BACWA
BAY AREA
CLEAN WATER
AGENCIES

# EMERGING & INNOVATIVE NUTRIENT REMOVAL TECHNOLOGIES SEMINAR AND TOUR

June 9, 2025

CWT CALISKANER WATER TECHNOLOGIES

# WELCOME & INTRODUCTIONS

Onder Caliskaner, PhD, PE

# Agenda Items

- BACWA Welcome/Background – Mike Falk
- Project Background – Onder Caliskaner
- Demonstration Site – Linda County Water District Wastewater Treatment Plant – Brian Davis
- Advanced Primary Treatment Technologies  - Onder Caliskaner
  - Cloth Disc Primary Filter
  - Proteus Filter
  - Micro-Screen
  - Primary Filter Sludge Thickening: Volute Thickener
- Advanced Secondary Treatment Technologies – Derya Dursun
  - Aerobic Granular Sludge (AGS)
  - MicroVi
  - MABR
- Open Discussion

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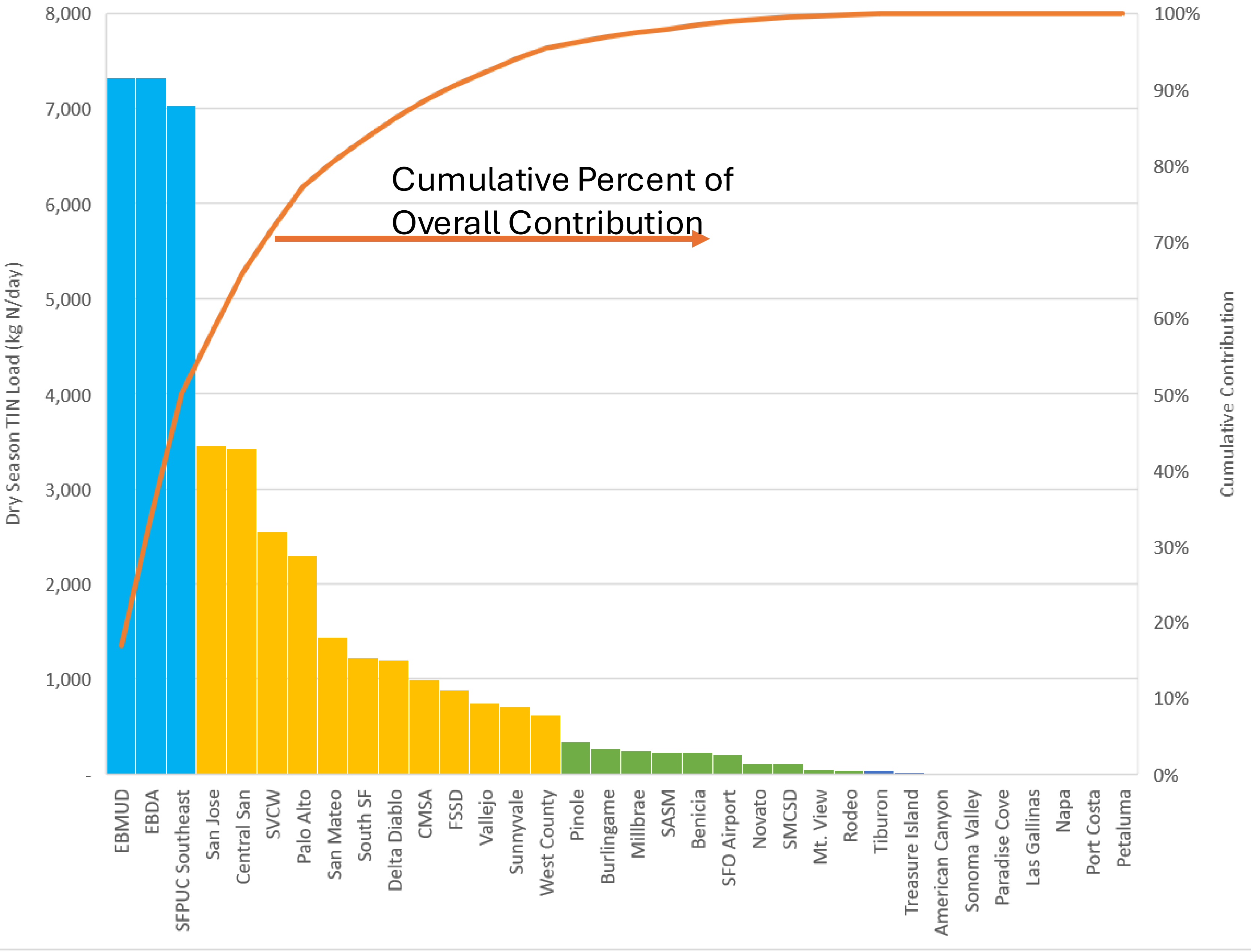
# 40 POTWs discharge 86% of dry season nitrogen to SF Bay

# The SF Bay has historically been resilient to nutrients

1. High turbidity blocks the light phytoplankton needs to grow

2. Strong tidal mixing reduces nutrient concentrations

3. Filter-feeding clams reduces phytoplankton concentrations

# San Francisco Chronicle

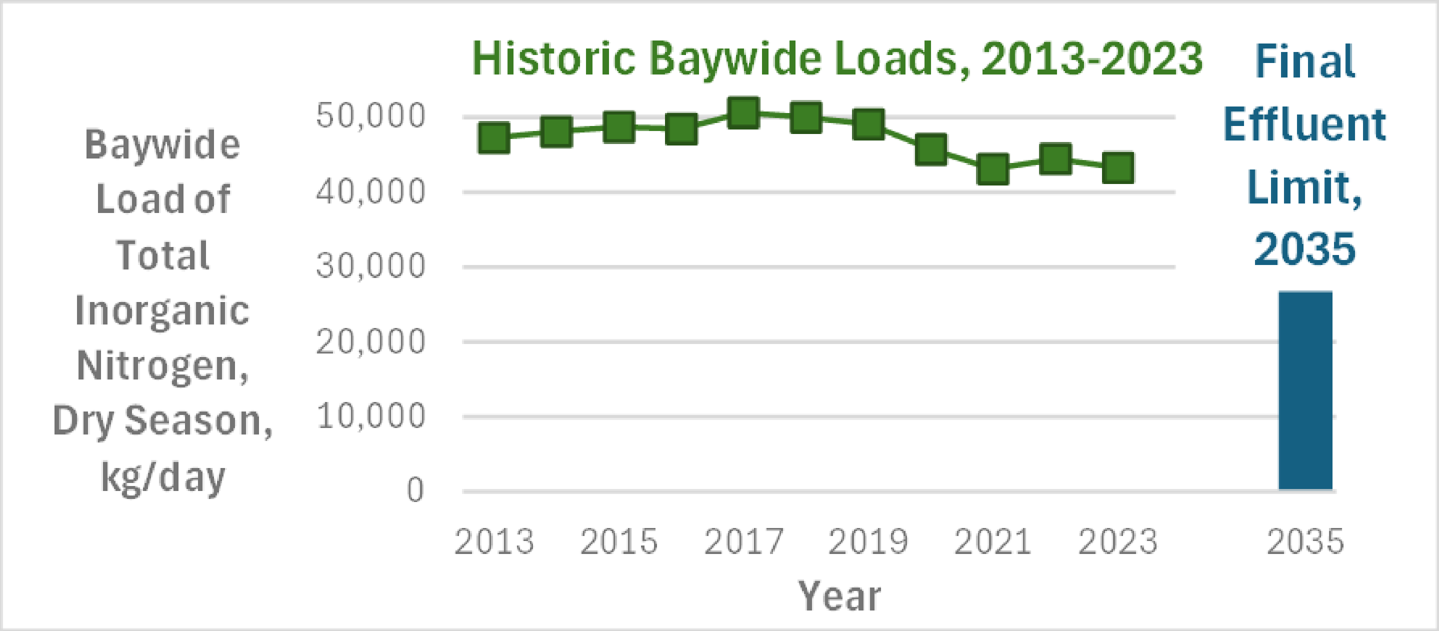
## Poop and pee cause algae blooms in S.F. Bay. Water agencies will spend $11 billion to fix the problem

# History of the Nutrient Watershed Permit

| #1: **2014** | #2: **2019** | #3: **2024** |
| --- | --- | --- |
| • Monitoring and Reporting<br>• Support for Science<br>• **Nutrient Reduction via Optimization and Upgrade Study** | • Monitoring and Reporting<br>• Support for Science<br>• **Nutrient Reduction via Recycled Water and NBS Studies** | • Monitoring and Reporting<br>• Support for Science<br>• **Regional Planning**<br>• **Load Limitations**<br>• **Compliance Milestone Reporting** |

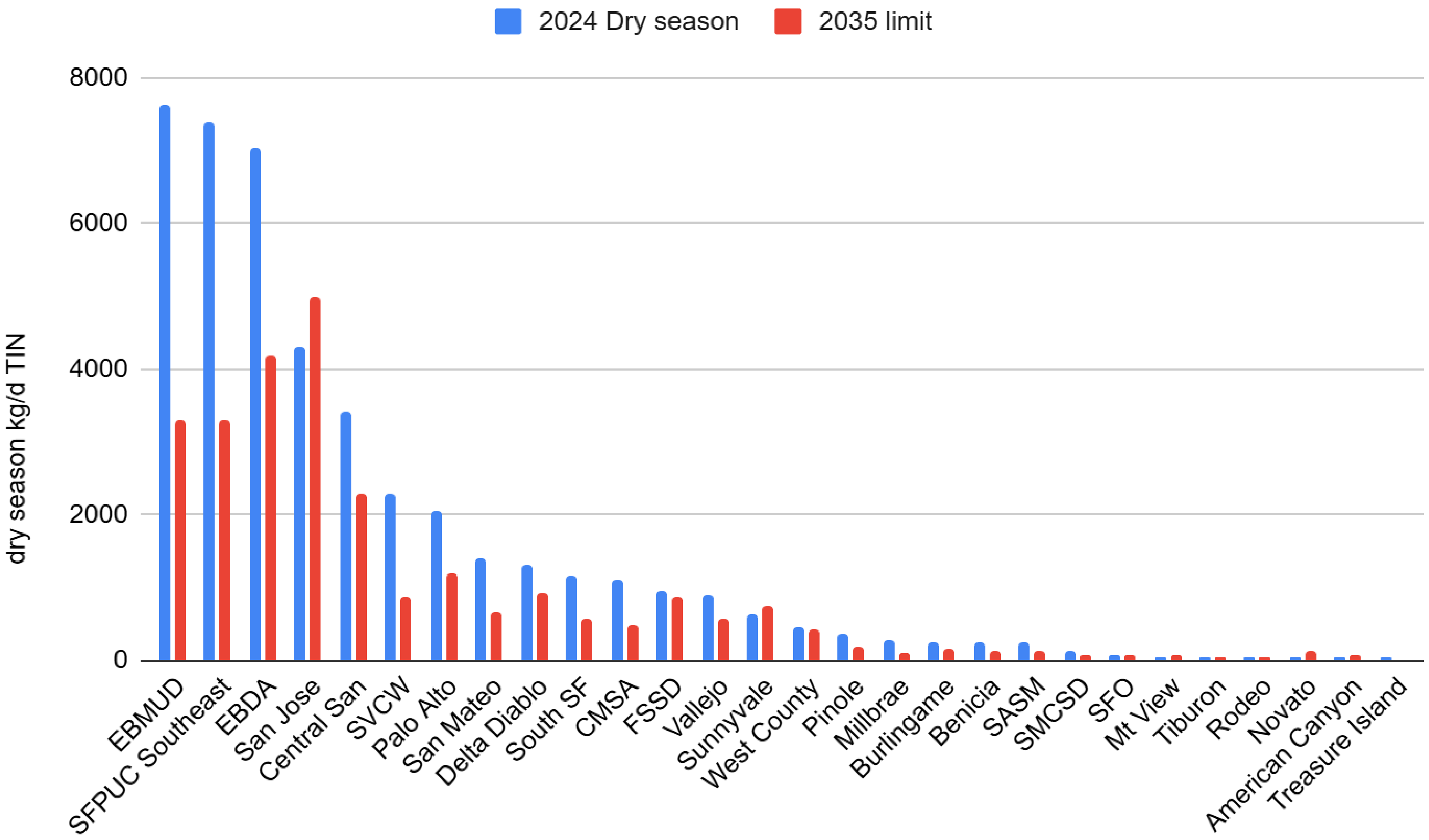
# Third Watershed Permit adopted July 10, 2024

- Requires **40% aggregate dry season** load reduction
- Apportioned based on current performance – load limits calculated by multiplying effluent flow by **20.5 mg/L** TIN

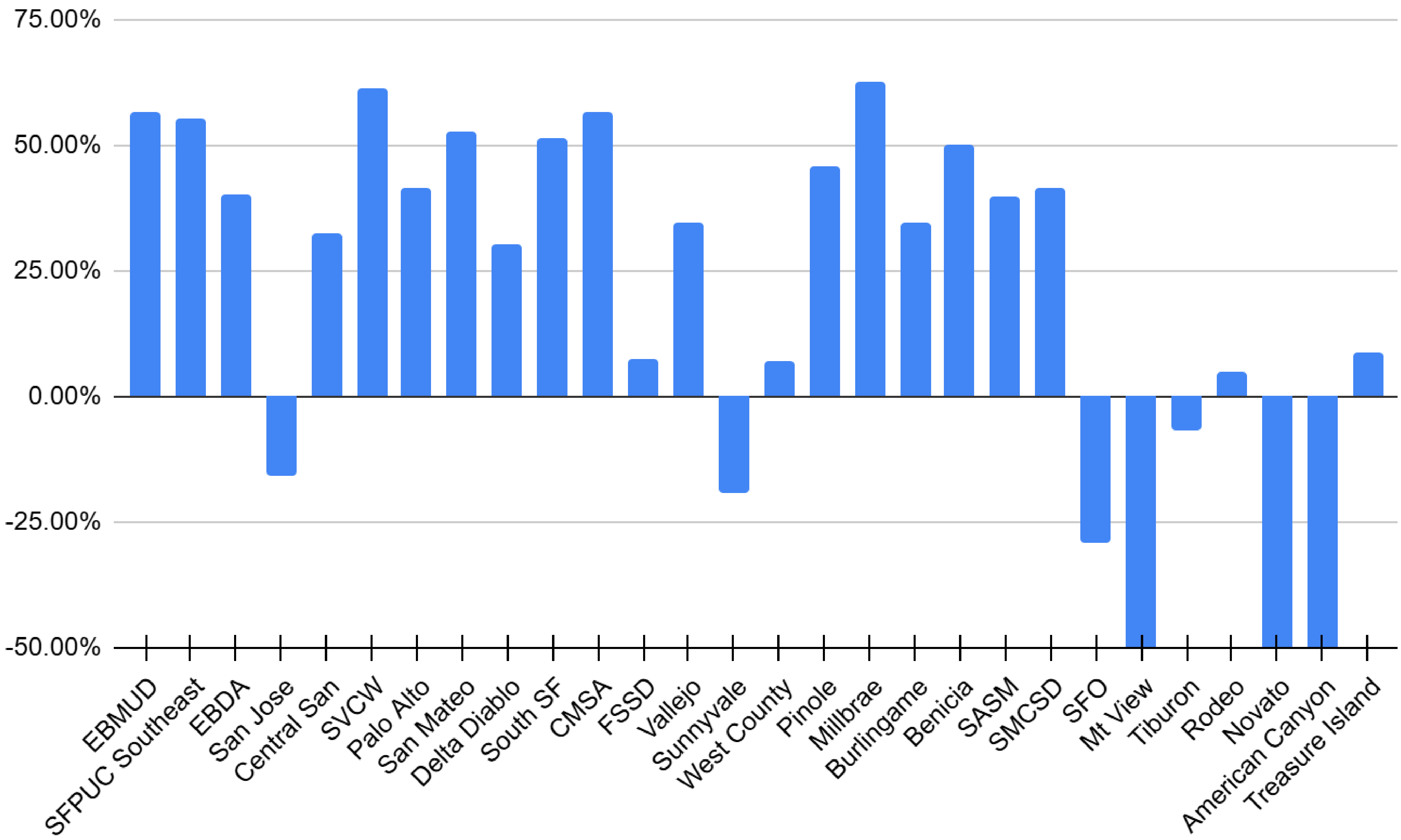



- **10-year** compliance schedule
- Allows nitrogen trading
- Recognition that early actors, projects with multiple benefits and others will need more time – **Water Board working on a Basin Plan Amendment to provide extended compliance schedules for some projects**

# Permit load reduction allocation across agencies



# Required percent reduction from 2024 loads



# PROJECT BACKGROUND

Onder Caliskaner, PhD, PE

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# Demonstration of Advanced Primary and Secondary Treatment Technologies for Energy and Performance Benefits to Wastewater Treatment
# California Energy Commission (CEC) Project EPC-20-044

## Why

To demonstrate the increased performance, energy, and economic benefits of the application of innovative advanced primary and secondary treatment technologies


## When

2022 – 2025

## Prime

Caliskaner Water Technologies, Inc.

## Budget

CEC Grant Funds: $ 4M

Match Contribution: $ 2.7 M (From 15 sources)

TOTAL: $6.7 M

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CWT CALISKANER WATER TECHNOLOGIES

Linda County Water District
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# Project Team

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## Technology Providers

AQUA-AEROBIC SYSTEMS, INC. A Metawater Company

TOMORROW WATER

Microvi

VEOLIA

HUBER TECHNOLOGY WASTE WATER Solutions

PWTech

HORIBA

WesTech®

dynamita PROCESS MODELING

EOSi

## Utility Partners

LOS ANGELES COUNTY SANITATION DISTRICTS
*Converting Waste Into Resources*

SVCW Silicon Valley Clean Water

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

BACWA BAY AREA CLEAN WATER AGENCIES

## Subject Matter Experts

THE Water Research FOUNDATION

Stantec

KJ

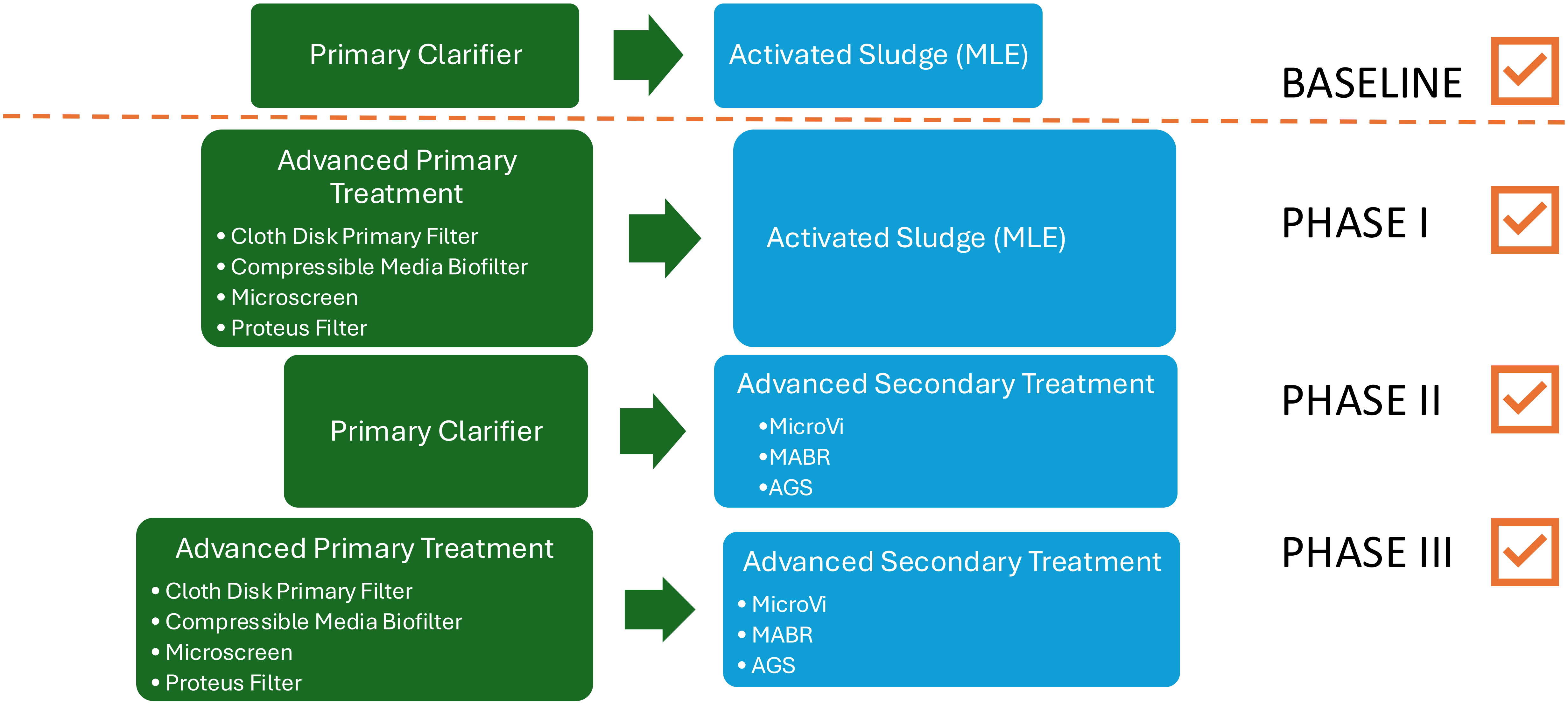
HDR

AECOM

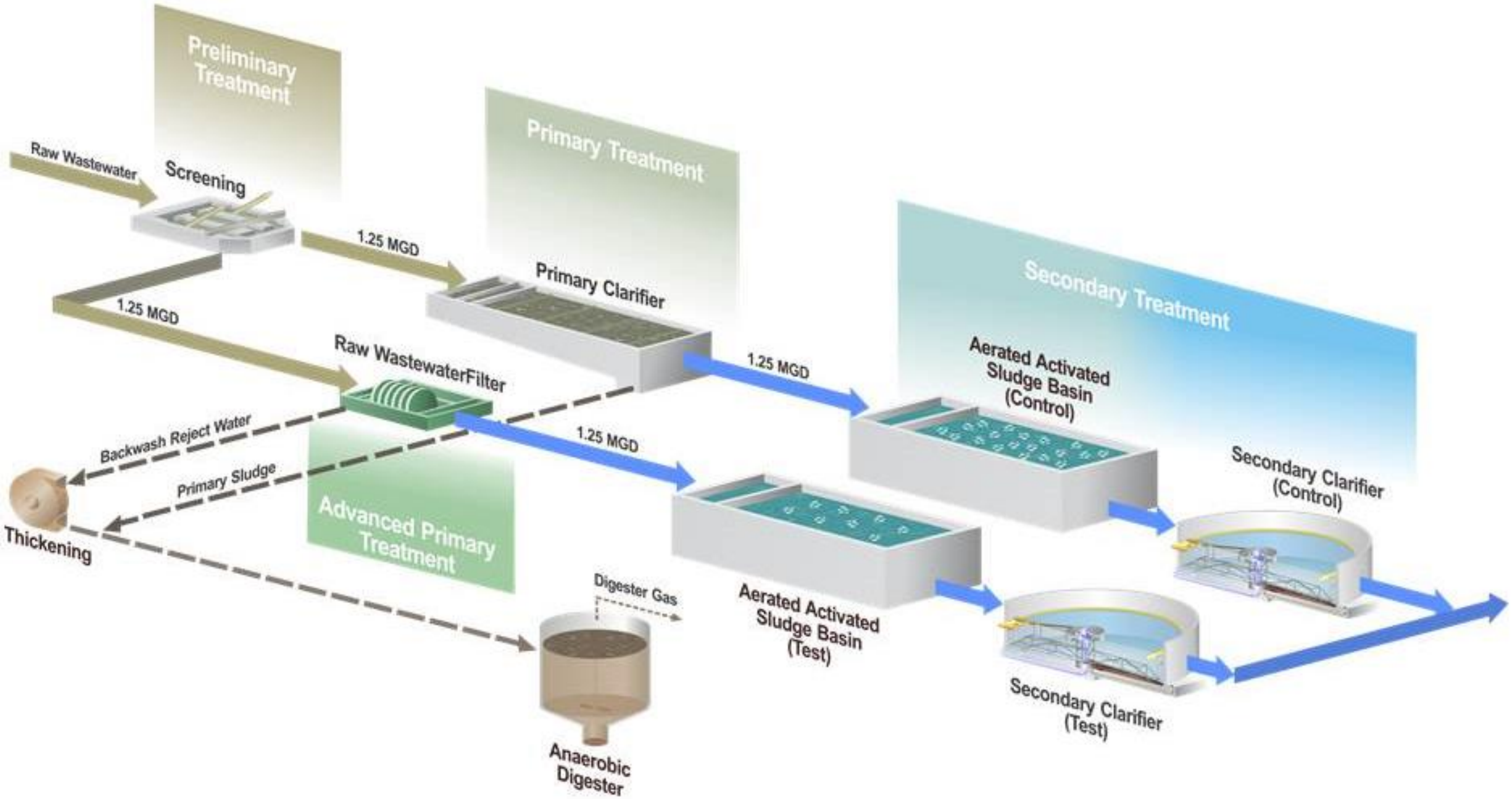
BASE ENERGY

Prof. George Tchobanoglous
Prof. Diego Rosso

# Demonstration Phases Review



# Overview of Project – Flow Diagram (Partial)

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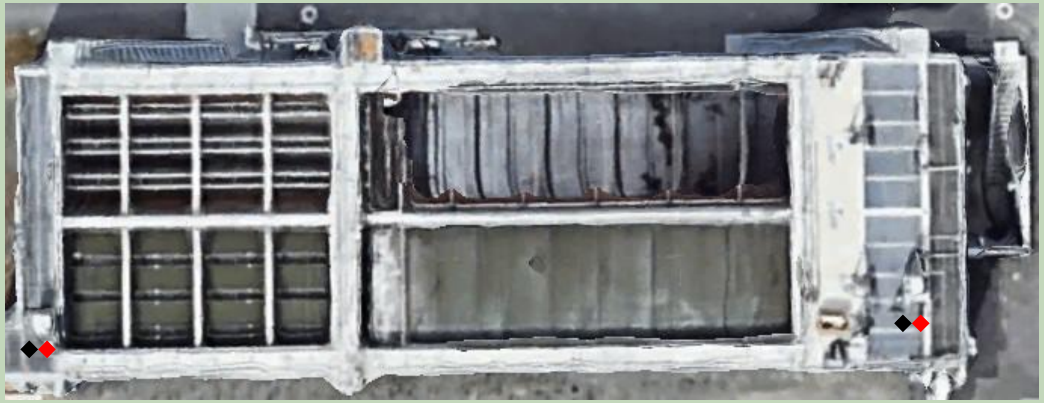
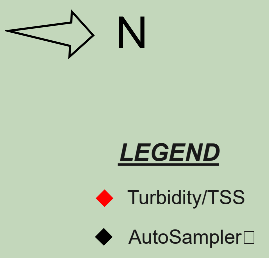
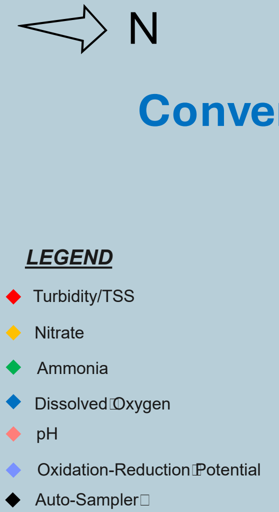
# Demonstration Site (Linda WRRF, CA)

