Global Water, Wastewater & Reuse Treatment Solutions

Ronen Barkan – N. America Sales Manager

RMCP Committee Meeting January 2020

fluence - Value from Water

Emefcy Value from Wastewater + RWL Water℠

Merging global innovators with a field-proven execution team to deliver breakthrough water technology solutions to the world

Formed in 2017

High-quality water solutions for potable and process water

Wastewater treatment for reuse in municipal, industrial and commercial sites

350 highly-trained water professionals

Experience operating in 70 countries

Offices at US, China, Argentina, Brazil, Israel, Italy and Dubai

Traded on the Australian Stock Exchange (FLC)

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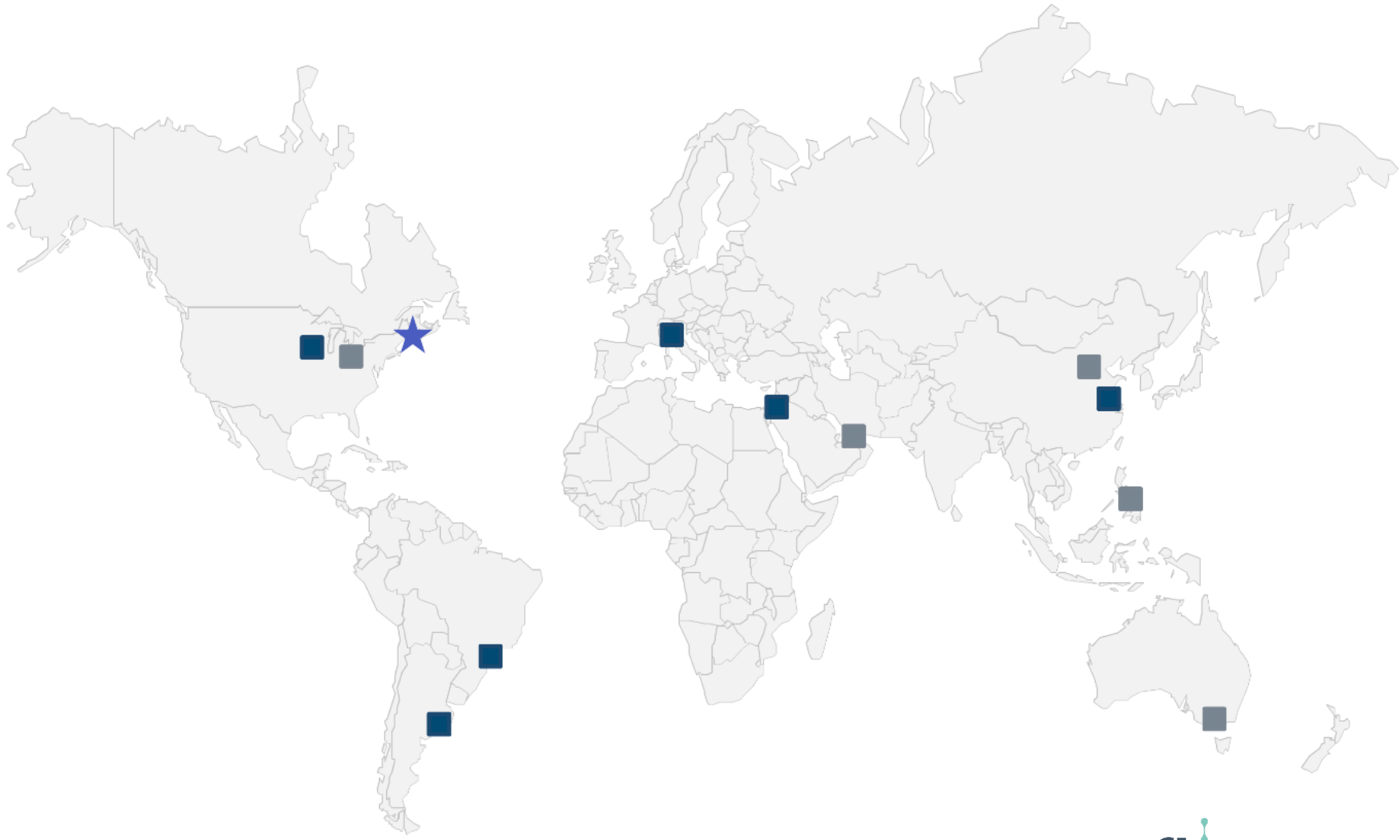
Global Presence

Headquarters
White Plains, USA

Operating Entities
Mar del Plata, Argentina
Jundíai, Brazil
Changzhou, Jiangsu, China
Caesarea, Israel
Padova, Italy
Minneapolis, USA

Regional Offices
Melbourne, Australia
Beijing, China
Shanghai, China
Karmiel, Israel
Dubai, UAE
Batavia, USA
Manila, Philippines



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Custom-Engineered Solutions: Solving Water and Wastewater Challenges

Industrial Water Treatment

Waste-to-Energy

Packaged Wastewater Treatment

Aeration

EPC Projects

Industrial Wastewater Treatment

Food & Beverage Processing

Industrial Process Water

Custom solutions designed and built for customers worldwide

Installations Worldwide








>7,000 installations in >70 countries

MABR Technology

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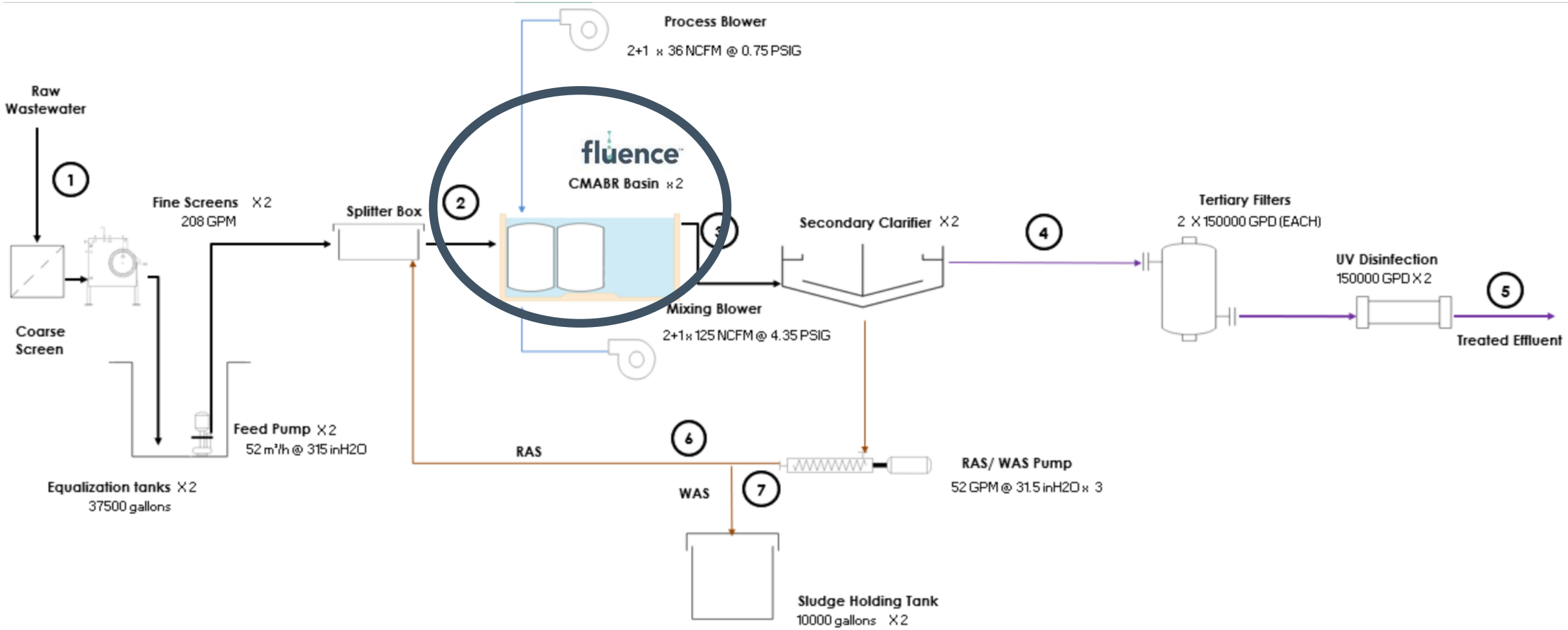
fluence™ - Process Flow Diagram



