AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

AquaNereda®

Aerobic Granular Sludge Technology

Introduction

Joe Tardio, M.S., BCES
Product Manager - AquaNereda®

Presentation Overview

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

1. Unique value proposition
2. North America Experience & Success Stories
3. Technology Overview
4. Benefits & Advantages

AQUA-AEROBIC SYSTEMS, INC.
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Unique Value Proposition

AquaNereda® Unique Value Proposition

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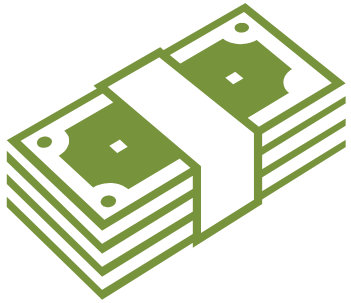
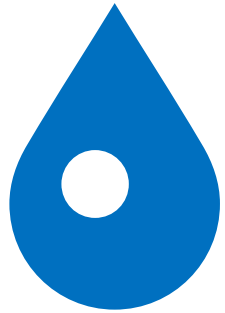
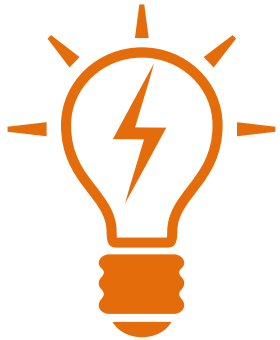
Minimal Footprint



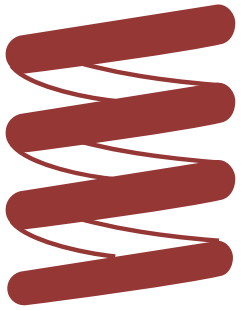
Major Installed Cost Savings



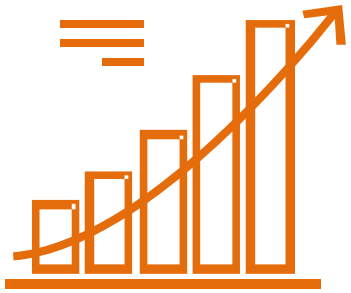
Enhanced Biological Nutrient Removal



Major Energy Savings



Operational Simplicity



Modular Expansion

Target Projects

AQUA-AEROBIC SYSTEMS, INC.
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- LOWEST TOTAL COST OF OWNERSHIP
- CONSTRUCTABILITY
- BIOLOGICAL NUTRIENT REMOVAL
- FOOTPRINT DRIVER
- HYDRAULIC CAPACITY INCREASE
- FUTURE EXPANSION AND TREATMENT FLEXIBILITY

Aerobic Granular Sludge

AQUA-AEROBIC SYSTEMS, INC.
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- Excellent Settling Properties
- Increased MLSS

Aerobic Granular Sludge

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Attributes

True Microbial Biomass

- No media carrier
- Fully sustainable process
- Minimum diameter of **200 µm**
- Robust & resilient

Superb Settling Properties

- AGS SVI5 ≈ CAS SVI30
- MLSS = 8 g/l
- Increased treatment capacity

Inherent BNR

- Discrete aerobic and anoxic/anaerobic layers
- SNDN (3 mg/L TN)
- Bio-P (1 mg/L)

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Experience

Global Overview

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64 Operational plants

105 Contracted plants

22 Countries

13M P.E. Treated

18 Years full-scale experience

150M kWhrs Power Saved

AquaNereda® in North America

AQUA-AEROBIC SYSTEMS, INC.
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14

Total Plants

7

Operational

2

Construction / Start-up

5

Pre -construction / submittals

23

Pre-selected

>260 MGD

Average Daily Flow

>435 MGD

Max. Daily Flow

Wolf Creek WWTP (Foley, AL)

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Operating since Jan 2020

Chemical Usage

↓ 100%

Power Consumption

↓ 50%

AquaNereda® in North America

Installation List

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	Site Name	Location	Status	Application	Start-up
1	Four Rivers Demo	Rockford, IL	Operational	Municipal	2018
2	Riviera Utilities WRF	Foley, AL	Operational	Municipal	2020
3	Idaho Springs WWTP	Idaho Springs, CO	Operational	Municipal	2021
4	Whitefish WWTP	Whitefish, MT	Operational	Municipal	2021
5	Wolcott WWTP	Kansas City, KS	Operational	Municipal	2021
6	Kahului Airport WWTP	Maui, HI	Operational	Municipal	2023
7	South Sioux City WTF	South Sioux City, NE	Operational	Mixed-use	2023
8	Greenville WWTP	Greenville, MI	Construction/ Start-up	Municipal	2023 (exp)
9	Bainbridge WPCP	Bainbridge, GA	Construction/ Start-up	Mixed-use	2023 (exp)
10	Confluence Park WRF	La Verkin, Ut	Submittals	Municipal	2024
11	Purgatory Metro District WWTP	Purgatory, CO	Submittals	Municipal	2024
12	Fort Pierce Utilities Authority	Fort Pierce, FL	Submittals	Municipal	2024
13	Iona Island WWTP Demo	Vancouver, BC	Submittals	Municipal	2025
14	Four Rivers Sewer Authority	Rockford, IL	Submittals	Municipal	2025

Large Projects in Design

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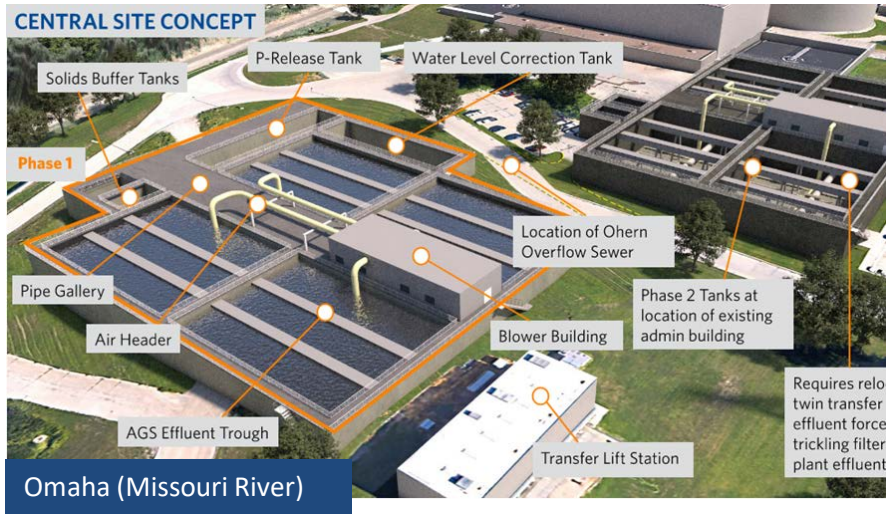
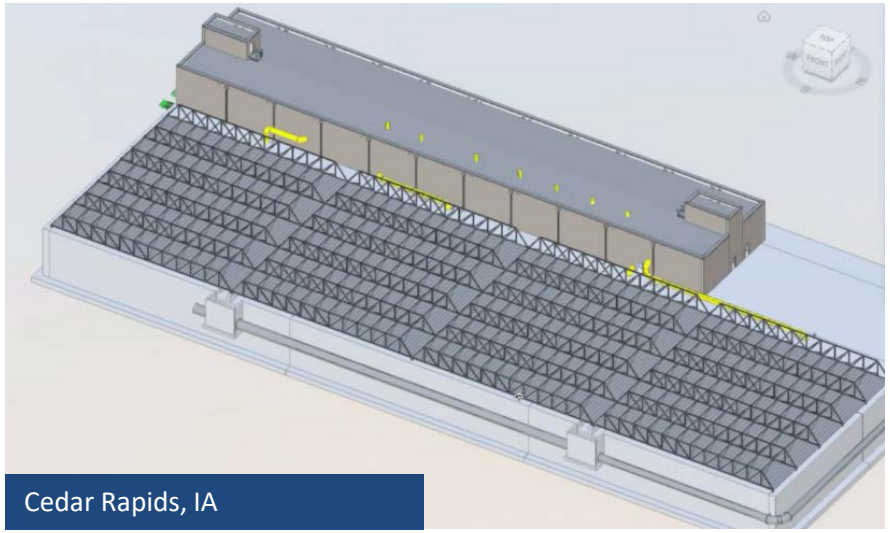


