

MBR Operations

DAIRY WASTEWATER APPLICATIONS

JOANNA HODGSON

Mechanical Engineer

The Probst Group

Wastewater Treatment Technologies

01

Process Comparison

ANAEROBIC & AEROBIC TREATMENT

02

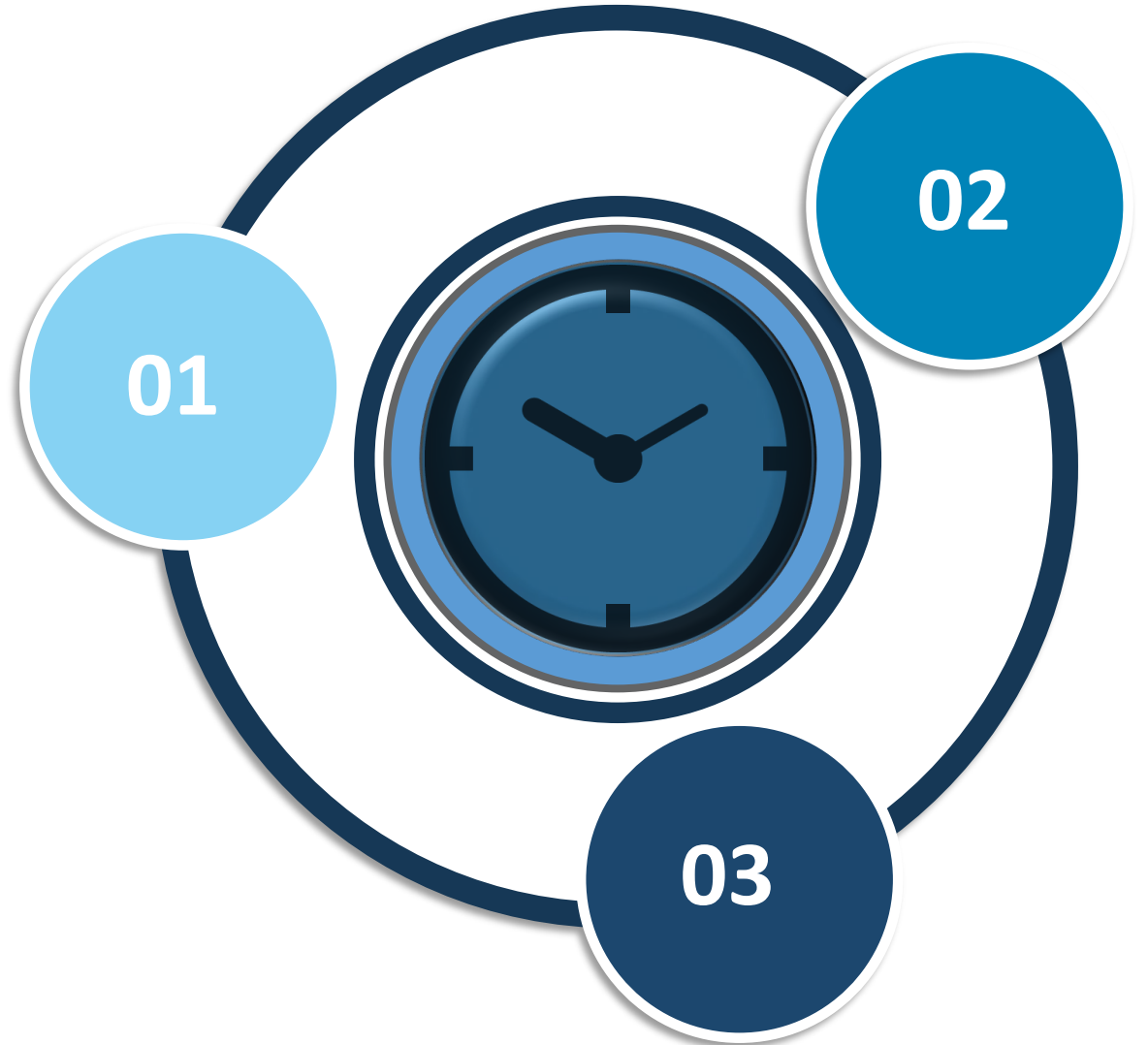
Case Studies

ANAEROBIC & AEROBIC TREATMENT

03

Challenges & Remedies

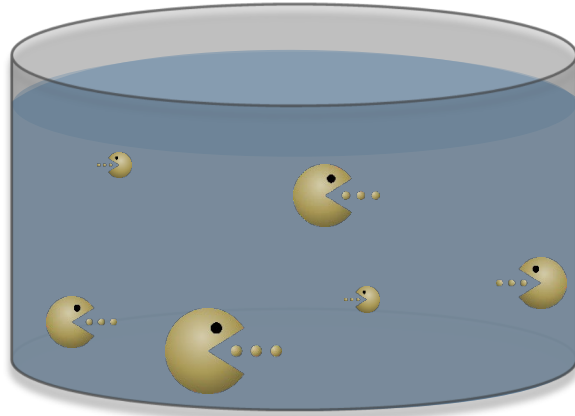
04



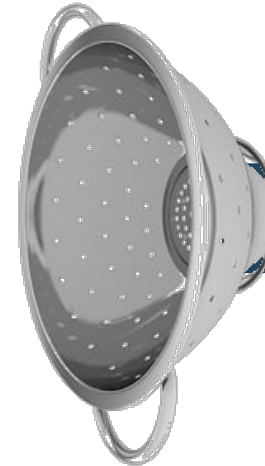
Wastewater

TREATMENT TECHNOLOGIES

WASTEWATER



BIOREACTOR



SOLIDS/LIQUIDS
SEPARATION (SLS)