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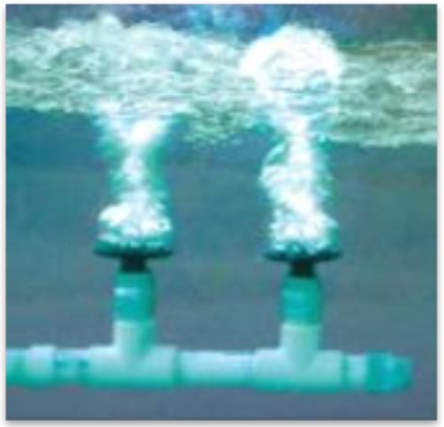
Wastewater Aeration Process

Evolution of Energy Consumption

Surface Aerators

3 kWh/kg COD

1950-1970



Coarse Bubble Diffusers

2 kWh/kg COD

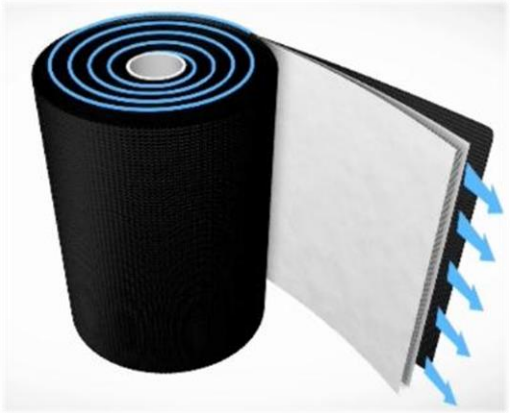
1980-1990

Fine Bubble Diffusers

1.5 kWh/kg COD

Including nitrification

1990-2010



Fluence MABR

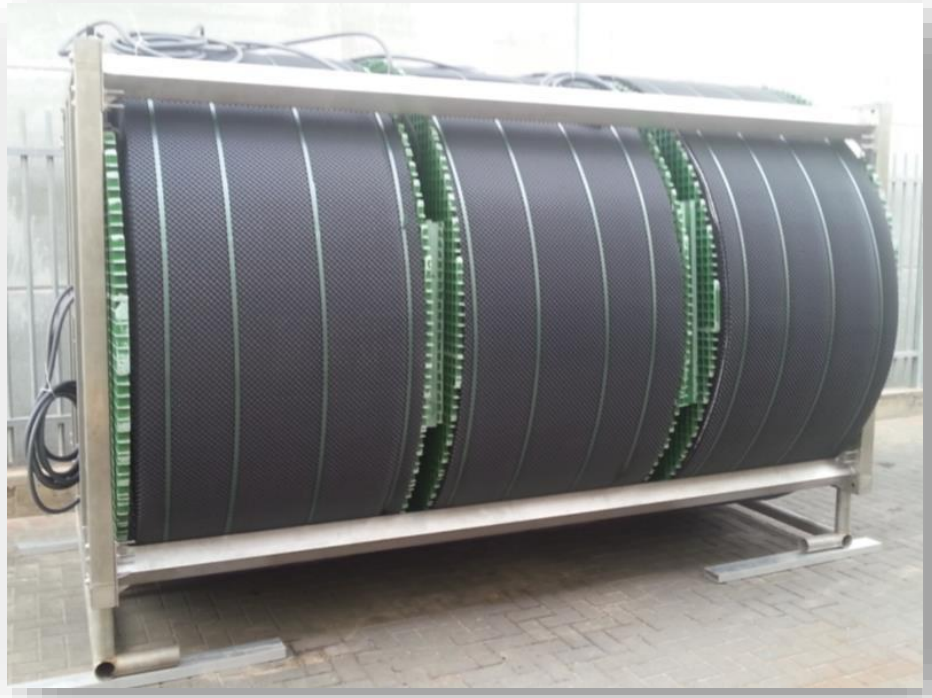
< 0.2 kWh/kg COD

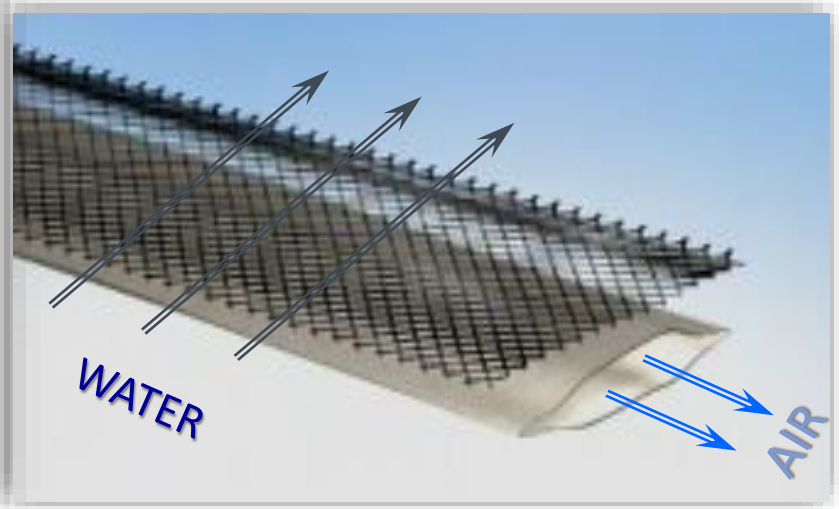
Including nitrification

2015 -

The MABR Technology

- Wastewater is contacted with the surface of an aerated sleeve of oxygen permeable material
- Aerobic bacteria that develop on the surface of the sleeve treat the wastewater



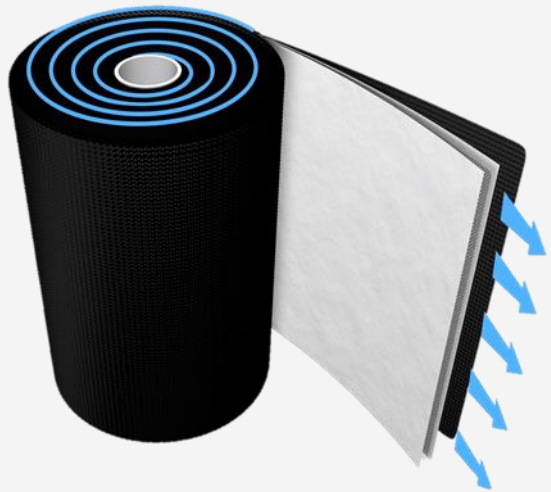


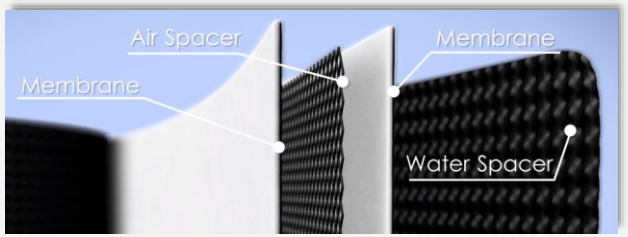
One spirally wound long sleeve

Fluence MABR Technology

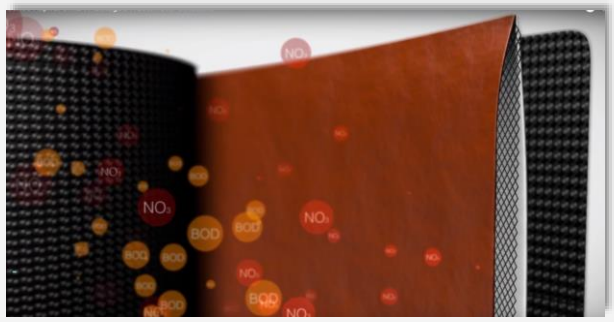
Membrane Aerated Biofilm Reactor

- Air is supplied to a spirally wound, semi permeable membrane
- The MABR spiral is submerged in the mixed liquor





- An air spacer inside the sleeve allows low pressure air flow
- A water spacer defines the water volume in contact with the membrane



- Intermittent mixing causes wastewater to circulate through the spiral
- An aerobic nitrifying biofilm develops on the surface of the membrane