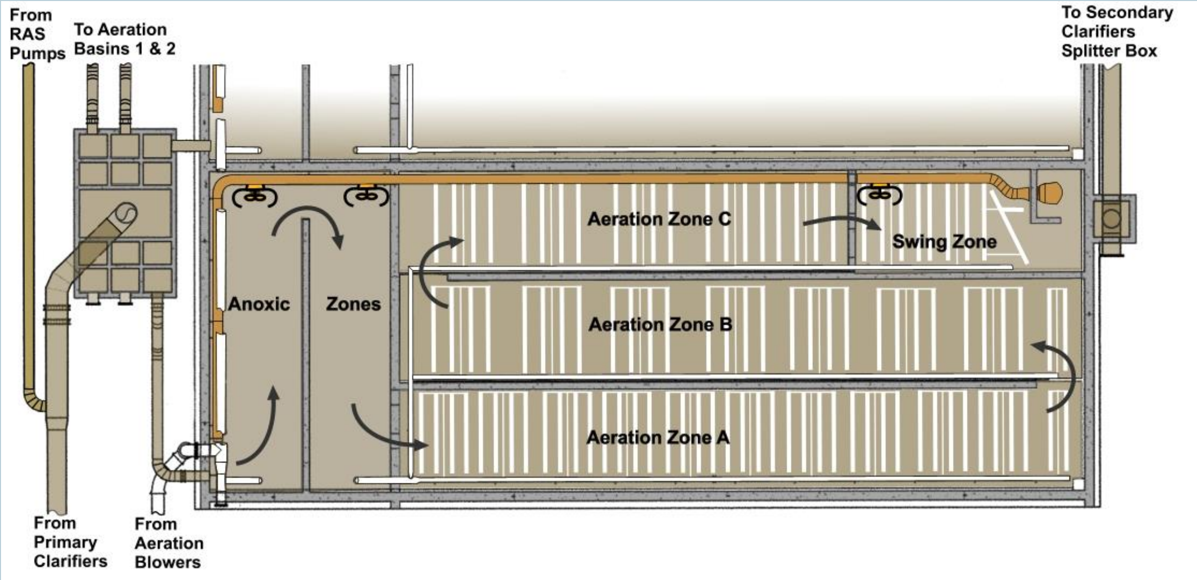
## Conventional Primary Clarifier






## Conventional Secondary Treatment with Activated Sludge

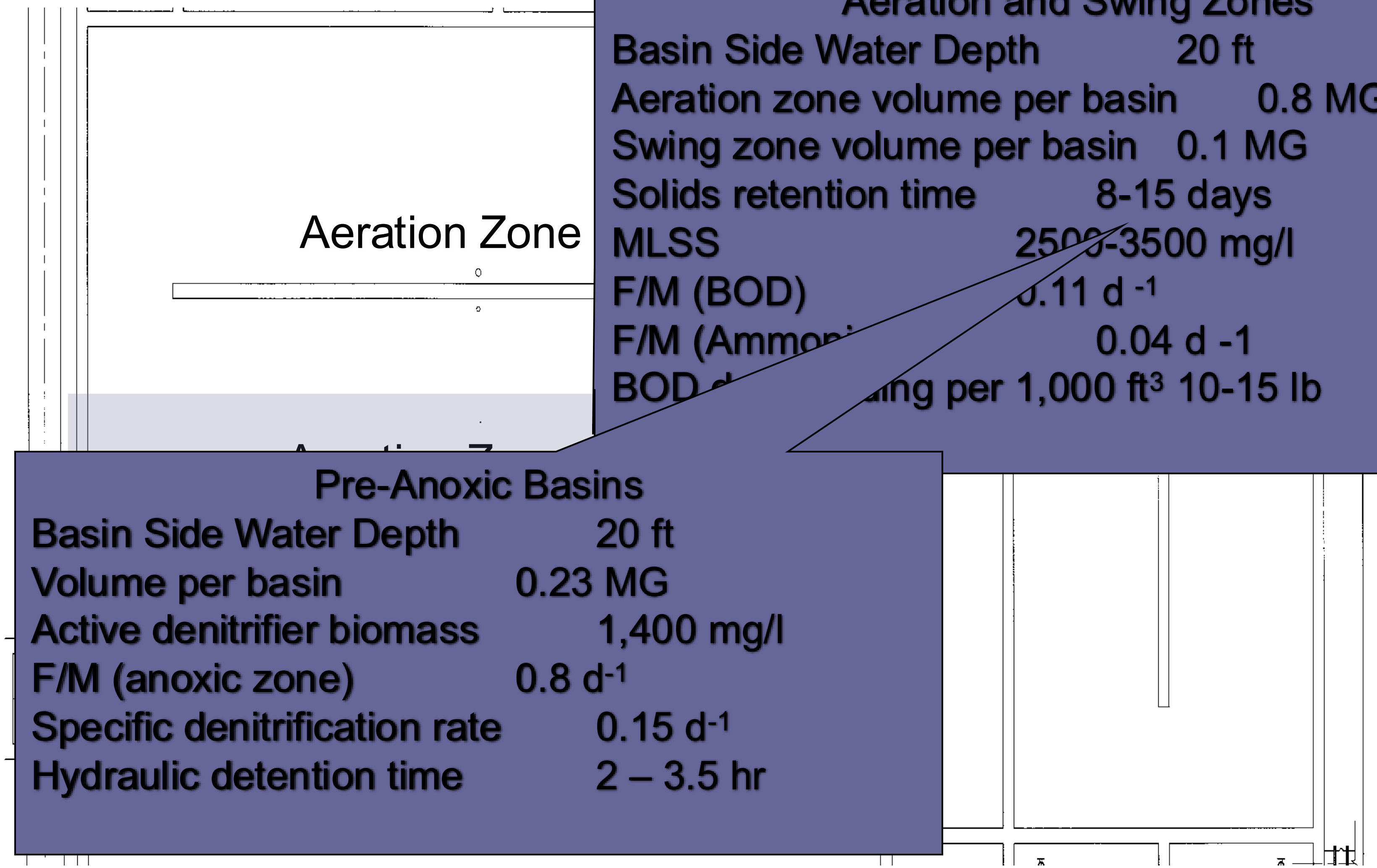


# LINDA COUNTY WATER DISTRICT WWTP

# Primary Clarifiers

# Activated Sludge Basins




**Aeration and Swing Zones**

| | |
|---|---|
| Basin Side Water Depth | 20 ft |
| Aeration zone volume per basin | 0.8 MG |
| Swing zone volume per basin | 0.1 MG |
| Solids retention time | 8-15 days |
| MLSS | 2500-3500 mg/l |
| F/M (BOD) | 0.11 $d^{-1}$ |
| F/M (Ammon | 0.04 d -1 |
| BOD d ing per 1,000 $ft^3$ | 10-15 lb |

**Pre-Anoxic Basins**

| | |
|---|---|
| Basin Side Water Depth | 20 ft |
| Volume per basin | 0.23 MG |
| Active denitrifier biomass | 1,400 mg/l |
| F/M (anoxic zone) | 0.8 $d^{-1}$ |
| Specific denitrification rate | 0.15 $d^{-1}$ |
| Hydraulic detention time | 2 – 3.5 hr |

# Demonstration Site – Linda WWTP

Brian Davis, PE

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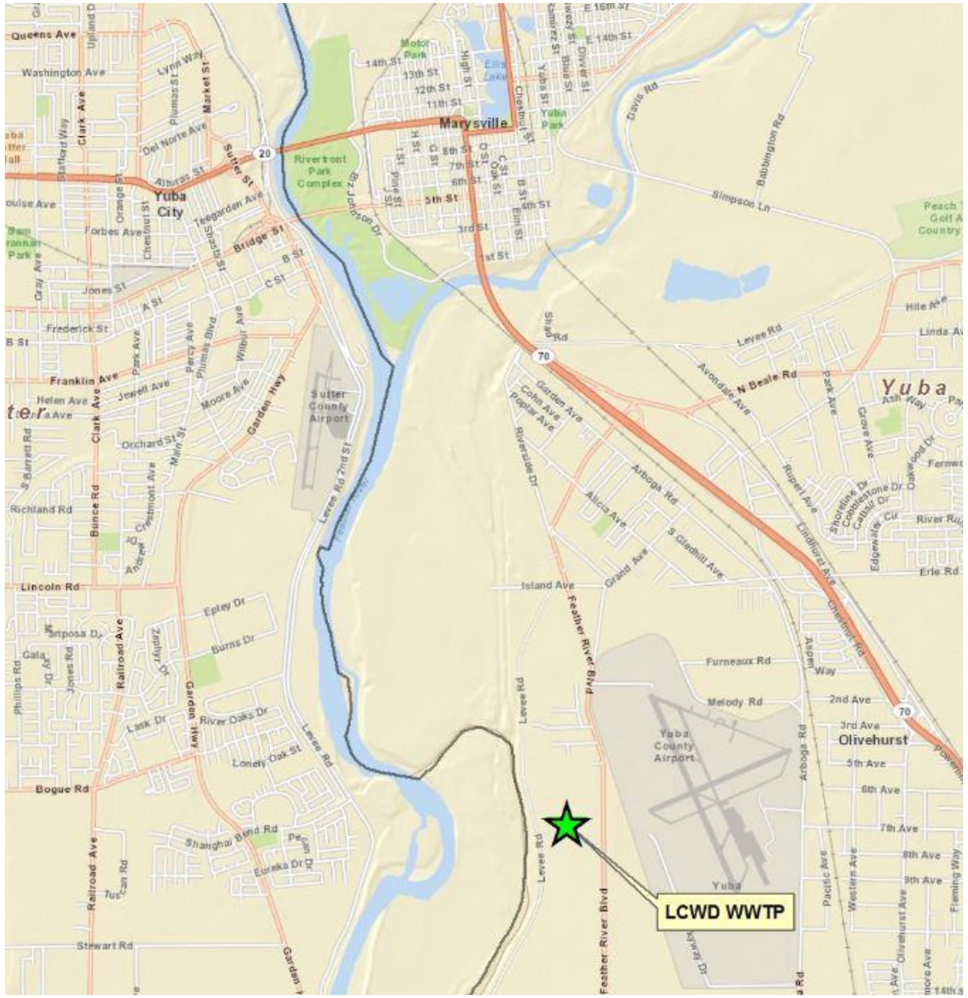
# LINDA COUNTY WATER DISTRICT

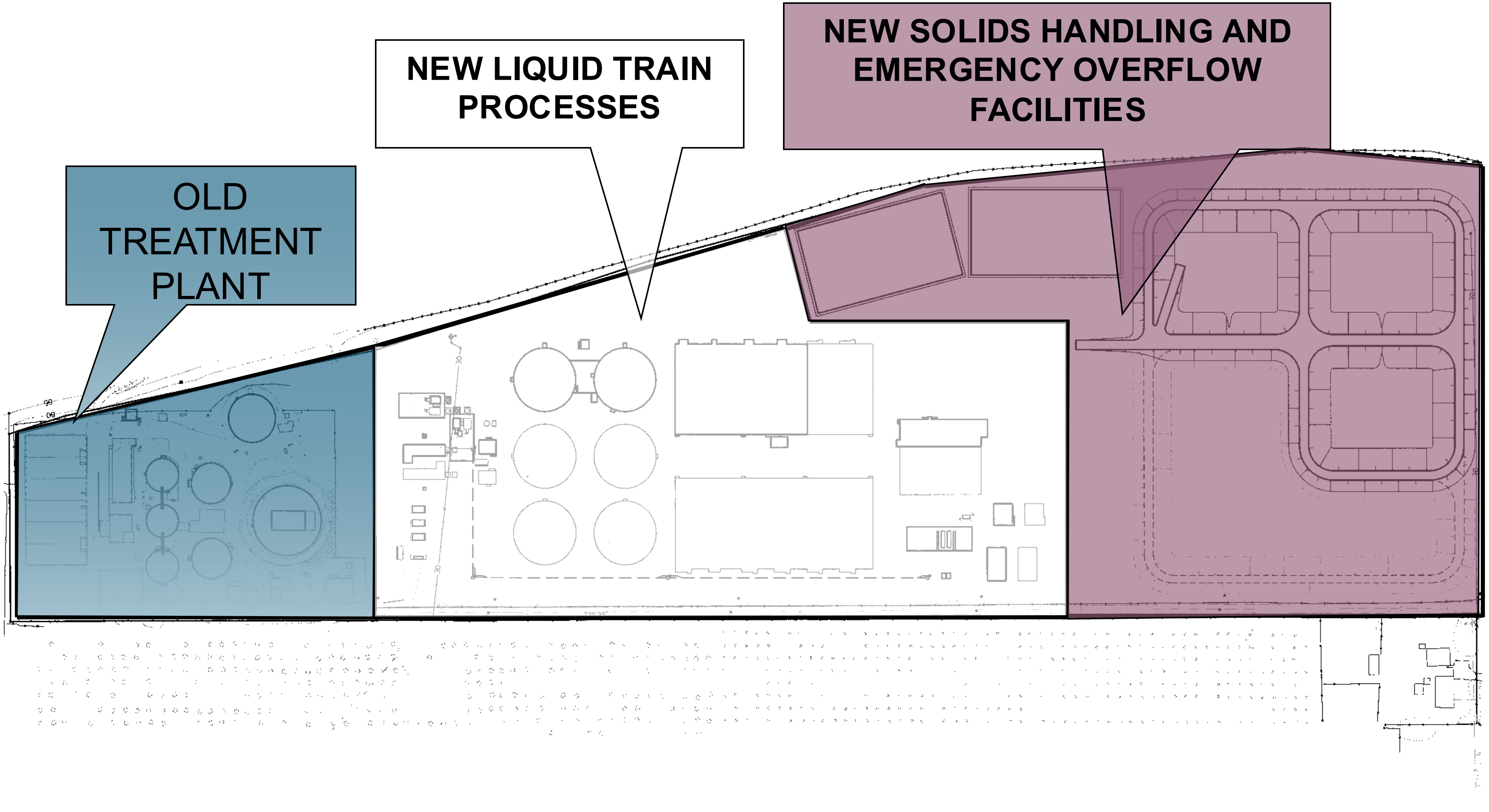
- Located in Yuba County, south of Marysville
- Provides water service to approximately 20,000 customers
- Provides wastewater treatment service to over 35,000 customers
- Serves primarily residential and light commercial
- Rural community was experiencing rapid growth due to development



# LINDA OLD WWTP

- Plant constructed in 1962 with land disposal and permitted river discharge.
- Secondary level plant with trickling filter, primary and secondary clarification and chlorination/de-chlorination.
- Capacity to treat average dry weather flow of 1.8 MGD.
- Growth from 1.8 MGD to 5.0 MGD
- Regulatory Consideration

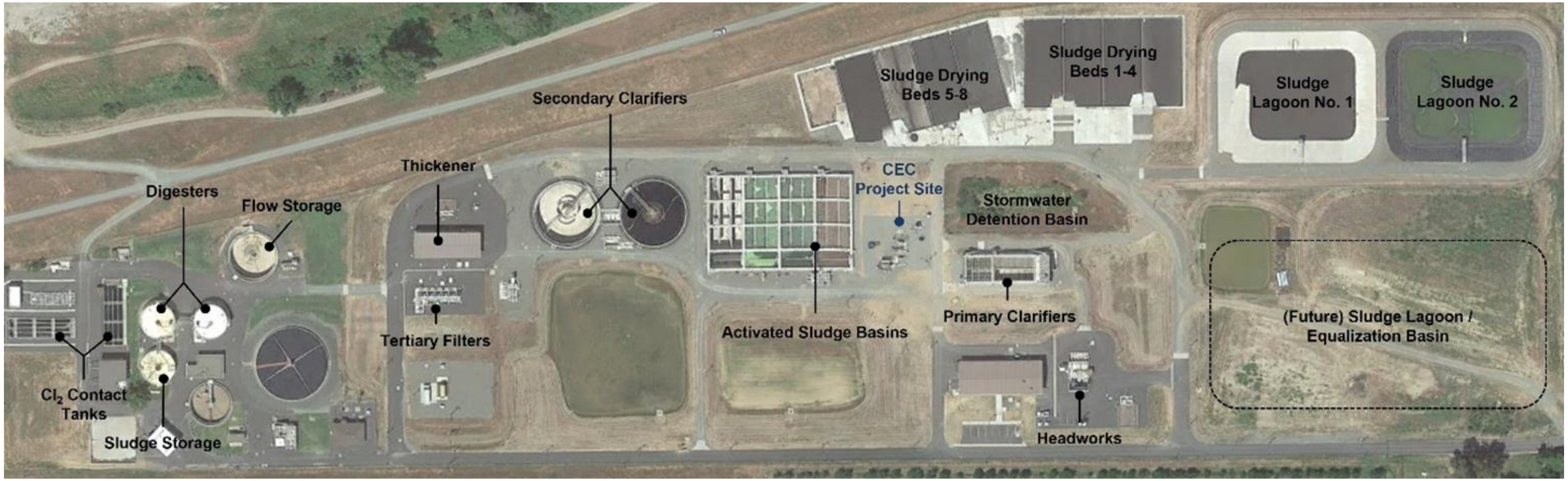
# LINDA COUNTY WATER DISTRICT WWTP EXPANSION/UPGRADE PROJECT



# Overall Design Features

- Energy savings
- Robustness
- Operational simplicity
- Expansion considerations: from 5 to 10-15 MGD
- Flexible Design

# LINDA COUNTY WATER DISTRICT WWTP




- 5.0 mgd permitted capacity, average flow 2.5 mgd
- Conventional Activated Sludge System, MLE Configuration
- New Permit[1] (issued in 2022) includes Nitrogen limits

| Parameter | Permit Limit (Monthly average ) |
|---|---|
| BOD, mg/L | 10 |
| TSS, mg/L | 10 |
| Turbidity, NTU | <2 |
| Ammonia, mg/L | 2.9 |
| Nitrate+Nitrite, mg/L | 10 |

1. Permit for LCWD WRRF (https://www.waterboards.ca.gov/rwqcb5/board_decisions/tentative_orders/2212/08_lindaco_npdes/lindaco_npdes.pdf)

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# Why is Linda involved in the project

- Potential energy savings
- Operator training for new technologies
- Environmental Stewardship
- Engineering support
- Familiarize with emerging technologies for:
    - Intensification / capacity increase
    - Energy savings
    - Performance increase

# ADVANCED PRIMARY TREATMENT TECHNOLOGIES

Onder Caliskaner, PhD, PE

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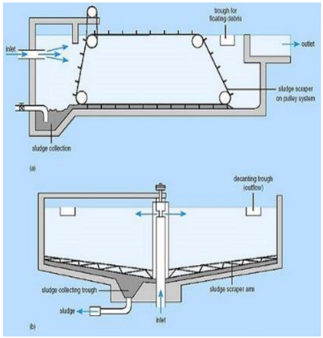
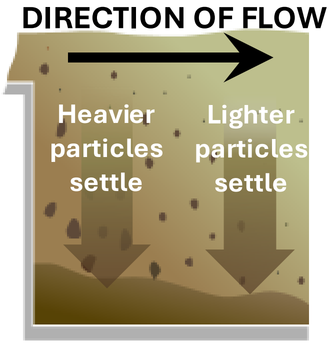
# Conventional Primary Treatment

Initial removal of organic and inorganic contaminants

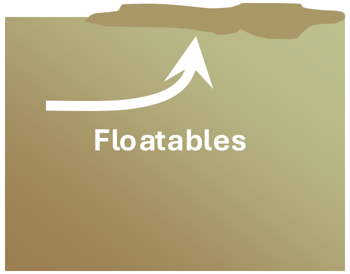
| Typical Performance | |
|---|---|
| **Residence Time** | 2-3 hours |
| **Solids Removal Efficiency** | 50-60% |
| **Organic Matter Removal Efficiency** | 25-30% |



Rectangular or Circular Tanks




Sedimentation of Settleable Solids

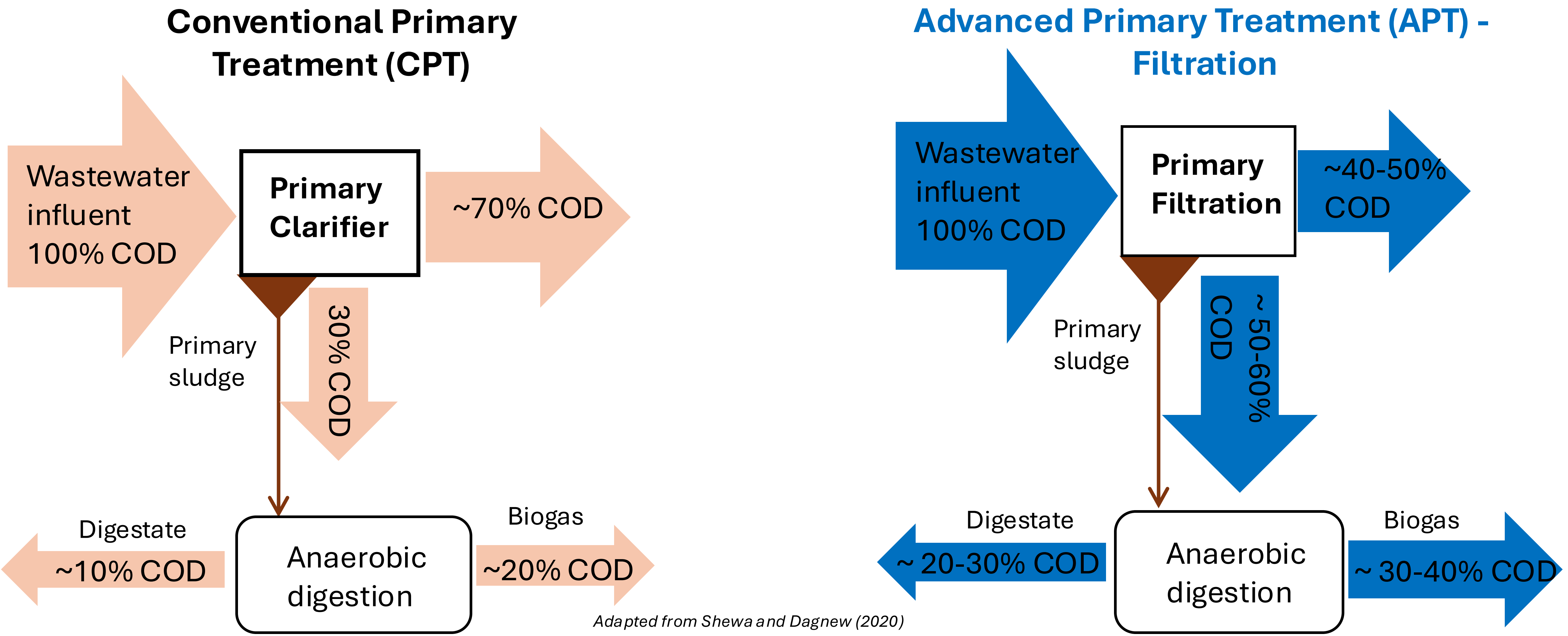



Skimming of Floatables

Requires **Large concrete basins**

**Essential for reducing the loads to the energy intensive secondary treatment**

# Enhancing Carbon Diversion for Energy-Savings with Advanced Primary Treatment




*Adapted from Shewa and Dagnew (2020)*

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# Advanced Primary Treatment Technologies Energy/Capacity/Performance Benefits

Secondary Treatment Capacity 15-30 %

Primary Effluent Water Quality 40-50%

Digester Biogas Energy Production 30-40%

Power and Capital Cost

Aeration Energy Decrease 20-40%

Primary Treatment Footprint Reduction 50 to 80%

Secondary Treatment Footprint reduction 15-30%

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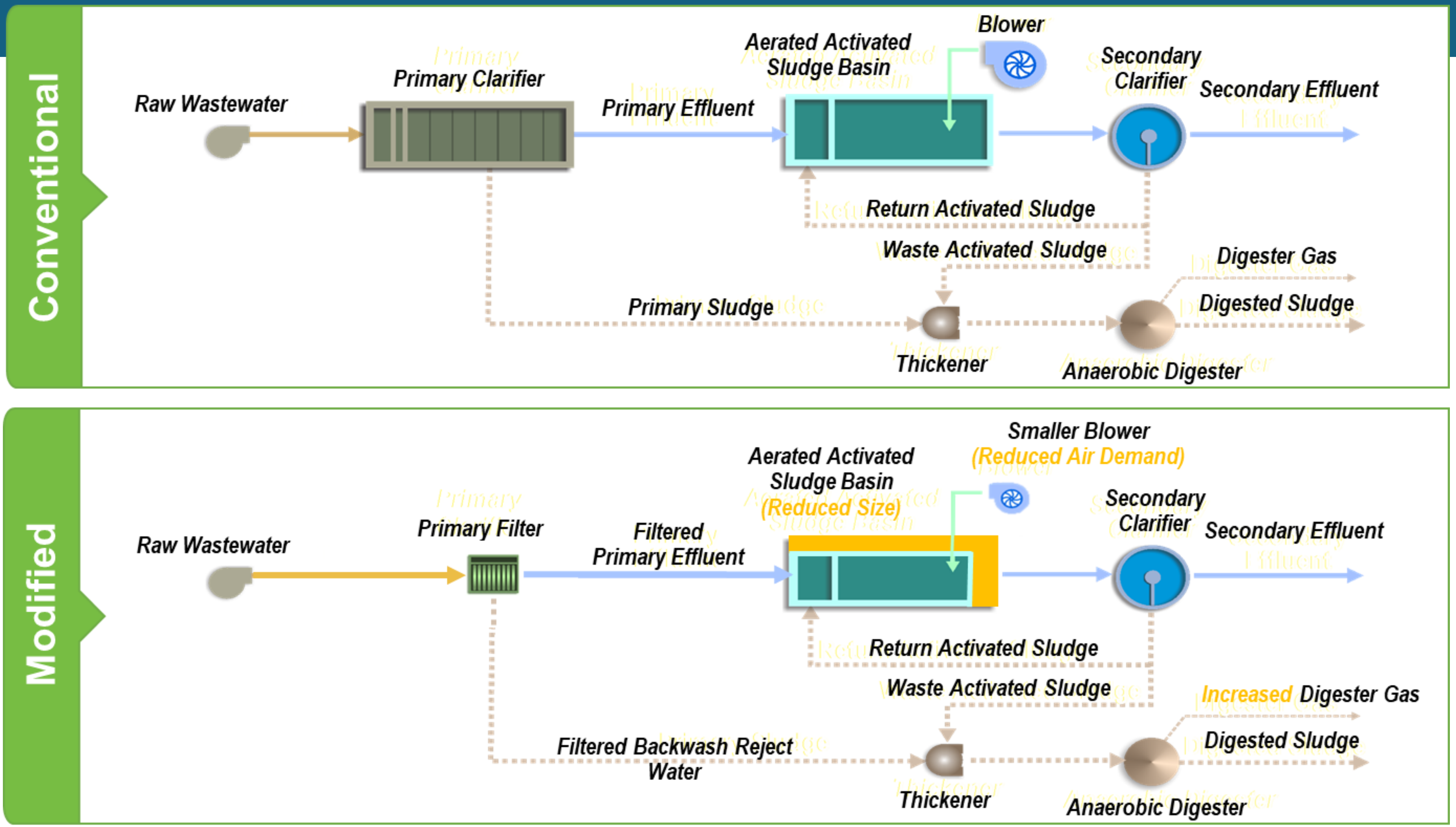
# Replacing Primary Clarifier with Primary Filter

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# Advanced Primary Treatment Technologies

### Cloth Disk Primary Filter

- Aqua-Aerobics
- Full-scale
- Average 1.2 MGD
- Peak 2.5 MGD
- In operation since April 2022

### Proteus Filter

- Tomorrow Water
- Demonstration-scale
- Average 0.02 MGD
- Peak 0.03 MGD
- In operation since July 2023

### Micro-Screen

- Huber
- Full-scale
- Average 0.3 MGD
- Peak 0.7 MGD
- Finished in December 2023

### Compressible Media Biofilter

- WesTech
- Demonstration-scale
- Average 0.06 MGD
- Peak 0.15 MGD
- Finished in September 2024

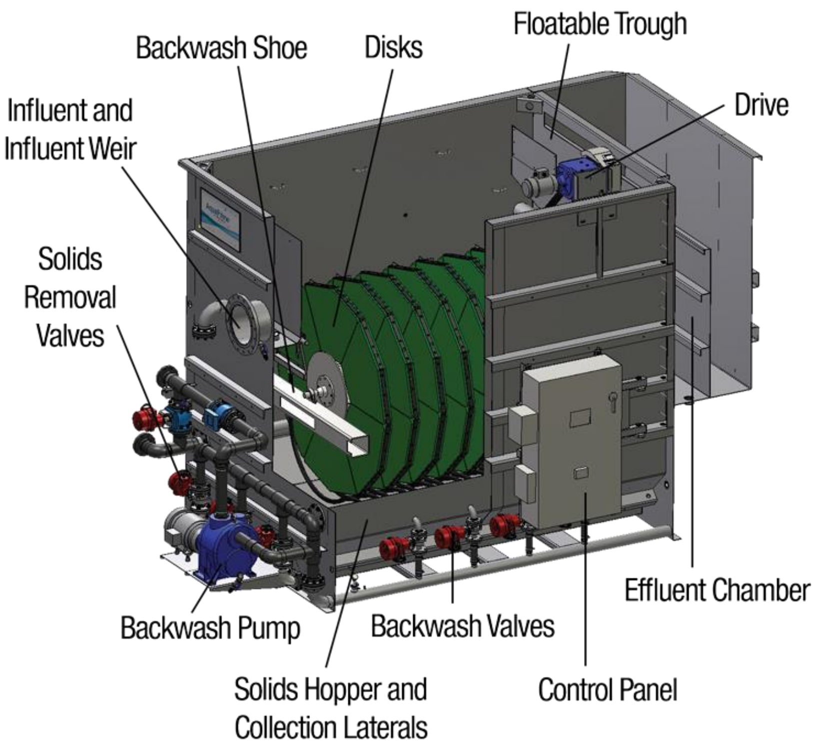
# Cloth Disk Primary Filter

Technology Provider: Aqua-Aerobics System Inc.

