Pilot scale studies on the forthcoming world's largest MBR facility

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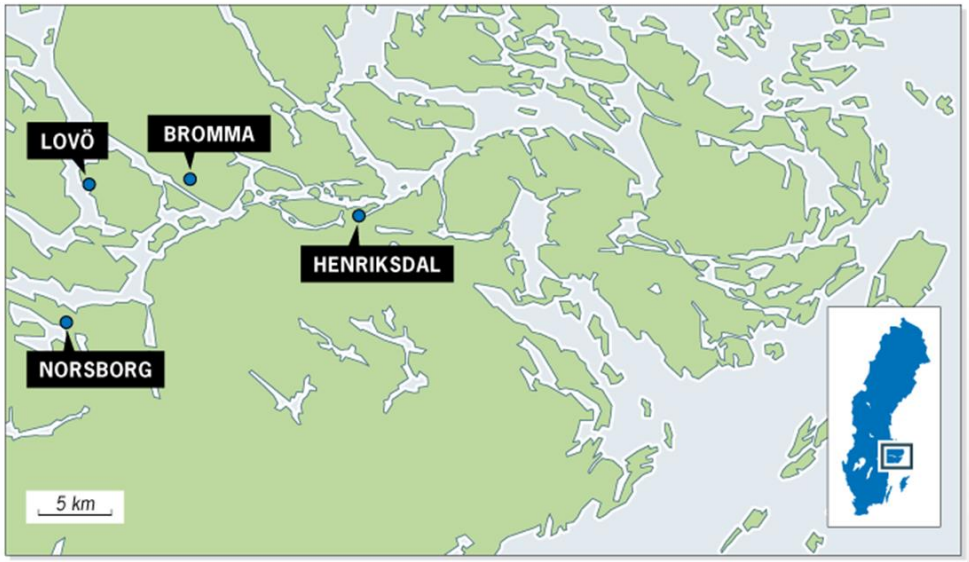
Current situation in Stockholm WWTP

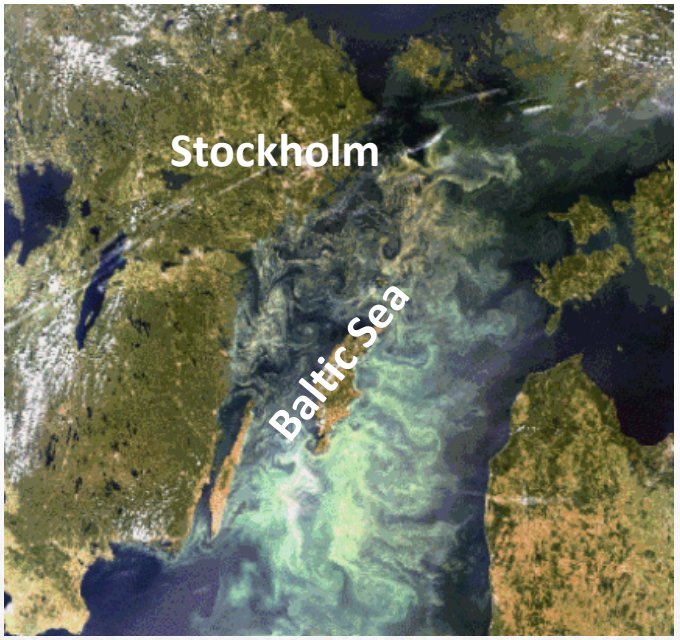


- Connected
  - HENRIKSDAL: 753 000 pe
  - BROMMA: 312 000 pe
- Average flows
  - HENRIKSDAL: 240 000 m^3/d
  - BROMMA: 120 000 m^3/d

- **Total**
  - No of connected: **1 065 000 pe**
  - Average flow: **360 000 m3/d**

Challenges in Stockholm WWT

- **More stringent effluent requirements** regarding nitrogen and phosphorous expected according to Baltic Sea Action Plan (BSAP) and EU Water Framework directive (WFD 2000/60/EEG)
- 1-1.5% **increase in population** per year => 1.6 million connected year 2040
- Modern, long lasting and sustainable solution with option for additional polishing steps