Omaha (Missouri River)


Lake Oswego, OR


Iona Island – Vancouver BC


Cedar Rapids, IA

AquaNereda® in North America

AQUA-AEROBIC SYSTEMS, INC.
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- ★ Operational (7)
- ■ Start-up / Construction / Submittals (7)
- ▲ Pilot completed or ongoing (13)
- ● Pre-selected (23)

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Recent Success Stories

Success Story

Ft Pierce FL (FPUA)

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FPUA
COMMUNITY PROUD

Status	Capacity	Consultant	Keys to Success
• 60% -> 90% Design • startup est. 2025	• 12 MGD (ADF); 24 MGD (MDF) • buildout to 30 MGD	• Hazen/Globaltech/ Haskell • Progressive DB)	• Plant tours, • installed cost • NPV • ease of expansion • future nutrient removal

Success Story

FRSA, IL

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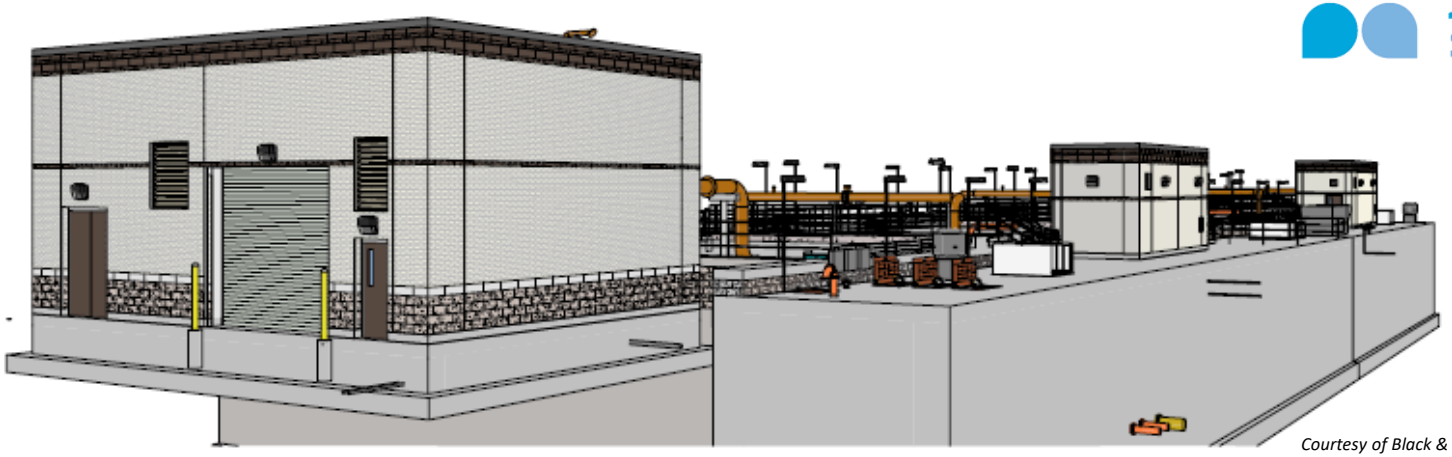
Four Rivers Sanitation Authority



NORTHEAST PERSPECTIVE

Courtesy of Black & Veatch

Status	Capacity	Consultant	Keys to Success
• 100% Design • Contractor awarded, submittals ongoing	• 10 MGD	• Black & Veatch	• Owner experience with technology • parallel treatment for enhanced effluent quality • future hybrid approach

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Technology Overview

What is Granular Sludge?

Spectrum of Activated Sludge

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Flocculant

Densified

Granular

Left and center images from Roche, et al. Water Environment Research Vol 94 Issue 1 Jan 2022 e1664

Granule size implications

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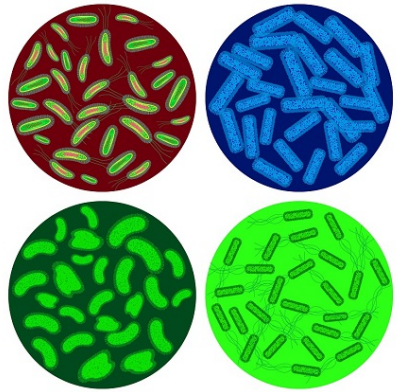
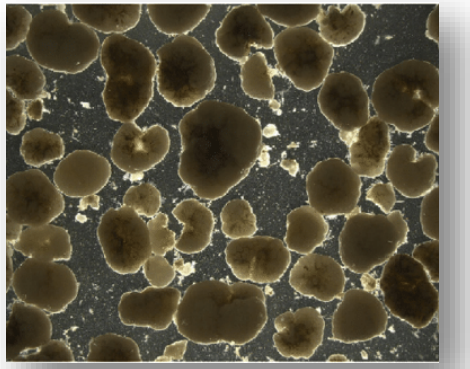
Settling velocity

Microbial population
(i.e. biological performance)



Process Resiliency



Achievable Effluent Quality

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BOD	<10.0 mg/l
TSS	<10.0 mg/l
NH4	< 1.0 mg/l
TN	< 3.0 mg/l
TP	< 1.0 mg/l

