Nereda® Aerobic Granular Sludge Demonstration

Bay Area Clean Water Agencies

March 17th 2017

Agenda

- Nereda® Aerobic Granular Sludge
  - Technology Overview
- Water Research Foundation Collaborative Demonstration Opportunity
- Discussion

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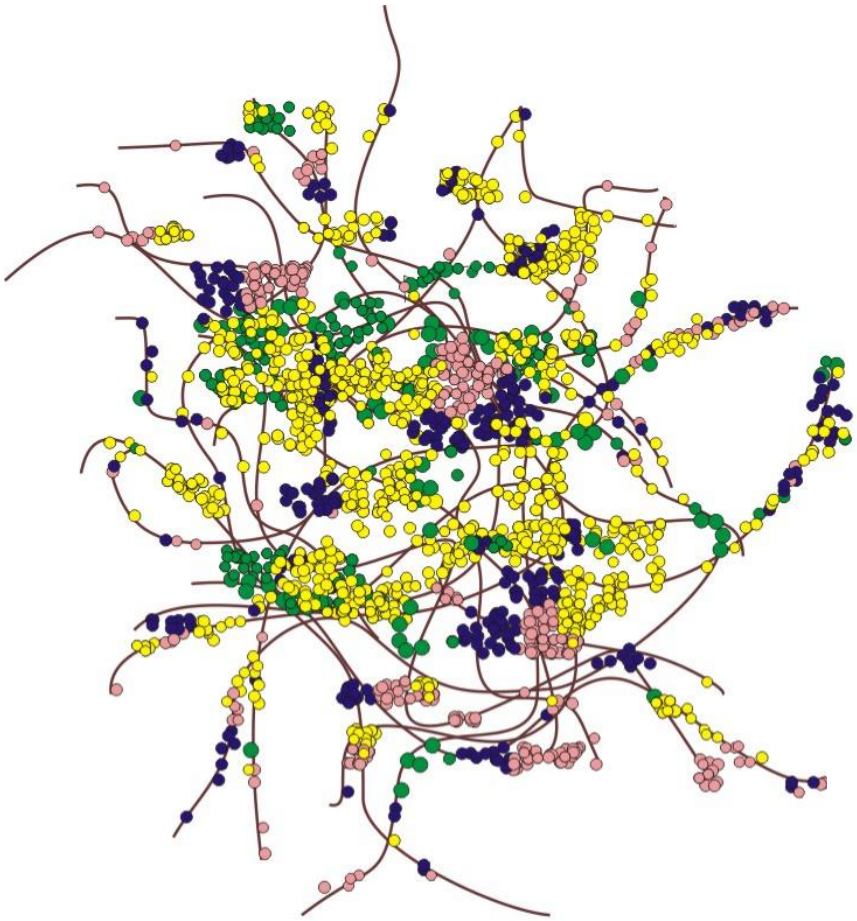
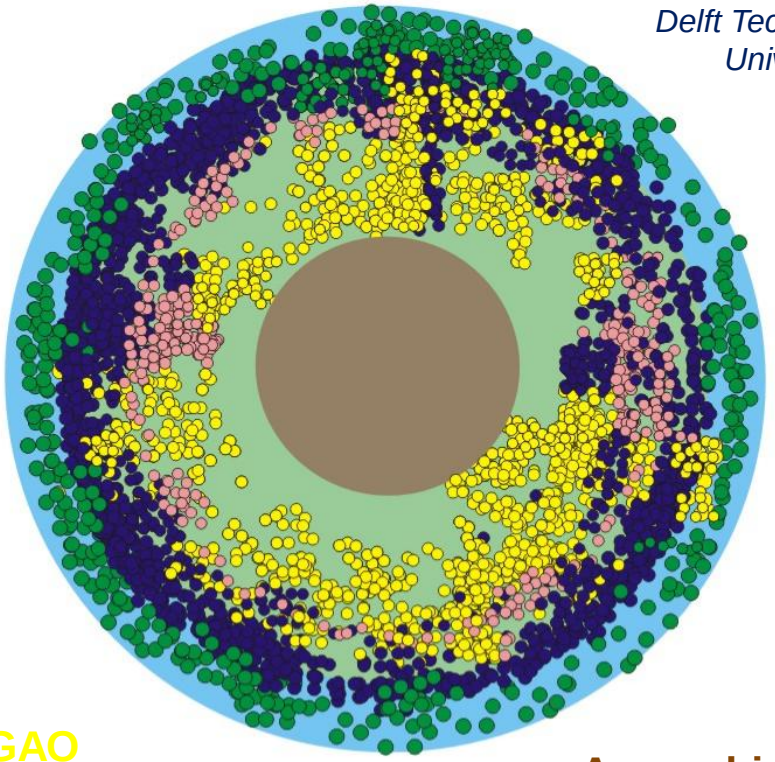
Aerobic Granular Sludge

