fluence™

MABR Nitro - Shortcut Nitrogen Removal

March 2022

Nitro

Small footprint. Large impact.

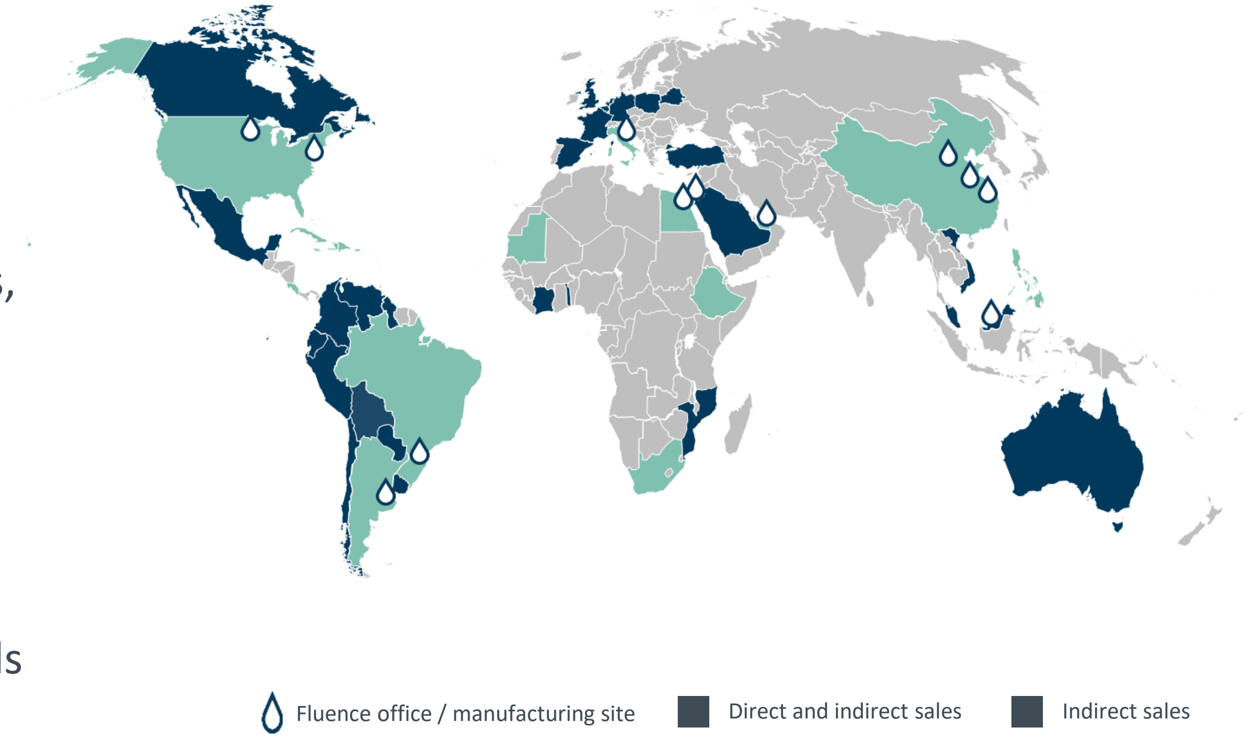
SWA

Singapore Water Association

-Proprietary-

Fluence Overview

- 350-person company, US$100M/year run rate, EBITDA profitable, ASX listed (FLC)
- Have deployed over 300 best in class wastewater treatment solutions
- Proprietary technology serves widest range of customers, from small cluster of homes to 800,000+ people
- Also have sold 120 units of containerized desalination: smallest footprint solution, energy efficient, fastest time to deliver
- Plants can be delivered and installed in weeks, operate remotely, produce no odor, can blend into neighborhoods



Proven, Proprietary & Quality Water Treatment Products

Smart & Automated • Fast-to-deploy • Low Maintenance

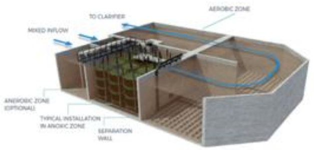
Wastewater Treatment Products

300+ plants sold

aspiral™

**Containerized
Smart Packaged Plants**

subre



**Retrofit / Newbuild
Fixed Facility**

KEY ADVANTAGES

- **Cost savings of ~30-70%** on a total cost of ownership (TCO) basis
- Pre-engineered and modular, allowing speedy deployment of plants. **Installed in weeks, not years.**
- **Automated operation, minimal maintenance and energy** requirements, resulting in quiet, odorless operation
- **Meets highest regulatory standards** & enables sustainable reuse (California Title 22 compliant)

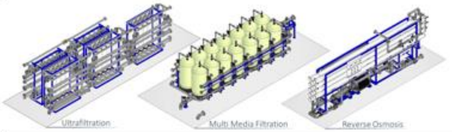
Desalination & Water Treatment Products

120 units, 28 plants sold

NIROBOX™

**Containerized
Smart Packaged Plants**

NIROFLEX



**Retrofit / Newbuild
Fixed Facility**

KEY ADVANTAGES

- Estimated **~65% shorter construction time** & **~40% less capex** than typical custom desalination plants
- Pre-engineered and modular, allowing speedy deployment of plants. **Installed in weeks, not years.**
- **Automated operation, minimal maintenance and energy** requirements resulting in quiet, odorless operation
- **Vastly reduces** process and related **risks**
- **Simple** to maintain and upgrade

Large Diversified Customer Base

Historical and Existing Customers and Partners

Water and wastewater treatment solutions for customers across the industrial, commercial and municipal sectors

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Evolution of Wastewater Aeration Processes

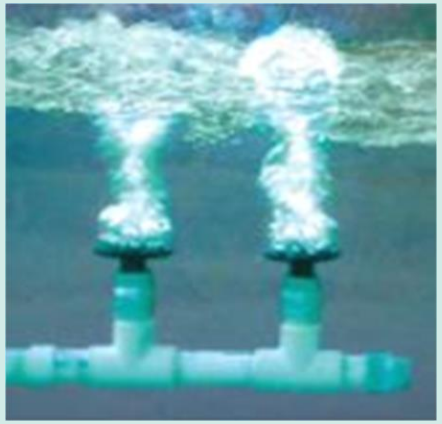
(total energy consumed in kWh per treated volume)

Surface Aerators

2-3 kWh/m³

>7.56 kWh/Kgal

1950-1970



Coarse Bubble Diffusers

1.5 kWh/m³

5.7 kWh/Kgal

1980-1990

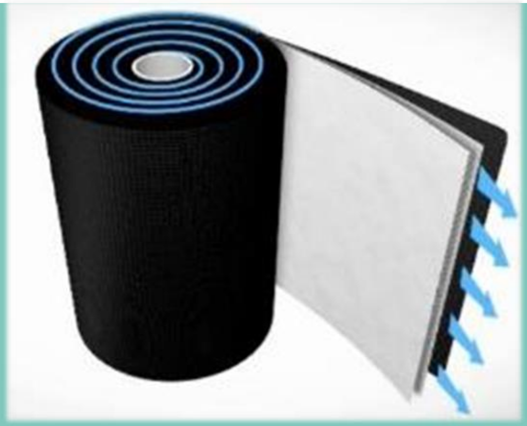
Fine Bubble Diffusers

0.55 kWh/m³

2.1 kWh/Kgal

Including nitrification

1990-2010



Fluence MABR

< 0.25 kWh/m³

<0.95kWh/Kgal

Including nitrification and denitrification

2015

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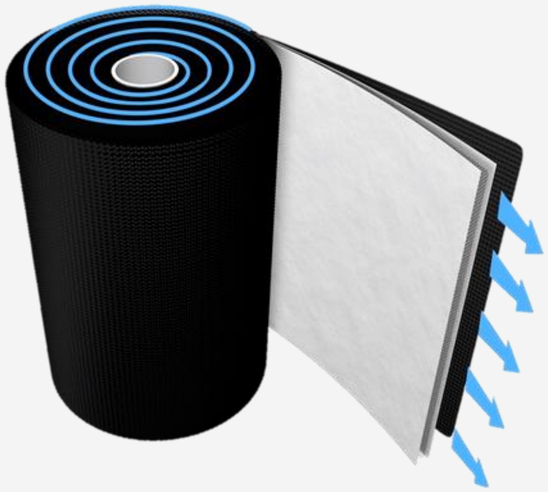
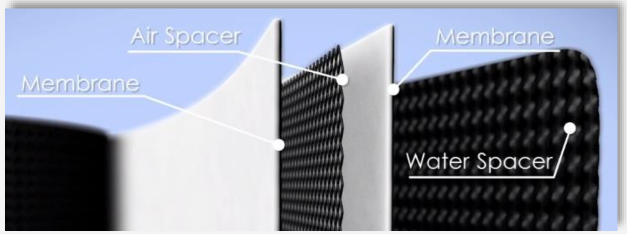
-Proprietary-

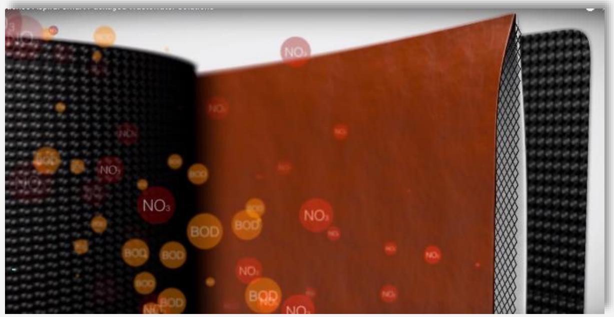
Fluence MABR Membrane Aerated Biofilm Reactor

- 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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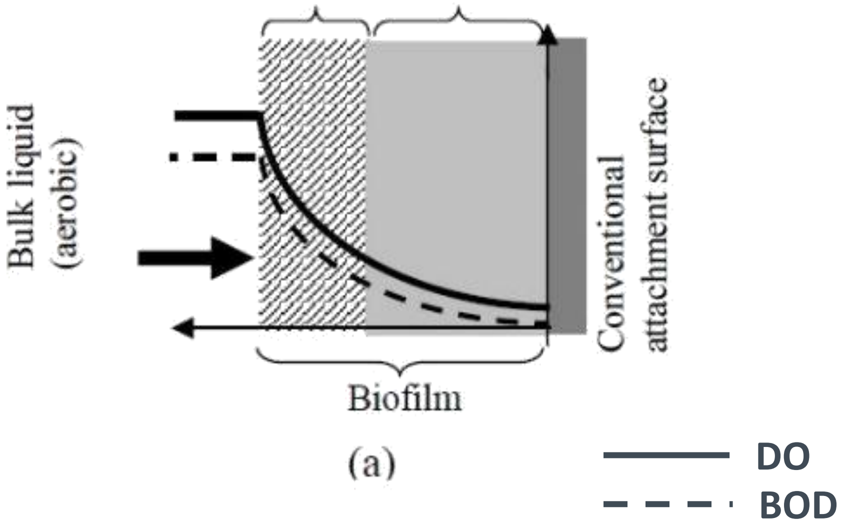
Membrane Aerated Biofilm Reactors ("MABR") Technology

"Unlike conventional biofilms, in the MABR the DO is highest at the attachment surface (Figure b) and drops to low levels in the bulk liquid. In this situation, NB are exposed to high DO levels, leading to higher nitrification rates. At the same time, the outer biofilm and bulk liquid are anoxic, allowing HB to reduce NO3 - with influent BOD as an electron donor. As a result, MBfRs can achieve BOD removal, nitrification, and denitrification within a single biofilm"

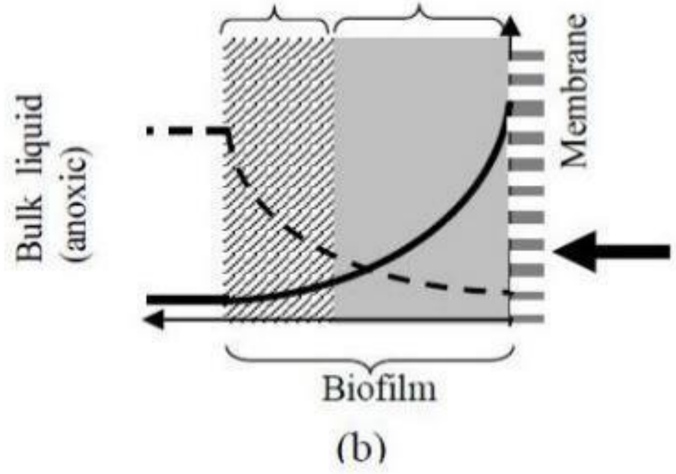
-Timberlake, Strand et al. 1988; Yamagiwa, Ohkawa et al. 1994; Hibiya, Terada et al. 2003; Semmens, Dahm et al. 2003; Terada, Hibiya et al. 2003; Satoh, Ono et al. 2004.