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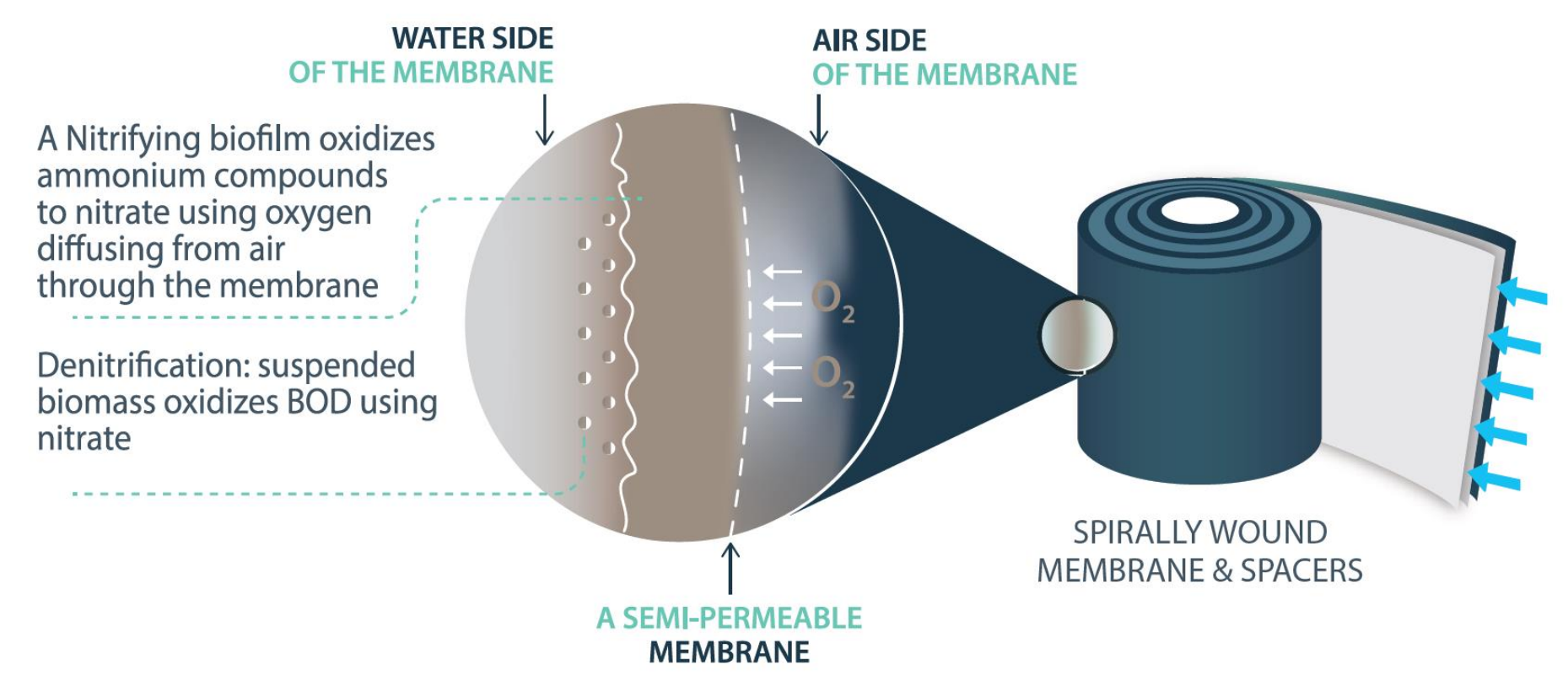
Membrane Aerated Biofilm Reactors ("MABR") Technology



"MABRs are especially effective for total nitrogen (TN) removal, due to the counter-gradient diffusion of substrates"
(Essila, Semmens et al. 2000; Lee and Rittmann 2002).

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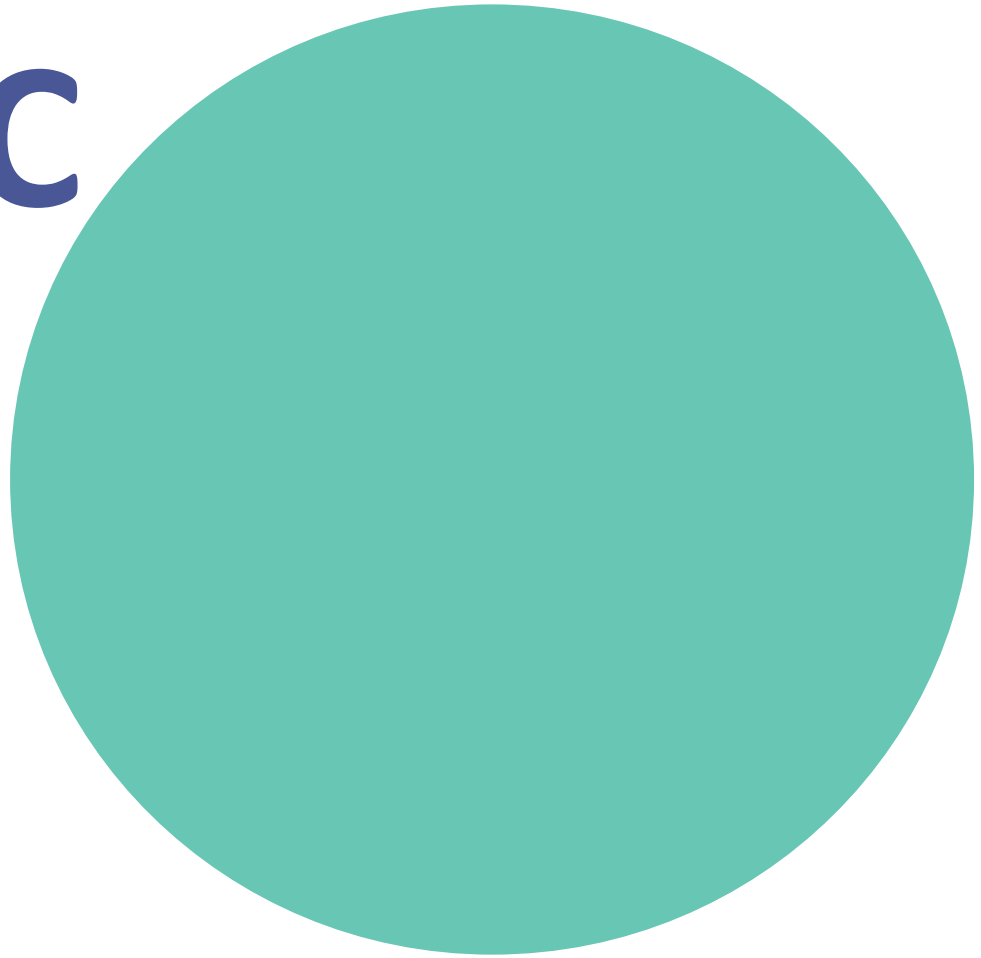
Stanford CR2C Case Study



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Stanford CR2C to evaluate Fluence MABR

- The Codiga Resource Recovery Center (CR2C) facility is equipped to perform pilot testing of promising technologies for the recovery of resources (clean water, nutrients, energy, renewable materials) from wastes
- CR2C consists of core infrastructure for supply of various water and wastewater streams and testing infrastructure for evaluating removal and recovery technologies
- Dr. Craig Criddle in the Department of Civil and Environmental Engineering is the principal investigator for this project
- The tests are aimed at:
  - Ascertaining that the new MABR process can achieve Title 22 standards
  - Checking the technology overall performance
  - Studying the unique properties of MABR treatment

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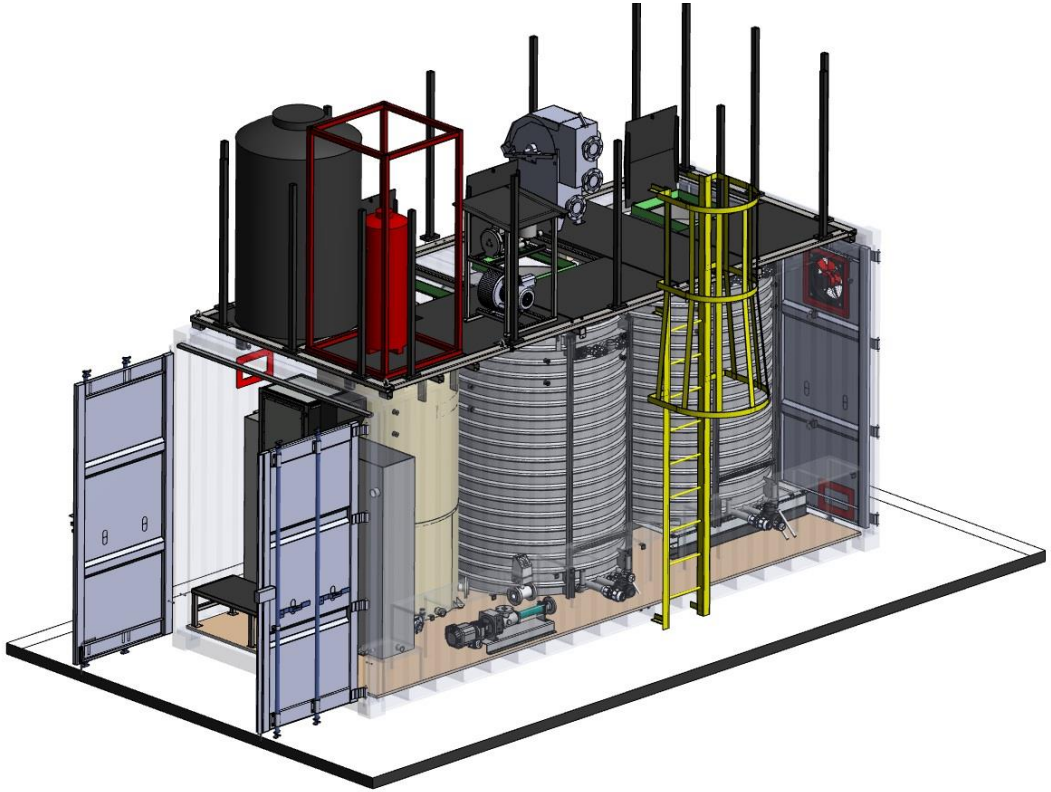
The MABR Demonstration and Test Unit