Dense Granules = Settle in 5 mins

Suspended & Granular – The Difference



Picture Courtesy Delft Technical University



PAO / GAO
Denitrifiers
Nitrifiers

Anaerobic
Anoxic
Aerobic

Conventional Activated Sludge
Mixed Microbial Community

Aerobic Granular Sludge
Layered Microbial Community

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Nereda® Performance - EPE WWTP, Netherlands

Parameter	Performance verification campaign March - May 2012 (flow proportional)		
	Influent mg/l	Effluent mg/l	Removal
COD	879	27	96.9%
BOD	333	< 2	> 99.4%
N_{Kj}	77	1.4	98.1%
NH_4-N	54	0.1	99.8%
N_{total}		< 4	> 94.7%
P_{ortho}	5.8	< 0.1	> 98.2%
P_{total}	9.3	0.3	97.2%
Suspended Solids	341	< 5	> 98.5%
40% lower power consumption			

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Benefits of Aerobic Granular Sludge

- 75% Less Space
- 40% Less Energy

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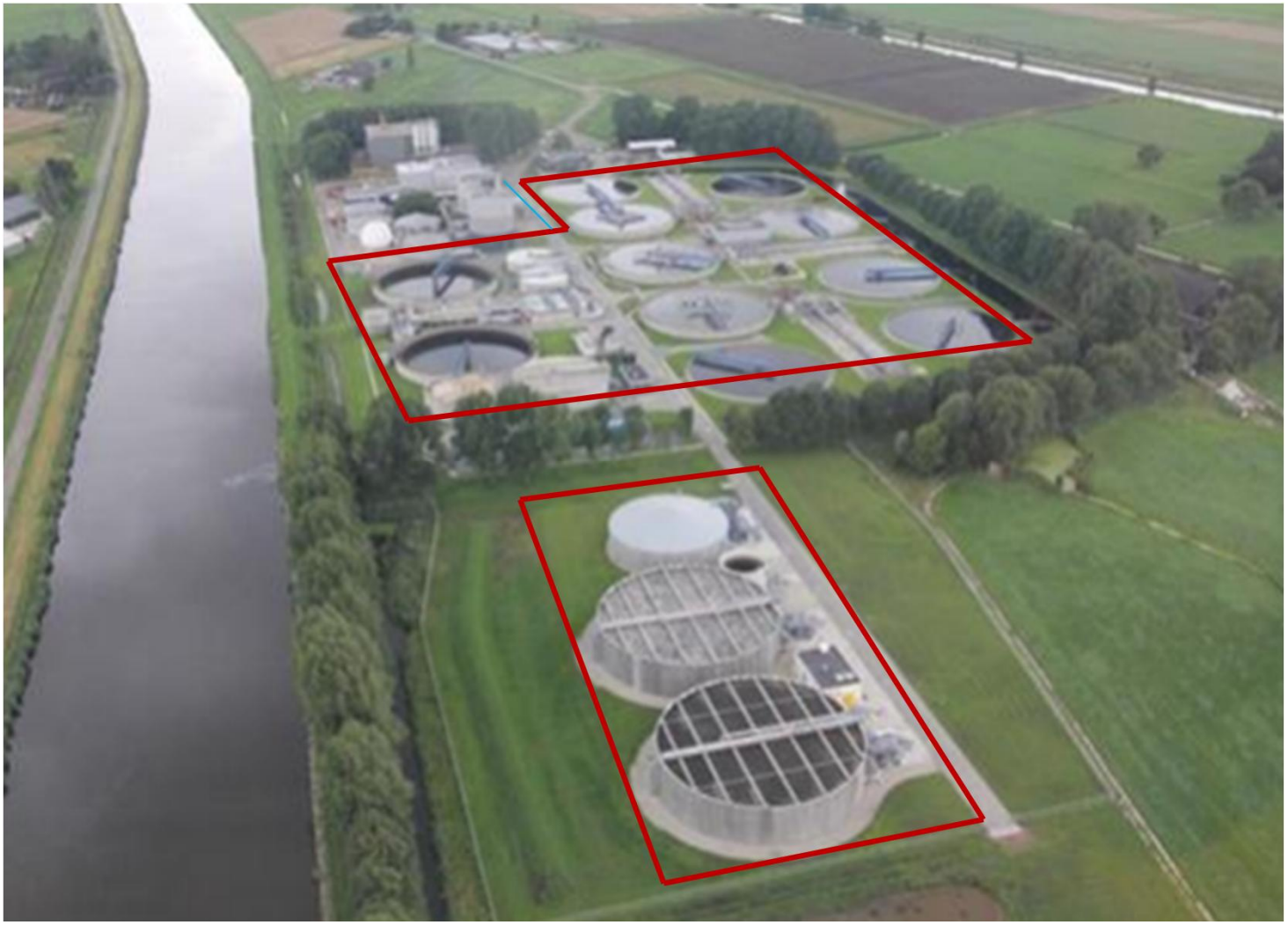
Garmerwolde, NL WWTP Nereda
Footprint Advantage – 75% Footprint Reduction