Conventional co-diffusion

Attached growth solutions such as: RBC, MBBR, IFAS

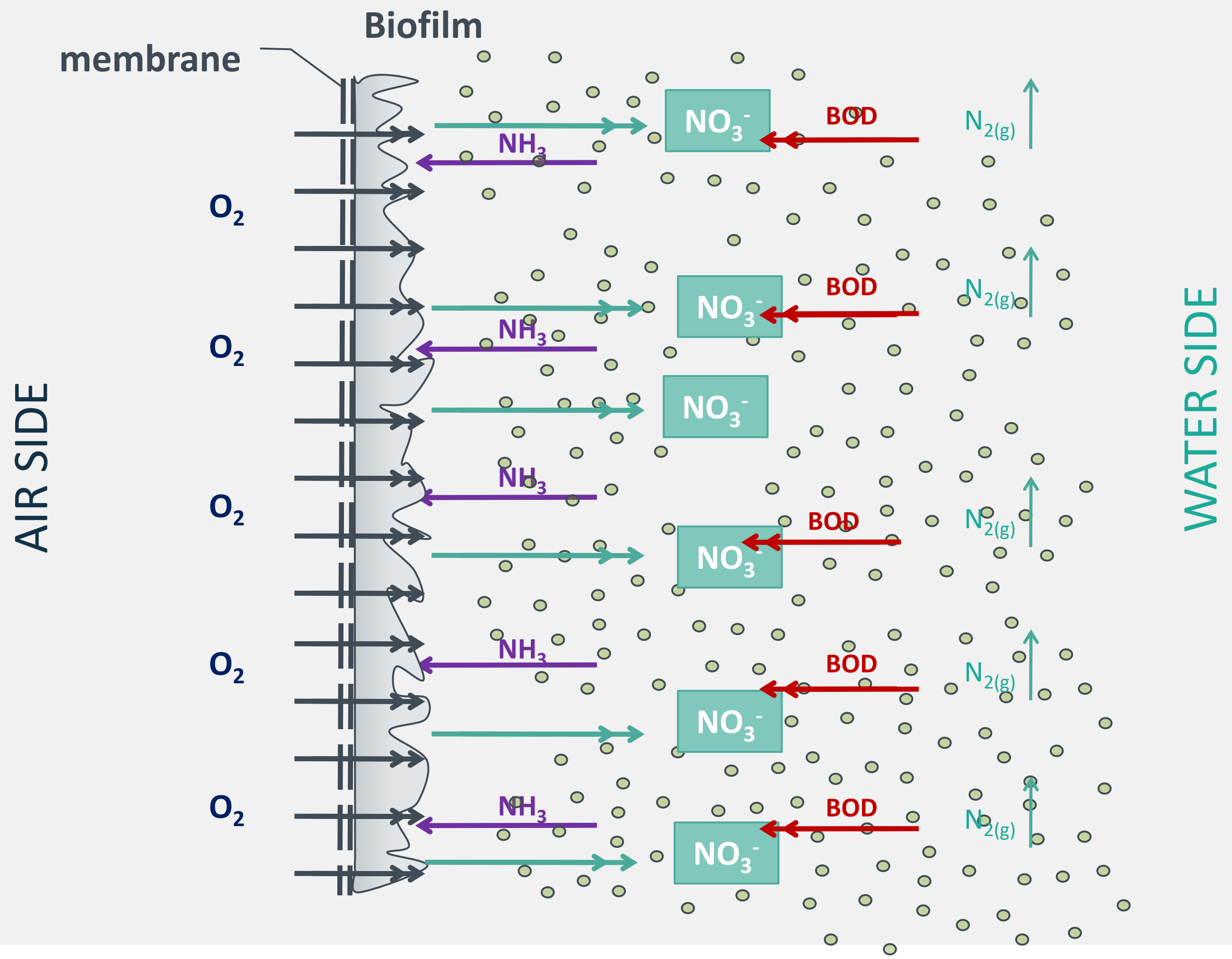


MABR counter-diffusion



A Unique Biofilm to support SND

Simultaneous Nitrification and Denitrification



Autotrophic biofilm develops at low BOD conditions, nitrifies ammonia using oxygen from the membrane

Heterotrophic suspended biomass denitrifies the nitrate at **anoxic** conditions

https://www.youtube.com/watch?v=gYMpkna22eU

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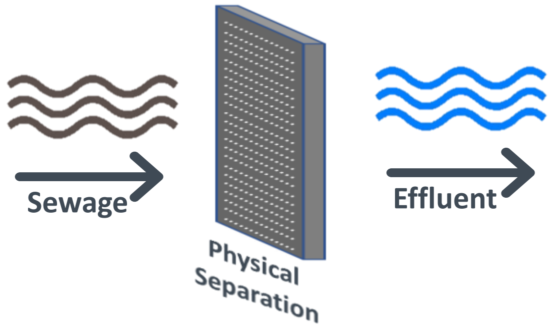
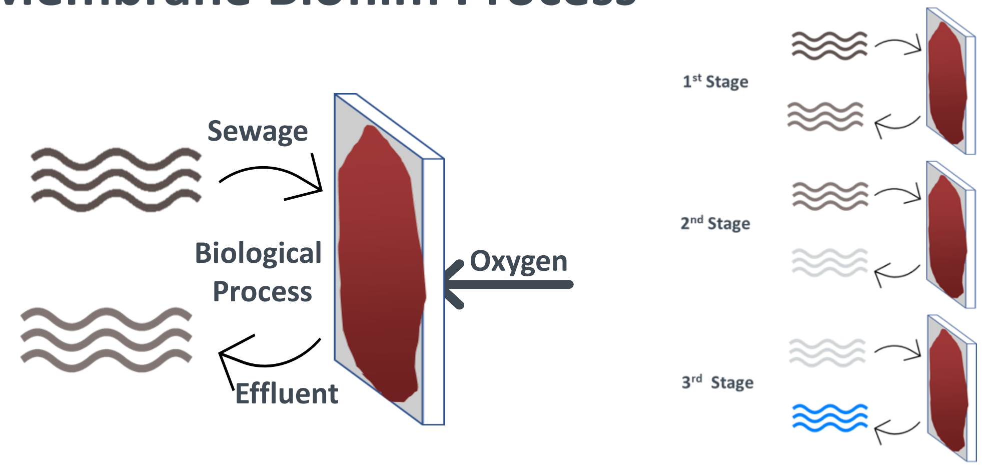
Filter vs. Biofilm

Membrane Filtration Process



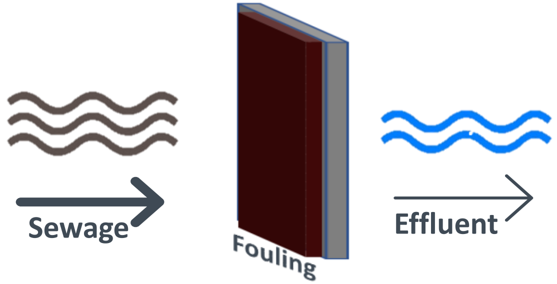
Membrane Biofilm Process



Filter Fouling Damages The Process and Flow

Physical barrier that separates solids:

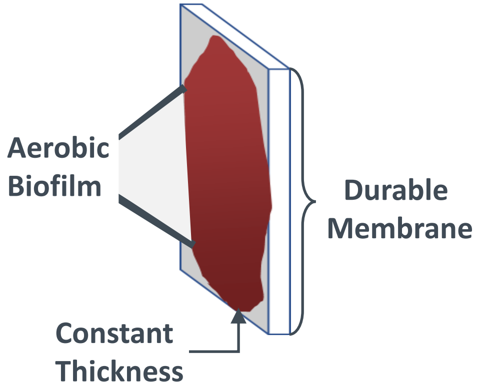
- **Membrane clogging**: need for chemical maintenance on a regular basis.
- **Membrane Replacement**: every 3-7 years
- **Membrane fouling** :reduce effluent capacity and increase energy demand
- **Very high OPEX:** high energy demand, maintenance and chemicals



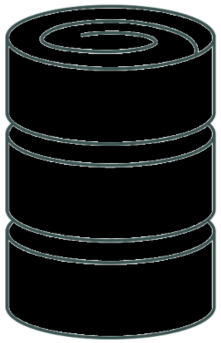
Biofilm Provides Consistent Reliable Results

Biological process that treats sewage:

- **Aerobic biofilm** constantly removes contaminants from the wastewater
- Biofilm thickness is **well controlled**
- **No need for maintenance or cleaning** of the membrane
- **Durable materials** with 20+ years lifespan

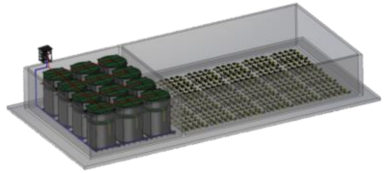


Fluence MABR Configurations

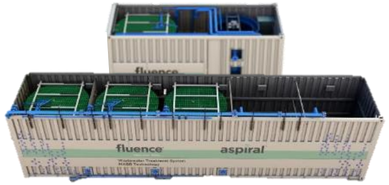


Aspiral Micro
On-site sewage treatment

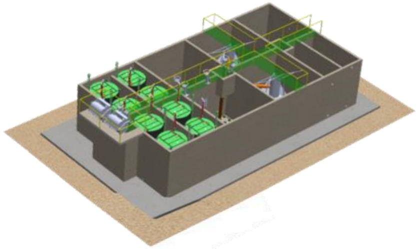
SUBRE Upgrade
Retrofit using MABR



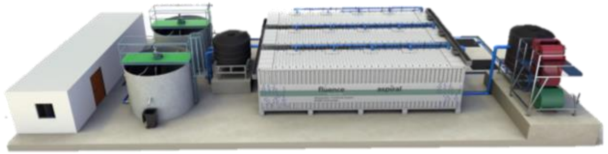
Aspiral
Smart Packaged Plant



SUBRE Plant
Concrete MABR plant



Aspiral plant
End-to-end wastewater solution



Modules
Integrate MABR in existing solutions

Nitro

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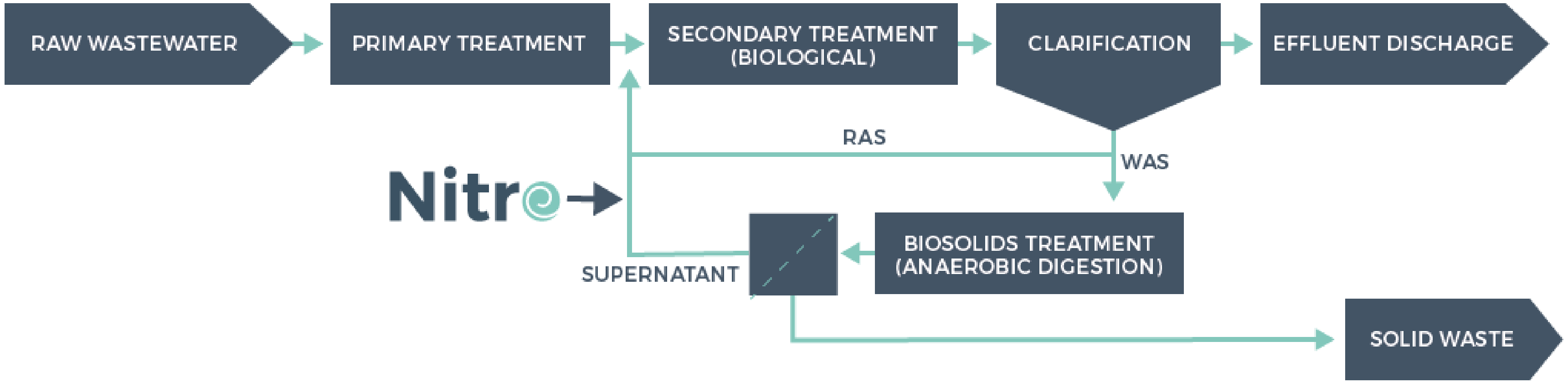
What Is Sidestream and Where can you Find It?