AquaNereda® Cycle Structure

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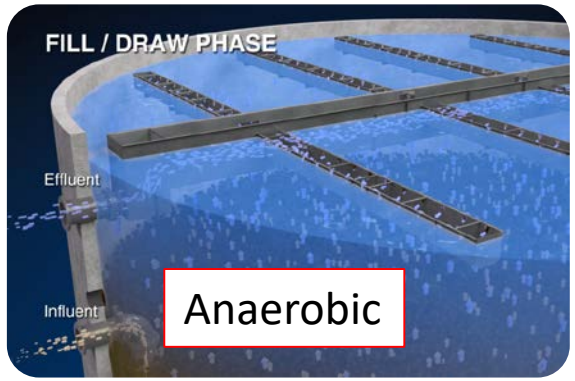
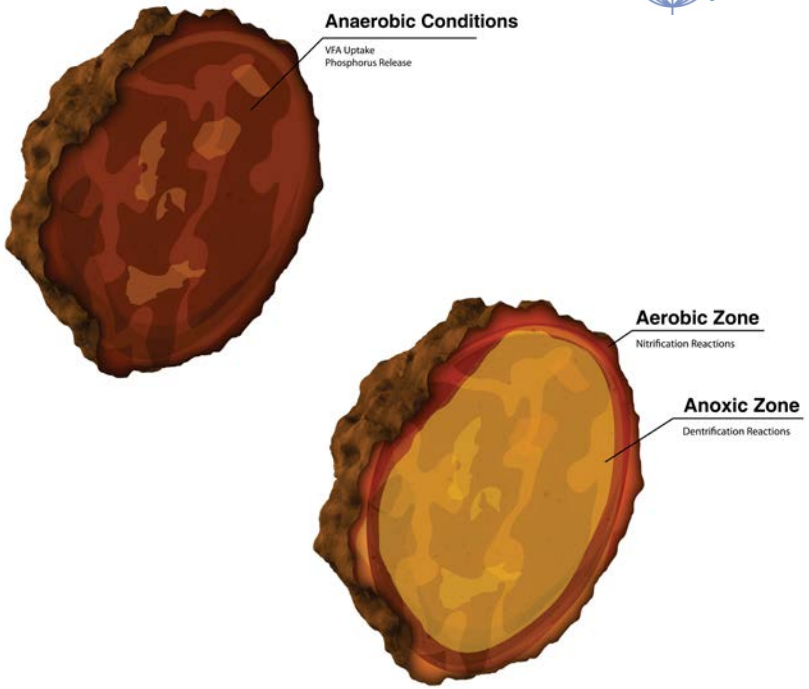
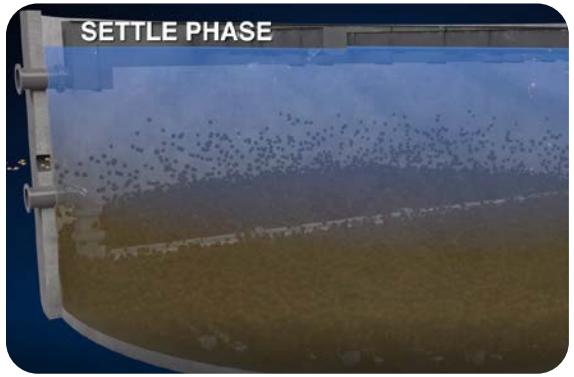
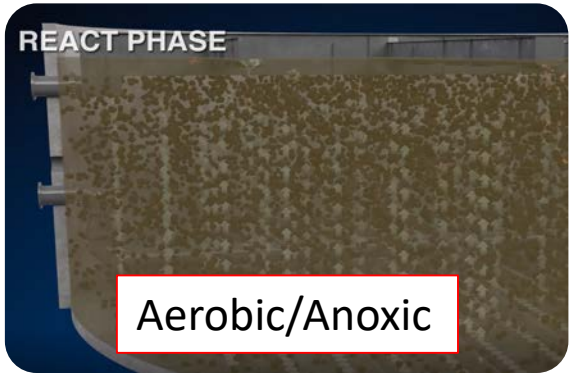






AquaNereda®
Cycle



Process Flows

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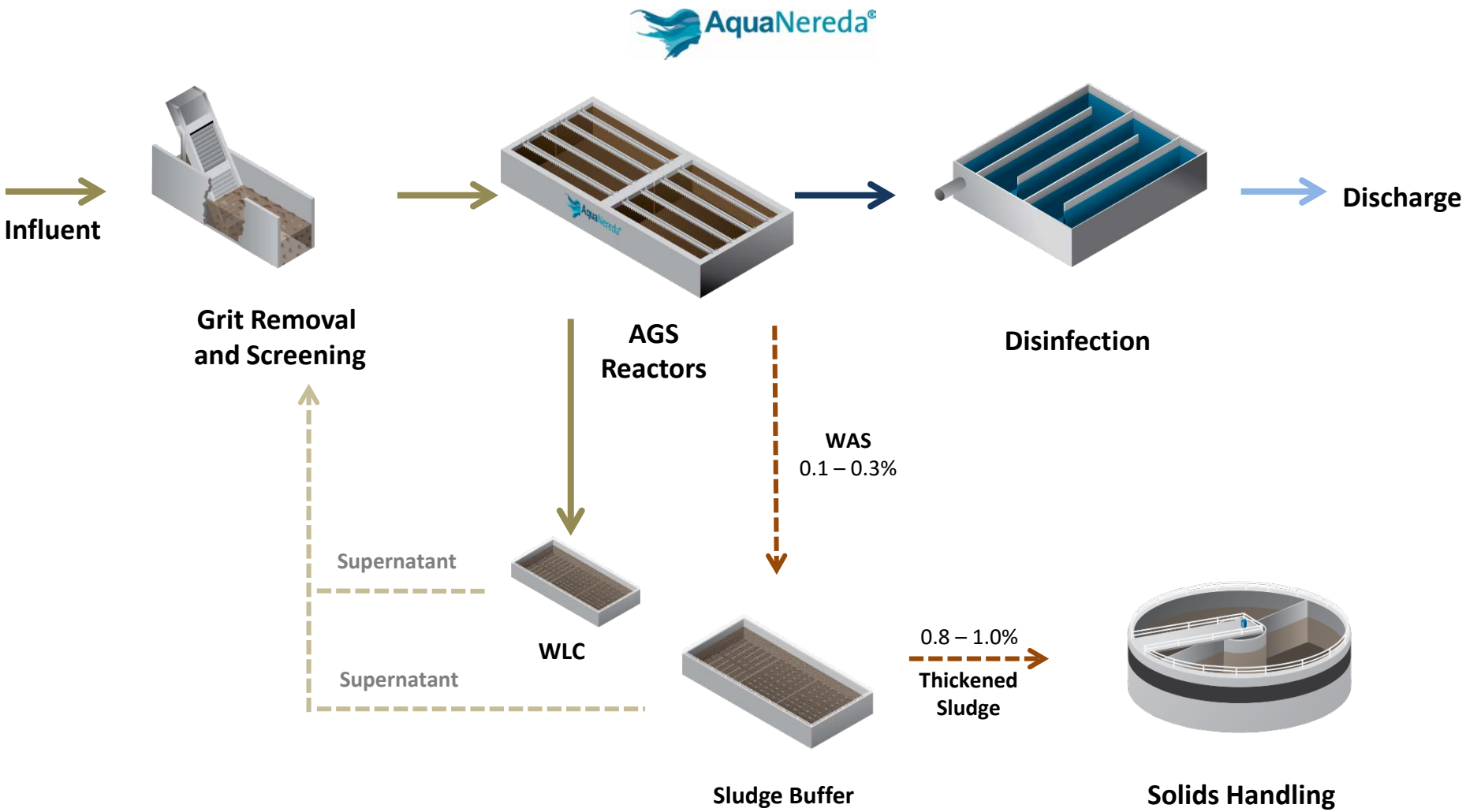

Startup & Granulation

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- 100% true biomass (NO media carriers)
- Developed within bioreactors as part of the AquaNereda® process
- Formed from conventional activated sludge
- Continually replenished by the process

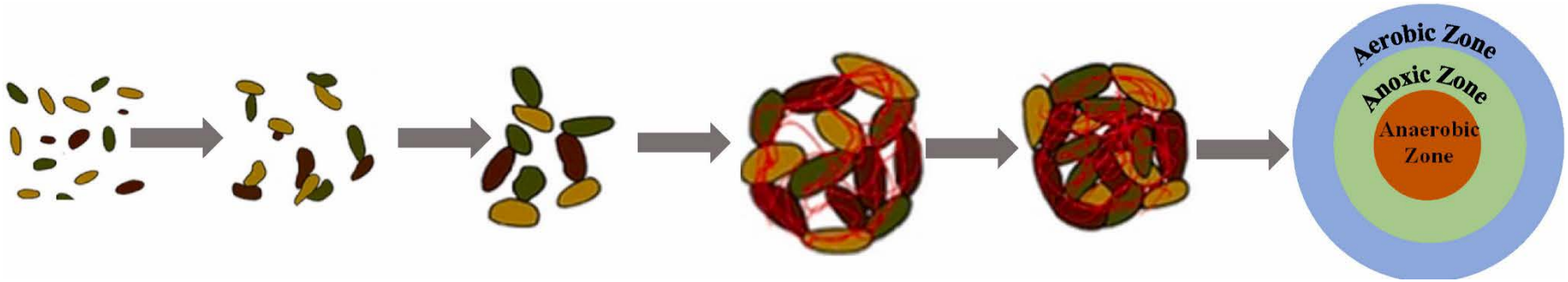

Image adapted from: Hamza, et al. Case Studies in Chemical and Environmental Engineering Volume 5, May 2022, 100173

