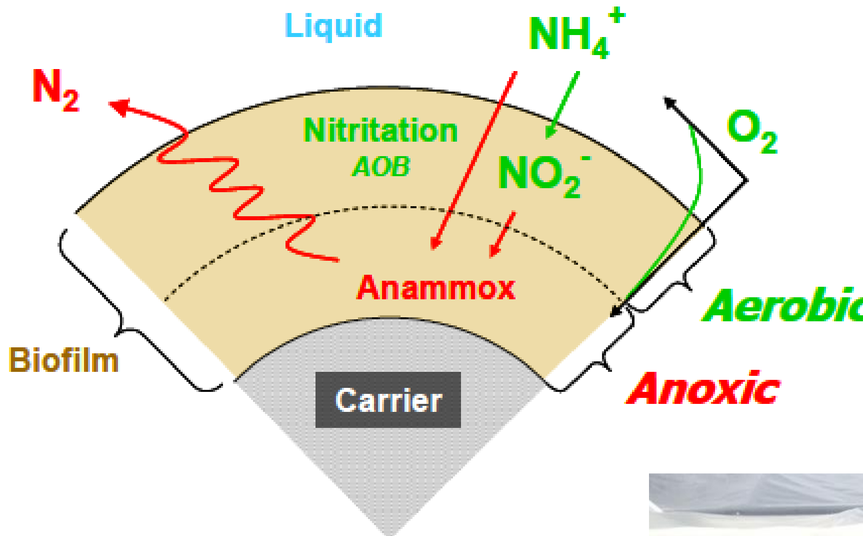
DEMON at HRSD York River (15 MGD)

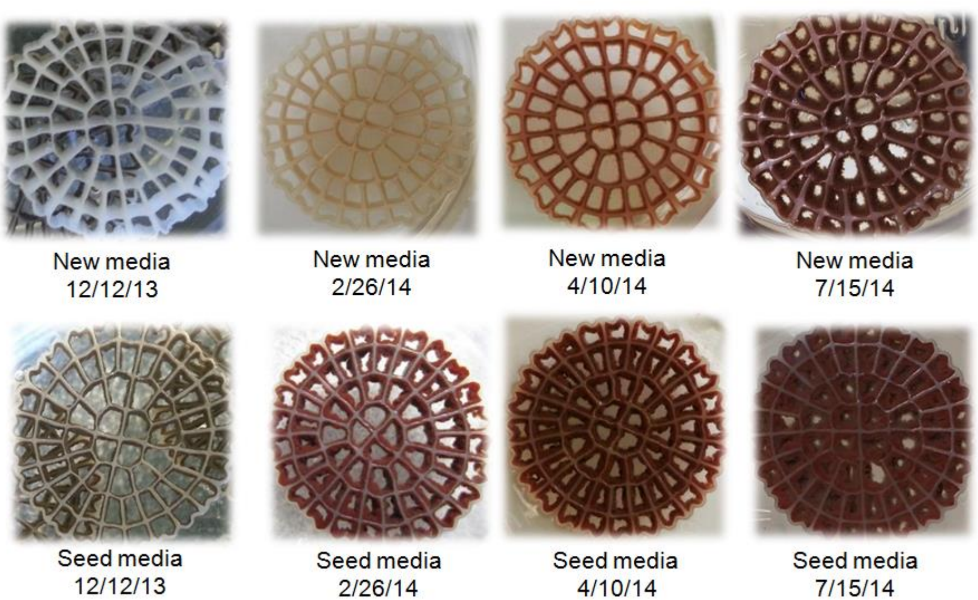
Implementation of DEMON at York River



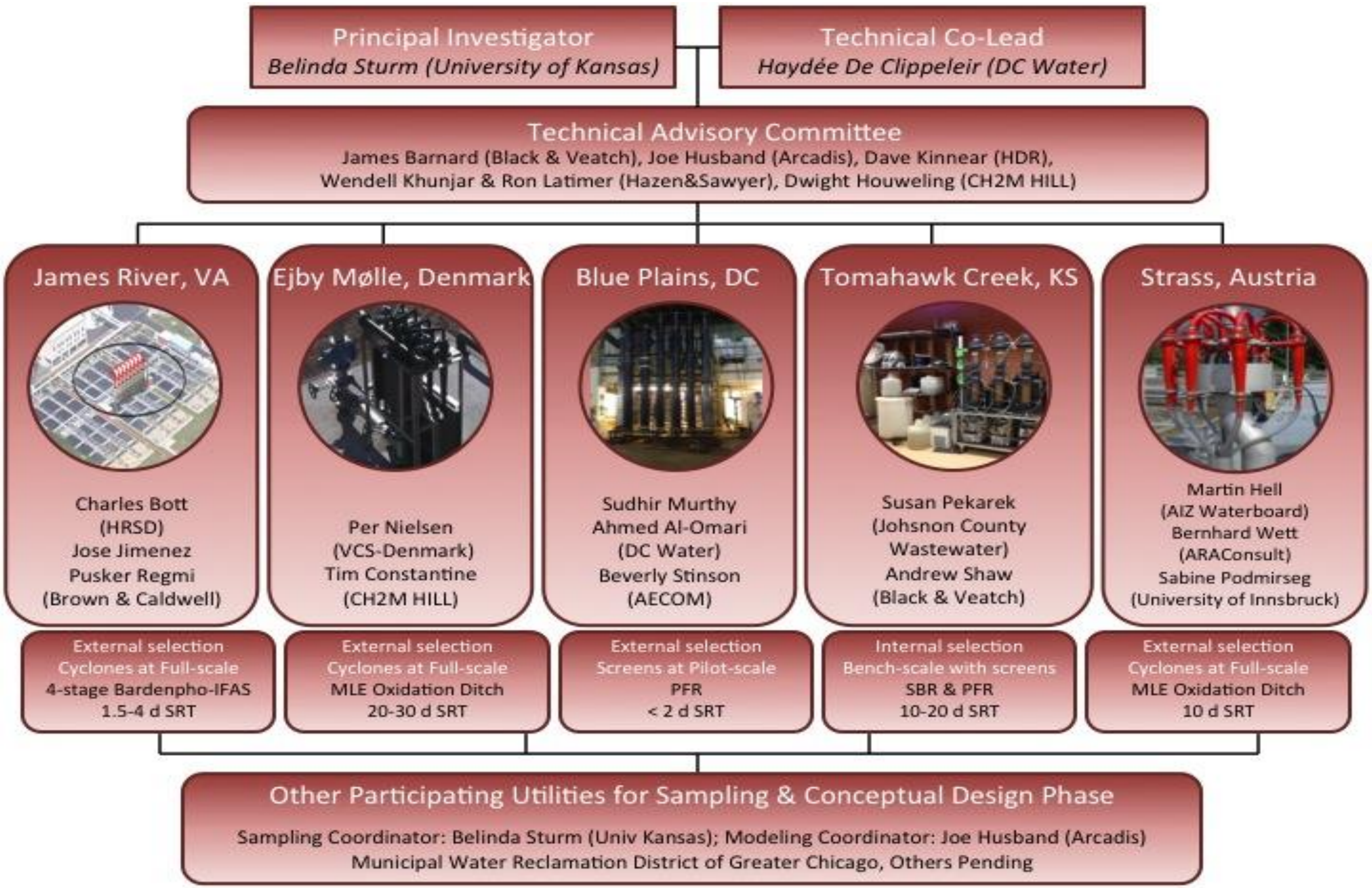
AnitaMox at HRSD James River (20 MGD)