- Unique properties of MABR technology will be evaluated including:
  - Biological Nutrients removal (TN and TP)
  - Simultaneous nitrification and denitrification
  - Energy savings over CAS-MLE and MBR technologies

- Tests are for pilot-scale testing facility
  - The unit treats 11m³/d (2880gpd) of raw sewage
  - The system includes:
    - An electro-mechanical fine screen
    - 2 MABR Gen 2.1 units with aeration and mixing accessories
    - A secondary clarifier with RAS/WAS circulation pump
    - A tertiary pressurized sand filter
    - A chlorination unit
  - The system is packaged in a 20’ container

Stanford Demo Unit



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SSV30 - 550 ml
SSV30 - 150 ml

	WW	1st	2st	Eff 2nd
COD	1125	69.1	54	32.5
NH_4^+	57	13.2	5	3.7
NO_3^-	< 1	29,1	33,3	23.1

Unit installation January 2018

William and Cloy Codiga Resource Recovery Center At Stanford University (CR2C)

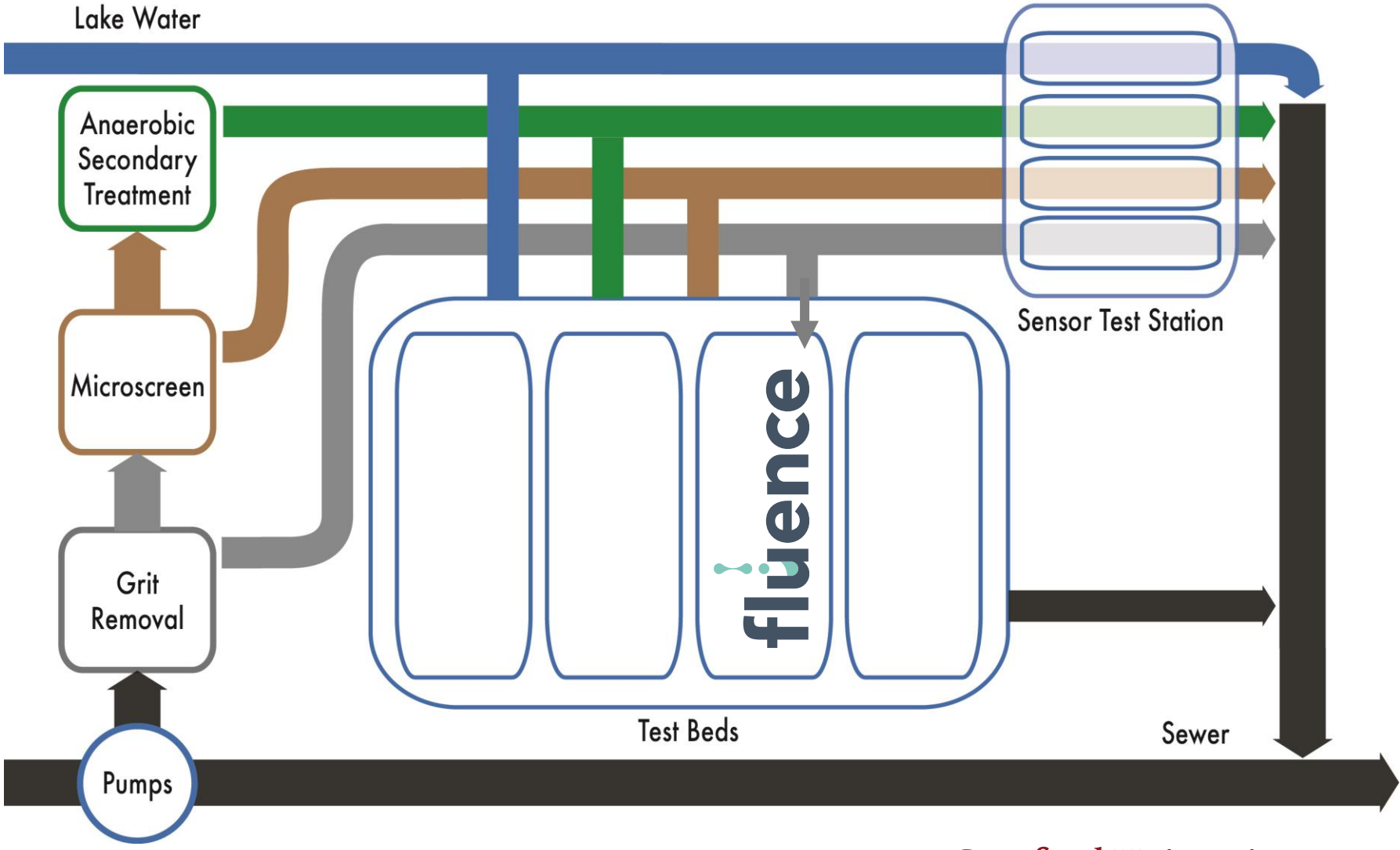
Facility dedicated to scale-up and testing of new technologies for resource recovery

