

PACAS & PAC-O₃

WWTP Leiden-Noord

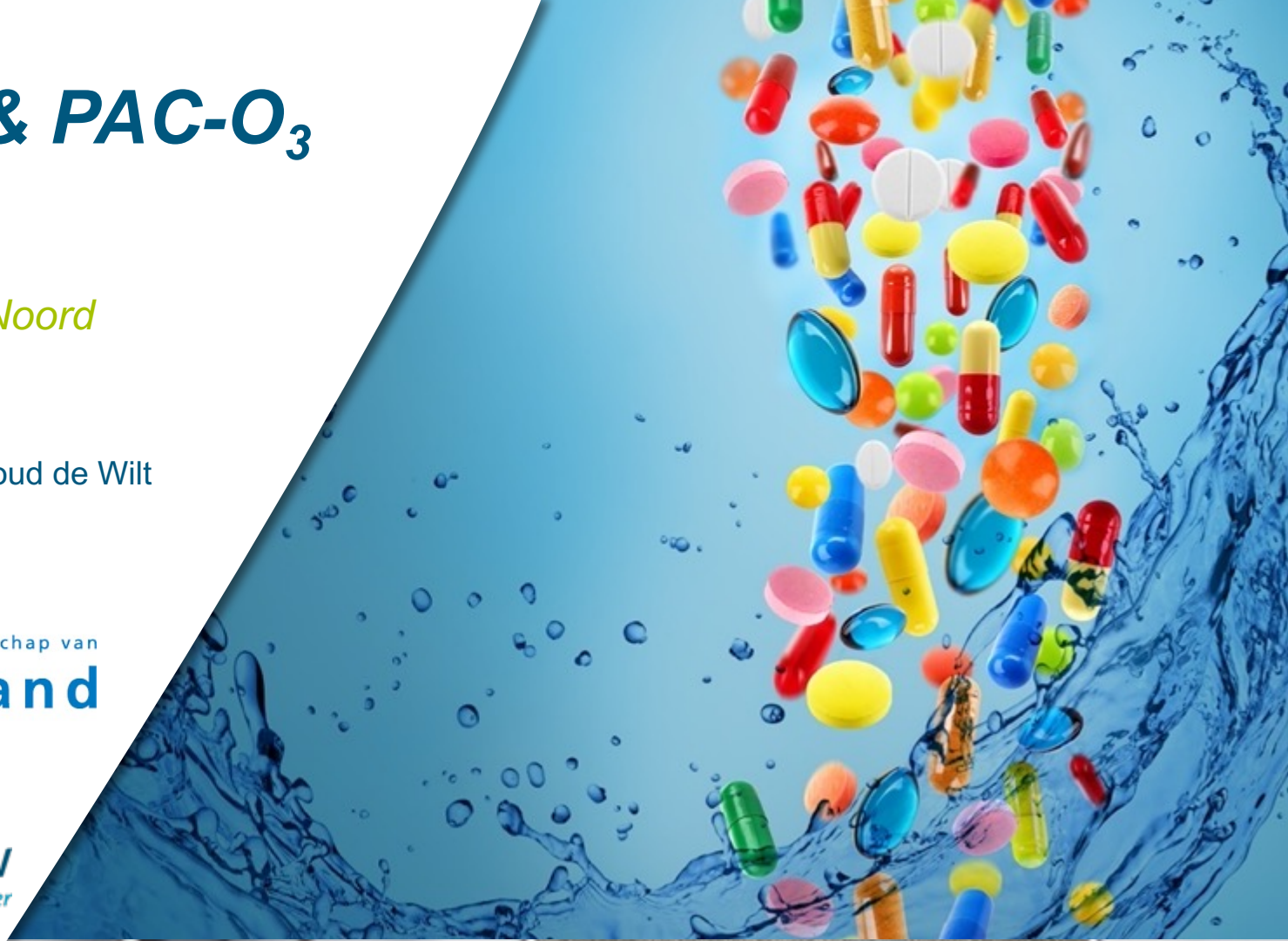
Paul Versteeg & Arnoud de Wilt



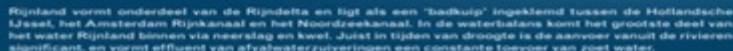
Hoogheemraadschap van
Rijnland



