



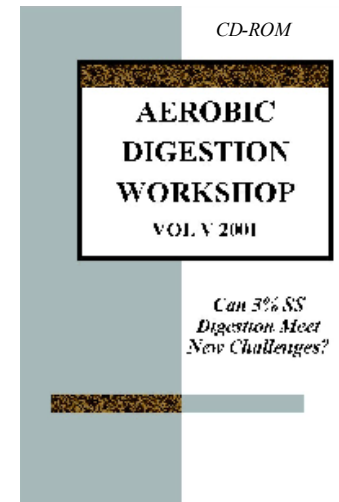
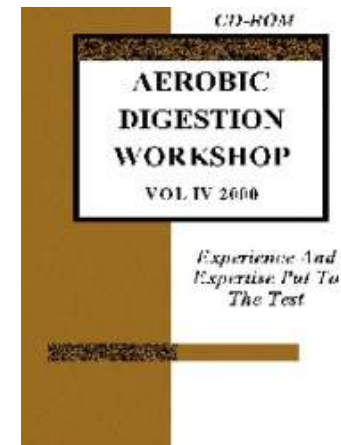
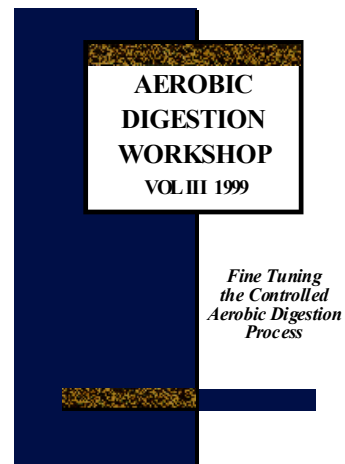
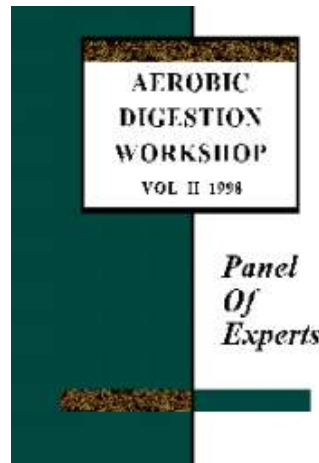
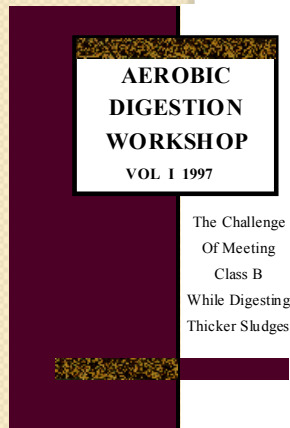
# **Membrane Thickening Aerobic Digestion Processes**

2012 PNCWA Conference

Bryen Woo, PE

# DIGESTION EXPERTISE

- WEFTEC 1997-2001



... recognized as the industry leader in aerobic digestion and thickening at high solids concentrations

# Membrane Thickening Digestion

- Aerobic digestion process using a Flat Plate Membrane Unit



**Ideal for:**

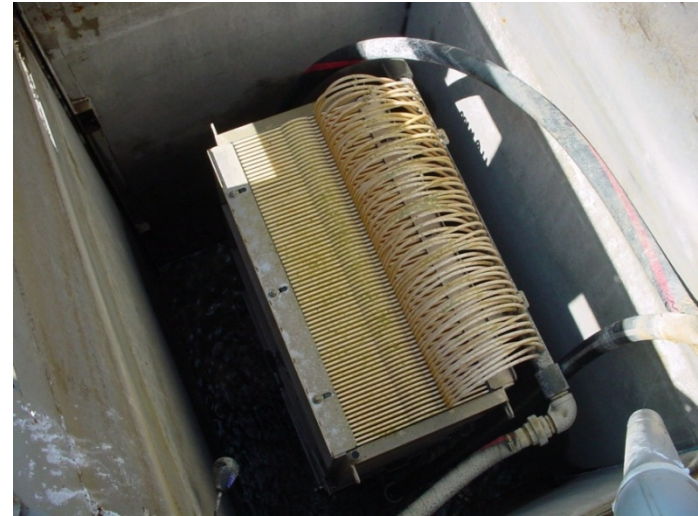
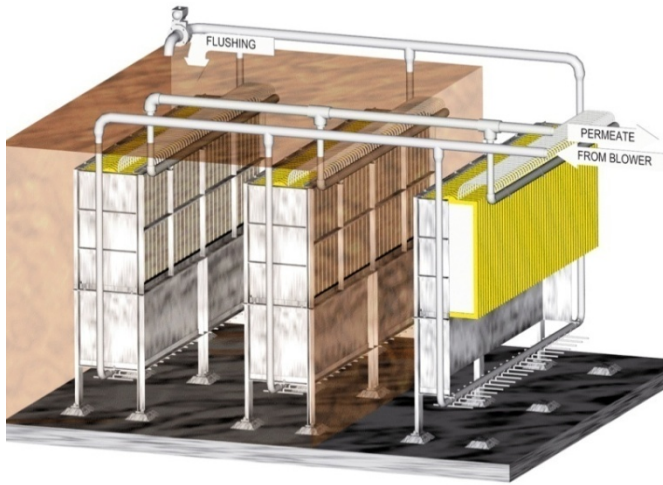
**Facilities obligated to meet stringent nutrient discharge limits, specifically total nitrogen and phosphorus**