What Makes AquaNereda® Unique

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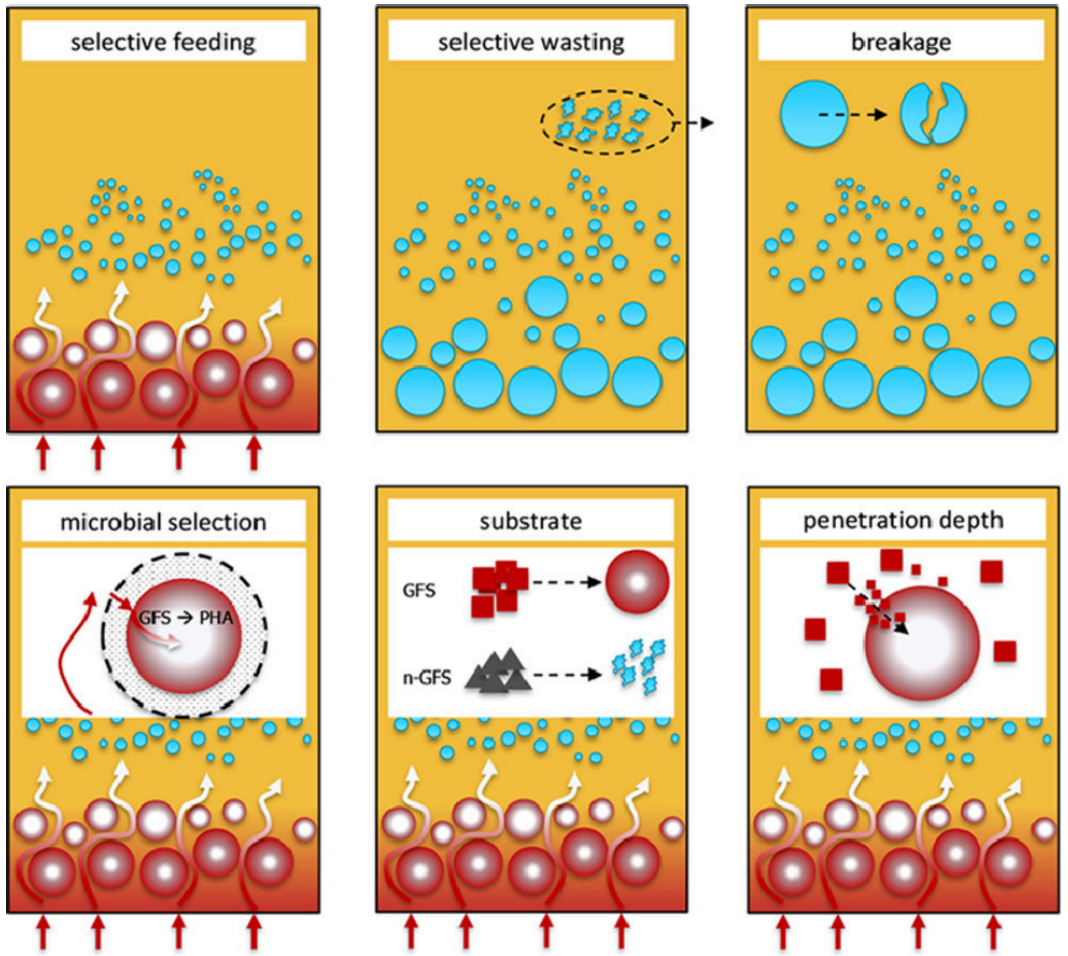
6 Selection Mechanisms



van Dijk, et al. On the mechanisms for aerobic granulation - model based evaluation Water Research Volume 216, 1 June 2022, 118365

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Benefits & Advantages

Greatly simplified vs Conventional BNR

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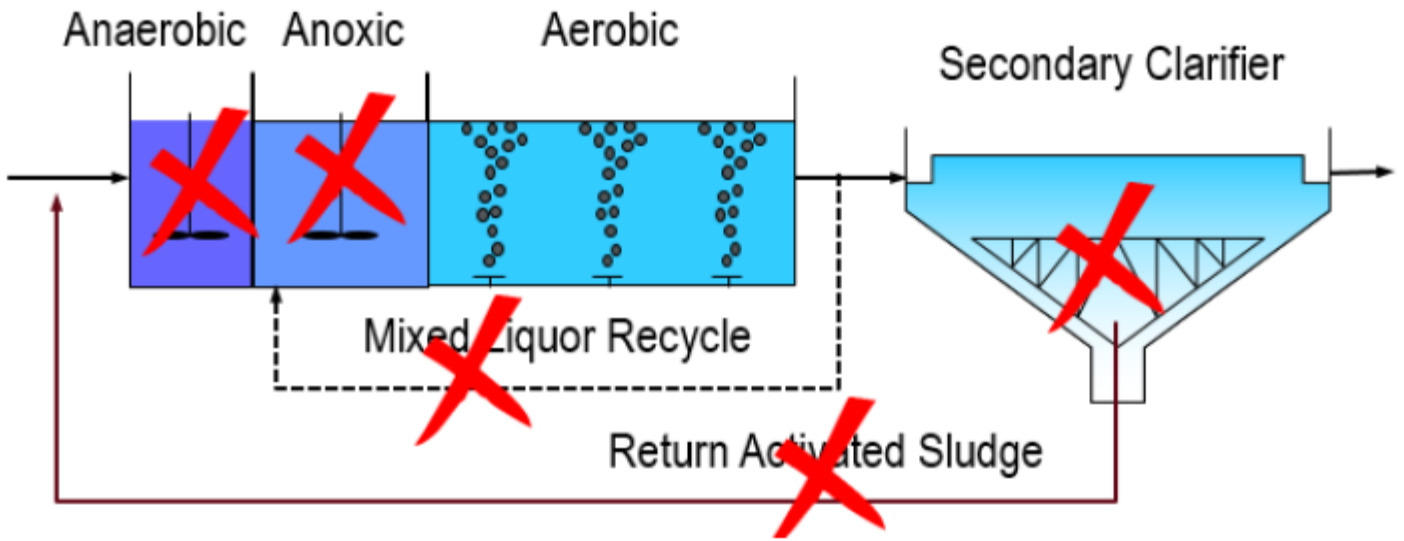
- Significant Reduction in Construction Cost
- Reduced OPEX – equipment to maintain and operate
- Increased operational simplicity