**Royal
HaskoningDHV**
Enhancing Society Together



HET RIJNLANDS WATERSYSTEEM



Rijnland Watersysteem

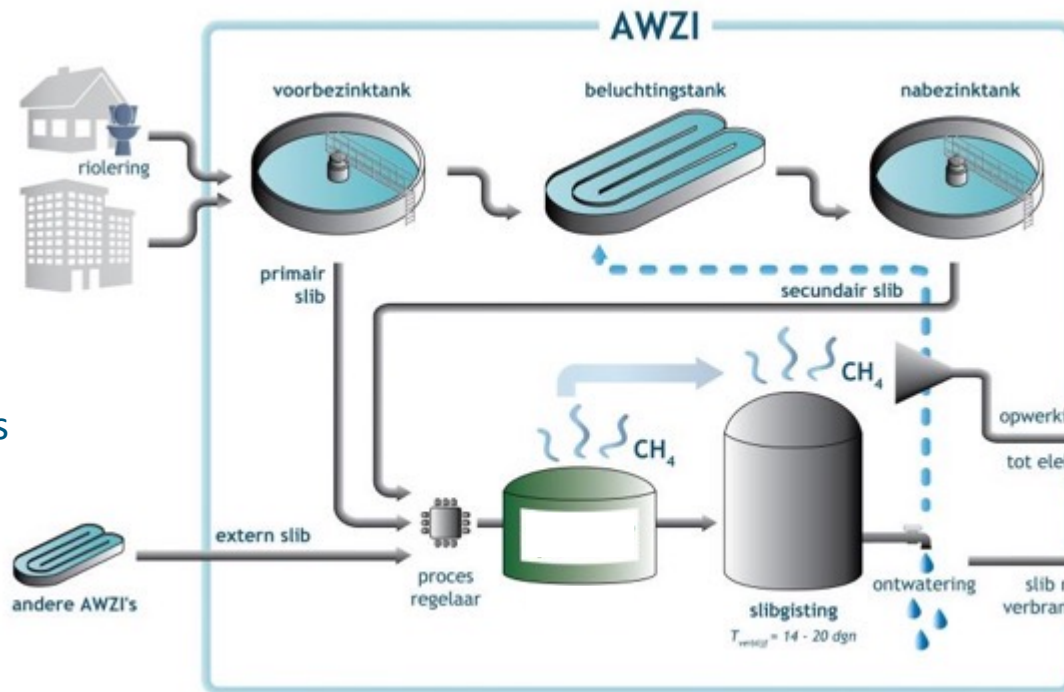


Waterboard Rijnland WWTP (annual figures)

