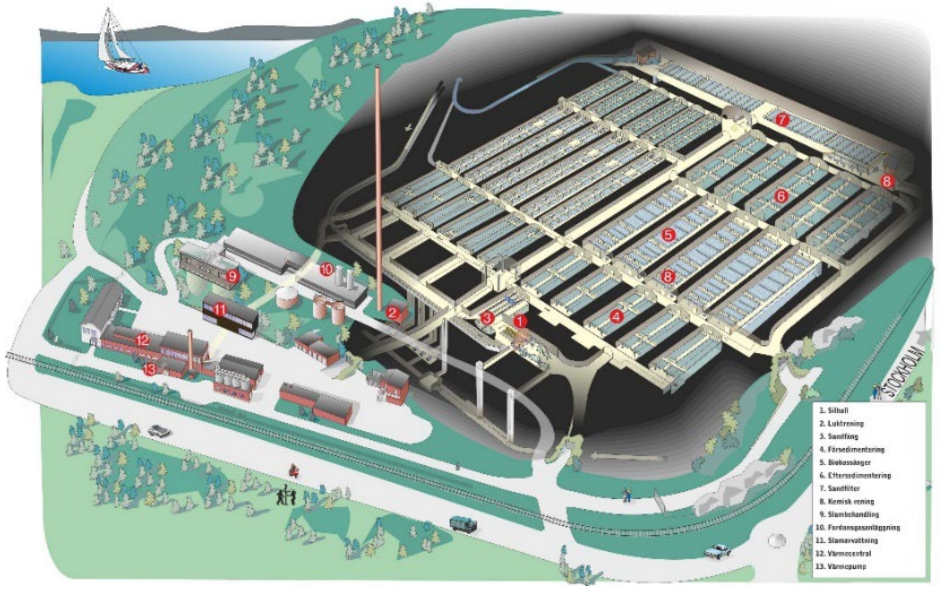
Grundlig utredning av framtida rejektvattenbehandling på Käppalaverket

Future reject water treatment at Käppala WWTP

Background

- Käppalaförbundet is an association of 11 municipalities
  - Lidingö, Danderyd, Nacka, Sigtuna, Sollentuna, Solna, Täby, Upplands-Bro, Upplands Väsby, Vallentuna och Värmdö.



The treatment plant

- Expansive phase at Käppala with great challenges
  - More strict discharge limits
  - Increased loading due to growth of population
  - Facility located in rock with small possibilities to expand

Parameter	Treatment today	Limits today	Limits future
Flow	1,7 m^3/s	-	**2,5 m^3/s***
BOD_7	< 2,0 mg/l	8 mg/l	**6 mg/l**
N-tot	8,2 mg/l	10 mg/l	**6 mg/l**
P-tot	0,16 mg/l	0,3 mg/l	**0,20 mg/l**
pe	465 000 pe	700 000 pe	**900 000 pe**