**Decentralized facilities or Reduced operations staff**

**Class B Applications**

# How Does Membrane Thickening Work?

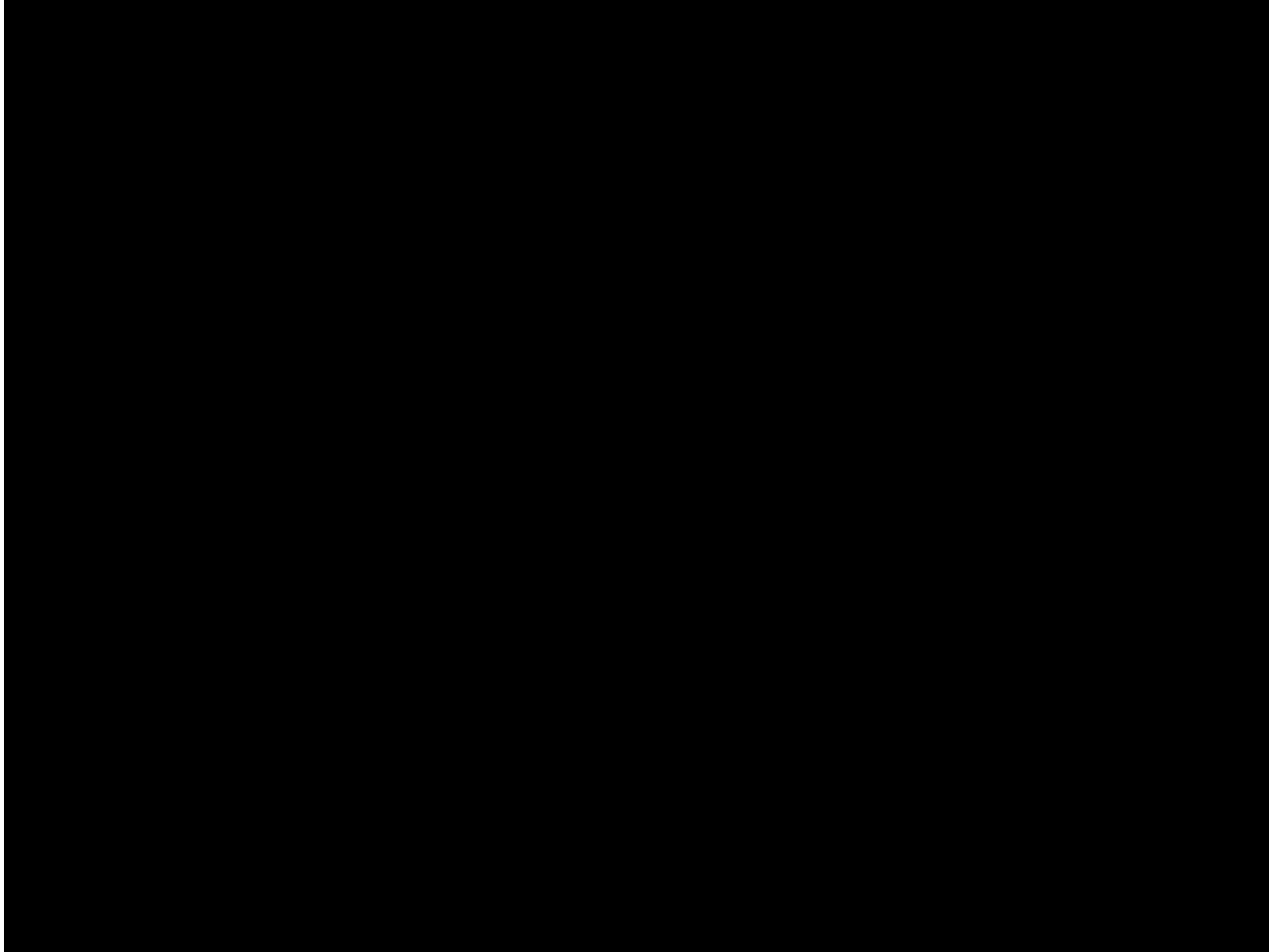
- **How Does Sludge Get Thickened With a Membrane?**



- A membrane thickening (MBT) submerged unit is used to create a physical barrier across which to extract clear water from sludge.
- Air diffuser incorporated on the lower part of the cassette.



# Air Scouring



# Membrane Thickener Key Ingredients

- **Key Ingredients**

- **Flux** = Rate of filtration per unit area of membrane material. Since thickening is typically three times more than an MBR process, flux rates are significantly lower
  - MBR flux @ 20° C = 17.2 gfd vs MBT flux @ 20°C = 5.1 gfd
- **Transmembrane Pressure (TMP)** = The pressure across the membrane during filtration.
  - Typical TMP at design flux rates = 0.5 to 0.75 psig
  - Maximum TMP = 3.0 psig
- **Air Scour** = Air flow required to scour membranes to prevent fouling
- **Biofilm** = Complex dynamic of microorganisms. The interdependency between biological process conditions and membrane filtration performance through a biofilm is termed *BioHydraulics*

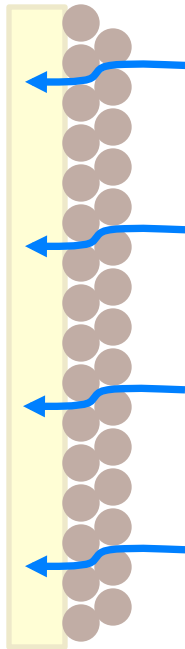
# The Importance of Biofilm

- Biofilm Basics

- ***YOU DON'T GET TO CHOOSE:*** All submerged membranes have a biofilm. As soon as filtration starts and biological solids are brought to the membrane surface, biofilm formation occurs.
- **Benefits**
  - Biofilm serves as a secondary dynamic filter and represents a changing to filtrate flow.
  - Create a dense secondary membrane that can allow for enhanced nutrient removal and degradation of refractory organics.
- **Biofilm management is the key to operating a successful membrane thickening system.**

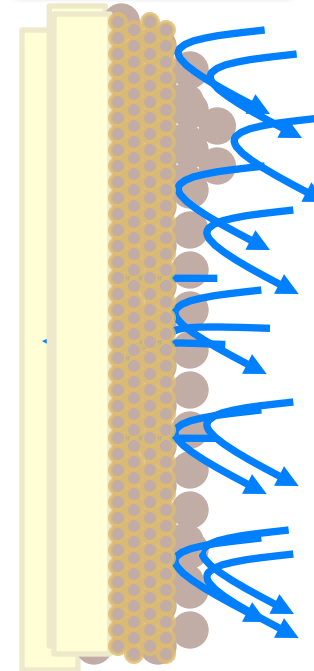
# Biofilm Conditions

Ideal



Stable  
TMP

Non-Uniform



High TMP

# Biofilm Conditions

GOOD



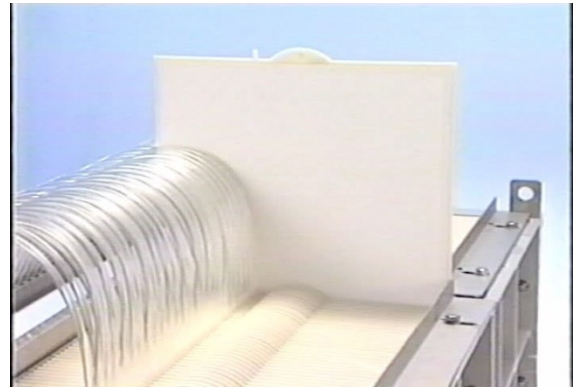
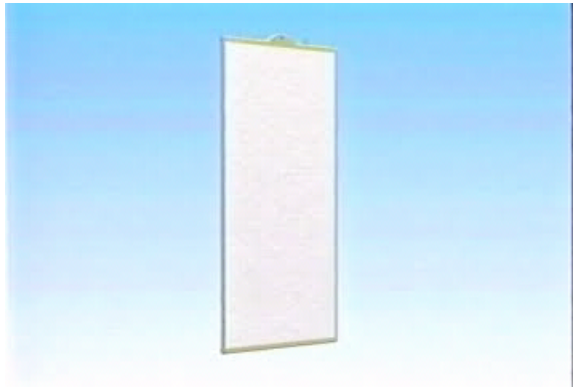
BAD





