hoogheemraadschap
Hollands
Noorderkwartier

Ozonation of effluent from wwtp Wervershoof

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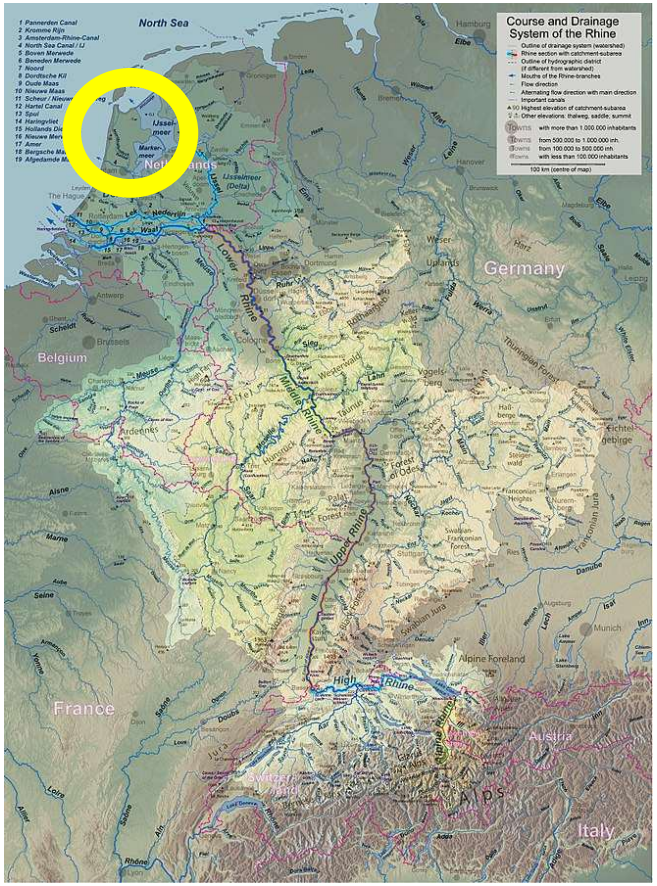
Motivation