# Overview of APT Technologies

## Cloth Disk Primary Filter (Outside-in)

## Aqua-Aerobic Systems, Inc.





Courtesy of Aqua-Aerobic Systems

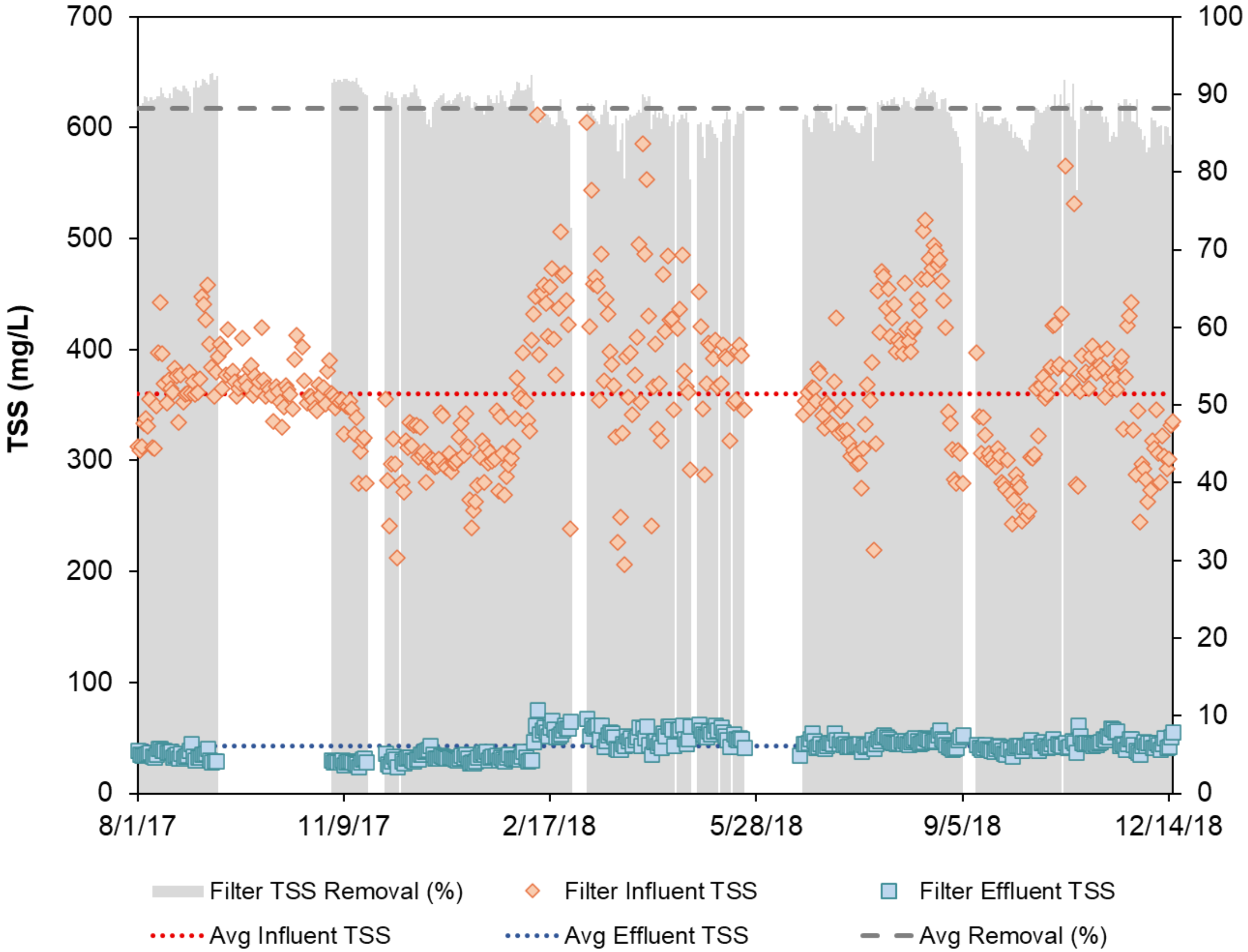
- Filtration and settling based process receiving primary wastewater after headworks
- Utilizing pile cloth media with pore size of 5-µm to remove organic and solids

# Operation of CDPF


Courtesy of Aqua-Aerobic Systems Inc.

# Treatment Performance - Cloth Disk Primary Filter

## Results from Previous Demonstration Projects at Linda WWTP

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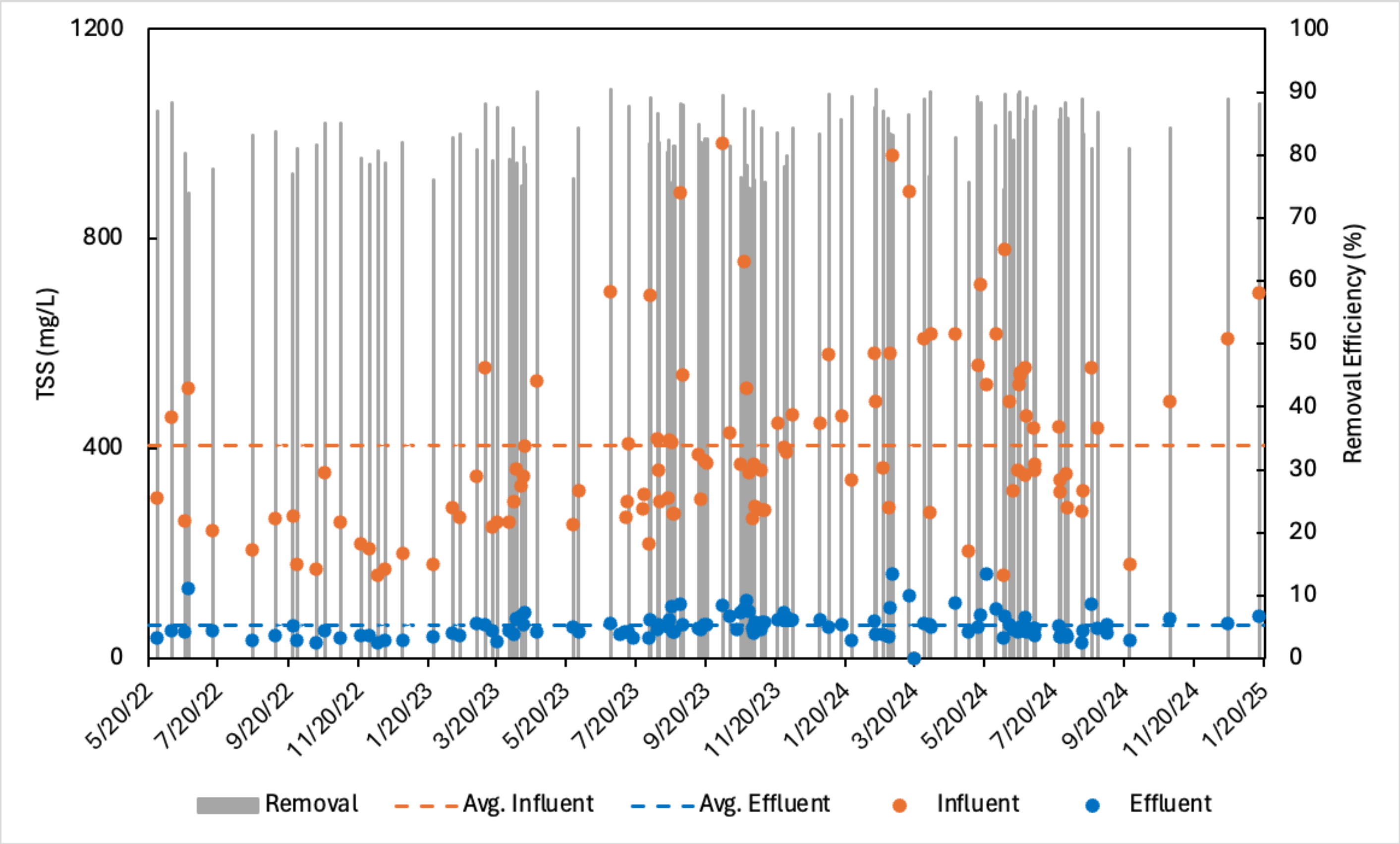
# Treatment Performance - Cloth Disk Primary Filter

## Total Suspended Solids (TSS)




- Started operation in May 2022
- TSS results are based on 24-h composite and grab samples (n:148)
  - Average Influent: 405 mg/L
  - Average Effluent: 63 mg/L
  - Average Removal: 84 %
- Average TSS removal from previous projects:
  - Linda, CA: 82%
  - Lancaster, CA: 83%
  - Manteca, CA: 83%
  - Sand Island, HI: 78%
  - Wailua, HI: 86%
  - Village Creek, TX: 88%


Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orleans, LA.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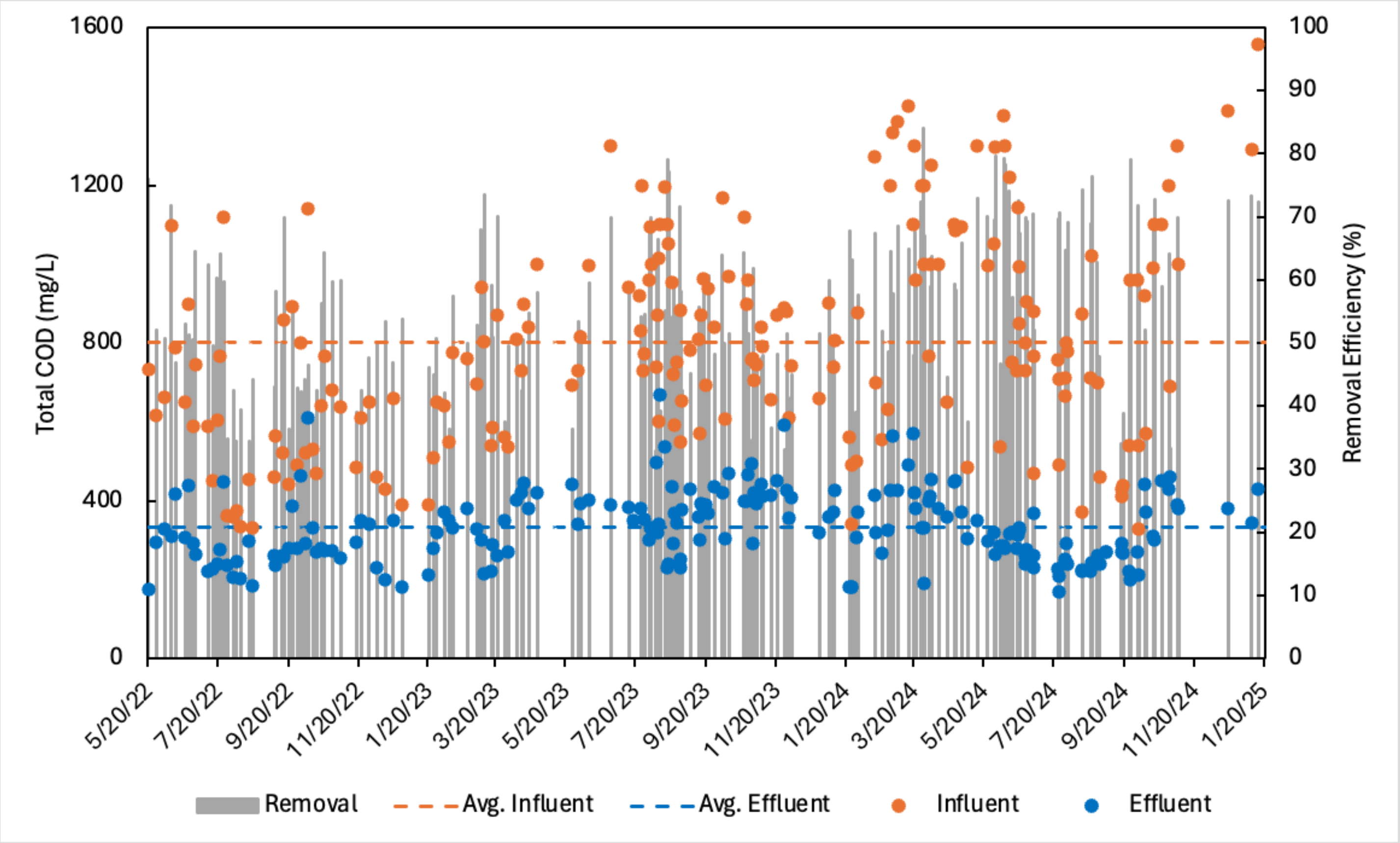
# Treatment Performance - Cloth Disk Primary Filter

## Total Chemical Oxygen Demand (COD)




- Started operation in May 2022
- tCOD results are based on 24-h composite and grab samples (n:175)
  - Average Influent: 803 mg/L
  - Average Effluent: 333 mg/L
  - Average Removal: 56 %
- Average tCOD removal from previous projects:
  - Linda, CA: 57%
  - Lancaster, CA: 55%
  - Manteca, CA: 47%
  - Sand Island, HI: 54%
  - Wailua, HI: 47 %
  - Village Creek, TX: 64%


Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orleans, LA.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# Implementation Status

- Numerous pilot/demonstrations
- >5 Operational in US
- >10 Design and construction in US


Courtesy of Aqua-Aerobic Systems

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# Advantages - Intensification/Compact Footprint

- Significant footprint reduction (e.g., up to 70 %) compared to conventional primary treatment system
- Average flow treatment capacity of 1.2-1.5 MGD with a footprint of 220 $ft^2$
- Potential of retrofitting into existing infrastructures

Courtesy of Aqua-Aerobic Systems

# Advantages - Energy Savings

- Low hydraulic head required
- Up to 30-40% reduction in aeration power consumption
- Up to 30-40% increase in digester gas production
- Up to 20-30% increase in secondary treatment capacity

Courtesy of Aqua-Aerobic Systems

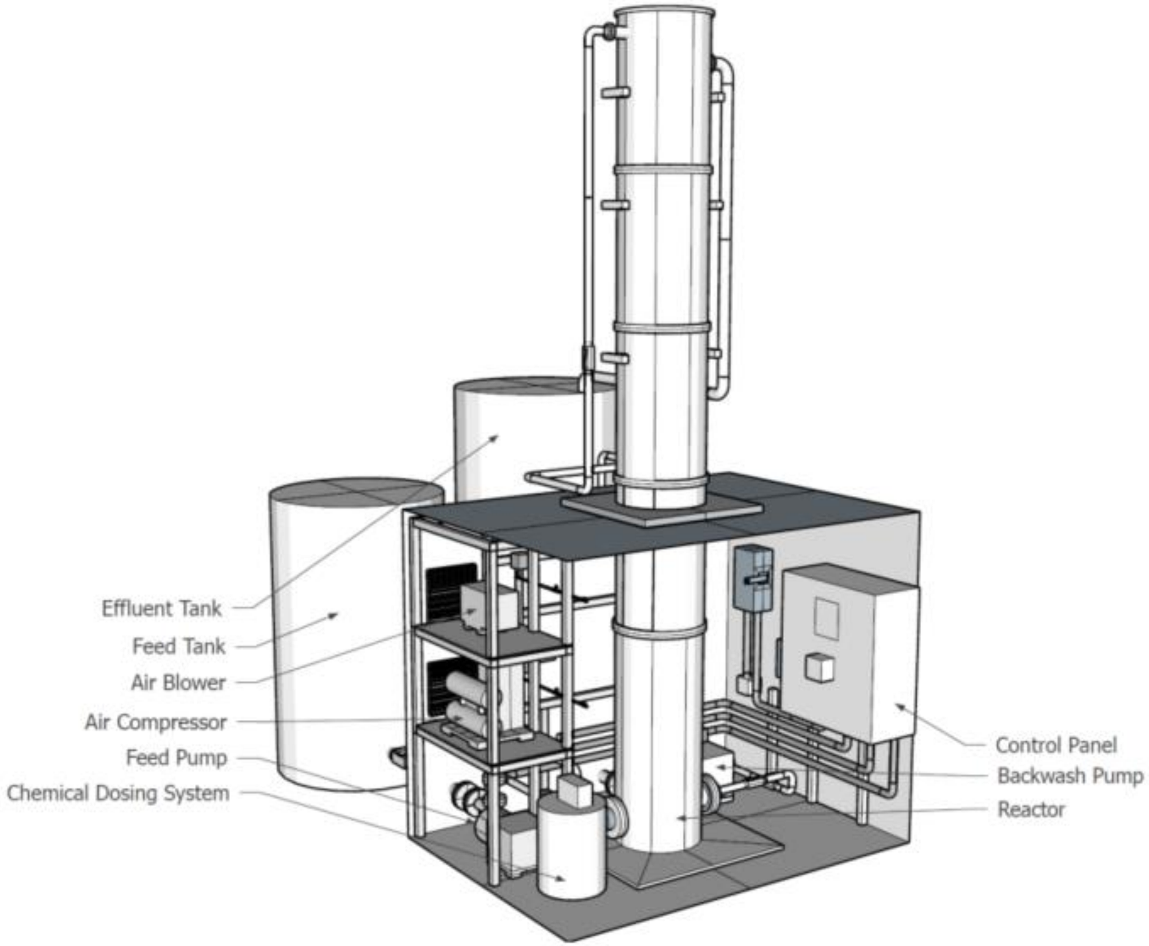
# Challenges / Additional Design Consideration

- Large filter backwash reject and sludge volume production
  - Reject/Sludge with low solids concentration
  - Thickening step is required
  - Sludge characteristics and quantities need to identified
- Impacts on downstream BNR

# Proteus Filter

Technology Provider: Tomorrow Water

# Pilot Set – up at Linda WWTP





Courtesy of Tomorrow Water

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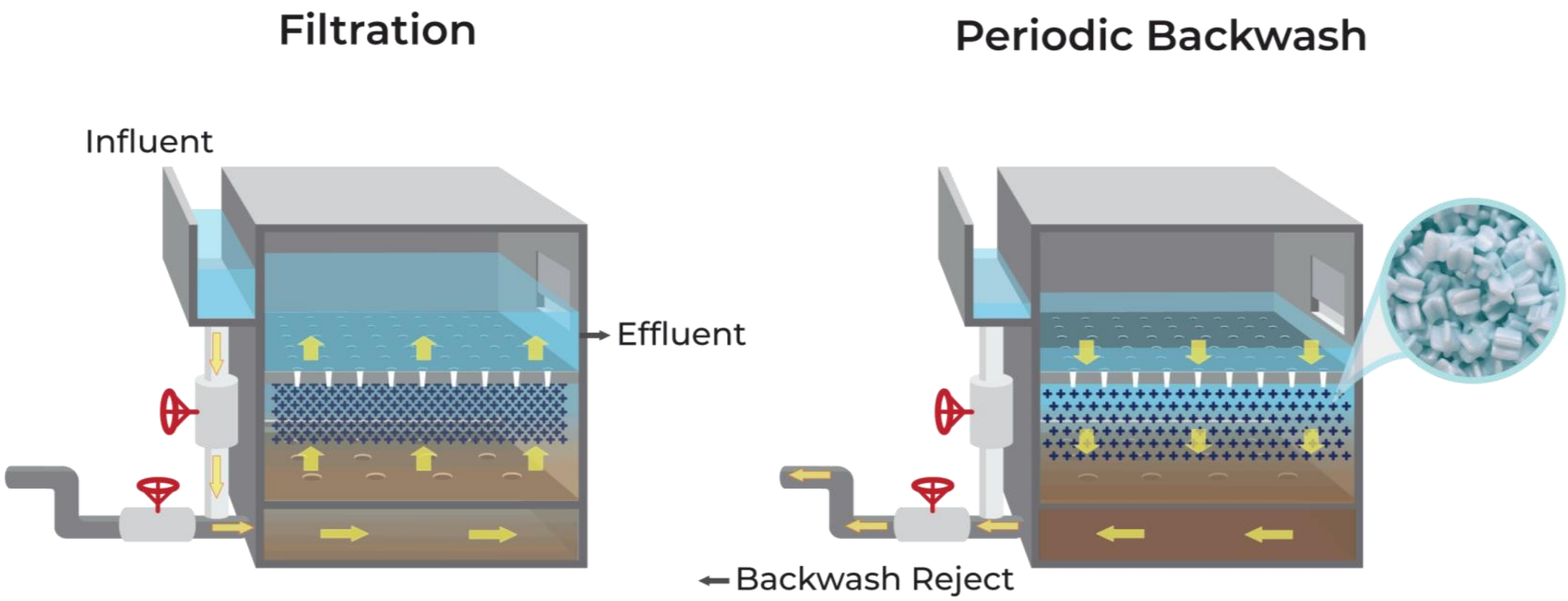
# Overview of APT Technologies

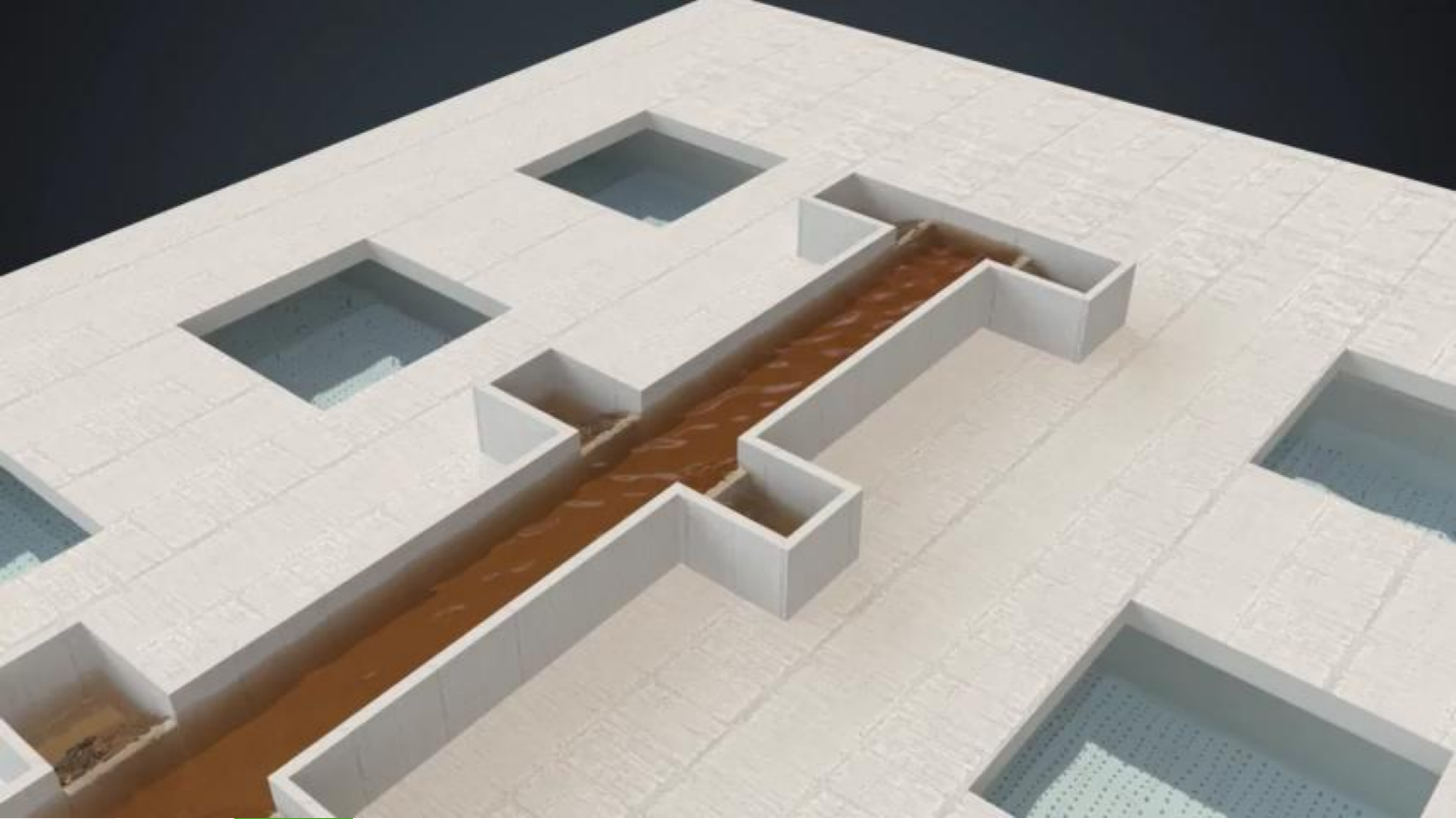
## Proteus Filter

## Tomorrow Water




Courtesy of Tomorrow Water

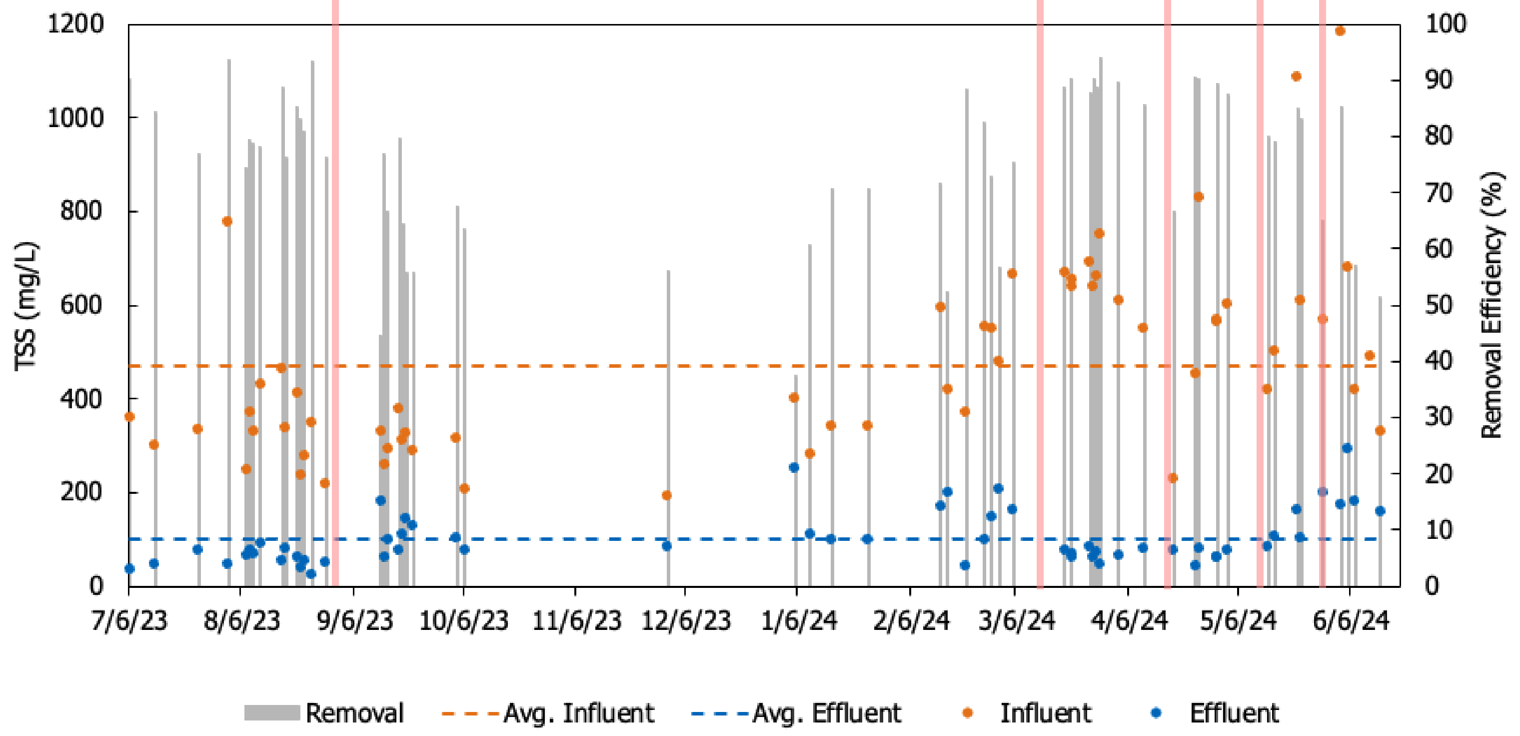
- Up-flow filtration-based process feed with primary wastewater after headworks
- Utilizing cross shaped Expanded Polyproylene (EPP) beads as filtration media



# Treatment Performance – Proteus Filter[1,2]

## Total Suspended Solids (TSS)

| | Phase 1 | Phase 2 | Phase 3 | P4 | P5 | P6 |
|---|---|---|---|---|---|---|
| HLR (gpm/sf) | 2 | 6 | 2 | 2 | 4 | 6 |
| Media H. (ft) | 6.6 | 6.6 | 6.6 | 5 | 5 | 5 |




Average Influent TSS = 471 mg/L

Average Effluent TSS = 100 mg/L

Average Removal Efficiency = 76%

1. On-going demonstration since July 2023 and the Proteus Filter is scheduled to operate at different filtration rates (e.g., 2 gpm/sf, 6 gpm/sf) and different media height (e.g., 1.5m, 2m).
2. Media H. = Media Height

Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orleans, LA.