# Membrane Thickener Facts

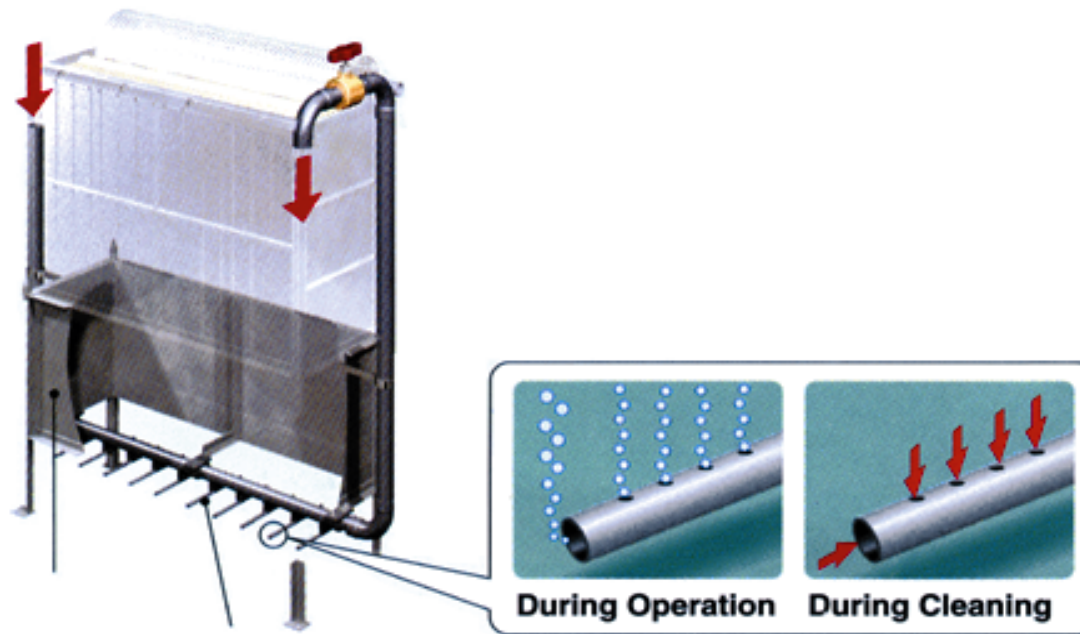
- **Membrane Thickener**



- **Flat Plate Membrane Thickener Facts**

- PE membrane ultrasonically welded to ABS plate.
- Nominal pore size 0.4 micron, effective pore size 0.1 micron
- Effective air filtration area 8.6 ft<sup>2</sup> per cartridge
- MBT Design flux 5 gfd @ 20° C
- MBT Cross flow velocity is 2.25 ft / sec

# Minimum Maintenance Requirements



- Automated Diffuser Cleaning, approximately 30 min/day
- Membrane Relax, approximately 1 min/10 min
- Chemical Cleaning, in-situ cleaning every 6 months, approximately 2 hour duration

**NO NEED TO DRAIN TANKS OR TAKE OUT OF SERVICE FOR CHEMICAL CLEANING.**

# Why use a Membrane Thickening Process

## Operational Benefits of Membrane Thickening

### 1. Improved and Reliable Thickening



# Why use a Membrane Thickening Process

Operational Benefits of Membrane Thickening

**SO.....**

**Polymer  
and  
Decanting** =



**Reduced Operator Attention**

# Why use a Membrane Thickening Process

## Economic Benefits of Membrane Thickening

### 2. Reduced Footprint



*Digestion with  
Membrane Thickening*



*Traditional Digester*

- **Class B Stabilization in a Reduced volume**
- **Reduced Tanks Sizes and Ideal for Retrofits**
- **Less air requirements/energy usage.**



# Why use a Membrane Thickening Process

## Process Benefits of Membrane Thickening

### 3. Produces a High Quality Permeate that features:



- Minimal Total N and P without chemical addition
- Reuse quality that can be recycled to head of plant or sent to disinfection
- Protects effluent quality of BNR Process

# Aerobic Digestion Processes vs Activated sludge processes

Aerobic Digestion is a biological process similar to Activated Sludge.

**Activated Sludge = Growth**

**Aerobic Digestion = Decay**



# Aerobic Digestion Processes vs Activated sludge processes

## Practical Approach To Help Understand the Difference!



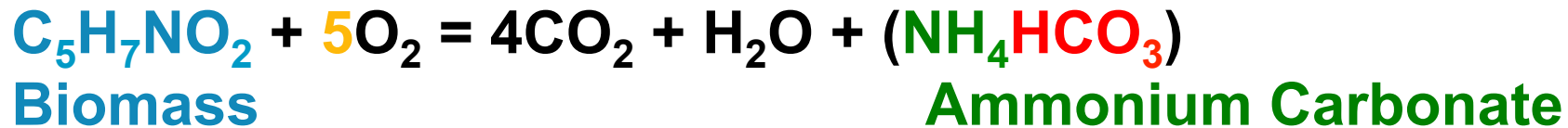
*Activated Sludge*



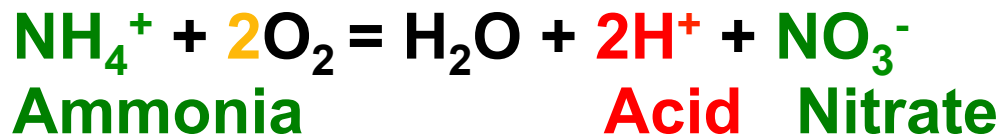
*Aerobic Digestion*

# Aerobic Digestion Chemistry

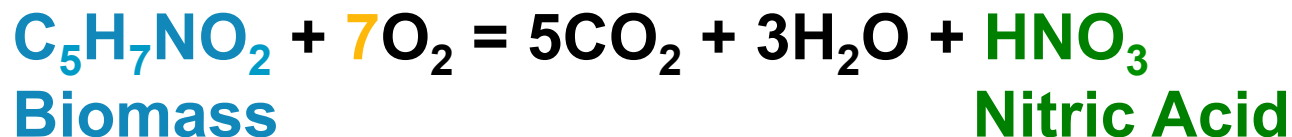
## 1. Digestion:



## 2. Nitrification:



## 3. Digestion with Nitrification:

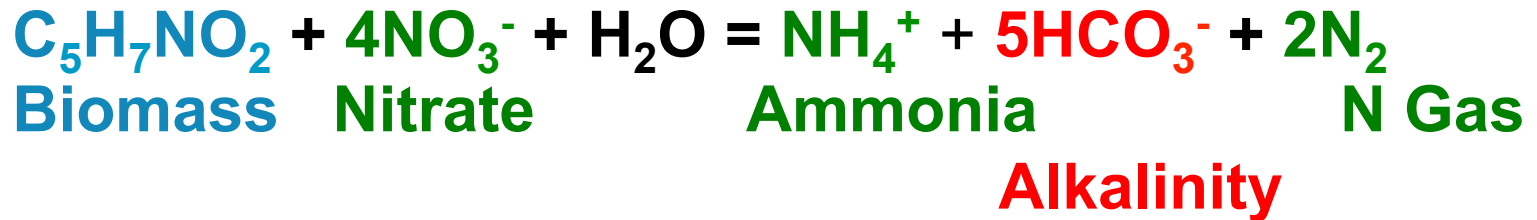


# Aerobic Digestion Chemistry

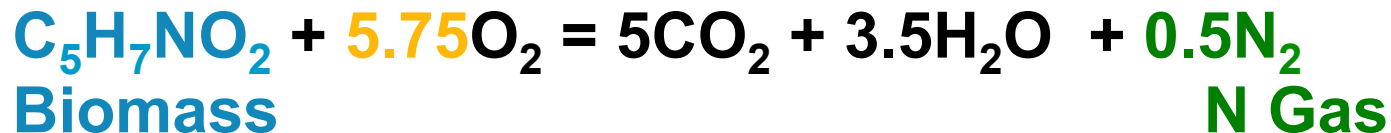
## 4. Digestion with Nitrification:



## 5. Denitrification:

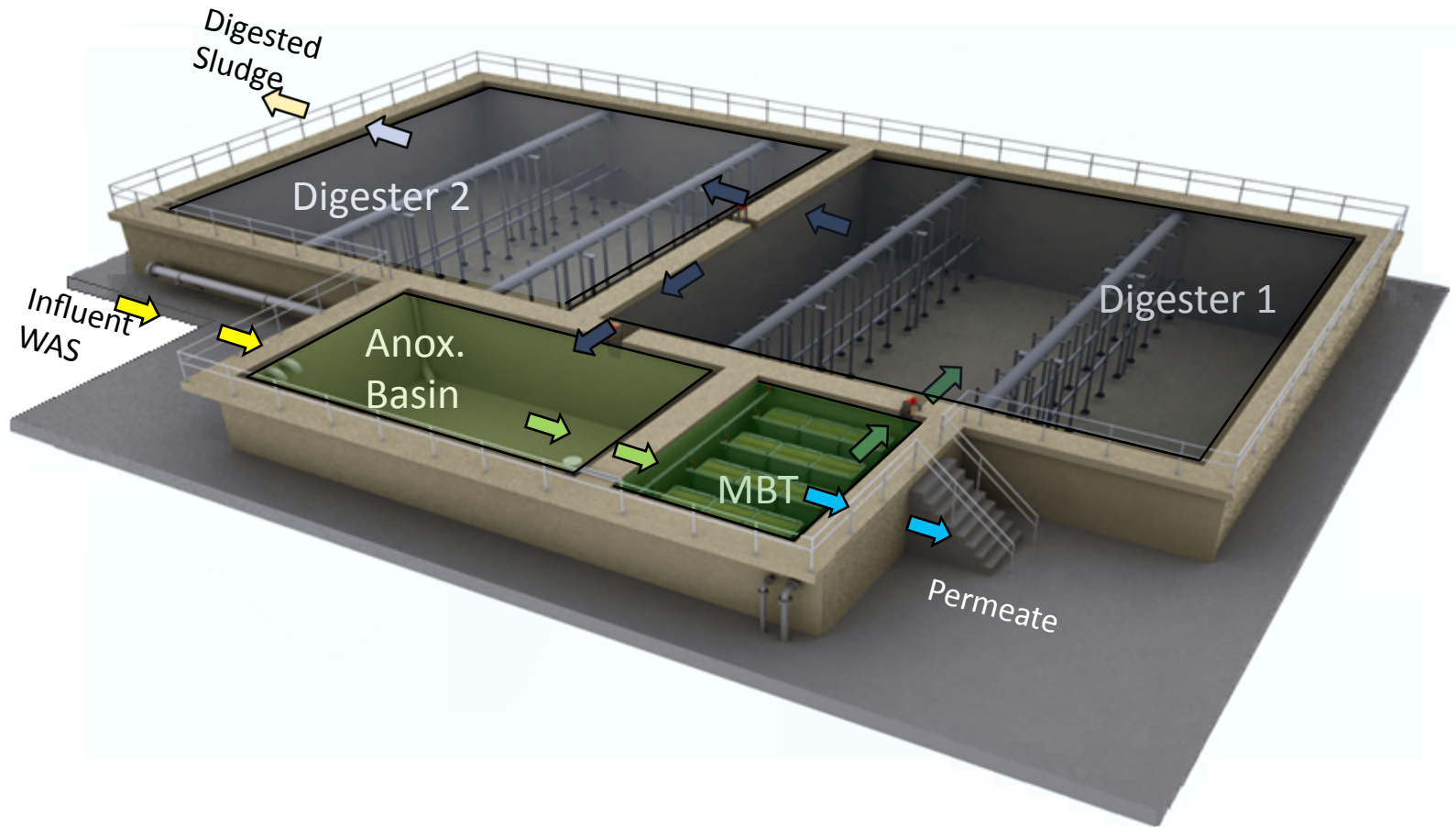


## 6. Complete Nitrification / Denitrification:





# Membrane Thickening Aerobic Digestion Process



# Case Studies

## Case Studies Membrane Thickening Aerobic Digestion Processes



# Dundee WWTP, Michigan

## First U.S. Installation

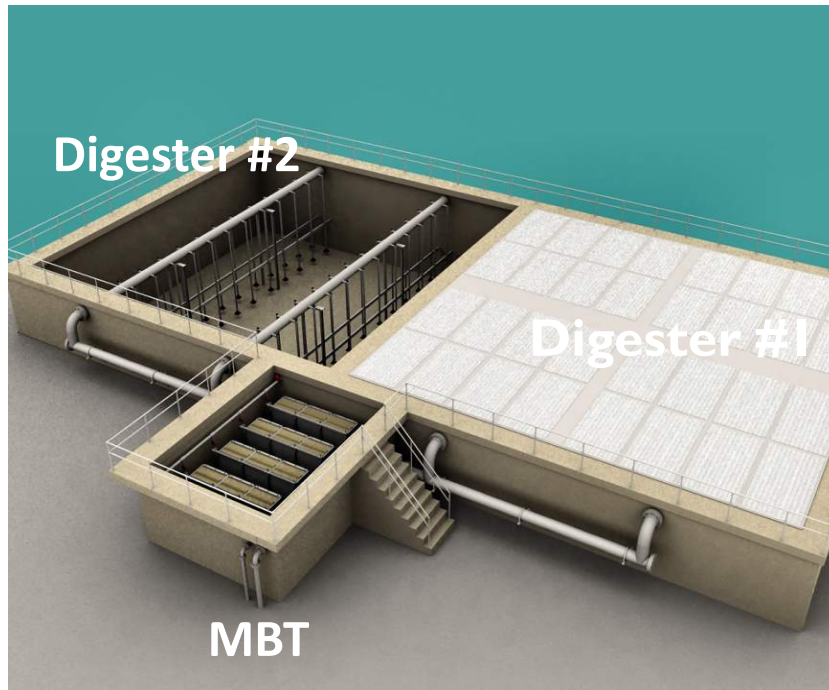


# Dundee WWTP, Michigan

<b>Commissioned:</b>	<b>2005</b>
<b>Liquid Process:</b>	<b>MBR (1.2 MGD)</b>
<b>MBT Size:</b>	<b>800 plates</b>
<b>Solid Conc.:</b>	<b>3%-5.25%</b>
<b>Chemical Cleaning:</b>	<b>2-3 / year (scheduled)</b>



# Dundee WWTP, Michigan



Engineer: Arcadis

## History:

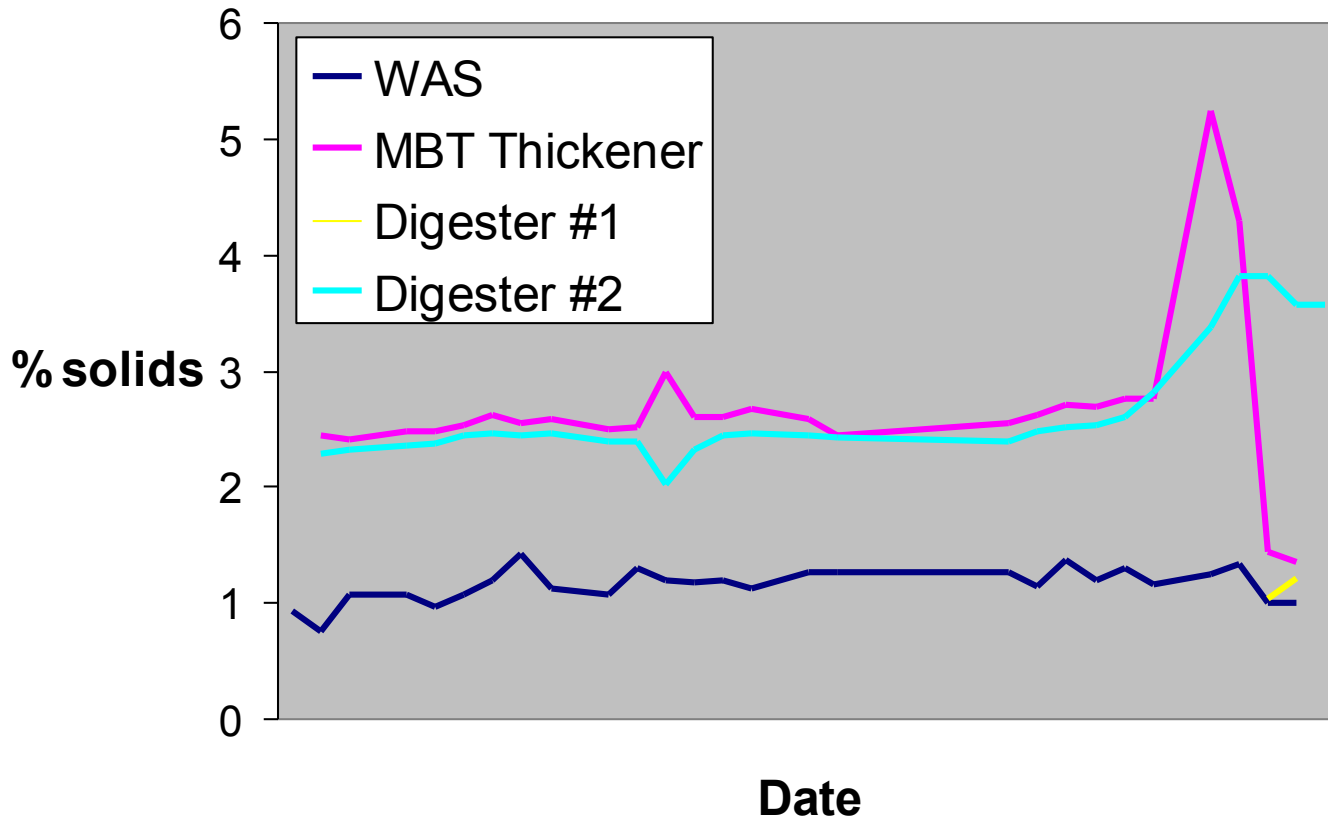
- Objective was to reduce the hauling to 2 times per year. Tanks are designed to store 180 days at 3% solids.
- Operator friendly when compared to other systems.