Dutch ministry infrastructure and water (I&W):

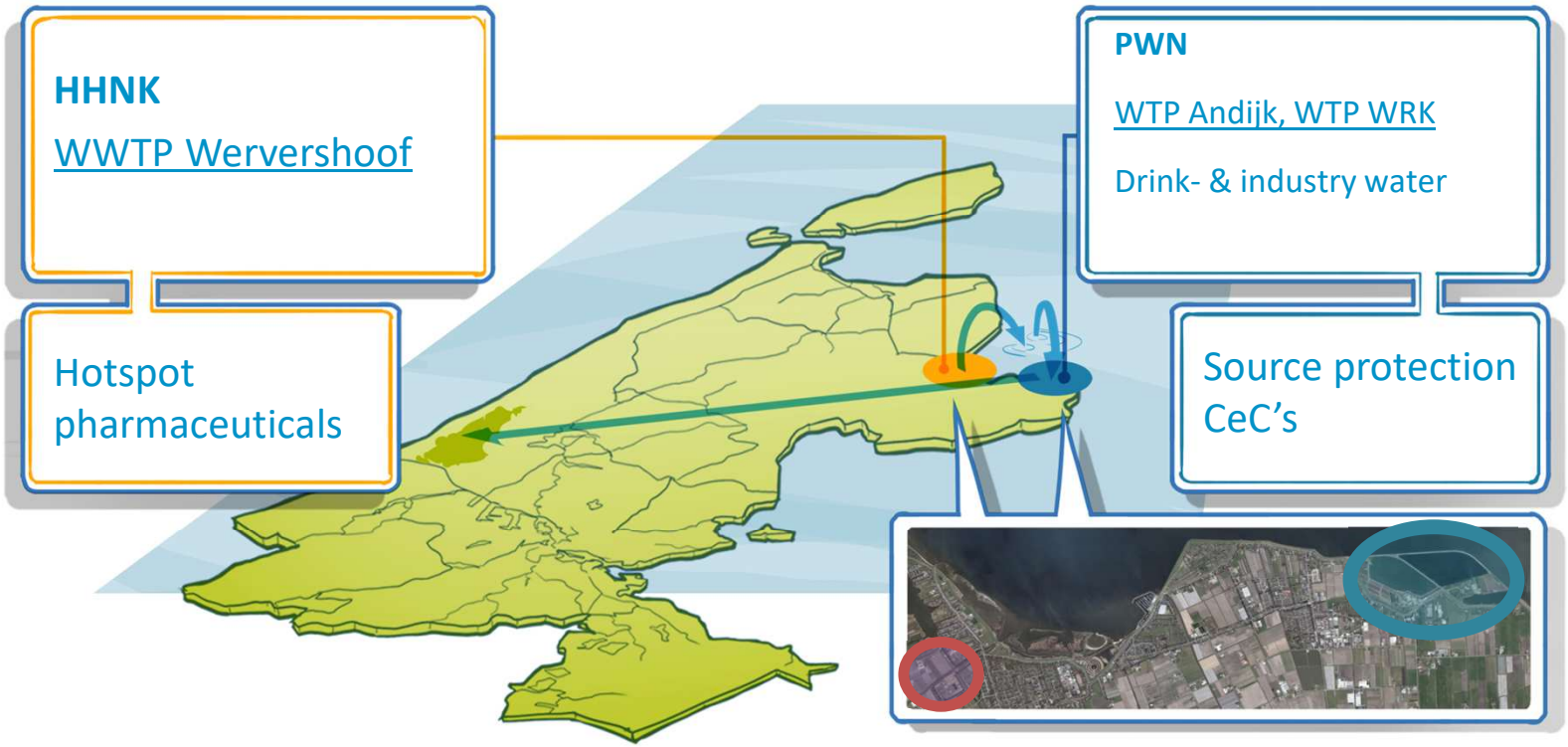
- Industry wide approach for pharmaceutical control in Dutch delta
- Update EU's urban wastewater treatment directive, including micropollutants