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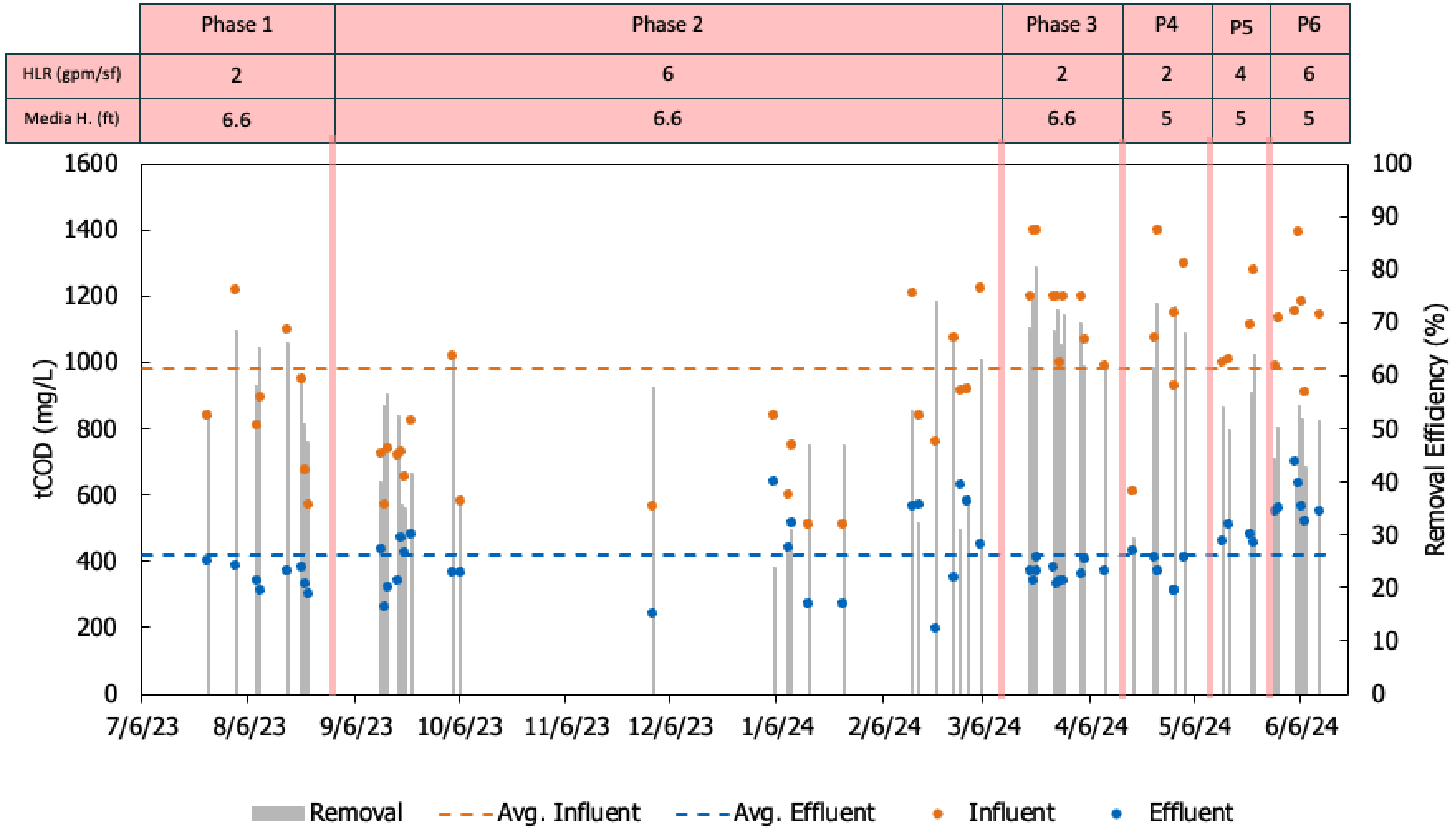
# Treatment Performance – Proteus Filter[1,2]

## Total Chemical Oxygen Demand (COD)




Average Influent COD = 981 mg/L

Average Effluent COD = 419 mg/L

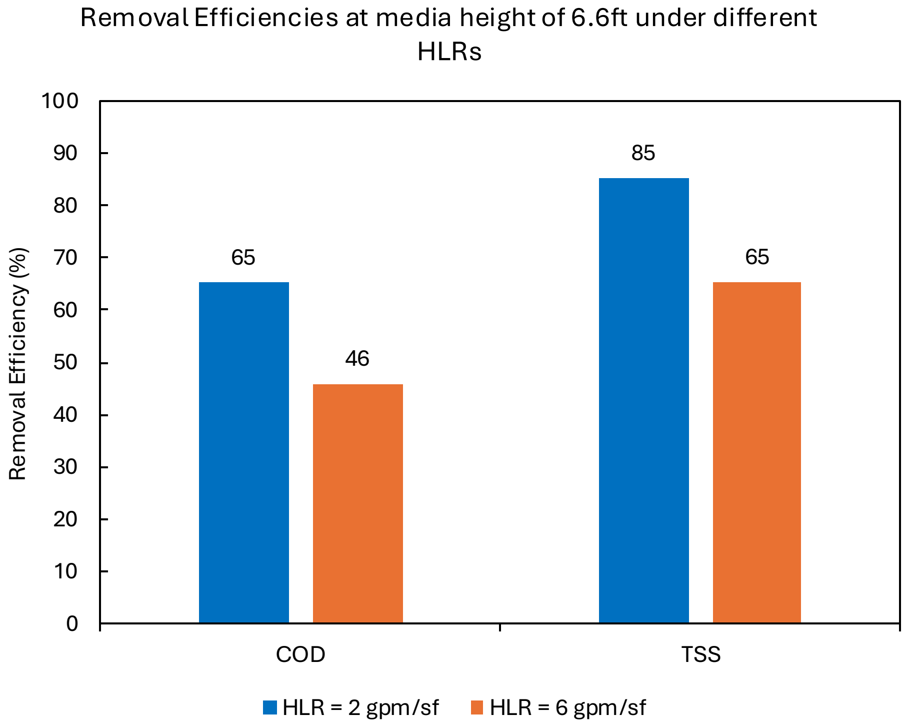
Average Removal Efficiency = 55%

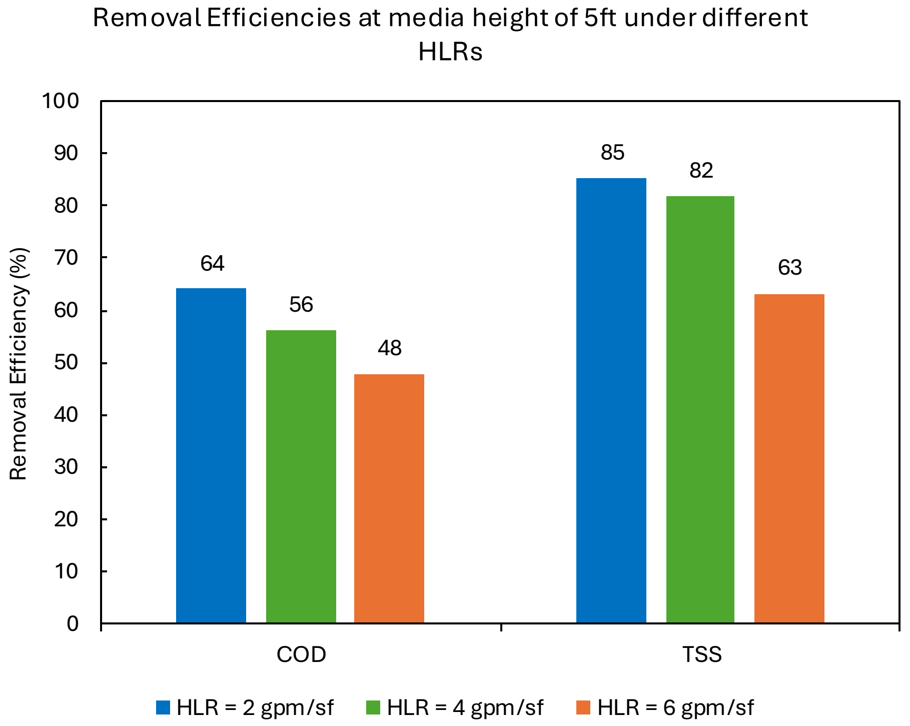
1. On-going demonstration since July 2023 and the Proteus Filter is scheduled to operate at different filtration rates (e.g., 2 gpm/sf, 6 gpm/sf) and different media height (e.g., 1.5m, 2m).
2. Media H. = Media Height


Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orleans, LA.

# Treatment Performance – Proteus Filter[1,2]

## At different HLRs and media heights

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# Implementation Status

- Two large (>50MGD) operational systems  in Korea for primary treatment
- Pilot / Full-scale demonstration projects happening in the US


Courtesy of Tomorrow Water

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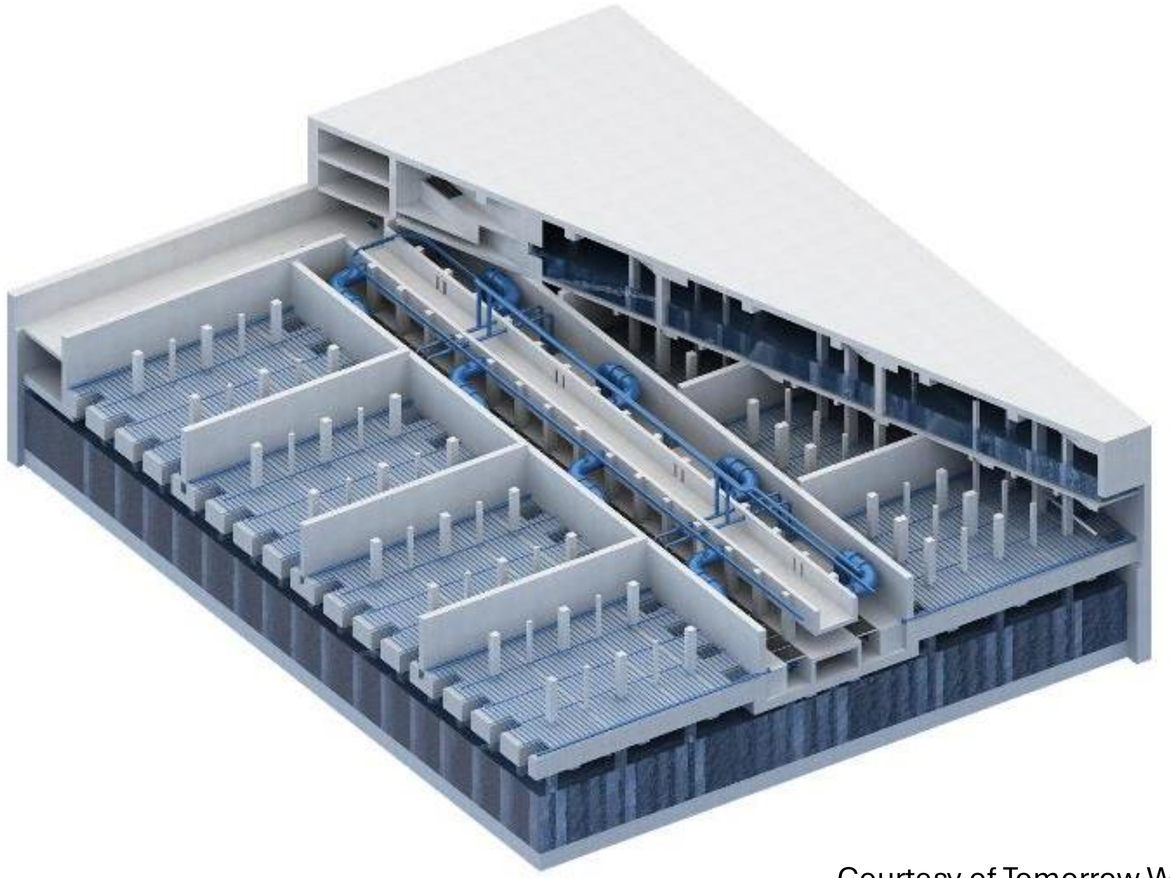
# Advantages - Improved Treatment Performance

- Higher organic and solids removal compared to conventional primary clarifier

- Potential soluble COD and nitrogen removal when added aeration supply



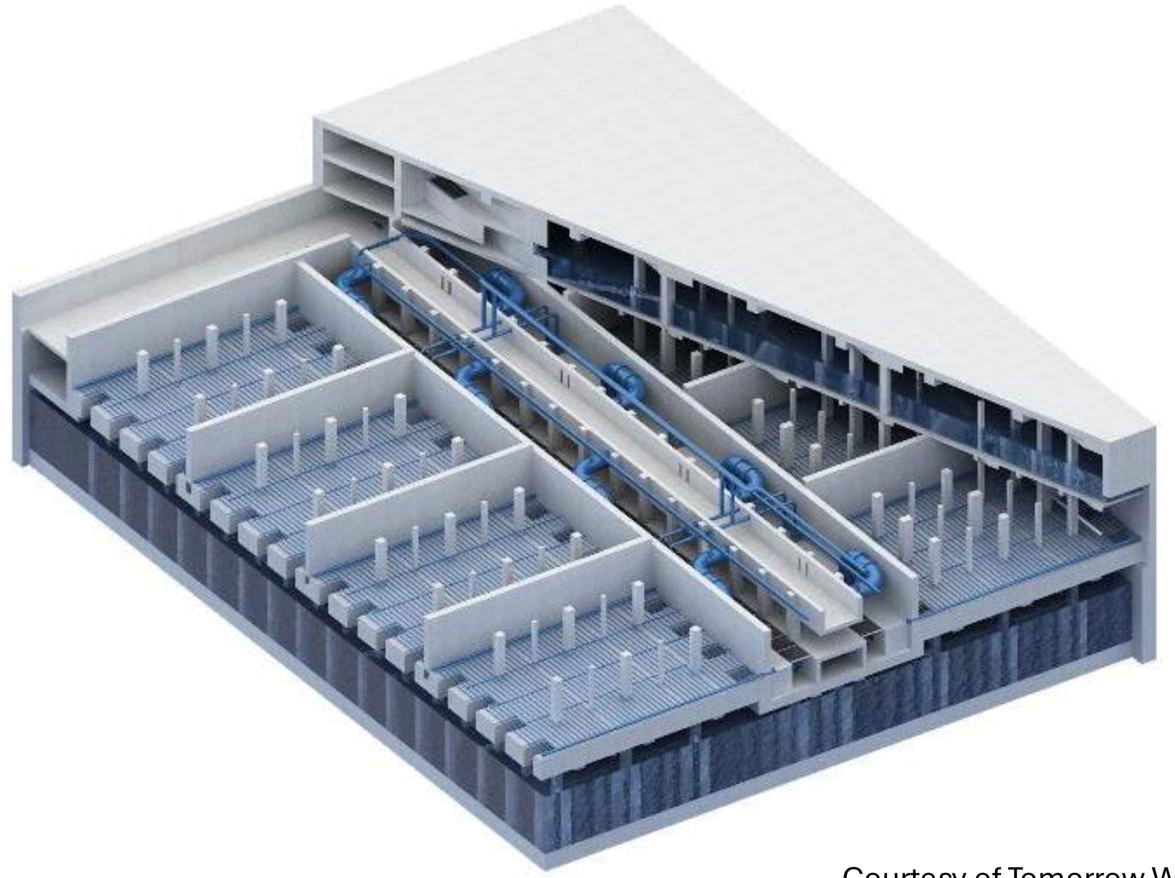
Courtesy of Tomorrow Water

CWT CALISKANER WATER TECHNOLOGIES

# Advantages - Intensification/Compact Footprint

- Full-scale installation can achieve significant footprint reduction (e.g., up to 70 %) compared to conventional primary treatment system

- Potential to retrofit into existing infrastructures

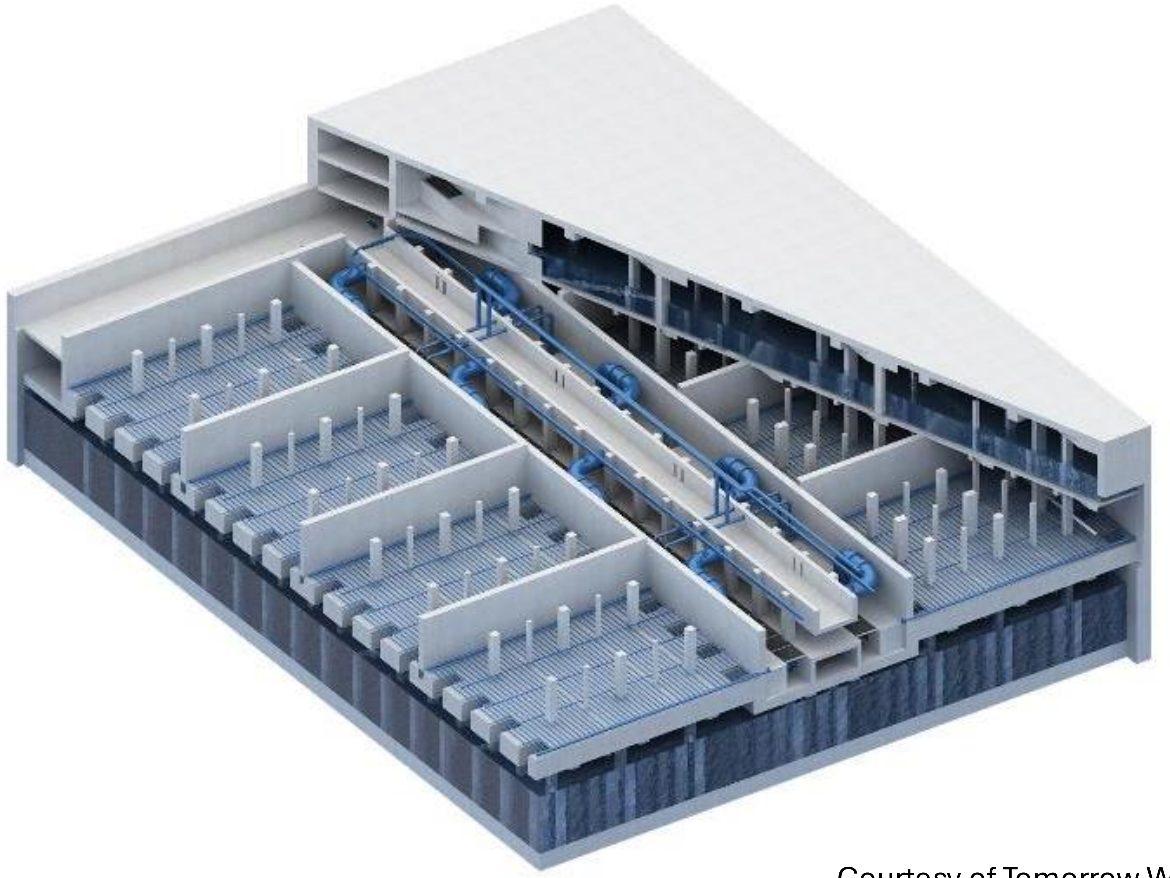


Courtesy of Tomorrow Water

# Advantages - Energy Savings

- Low power consumption

- For average loading rates:
    - Up to 30-40% reduction in aeration consumption
    - Up to 30-40% increase in digester gas production
    - Up to 20-30% increase in secondary treatment capacity



Courtesy of Tomorrow Water

# Challenges/Additional Design Consideration

- Moderate to large filter backwash reject volume production
    - Reject with low solids concentration
    - Thickening step is required
    - Sludge characteristics and quantities need to identified
- Higher hydraulic head requirement
- Impacts on downstream BNR

# Micro-Screen

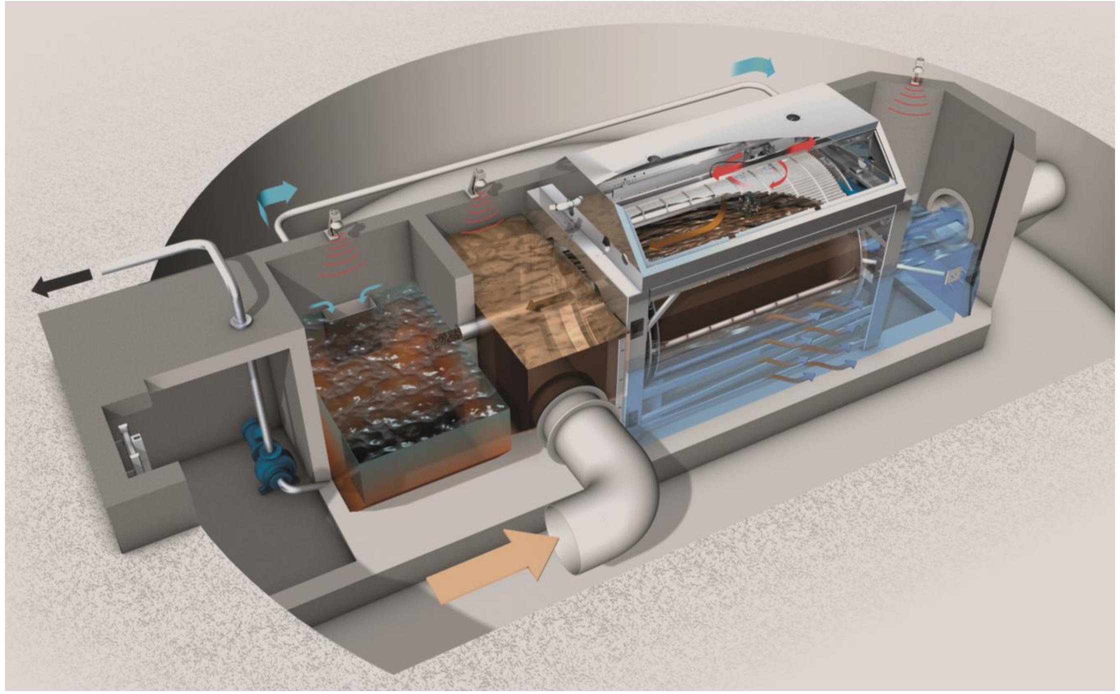
Technology Provider: HUBER

# Overview of APT Technologies

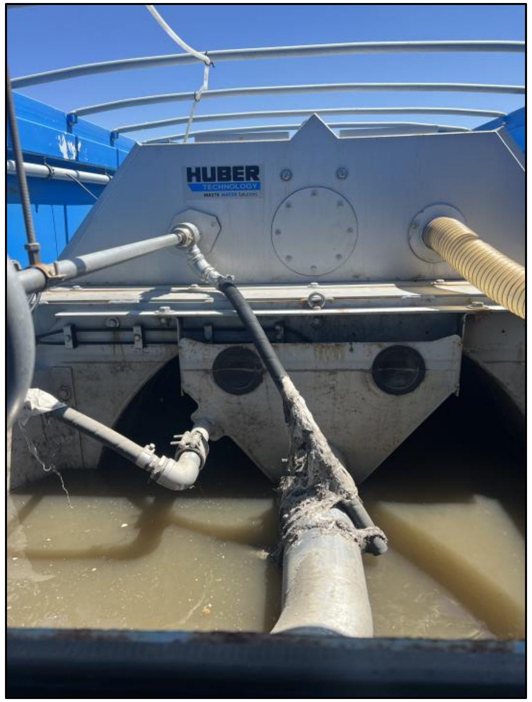
## Micro-Screen (Inside-Out)

## Huber

DSL basket with 200-μm SSTL mesh

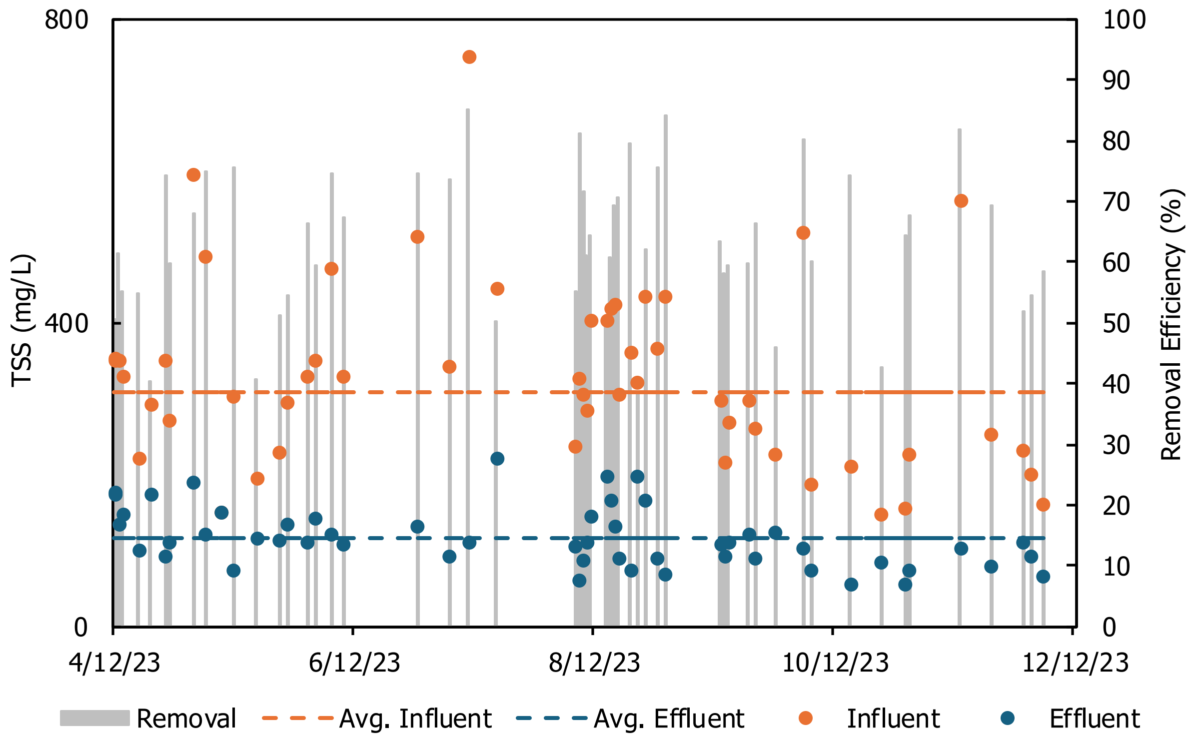


Courtesy of Huber




- Screening based process receiving primary wastewater after headworks
- Utilizing stainless steel mesh with pore size of 200-μm
- Wastewater is filtered through drum screen inside to outside

# Treatment Performance - MicroScreen
## Total Suspended Solids (TSS)




Average Influent TSS = 328 mg/L

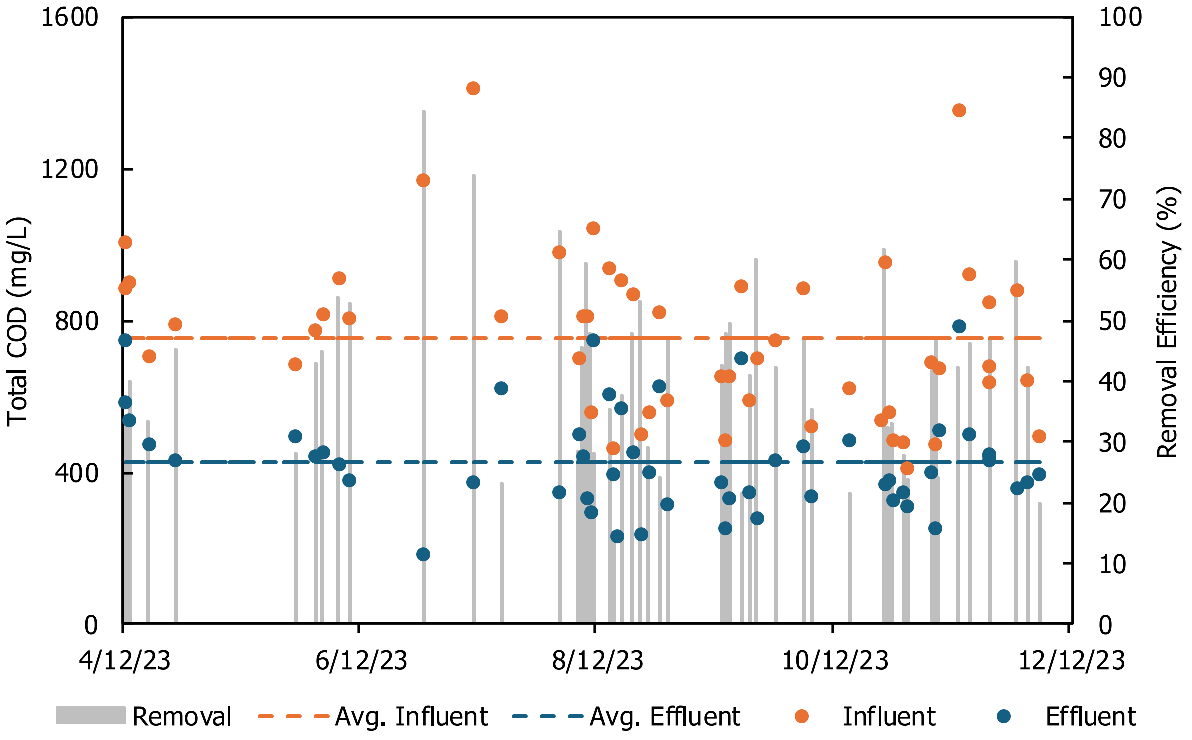
Average Effluent TSS = 115 mg/L

Average Removal Efficiency = 63%


Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orleans, LA.