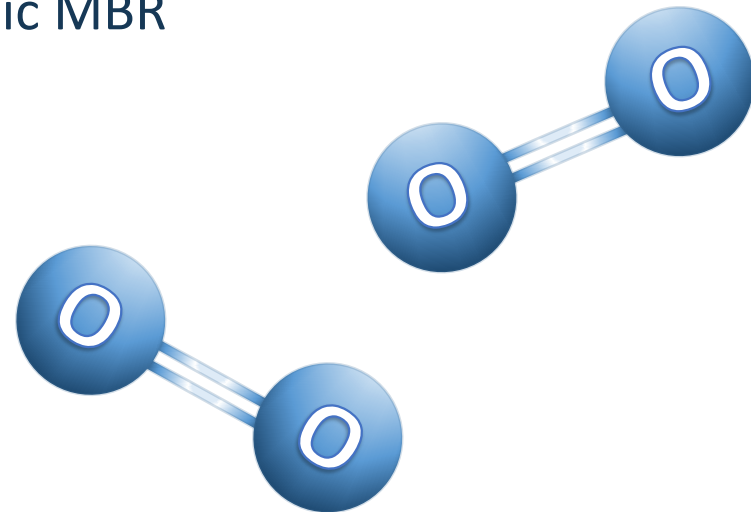
TREATED EFFLUENT

ANAEROBIC

- Bulk Volume Fermenter (BVF)
- Upflow Anaerobic Sludge Blanket (UASB)
- Complete Mix Reactor (CSTR)
 - Gravity Clarifier
 - DAF/Centrifuge/Screen
 - UF – Anaerobic MBR

AEROBIC

- Conventional Activated Sludge
- Sequencing Bioreactor (SBR)
- Aerobic MBR



Anaerobic

PROCESS COMPARISON

BULK VOLUME
FERMENTER
(BVF)

UPFLOW
ANAEROBIC
SLUDGE BLANKET
(UASB)

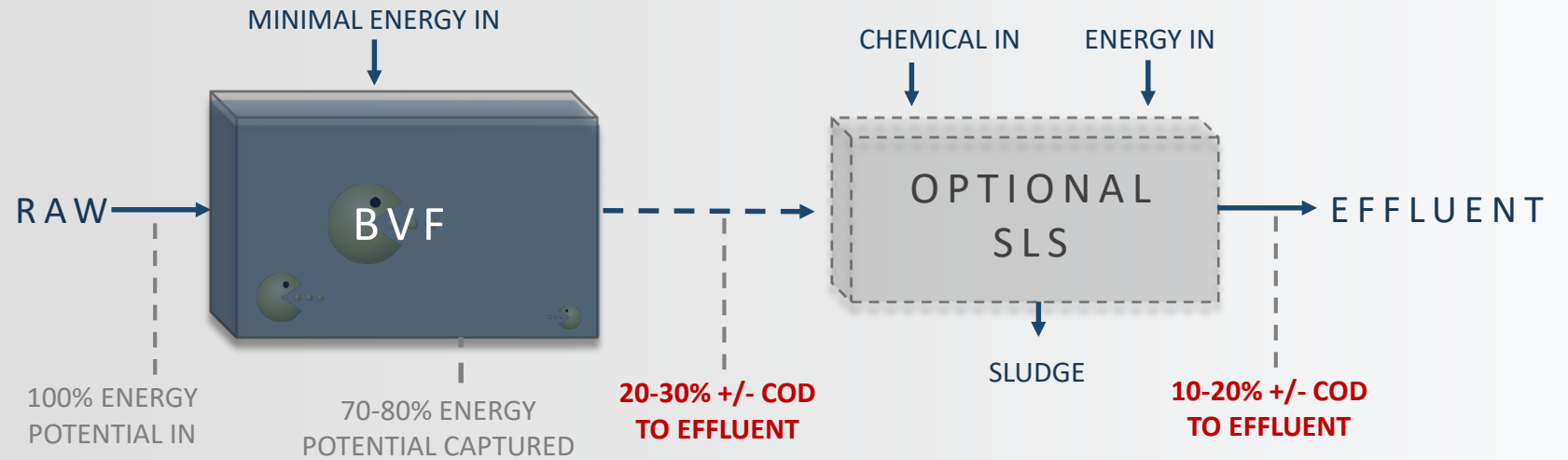
COMPLETE MIX
WITH
GRAVITY SLS

ANAEROBIC
MEMBRANE
BIOREACTOR
(ANMBR)

BULK VOLUME FERMENTER (BVF)