AnitaMox Sidestream Deammonification MBBR

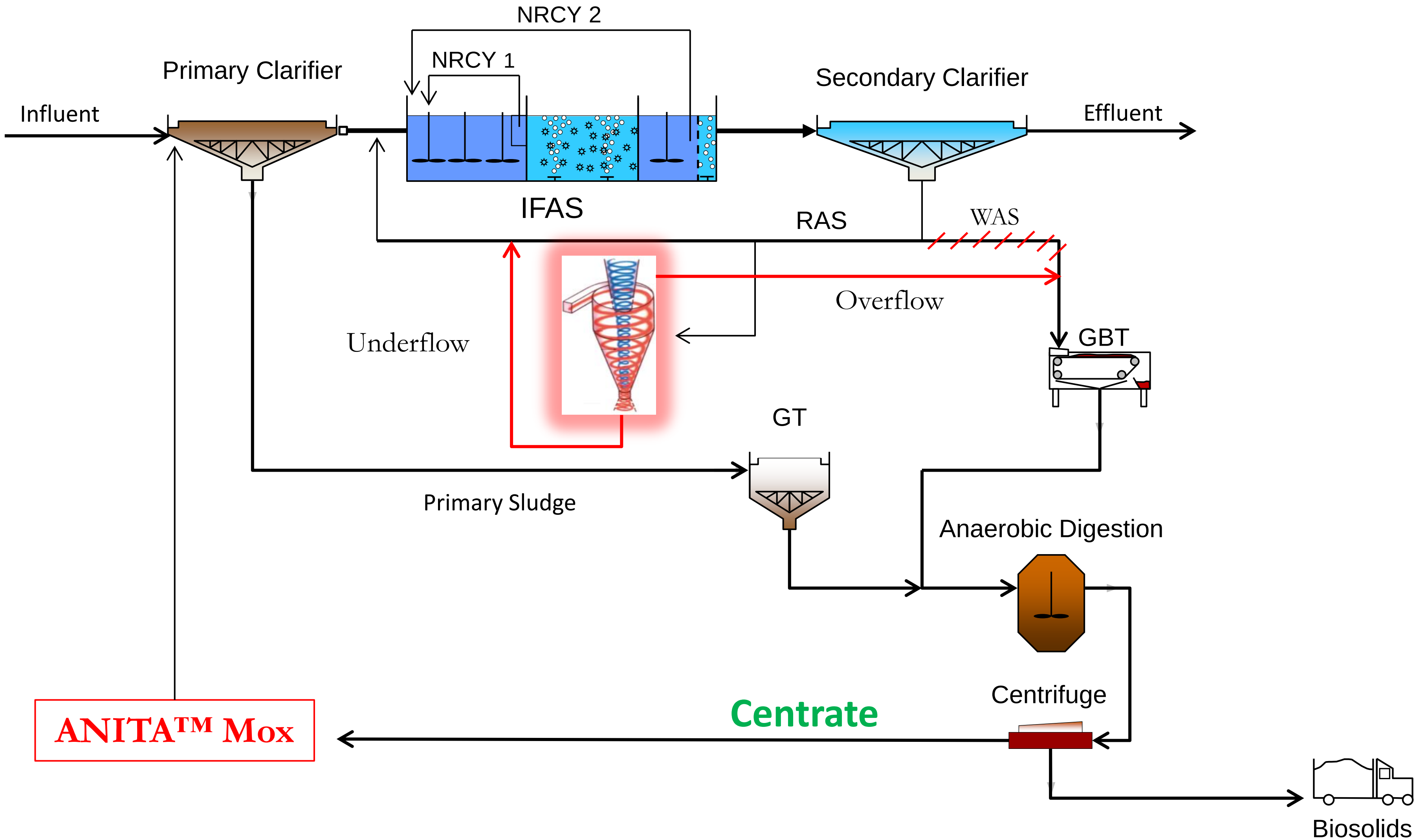




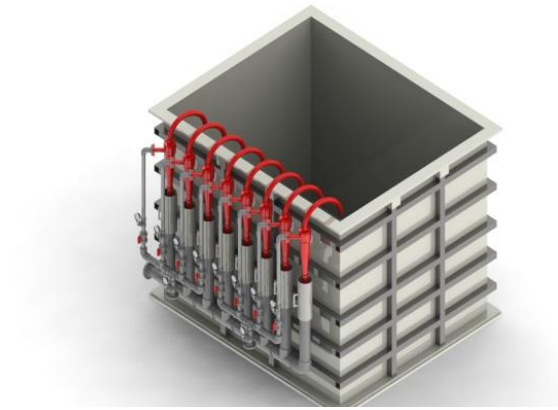
Granular Sludge Research

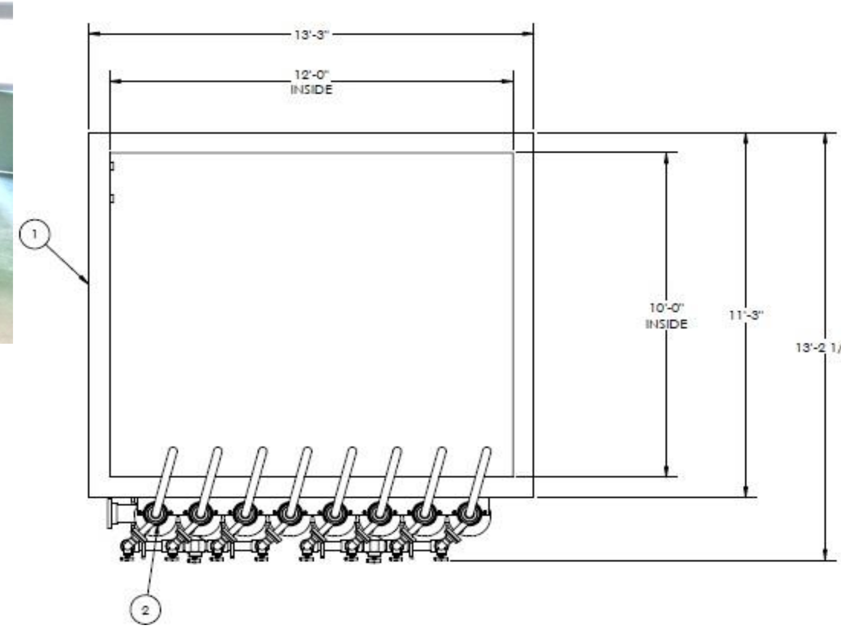


inDense® Implementation at James River

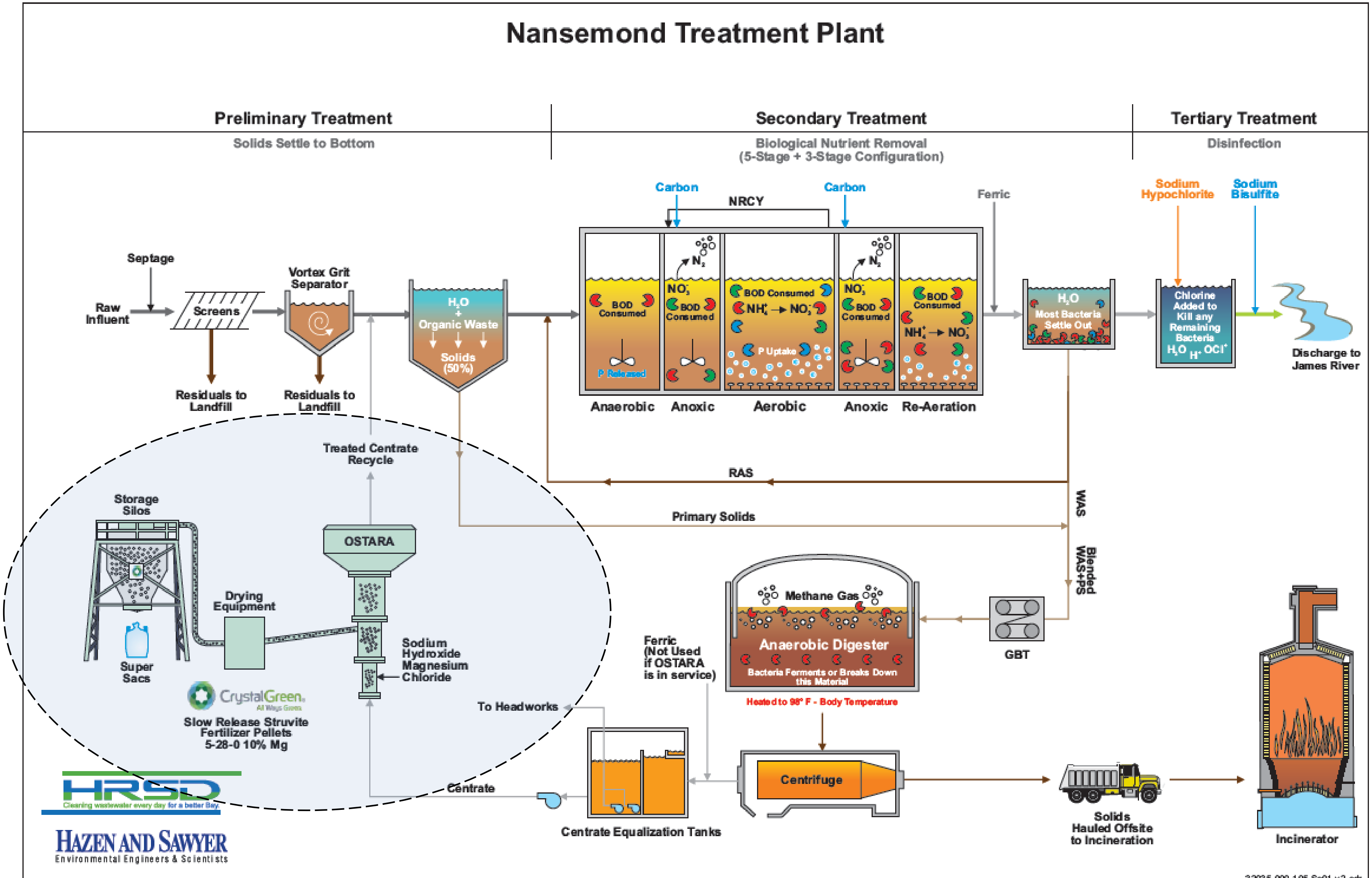