Constructability

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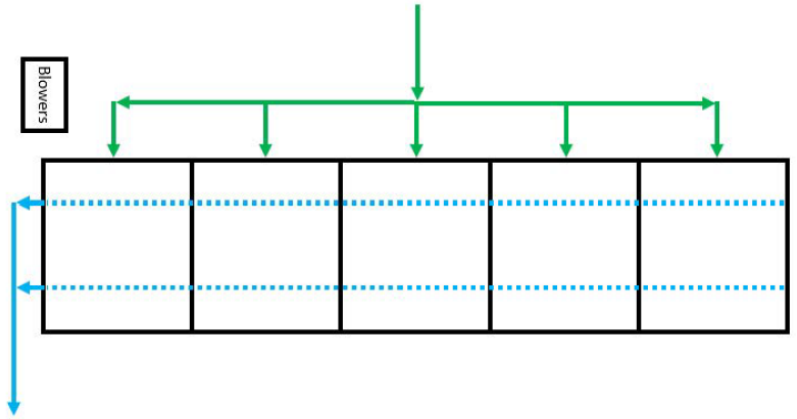
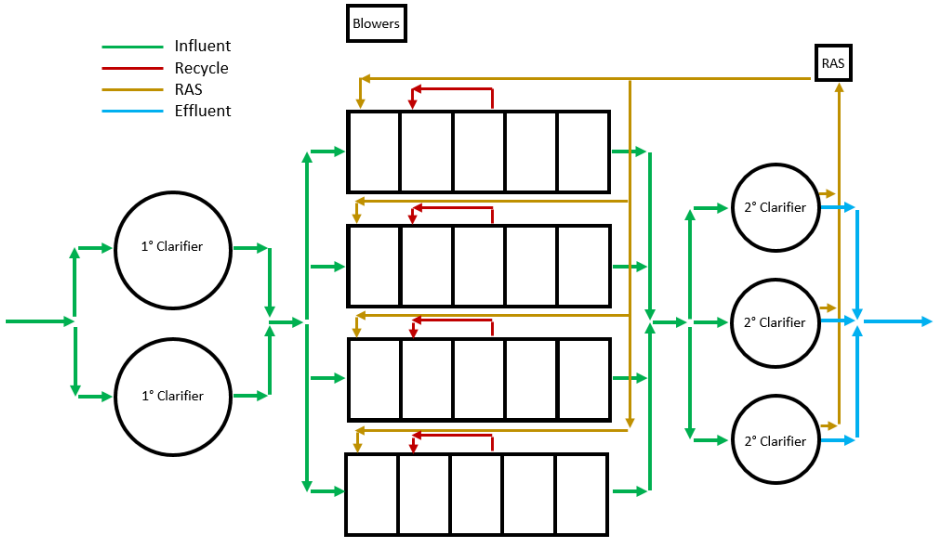
Yard piping difference vs. multi-stage BNR





Continuous Feed

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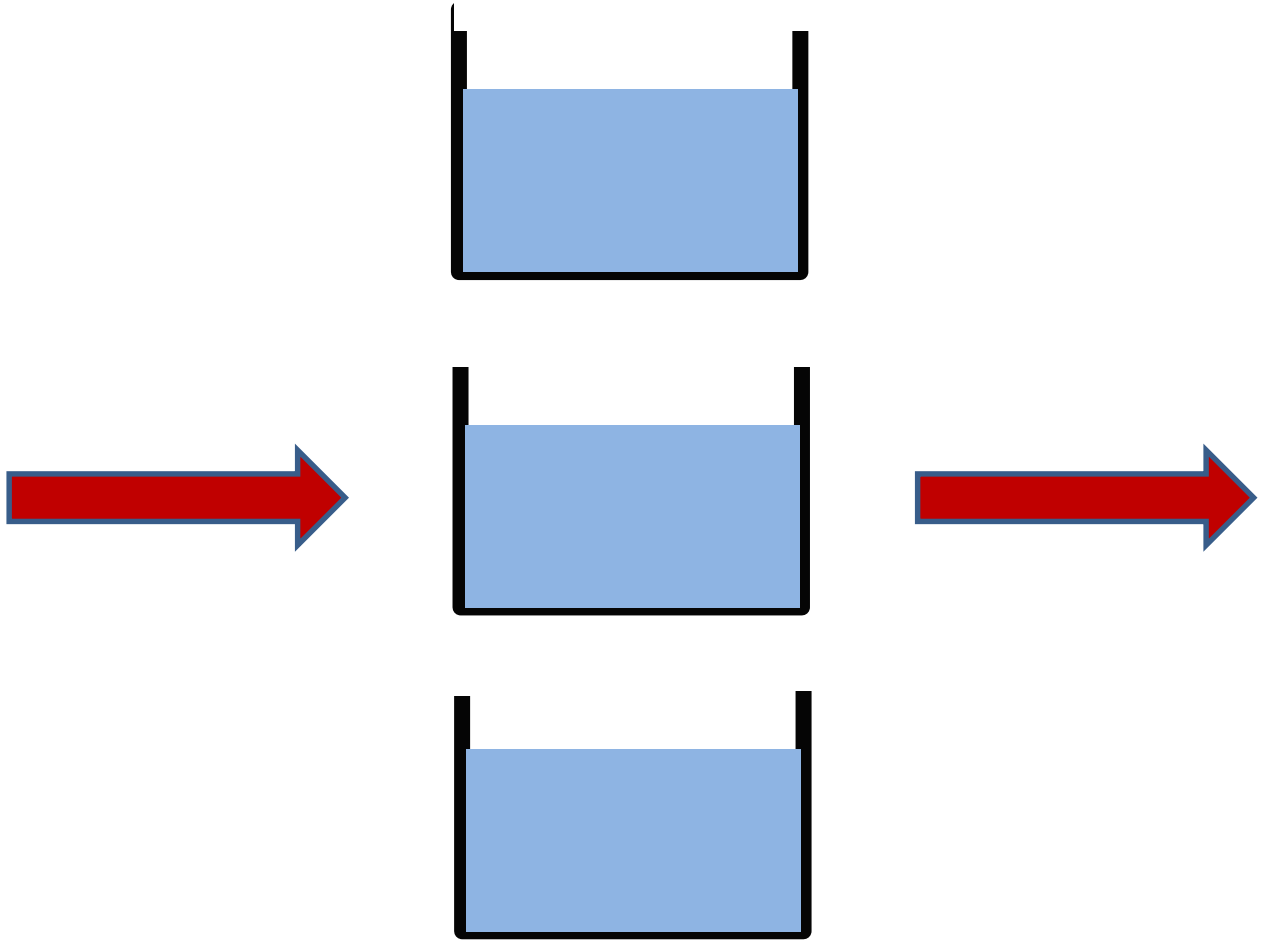

No Pre- or Post- Equalization

Dynamic Cycle Structure

Foley, AL

AQUA-AEROBIC SYSTEMS, INC.
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- Continuous flow (no EQ)
- 3.5 MGD (avg), 6.0 MGD (peak)
- **21 → 24 cycles/day**

Normal Operation (3.5 hr)	
Fill/Draw	70 min
React	120 min
Settle/Waste	20 min

Storm Operation (3 hr)	
Fill/Draw	60 min
React	100 min
Settle/Waste	20 min

Simplified Operations & Increased Reliability

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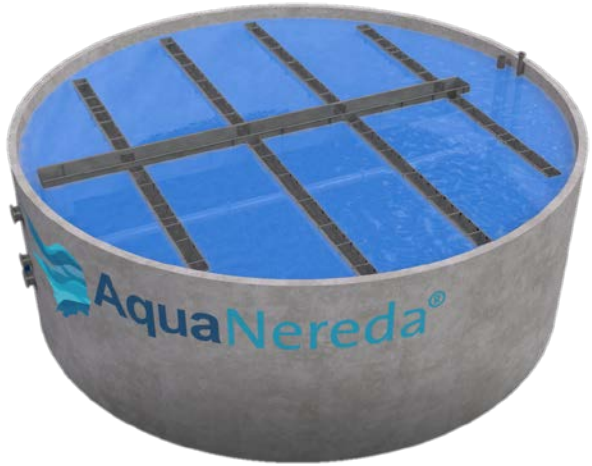
Inside the Tank