70-80% ENERGY CAPTURE

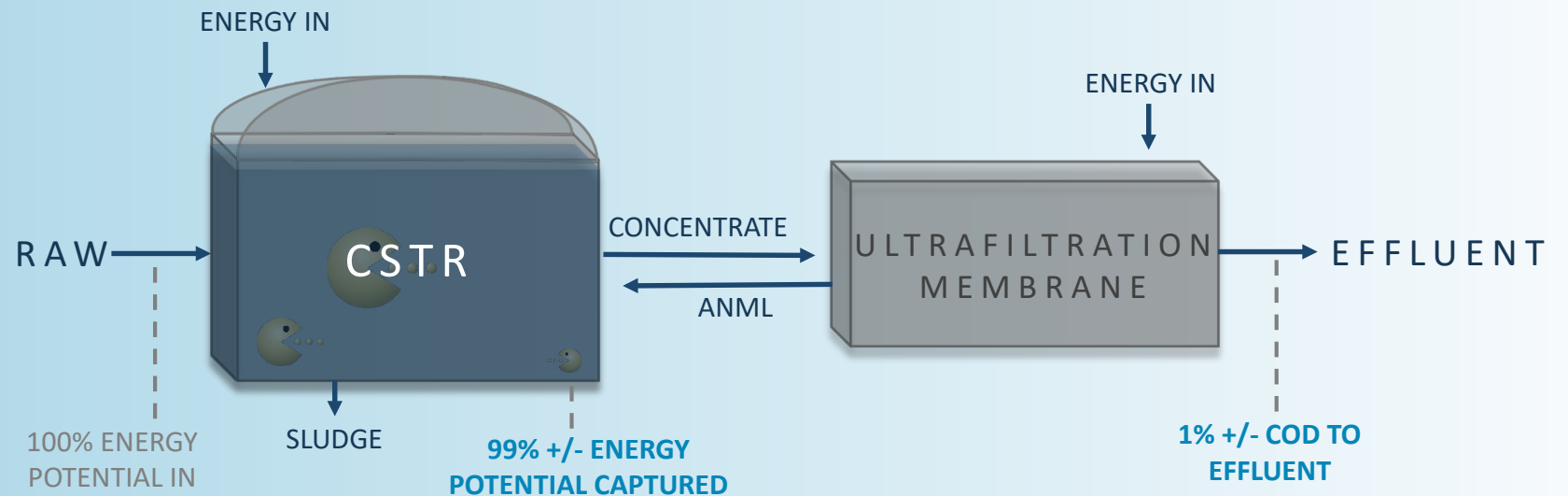
10-30% COD TO EFFLUENT



ANAEROBIC MEMBRANE BIOREACTOR (MBR)

70-80% ENERGY CAPTURE

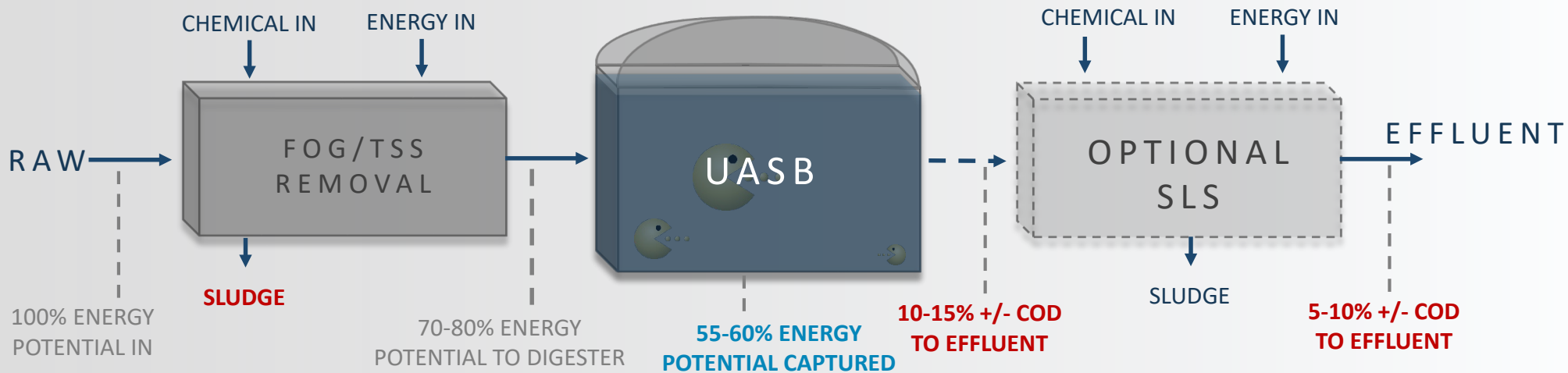
10-30% COD TO EFFLUENT



UPFLOW ANAEROBIC SLUDGE BLANKET (UASB)

50-60% ENERGY CAPTURE

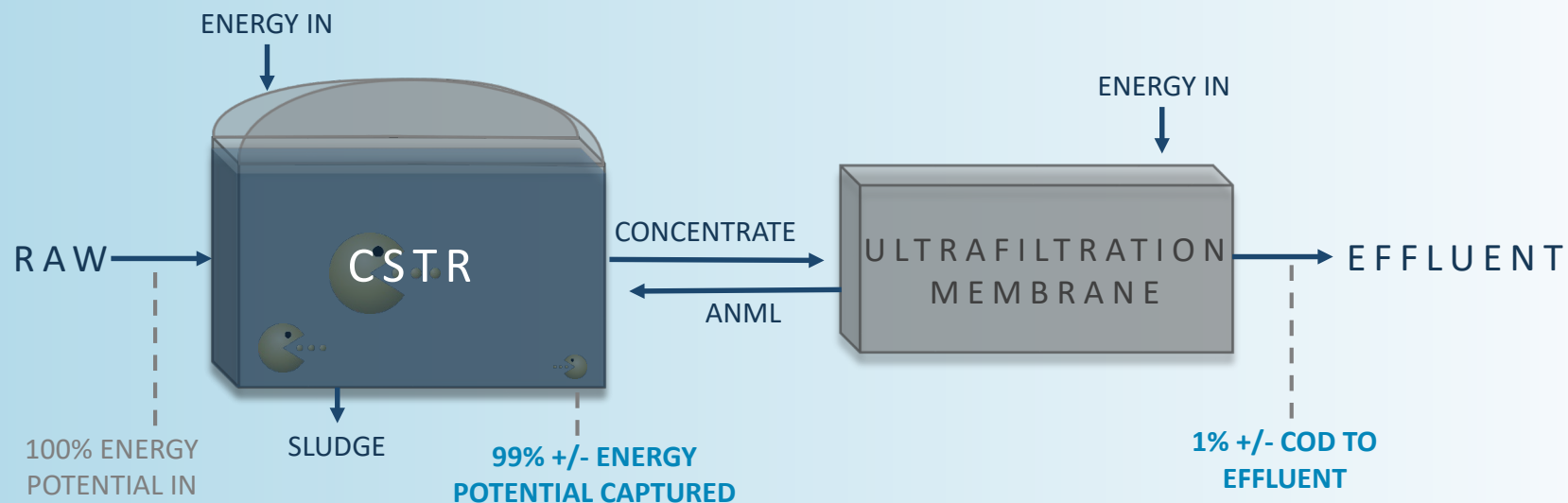
5-10% COD TO EFFLUENT



ANAEROBIC MEMBRANE BIOREACTOR (MBR)