Hydrocyclone Installation

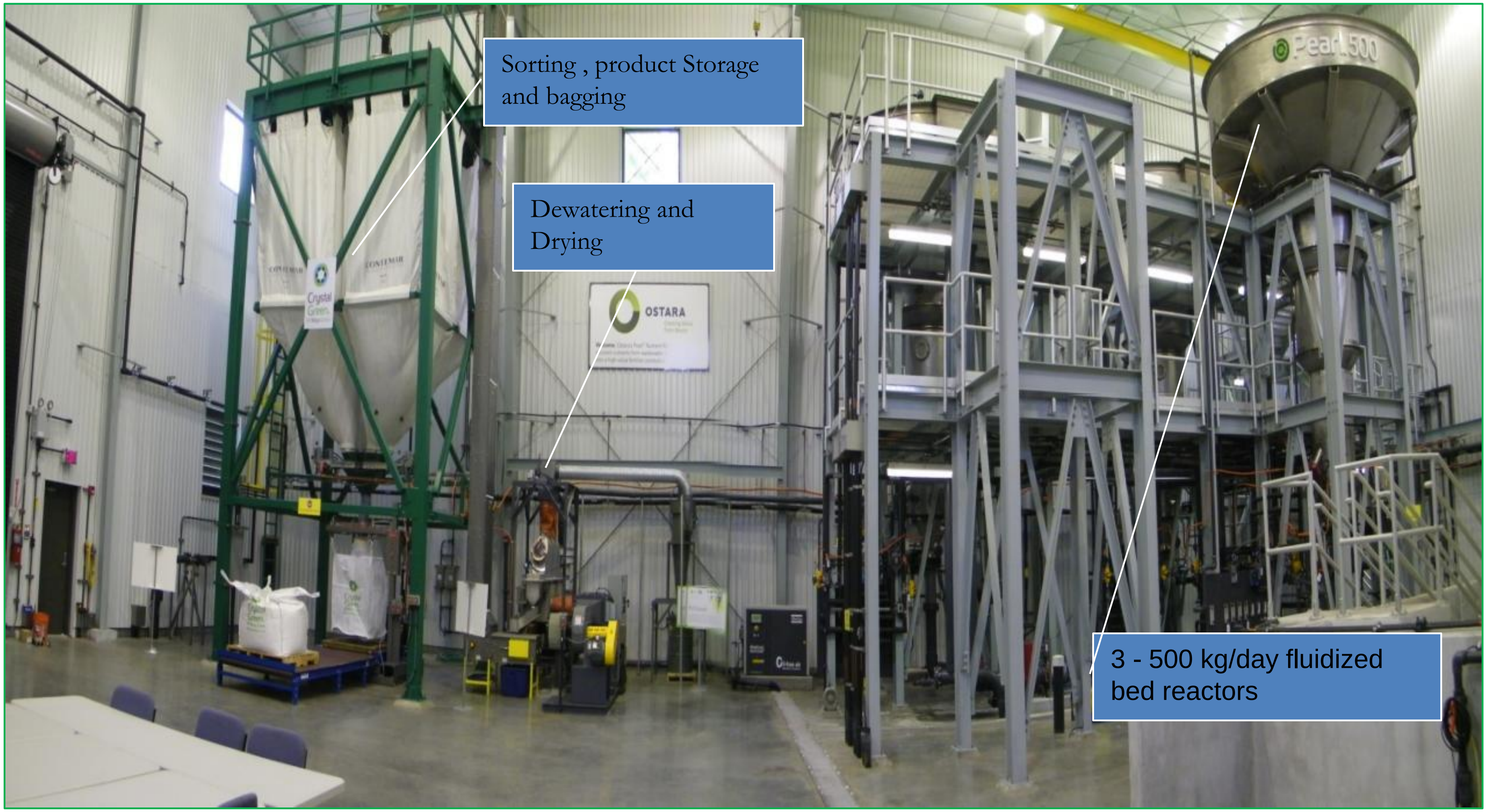




Nansemond Plant Process Flow Diagram



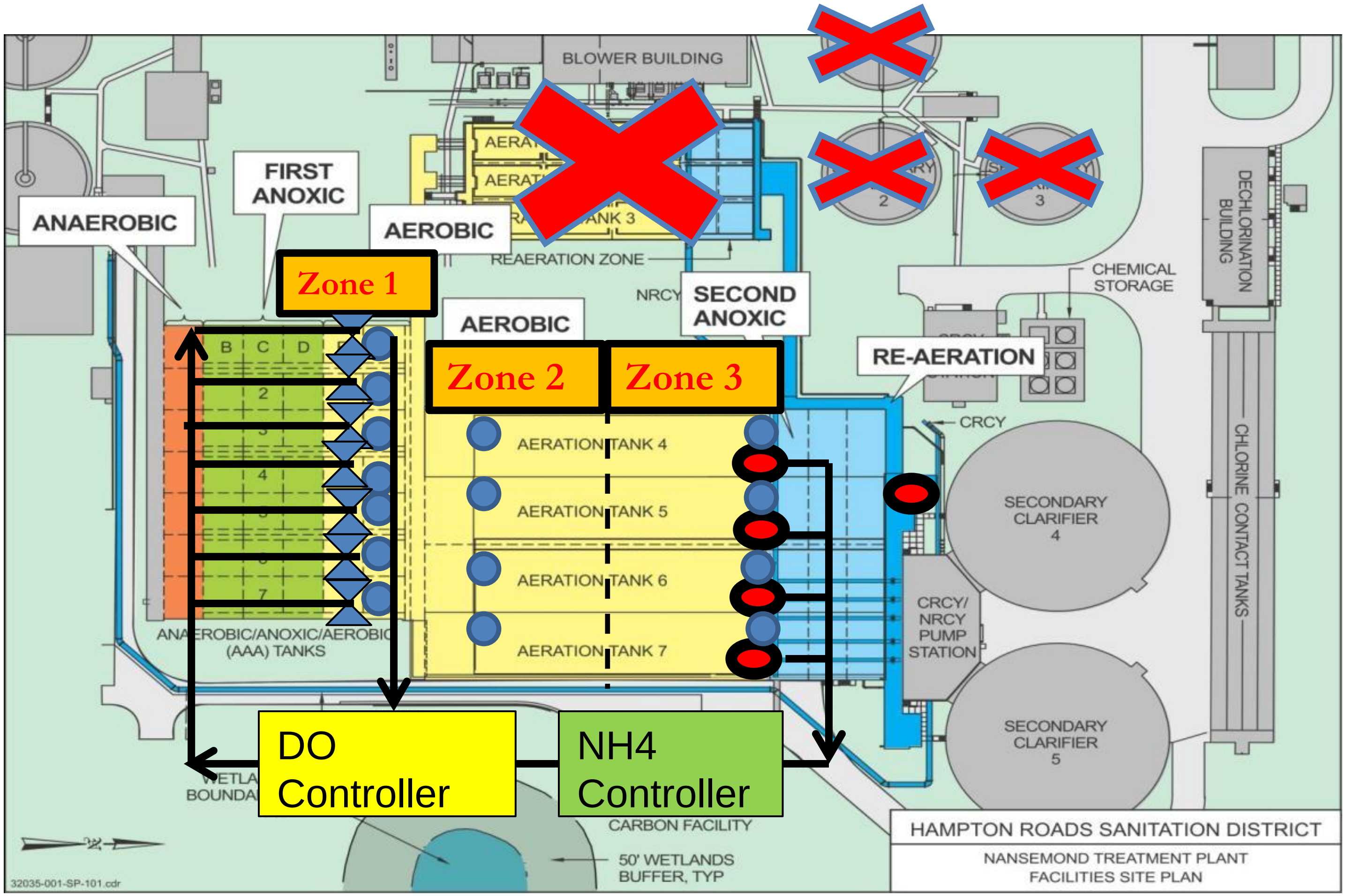
Struvite Recovery Facility



Struvite Recovery - Business Case Review

	Option 1 SideStream Treatment Cost Estimate	Option 2 Original Ostara Cost Estimate	Ostara CY 2013 Actual Costs	Ostara CY 2014 Projected Costs
Product Sales		165,000	65,300	111,900
Annual Operating Costs	(514,800)	(88,800)	(141,900)	(86,600)
Annual Debt Service		(425,300)	(425,300)	(425,300)
Net Annual Operating Costs	(559,000)	(349,100)	(501,900)	(400,000)