# Dundee WWTP, Michigan

## Thickening Performance

Sep & Oct 2005 Operation



# Dundee WWTP, Michigan

## September 2005 to June 2008 Data

### Sustainable Permeate Quality

<b>BOD:</b>	<b>1.12 mg/l</b>
<b>TSS:</b>	<b>2.00 mg/l</b>
<b>NH<sub>3</sub>-N:</b>	<b>0.22 mg/l</b>
<b>NO<sub>3</sub>-N:</b>	<b>0.03 mg/l</b>
<b>TP:</b>	<b>1.09 mg/l</b>

# Dundee WWTP, Michigan

## Sludge Hauling Cost Summary

Years	Gallons Hauled	Dry Tons	Yearly Cost
2004 (0.6 MGD)	248,885 – Belt 943,200 – Truck 1,192,100 - Total	22.67 – Belt 99.39 – Truck 122.06 - Total	\$16,850 – Belt \$30,088 – Truck <b>\$46,938 - Total</b>
2005 (1.2 MGD) MBT operational for 2 <sup>nd</sup> half of year only	572,400 – Belt 432,000 – MBT 1,004,400 - Total	55.62 – Belt 47.55 – MBT 103.17 - Total	\$39,135 – Belt \$14,623 – MBT <b>\$53,758 – Total</b>
2006	<b>887,400 - MBT</b>	<b>130.48 – MBT*</b>	<b>\$32,739 - MBT</b>

**Belt press was needed for years 2003 -05 due to lack of storage space.**

**Sludge Hauling costs for first full year of operation of MBT in 2006 was \$32,739 which is cheaper than the last 5 years**

**\* Sludge Production minimized due to N/DN**

# McFarland Creek WWTP, Ohio

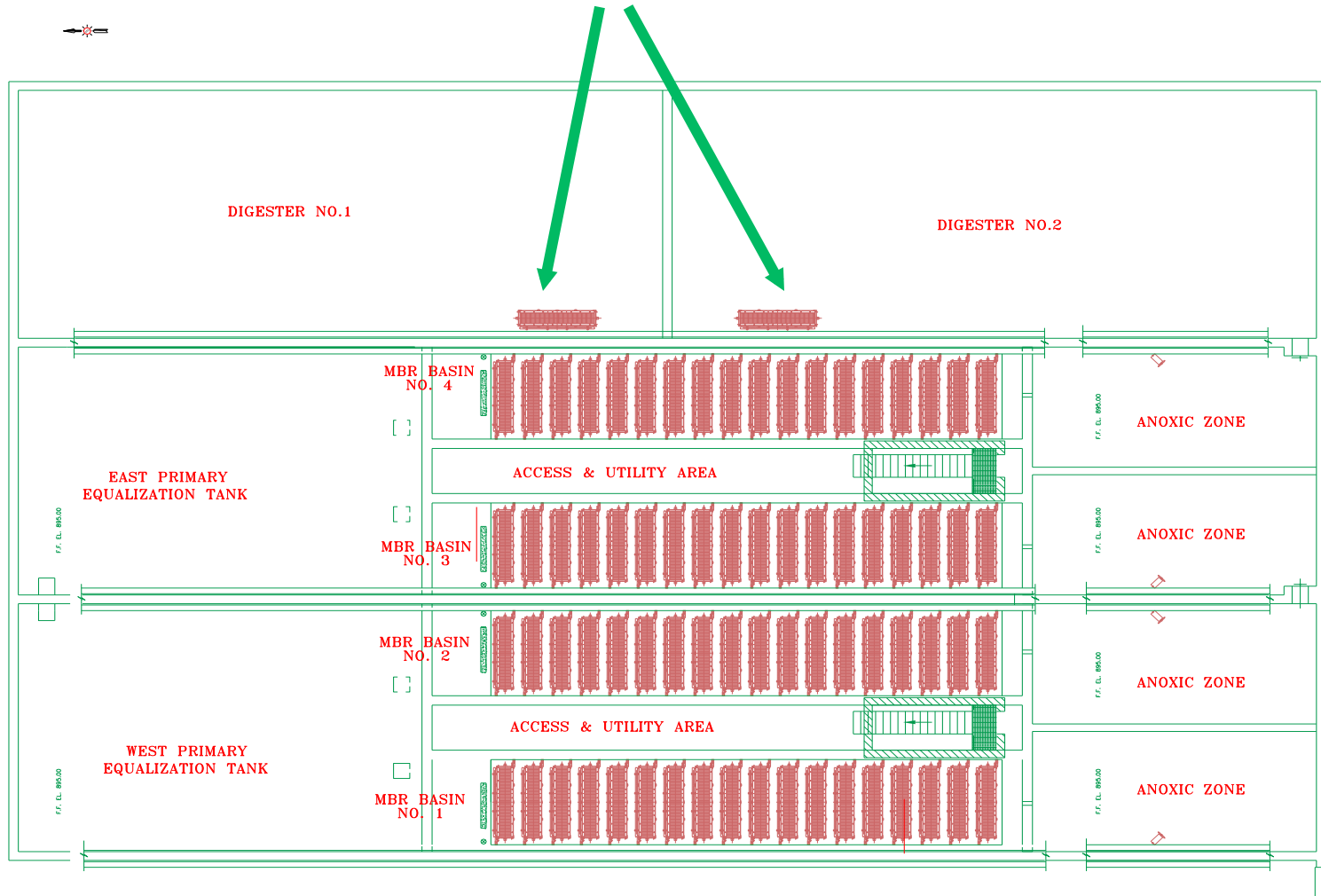
**Engineer: CT Consultants**

**Two Stage Membrane Thickening Aerobic  
Digestion Process**



# McFarland Creek WWTP, Ohio

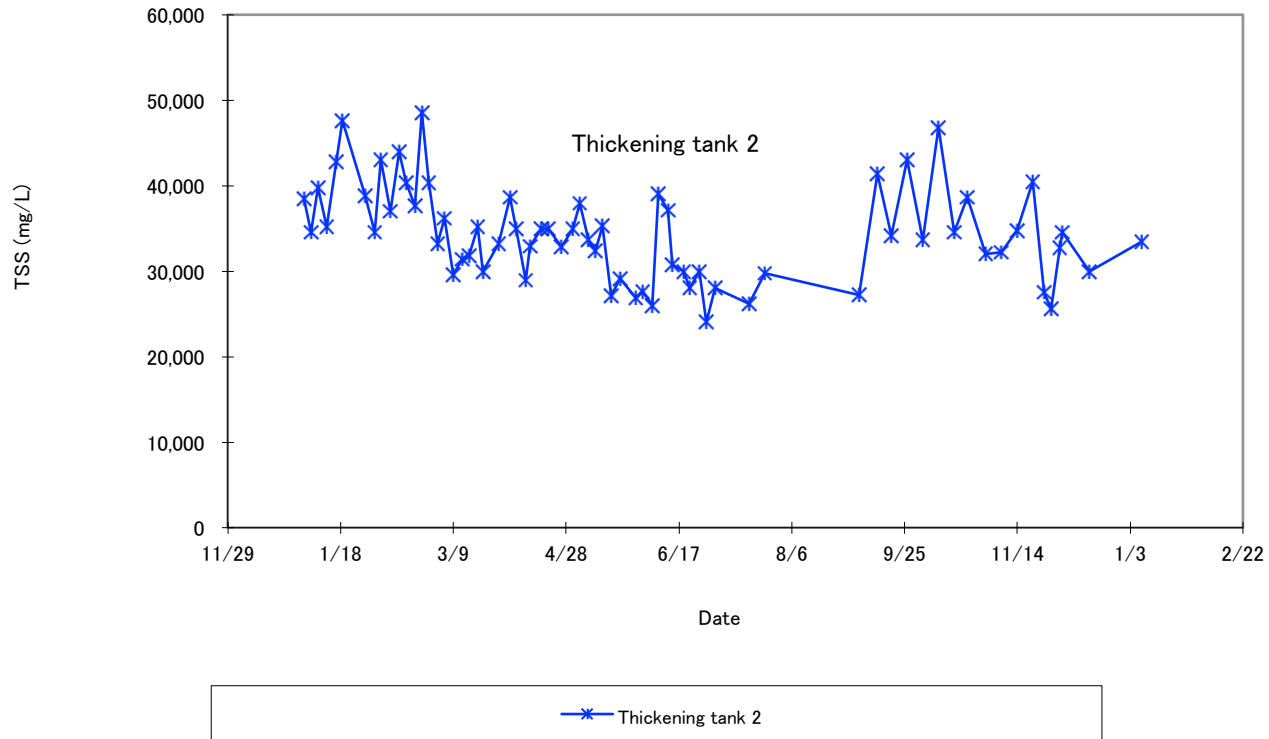
## Membrane Units Installed Directly Inside the Digesters