70-80% ENERGY CAPTURE

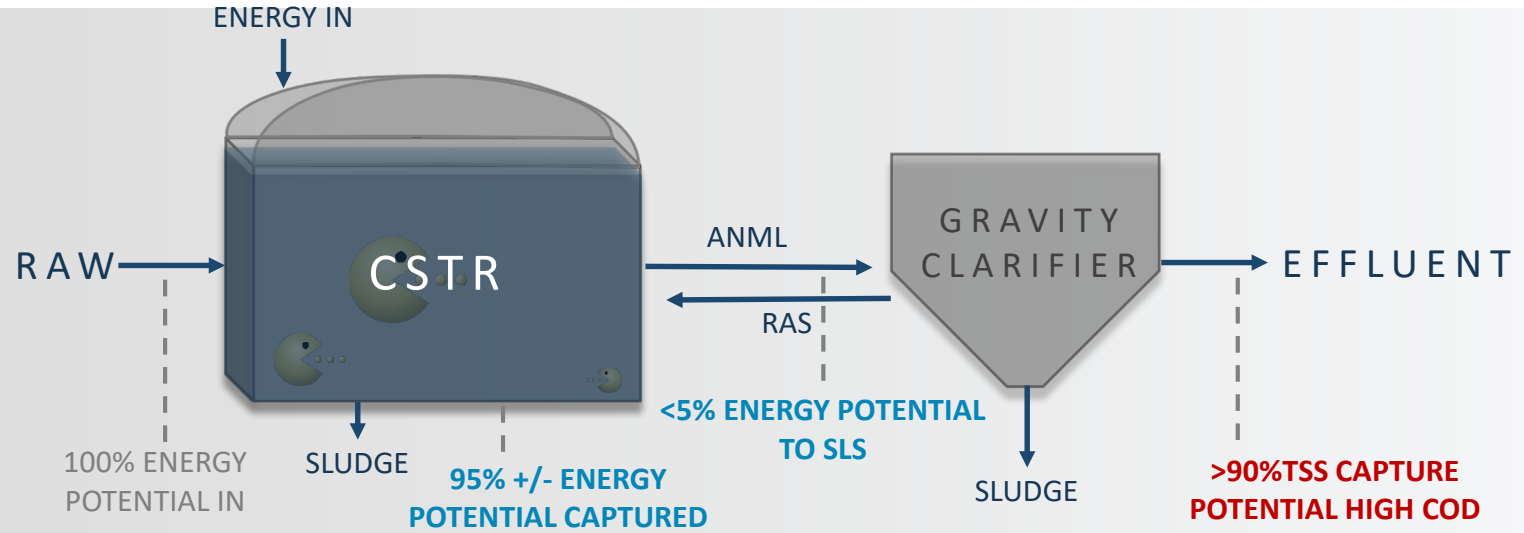
10-30% COD TO EFFLUENT



COMPLETE MIX WITH GRAVITY SLS

95% ENERGY CAPTURE

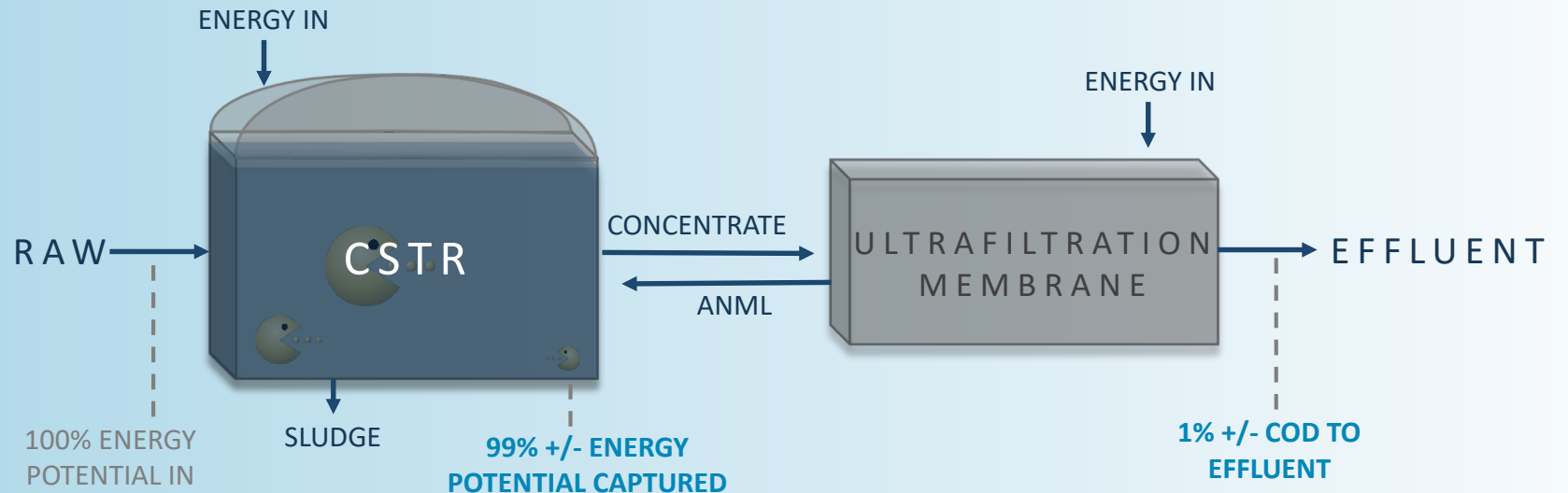
>90% TSS CAPTURE



ANAEROBIC MEMBRANE BIOREACTOR (MBR)