Stanford | Codiga Resource Recovery Center

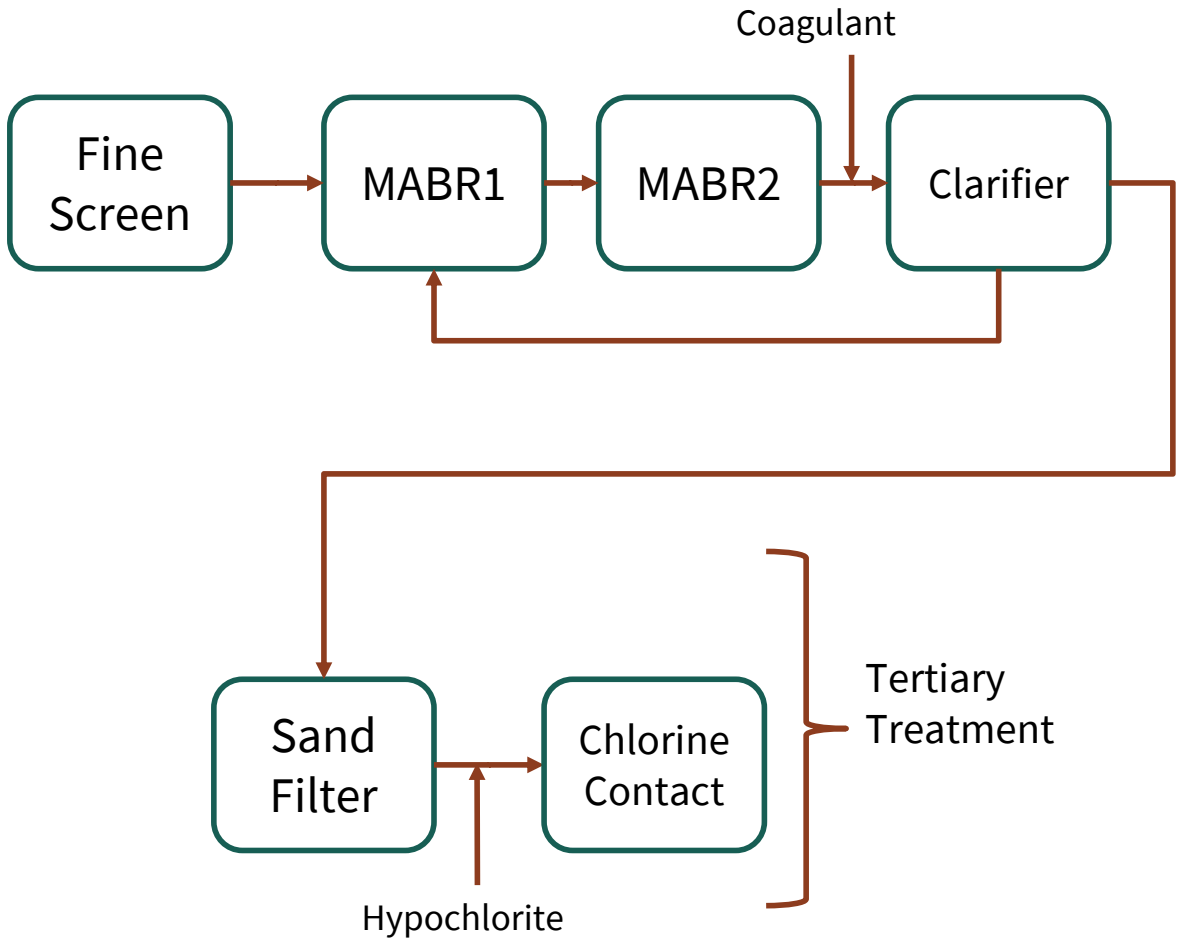
Stanford University

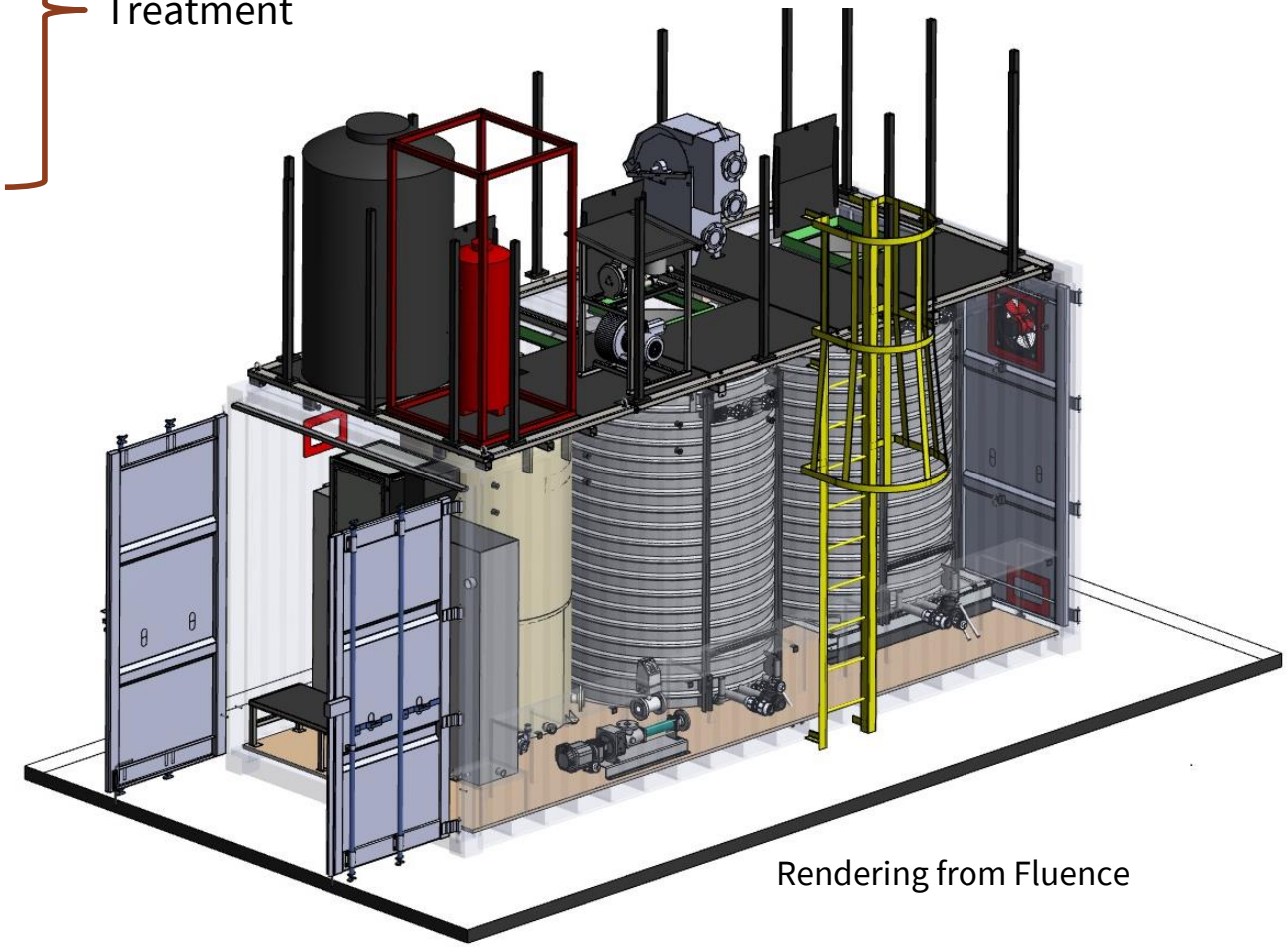
CR2C Process Diagram & Test Beds

- Currently connected to de-gritted wastewater
- Tested with MS effluent during startup



Process Flow





Rendering from Fluence

Testing for N Removal & California Title 22 Reuse Standards

Target Category: disinfected Tertiary Recycled Water

With Coagulation:

- **Tertiary effluent turbidity**

  Average < 2 NTU within 24-hr period

Bacteriological:

- Total Coliform of **2.2 MPN/100 mL**

AND

- Chlorine CT of 450 mg-min with 90 minute contact time

  OR

- 99.999% removal of MS2 bacteriophage virus or polio virus

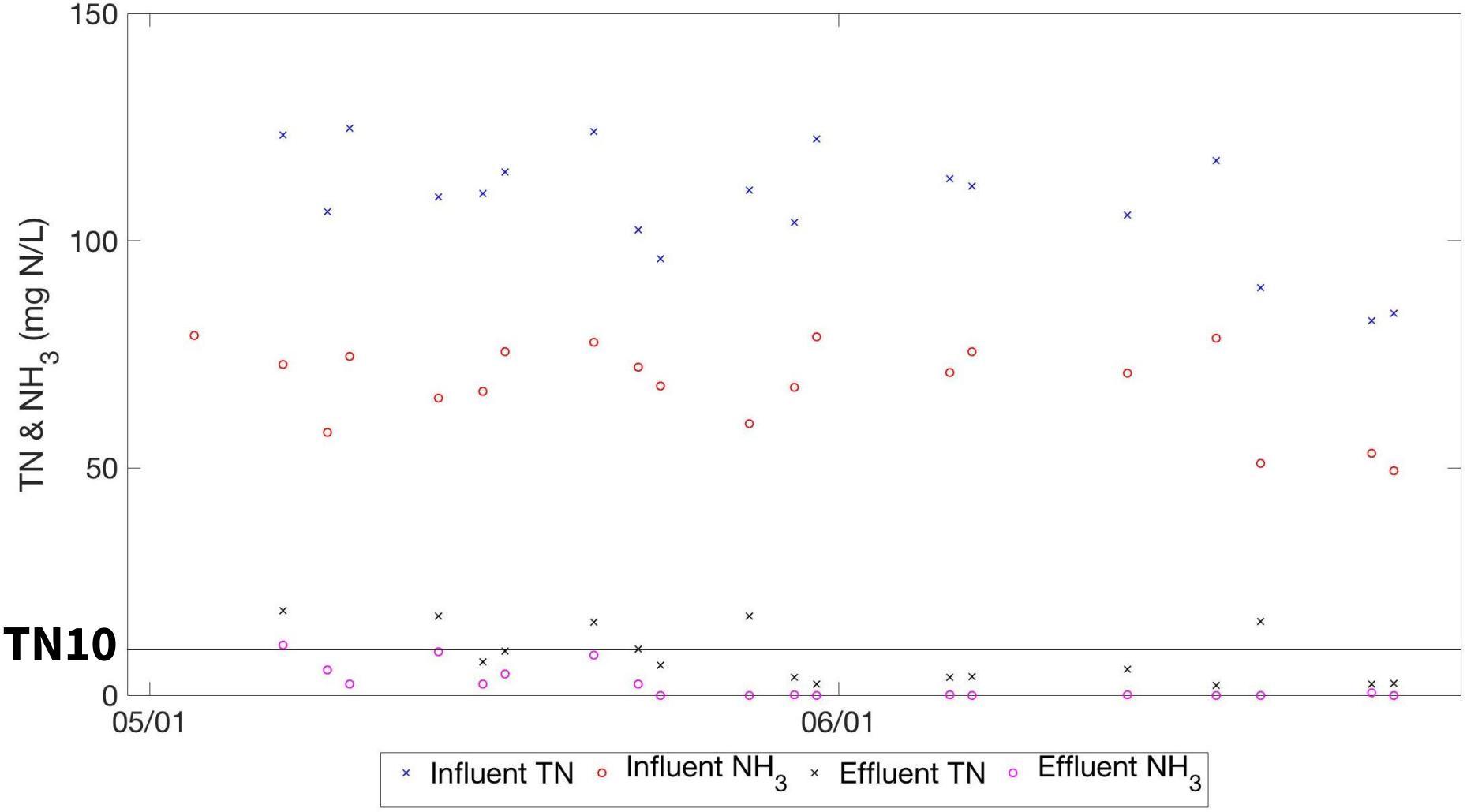
Fluence MABR Influent Wastewater Characteristics