- Fixed fine bubble diffusers

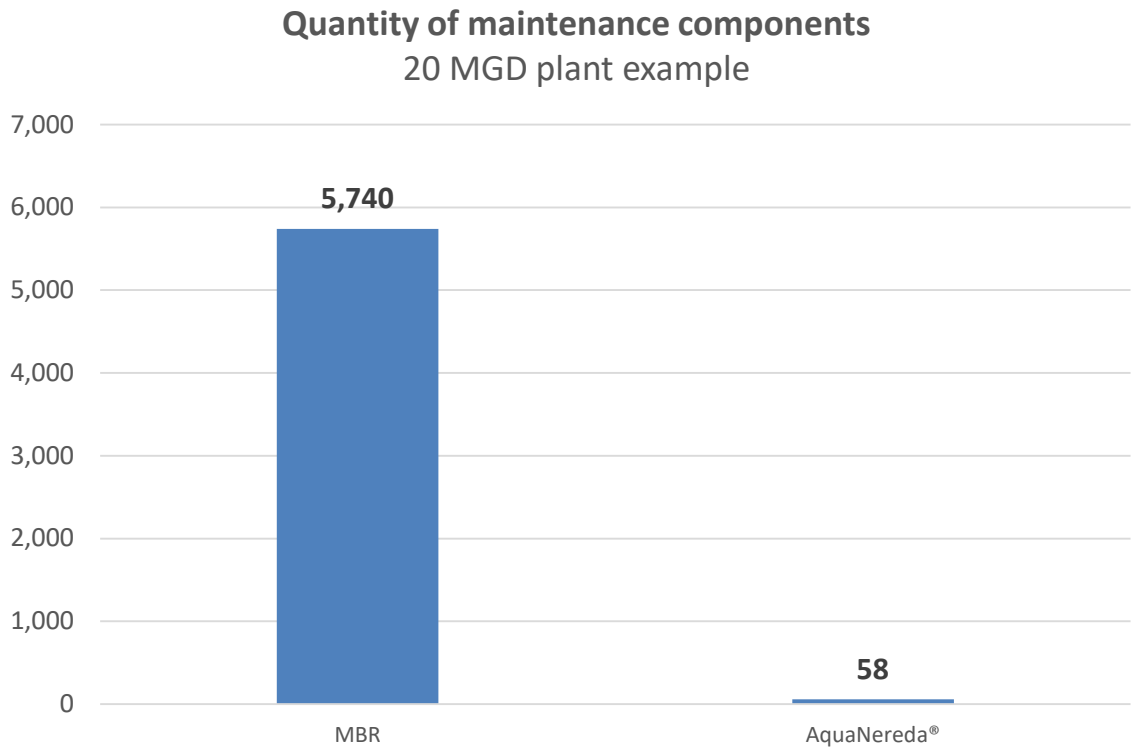


Outside the Tank

- Pumps
- Valves
- Blowers
- Instrumentation
  - Probes (pH, DO, ORP, TSS)
  - Analyzers (Phosphorus, Ammonia)

Mechanical Simplicity & Reduced O&M

20 MGD ADF example



Mechanical equipment summary

AquaNereda®	Flow-through hollow-fiber MBR
▪ SB/WLC pumps ▪ Instruments ▪ Air control valves ▪ WAS/WLC valves ▪ 6mm screens ▪ Blowers	▪ Mechanical mixers – anoxic ▪ Mechanical mixers – RAS ▪ Membrane cassettes ▪ Membrane modules ▪ Permeate isolation valves ▪ Air header isolation valves ▪ Membrane influent sluice gates ▪ Discharge valves ▪ Chemical dosing pumps ▪ Chemical dosing transmitters ▪ Chemical dosing valves ▪ 1mm screens ▪ Effluent pumps ▪ Effluent pump VFDs ▪ Blowers

Lowest 20-year Present Worth

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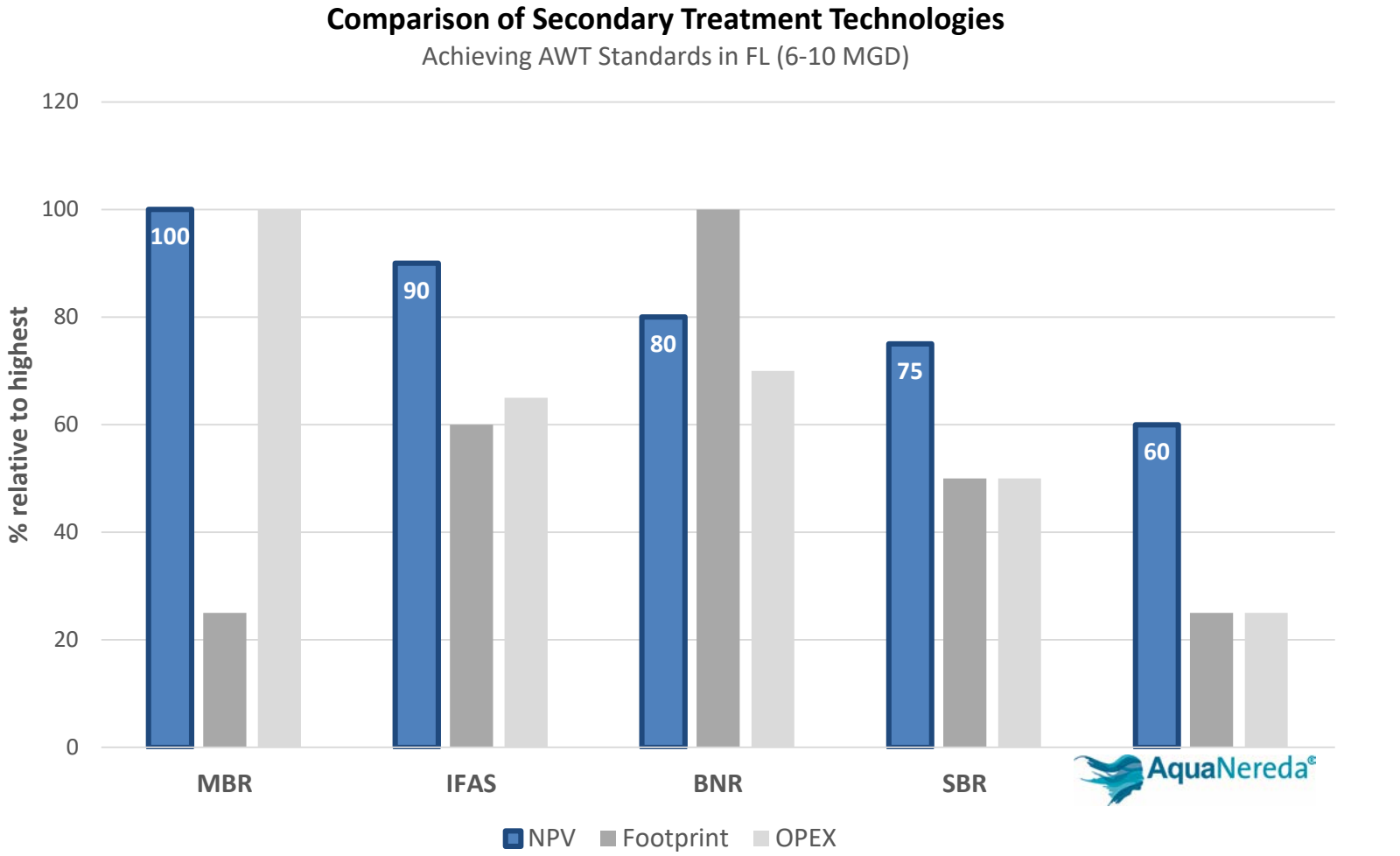