70-80% ENERGY CAPTURE

10-30% COD TO EFFLUENT

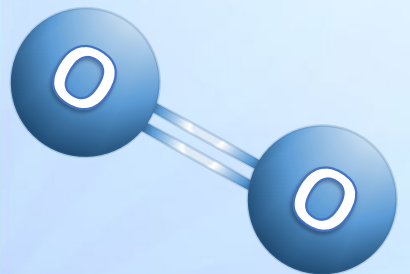


Aerobic PROCESS COMPARISON

SEQUENCING
BATCH REACTOR
(SBR)

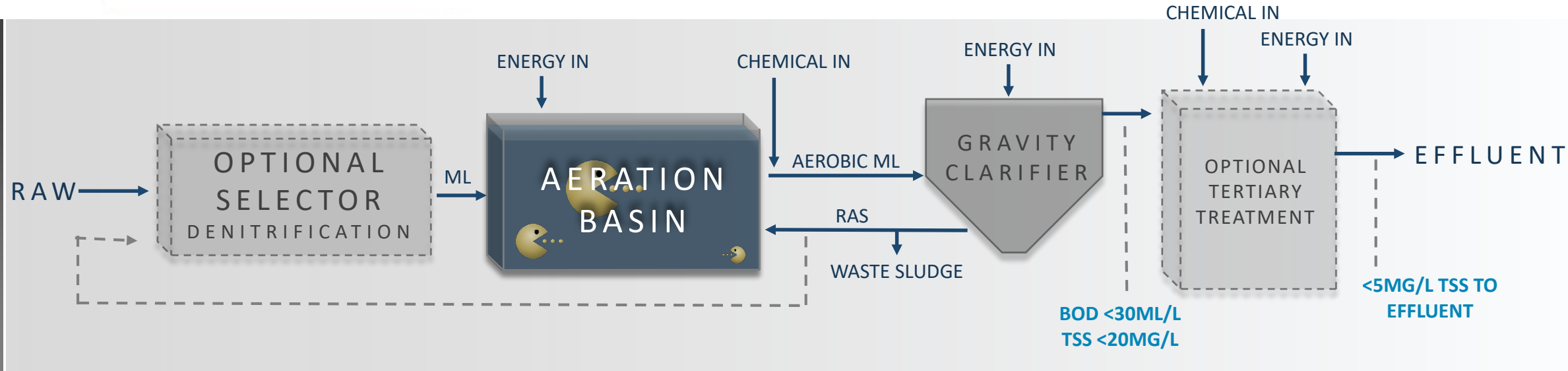
COMPLETE MIX
WITH GRAVITY
SLS

AEROBIC
MEMBRANE
BIOREACTOR
(MBR)