** Future flow, not a limit*

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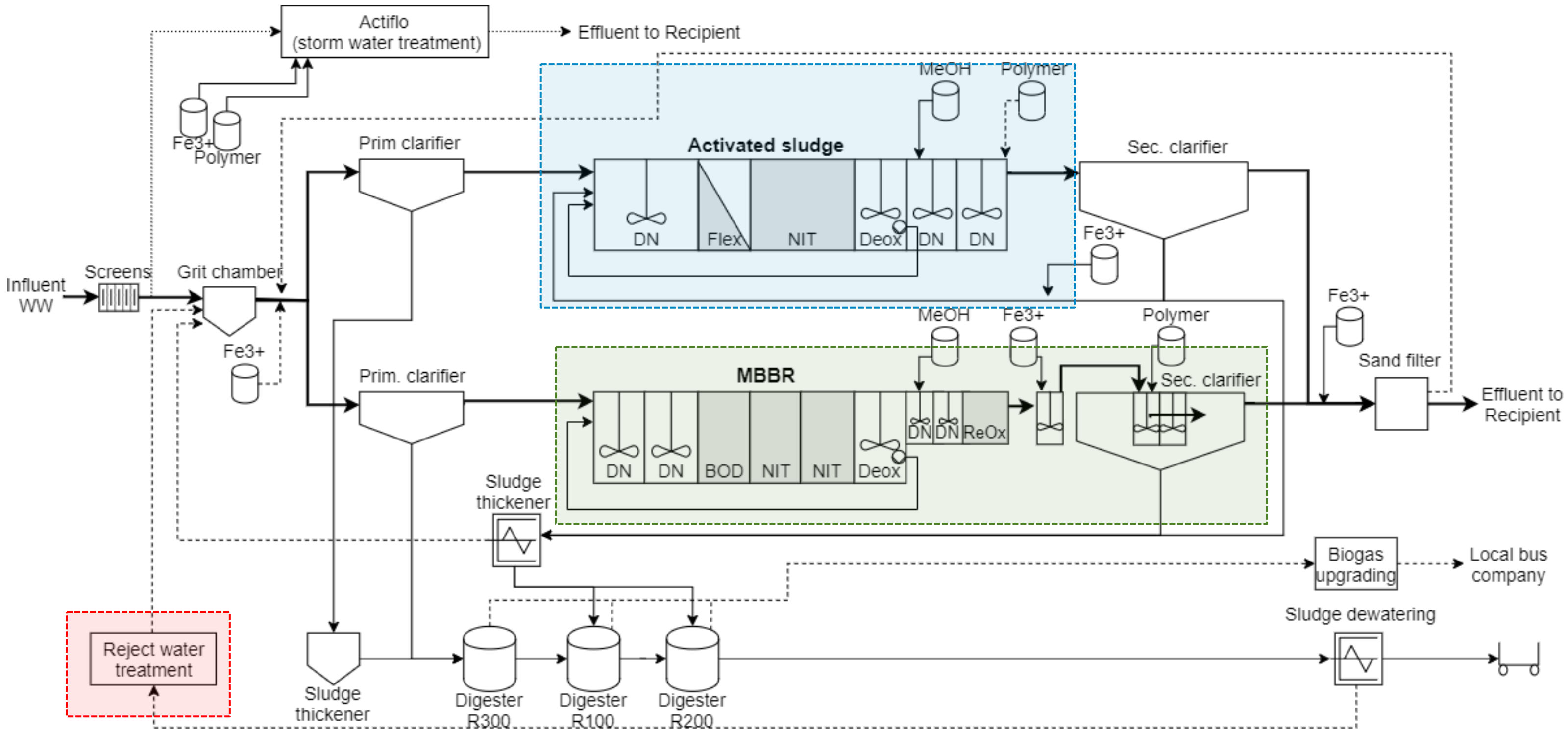
Future process description

- 20% of loading treated with AS
- 80% of loading treated with MBBR
- Pre denitrification combined with post denitrification with external carbon (methanol)
- Reject water treatment facility, planning phase



Process configuration from 2023

Process configuration from 2028

Planned need from 2032

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Steps throughout the feasibility study