- Mid scale Municipal WW (30 MLD/8MGD) or more
- Mainly Biosolids treatment process, But also as industrial WW
- Anaerobic Digesters (Meso/Thermo)
- High Ammonia Content (>700 mg/l), relatively low BOD content
- Small Stream, Huge impact - 1% of WWTP's flow & up to 25% N loading



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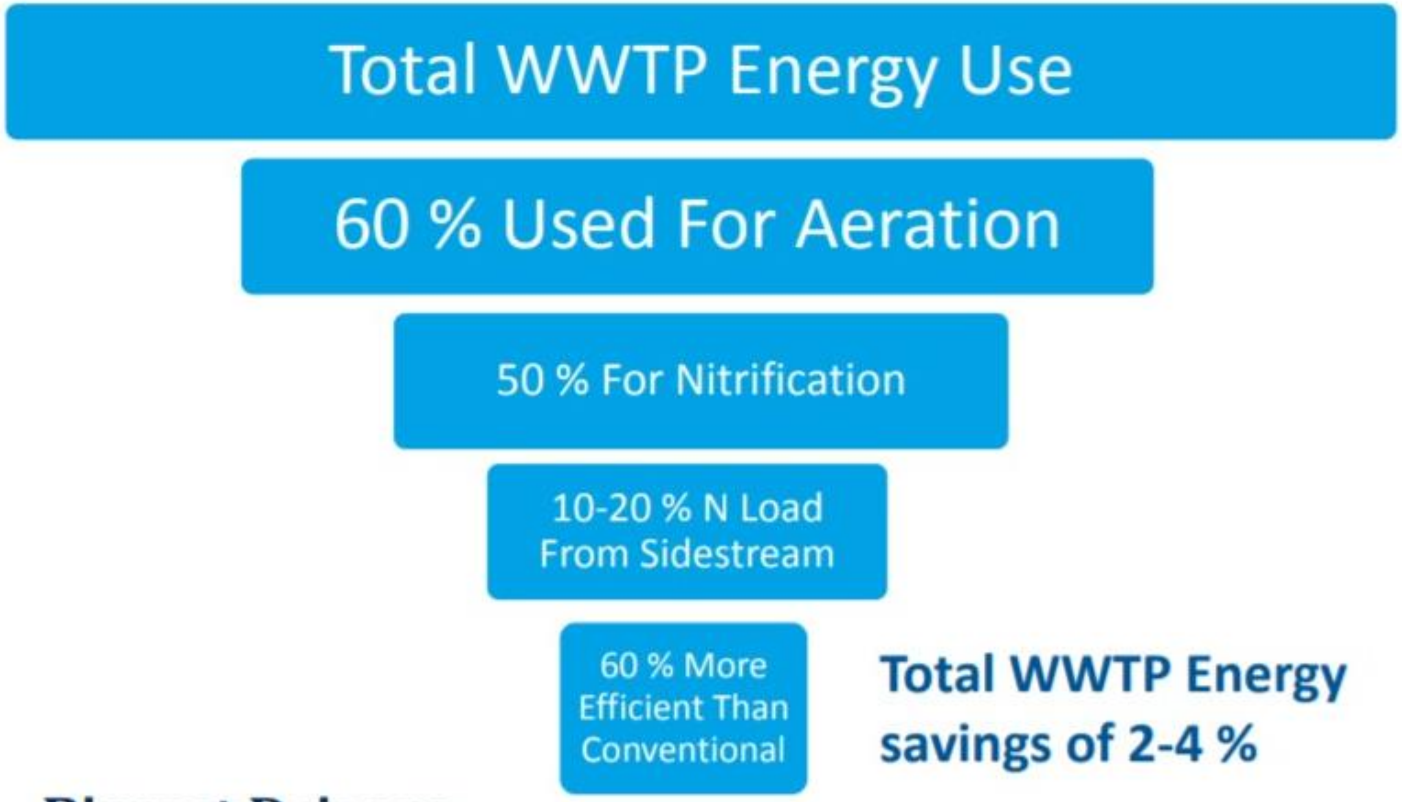
Side-stream nitrogen treatment in WWTPs

Digestate Sidestream Application



Biggest Drivers

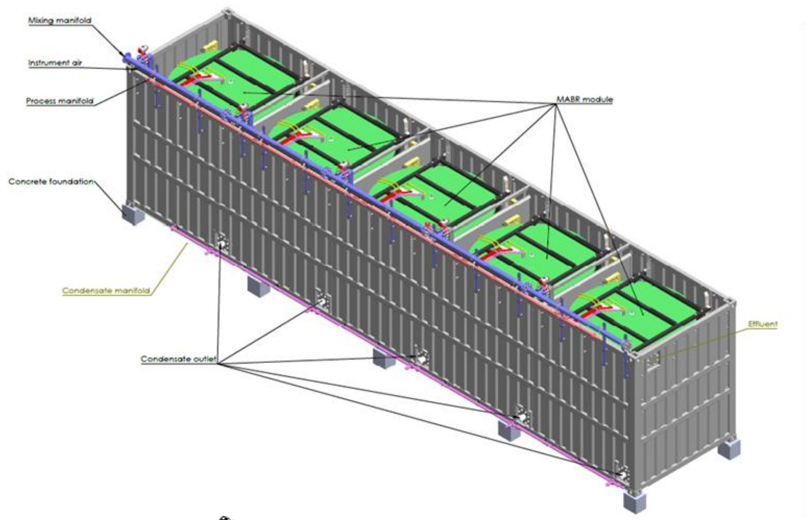
1. Reduce or eliminate carbon supplementation
2. N removal in a small footprint

Source: Black & Veatch

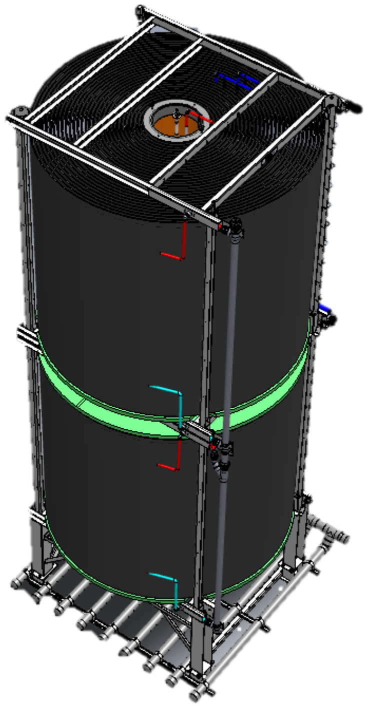

3.5 MGD
Anaerobic sludge digestion
Centrate NH4-N ~650 mg/l
Centrate N load on plant ~23%

Nitro

Small footprint. Large impact.



- MABR based shortcut Nitrogen removal
- Same MABR products, different process
- Launched Sep 2021
- Validated in 2 commercial pilots in Israel
- **MABR at its best**



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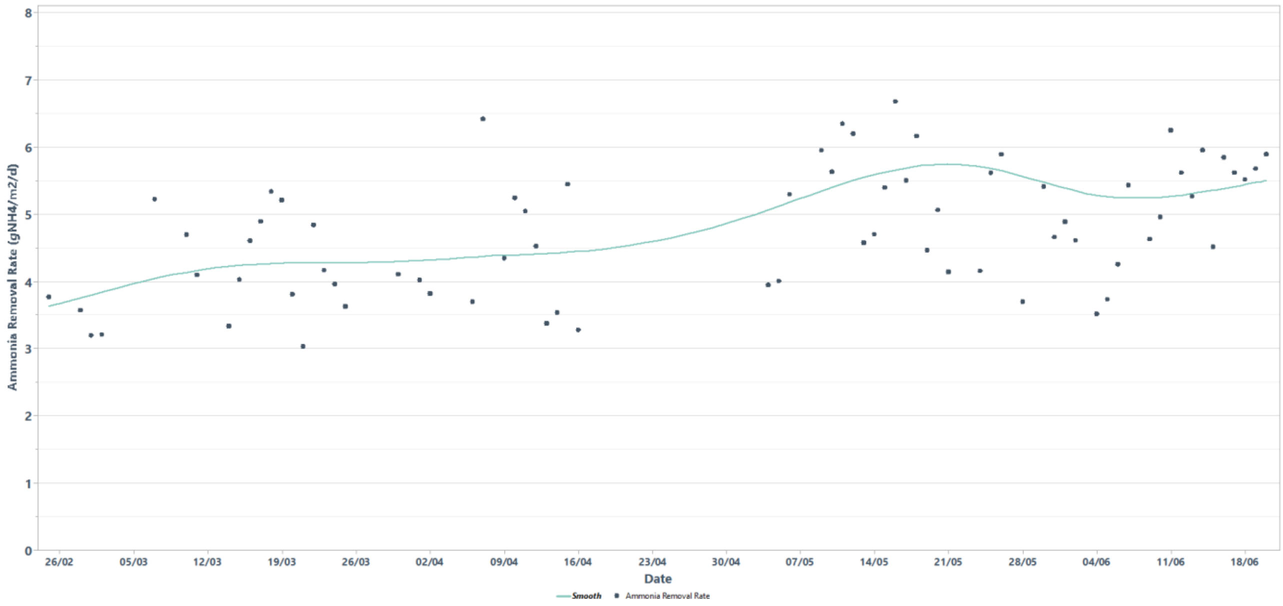
What is Nitro ?

- Based on Aspiral L5 or SUBRE T3/4 products (with minor changes)
- Single Pass, Biofilm only process (and negligible MLSS)
- High Ammonia removal rate (and some TIN removal) up to 90%
- Process's effluent discharge to WWTP main process stream

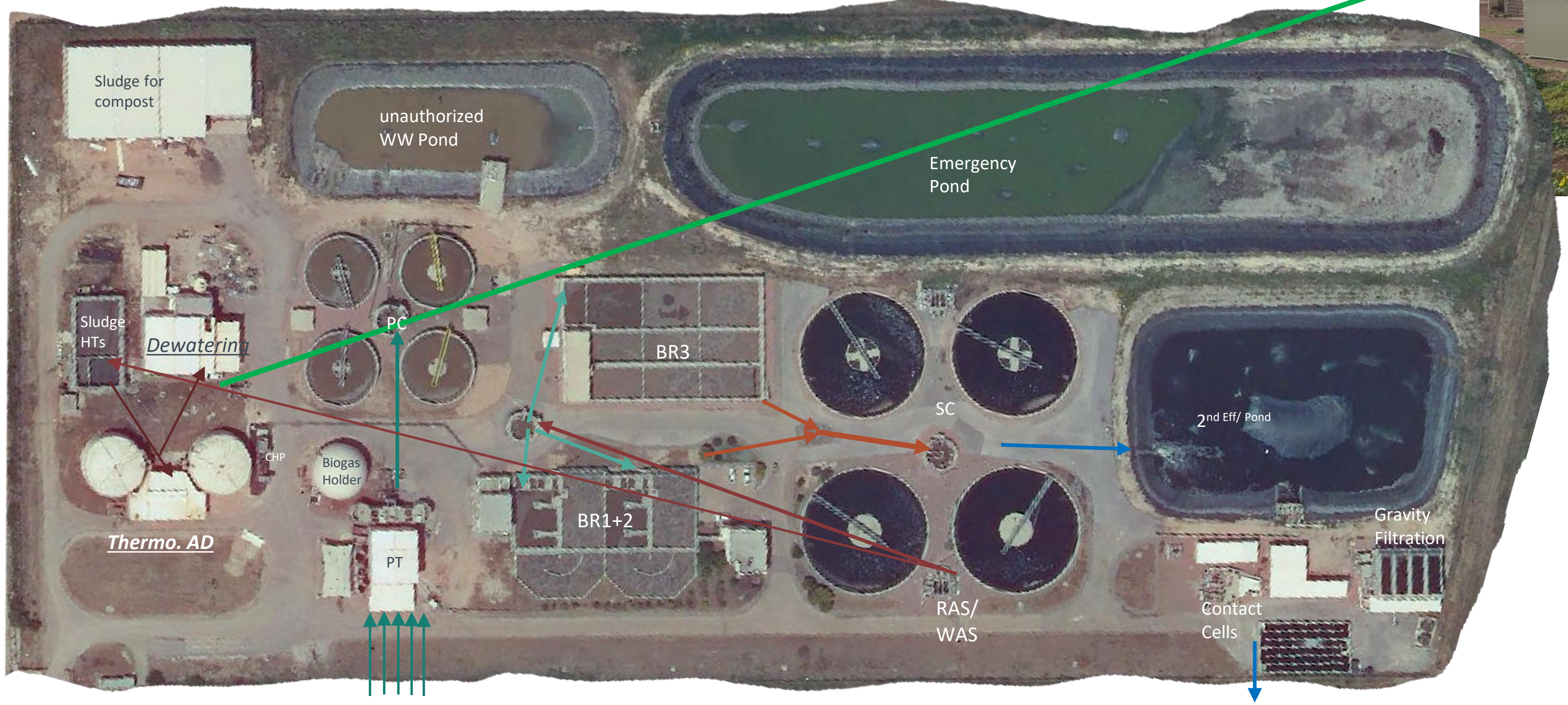


What are the Benefits of Nitro ?