# McFarland Creek WWTP, Ohio

<b>Commissioned:</b>	<b>2005</b>
<b>Waste Type:</b>	<b>Municipal</b>
<b>Liquid Process:</b>	<b>MBR (1.8 MGD)</b>
<b>MBT Size:</b>	<b>400 plates</b>
<b>Solids Conc.:</b>	<b>3.5%-5.5%</b>

# McFarland Creek WWTP, Ohio



**Membrane thickening at McFarland Creek WWTP was able to thicken up to 5% solids.**



# McFarland Creek WWTP, Ohio

## McFarland Creek WWTP Improved Dewatering Operations

Annual BFP run time w/o PAD <sup>®</sup> -K	8,736 hours
Annual BFP run time with PAD <sup>®</sup> -K	3,744 hours
Reduction BFP run time	57.14%

**MORE EFFICIENCY MEANS BETTER RESULTS.....**

**41% Reduction in CUBIC YARDS PRODUCED**

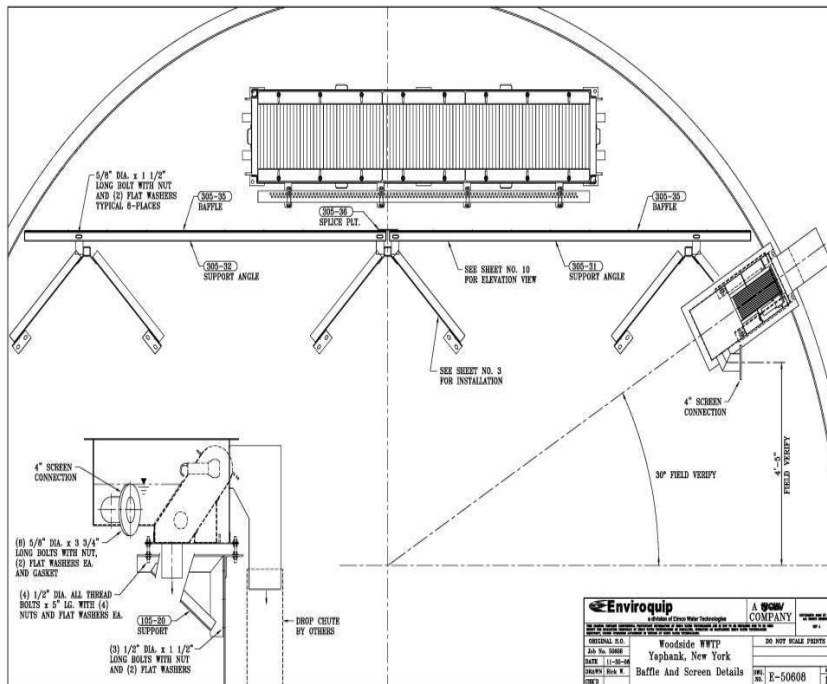
**36.5% Reduction in DRY TONS PRODUCED**

**41% Cost Reduction in POLYMER**

**41% Cost Saving in SLUDGE DISPOSAL**

# Woodside WWTP, New York

## Biological Process: Concentric Circular Plant GOAL: Reduce Number of Sludge Hauling Trips



Less gallons to haul per year:  
Sludge hauling reduction 625,783 gal.  
Savings per year \$59,449  
ROI of 2.57 years based solely on hauling