1,3 mln inhabitants

35.000 industrial

5500 ton Nitrogen
900 ton Phosphorus



19 WWTP

125 mln m3 effluent

730 ton Nitrogen
115 ton Phosphorus

3,5 mln m3 biogas
7 GWh

100.000 ton sludge

First full-scale PACAS in the Netherlands

WWTP Leiden Noord

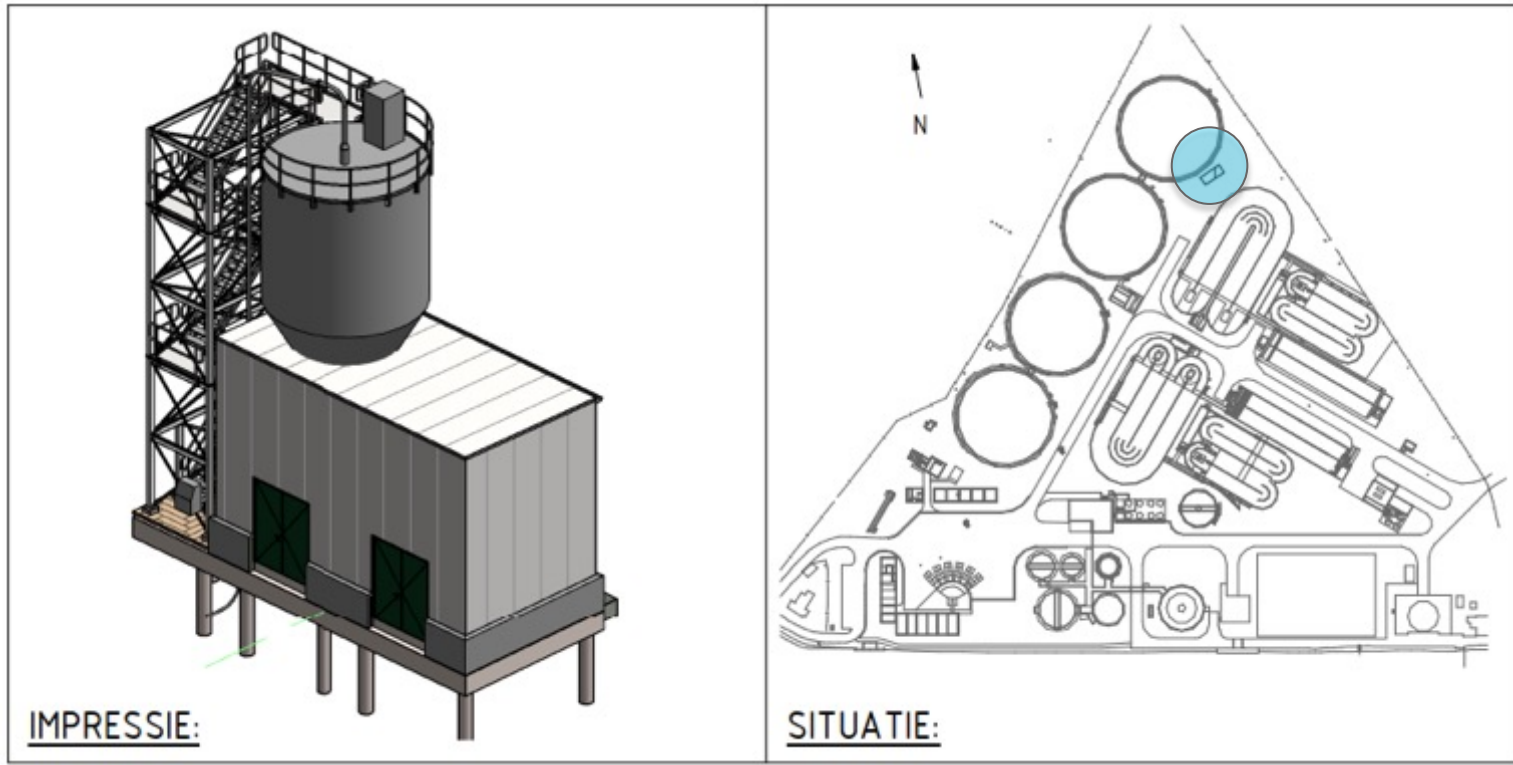
- Capacity 168.000 p.e
- DWF; 1.900 m³/hr
- SWF; 4.900 m³/hr
- Sandfiltration for N- and P-removal

Requirements (year average);