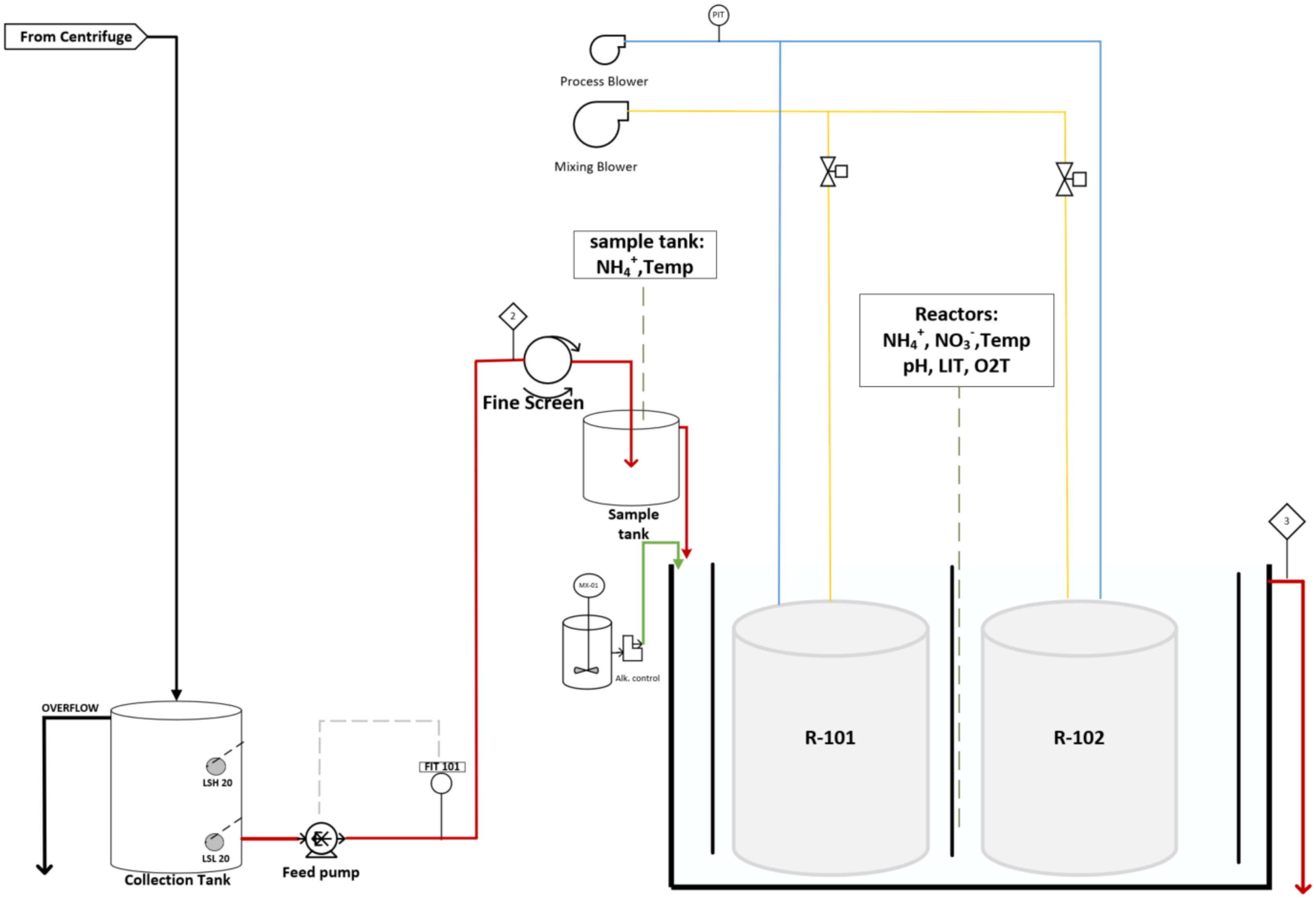
- Easy to install – only few elements (Aspiral and Blowers)
- Non-invasive – main process continues during installation/maintenance
- True energy savings !
- Donating oxygen to the mainstream process for free.
- Resilience – Stable process, not effected by storm weather conditions
- Steady conditions along the year – regardless to seasonal changes

Nitro Pilot plant- Akko WWTP, Northern Israel

1. MABR process overview
2. System presentation
3. Loads, process, and results
4. NGS analysis
5. Summary



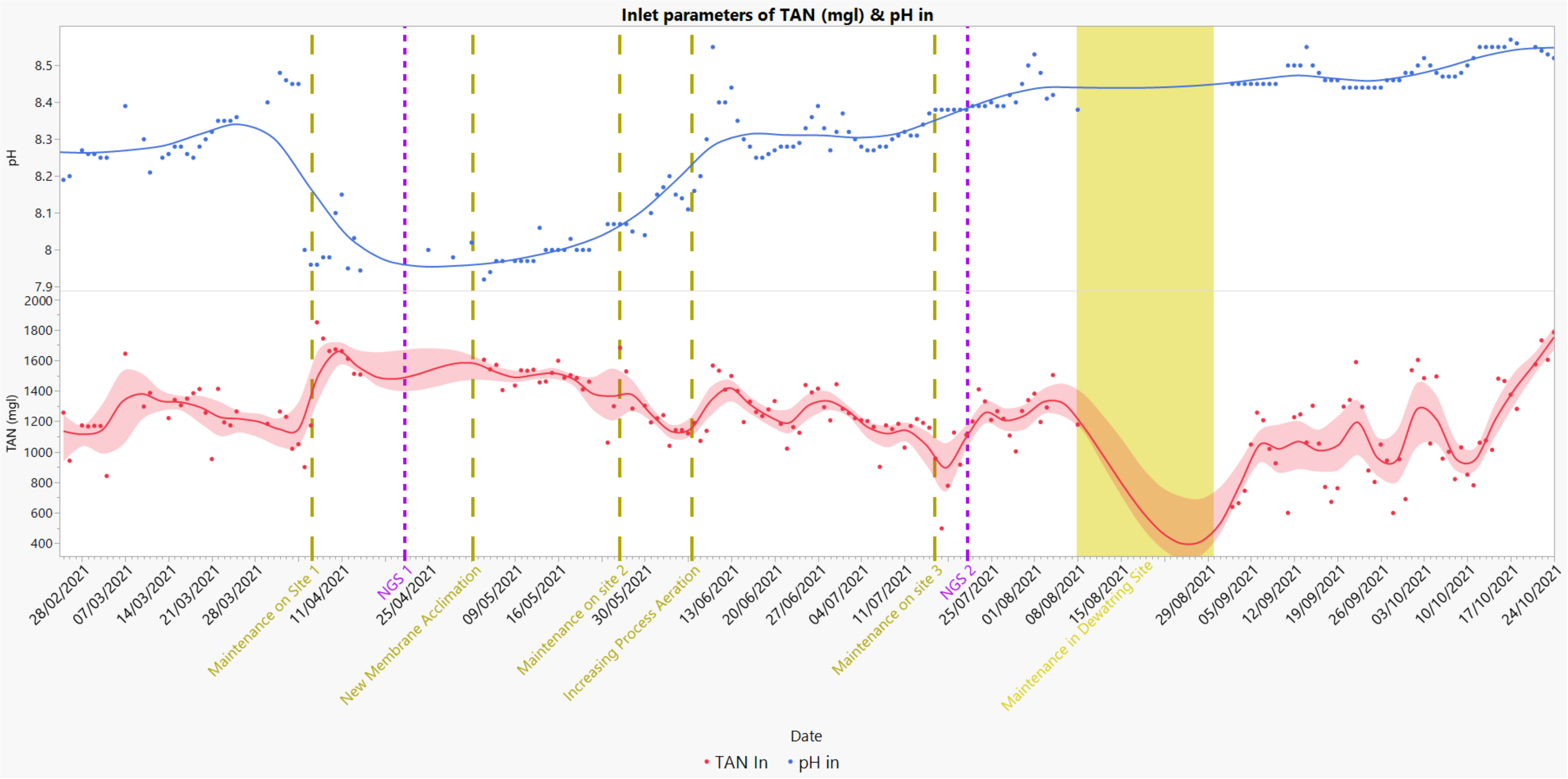
System layout and sampling



Online analysis
Temp (in & out)
pH (MABR)
NH_4^+ (in & out)
NO_3^- (out)
O_2 (exhaust)

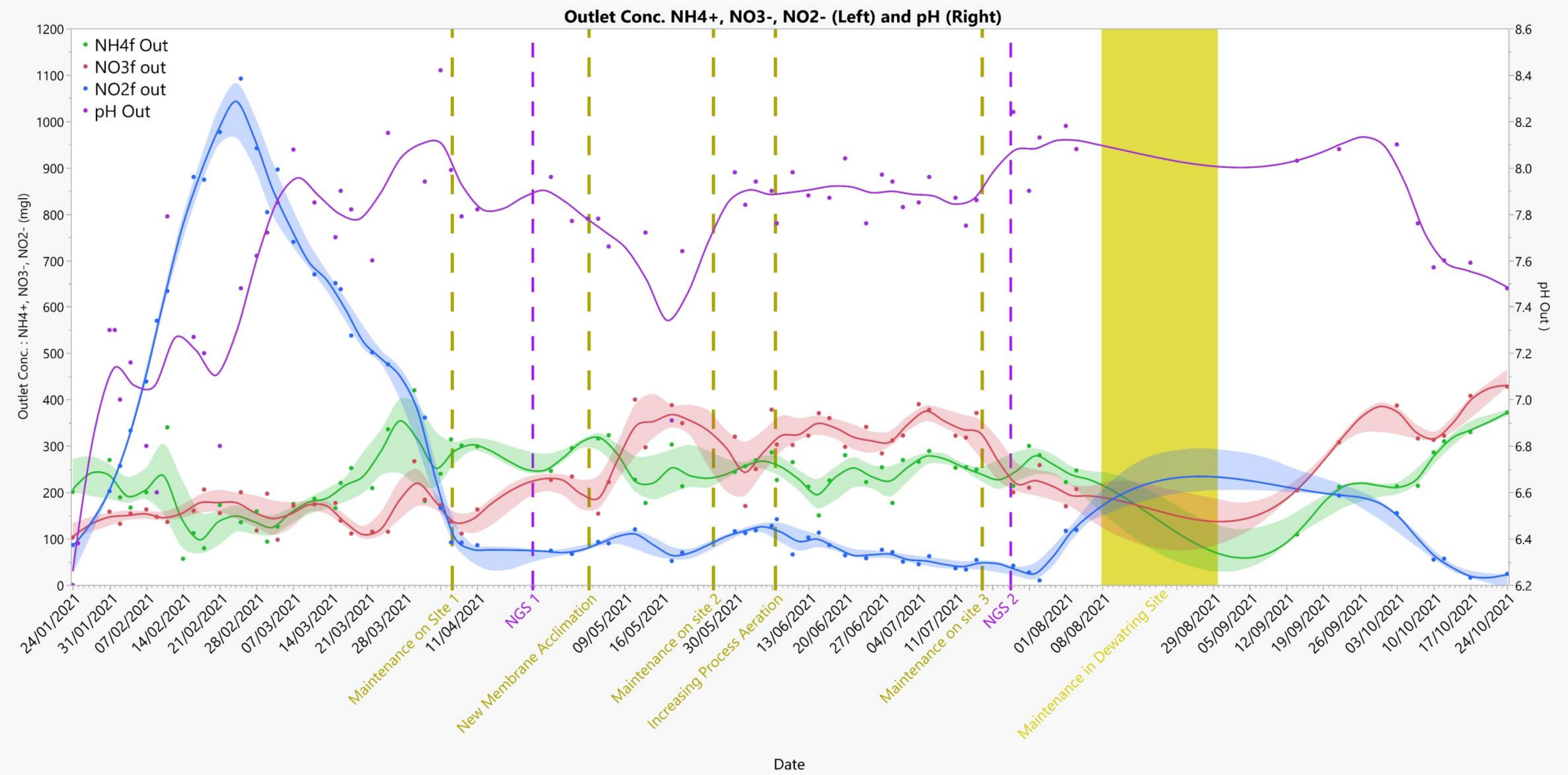
	Grab Sample		
Times a week	Test	SN in	MABR out
1	TSS	X	X
1	TN	X	X
3	NH_4^+	X	X
3	NO_3^-	X	X
3	NO_2^-	X	X
3	Alkalinity	X	X
1	COD	X	X
1	BOD	X	X
1	TP	X	X