Limits at Henriksdal WWTP

- Space limitations (underground, in city location)
- Large unused capacity in biological treatment:
  - 209 000 m^3 in aeration basins.
  - Increased sludge content can double the organic load.
- Secondary sedimentation limiting for both hydraulic and organic load:
  - 11 000 m^2
  - Improved separation increases capacity

Stockholm's future WWTP – the largest MBR

- Pre-requisites for membrane technology given
  - Limited space for extension ✓
  - Increased load ✓
  - More stringent requirements on effluent ✓
  - Sensitive recipient ✓

Therefore…

- Membrane separation will replace the post-sedimentation step at Henriksdal WWTP
- Bromma WWTP will be shut down
- Sewage tunnel from Bromma WWTP to Henriksdal WWTP

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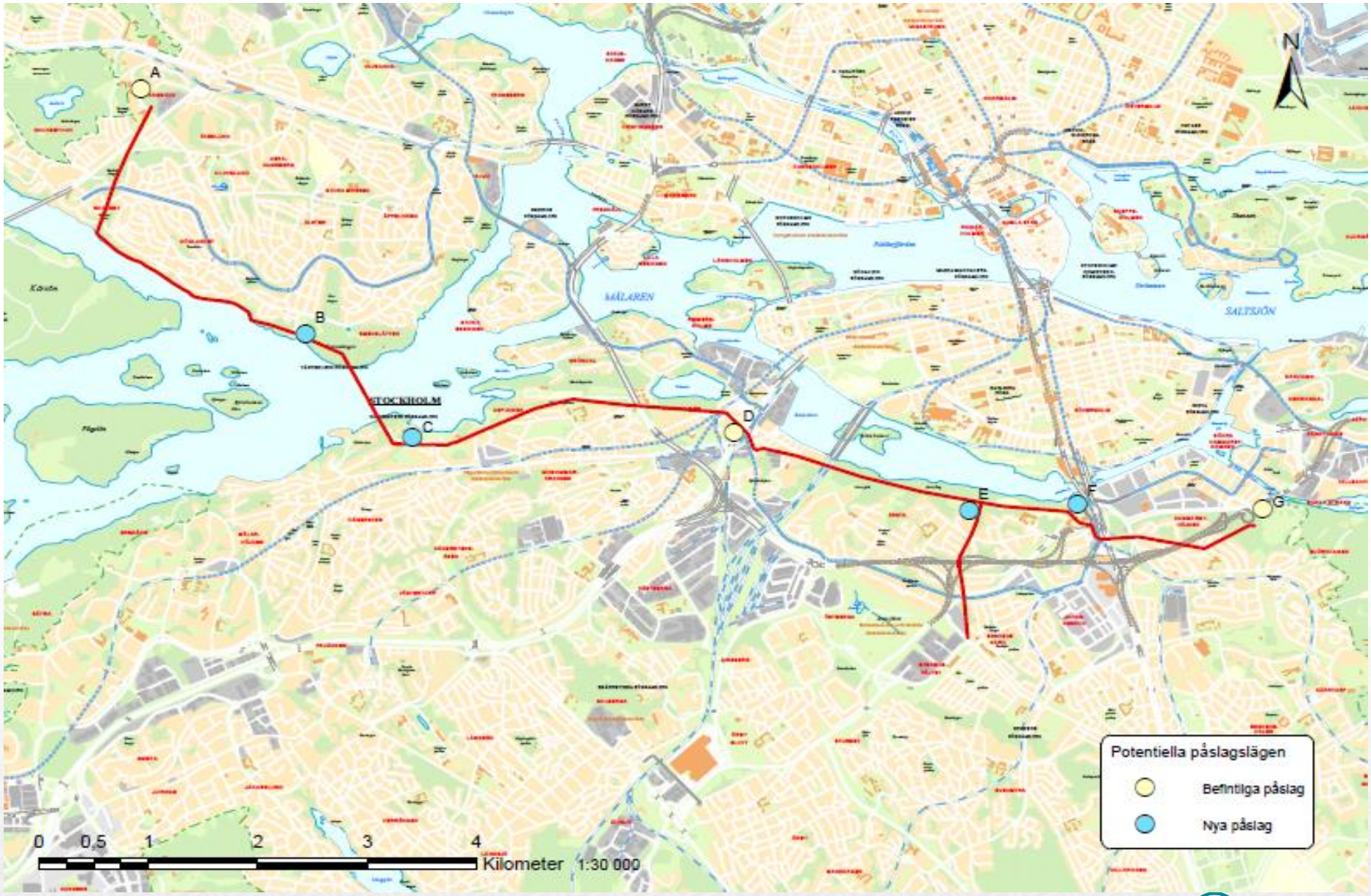