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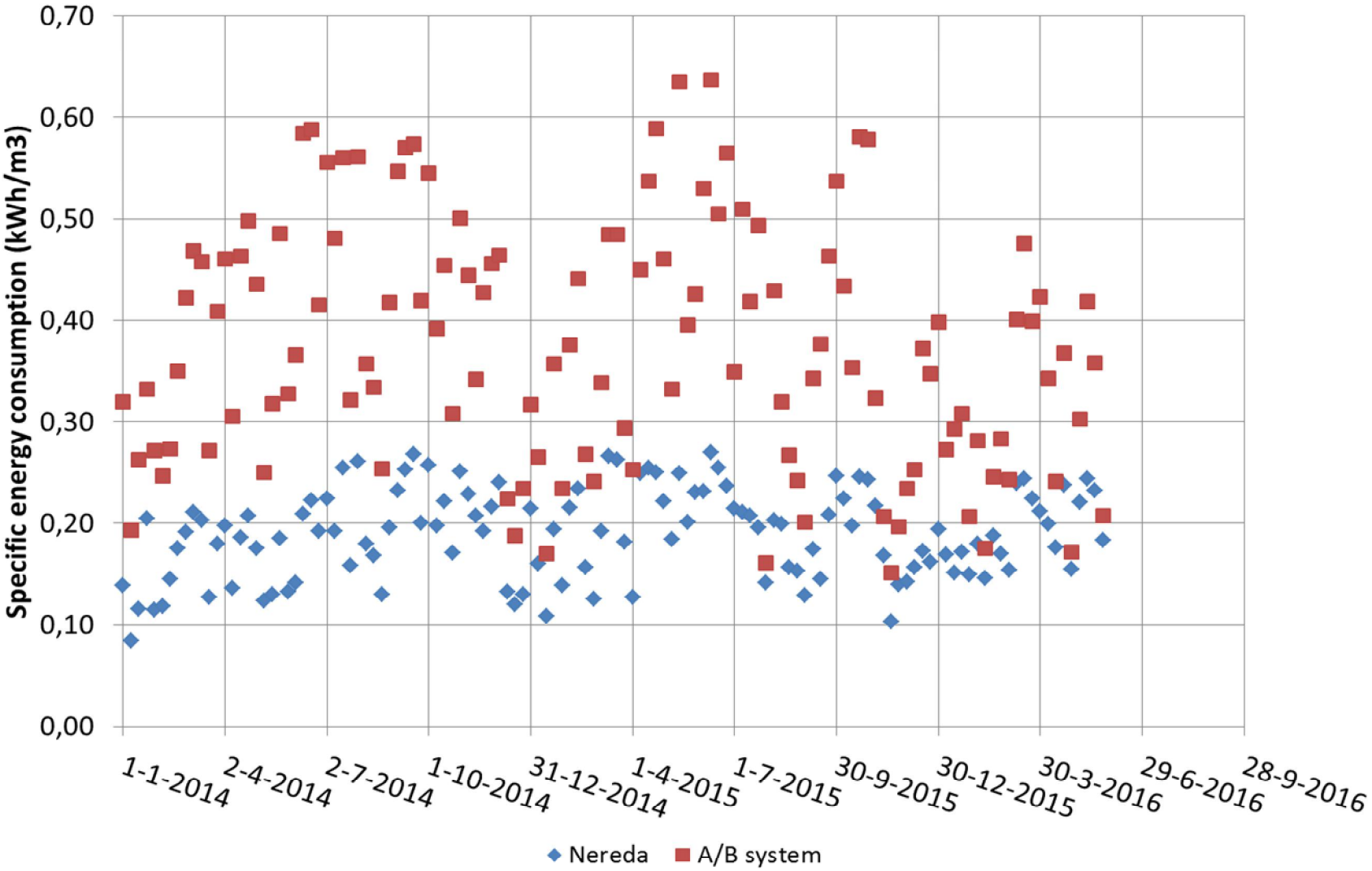
Garmerwolde, NL WWTP Nereda
Energy Advantage – 50% Energy Reduction