Inlet parameters

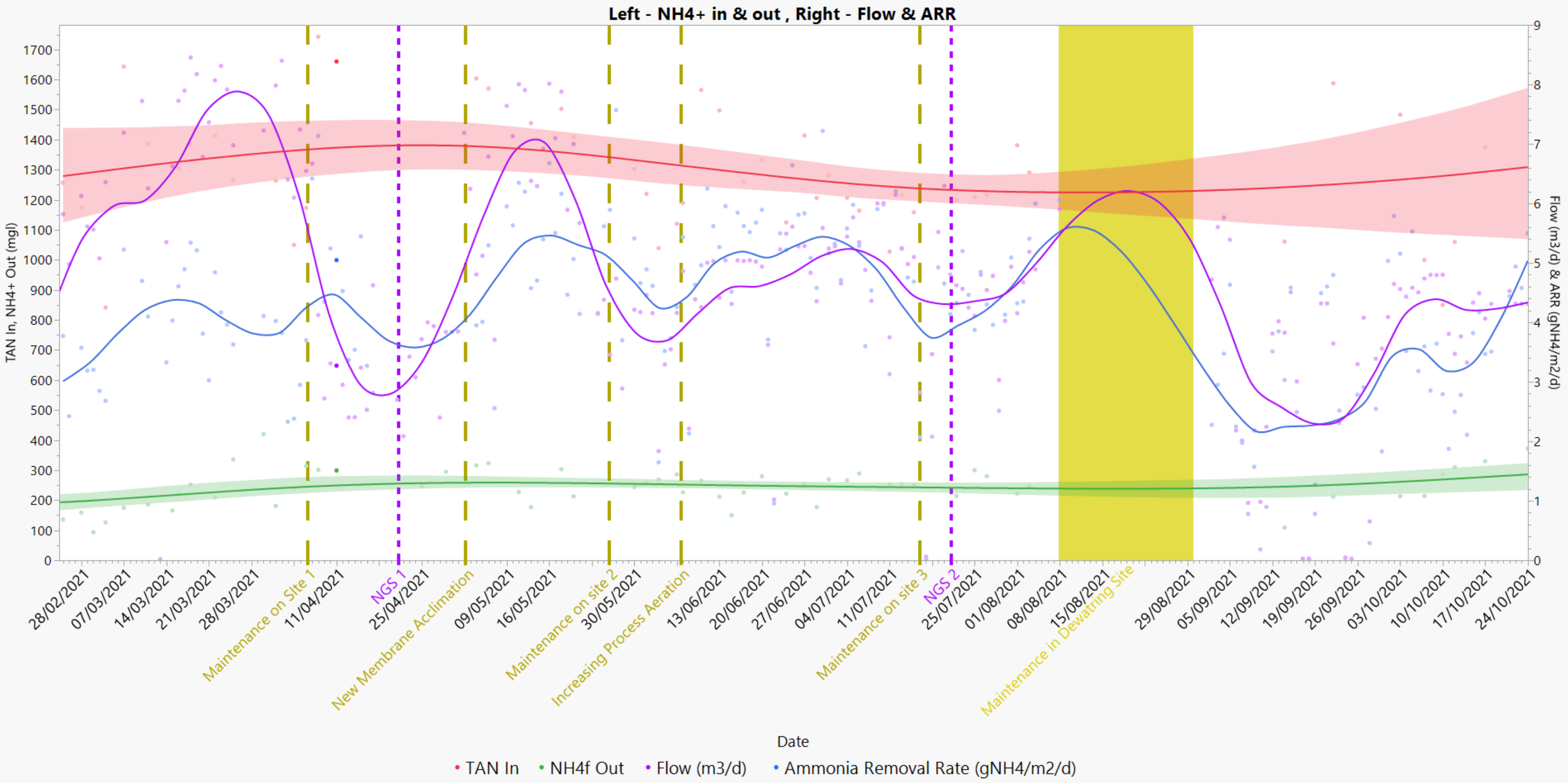


Parameter	Unit	value
Temp	ºC	35-45
Alkalinity (as $CaCO_3$)	mg/l	~3500
NH4-N	mg/l	1,250
NO3-N	mg/l	0
NO2-N	mg/l	0
TN (TAN)	mg/l	1,376
CODt	mg/l	1,788
BODt	mg/l	795
PH	-	8.2