Research partners:

- Water Authority
  Hoogheemraadschap Hollands Noorderkwartier
- Drinking water company
  PWN
- PWNT



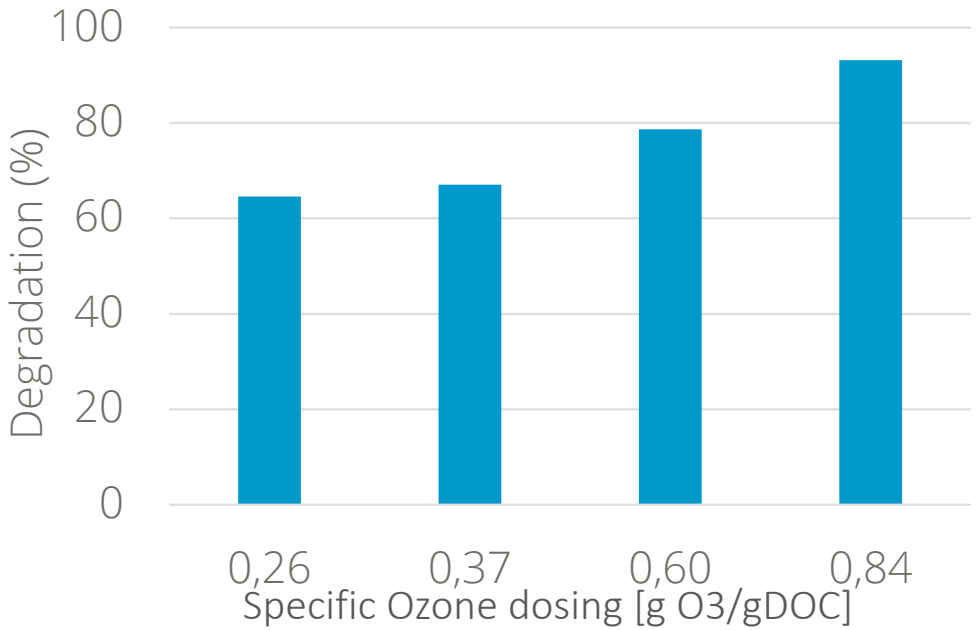
Collaboration objectives



Approach: ozonation based on drinking water experiences

Bench scale bubble column ozonation

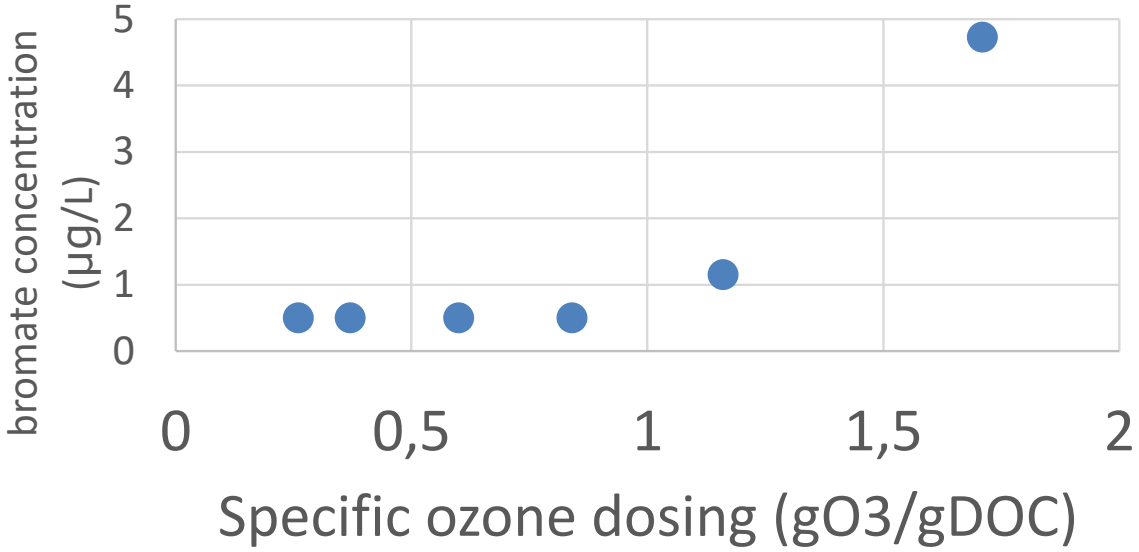
Compound
Carbamazepine
Diclofenac
Hydrochlorothiazide
Propranolol
Sotalol
Sulfamethoxazole
Trimethoprim