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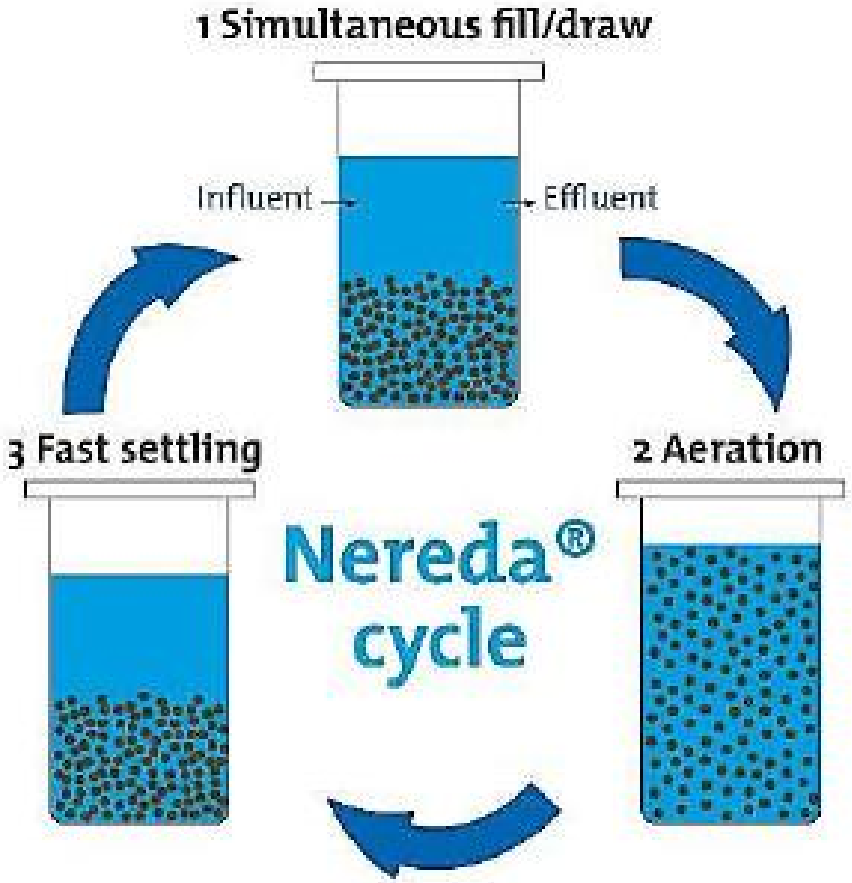
Nereda® SBR Process Cycle

- Simple one-tank concept
- No clarifiers
- No moving decanters
- No mixers
- Extensive biological COD, TN & TP removal
- Low energy consumption
- Easy operation
- Compact



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Summary

- Aerobic granular sludge technology shows tremendous promise for compact BNR plants
- Demonstrated successfully at full scale (30 plants) …but not in U.S.
- Sequencing batch reactor operations-based… limited experience with retrofit of conventional plug flow, continuously-fed systems

Water Research Foundation Collaboration

- Tailored Collaboration Program with WRF to demonstrate AGS at full scale
- AECOMs Pre-Proposal Accepted
- Up to $100K in matching funds
- Goal – Secure partners & submit proposal for full scale demonstration by May 1st

Nereda® Full Scale Demonstration Goals

- Demonstrate reliability of aerobic granular sludge to remove COD, TSS, TP and TN
- Stress Test & Optimize Performance
- Demonstrate Energy Efficiency & Cost Effectiveness
- Optimize retrofit process for typical U.S. CAS infrastructure – Basis of Design Guidance
- Quantify Capacity Increase