# Treatment Performance - MicroScreen

## Total Chemical Oxygen Demand (COD)




Average Influent tCOD = 751 mg/L

Average Effluent tCOD = 428 mg/L

Average Removal Efficiency = 41%


Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orleans, LA.


CWT CALISKANER WATER TECHNOLOGIES

# Implementation Status

- Multiple installations overseas in EU
- Pilot projects happening in the US

STP Øygarden WWTP, Norway

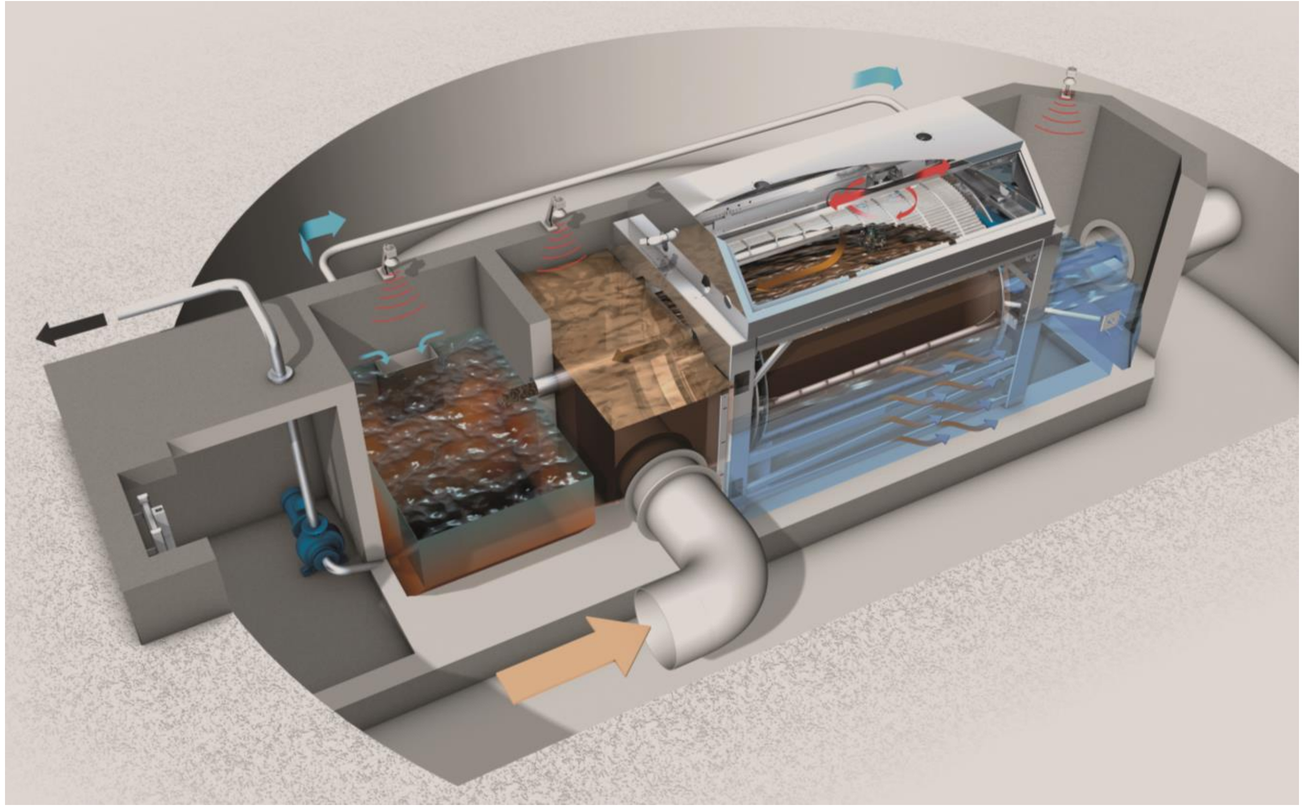
Courtesy of Huber

# Advantages - Intensification/Compact Footprint

- Comparable capacity and organic and solids removal to conventional primary clarifier with small footprint

- Significant footprint reduction (e.g., up to 70 %) compared to conventional primary clarifier

- Average flow treatment capacity of 0.5 MGD with footprint of approximately 120 $ft^2$

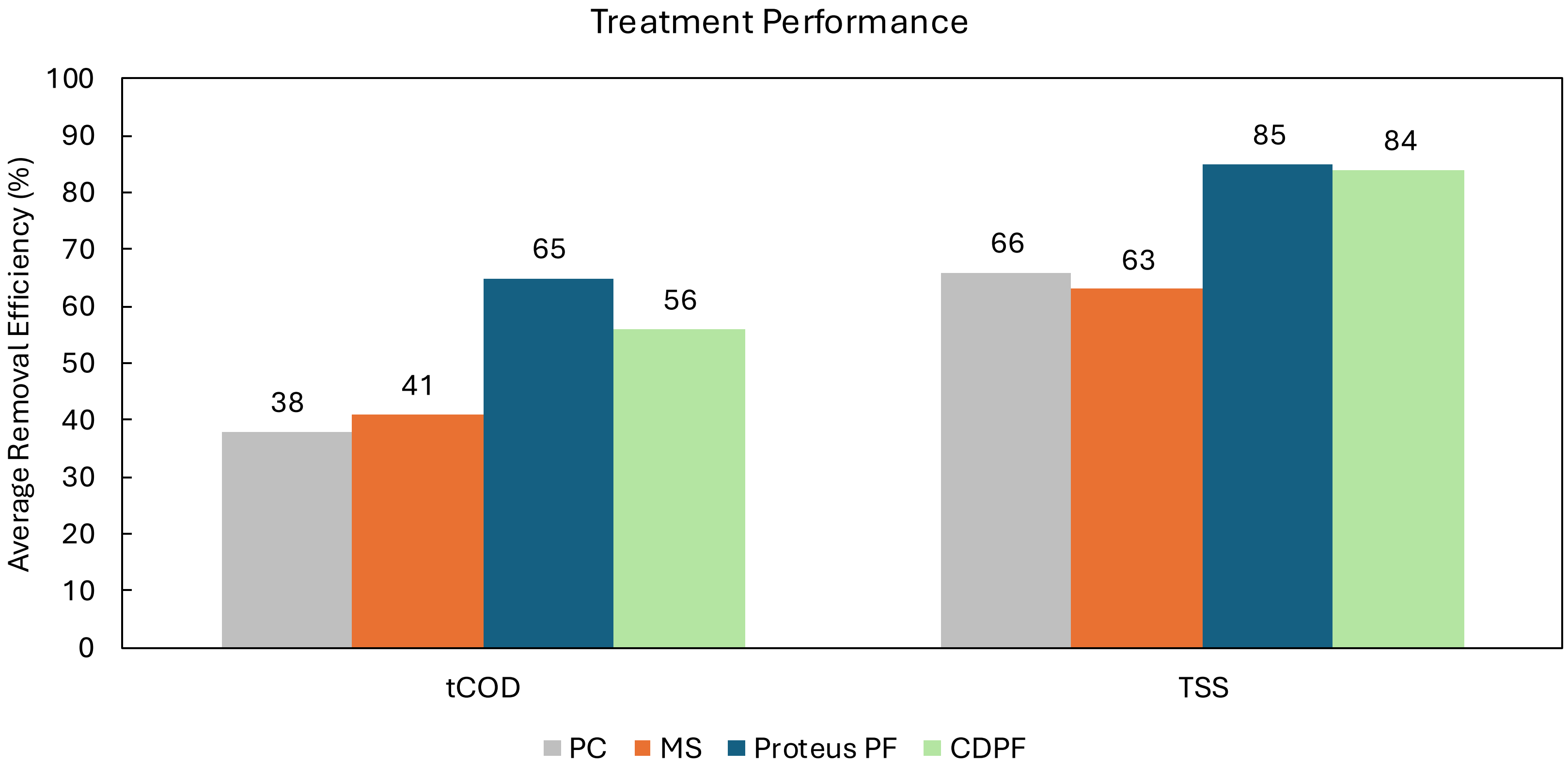


Courtesy of Huber

# Challenges/Additional Design Consideration

- Chemical required to exceed primary clarifier performance (i.e., by more than 5-15 %)
- Available largest unit size may limit its implementation for large plants (e.g., larger than 50-100 MGD)

# Conclusions - Advanced Primary Treatment Technologies

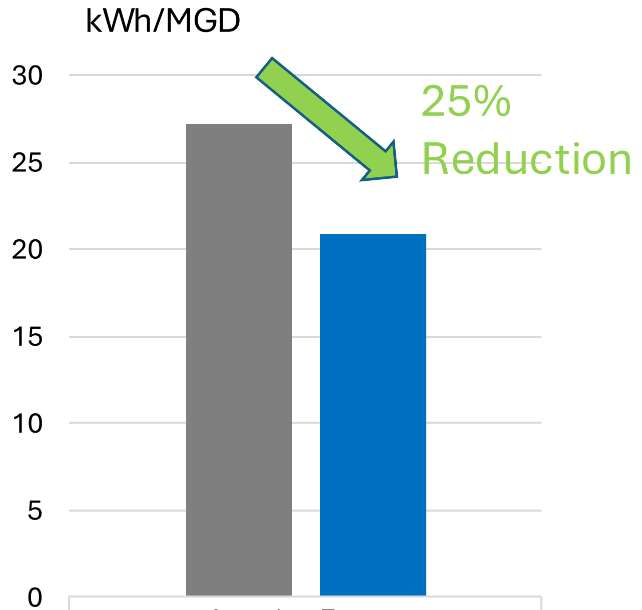



1. Micro-Screen was decommissioned in December 2023.
2. Results shown are obtained for average design hydraulic loading rates

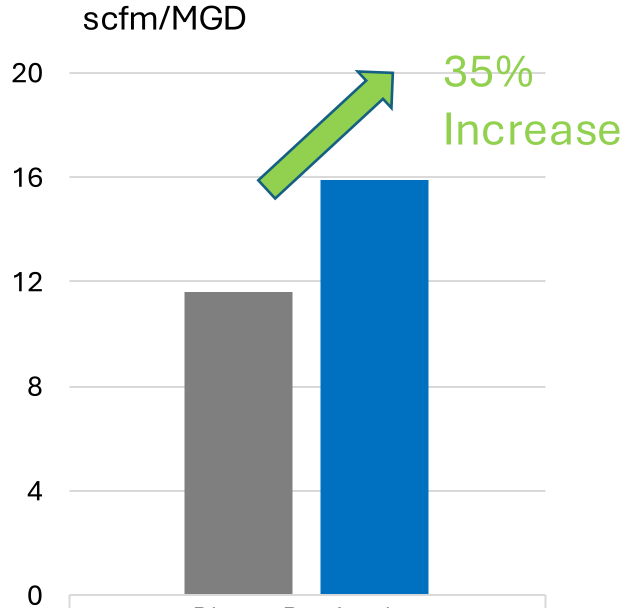
Caliskaner, et al. (2024). "Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference." New Orlean s, LA.

# Impacts of Advanced Primary Treatment on Energy Balance

## Aeration Energy Savings and Digester Gas Energy Recovery*




| | Aeration Energy |
|---|---|
| Conventional MLE | 27.20 |
| Advanced MLE | 20.88 |



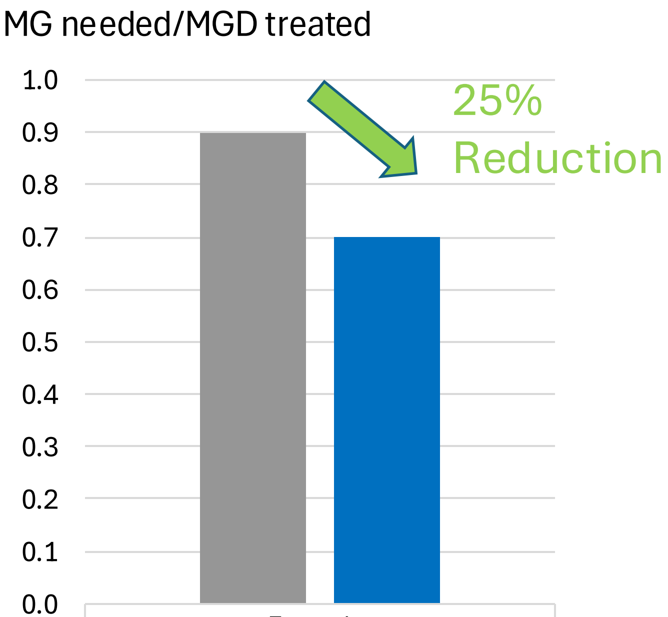

| | Biogas Production |
|---|---|
| Conventional MLE | 11.60 |
| Advanced MLE | 15.89 |

**Results are based on observed Primary Clarifier and Primary Filtration performances for specific conditions at Linda*

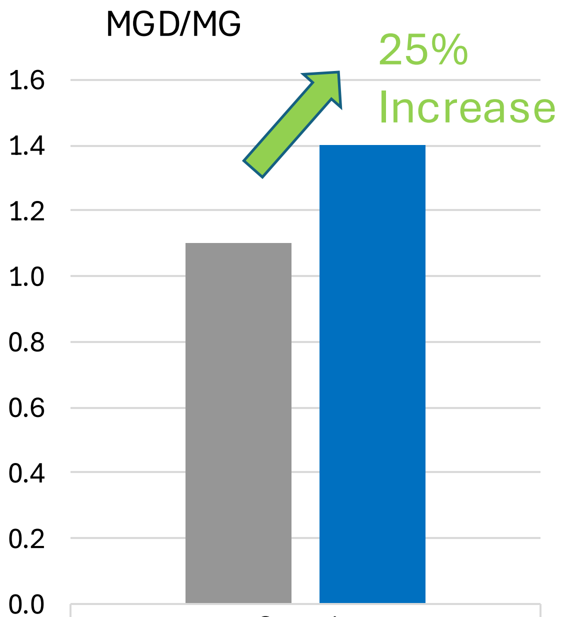
CWT CALISKANER WATER TECHNOLOGIES

# Impacts of Advanced Primary Treatment on Secondary Treatment

## Footprint Reduction for New Plants & Capacity Increase for Existing Systems*




| | Footprint |
|---|---|
| Conventional MLE | 0.90 |
| Advanced MLE | 0.70 |




| | Capacity |
|---|---|
| Conventional MLE | 1.10 |
| Advanced MLE | 1.40 |

**Results are based on observed Primary Clarifier and Primary Filtration performances for specific conditions at Linda*

CWT CALISKANER WATER TECHNOLOGIES

# Conclusions - Advanced Primary Treatment Technologies

| Comparison to Conventional Primary Treatment | CDPF %Range | MS %Range | Proteus Filter %Range |
|---|---|---|---|
| Increase in Treatment Removal Efficiency | 40-60 | 0-5 | 40-60 |
| Reduction in Aeration Power | 15-30 | 0-5 | 15-30 |
| Reduction in Primary Treatment Footprint | >60-70 | >60-70 | >60-70 |
| Increase in Secondary Treatment Capacity | 15-30 | 0-5 | 15-30 |
| Increase in Digester Gas Energy Production | 30-45 | 0-5 | 30-45 |

Caliskaner, et al. (2024). “Evaluation of Advanced Primary Treatment Technologies at Water Resource Recovery Facilities for Carbon Diversion and Management. Proceedings from 2024 Water Environment Federation Technical Exhibition and Conference.” New Orlean s, LA.

# Volute Thickener

Technology Provider: Process Wastewater Technologies

# Primary Filtration Challenge: Filter Backwash Sludge Needs to be Thickened

Thickening step is required:

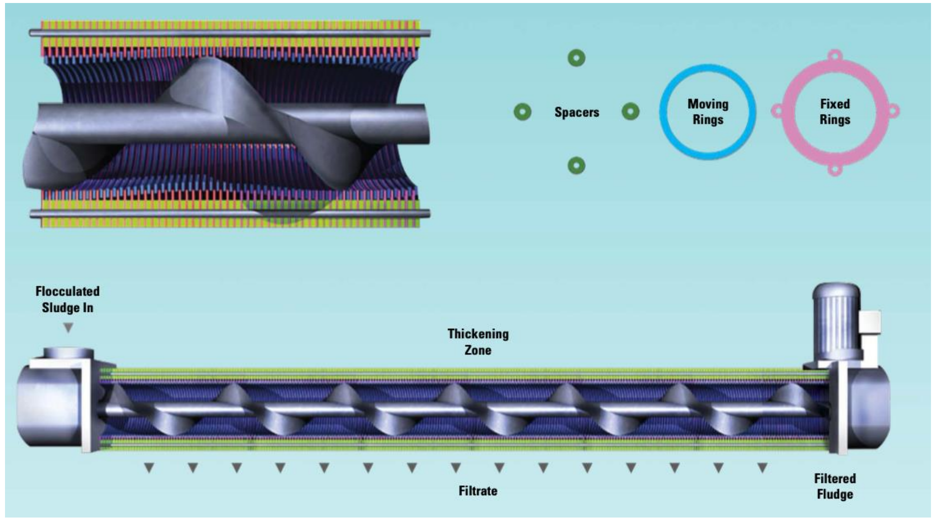
- Backwash reject flow needs to be thickened to 4-5% before pumping to the anaerobic digester
- Filtrate from thickener goes back to headworks
- Typical operation of thickening with polymer addition

Volute Thickener from Process Wastewater Technologies


Courtesy of PW Tech

# Overview of Thickening Technologies

## Volute Thickener
## Process Wastewater Technologies

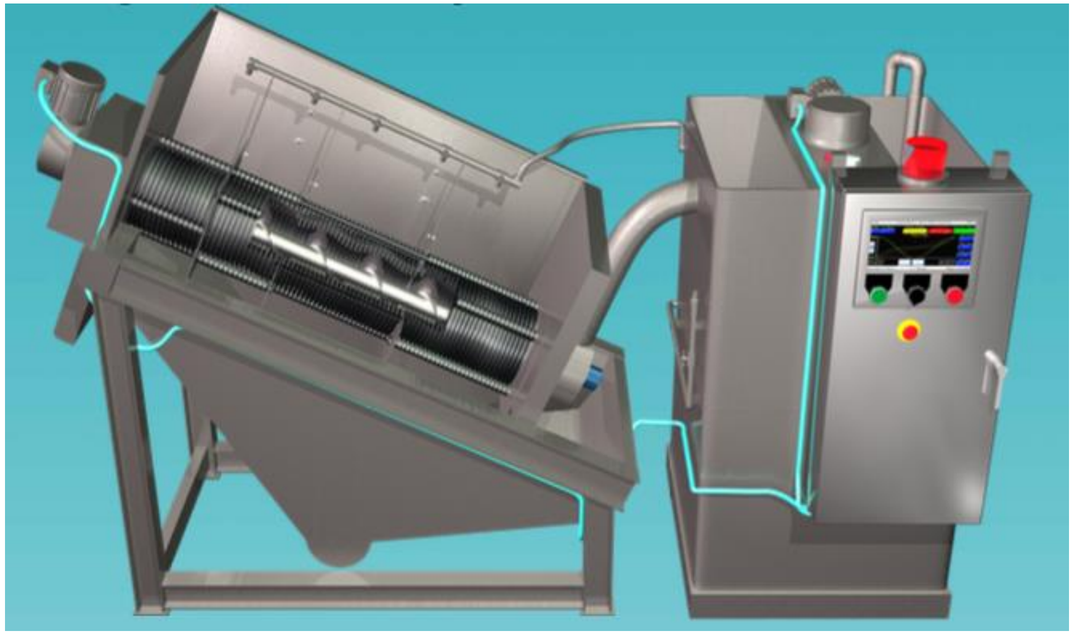



Courtesy of PW Tech

- Handles backwash rejected flow with low solids concentration (0.03%-5%) from APT and allows thickened to >10%
- Utilize polymer to aid formation of flocs
- Gaps are created by a series of fixed and moving rings that free water can pass, thickened sludge is conveyed along the drum

# Implementation Status

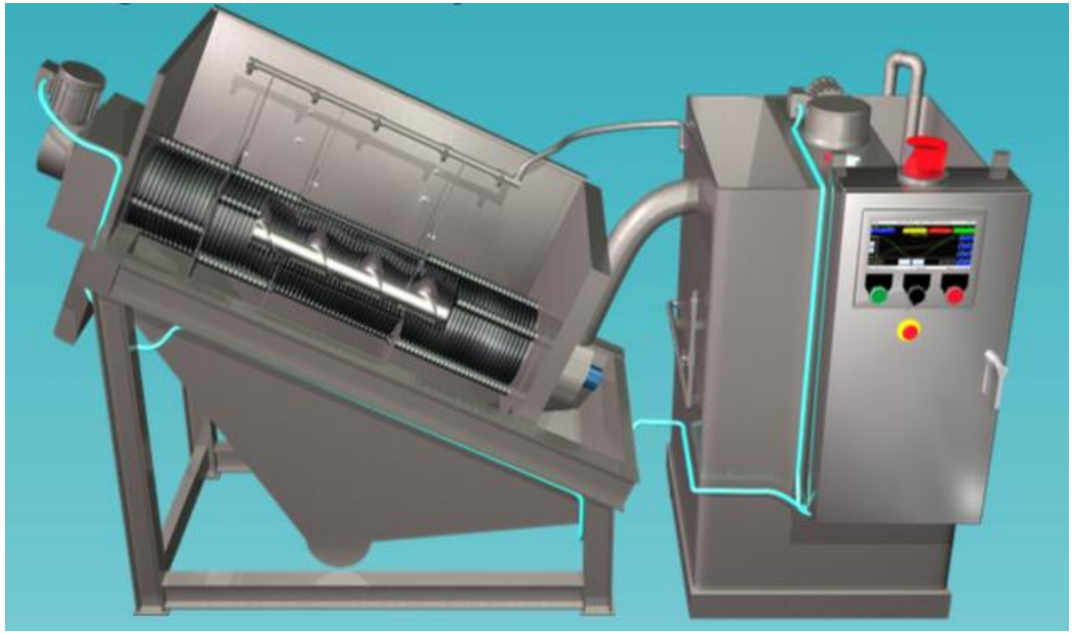
- Established technology with 100+ application in the US for thickening
- First application for thickening Primary Filtration Backwash solids



Courtesy of PW Tech

# Site Observations for Primary Filtration Thickening

- Compact Footprint
- Fully enclosed container is used to minimize odor and gas emission
- Ability to handle FOG, trash, and debris
- Polymer addition is required
- Ability to handle low solids concentration as 0.2-0.3 % to 1-2%
- Thickened sludge concentration can be as high as



Courtesy of PW Tech

CWT CALISKANER WATER TECHNOLOGIES

# ADVANCED SECONDARY TREATMENT TECHNOLOGIES

Derya Dursun, PhD, PE

# Conventional Secondary Treatment Technologies

Aeration System[1]

- 50 to 60 % of the total WWTP power consumption
- Requires long detention times, high air demand and large concrete infrastructure

| Typical Performance | |
|---|---|
| **Residence Time** | 8-10 hours |
| **Solids Removal Efficiency** | >90% |
| **Organic Matter Removal Efficiency** | >90% |
| **Nutrient[2] (Nitrogen) Removal Efficiency** | >95% |

1. Source: https://www.wteitaly.com/en/news/optimize-lifespan-and-efficiency-guide-to-aeration-system-maintenance
2. Nutrient removal is not required for all conventional WWTP, it's an add-on configuration which requires more volume and air supply

# Advanced Primary + Secondary Treatment Energy/Capacity/Performance Benefits

Secondary Treatment Capacity 30-70 %

Secondary Treatment Rate 30-70 %

Digester Biogas Energy Production 30-40 %

Power and Capital Cost

Aeration Energy Decrease 30-60 %

Primary Treatment Footprint Reduction 50 to 80 %

Secondary Treatment Footprint Reduction 30-60 %

CALIFORNIA ENERGY COMMISSION

CWT CALISKANER WATER TECHNOLOGIES

Linda County Water District

Committed to Providing Clean, Safe Water for All Our Residents

# Advanced Secondary Treatment Technologies

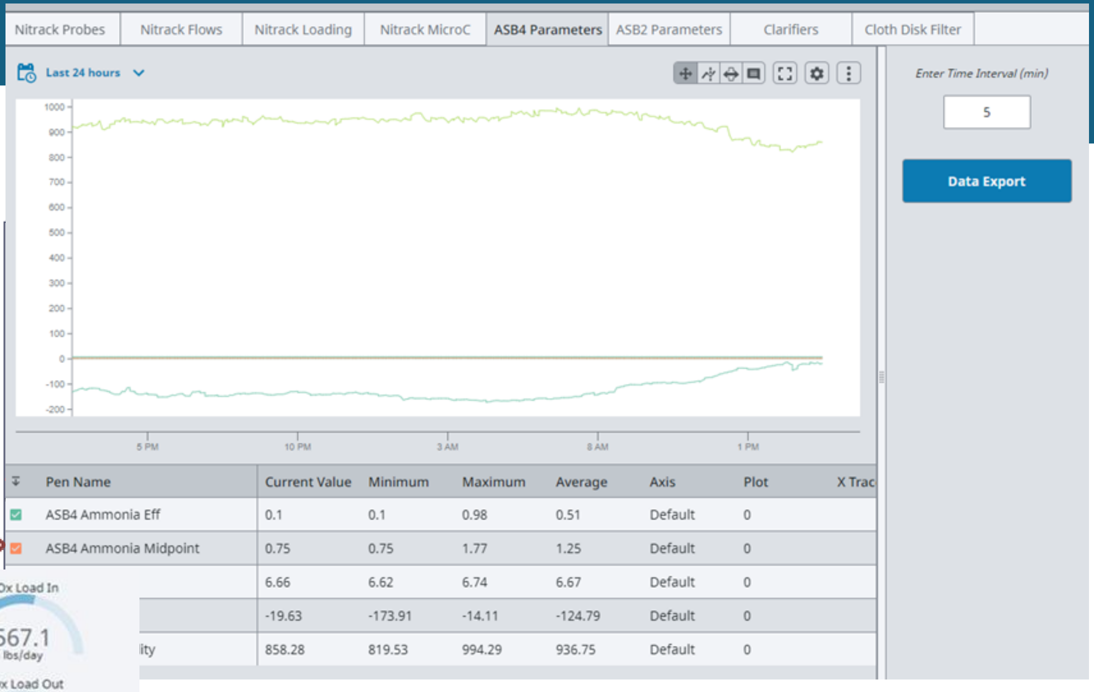
MicroVi
- MicroVi  Biotech
- Demonstration-scale
- Average 0.015-0.02 MGD
- In operation since June 2022