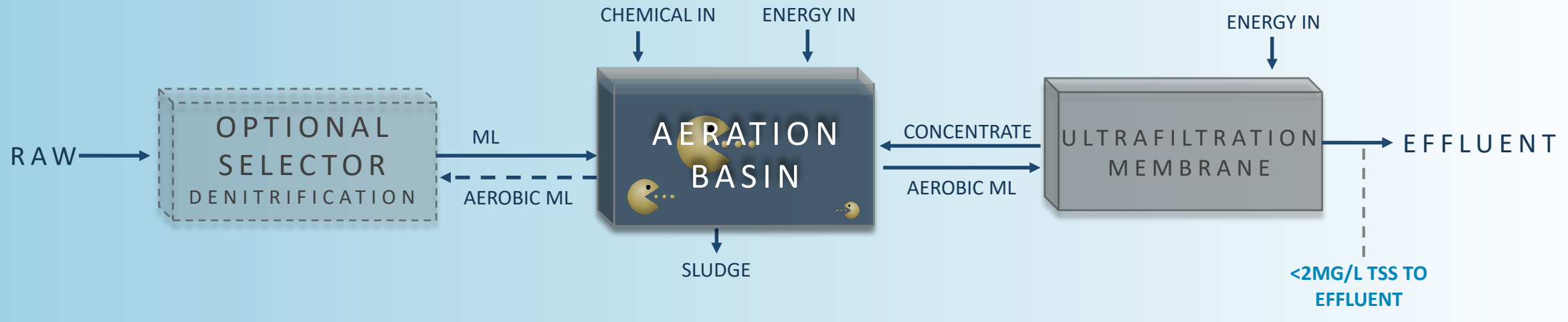


PROCESS COMPARISON: CSTR W/ GRAVITY SLS VS. MBR

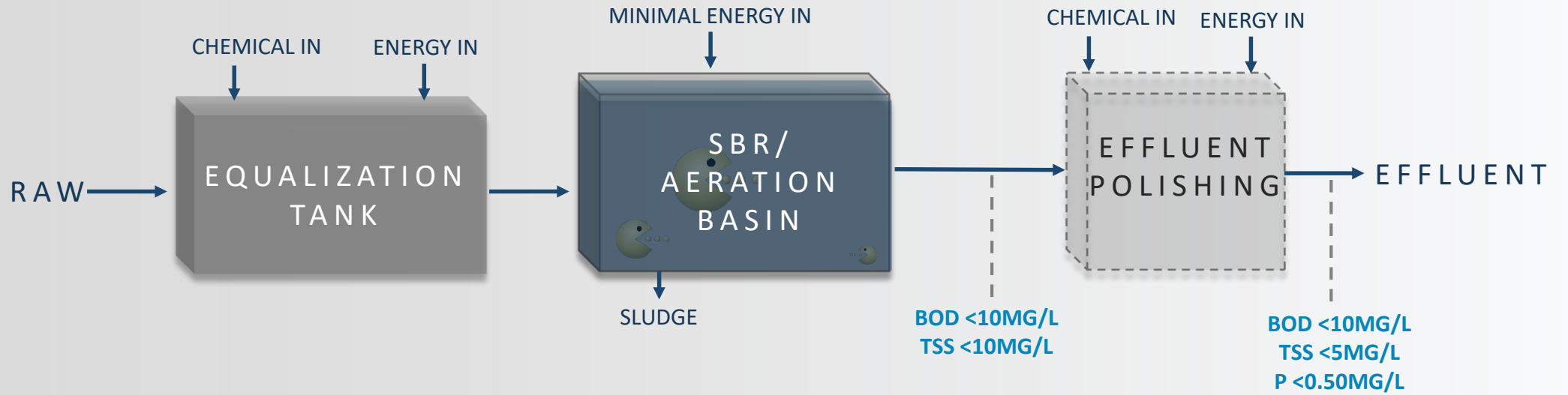
COMPLETE MIX WITH GRAVITY SLS



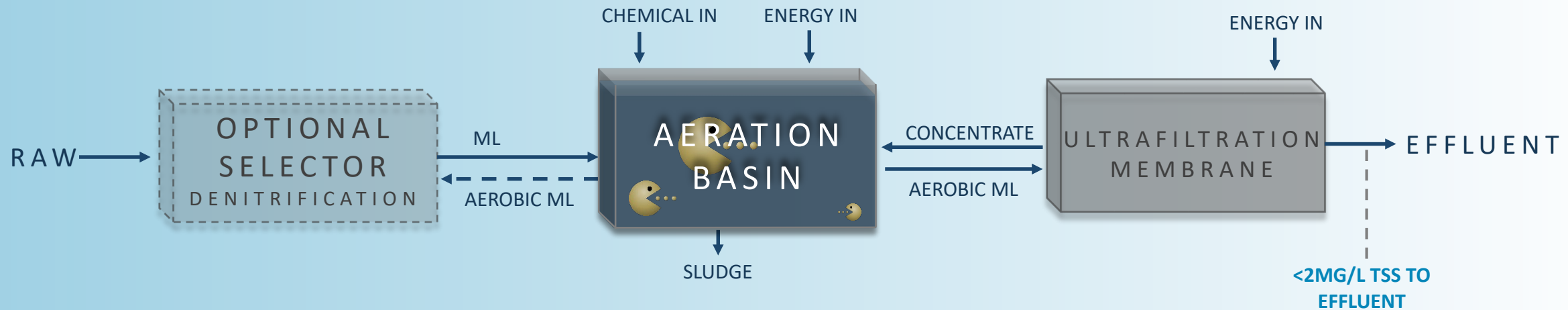
AEROBIC MEMBRANE BIOREACTOR (MBR)



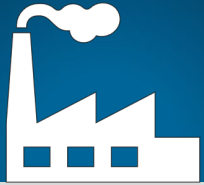
SEQUENCING BATCH
REACTOR (SBR)



AEROBIC MEMBRANE
BIOREACTOR (MBR)



Case Studies



**BACKGROUND &
PROBLEM**

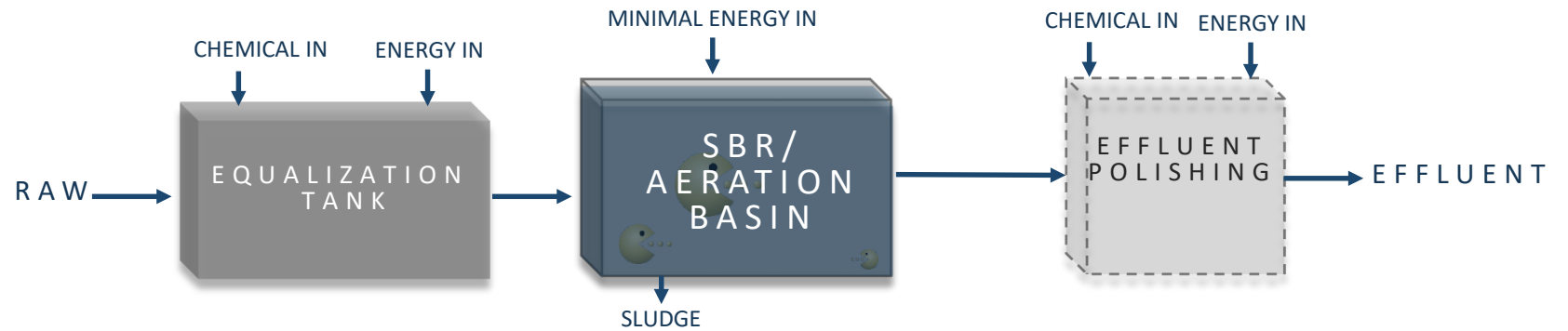
- NEED FOR ADDITIONAL HYDRAULIC CAPACITY
- EFFLUENT DAF POLISHING
- INCREASED LOADING CAPACITY



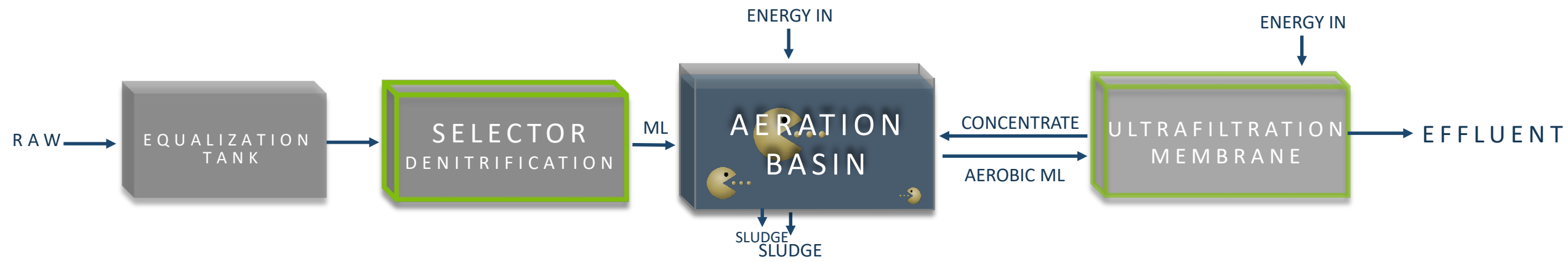


SOLUTION

EXISTING SBR SYSTEM



CONVERTING SBR SYSTEM TO AEROBIC MBR





RESULTS



FLOW	500,000 – 800,000 gpd
BOD (AVERAGE)	<1.0 MG/L
TSS (AVERAGE)	<1.0 MG/L
FLUX RATE	>200 LMH
ENERGY USE	8.1 KWH/1000 GAL @ \$0.10/KWH = \$0.81/1000 GAL = \$0.00081/GAL