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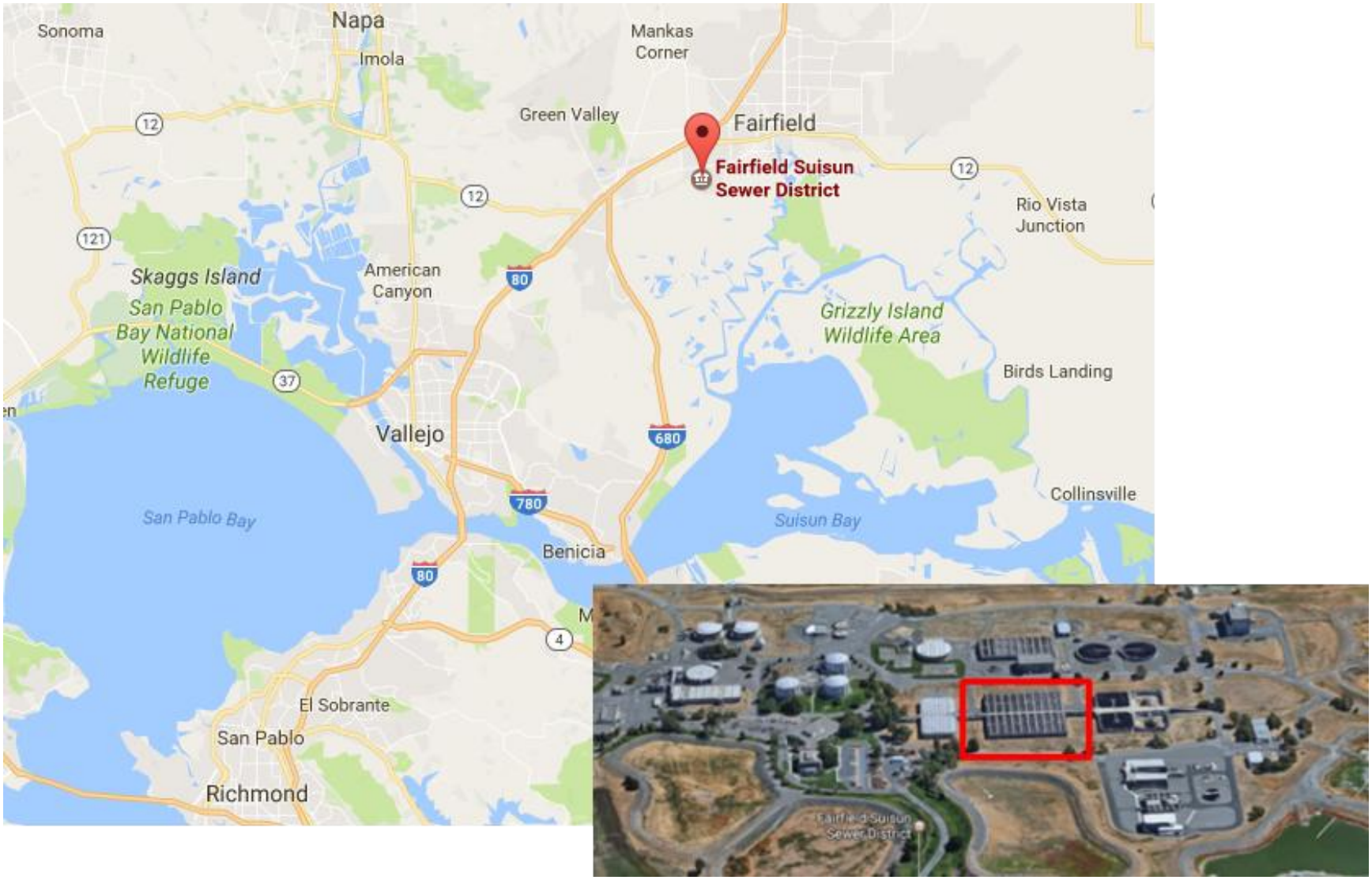
Potential Nereda Demonstration Site
Fairfield-Suisun Sewer District (FSSD)