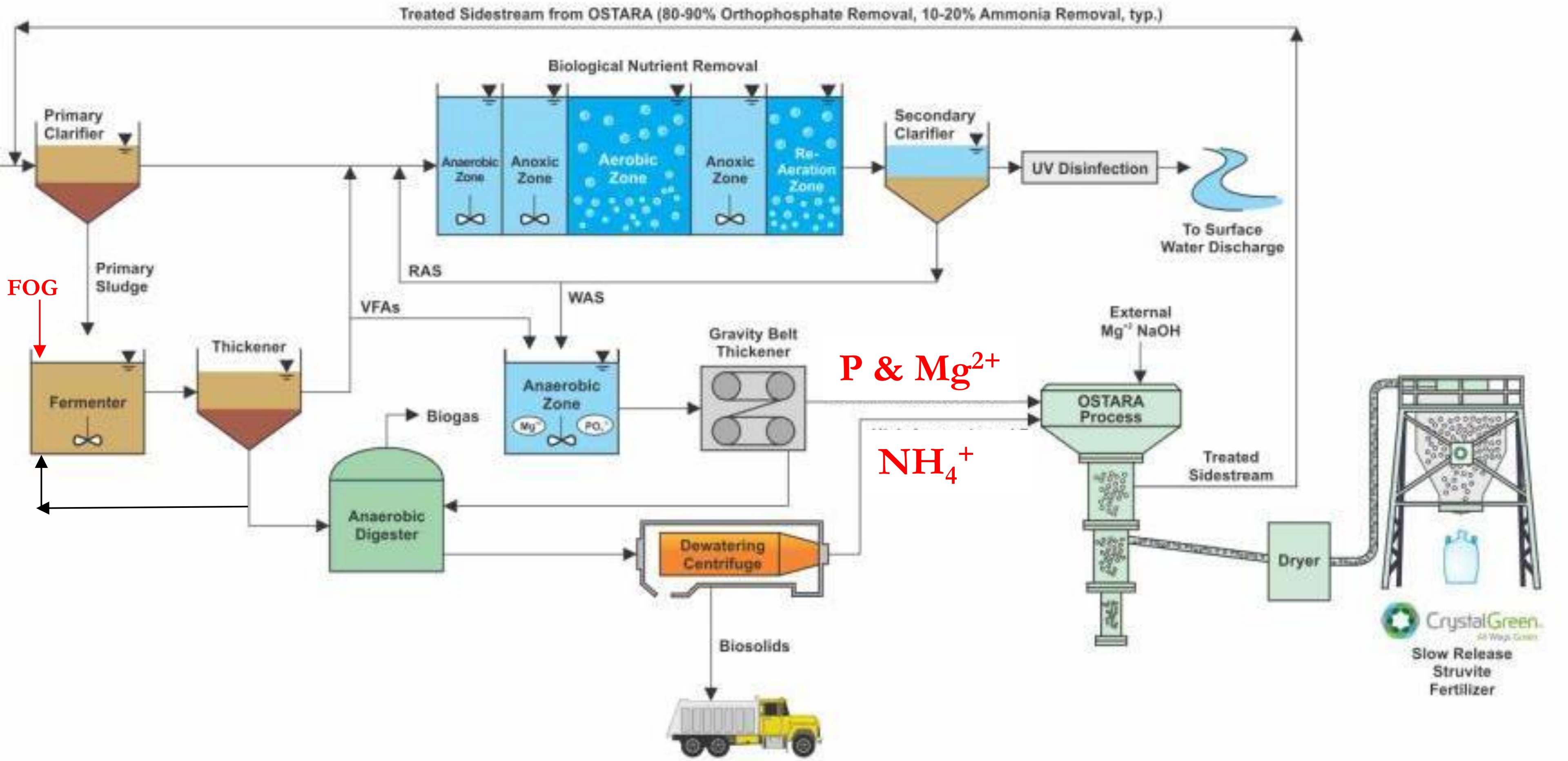
Ammonia Based Aeration Control



Ammonia

Dissolved Oxygen

Fermentation and WASSTRIP Evaluation for Nansemond Plant



Primary Sludge and FOG Fermentation

Short-Cut Nitrogen Removal Processes:

Mainstream Nitrite Shunt & Deammonification

HRSD

AIZ

dc water

COLLABORATORS

HRSD
Cleaning wastewater every day for a better Bay.