- High strength wastewater
- ~3X nitrogen concentrations
- Low Alkalinity
- COD:BODu = 2.4
- BOD_u to TN ratio: 5.0 vs. 8.4 (regular WW)

Parameter	Unit	CR2C Concentration	Metcalf & Eddy[1]
COD			Medium Strength
- Total COD	mg/L	1220	806
- Soluble COD	mg/L	377	-
BOD_5	mg/L	341	200
BOD_u	mg/L	499	293[2]
TSS	mg/L	563	195
VSS	mg/L	529	152
pH	-	7.93	-
Alkalinity	mg $CaCO_3$/L	331	-
Ammonia	mg N/L	64	20
Nitrate	mg N/L	0-1	0
Total Nitrogen	mg N/L	100	35
Total Phosphorus	mg P/L	8.1	5.6

1. Metcalf and Eddy (2014), "Wastewater Engineering: Treatment and Reuse", 5th Edition, the McGraw-Hill Companies, Inc.
2. Calculated from the data given in the book

Total Nitrogen and Ammonia



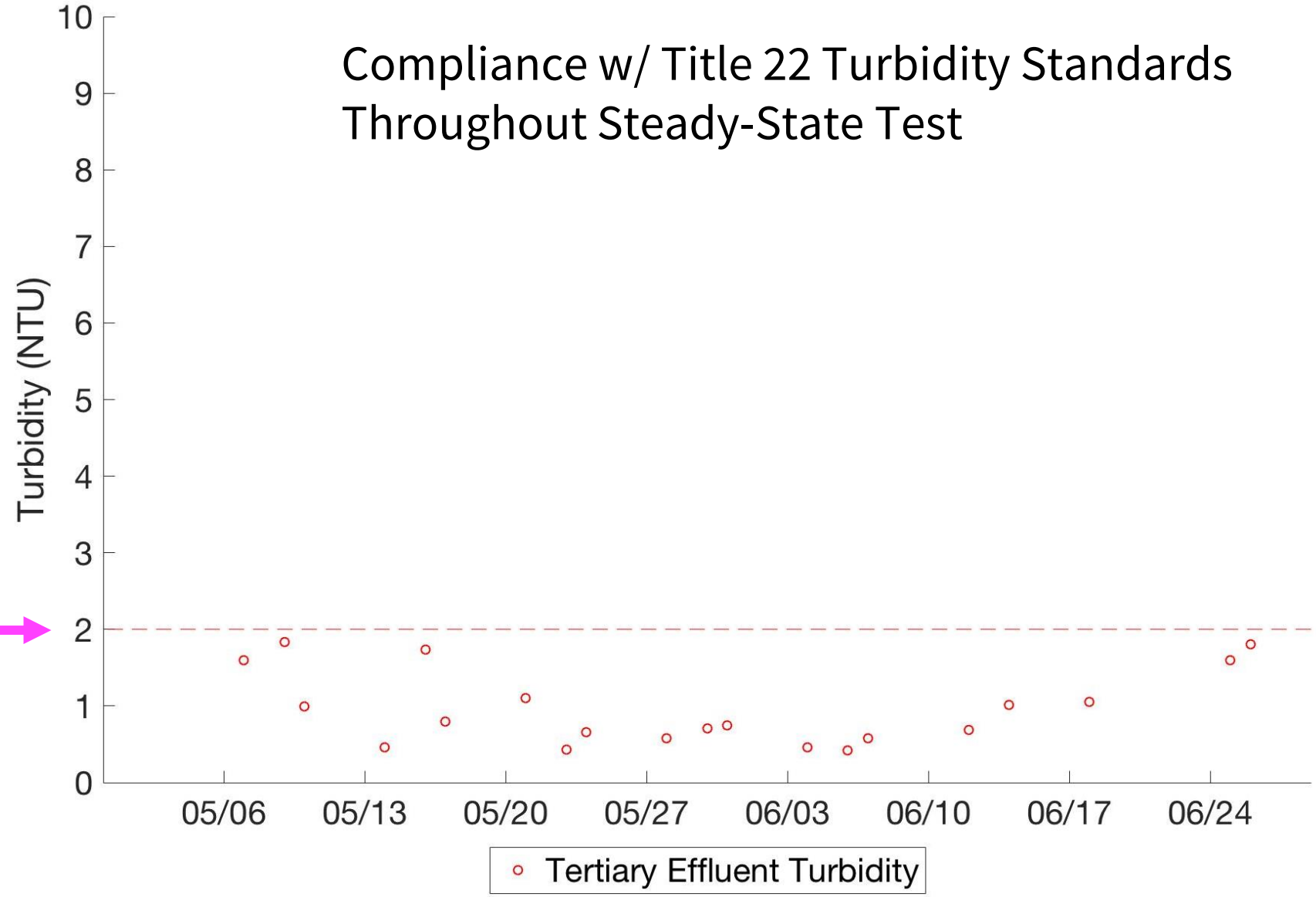
TN		
	Influent	Effluent
MAX	125	19
MIN	82	2.20
Mean	108	8.6
STDev	12.8	6.15
n	19	17

NH3		
	Influent	Effluent
MAX	79	11.1
MIN	49	0.00
Mean	68	2.52
STDev	9.44	3.68
n	20	19

Removal Efficiency		
	TN	NH_3
Range	82-98%	85-100%
Mean	92%	96%

Turbidity

Compliance w/ Title 22 Turbidity Standards Throughout Steady-State Test



Title 22

Acknowledgements

Prof. Craig Criddle

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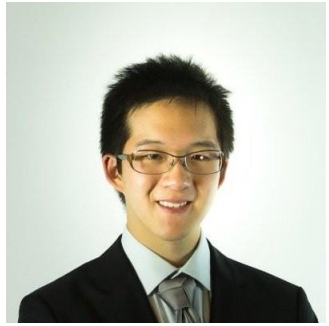


Fabrizzio Bulacia

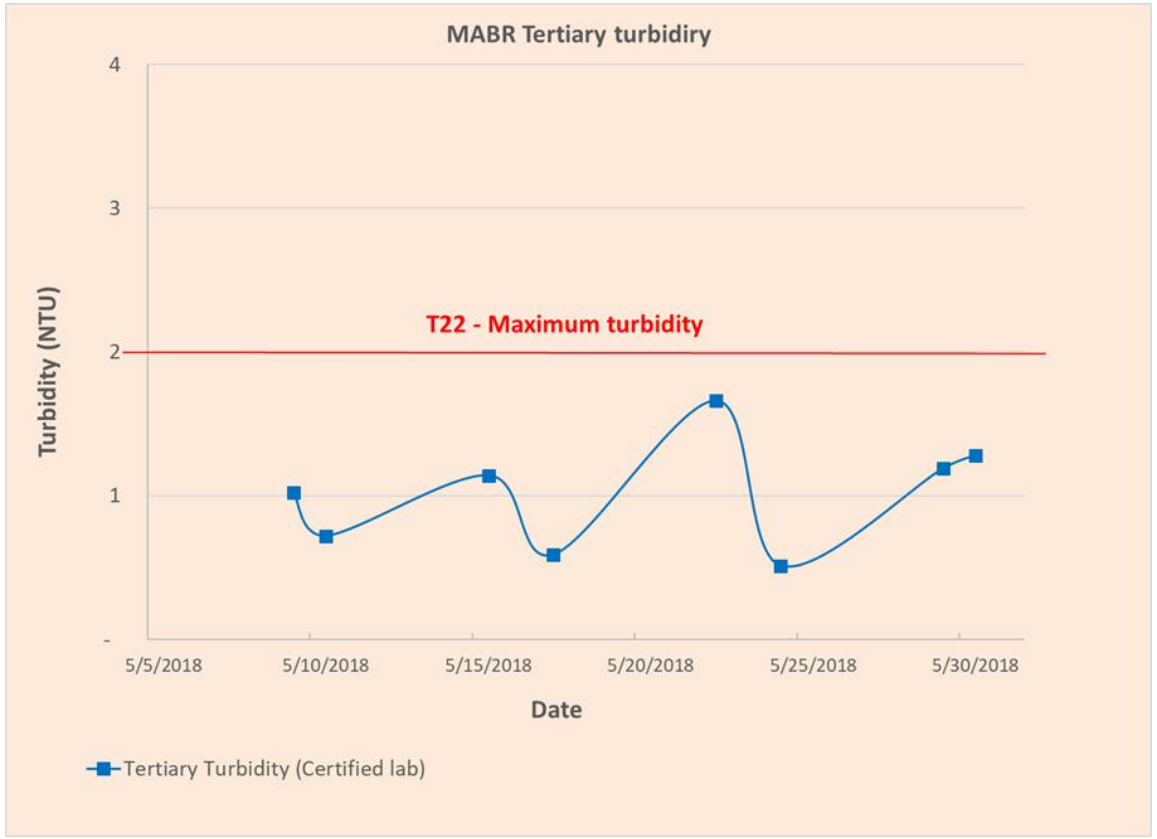
Stanford | Codiga Resource Recovery Center