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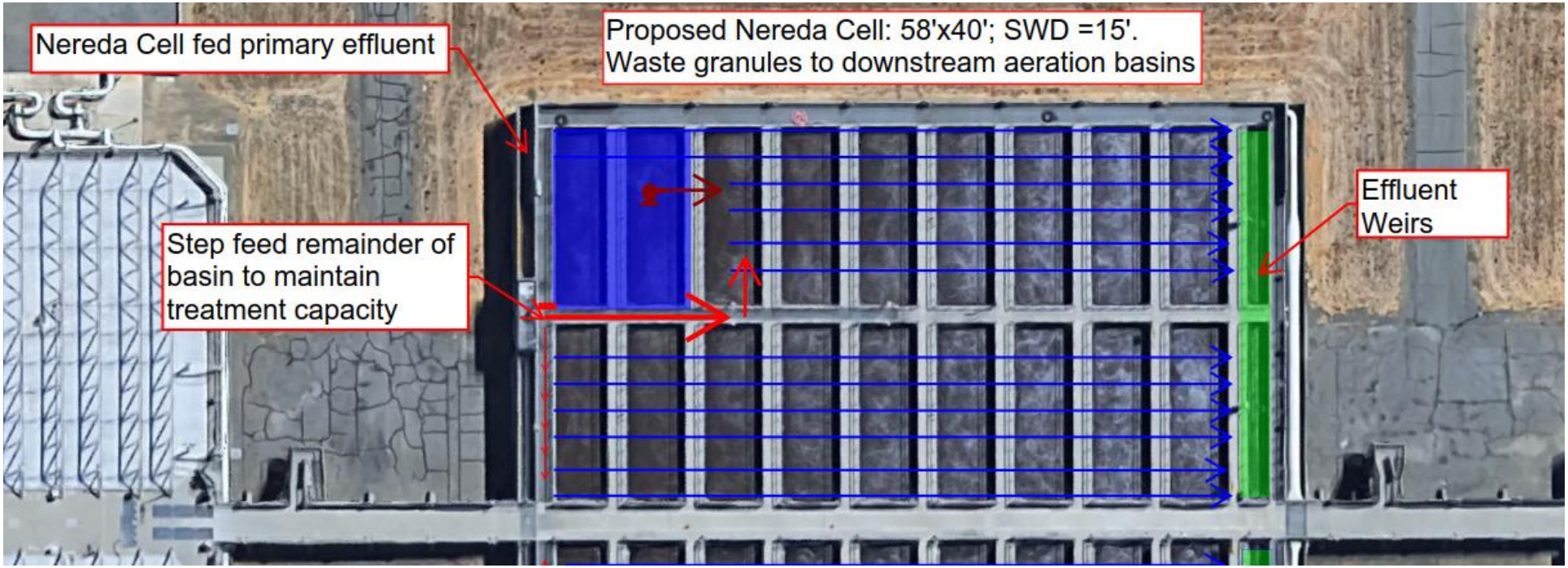
Demonstration Scale – Fairfield-Suisun Sewer District (FSSD)



- Utilize Existing Aeration System (Blowers and Diffusers)
- Add Influent Distribution Grids and Effluent Weirs
- No Other Equipment or Chemicals

Discussion

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Thank You

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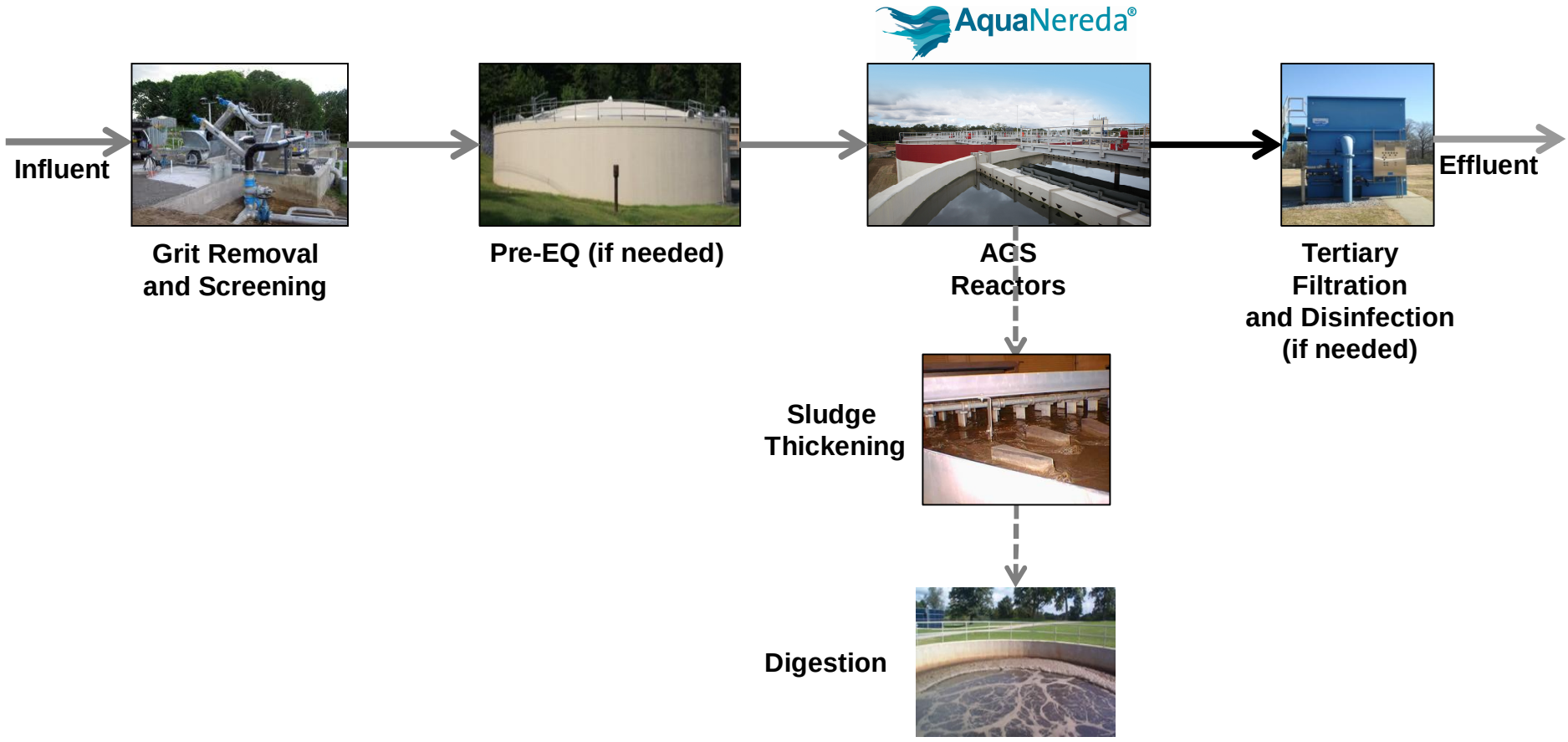
Nereda® Process Flow