**BACKGROUND &
PROBLEM**

- ALL PROCESS WW WAS HAULED OFF TO LOCAL MUNICIPALITIES
- HIGH DISPOSAL COST
- LIMITED ABILITY TO INCREASE PRODUCTION AND REDUCE WHEY TRANSPORT COSTS





SOLUTION

- CONSTRUCTING & MANAGING THEIR OWN WWTP
- AEROBIC MBR WITH UF MEMBRANES AND AN ANOXIC SELECTOR TANK FOR EBPR





RESULTS

FLOW	150,000 – 350,000 gpd
BOD (AVERAGE)	<1.0 MG/L
TSS (AVERAGE)	<1.0 MG/L
TP	0.05 MG/L
AMMONIA	<1.0 MG/L +/-
FLUX RATE	>200 LMH
ENERGY USE	8.1 KWH/1000 GAL @ \$0.10/KWH = \$0.81/1000 GAL = \$0.00081/GAL



**BACKGROUND &
PROBLEM**

- DIFFICULTIES WITH LAND APPLICATION
- STRICT SURFACE WATER DISCHARGE REQUIREMENTS





SOLUTION

- NEW BUILD WWTP
- AEROBIC MBR
- WATER QUALITY TRADING





RESULTS

FLOW	75,000 gpd
BOD (AVERAGE)	<2.0 MG/L W/ NCCW
TSS (AVERAGE)	<2.0 MG/L
TP	0.3 MG/L
FLUX RATE	100 LMH +/-
ENERGY USE	8.6 KWH/1000 GAL @ \$0.10/KW = \$0.86/1000 GAL = \$0.00086/GAL





**BACKGROUND &
PROBLEM**

- INADEQUATE MUNICIPAL TREATMENT PLANT
- COMPLIANCE WITH STRICT DISCHARGE LIMITS





SOLUTION

- DESIGN & BUILD NEW WWTP TO EFFECTIVELY TREAT WW FROM ALL PRODUCTION FACILITIES





RESULTS



FLOW >300,000 GPD

COD IN 50,000-70,000 MG/L

COD OUT 200 MG/L (300 LBS/DAY)