AIZ

dc water

Brown AND Caldwell

HDR

Old Dominion University

Virginia Tech. VT

BV

AECOM

Columbia University

Universiteit Gent

ARA consult GmbH

dynamita PROCESS MODELING

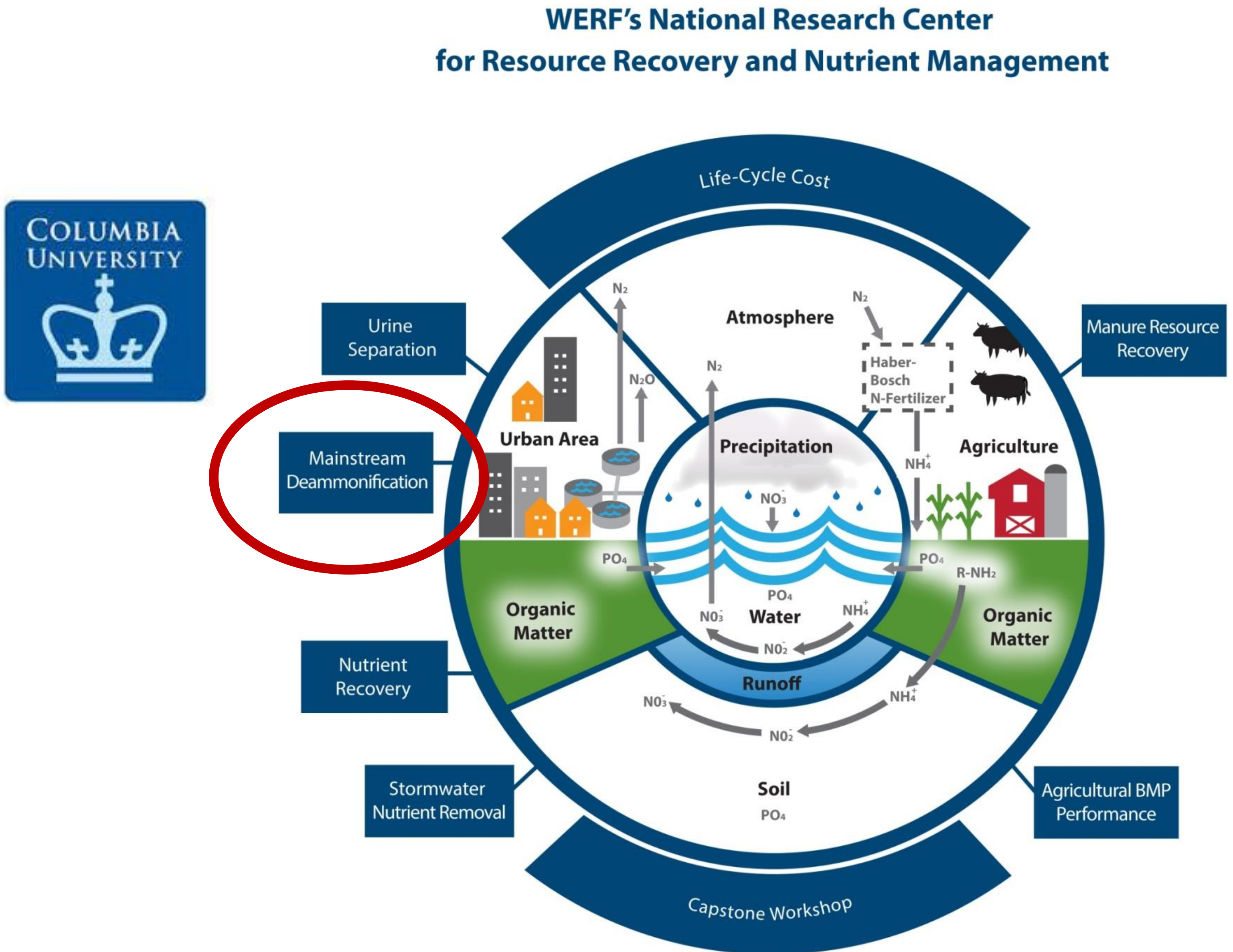
universität innsbruck

M

WERF
Water Environment Research Foundation
Collaboration. Innovation. Results.

United States Environmental Protection Agency

Funding from EPA through grant to WERF



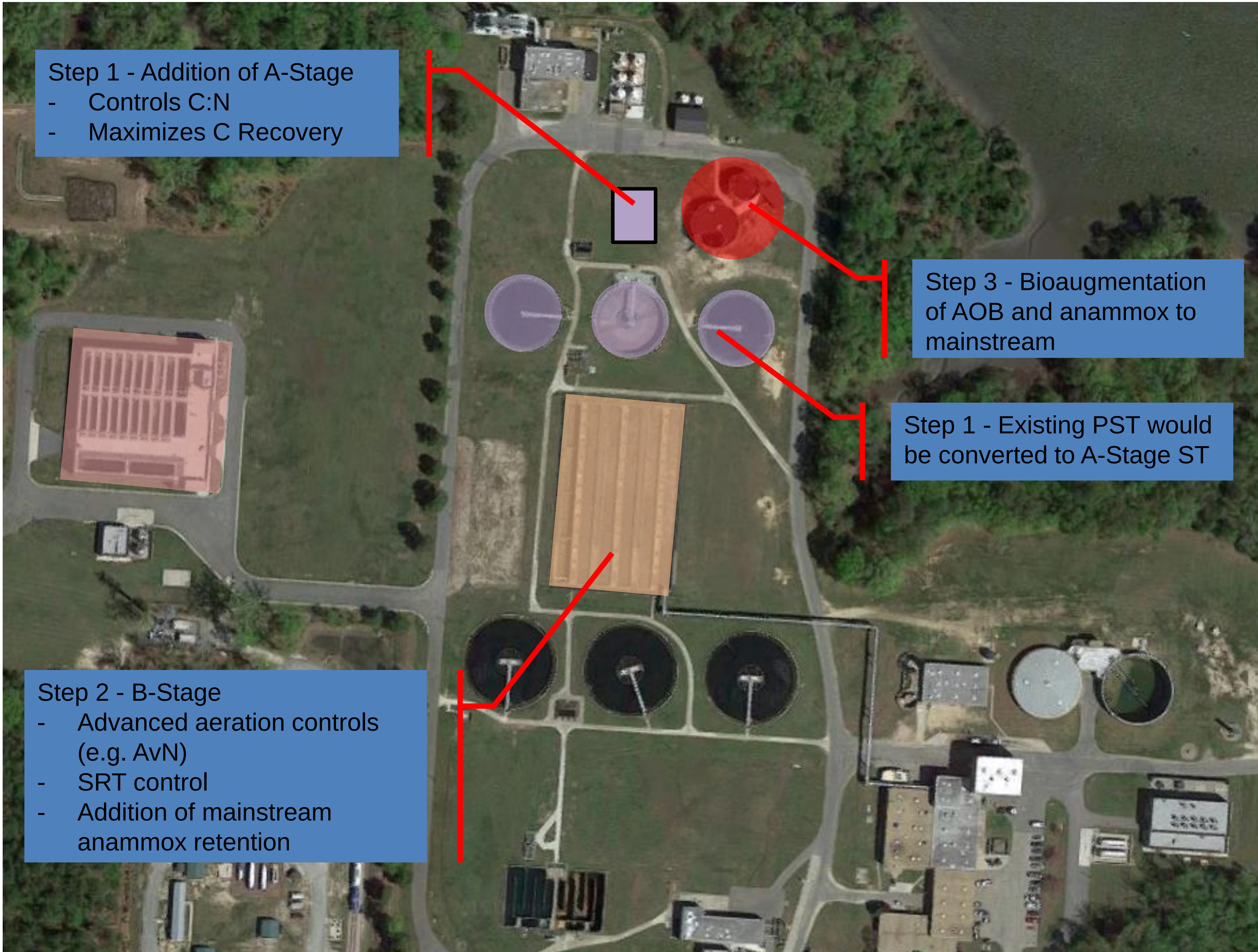
Drivers for Mainstream Shortcut N Removal