Aerobic Granular Sludge
- Aqua-Aerobics
- Demonstration-scale
- Average 0.015-0.02 MGD
- In operation since May 2024

✓ Reduce footprint
✓ Decrease energy demand
✓ Increase capacity

Membrane Aerated Biofilm Reactor
- Veolia
- Full-scale
- Average 0.5 MGD
- In operation since August 2024

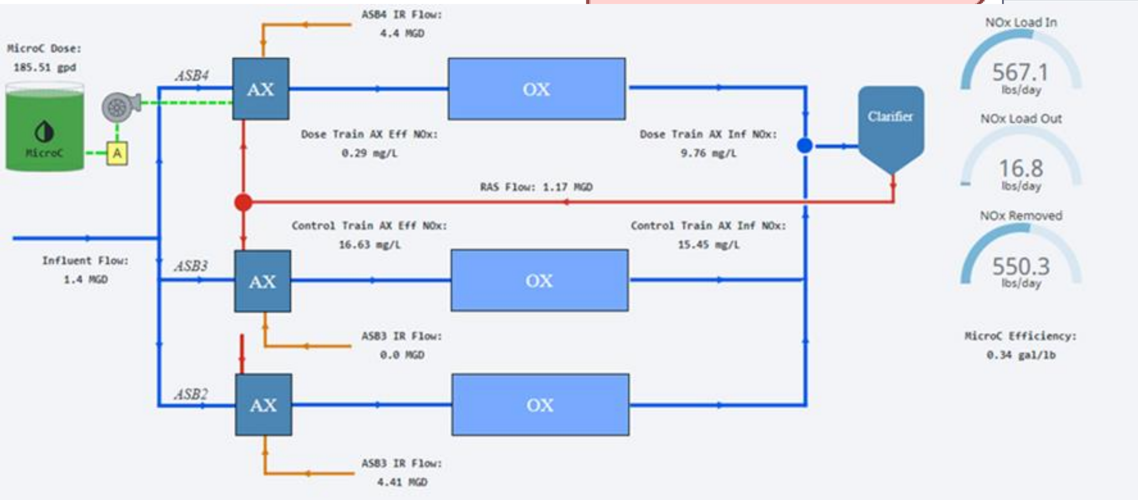
# Real – time Monitoring at Secondary Treatment (Baseline)

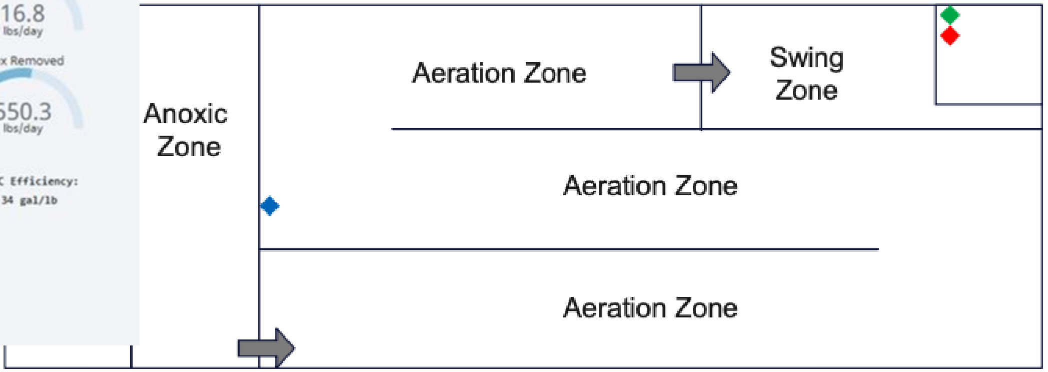



- Turbidity/TSS
- Nitrate
- Ammonia
- DO
- pH
- ORP

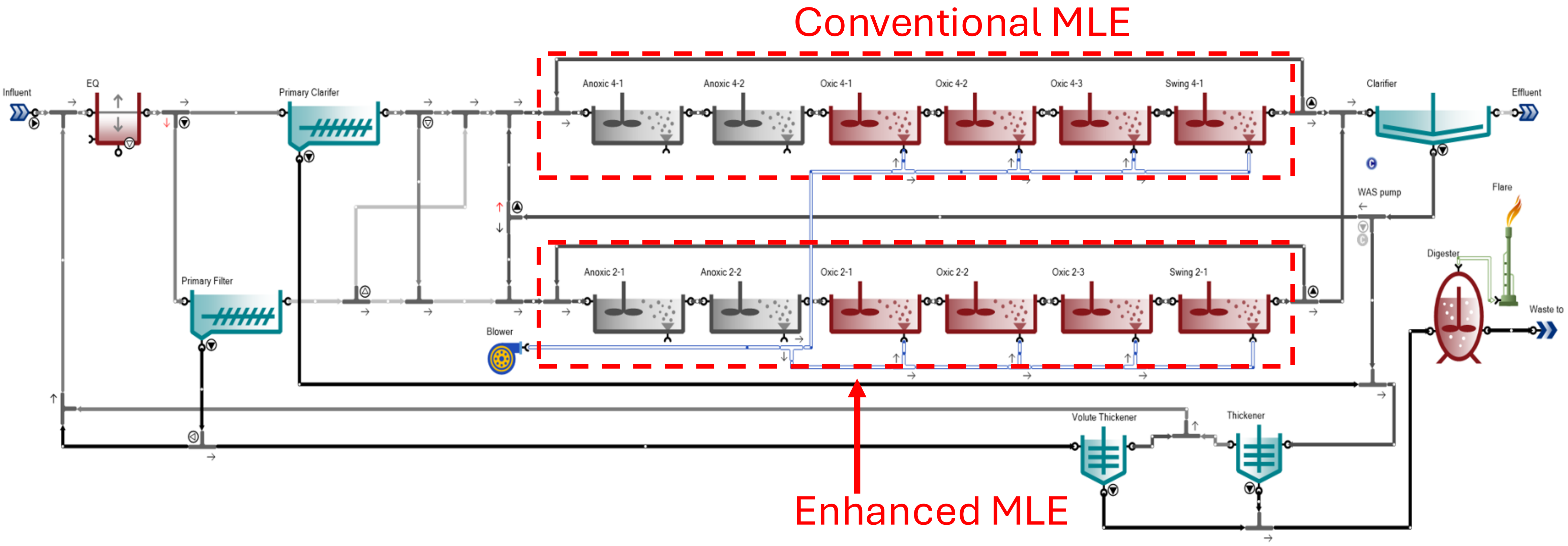
ASB4
Enhanced Activated Sludge Basin

Advanced Primary Effluent



# Impacts of Advanced Primary Treatment on Secondary Treatment (Modelling Baseline)

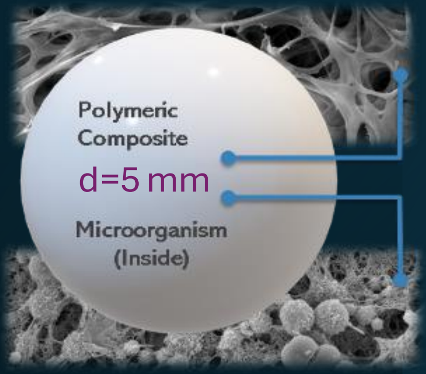


# MicroVi

Technology Provider: MicroVi BioTech

# Process Description

Biocatalyst Composite




Biocatalyst Suspended in Reactor

- Decouples wastewater treatment from sludge age by utilizing biocatalyst composites
- Biocatalysts contain a high density of pre-grown and highly efficient monocultures of microorganisms for targeted contaminant removal

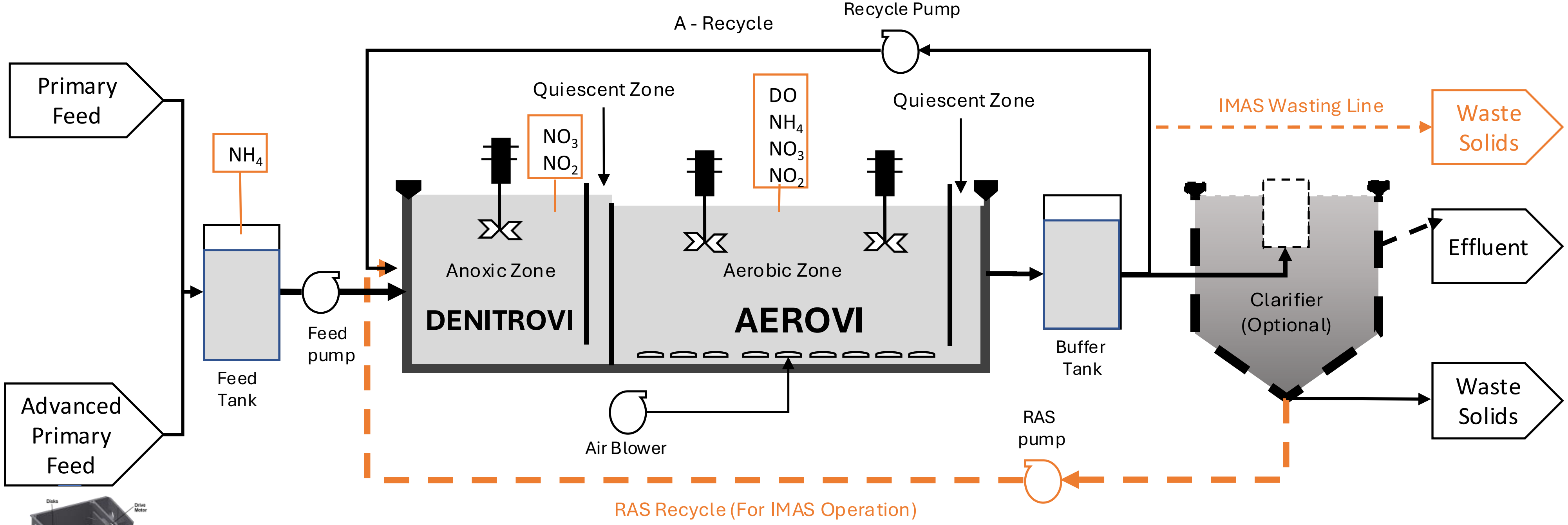
Courtesy of MicroVi

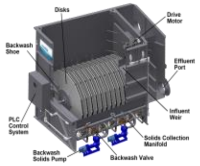
https://www.youtube.com/watch?v=XzDJq9WoAJE

CWT CALISKANER WATER TECHNOLOGIES

# Process Description

## Demonstration Unit at Linda



Courtesy of MicroVi

- Single pass process
- No RAS flow – pumping / Only Nitrate Cycle
- Mixing in Anoxic Zone
- Fine bubble diffusers in Aerobic Zone
- APT and CPT Feed have different characteristics

CWT CALISKANER WATER TECHNOLOGIES

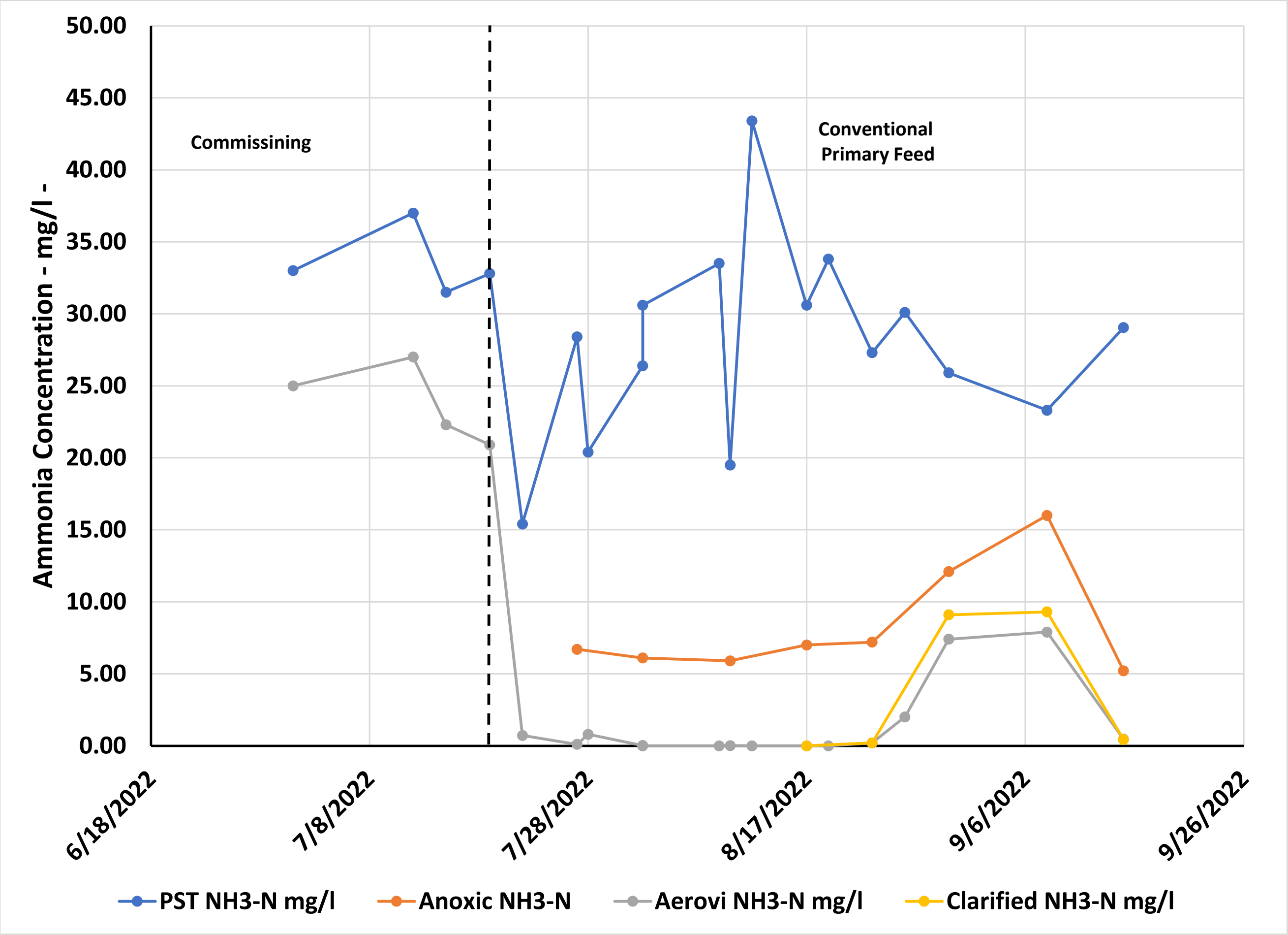
# Operational Summary

- **Phase 1: Preliminary Baseline Primary Clarifier Feed (3 months - July 22 – Sept 22)**
  - Feed 4 – 8.5 gpm
  - Aerobic HRT 2.7 – 5.0 Hours
  - Anoxic HRT 1.1 – 2.3 Hours
  - Recycle Ratio 3.0 – 3.5
  - Average DO 2.9 mg/l
- **Phase 2: Advanced Primary Feed (13 months - Sept 22 – October 24)**
  - Feed 4.0 – 10 gpm
  - Aerobic HRT 2.3 – 5.0 Hours
  - Anoxic HRT 0.9 – 2.3 Hours
  - Recycle Ratio 2 – 5.8
  - Average DO 2.5 mg/l

# Treatment Performance
# Primary Clarifier Feed

- Observed on average 94% ammonia removal
  Inf: 27.8g/L
  Eff: 1.31 mg/L

- Specific loading base:
  0.19 kg/m$^3$/d applied
  0.18 kg/m$^3$/d removed

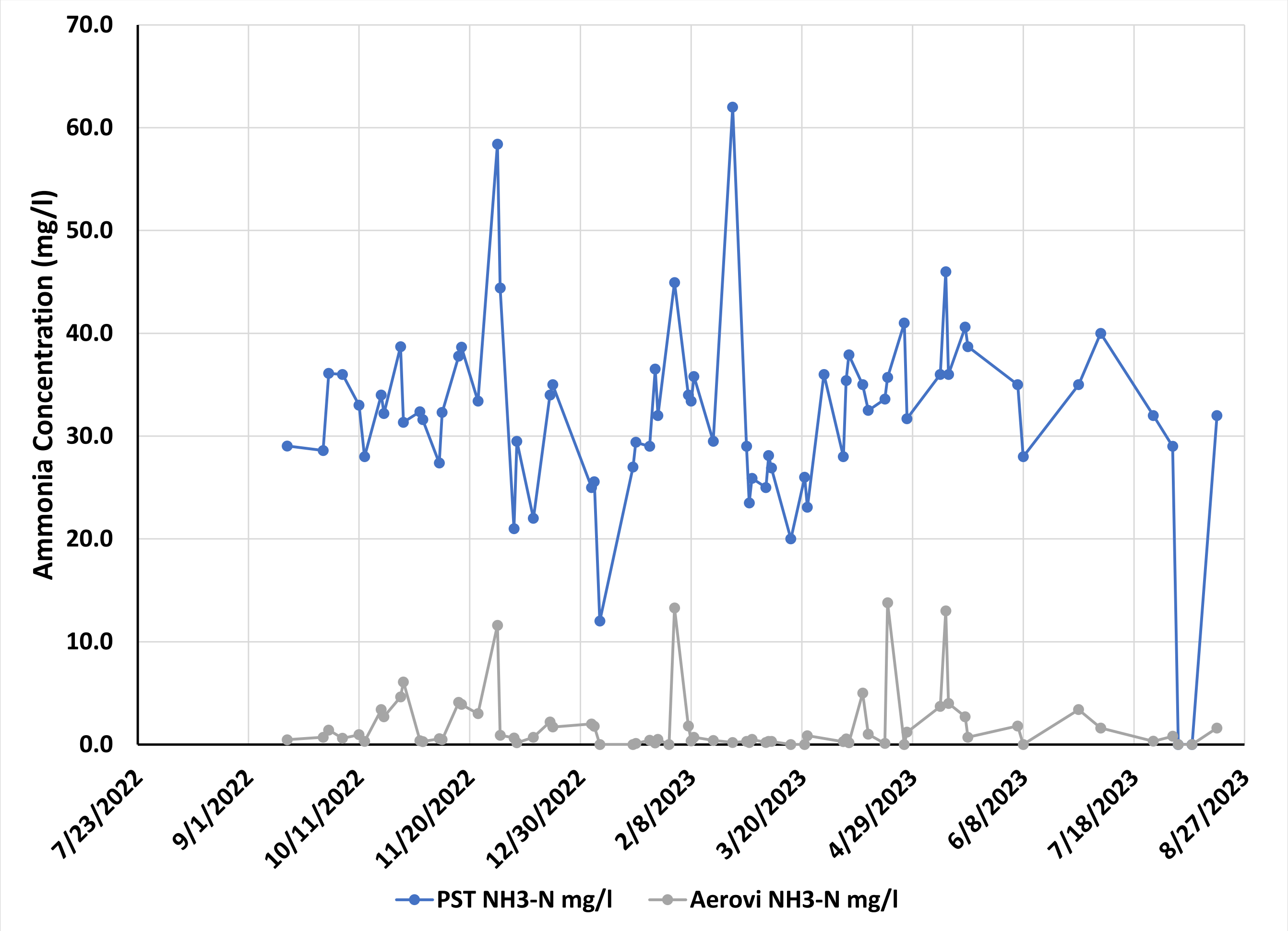



CWT CALISKANER WATER TECHNOLOGIES

# Treatment Performance
# Advanced Primary Treatment Feed

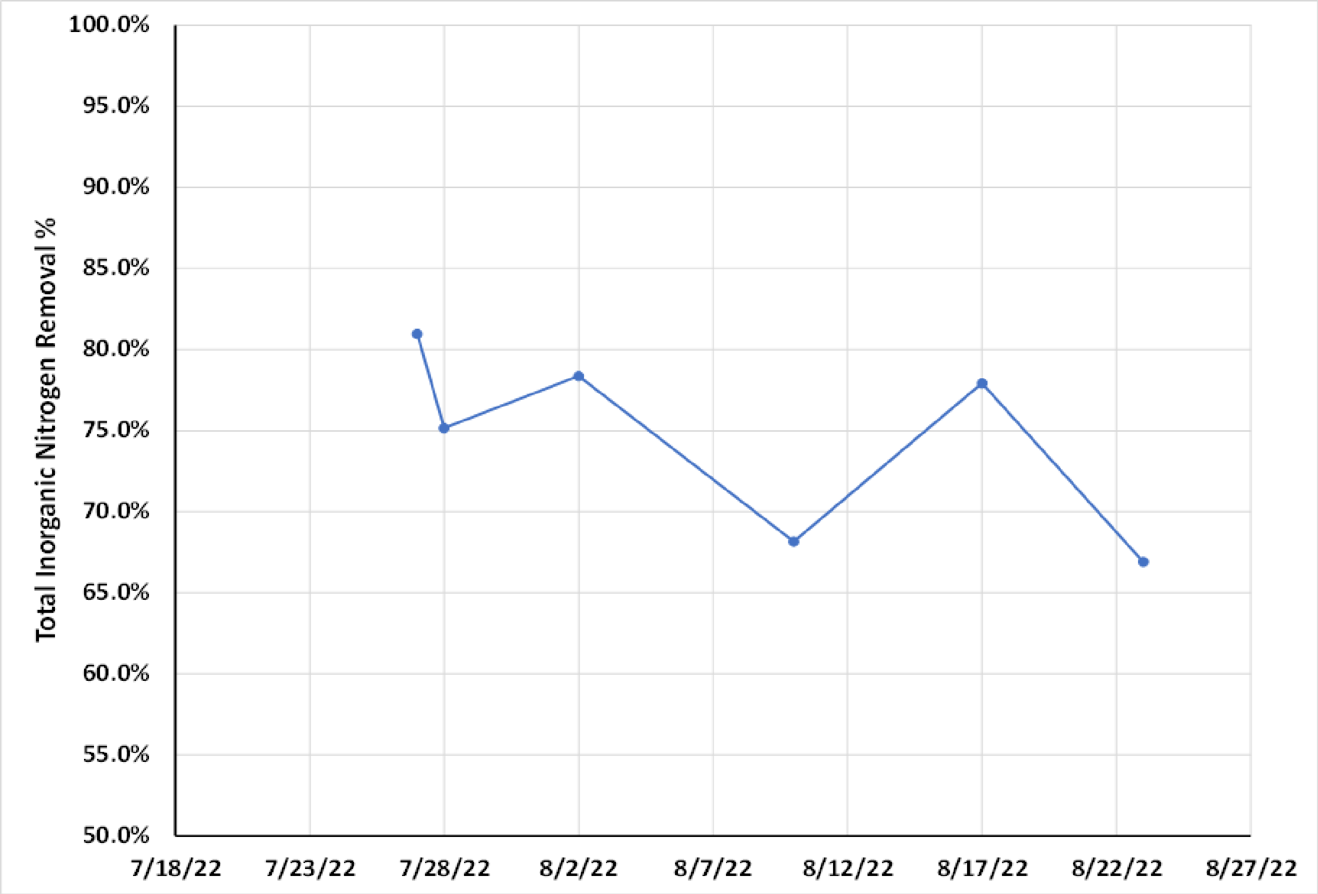
- Observed on average 94% ammonia removal
  - Inf: 33. 7mg/L
  - Eff: 1.9 mg/L

- Specific loading base:
  - 0.21 kg/m$^3$/d applied
  - 0.205 kg/m$^3$/d removed




CWT CALISKANER WATER TECHNOLOGIES

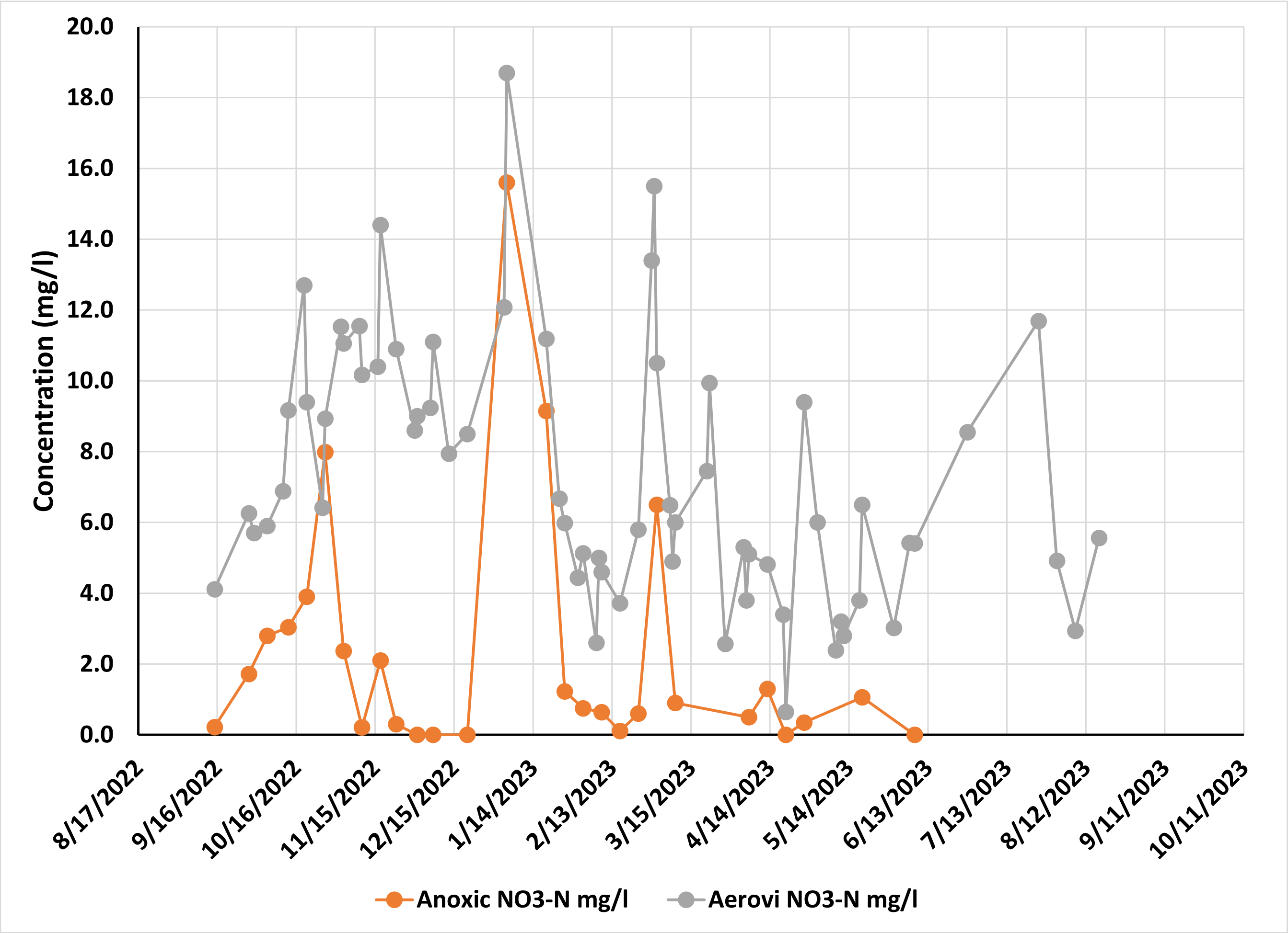
# Treatment Performance
# Primary Clarifier Feed