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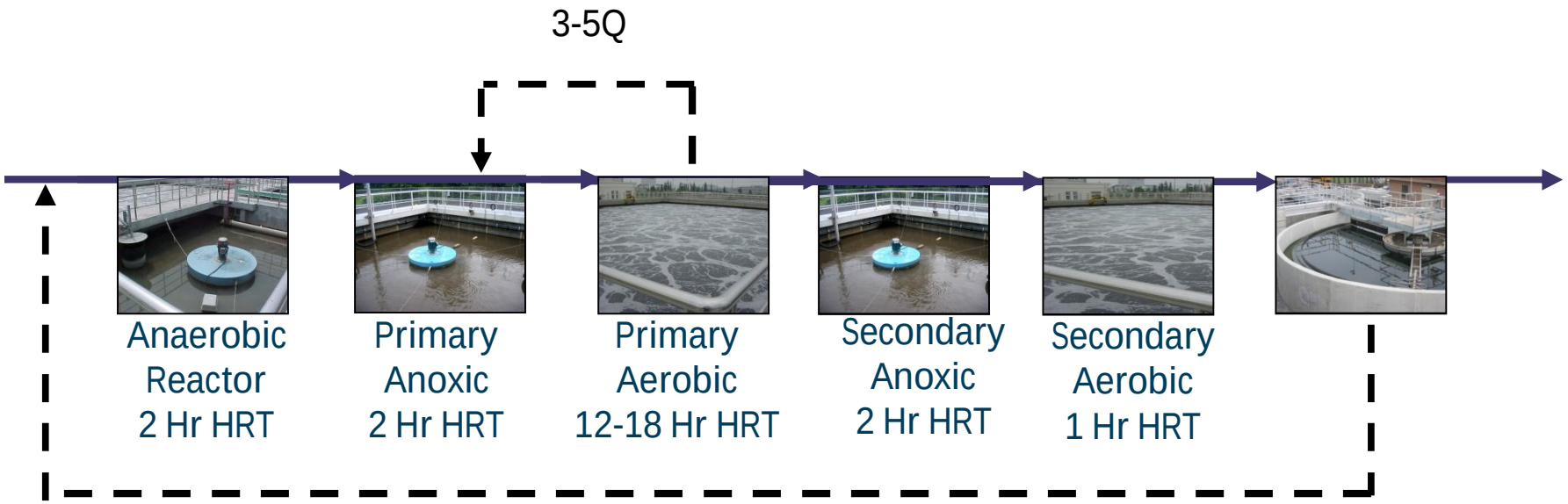
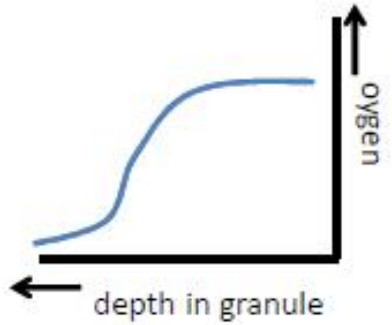
Comparison to Conventional Activated Sludge Nutrient Removal Process