- Eliminate External Carbon
- Energy
  - decreases aeration demand for N removal
  - decreases aerobic COD oxidation
  - diverts wastewater carbon to anaerobic digestion
- Intensification
  - carbon diversion = much smaller aeration tank volume required

Challenges

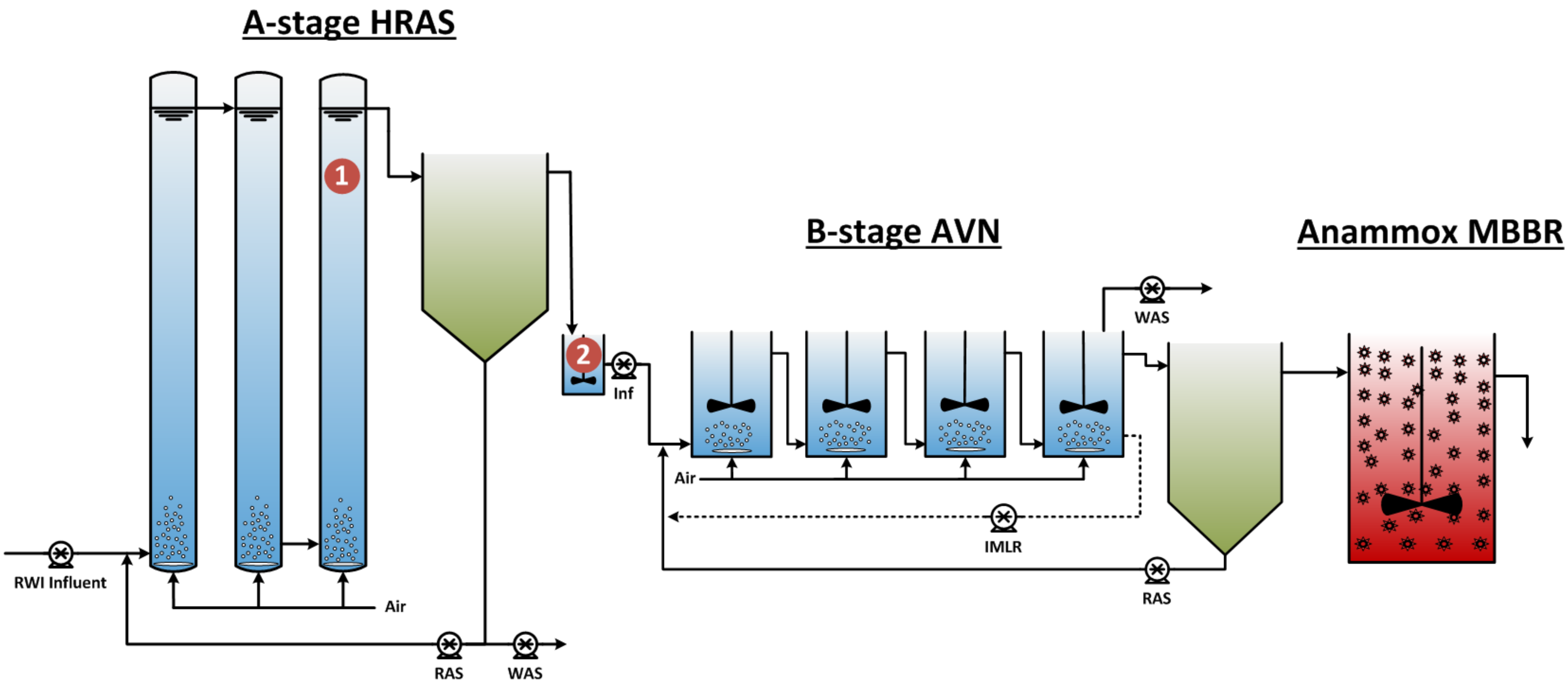
Management of populations

1. NOB out-selection (max. AerAOB rates)
2. Anammox retention



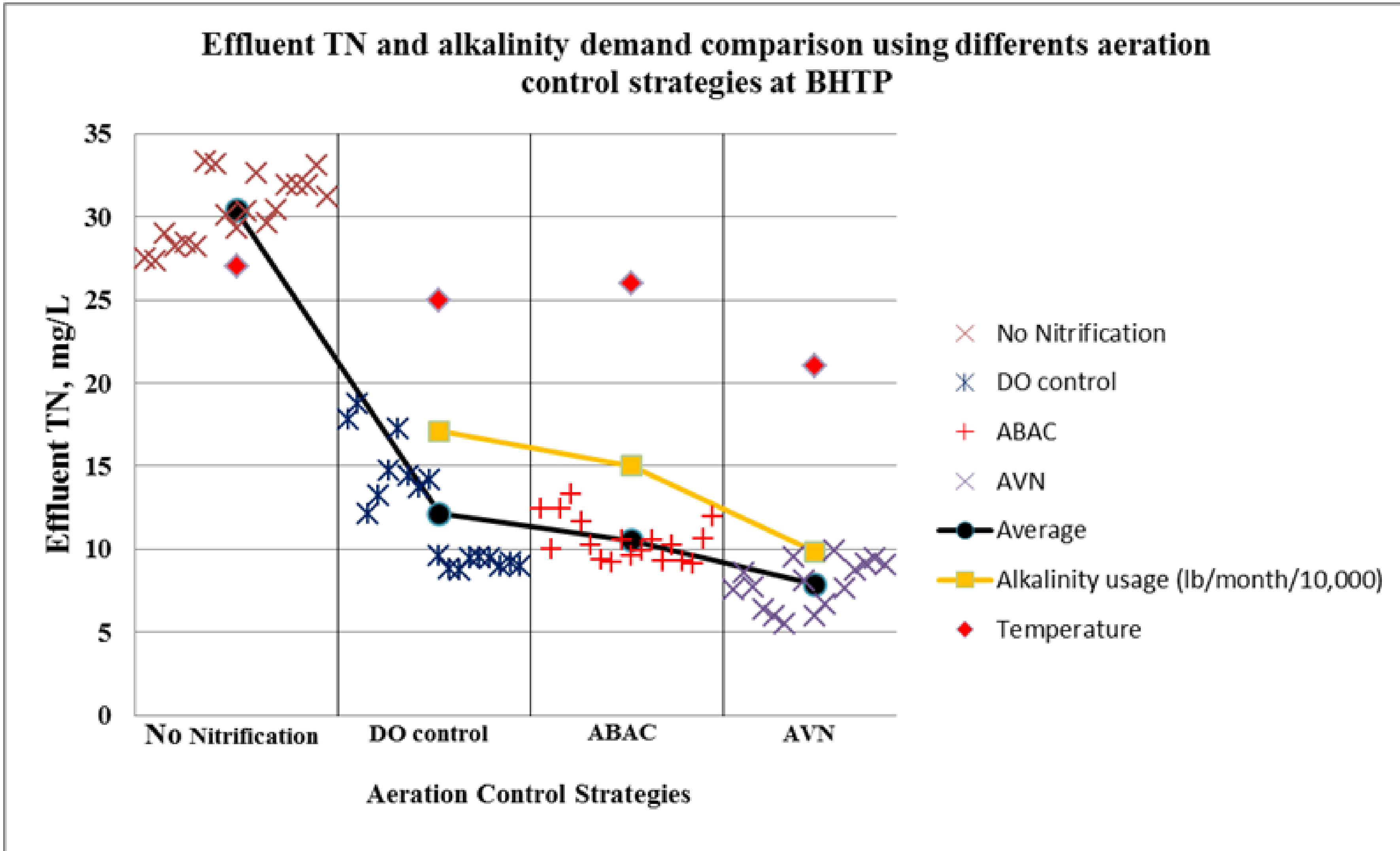
Step 1 - Addition of A-Stage
- Controls C:N
- Maximizes C Recovery
Step 3 - Bioaugmentation of AOB and anammox to mainstream
Step 1 - Existing PST would be converted to A-Stage ST
Step 2 - B-Stage
- Advanced aeration controls (e.g. AvN)
- SRT control
- Addition of mainstream anammox retention