New tunnel from Bromma WWTP, across Stockholm, connecting to Henriksdal WWTP.

Pilot scale studies prior to implementation

- Pilot scale studies at R&D facility **Hammarby Sjöstadsverk** in Stockholm
- Using **same influent** as Henriksdal WWTP
- The **treatment line is an almost identical copy** of Henriksdal WWTP, today and in the future (0.014% of biological volume Henriksdal WWTP)
- Running since September 2013, currently finalising year No.2

Hammarby Sjöstadsverk

- Unique facility for R&D and high quality demonstration
- Collaboration between researchers, industry and social stakeholders to develop future water treatment technologies
- Part of Sweden Water Innovation Center (SWIC)
- Also see: www.hammarbysjostadsverk.se

The aim of the pilot scale studies

- Show function and operation stability; i.e. that the process **can handle future effluent targets** in the Stockholm region
- Provide information on options and possibilities for the **full-scale Henriksdal WTTP process design**, and how these options effect the treatment efficiency
- Receive **operational experience** from a membrane unit; level of needed operation and maintenance, problems that can occur, etc.
- Study **possible secondary effects**, such as greenhouse gas emissions, polishing steps, sludge properties, cleaning possibilities, etc.

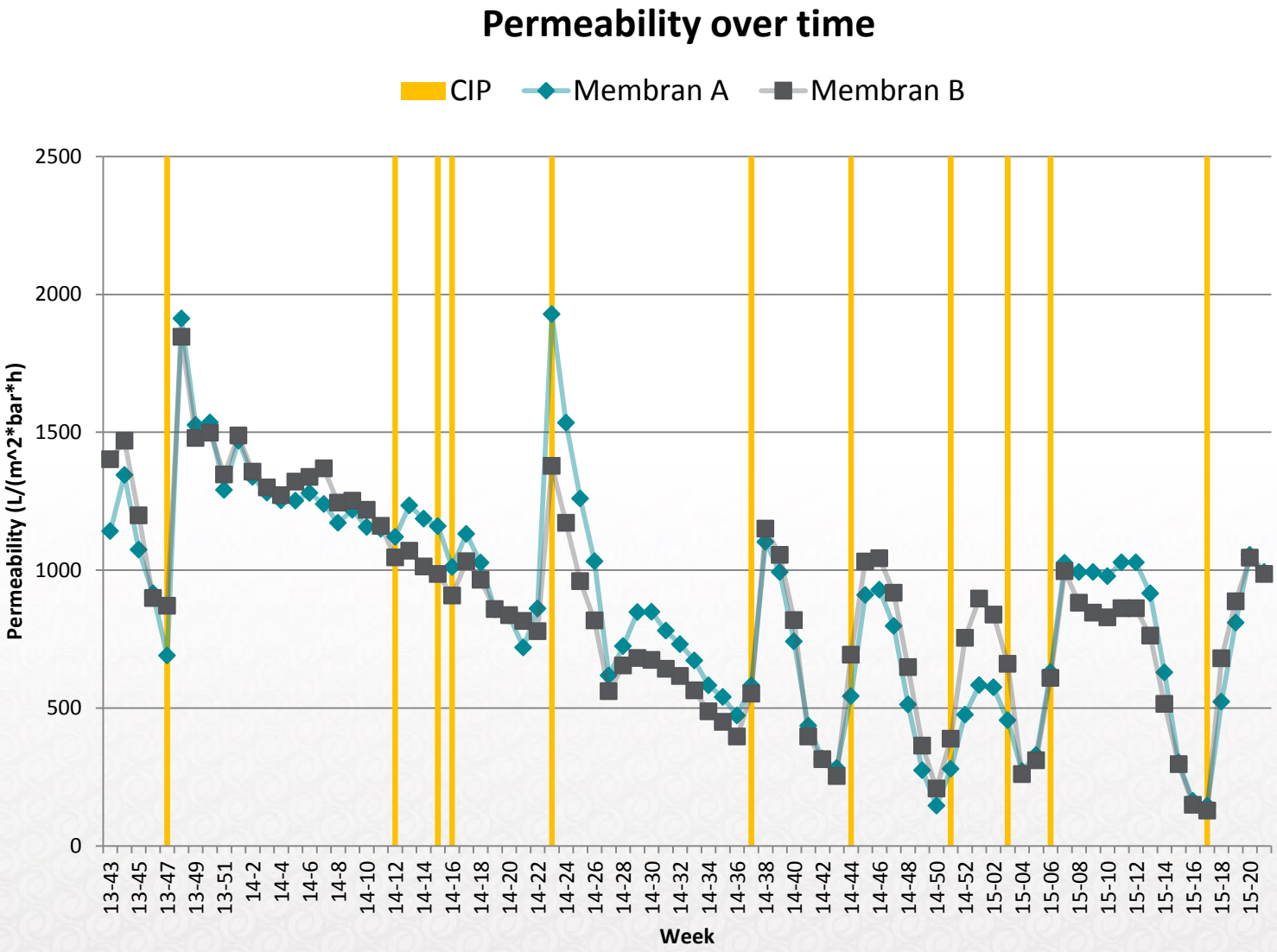
Results and experiences so far

- Stable operation
- Capacity better than expected
- Reaches effluent targets for both nitrogen and phosphorus, even at high loads
- High removal of suspended solids
- Promising results with complementary treatment O_3 & GAC
- Biofilm growth on permeate side

But…

- The type of precipitation chemical used, where it is added and in which amount have a big effect on the fouling of the membranes
- More cleaning of membranes than expected

Official report from the first year (Sep 2013 – Sep 2014) of the project available at www.ivl.se (NR B 2215).