Adapted from: R. Reardon, et. al., "Can Innovative Technologies Provide Benefits to Municipal Water Resource Recovery Facilities." 2016

OPEX Comparison – 9.0 MGD

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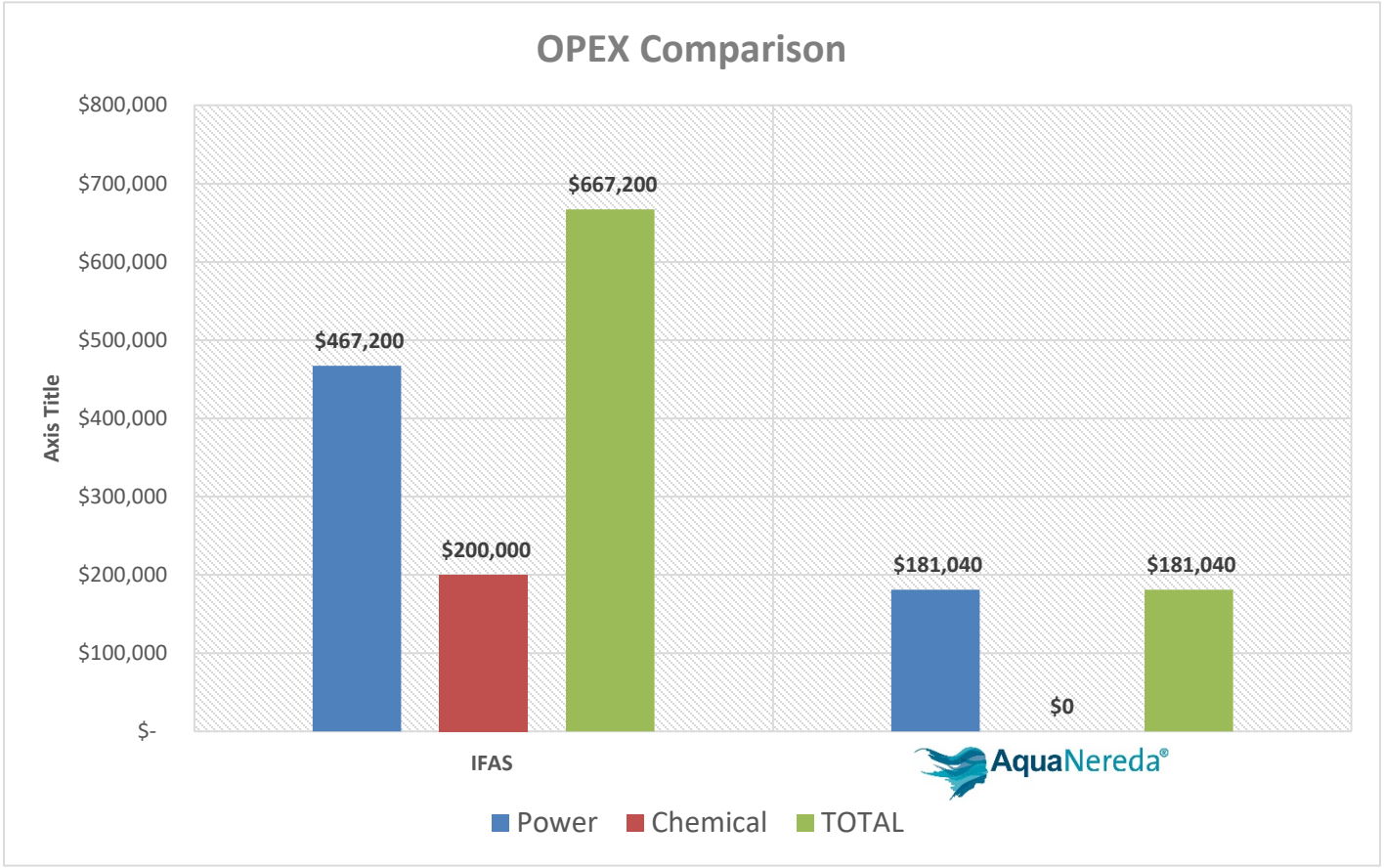
Estimated savings of ~$9.7M over 20 years compared to IFAS



Instrumentation Flexibility for Effluent Targets

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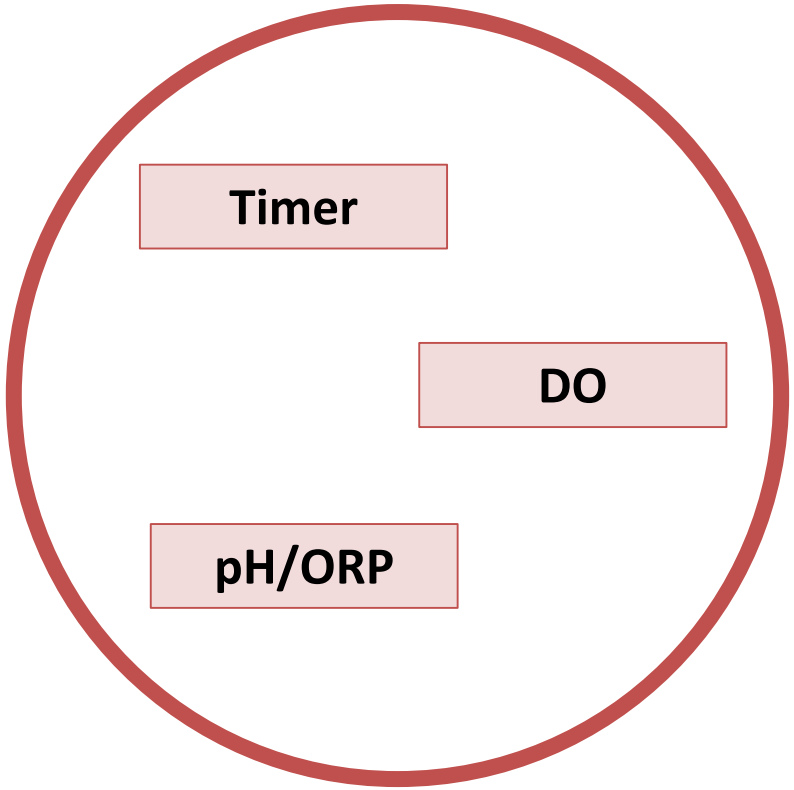
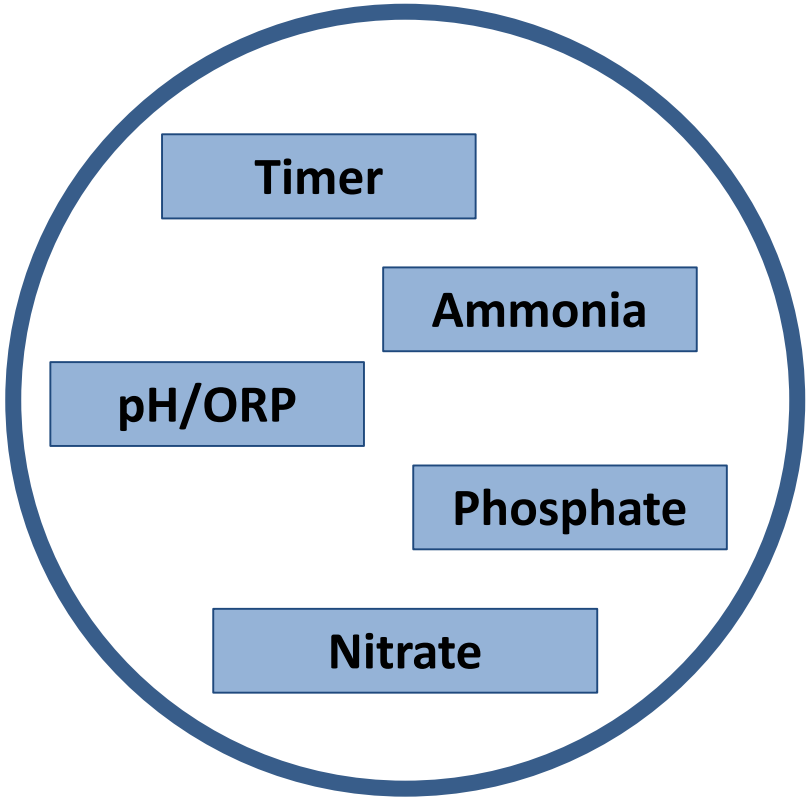
BOD/TSS Only