Oxygen gradient in granule



Heterotrophic organisms

Anaerobic zone:

- Nitrate reduction to nitrogen gas
- Phosphate removal

$COD + NO_x + PO_4^{3-} \rightarrow N_2 + CO_2 + H_2O + poly\text{-}P$

Aerobic zone:

- Biological oxidation
- Ammonium oxidation to nitrate

$COD + O_2 \rightarrow CO_2 + H_2O$

$NH_4 + O_2 \rightarrow NOx$

Ammonium oxidising organisms

Transport by diffusion, not by pumping

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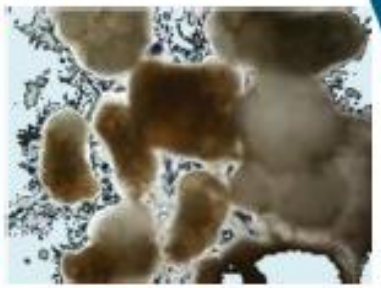
Aerobic Granular Biomass

Activated Sludge

Aerobic Granules



Excellent settling properties

Pure biomass

No support media

High MLSS levels (up to 15 g/L)

Reliable and stable operation

No bulking sludge

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High process robustness

- Continuous suppression of filamentous growth
- Robust during less favourable conditions, like:
  - salt fluctuations
  - chemical spikes
  - pH fluctuations
  - T fluctuations
  - load variations

Activated sludge and granular sludge with shock addition of 5,000 ppm NaCl after 5 min settling

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30 Full Scale Nereda® Plants Around the World

	Daily average flow (MGD)	Peak flow (MGD)	Startup
Vika, Ede (NL)	0.07	0.07	2005
Cargill, Rotterdam (NL)	0.18	0.18	2006
Fano Fine Foods, Oldenzaal (NL)	0.10	0.10	2006
Smilde, Oosterwolde (NL)	0.13	0.13	2009
STP Gansbaai (RSA)	1.32	2.54	2009
STP Epe (NL)	2.11	9.51	2011
STP Garmerwolde (NL)	7.93	26.63	2013
STP Vroomshoop (NL)	0.40	2.54	2013
STP Dinxperlo (NL)	0.82	3.61	2013
STP Wemmershoek (RSA)	1.32	3.96	2013
STP Frielas, Lisbon (PT)	3.17	3.17	2014
STP Ryki (PL)	1.40	2.73	2015
Westfort Meatproducts, Ijsselstein	0.37	0.37	2015
STP Clonakilty (IRL)	1.29	3.97	2015
STP Carrigtwohill (IRL)	1.78	5.35	2015
STP Deodoro, Rio de Janeiro (BR)	22.82	38.80	2016
STP Jardim Novo, Rio Claro (BR)	0.47	11.18	2016
STP Hartebeestfontein (RSA)	1.32	7.93	2016
STP Kingaroy (AUS)	0.71	2.85	2016
STP Ringsend SBR Retrofit 1 Cell, Dublin (IRL)	21.66	42.80	2016
STP Highworth (UK)	0.37	1.27	2016
STP Cork Lower Harbour (IRL)	4.83	11.60	2016
STP Simpelveld (NL)	0.97	5.99	2016
STP Ringsend Capacity Upgrade, Dublin (IRL)	30.91	58.58	2019
STP Alphach (CH)	3.70	11.70	2017
STP Österröd, Strömstad (S)	0.99	2.28	2017
STP Tatu, Limeira (BR)	15.06	22.14	2016
STP São Lourenço, Recife (BR) 1st phase	5.04	10.61	2016
STP São Lourenço, Recife (BR) 2nd pahse	6.64	10.61	2024
STP Jaboatão, Recife BR) 1st phase	28.97	73.47	2017
STP Jaboatão, Recife BR) 2nd phase	40.81	73.47	2025
STP Jardim São Paulo, Recife (BR)	5.16	37.15	2017
STP Jardim São Paulo, Recife (BR)	20.64	37.15	2025
STP Utrecht (NL)	14.53	83.69	2018
STP Faro-Olhão (PT)	7.44	24.99	2018