Permeability over time
CIP
Membran A
Membran B
Permeability (L/(m^2*bar*h)
2500
2000
1500
1000
500
0
13-43
13-45
13-47
13-49
13-51
14-2
14-4
14-6
14-8
14-10
14-12
14-14
14-16
14-18
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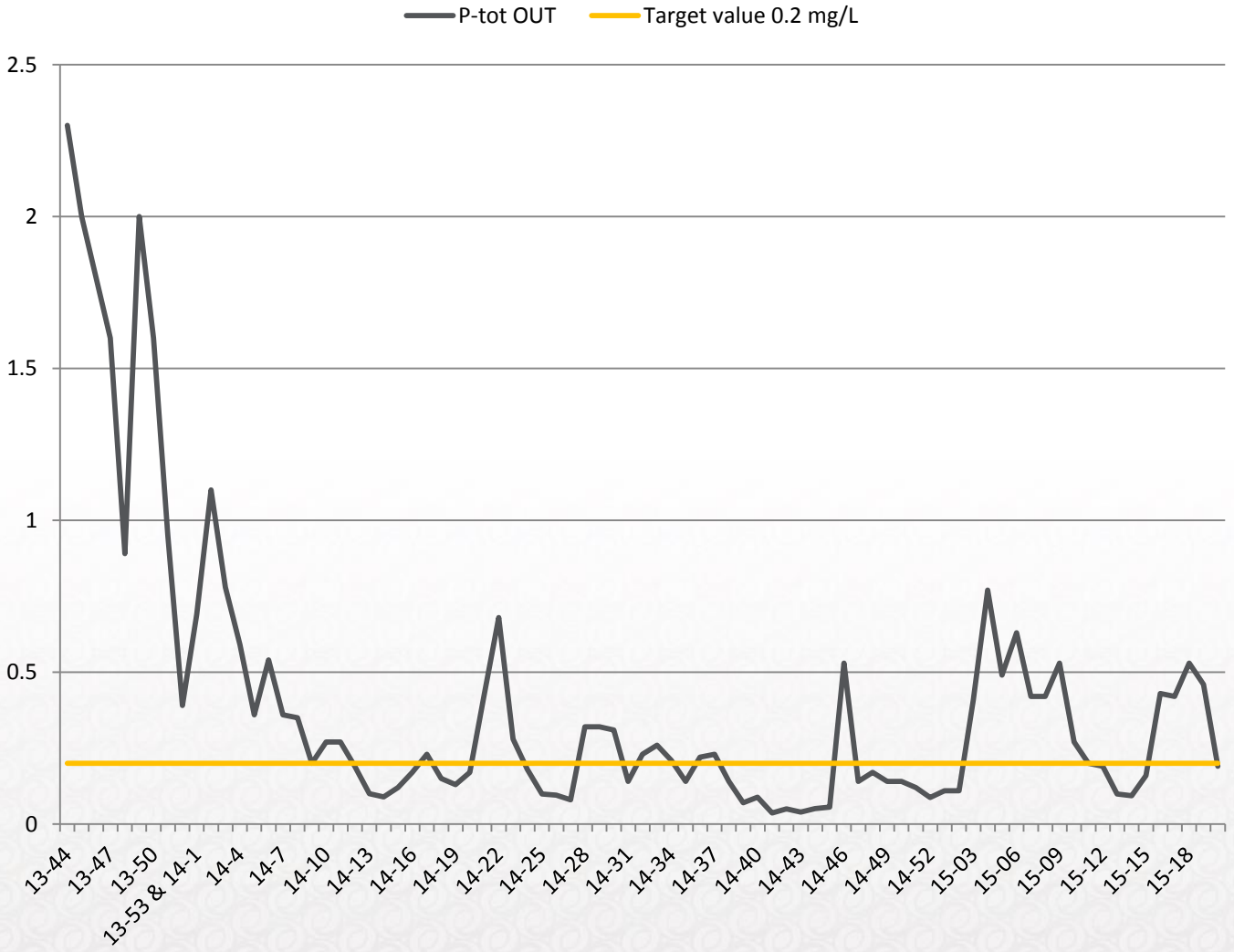
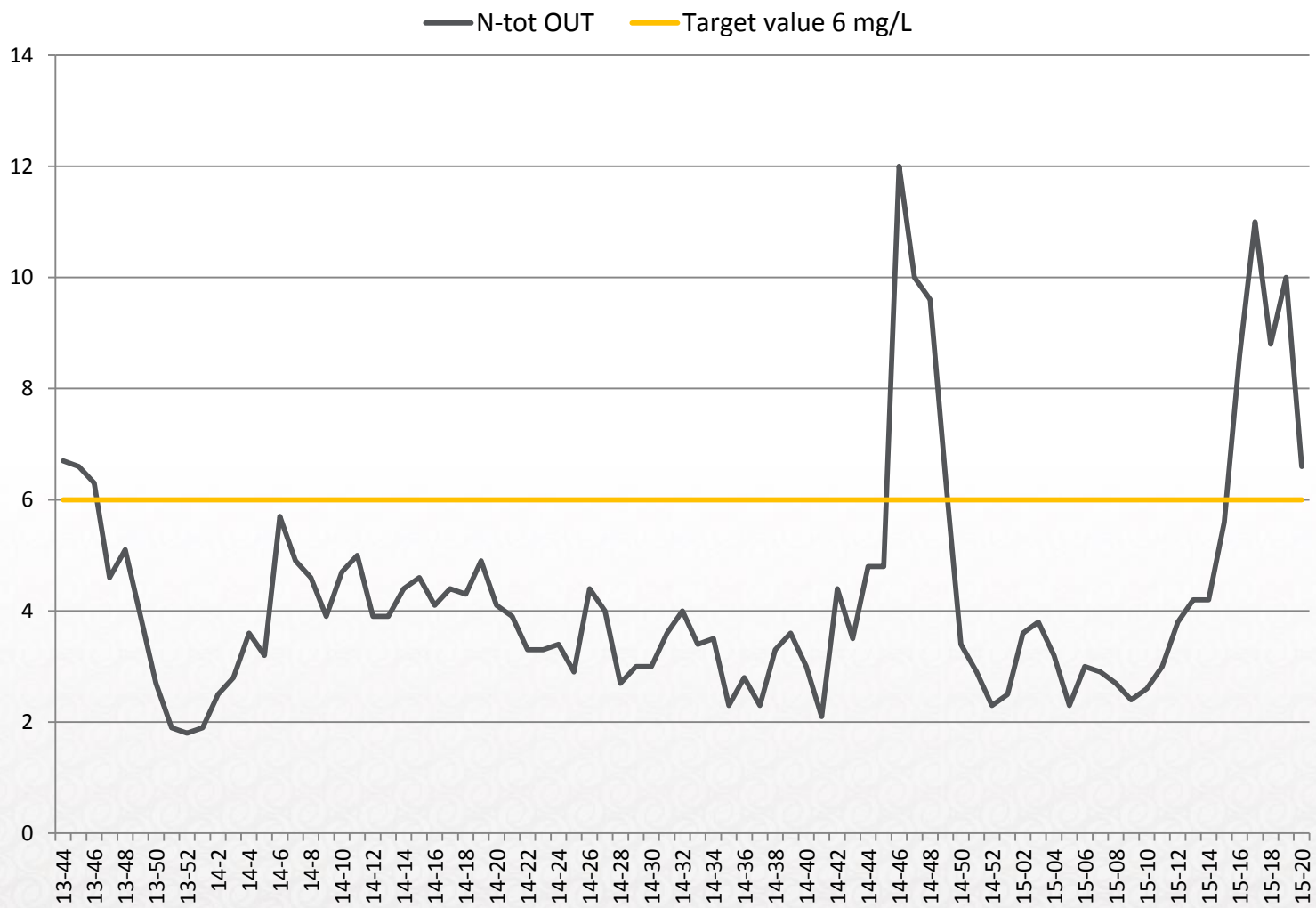
14-38
14-40
14-42
14-44
14-46
14-48
14-50
14-52
15-02
15-04
15-06
15-08
15-10
15-12
15-14
15-16
15-18
15-20
Week