Nutrient Removal



Footprint

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Footprint

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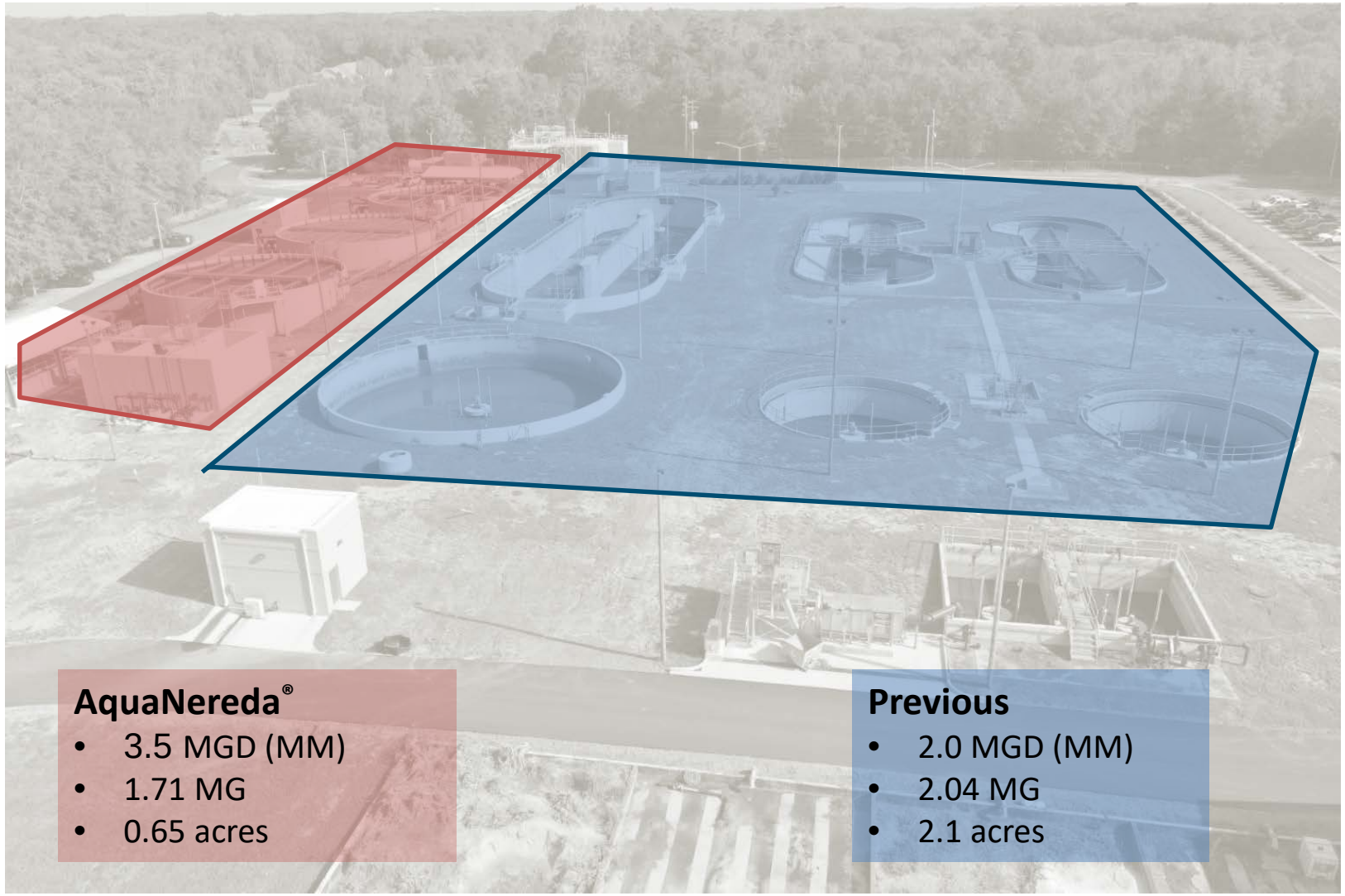

Capacity per reactor

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No decanter (Fixed effluent weir)

> 10 MGD/reactor

Process Resiliency

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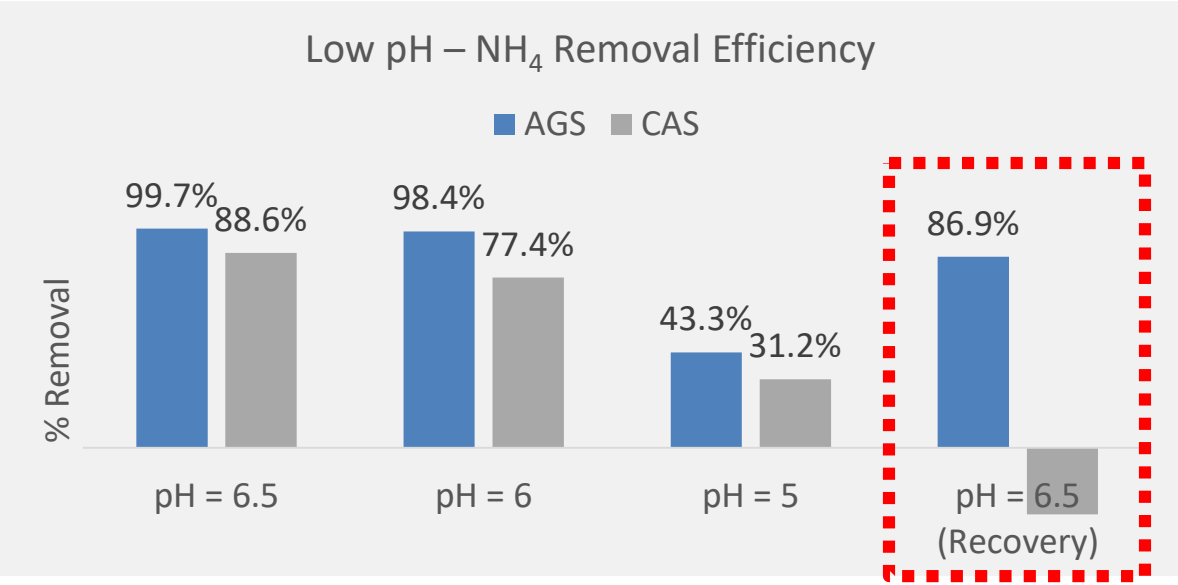
- The granule protects the bacteria
- More robust during difficult conditions:
  - Temperature, pH, or salinity fluctuations
  - Chemical spikes
  - Flow and load variations



Summary

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

- AquaNereda® is a long-proven technology
- AquaNereda® offers significant CAPEX and OPEX savings compared to conventional treatment
- Aerobic granular sludge enhances process resiliency compared to conventional activated sludge
- AquaNereda® is being adopted at a rapid pace in North America across a variety of applications