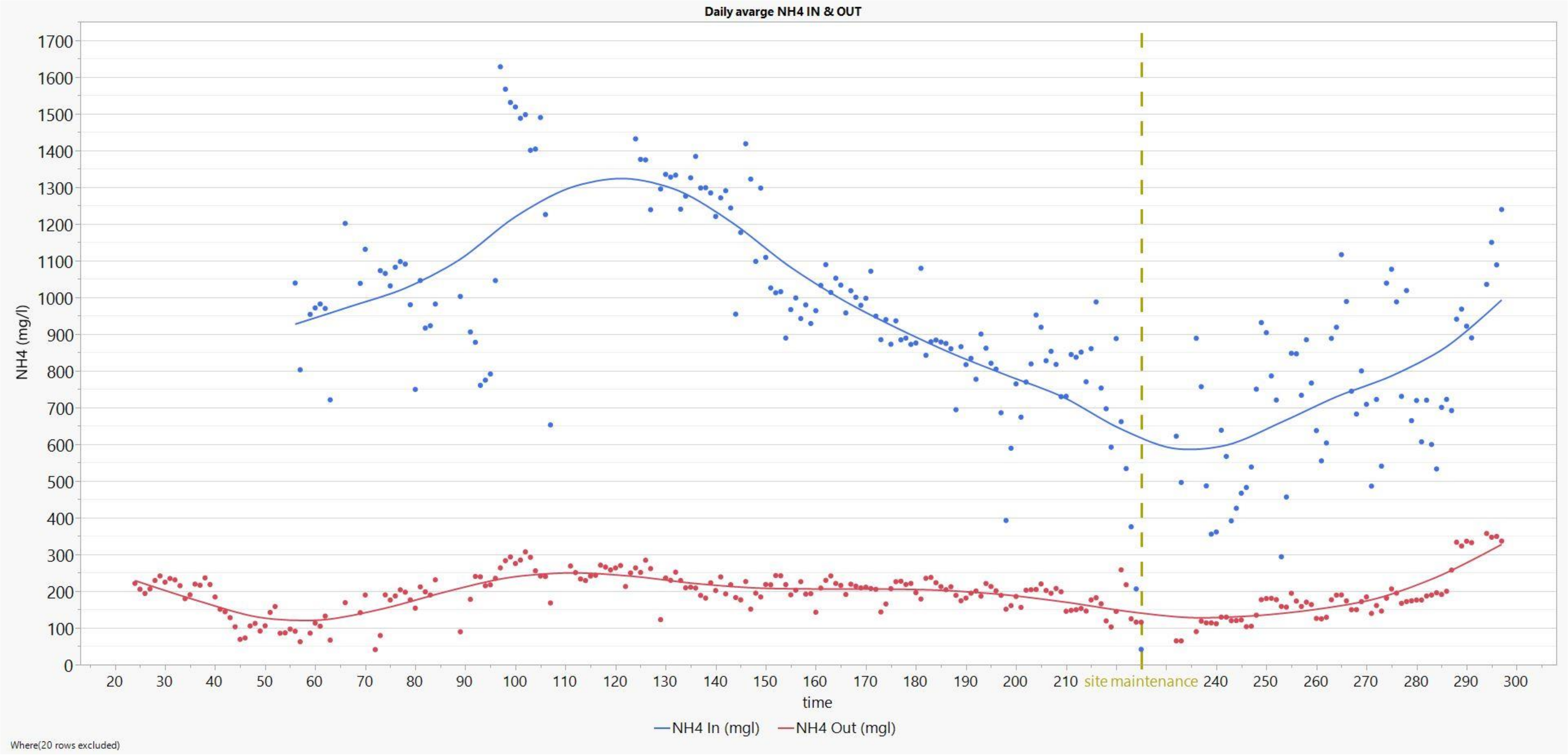
Outlet parameters



Ammonia removal rates



10-month influent and effluent performance

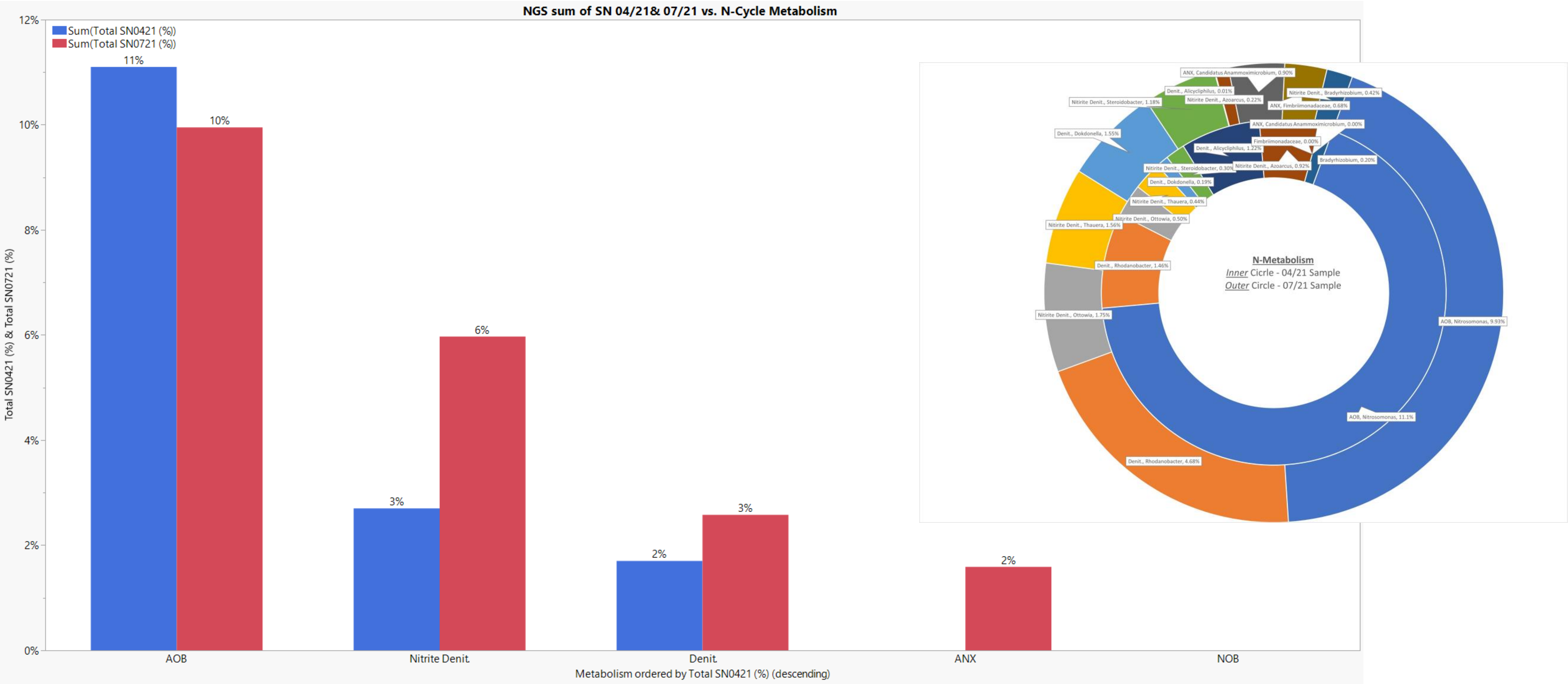


Biofilm Sampling

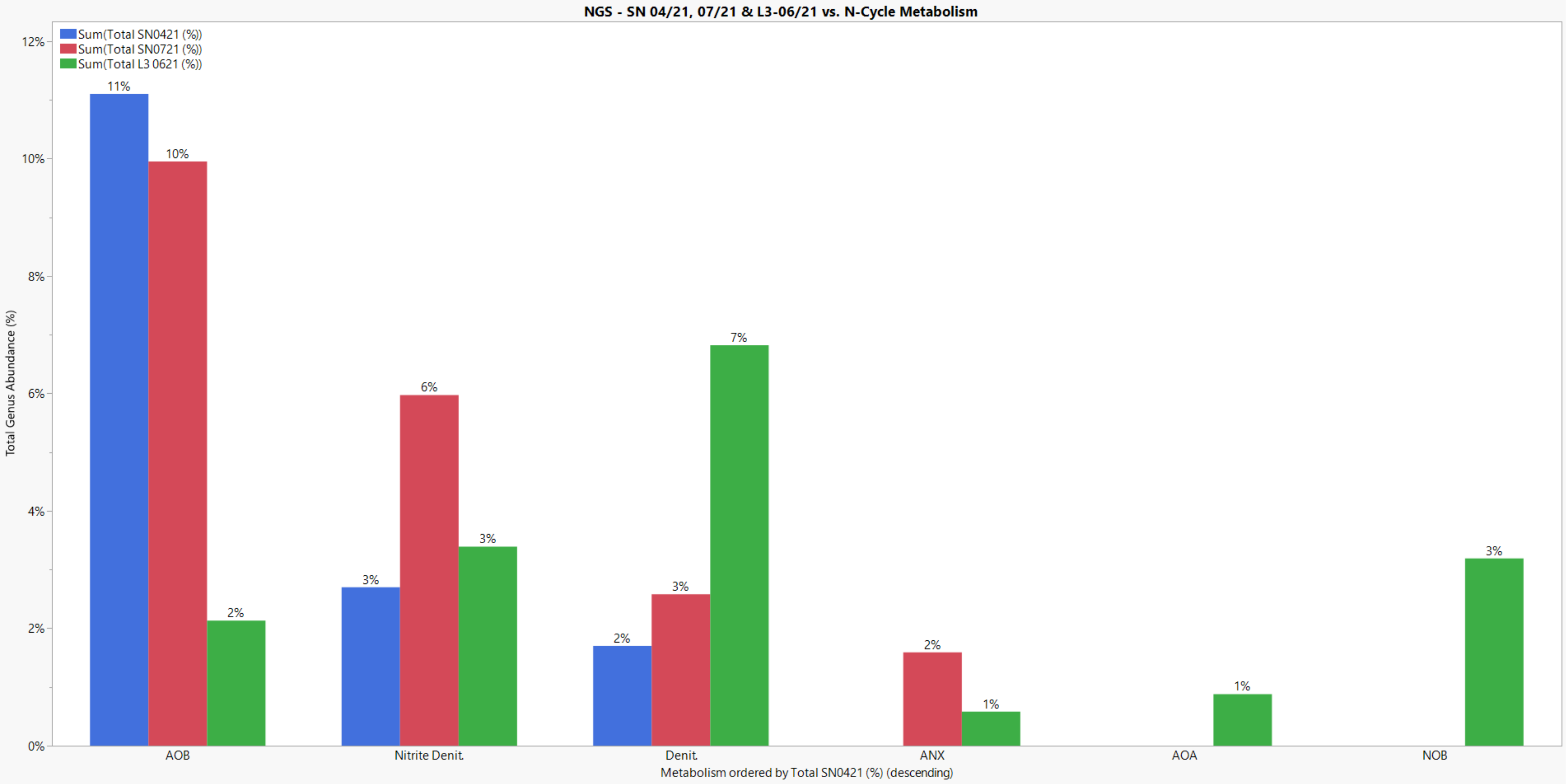
ID (Aggregated)	Taxonomy	All NGS	All SN	Total SN-0421 (%)	SN0421-Down1_S3	SN0421-Down2_S4	SN0421-Up1_S1	SN0421-Up2_S2	Total SN-0721 (%)	SN0721-1-Thin-Biofilm_S1	SN0721- Thick-Biofilm-pl-MLSS_S2	SN0721- 3-Thick-Biofilm_S3	SN0721- 4-MLSS_S4	Total L3 0621 (%)
Nitrosomonas	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Nitrosomonadaceae, D_5__Nitrosomonas	6.06%	10.5%	11.1%	1392	2159	987	1478	9.93%	1966	1930	1752	617	0.94%
NS9 marine group	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Flavobacteriales, D_4__NS9 marine group, Ambiguous_taxa	4.87%	9.05%	14.8%	1404	2416	1966	2200	4.16%	738	652	480	754	0.03%
Chitinophagaceae	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Chitinophagales, D_4__Chitinophagaceae, D_5__uncultured	4.38%	7.56%	7.6%	704	1185	949	1298	7.49%	1739	1394	1284	304	0.70%
Comamonas	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Burkholderiaceae, D_5__Comamonas	2.71%	5.03%	6.3%	671	745	769	1237	3.91%	581	621	819	447	0.02%
Thermomonas	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Xanthomonadales, D_4__Xanthomonadaceae, D_5__Thermomonas	2.45%	3.84%	6.1%	439	1236	699	906	1.93%	178	546	484	10	0.85%
Rhodanobacter	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Xanthomonadales, D_4__Rhodanobacteraceae, D_5__Rhodanobacter	1.73%	3.19%	1.5%	179	265	156	190	4.68%	1460	756	660	73	0.04%
OLB8	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Chitinophagales, D_4__Saprospiraceae, D_5__OLB8	1.55%	2.74%	0.3%	16	43	28	87	4.82%	985	844	941	270	0.16%
Ideonella	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Burkholderiaceae, D_5__Ideonella	1.45%	2.64%	5.5%	675	954	631	734	0.16%	62	19	16	2	0.07%
OLB13	D_0__Bacteria, D_1__Chloroflexi, D_2__Anaerolineae, D_3__SBR1031, D_4__A4b, D_5__OLB13	1.29%	2.40%	0.0%	0	3	9	3	4.43%	1215	711	692	178	0.00%
Truepera	D_0__Bacteria, D_1__Deinococcus-Thermus, D_2__Deinococci, D_3__Deinococcales, D_4__Trueperaceae, D_5__Truepera	1.26%	2.36%	2.7%	254	499	281	416	2.08%	282	354	157	518	0.00%
Phaeodactylibacter	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Chitinophagales, D_4__Saprospiraceae, D_5__Phaeodactylibacter	1.28%	2.31%	0.0%	1	0	1	2	4.28%	481	673	552	996	0.10%
Arenimonas	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Xanthomonadales, D_4__Xanthomonadaceae, D_5__Arenimonas	1.37%	2.13%	4.4%	318	693	572	806	0.18%	30	51	28	2	0.49%
OPB56	D_0__Bacteria, D_1__Bacteroidetes, D_2__Ignavibacteria, D_3__OPB56, Ambiguous_taxa, Ambiguous_taxa	1.08%	1.93%	2.0%	216	180	301	389	1.87%	337	214	224	403	0.08%
OLB12	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Cytophagales, D_4__Microscillaceae, D_5__OLB12	0.89%	1.63%	0.0%	0	0	0	0	3.02%	856	337	175	538	0.05%
Gemmatimonas	D_0__Bacteria, D_1__Gemmatimonadetes, D_2__Gemmatimonadetes, D_3__Gemmatimonadales, D_4__Gemmatimonadaceae, D_5__Gemmatimonas	0.86%	1.60%	3.3%	401	455	400	505	0.18%	26	43	39	3	0.01%
OLB14	D_0__Bacteria, D_1__Chloroflexi, D_2__OLB14, D_3__uncultured bacterium, D_4__uncultured bacterium, D_5__uncultured bacterium	0.88%	1.52%	0.1%	11	10	24	26	2.72%	271	362	197	884	0.14%
env.OPS 17	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Sphingobacteriales, D_4__env.OPS 17, Ambiguous_taxa	0.84%	1.51%	2.5%	278	414	234	441	0.64%	50	92	65	196	0.07%
Afipia	D_0__Bacteria, D_1__Proteobacteria, D_2__Alphaproteobacteria, D_3__Rhizobiales, D_4__Xanthobacteraceae, D_5__Afipia	0.75%	1.36%	0.6%	43	102	78	99	2.02%	370	524	372	5	0.06%
Ottowia	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Burkholderiaceae, D_5__Ottowia	0.91%	1.17%	0.5%	22	41	87	118	1.75%	59	240	69	736	0.61%
Bryobacter	D_0__Bacteria, D_1__Acidobacteria, D_2__Acidobacteriia, D_3__Solibacterales, D_4__Solibacteraceae (Subgroup 3), D_5__Bryobacter	0.66%	1.05%	0.9%	109	107	119	152	1.18%	204	280	178	83	0.22%
Thauera	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Rhodocyclaceae, D_5__Thauera	0.65%	1.04%	0.4%	16	11	58	152	1.56%	13	160	38	771	0.21%
N/A	N/A	1.27%	1.03%	1.3%	141	231	156	190	0.77%	127	112	147	100	1.54%
Bdellovibrio	D_0__Bacteria, D_1__Proteobacteria, D_2__Deltaproteobacteria, D_3__Bdellovibrionales, D_4__Bdellovibrionaceae, D_5__Bdellovibrio	0.61%	1.00%	0.6%	70	49	95	91	1.38%	252	258	327	35	0.15%
Dokdonella	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Xanthomonadales, D_4__Rhodanobacteraceae, D_5__Dokdonella	0.59%	0.92%	0.2%	21	26	22	34	1.55%	448	262	248	19	0.20%
Coprothermobacter	D_0__Bacteria, D_1__Coprothermobacteraeota, D_2__Coprothermobacteria, D_3__Coprothermobacterales, D_4__Coprothermobacteraceae, D_5__Coprothermobacter	0.49%	0.92%	0.3%	29	22	34	60	1.48%	79	82	93	681	0.00%
Rubellimicrobium	D_0__Bacteria, D_1__Proteobacteria, D_2__Alphaproteobacteria, D_3__Rhodobacterales, D_4__Rhodobacteraceae, D_5__Rubellimicrobium	0.48%	0.89%	1.5%	100	374	135	192	0.39%	40	65	65	76	0.00%
PLTA13	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__PLTA13, Ambiguous_taxa, Ambiguous_taxa	0.66%	0.88%	0.8%	93	120	82	137	0.95%	84	333	158	24	0.42%
Novosphingobium	D_0__Bacteria, D_1__Proteobacteria, D_2__Alphaproteobacteria, D_3__Sphingomonadales, D_4__Sphingomonadaceae, D_5__Novosphingobium	0.53%	0.88%	1.7%	167	248	227	266	0.19%	52	34	31	3	0.12%
PHOS-HE36	D_0__Bacteria, D_1__Bacteroidetes, D_2__Ignavibacteria, D_3__Ignavibacteriales, D_4__PHOS-HE36, D_5__uncultured bacterium	0.43%	0.78%	0.0%	0	0	0	0	1.44%	113	256	125	417	0.03%
Steroidobacter	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Steroidobacterales, D_4__Steroidobacteraceae, D_5__Steroidobacter	0.42%	0.77%	0.3%	35	63	19	45	1.18%	444	130	170	2	0.00%
Haliangium	D_0__Bacteria, D_1__Proteobacteria, D_2__Deltaproteobacteria, D_3__Myxococcales, D_4__Haliangiaceae, D_5__Haliangium	0.59%	0.71%	0.0%	3	9	4	5	1.28%	380	190	179	58	0.46%
Saccharimonadales	D_0__Bacteria, D_1__Patescibacteria, D_2__Saccharimonadia, D_3__Saccharimonadales, D_4__uncultured bacterium, D_5__uncultured bacterium	0.47%	0.69%	0.4%	40	63	63	75	0.90%	52	219	40	259	0.22%
Sphingomonas	D_0__Bacteria, D_1__Proteobacteria, D_2__Alphaproteobacteria, D_3__Sphingomonadales, D_4__Sphingomonadaceae, D_5__Sphingomonas	0.46%	0.67%	1.4%	95	163	239	287	0.01%	0	4	0	0	0.22%
NS11-12 marine group	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Sphingobacteriales, D_4__NS11-12 marine group, Ambiguous_taxa	0.38%	0.67%	0.3%	27	25	55	68	0.97%	69	82	85	375	0.05%
Limnobacter	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Burkholderiaceae, D_5__Limnobacter	0.36%	0.61%	0.5%	62	40	63	117	0.69%	48	146	73	167	0.07%
Alicycliphilus	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Burkholderiaceae, D_5__Alicycliphilus	0.31%	0.57%	1.2%	29	112	182	336	0.01%	1	2	0	3	0.00%
Taibaiella	D_0__Bacteria, D_1__Bacteroidetes, D_2__Bacteroidia, D_3__Chitinophagales, D_4__Chitinophagaceae, D_5__Taibaiella	0.36%	0.56%	0.1%	11	5	4	15	0.98%	282	109	131	98	0.14%
Azoarcus	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Rhodocyclaceae, D_5__Azoarcus	0.29%	0.55%	0.9%	102	102	132	164	0.22%	16	65	21	37	0.00%
SC-I-84	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__SC-I-84, D_5__uncultured bacterium	0.50%	0.53%	0.0%	3	11	1	6	0.95%	170	184	115	133	0.46%
BD1-7 clade	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Cellvibrionales, D_4__Spongiibacteraceae, D_5__BD1-7 clade	0.44%	0.52%	0.9%	81	146	110	164	0.18%	14	31	10	59	0.35%
Luteococcus	D_0__Bacteria, D_1__Actinobacteria, D_2__Actinobacteria, D_3__Propionibacteriales, D_4__Propionibacteriaceae, D_5__Luteococcus	0.26%	0.49%	0.0%	0	0	0	0	0.91%	14	122	27	409	0.00%
Candidatus Anammoximicrobium	D_0__Bacteria, D_1__Planctomycetes, D_2__Planctomycetacia, D_3__Pirellulales, D_4__Pirellulaceae, D_5__Candidatus Anammoximicrobium	0.26%	0.48%	0.0%	0	0	0	0	0.90%	90	163	213	102	0.00%
Terrabacter	D_0__Bacteria, D_1__Actinobacteria, D_2__Actinobacteria, D_3__Micrococcales, D_4__Intrasporangiaceae, D_5__Terrabacter	0.25%	0.47%	0.0%	0	0	0	0	0.87%	7	73	23	444	0.00%
Anaerolineaceae	D_0__Bacteria, D_1__Chloroflexi, D_2__Anaerolineae, D_3__Anaerolineales, D_4__Anaerolineaceae, D_5__uncultured	0.48%	0.42%	0.0%	0	0	0	0	0.77%	100	124	256	8	0.56%
Burkholderiaceae	D_0__Bacteria, D_1__Proteobacteria, D_2__Gammaproteobacteria, D_3__Betaproteobacteriales, D_4__Burkholderiaceae, D_5__uncultured	1.09%	0.40%	0.1%	0	6	16	41	0.62%	19	45	23	306	1.89%

Louca lab, University of Oregon
Microbial ecology and evolution (and other rabbit holes)