Feasibility study

Step 1
- Historical data for prognosis
- Determination of design data

Step 2
- First selection of process configuration
- Screening of 10 techniques

Step 3
- Second selection of process configuration
- Detailing of 5 techniques

Step 4
- Detailing of the chosen process solution

Step 5
- Concluding report

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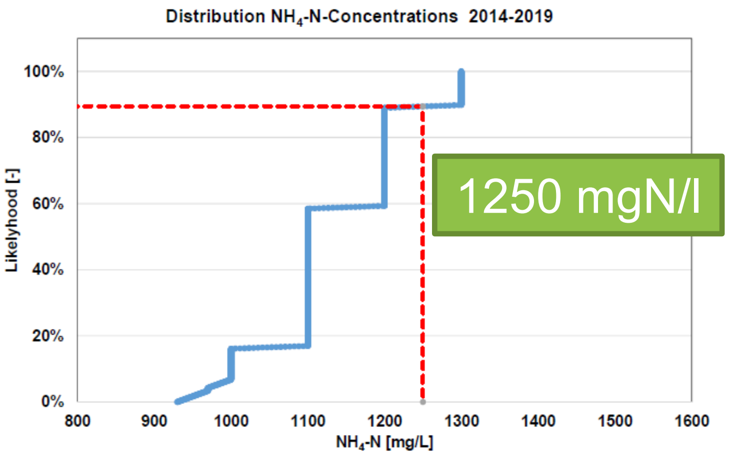
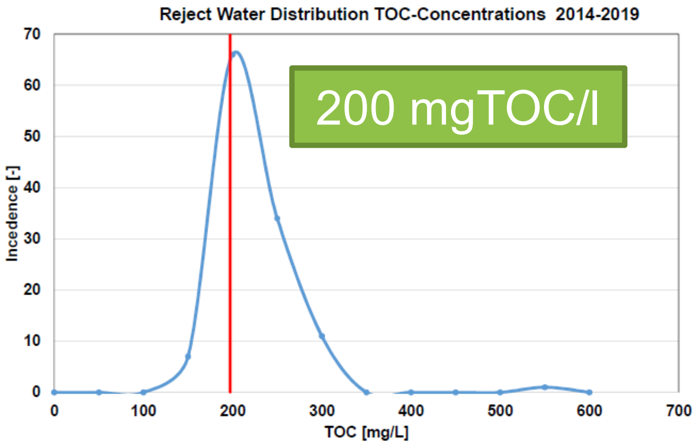
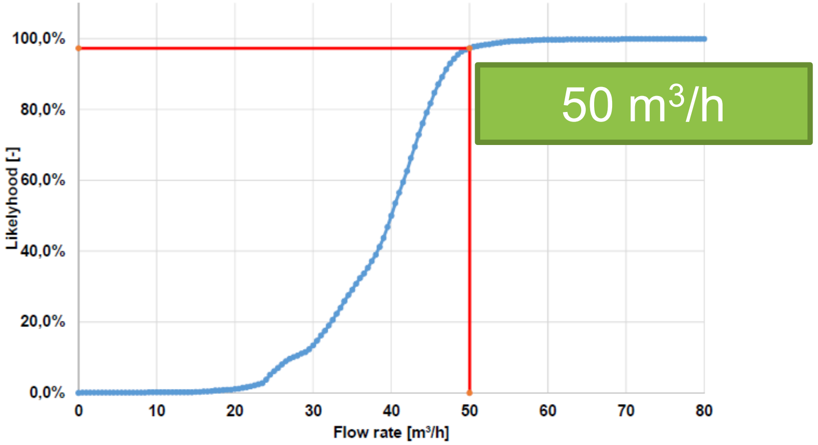
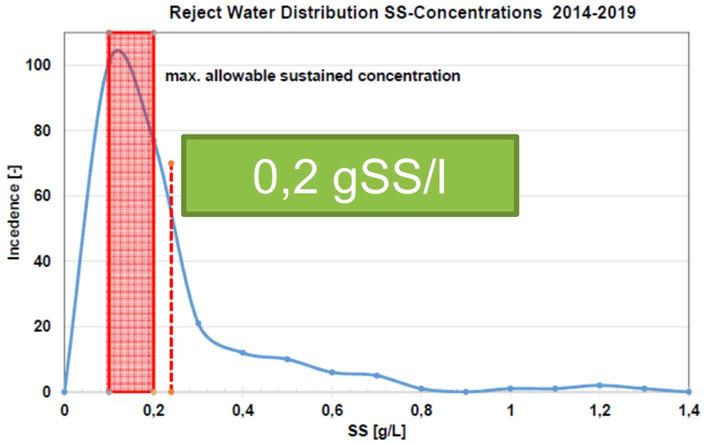
Step 1 – Design data

Historical data was used for design









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Step 1 – Design data

Uncertain prognosis – future sludge treatment?

1) Mesophilic digestion, sludge dewatering 25% DS
2) Thermophilic digestion, sludge dewatering 25% DS, load expects to increase 7,5%
3) Thermophilic hydrolysis, sludge dewatering 33% DS, load expects to increase 40%

Parameter	Unit	2018	2018	2050
Flow	m^3/h	50	50	87,5
NH_4-N	mg/l	1130	1582	1582*
NH_4-N	kg/d	1356	1898	3322
Sludge		1)	3)	3)