- N-total 4,0 mg/l
- P-total; 0,4 mg/l

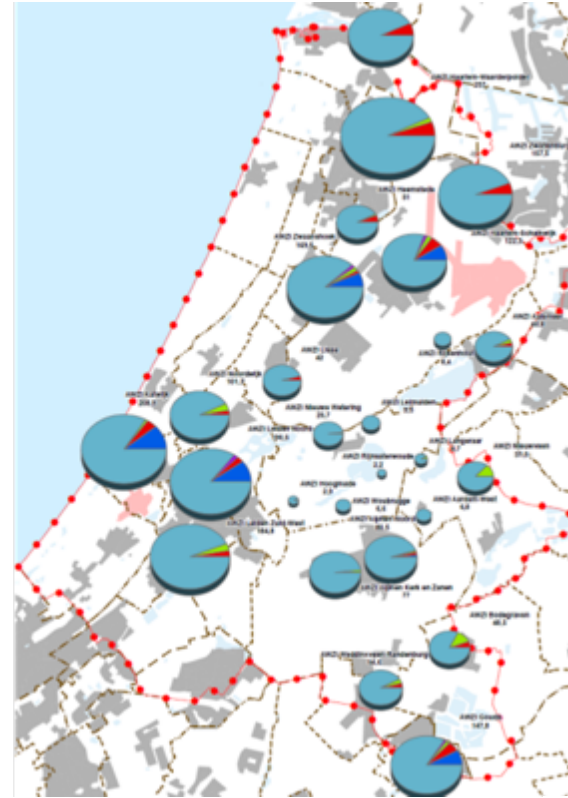


Powder Activated Carbon in Activated Sludge

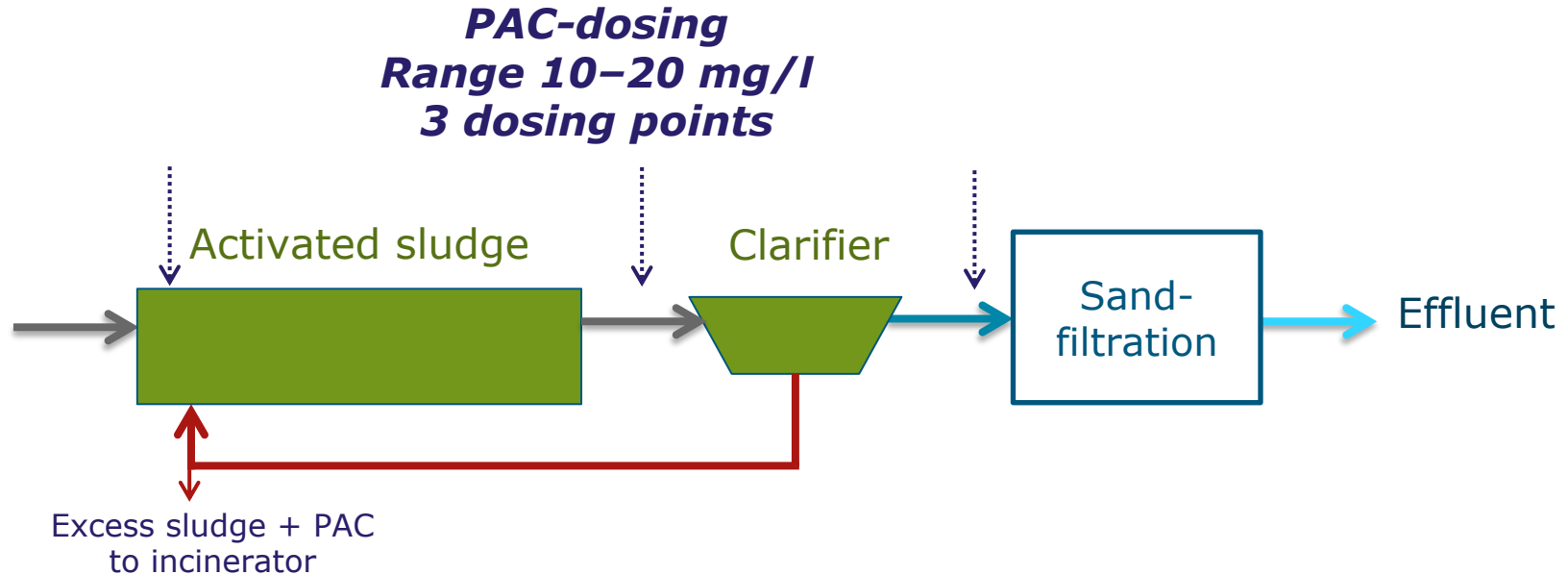


Why PACAS

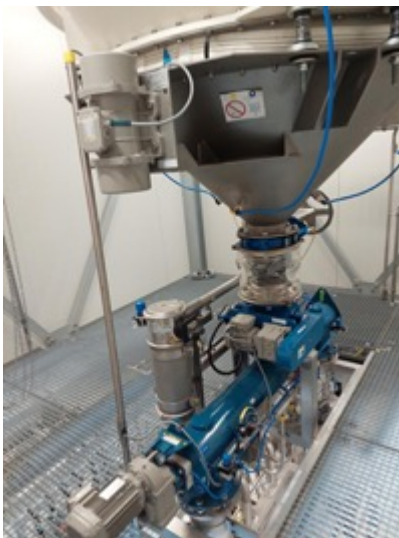
- Removal of micropollutants ; mainly pharmaceutical residues, maybe X-ray contrast agents, maybe PFAS/PFOS
- No requirements; precautionary principle
- Low investment costs, low energy usage
- Easy to operate
- Part of the implementation programme



How does it work



Impression



PACAS cost figures



- Treatment of 9 mln m³/yr
- Funding Min I&W; € 3,8 mln
- Construction costs € 2,4 mln
- Engineering costs € 0,8 mln.

Operational costs

- PAC-dosage; estimated 2022 € 252.000,-
(at a dosage of 15 mg/l)
- Electricity ; estimated 2022 € 50.000,-
- Operation ; 0,5 fte

Research programme 2021-2031

- From 01-2019; baseline measurement WWTP and watersystem ; bioassays, X-ray contrast agents , PFAS/PFOS
- Start up phase till end of 2022; Determine dosage and dosing point, PAC-O₃ research
- Duration phase; till 2031; to meet funding requirements (70% removal of 11 guidance substances), determine side-effects N and P-removal, sludge handling and sludge incineration (e.g. PFAS/PFOS)