P IN 400 MG/L

P OUT 50 MG/L

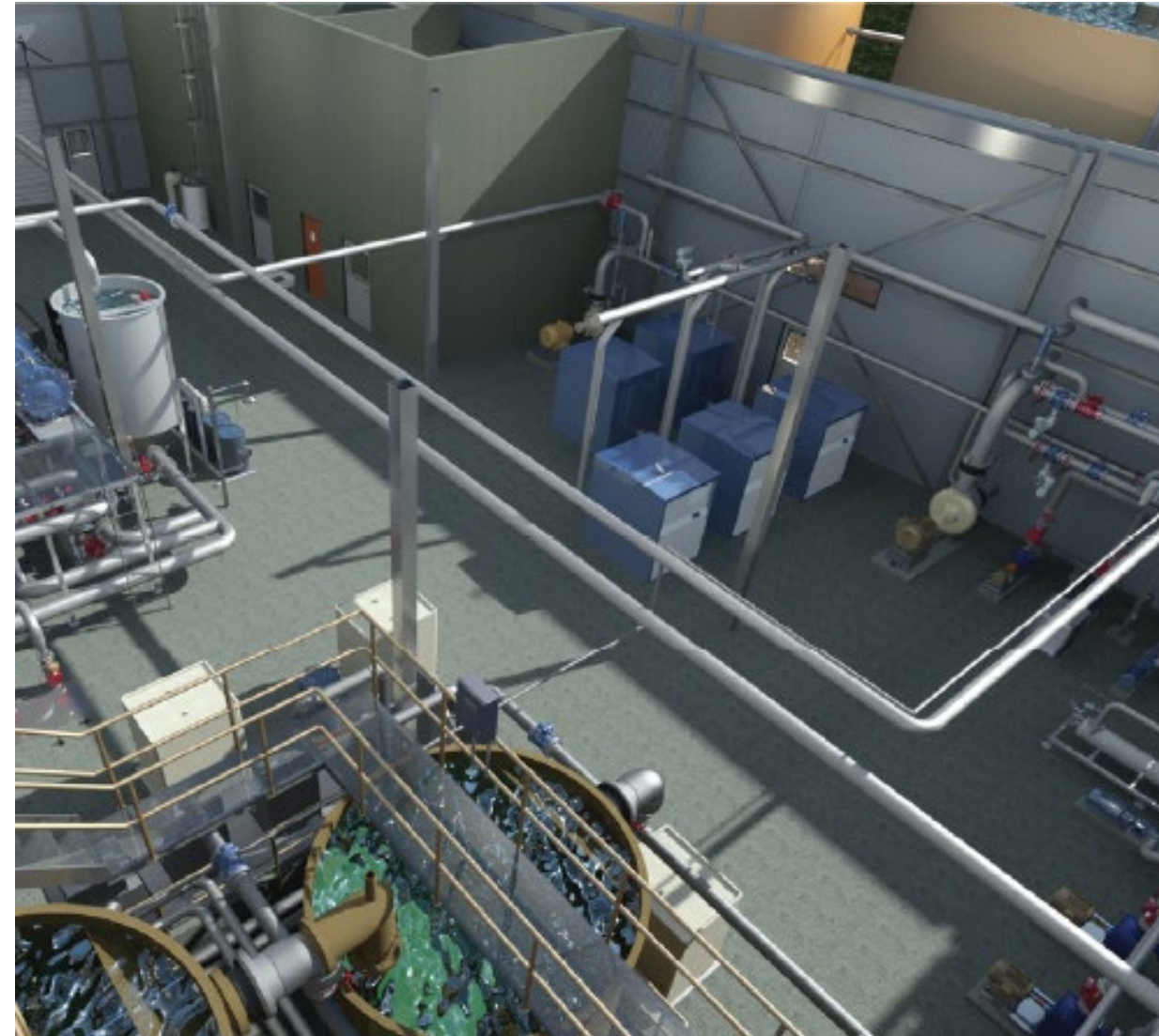
99.5% COD REDUCTION

85% P REDUCTION



**BACKGROUND &
PROBLEM**

- INCREASED PRODUCTION & HIGH-STRENGTH WASTEWATER
- INADEQUATE RIDGE AND FURROW SYSTEM
- LONG TERM SOLUTION NEEDED





SOLUTION

- NEW CONSTRUCTION AEROBIC AND ANAEROBIC WWTP
- ANAEROBIC MBR PRETREATMENT FOR HSW
- AEROBIC AS TREATMENT WITH EBPR





RESULTS

FLOW 50,000 GPD

COD IN >30,000 MG/L

COD OUT 550 MG/L

MORE THAN 98% COD REDUCTION

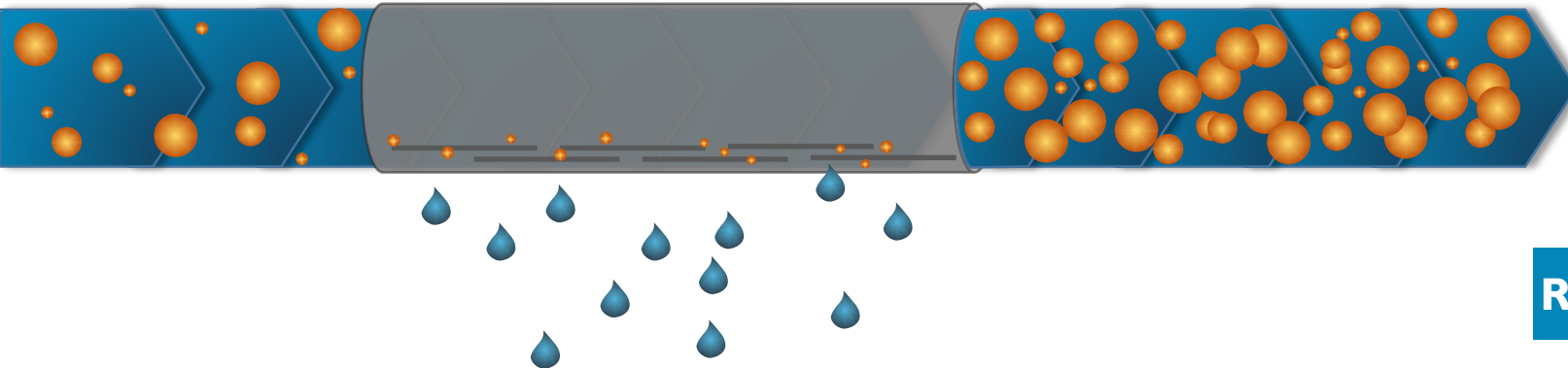


COMMON UF SYSTEM CHALLENGES & REMEDIES

MEMBRANE FOULING

CONTAMINATE BUILD UP ON MEMBRANE SURFACE

As membranes filter the wastewater, fouling occurs naturally



SIGNS SYMPTOMS

- Permeate rate decreases
- System pressures increase

REMEDIES

- Physical cleaning like forward flush
- Chemical cleaning
- Optimize operations

MEMBRANE FOULING

THREE PRIMARY FORMS OF FOULING

SCALING

Crystallization of inorganic salts on membrane surface

SIGNS SYMPTOMS

Blocked pores, flux decline, membrane degradation, production loss

REMEDIES

Acidic washes
Nitric Acid targets precipitated salts & mineral deposits. Citric Acid targets metal oxides and carbonate scales

CAKE LAYER FORMATION

Accumulated particles that form fouling layer on membrane surface

SIGNS SYMPTOMS

Blocked pores, flux decline, membrane degradation, production loss

REMEDIES

Acidic/Caustic washes at high temperatures

BIOFOULING

Microorganisms adhere to membrane surface creating a film

SIGNS SYMPTOMS

Increased flow resistance
Acts as additional barrier to permeation

REMEDIES

Caustic washes with sodium hypochlorite



MEMBRANE PLUGGING

MEMBRANE TUBES ARE BLOGGED

Biomass & other solids preventing feed water from passing through

SIGNS SYMPTOMS

- Pressure Increase across the module
- Loss of flow

REMEDIES

Can only be corrected by manually cleaning each membrane by hand

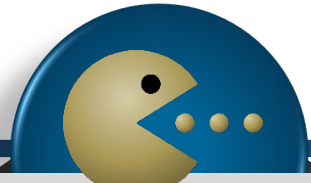
MEMBRANE PLUGGING

WHAT CAUSES PLUGGING?

- High FOG in bioreactor
- High TSS in feed water (20,000mg/L +)
- Improper straining
- Continuous operation at low crossflow velocities
- Failure to flush system after stopping filtration
- Poor biological activity in bioreactor
- Failure to perform proper cleaning protocols

AVOIDING

MEMBRANE PLUGGING



HAPPY BIOLOGY



PROPER STRAINING



CLEANING



VALVES



RECIRC PUMP



OPERATIONS

THANK YOU

QUESTIONS?

JOANNA HODGSON
Mechanical Engineer
The Probst Group