# Cayce WWTP, South Carolina

**Engineer:** American Engineering Consultants

**Membrane Thickening Digestion Following a Carrousel Biological Process: Coming To A Theatre Near You**

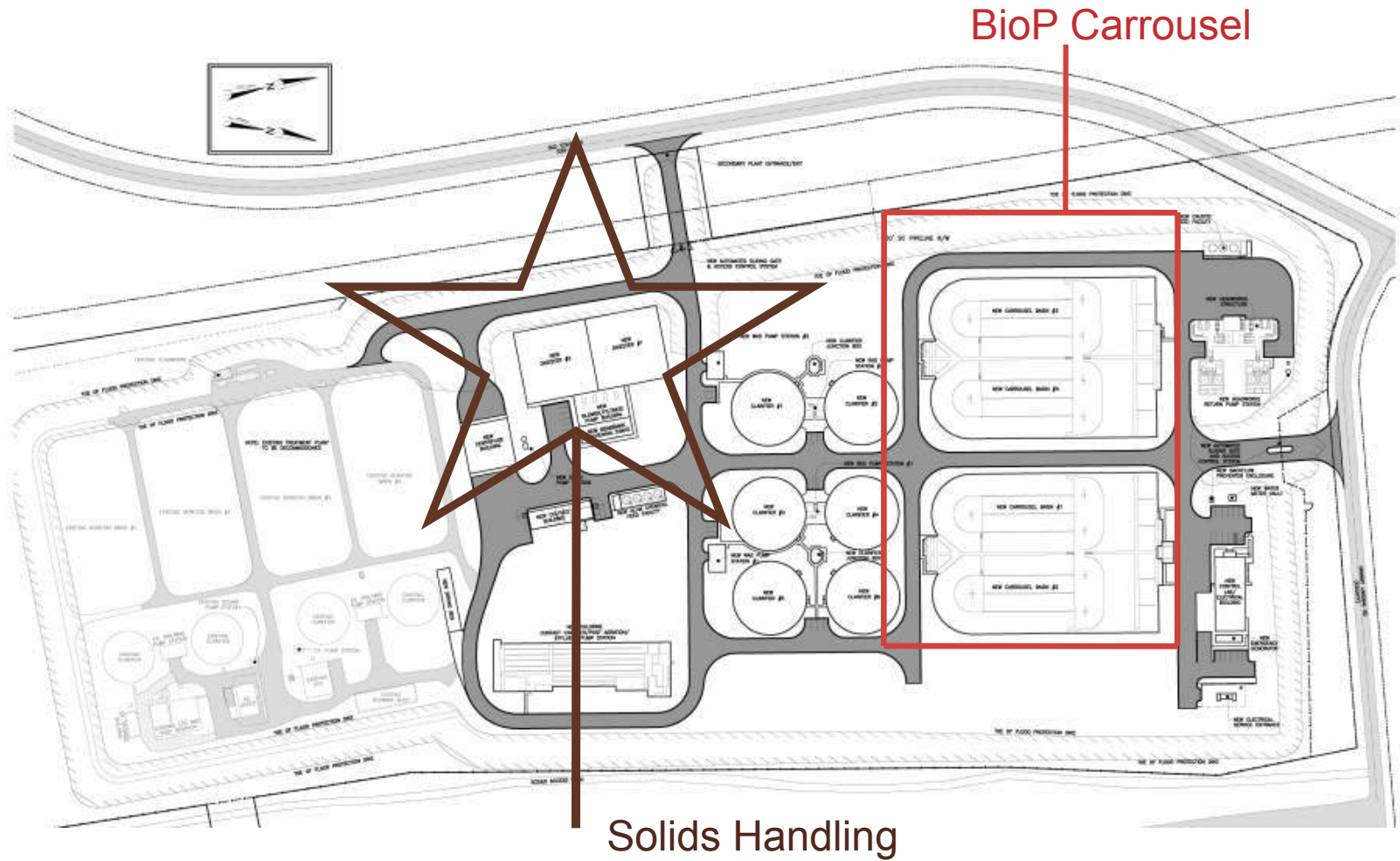
**Current Site  
8 MGD Cap.  
To be expanded to  
25 MGD**

**Membrane  
Thickening  
Digestion selected  
to protect BioP  
Carrousel Ditch**



# Cayce WWTP, South Carolina

## Plant Layout at 25 MGD



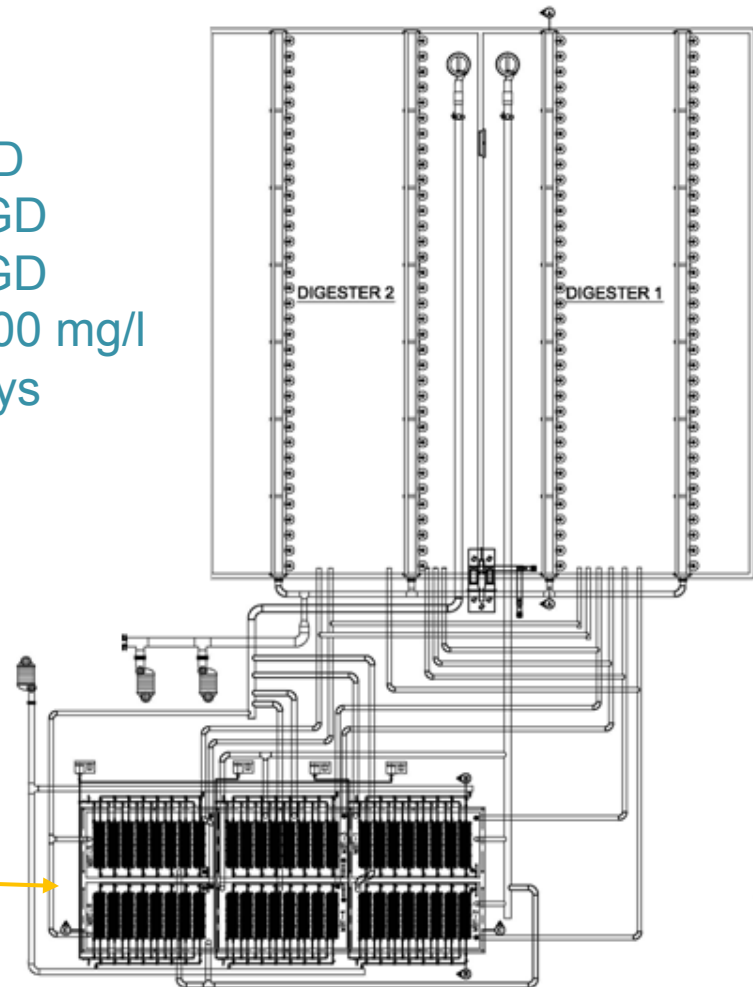


# Cayce WWTP, South Carolina

## Cayce WWTP Carrousel MD Process

Start-up Plant Flow= 8 MGD  
Intermediate Plant Flow= 12 MGD  
Design Influent Plant Flow= 25 MGD  
WAS concentration= <10,000 mg/l  
Design digestion SRT= 20 days

Membrane  
modules in  
Series



# Cayce WWTP, South Carolina

- **Benefits**

- **Eliminated construction of thickener building.**
- **Reduced number and size of digesters by operating at 4% TS.**
- **Provided flexibility for a gradual flow increase.**
- **Reduced O&M costs by eliminating use of polymer for thickening.**
- **Reduced O&M costs due to less aeration / energy needs.**
- **Reduced O&M costs due to less supervision needs.**

**SAFEGUARD HIGH QUALITY BIO-P CARROUSEL EFFLUENT**

# Conclusions

## MEMBRANE THICKENING AEROBIC DIGESTION PROCESSES BRING:

### ECONOMIC VALUE:

- Reduced Tank Sizes and Ideal for Retrofits
- Savings on Energy, Disposal, Chemical, and Concrete Costs

### PROCESS VALUE:

- Class B Stabilization
- Reuse Quality Permeate with Low Total N and P
- Odor Control
- Increased Solids Storage Capacity in existing or new tanks

### OPERATIONAL VALUE:

- Reduced Operator Attention
- Thickening Without Polymers
- No Attention to Decanting



**Any Questions?**



**ANY QUESTIONS?**

**Thank You**

**THAT'S ALL FOLKS!**



**Bryen Woo, PE**  
**Aerobic Digestion/Aeration Product**  
**Manager**  
**512-652-5818**  
**[Bryen.woo@ovivowater.com](mailto:Bryen.woo@ovivowater.com)**