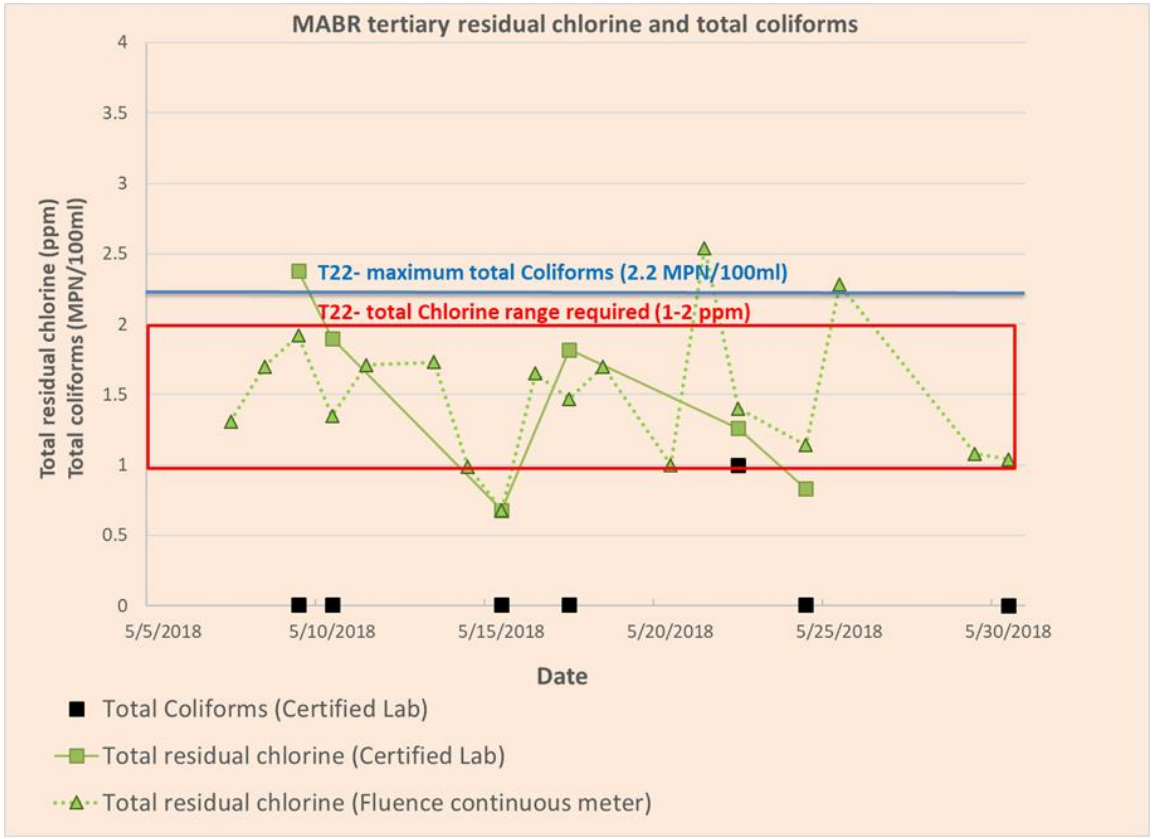
Stanford University

Pilot Plant at Codiga Resource Recovery Center

Location	Stanford, CA, USA
Project	Pilot plant for 3rd party evaluation
Design Parameters	○ Flow: 11 m^3/D (3,000 GPD) ○ Wastewater characteristics: Highly concentrated wastewater ○ Wastewater minimum temperature: 60^0 F
Raw waste water Influent	○ COD_t: 1,220 mg/l ○ TSS: 563 mg/l ○ TN: 100 mg/l ○ Phosphorous: 8.1 mg/l
Effluent Requirements	○ Phase 1 (Title 22): ○ Turbidity: 2 NTU ○ E. Coli: 2.2 MPN/100 ml ○ Phase 2 (MD Reg.): ○ TN: 3 mg/l ○ TP: 0.3 mg/l
Solution	**MABR**
Results	Next Slide

Pilot Plant at Codiga Resource Recovery Center
Meets California Title 22 Requirements





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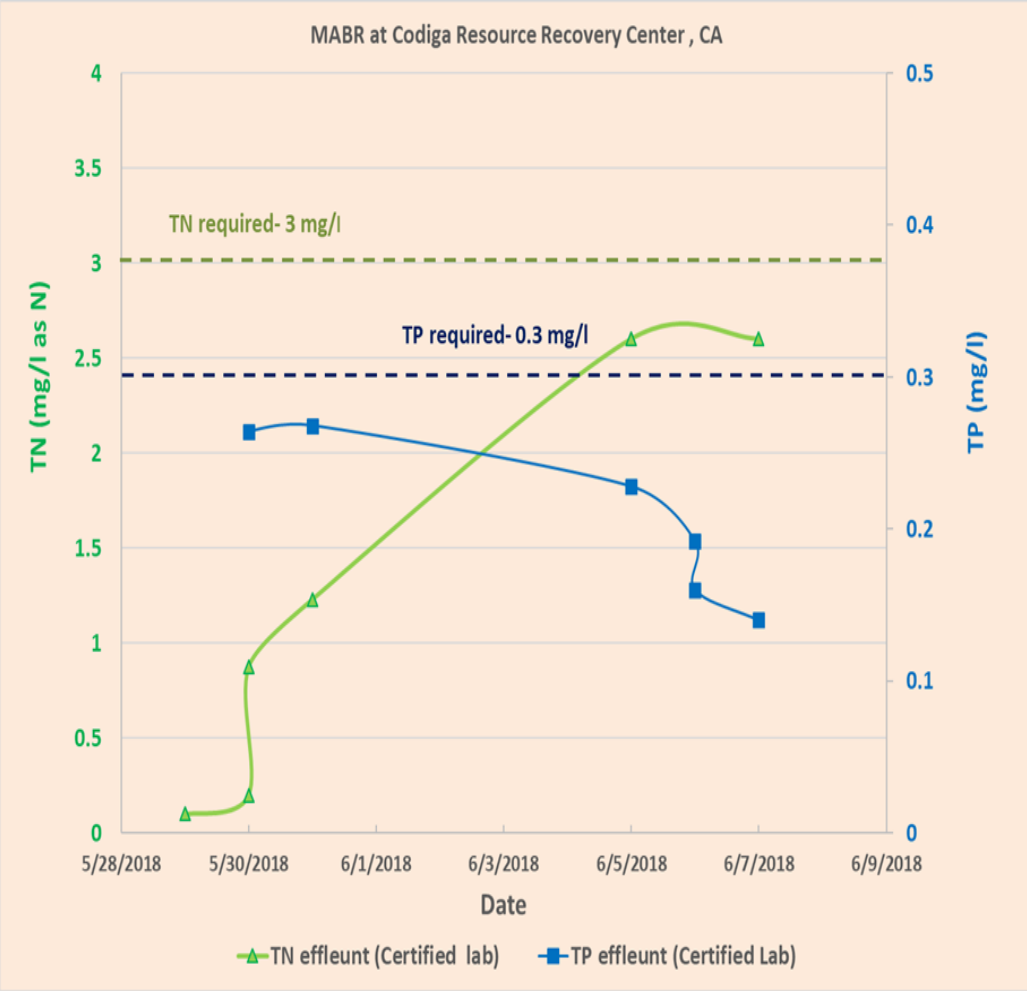
Pilot Plant at Codiga Resource Recovery Center Meets Maryland ENR Requirements