Species abundance

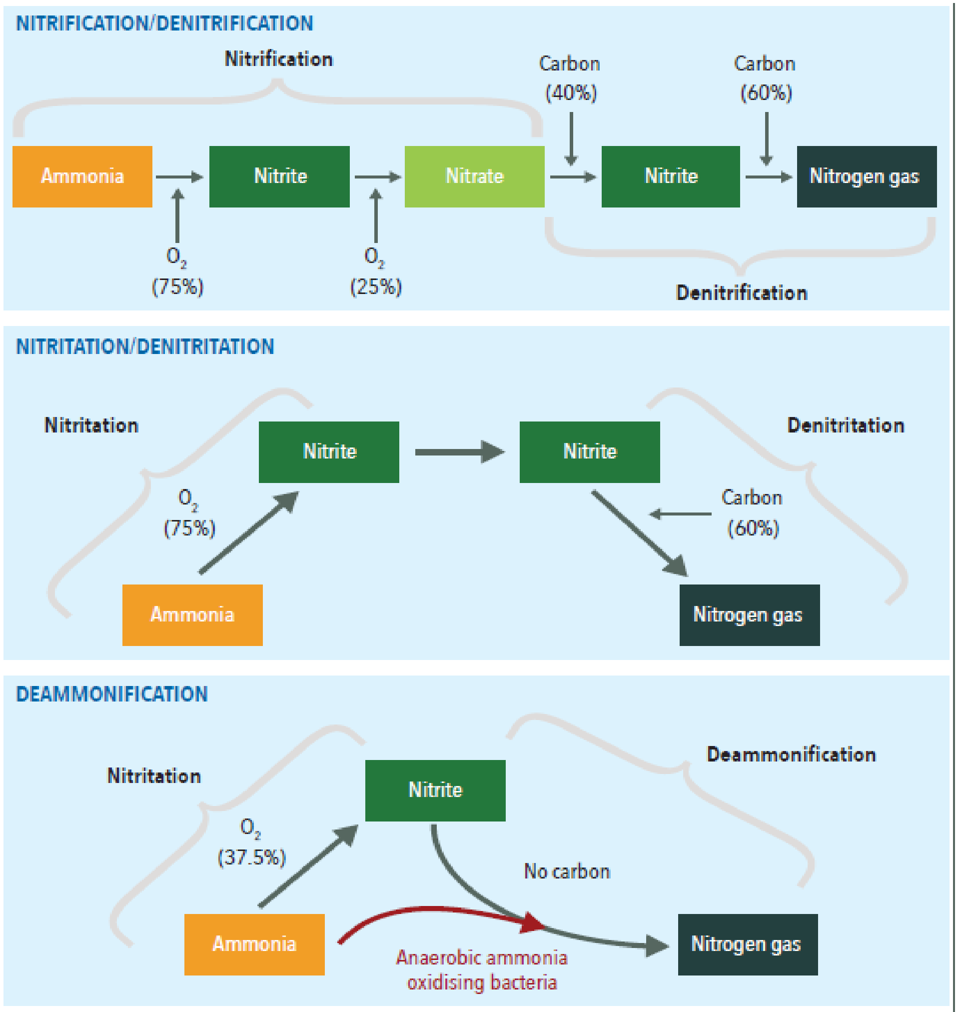


Comparison to traditional activated sludge population



Summary

This trial might suggest the existence of an alternative Nitrogen removal pattern – Partial Nitritation- Denitritation and Anammox (PANDA) process

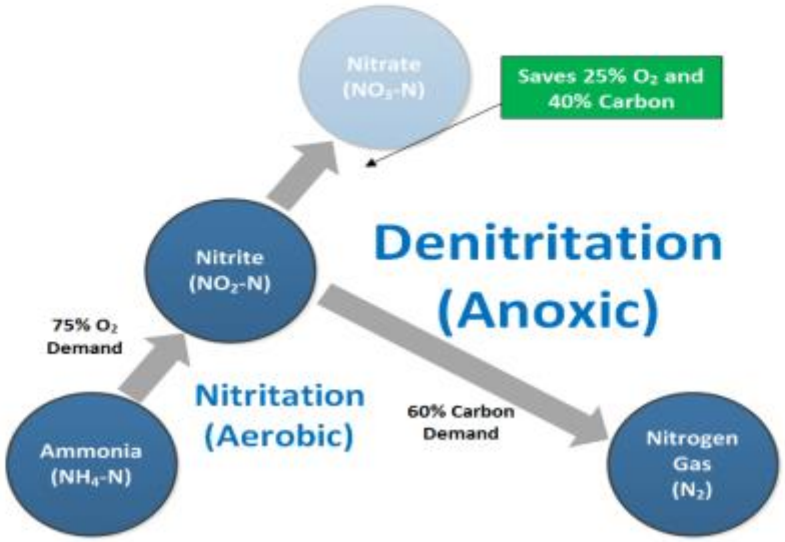


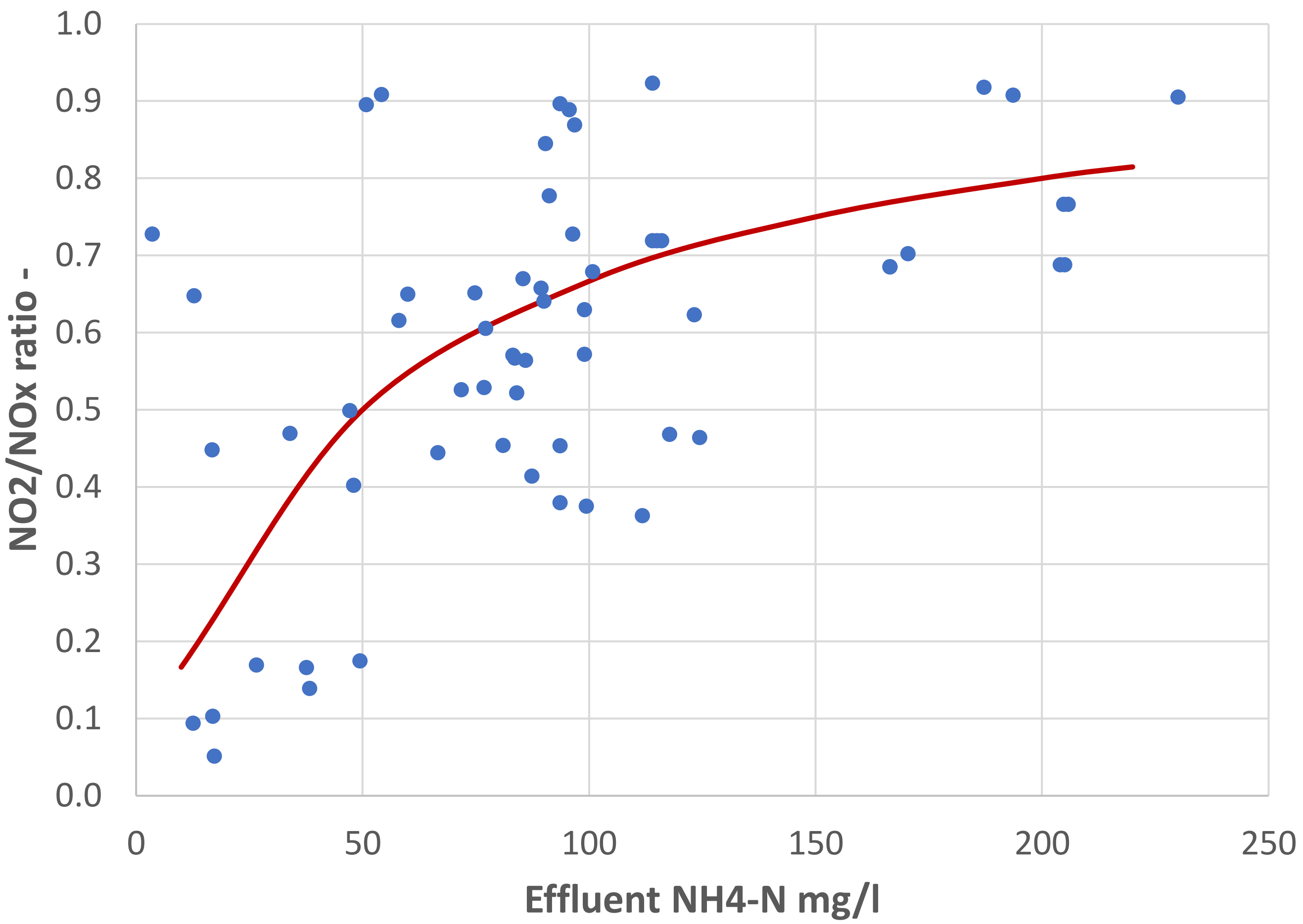
Source: WEF; WRF

Process

Nitritation over Nitrification

- 25% O_2 and 40% Carbon savings
- Anoxic conditions
- Avoid Nitrate accumulation





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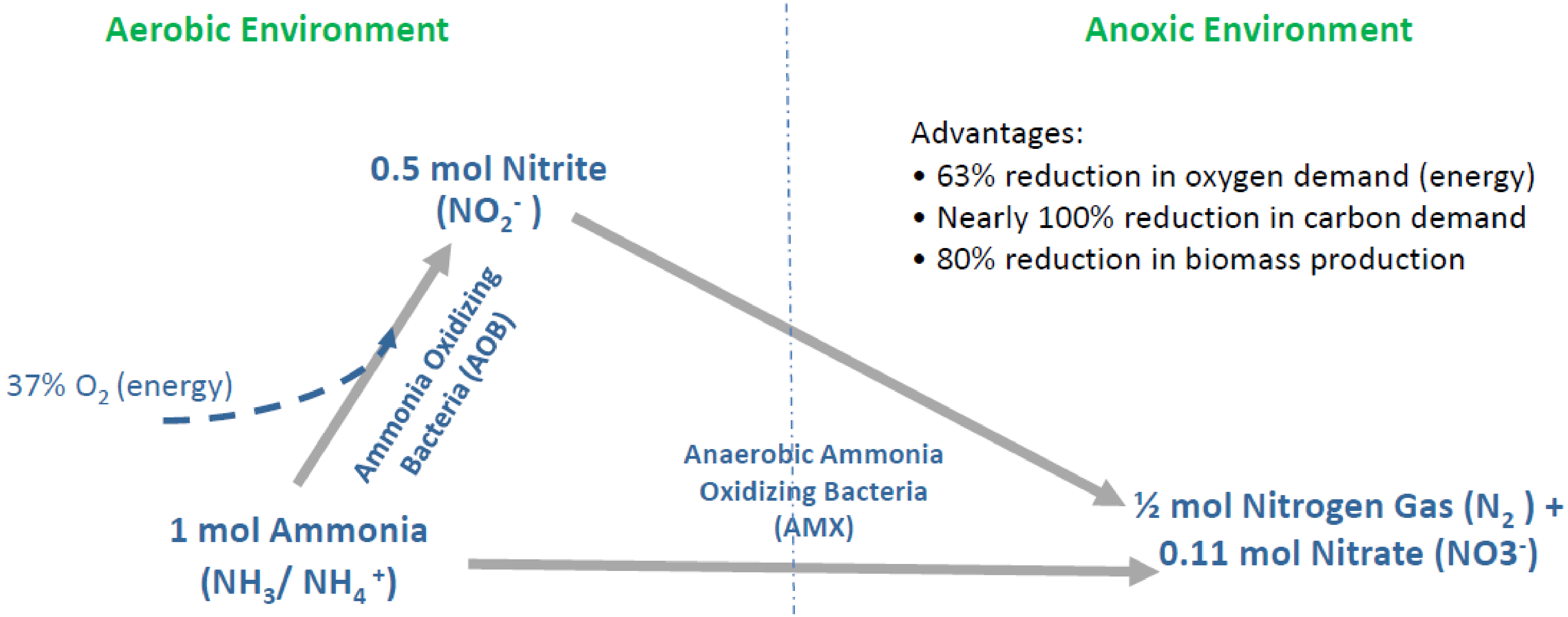
Competing processes

Partial Nitritation + Anammox = Deammonification

$$NH_4^+ + 1.32\ NO_2^- + 0.066\ HCO_3^- + 0.13\ H^+ \rightarrow 0.26\ NO_3^- + 1.02 N_2 + 0.066\ CH_2O_{0.5}N_{0.15} + 2.03\ H_2O$$



Advantages:

- 63% reduction in oxygen demand (energy)
- Nearly 100% reduction in carbon demand
- 80% reduction in biomass production

Competing processes

Parameter	MABR	Anammox (PN/A)
Outcome (claim to fame)	Controlled nitritation Additional step required for TN removal, with addition of carbon	TN removal, no carbon addition (often a two-stage process)
Volume rate (kg/d/m^3)	0.48	0.54
Energy consumption	100% of the ammonia oxidized to nitrite at 25% of conventional aeration energy due to MABR	50% of ammonia oxidized to nitrite through conventional aeration
Operational complexity factors	Practically none (biofilm process)	2-stage process, specific bacteria, pH sensitive, COD sensitive
Alleged stability	High	Low