** Design for chemical-physical processes is based on a higher concentration, 1750 mg/l*

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Step 2 – First selection

	1	2	3	4a	4b	4c	5	6	7a	7b	8	9	10
Basic description	physico-/chemical process	physico-/chemical process	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification	Deammonification
Process description	Ammonia stripping and acid washing	membrane stripping	suspended sludge; Single-stage	suspended / granular sludge; Single-stage	suspended / granular sludge; Single-stage	suspended / granular sludge; Single-stage	suspended sludge, Two-stage	suspended sludge, Two-stage	suspended (granular) sludge, Two-stage	suspended (granular) sludge, Two-stage	fixed film, Single-stage	suspended sludge + fixed film, Two-stage	fixed film + suspended biomass
additional process description	air-stripping and acid washing in separate columns	Ammonia moving across a hydrophobic membrane separating acid and reject-water	sequencing-batch reactor (SBR)	sludge separation: hydrocyclone	sludge separation: lamella separator	sludge separation: settling tank	CSTR (continously stirred tank reactor) + SBR	quasi-continuous (intermittendly operated CSTR) + SBR	quasi-continuous (intermittendly operated CSTR) + reactor with settling tank	quasi-continuous (intermittendly operated CSTR) + reactor with lamella separator	Moving bed biofilm reactor (MBBR)	continously stirred tank reactor + Moving bed (MBBR)	Hybrid-system (IFAS):Moving bed (MBBR) + sludge separation (settling tank)
1.TN reduction > 70%	++	++	+	++	++	++	++	++	++	++	++	++	++
2. NH4-N reduction > 80%	++	++	+	++	++	++	++	++	++	++	++	++	++
3. Area footprint Alt 1 440m^2 + 760 m^2 Alt 2 440m^2 + 960 m^2 Alt 3 440m^2 + 960m^2	++	++	-	+	+	+	O	+	+	+	+	+	+
4. Height above groundlevel < 12 m	+	+	++	++	++	++	++	++	++	++	++	++	++
5a. TRL 8 – system complete and qualified	++	++	++	++	++	++	++	++	++	++	++	++	++
5b. TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)	++	O	++	+	+	++	++	++	++	+	++	++	+
7. Odor + open surfaces w/o strong odor ++ closed system	++	++	+	+	+	+	+	+	+	+	+	+	+
13. Chemical consumption	O	O	++	++	++	++	++	++	++	++	++	++	++
15. energy consumption	O	O	++	++	++	++	++	++	++	++	++	++	++
18. Process robustness	++	+	O	+	+	O	++	++	++	++	+	++	++
Brand		various Contractors for example: WABAG, Sustec, Kunst		EssDe	ANAMMOX					ANAMMOX	ANITA Mox	DeAmmon	ANITA Mox / IFAS
Patent Holder		Membrane: 3M Coating: Kunst		EssDe GmbH (former Demon AG)	Paques					Paques	Veolia	PURAC	Veolia

Step 3 – Second selection

Evaluation criteria

- Areal footprint
- Odor
- Other emissions (noice, N_2O)
- Ease of start-up
- Ease of operation
- Reliability
- Traffic (chemicals etc.)
- References
- LCC

	Variant-Number		1	4a	6	7b	10
	basic principle		physico-/chemical process	Deammonification	Deammonification	Deammonification	Deammonification
	process description		Ammonia stripping and acid washing	suspended / granular sludge; Single-stage	suspended sludge, Two-stage	suspended (granular) sludge, Two-stage	fixed film + suspended biomass
	additional process description		air-stripping and acid washing in separate columns	sludge separation: hydrocyclone	quasi-continuous (intermittently operated CSTR) + SBR	quasi-continuous (intermittently operated CSTR) + reactor with lamella separator	Hybrid-system (IFAS): Moving bed (MBBR) + sludge separation (settling tank)
Area	Area needed	m²	1000	1196	1145	1145	1017
	Smallest Area needed	m²	1000	1000	1000	1000	1000
	Quotient	-	100%	84%	87%	87%	98%
	Factor	-	15	15	15	15	15
	Points	-	15,0	12,5	13,1	13,1	14,8
Reliability			biomass	Biomass can make problems	process, Biomass can make problems	process, Biomass can make problems	problems, but fixed film more reliable than suspended biomass
	result	-	6	2	4	4	4
	Factor	-	6,0	6,0	6,0	6,0	6,0
	Points	-	36,0	12,0	24,0	24,0	24,0

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Step 3 – Second selection

Tabell 6. Summering av utvärdering.

Variant-Number	1	4a	6	7b	10
basic principle process description	physico-/chemical process Ammonia stripping and acid washing	Deammonification suspended / granular sludge; Single-stage	Deammonification suspended sludge, Two-stage	Deammonification suspended (granular) sludge, Two-stage	Deammonification fixed film + suspended biomass
additional process description	air-stripping and acid washing in separate columns	sludge separation: hydrocyclone	quasi-continuous (intermittently operated CSTR) + SBR	quasi-continuous (intermittently operated CSTR) + reactor with lamella separator	Hybrid-system (IFAS): Moving bed (MBBR) + sludge separation (settling tank)
Costs	25	100	88	88	79
Other Criteria	148	104	122	122	113
Total Points	173	204	210	210	192
Ranking	5	3	1	1	4