- With an average recycle ratio of 2.93, an average of 79% TIN reduction was observed across the system
- It is possible that a higher TIN removal can be achieved using higher recycle ratios

# Treatment Performance
# Advanced Primary Treatment Feed

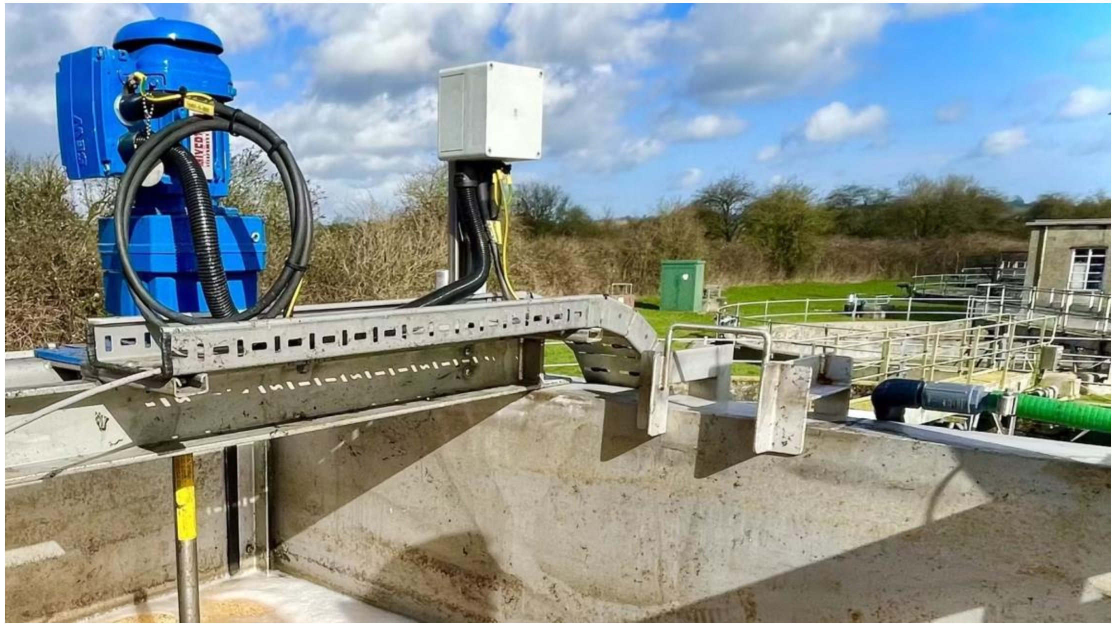
- Observed on average 7.9 mg/L Nitrate from aerobic zone
- Applied and removed 0.5 and 0.4 kg/m3/day across the anoxic reactor
- Observed effluent TIN averaged of 33 mg/L from influent of 9 mg/L (72%removal)




CWT CALISKANER WATER TECHNOLOGIES

# Implementation Status

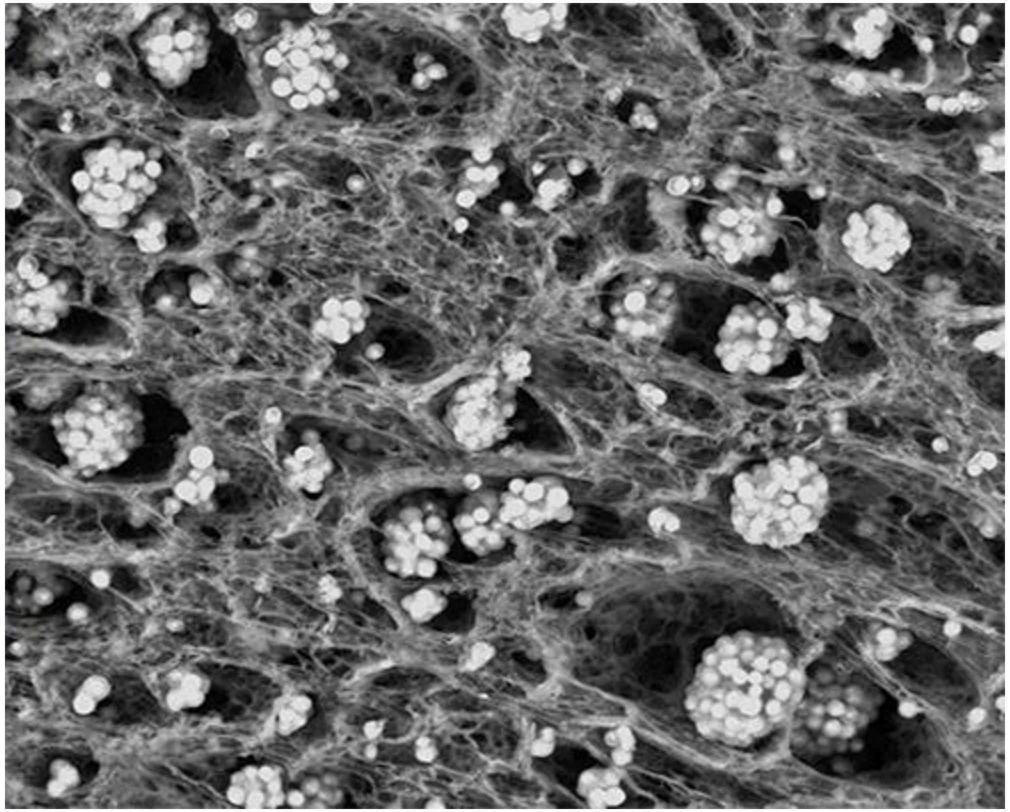
- Several installations overseas (UK)
- One installation in CA for sidestream treatment
- First MicroVi application to investigate the downstream impact of advanced primary treatment



*https://www.waterworld.com/wastewater-treatment/press-release/14205897/wessex-water-evaluates-microvi-mne-for-ammonia-and-nitrate-removal*

# Advantages - Significant Treatment Performance Improvement

- Hybrid Technology combining attached growth with suspended growth
- Rapid mass transfer of specific contaminants and products
- Able to grow specific targeted microorganism
- Stable cell population and resistance to toxicity



CWT CALISKANER WATER TECHNOLOGIES

# Advantages - Intensification/Compact Footprint

- Ability to achieve short HRT
- Ability to achieve high targeted nutrient removal performance with short HRT
- No RAS recycle required

# Advantages - Energy Savings

- Lower specific aeration power consumption with short HRT and SRT
- RAS pumping is not required

CWT CALISKANER WATER TECHNOLOGIES

# Challenges/Additional Design Consideration

- Removal of particulate organic material
- The fate and lifetime of the biocatalysts
- Impact of the biocatalysts on aeration demands
- Integration and retrofit into existing facilities
- Application at larger scale

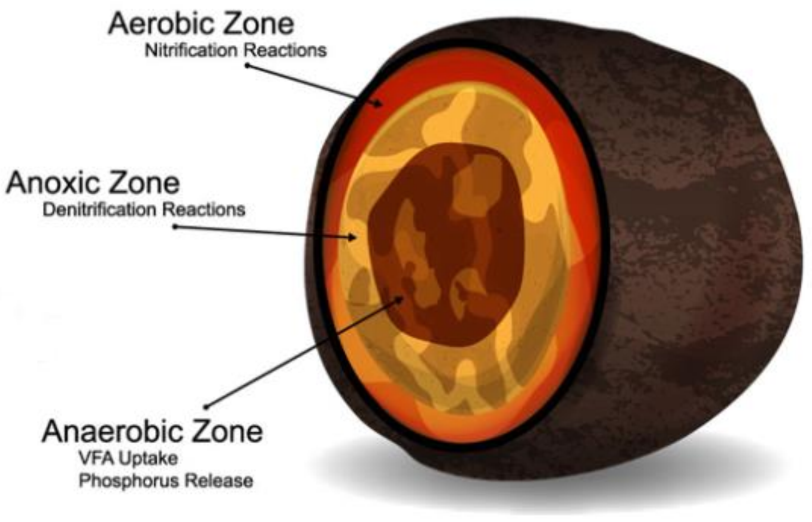
CWT CALISKANER WATER TECHNOLOGIES

# Aerobic Granular Sludge (AGS)

Technology Provider: Aqua-Aerobics System Inc. (AquaNereda)

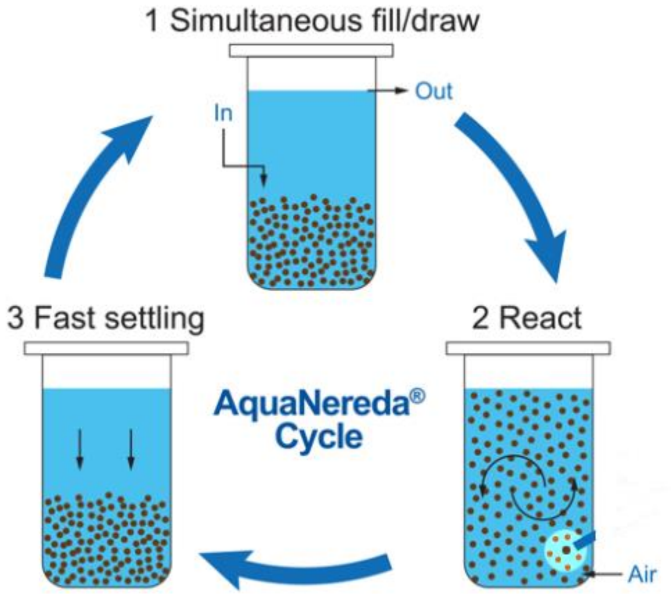
# Process Description

**The AGS process forms dense granules of biomass to treat wastewater more effectively**




Courtesy of Aqua-Aerobic Systems

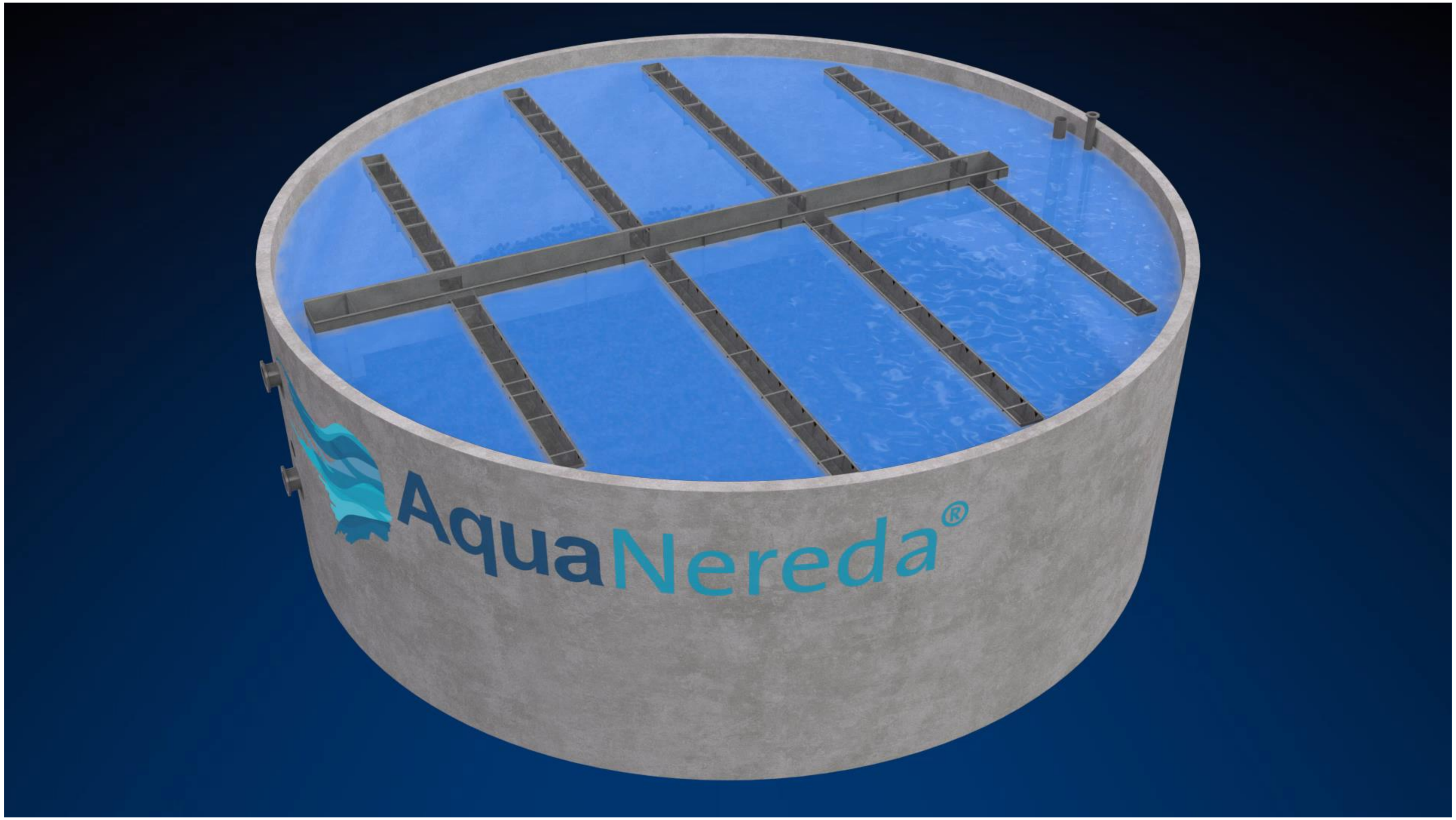
- **Fast settling:** SVI of 30-50 mL/g
- **High MLSS concentration:** > 8,000 mg/L




- **Sequencing Batch Reactor (~4 hour)**
  1. Simultaneous fill/draw(60 min)
  2. Reaction (160 min)
  3. Fast settling (20 min)

CWT CALISKANER WATER TECHNOLOGIES

# Process Description – Full scale Application



# Process Description – Settling Characteristics

**A Settling Comparison:**
Conventional Activated Sludge vs.
Aerobic Granular Sludge

AQUA-AEROBIC SYSTEMS, INC.®
A Metawater Company

# Demonstration Scale Unit at Linda

Demonstration Scale Unit at Linda (0.015MGD)


Reactor Column

Real - time Process Monitoring

**There are two AGS Reactors operated side by side**

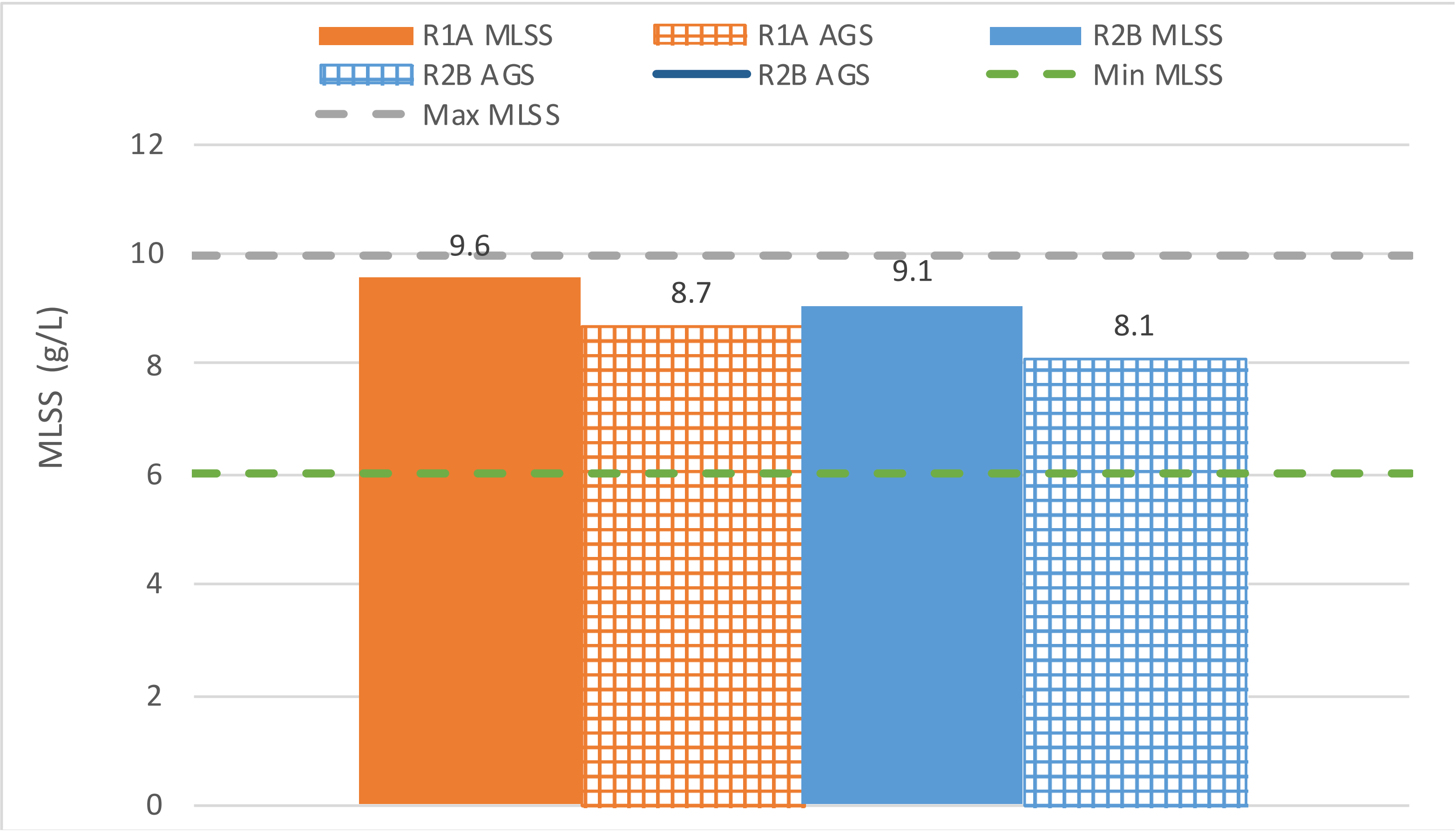
- Reactor A: With APT (CDPF) Influent
- Reactor B: With CPT (Primary Clarifier) Influent

CWT CALISKANER WATER TECHNOLOGIES

# Influent Feed Characteristics
# CPT Feed vs. APT Feed

| | Flow Rate (gpm) | COD (mg/L) | sCOD (mg/L) | sCOD/COD ratio | TSS (mg/L) | TN (mg/L) | TP (mg/L) | pH (SU) | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|
| **APT Fed Reactor** | 2.33 | 385 | 251 | 0.65 | 48 | 38 | 8.7 | 7.0 | 265 |
| **CPT Fed Reactor** | 2.33 | 444 | 236 | 0.53 | 79 | 42 | 12.9 | 7.0 | 271 |

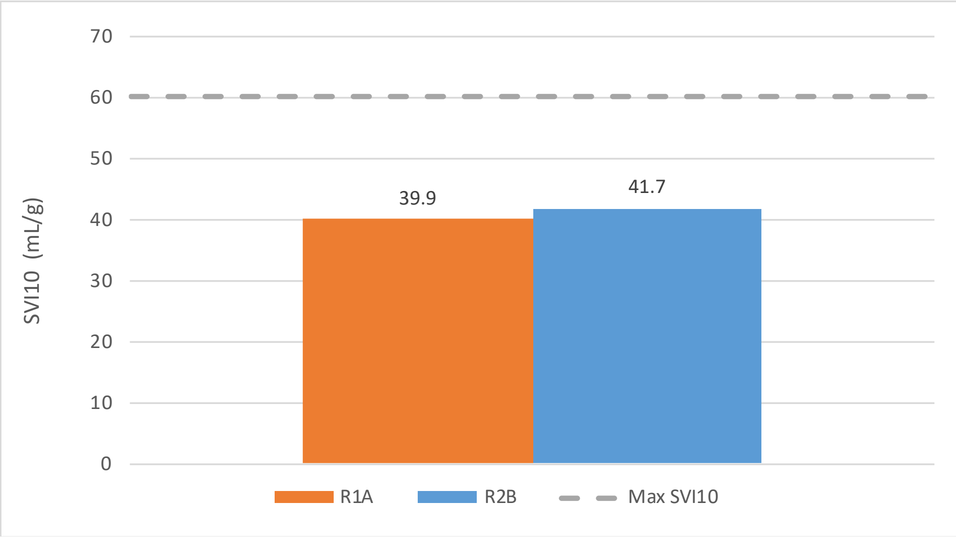
# Operation




- Cycle Time :4 hours
- Hydraulic Retention Time: 14 hours
- DO Control: Ammonia Based

CALISKANER WATER TECHNOLOGIES

# Settling & Granulation
# APT Feed (R1A) vs. CPT Feed (R2B)



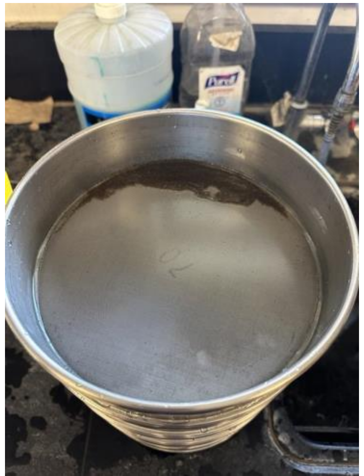

2mm

1.4mm

0.6mm

0.212mm

0.18mm



Settling Observation

SVI10 (mL/g)
- R1A: 42
- R2B: 46

SVI30 (mL/g)
- R1A: 40
- R2B: 39

# Treatment Performance

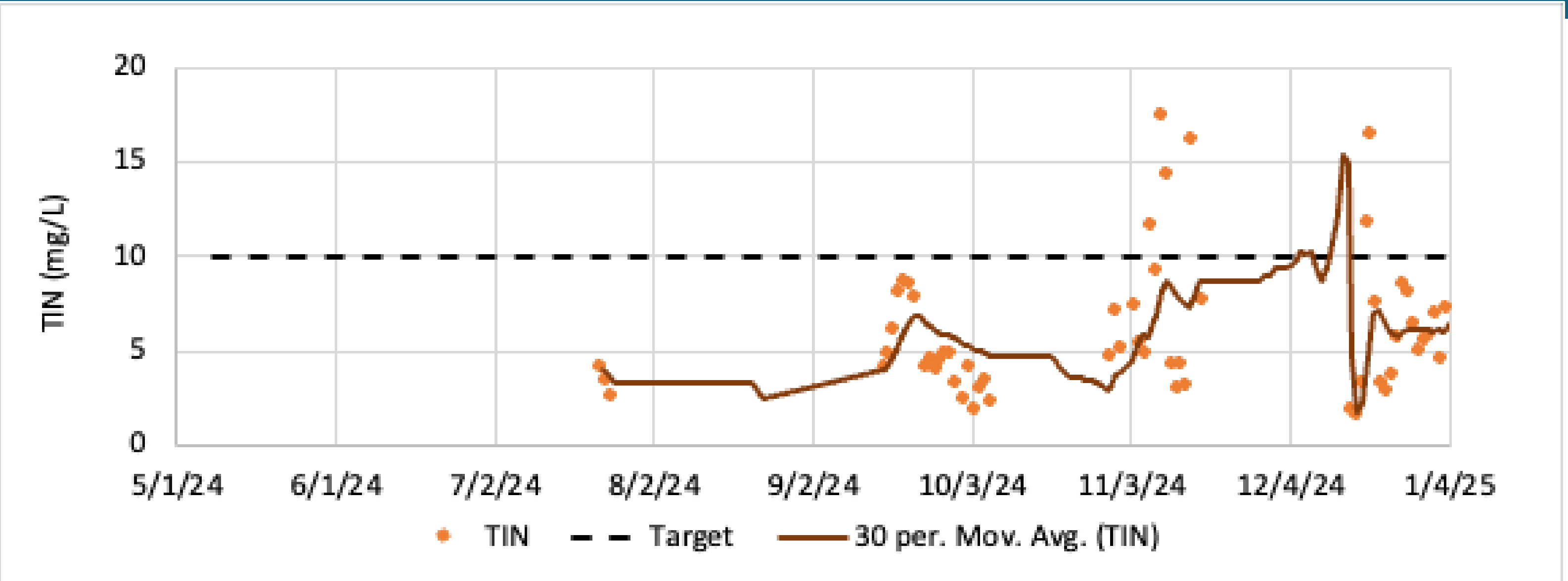
| | | cBOD5 (mg/L) | tCOD (mg/L) | sCOD (mg/L) | TKN (mg/L) | $NH_4$ (mg/L) | $NO_3$ (mg/L) | TP (mg/L) |
|---|---|---|---|---|---|---|---|---|
| APT Fed Reactor | Influent | 198 | 385 | 251 | 43 | 33.5 | - | 8.7 |
| | Effluent | 6 | 61 | 22 | 4 | 1.0 | 2.9 | 2.8 |
| | Removal(%) | 96 | 84 | 91 | 90 | 97 | - | 63 |
| CPT Fed Reactor | Influent | 193 | 444 | 236 | 41 | 34.0 | - | 12.9 |
| | Effluent | 5 | 40 | 31 | 3 | 0.5 | 2.2 | 2.2 |
| | Removal(%) | 97 | 92 | 87 | 94 | 99 | - | 80 |

Nitrification was successfully achieved in both reactors. Ammonia concentrations in the effluent were consistently maintained around 1 mg/L over long periods, indicating robust nitrification performance

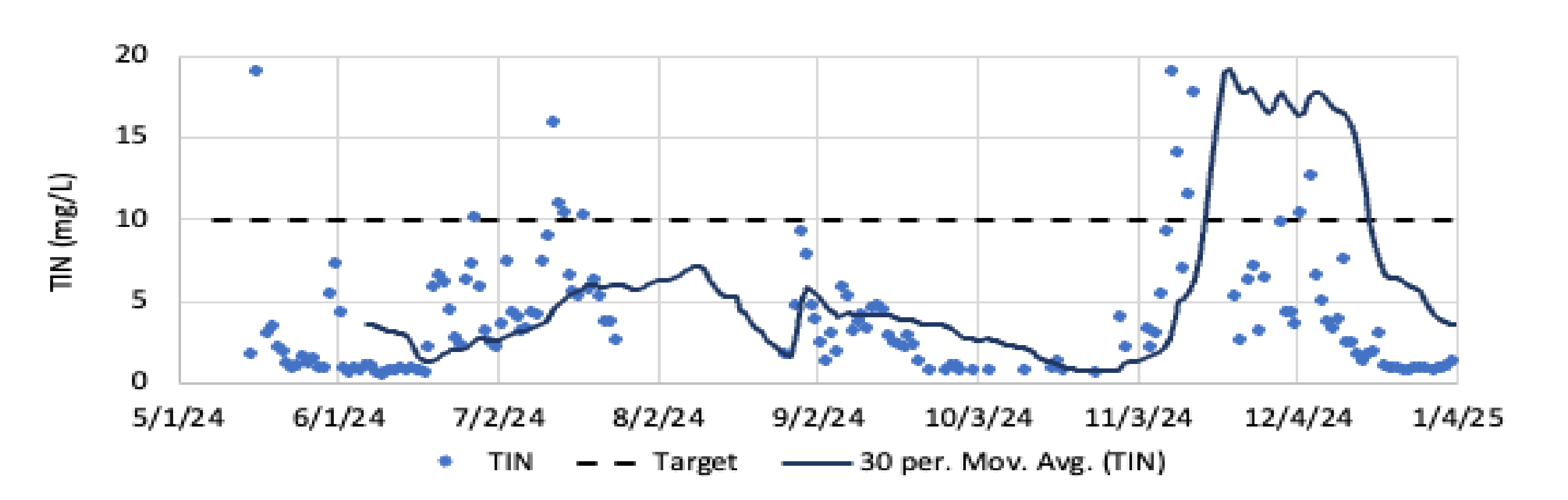
CWT CALISKANER WATER TECHNOLOGIES

# Treatment Performance

Reactor with APT Feed




Reactor with CPT Feed




ALISKANER
ATER TECHNOLOGIES

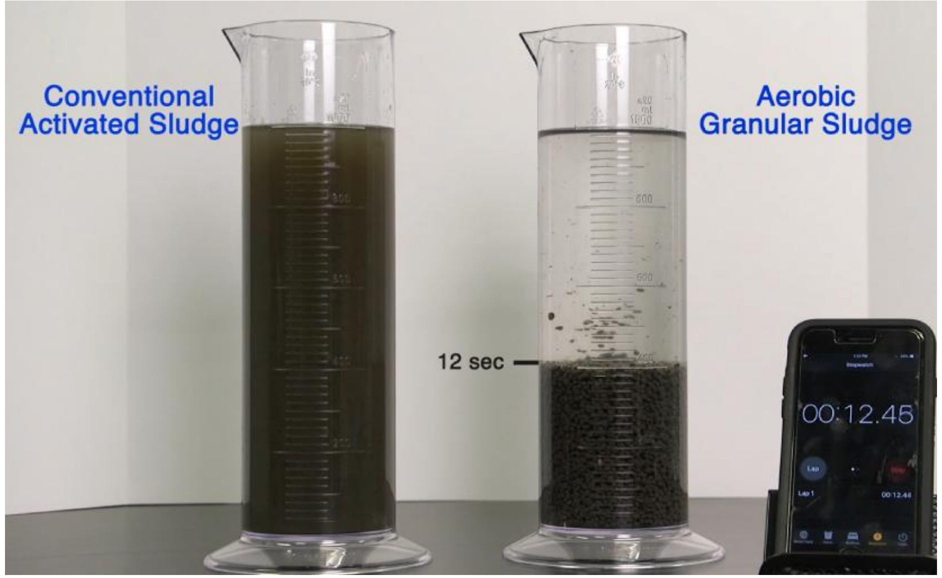
# Implementation Status

- Proven technology outside the US
- Multiple operational in US
- First side-by-side comparison of receiving conventional and advanced primary treatment effluent