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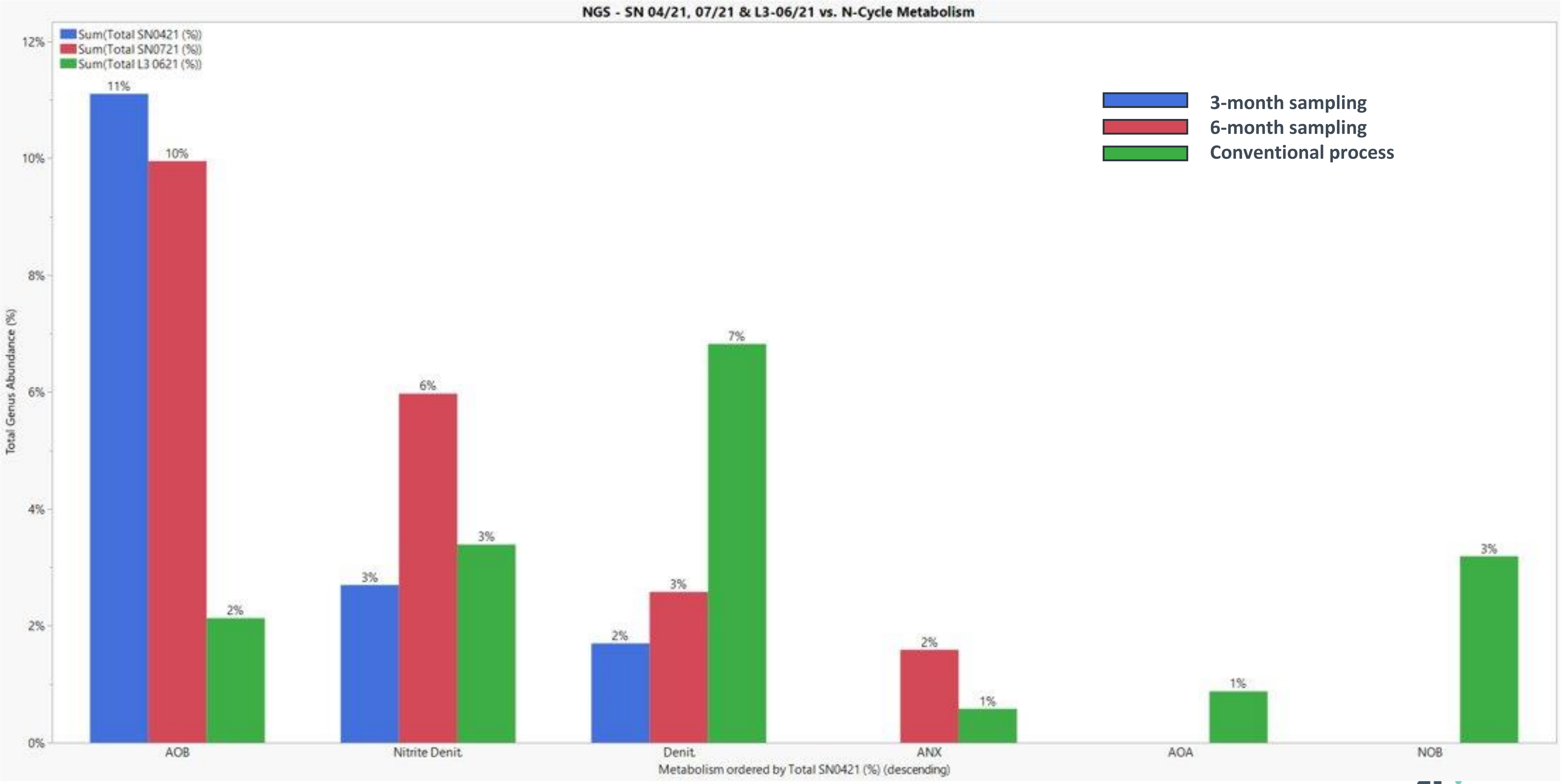
AOBs over NOBs



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Nitro advantages over competitive techs

- ✓ One-pass, continuous process
- ✓ No need for extensive mixing (part of the Aspiral / SUBRE modules)
- ✓ No need for biomass retention sieves/hydrocyclone/separators -> fixed film
- ✓ Low energy due to passive aeration
- ✓ Fixed film provides robust process (washout, load fluctuation)
- ✓ Anammox takes months to grow and stabilize + high degree of process control and maintenance

Energy Efficient

Uses 40% less energy than conventional nitrogen removal processes

Seamless

Non-invasive installation, one-pass, low maintenance, simple-to-operate,

Powerful

More than 90% TIN removal can be achieved. Eliminates up to 20% of total nitrogen load to the plant.

Robust & Resilient

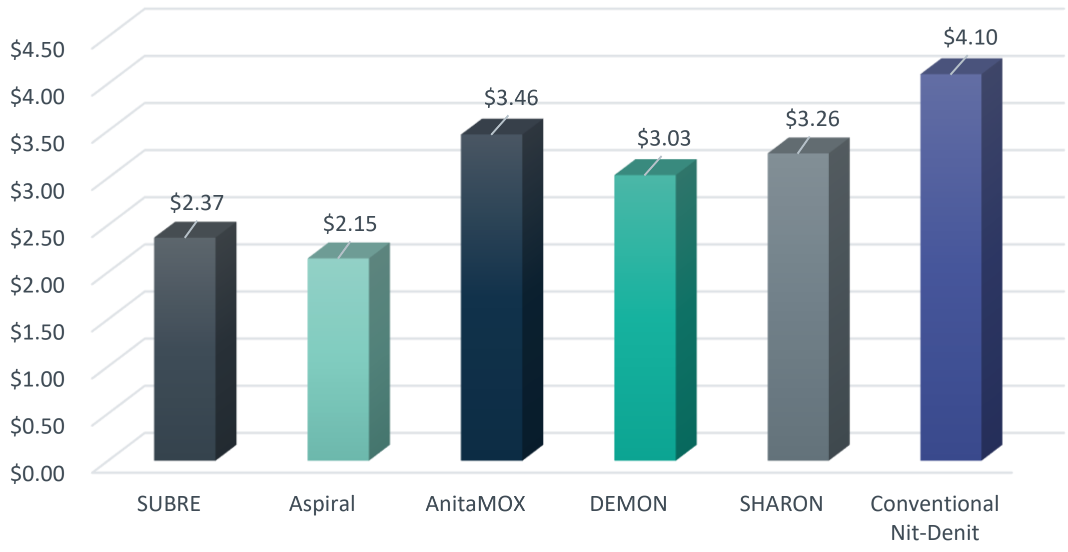
Biofilm process protects from load shocks and low temperature.

Sustainable

GHG emissions reduced, ultra-low energy.

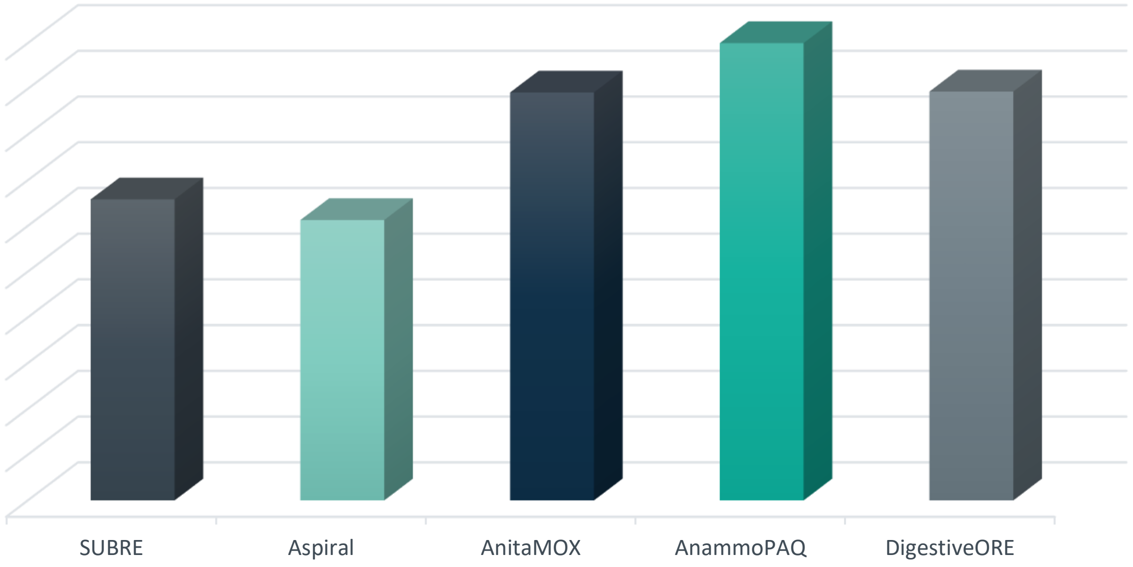
Cost comparison

Normalized NPC ($/kgN)



990 kg/d TKN, 90% removal application

Relative PV



253 kg/d TKN, 90% removal application

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Applications

- **Municipal**- Sidestream Nitrogen removal from AD centrate streams
- **Industrial**- high Nitrogen containing streams (landfill, compost, co-digestion, swine/cow farms, Fertilizer)
- **In conjunction** with AD solutions

Experience

- 2 Nitro full-scale pilots, 3 lab-scale systems
- Over 300 MABR plants sold globally since 2016.

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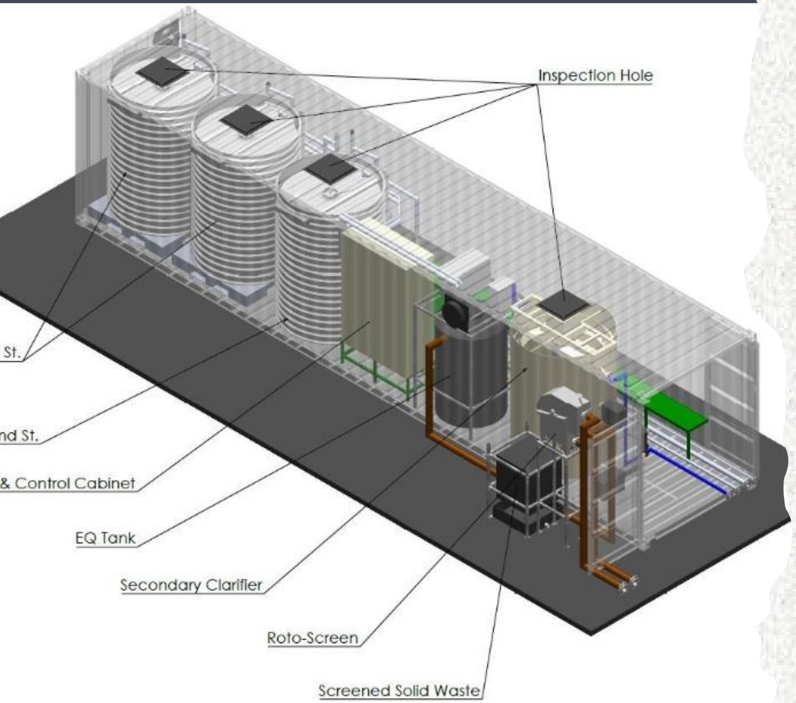
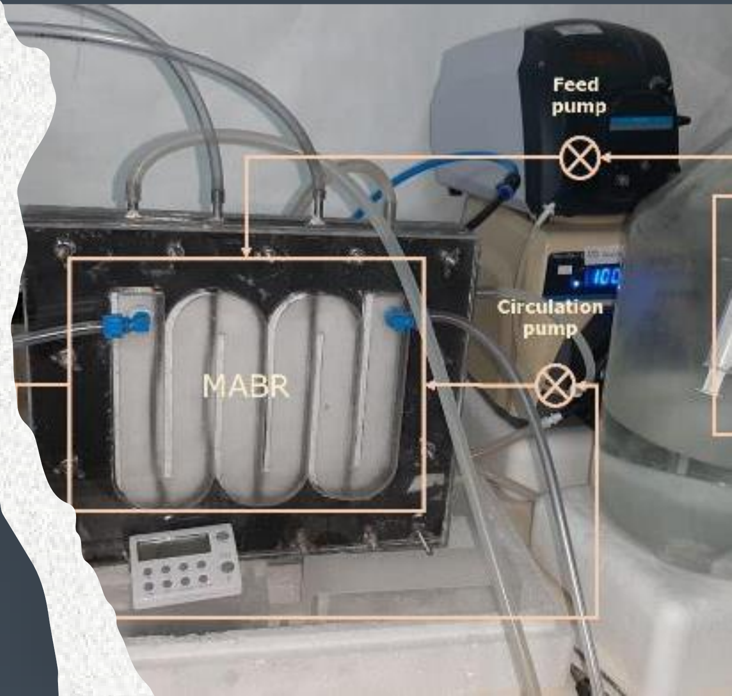

Inspection Hole
St.
nd St.
& Control Cabinet
EQ Tank
Secondary Clarifier
Roto-Screen
Screened Solid Waste

Questions? ??


Feed pump
Circulation pump
MABR

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