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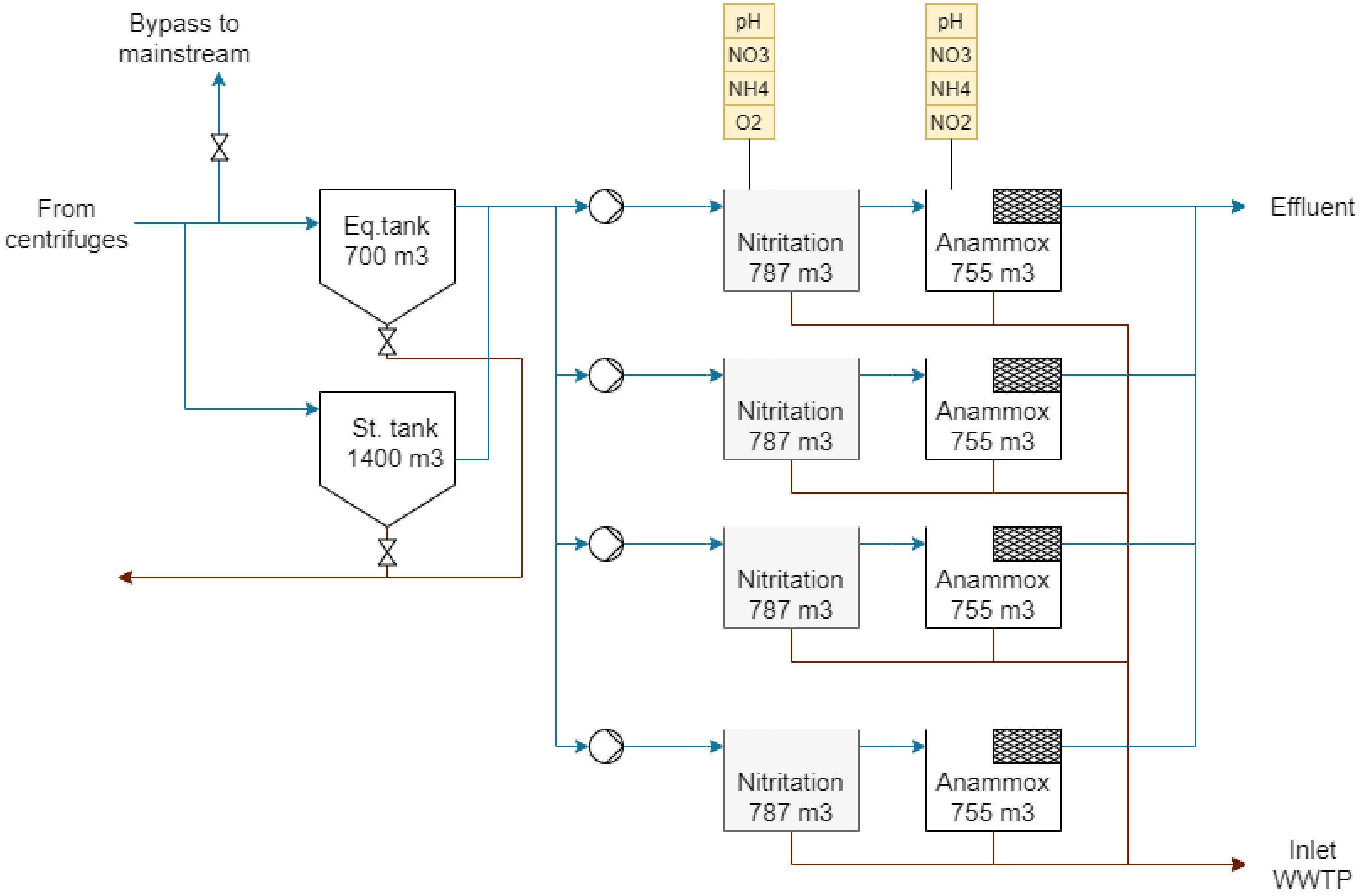
Step 4 – Process design of selected process



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Step 4 – Process design of selected process

Cost parameter		SEK
Construction		53 200 000
Machine		26 150 000
Electric and automation		10 460 000
Heating, Water and Sanitation (VVS)		3 780 000
Sum Construction		**93 590 000**
Unforseen	15%	14 040 000
Project planning	20%	**21 530 000**
Sum investment		**129 150 000**

Cost parameter	SEK/year
Maintenance	1 700 000
Electric power	1 700 000
Heating	120 000
Staff	1 000 000
Sum operating cost	**4 520 000**

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Next phase – What happens now?

- Reject water treatment is paused at the moment
  - The need is not urgent right now
  - Wait for sludge directive
  - Verify new capacity at Käppala WWTP MBBR
  - Compare incoming load with projected prognosis

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Questions?

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