			TN (mg/l-N)		TP (mg/l)	
Date	Time	Certified lab name	Infl.	Eff.	Inf.	Eff.
5/30/18	Evening	Cel analytical	104	0.873	8.3	0.264
31/5/18	Morning	Cel analytical	122.4	1.23	10.2	0.268
6/5/18	Evening	Cel analytical	113.6	2.6	9.1	0.228
6/6/18	Morning	Torrnet Laboratory	113.6	0	9.7	0.23
6/7/18	Morning	Torrnet Laboratory	112	2.6	9.1	0.14

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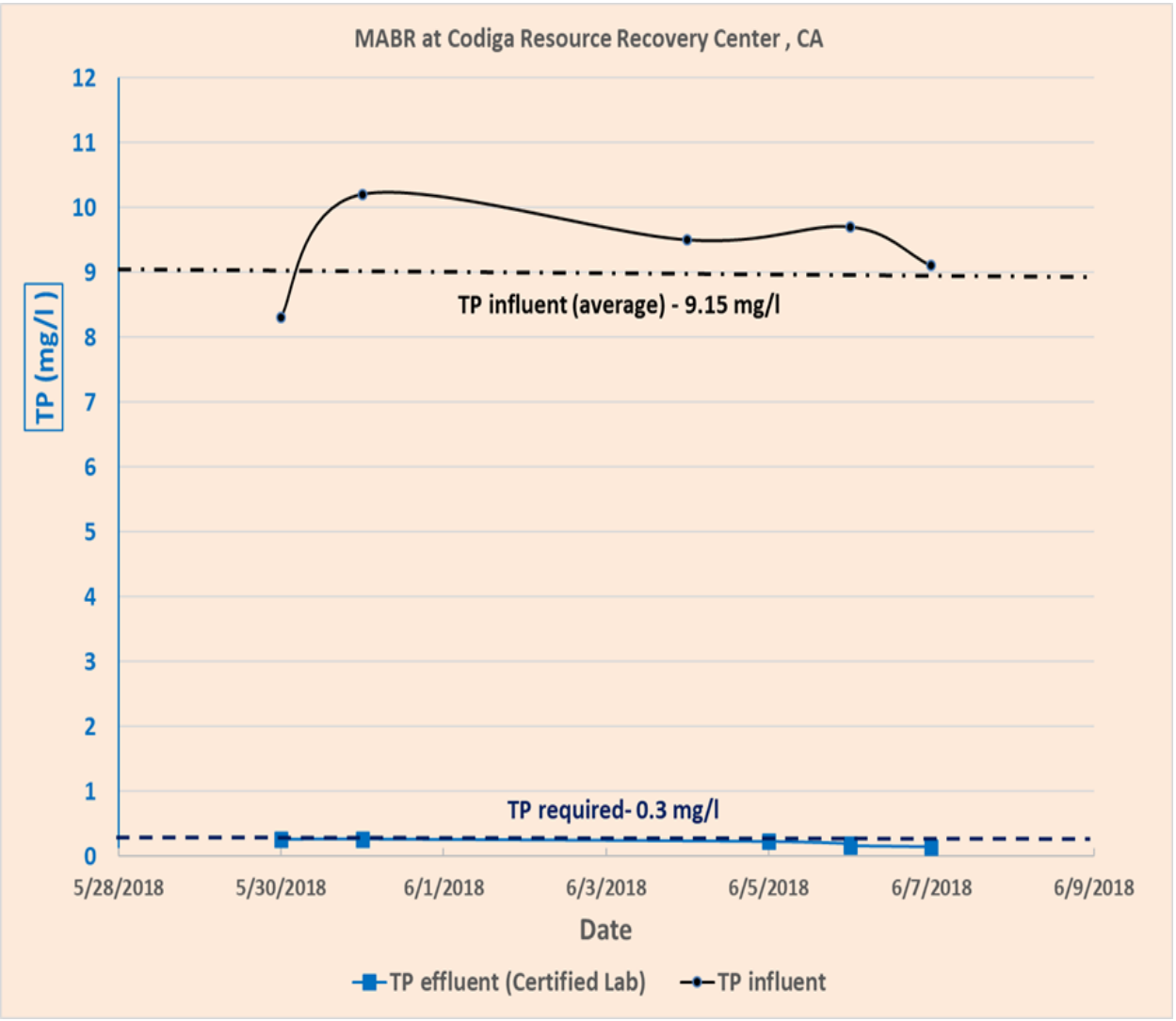
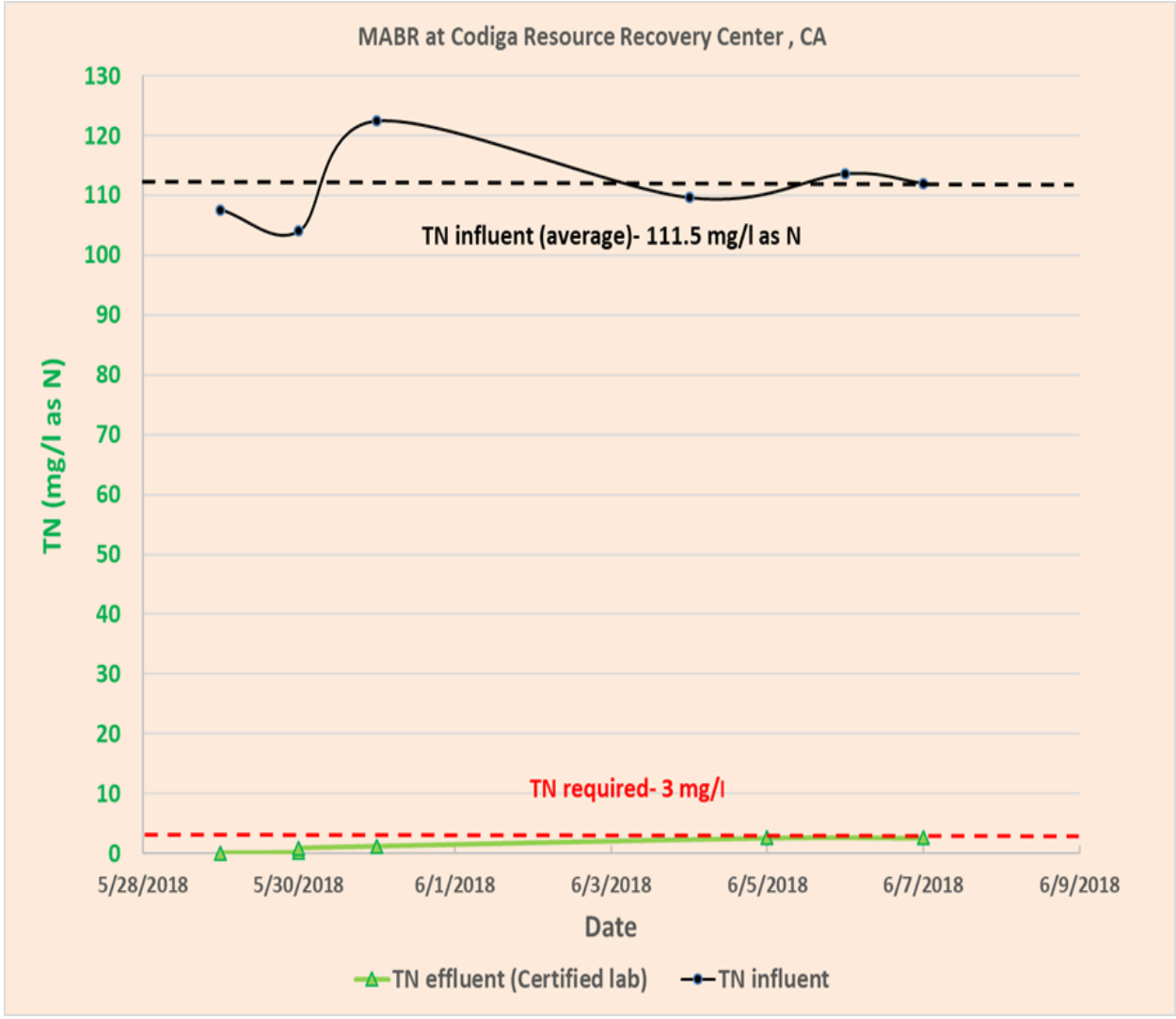
Maryland, ENR Regulations Met





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Thank you

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Ronen Barkan – N. America Sales Manager

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