CWT CALISKANER WATER TECHNOLOGIES

# Advantages - Significant Treatment Performance Improvement

- High MLSS and exemplary settleability
- Effective nitrogen removal
- Single reactor
- Does not need clarifiers, recycle flows
- Does not need any media/ carrier



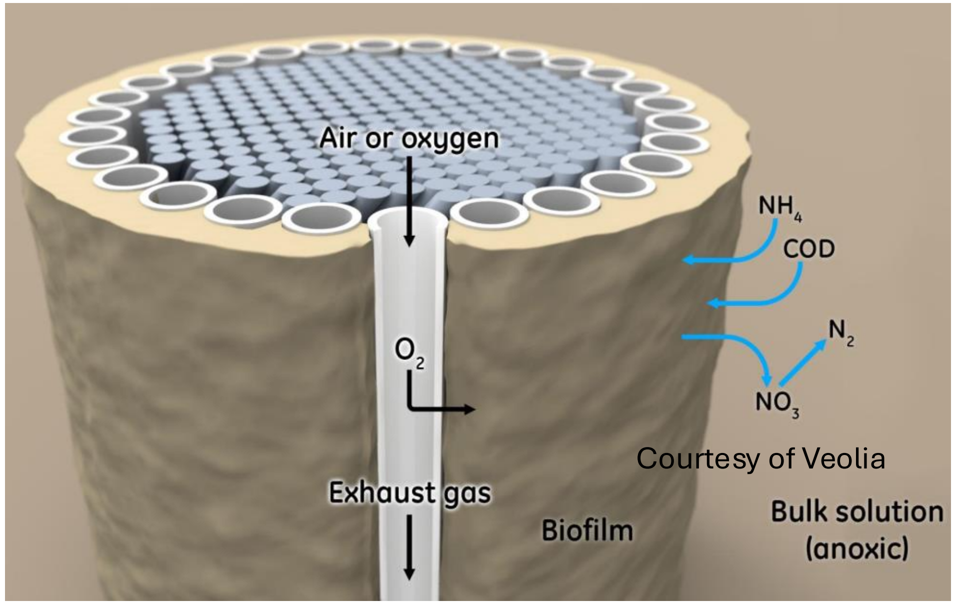
# Challenges/Additional Design Consideration

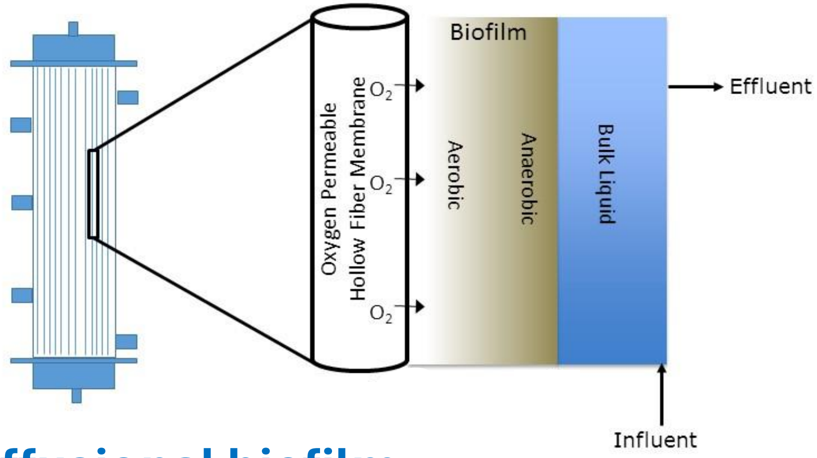
- Start – up , seed will expedite the process
- Batch process, continuous operation might be challenging at large scale
- Cycle adjustment for optimized nutrient removal
- High water depth requirement
- Integration and retrofit into existing facilities

# Membrane Aerated Biofilm Reactor (MABR)

Technology Provider: Veolia

# Process Description

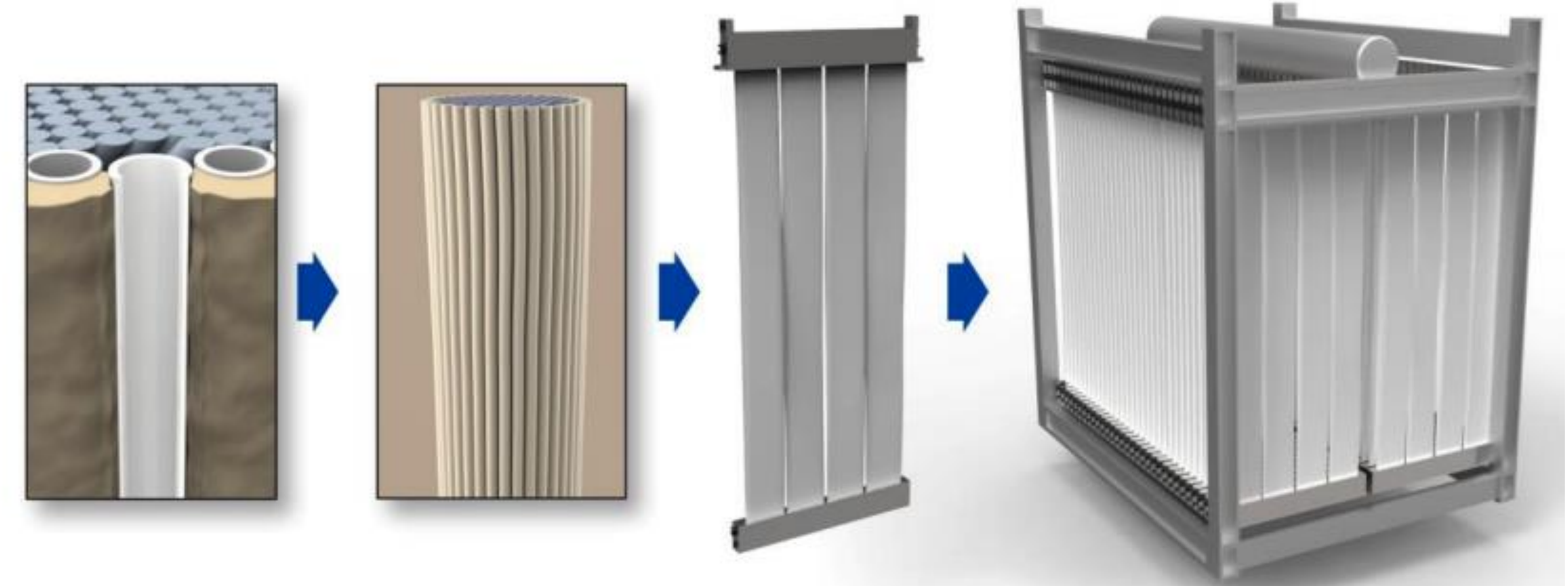



- **Counter-diffusional biofilm**
  - Oxygen transferred from inside, substrates transferred from outside of the biofilm
  - Reduce competition for $O_2$ between heterotrophs & autotrophs
- **Simultaneous nitrification and denitrification**
  - Nitrification in aerobic zone
  - Denitrification in anaerobic zone

- **Selective gas-permeable hollow membrane**
  - To provide air supply
  - To support biofilm development

# Process Description




https://www.youtube.com/watch?v=Aw_Vy1bixYg

VEOLIA

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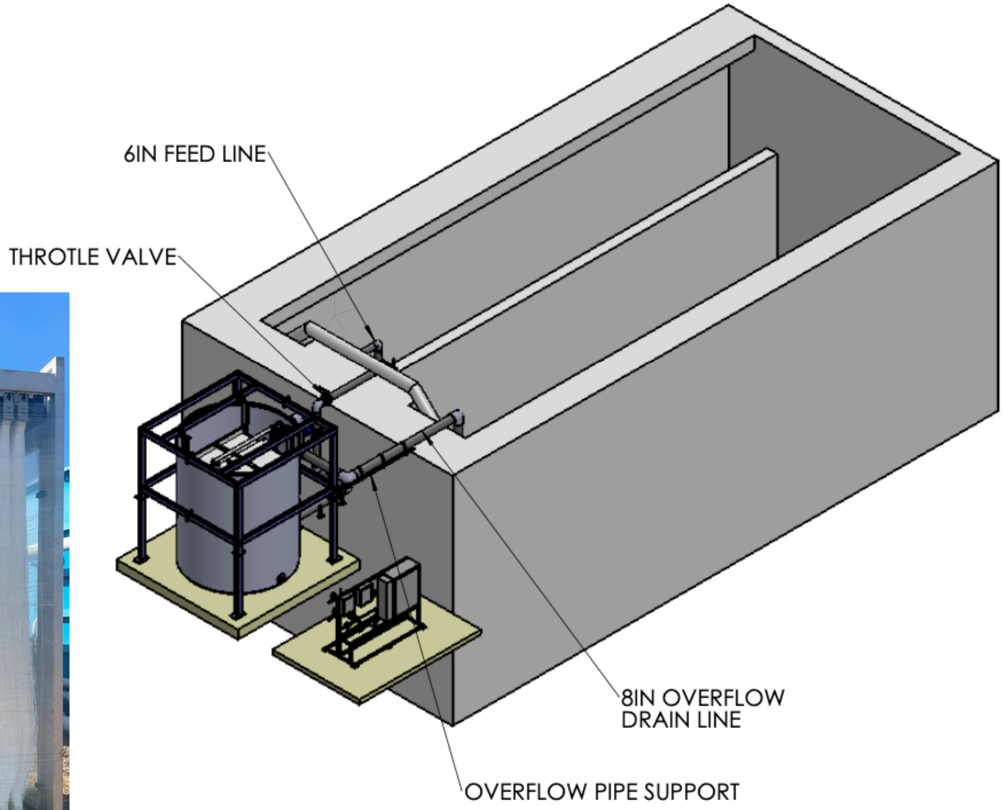
# Overview of AST Technologies

## Membrane Aerated Biofilm Reactor (MABR)

## VEOLIA

Full Scale Unit at Linda (0.5MGD)




### Intensify treatment performance

- Increase biomass inventory
- Enable biological nutrients removal
- Reduce Energy Consumption

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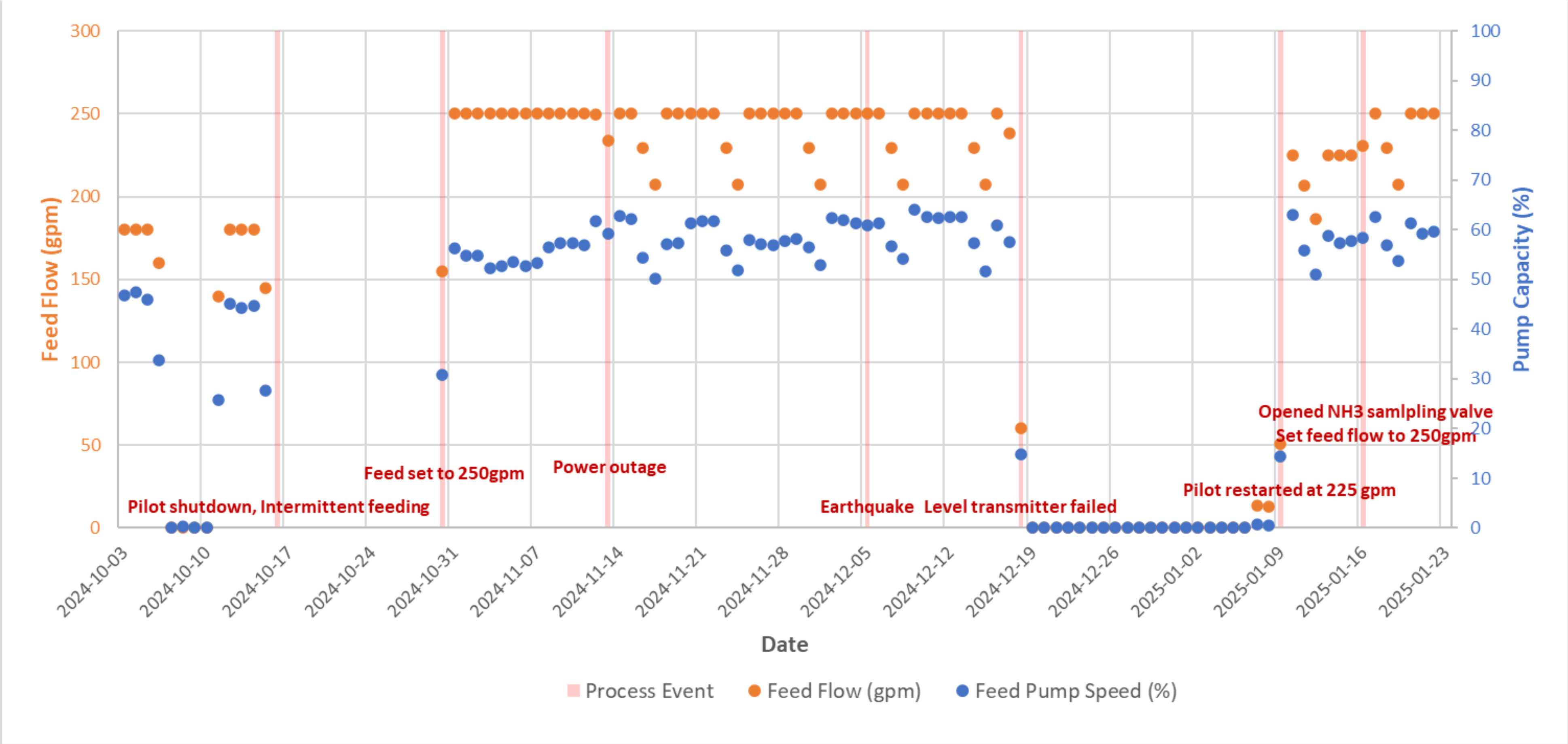
# Operation Summary




- Achieved rapid biofilm growth after commission and start up
- Observed on average MLSS and MLVSS of 2700 mg/Land 2300 mg/L

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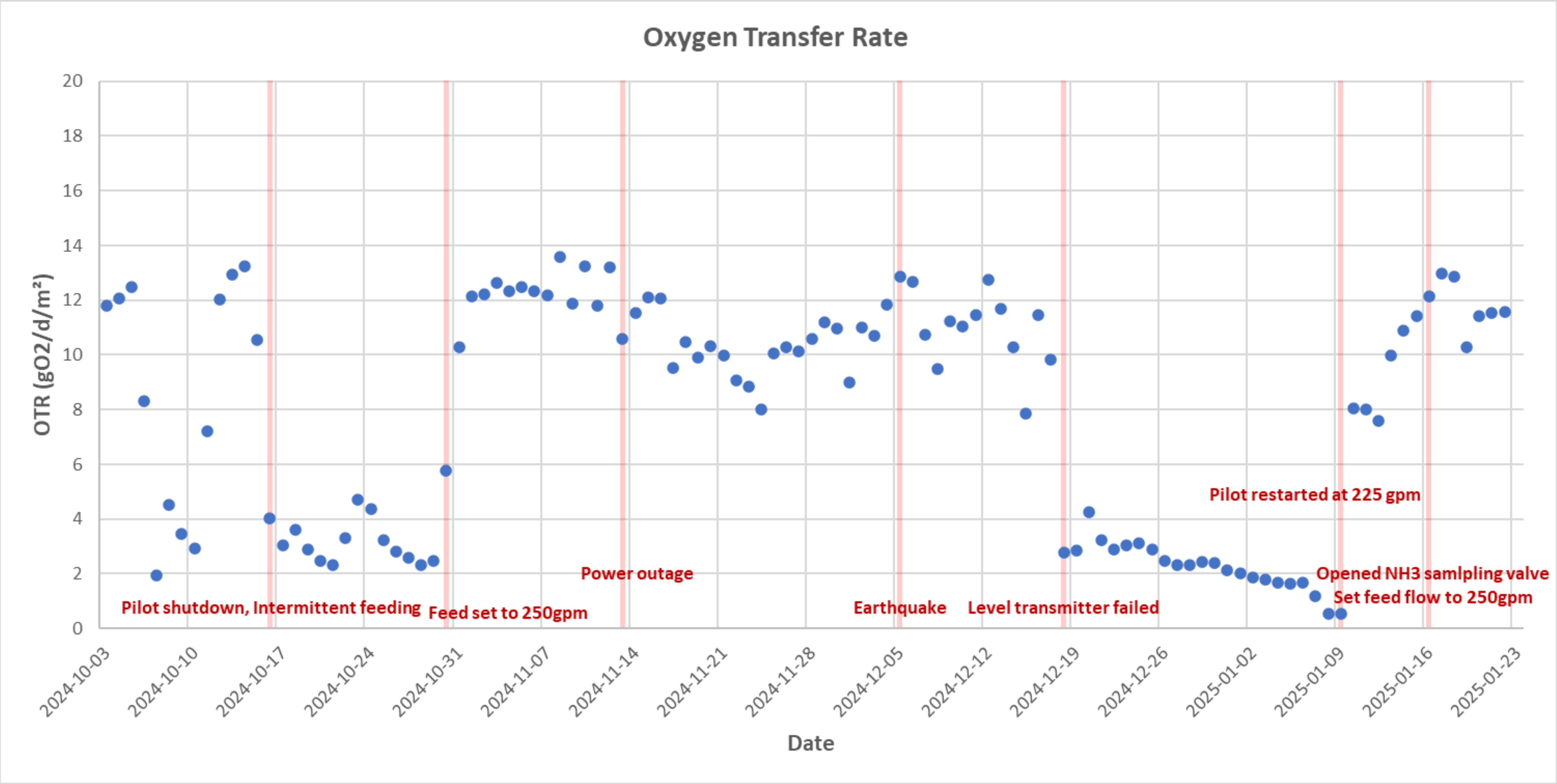
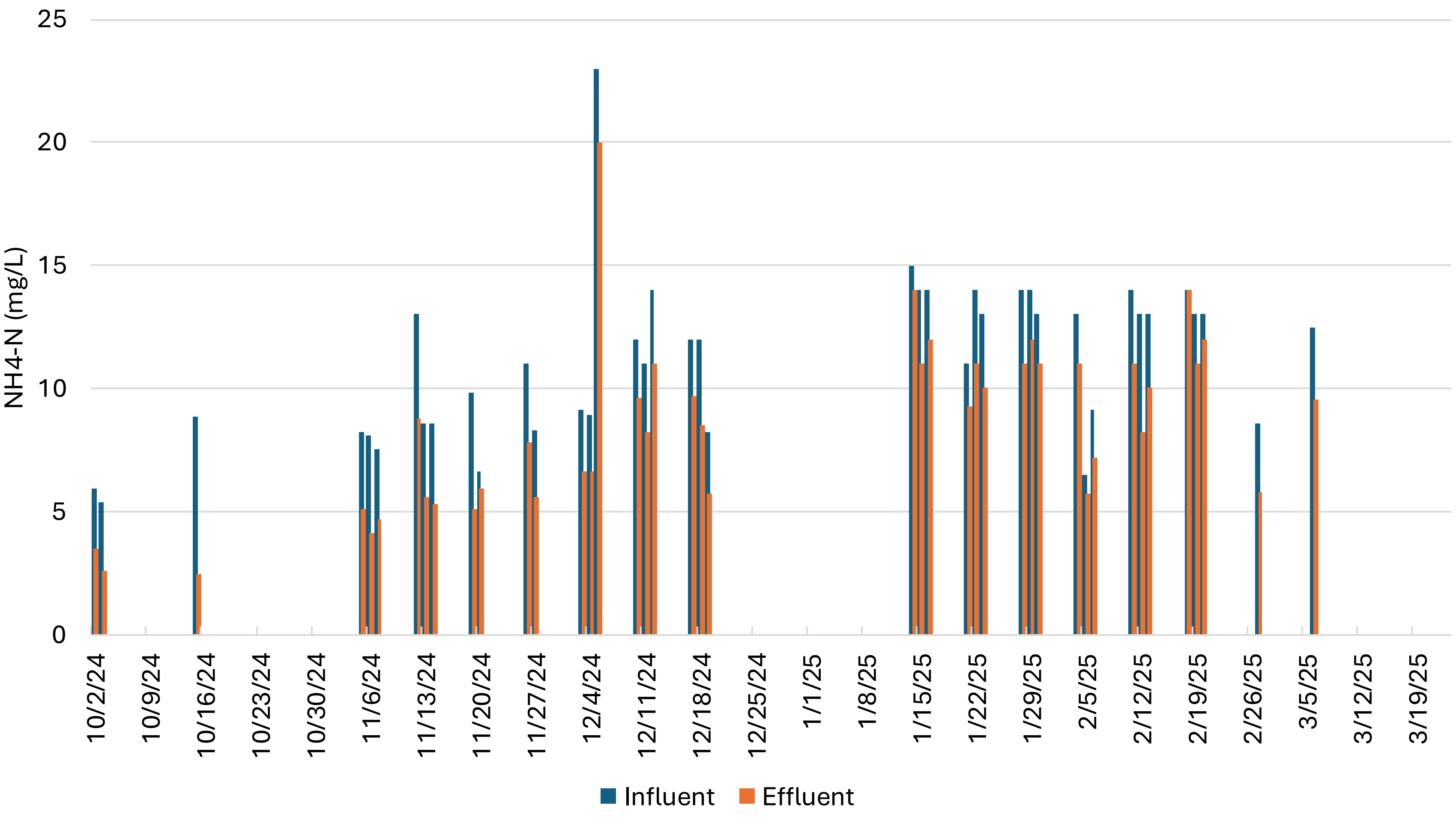
# Operation Summary



# Treatment Performance

- Observed on average 25-35 % ammonia removal with single cassette
    - Influent : 11mg/L
    - Effluent: 7.9mg/L

- HRT: 20-30 minutes




The NR has averaged at 1.9 g $NH_4$-N/$m^2$-d

CALISKANER WATER TECHNOLOGIES

# Implementation Status

- Full-scale installations and operations in North America

- The pilot at Linda is the first MABR application to investigate the downstream impact of APT

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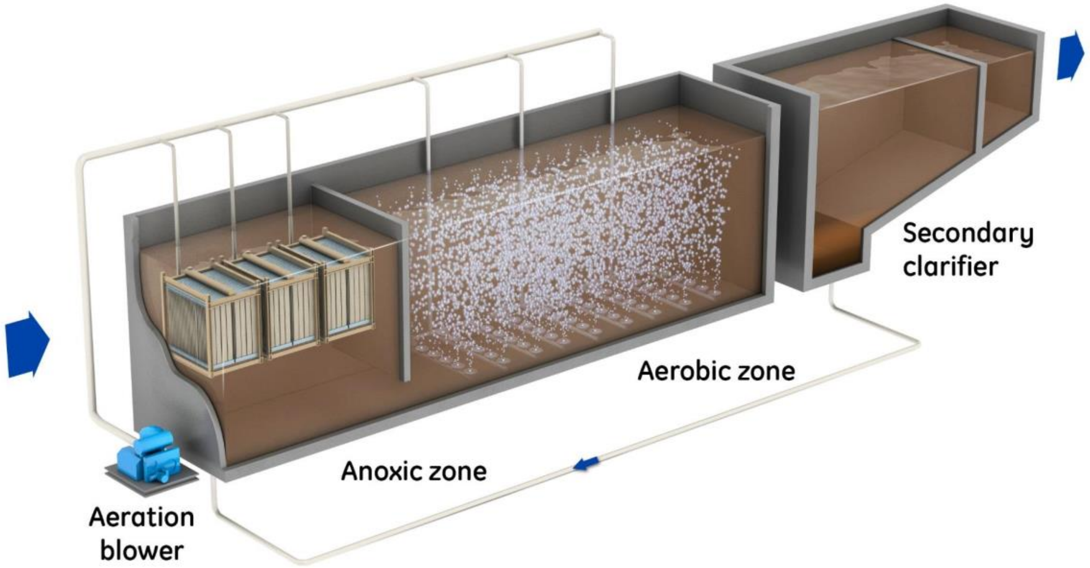
# Advantages - Significant Treatment Performance Improvement

- Higher oxygen transfer efficiency (OTE)
- Nitrogen removal with short HRT
- Prioritized Nitrification
- Instrumentation for precise biofilm control

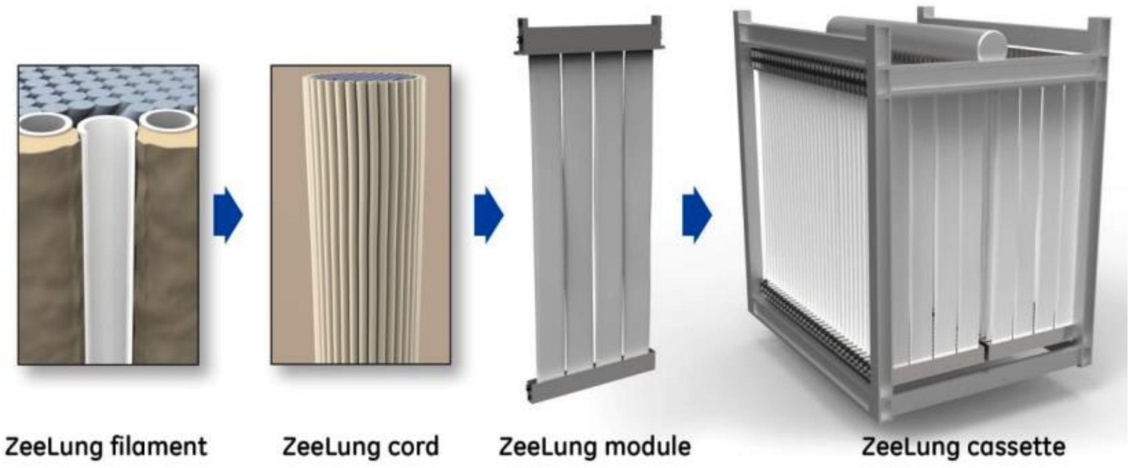



Courtesy of Veolia

# Advantages - Intensification/Compact Footprint

- Easy to integrate or retrofit into existing infrastructures

- High membrane surface area in each cassette




Courtesy of Veolia

# Advantages - Energy Savings

- Energy saving through recycling exhaust gas
- High oxygen transfer efficiency
- Shorter HRT

# Challenges/Additional Design Consideration

- Membrane Fouling
- Control of Biofilm Thickness
- Sensitivity to shock loadings
- Fungi growth
- N2O emissions

# On-going Emerging Technology Projects

- Emerging Technologies for Sludge / Biosolids

- Management and Treatment Advanced Water Reuse Technologies For Non-potable and Potable Reuse

- PdNA Demonstration using Biofilm Media

For more information

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# OPEN DISCUSSION

Thank you!

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