P-tot


P-tot OUT
Target value 0.2 mg/L
2.5
2
1.5
1
0.5
0
13-44
13-47
13-50
13-53 & 14-1
14-4
14-7
14-10
14-13
14-16
14-19
14-22
14-25
14-28
14-31
14-34
14-37
14-40
14-43
14-46
14-49
14-52
15-03
15-06
15-09
15-12
15-15
15-18

N-tot


N-tot OUT
Target value 6 mg/L
14
12
10
8
6
4
2
0
13-44
13-46
13-48
13-50
13-52
14-2
14-4
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15-18
15-20

Further upgrading of pilot plant

- Current upgrading of pilot plant to even further imitate the full scale Henriksdal WWTP (finished by end of 2015)
  - Implementation of deox-zone for recirculating sludge
  - Implementation of pre-aerated precipitation step prior to pre-sedimentation
  - Change of membranes from flat sheet to hollow fibre
  - Cooling of wastewater temperature to simulate different conditions

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Future work using the pilot (2015-)

- Continuous studies on phosphorous precipitation and its effect on membrane fouling
- Optimisation of flux and aeration on MBR
- Optimisation of membrane cleaning (incl. studies on the release of AOX during cleaning)
- Studies on sludge properties, biogas potential etc.
- Studies on MBR effluent; pharmaceutical residues, pathogens, and microscopic debris particles
- Measurements on greenhouse gas emissions
- Study the effect of very high sludge loads (>20.000 mg/L)
- Addition of pulverised activated carbon (PAC) in MBR
- Report on project year No.2 during autumn 2015
- Etc.

THANKS!

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