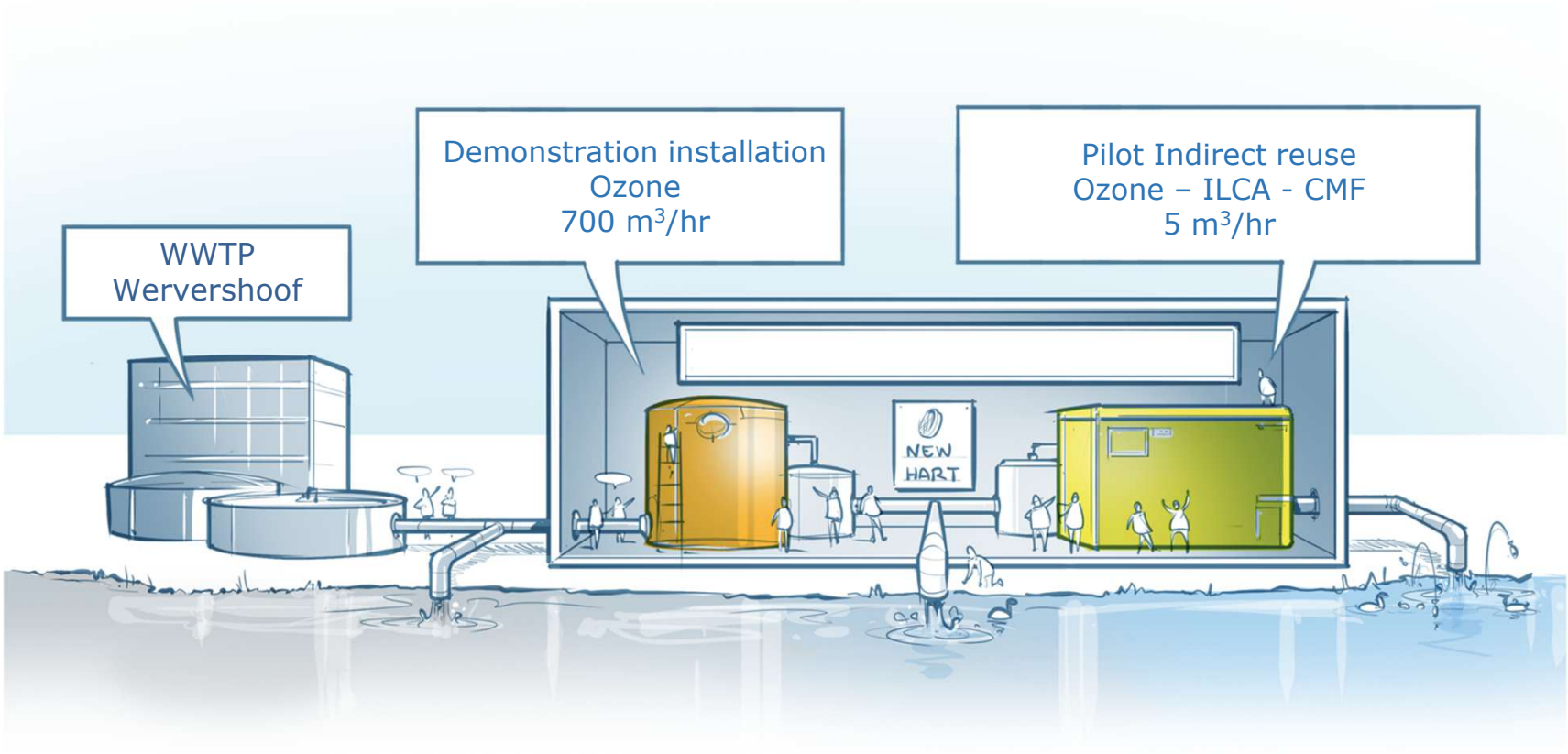


Approach: ozonation based on drinking water experiences

Bench scale bubble column ozonation

Detection limit bromate 0,5 µg/L; bromide 300 µg/L

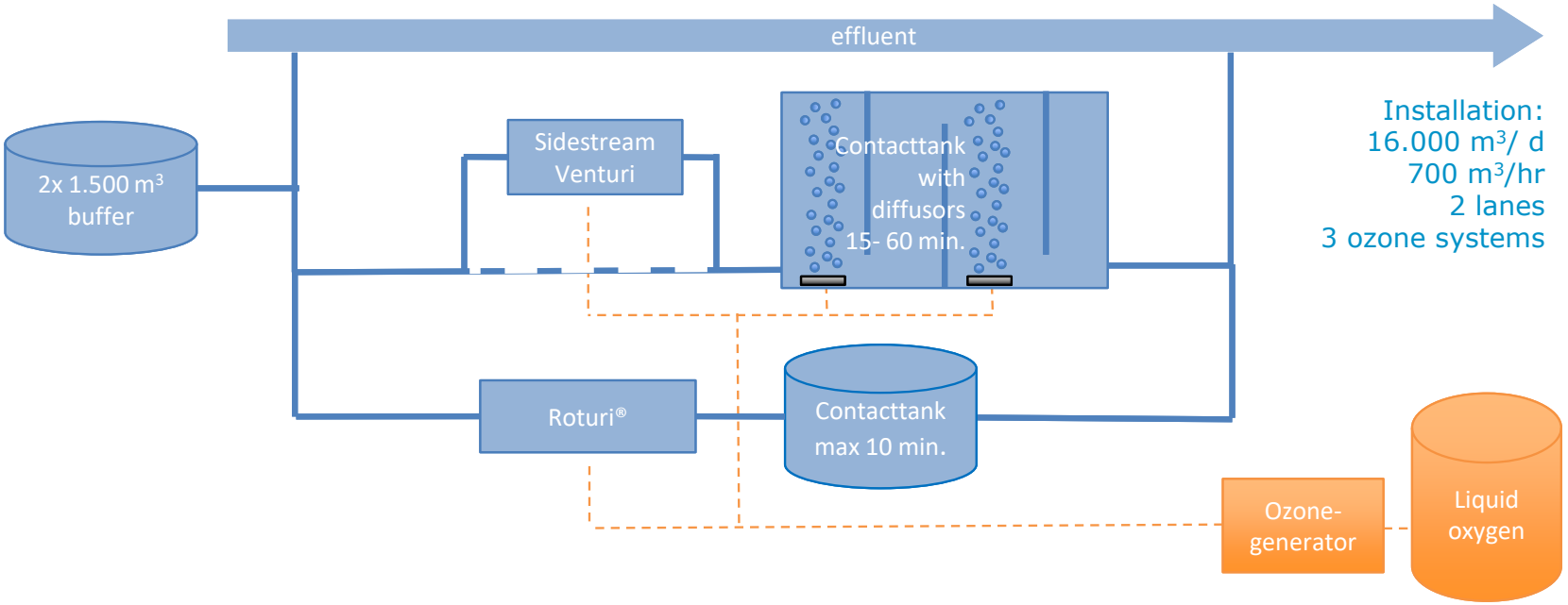



WWTP
Wervershoof
Demonstration installation
Ozone
700 m3/hr
Pilot Indirect reuse
Ozone – ILCA - CMF
5 m3/hr
NEW
HART

Ozone plant Wervershoof (demonstration scale)

- 700 m^3/h effluent of a conventional biological wastewater treatment plant
- 3 ozonation systems
  - Venturi (sidestream)
  - Roturi
  - Diffusers