HRSD BNR Pilot Study (version 3)

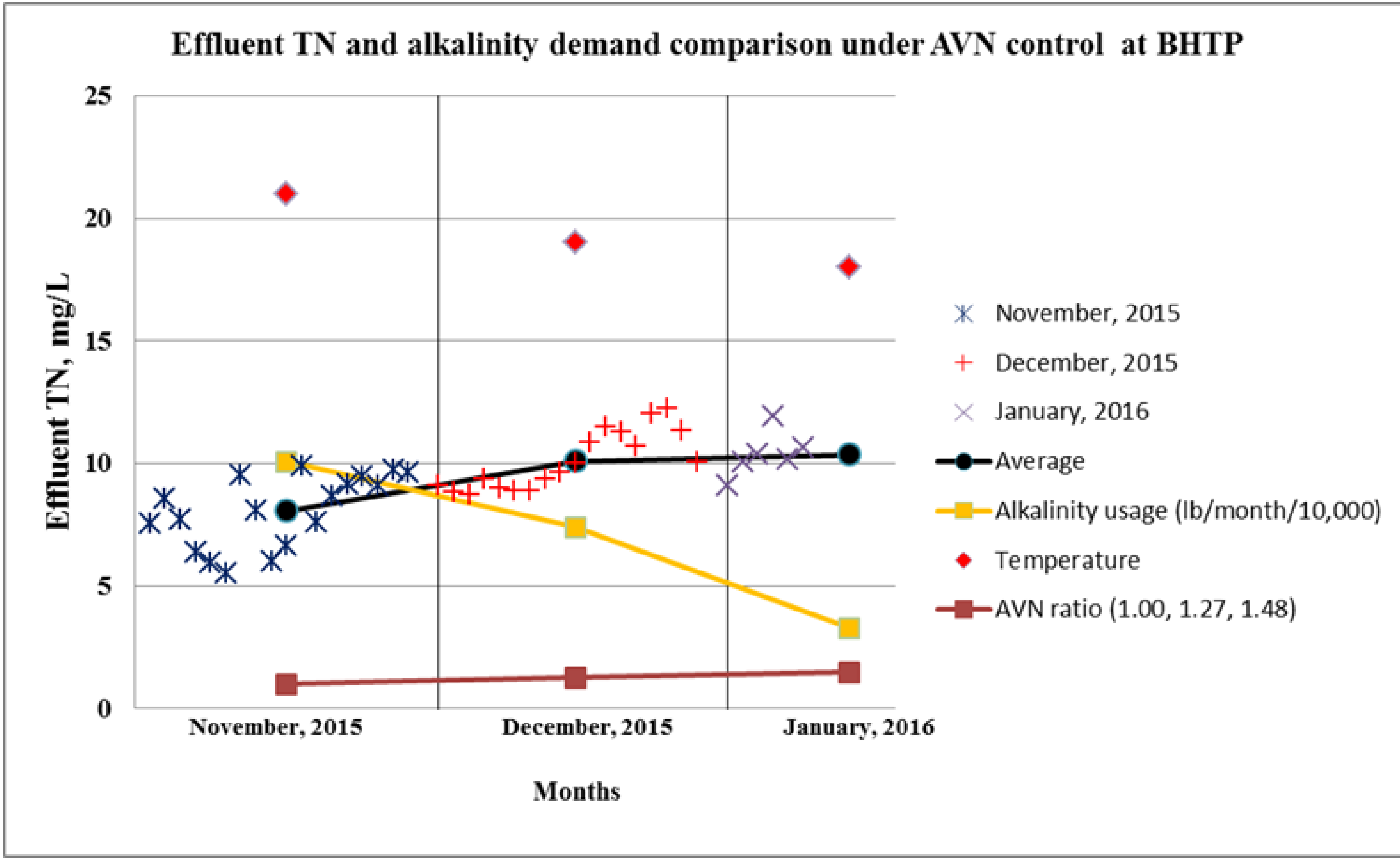


HRSD Boat Harbor (25 MGD)

AvN Control at Boat Harbor – Maximizes TN Removal & Minimizes Resource Utilization



AvN Control – Eliminates Caustic Addition



Final Thoughts…

- R&D program guides technology implementation
- And technology implementation guides R&D
- Technology testing/development:
  - Increases maturity
  - Provides experience
- University partnerships and graduate students are a HUGE resource
- New technology is implemented when:
  - Regulations drive it
  - Business case is clear
  - Maturity is reasonable (plug-and-play not required - perhaps not so for smaller utilities)

Questions?

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- 757-460-4228

HRSD