- Removal of 70% of 7:11 micropollutants
- In operation for 10 years

Wwtp Wervershoof
300.000 p.e.
35.500 m3/d dry weather

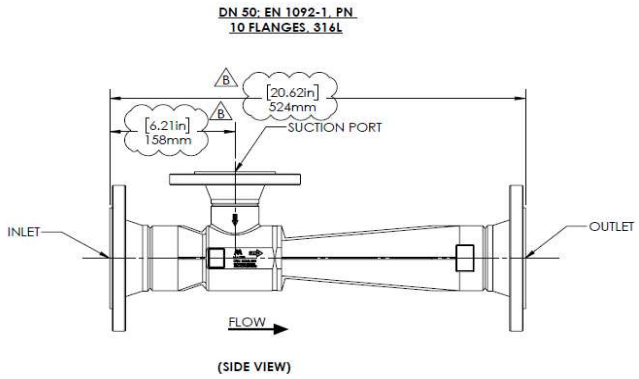


Installation:
16.000 m³/ d
700 m³/hr
2 lanes
3 ozone systems

Venturi

Validation tests / startup

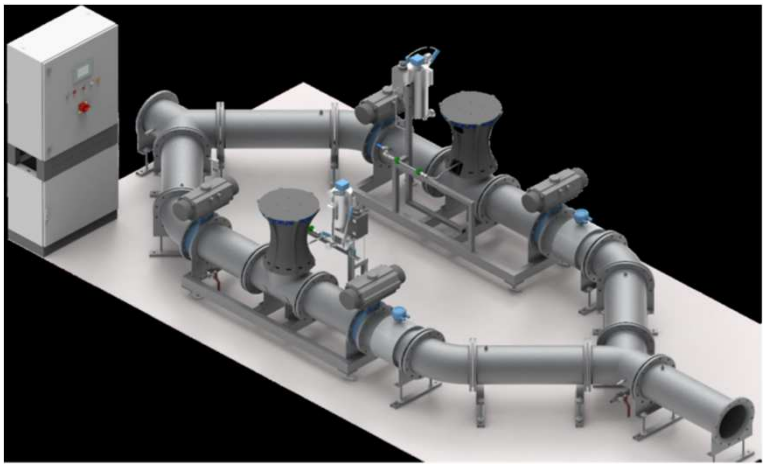
- Measure residual ozone concentration and relate with bromate formation
- Ozone dose per water volume
- Fixed sidestream to mainstream ratio



Roturi

Validation tests / startup

- Measure residual ozone concentration to avoid bromate formation
- Ozone dose per water volume

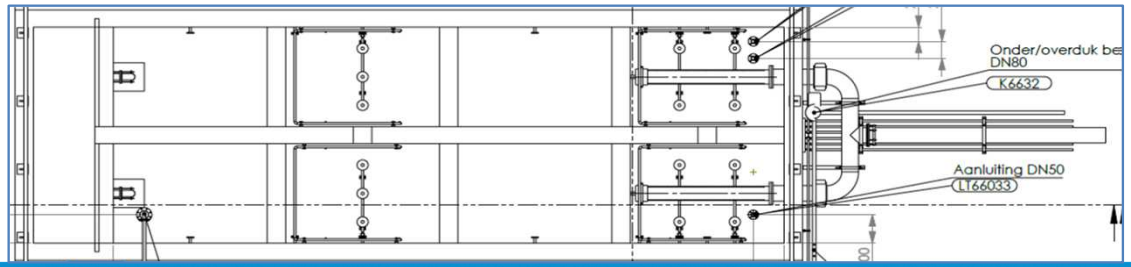


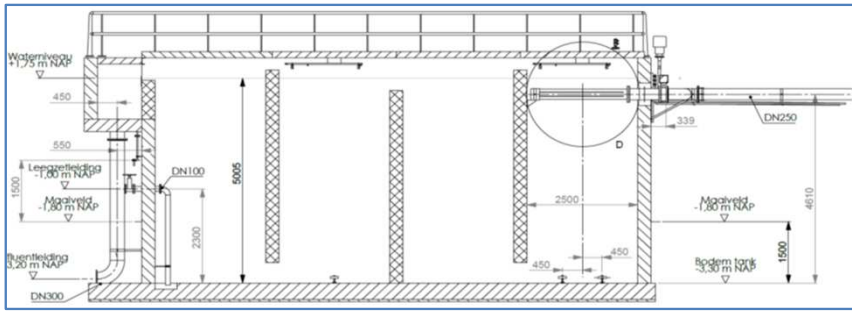
- Possible application of ultrasonic unit in the future

Diffusers

Validation tests / startup

- Measure residual ozone concentration to avoid bromate formation
- Ozone dose per water volume
- Multi-point ozone dissolution in compartment 1 and 3 (out of 4)





Demonstration installation first two years

Comparison 3 different ozone dispersion systems

- Efficiency in degradation of micropollutants
- Bromate formation
    - Dutch surface water limit 1 µg/L bromate
    - Bromide in wwtp effluent 200-400 µg/L bromide
- Energy consumption

Research focus Water Authority HHNK:

- Digital twin
- Reuse applications
- Ultrasonic modules in Roturi lane
- Influence of biological wwtp f.i. ammonium concentration
- Antibiotic resistance genes
- Physical-chemical wwtp

Summary Performances

	UNIT	PACAS	Ozone + Sand Filtration	Ozone Wervershoof
CO_2-footprint [1]	g CO_2/m^3	122	128	137
Costs [1]	€/m^3	0,05	0,17	
Removal Efficiency Dutch guide substances[2]	%	70-75%	80-85%	

[1] 1 Per treated m3 wastewater: peak dry weather flow must be treated. ***Please note: standardized cost and CO2 levels for 2018****; recalibration of all CO2- and cost levels will take place during the evaluation of the Innovation Program in 2024*

[2] Overall Removal Efficiency of effluent wwtp to influent wwtp (including bypass post treatment) for 7 of 11 guide substances: benzotriazool, carbamazepine, diclofenac, irbesartan, gabapentine, metropolol, hydrochloorthiazide, mixture of 4- en 5-methylbenzotriazool, sotalol, trimethoprim en venlaflaxine in every 24h or 48h flow or time proportional sample. The sampling has to take the hydraulic retention time of the wwtp into account.

Consequences stricter removal efficiencies Proposal EU Urban Wastewater Treatment Directive
(80% in EU in stead of 70% in NL and different guide substances):

- PACAS will have a footprint of 160 g CO2/m3 and a cost level of € 0,08/m^3; no changes for ozone

Thank you for your attention!

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stowa

Rijkswaterstaat
Ministry of Infrastructure and Water Management

Tackling Micropollutants in Wastewater
Results of the Dutch Innovation and Implementation Program

November 8 and 9 2023
Aquatech Amsterdam