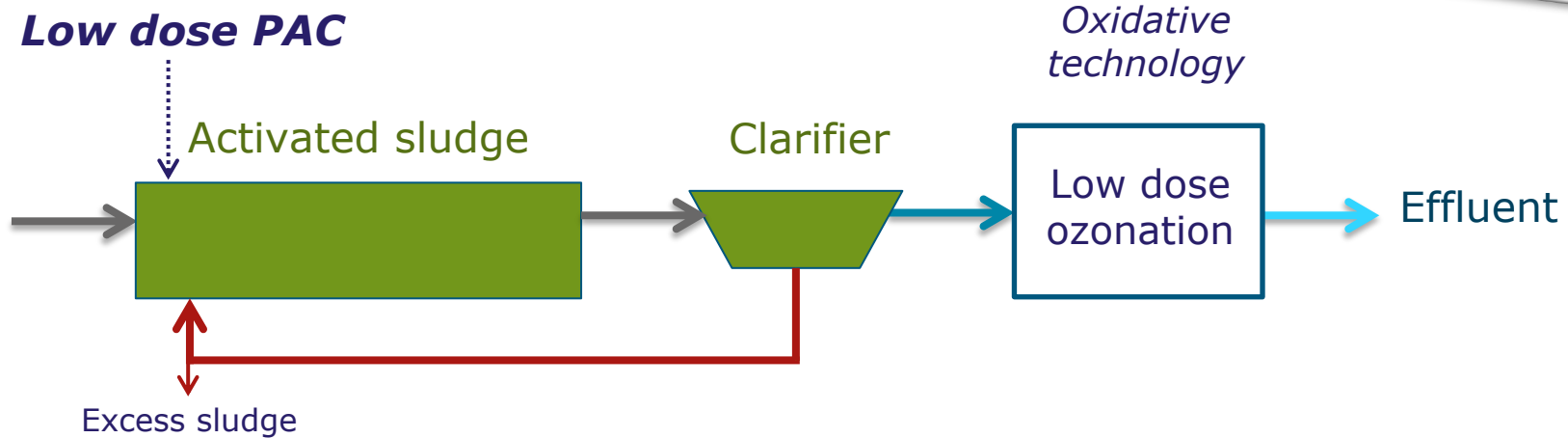


PAC-O₃

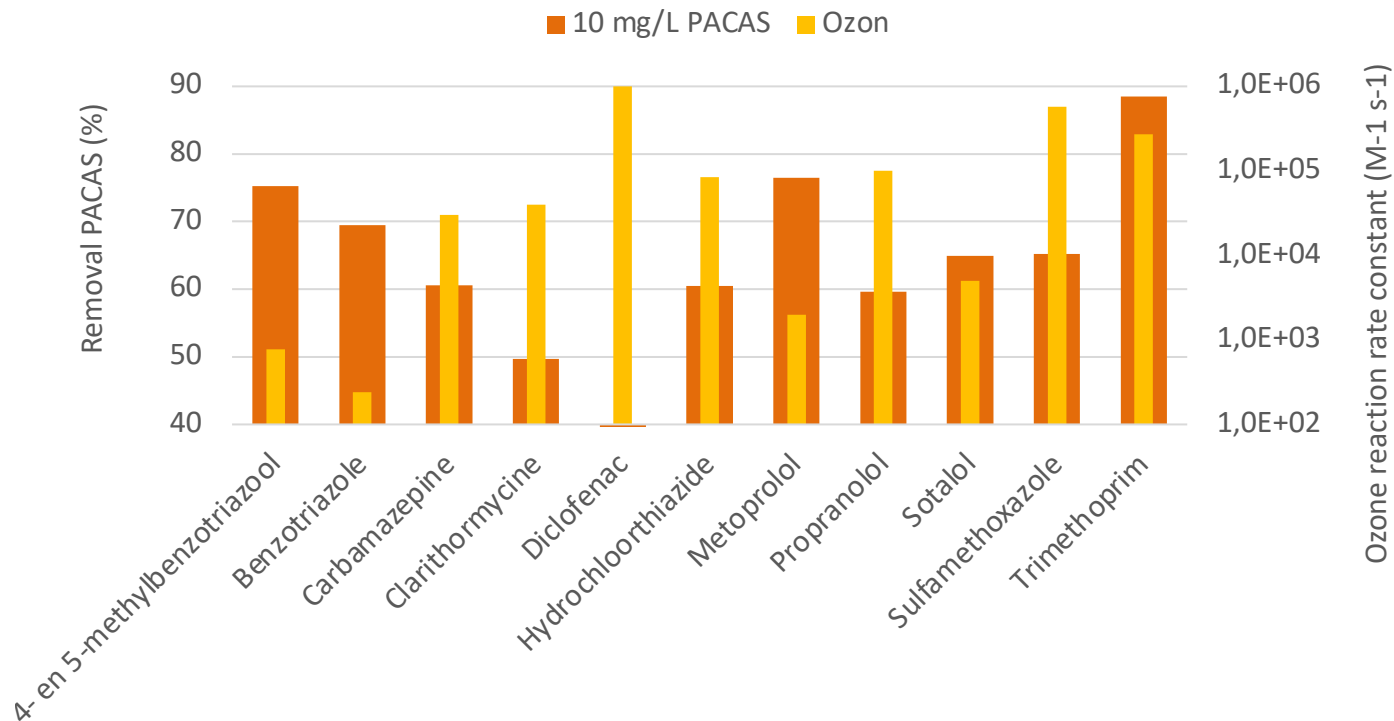
Double barrier



PAC-O₃



Why two technologies?



Other advantages

- Low PAC dose
 - *Lower CO₂-footprint*
 - *Lower sludge production (handling and incineration)*
- Low ozone dose
 - *Less energy input*
 - *Reduced formation oxidation products (e.g. bromate)*
- Stable micropollutant removal (back-up)

Comparisson



	Unit	PACAS	Ozon + SF	GAC	PAC-O ₃
CO ₂ -footprint ¹	kg CO ₂ /m ³	122	128	325	116 (198)
Costs ¹	€/m ³	0,05	0,17	0,26	0,10 (0,13)
Removal “gidsstoffen” ²	%	70-75%	75-80%	80-85%	70-75 (85-90%)
Broad array of compounds		-	-	-	+
Bromate formation		n.a.	++	n.a.	0 / +
Metabolite formation		n.a.	++	n.a.	+
Additional sludge production	% dm	+7,6%	n.a.	n.a.	+4%

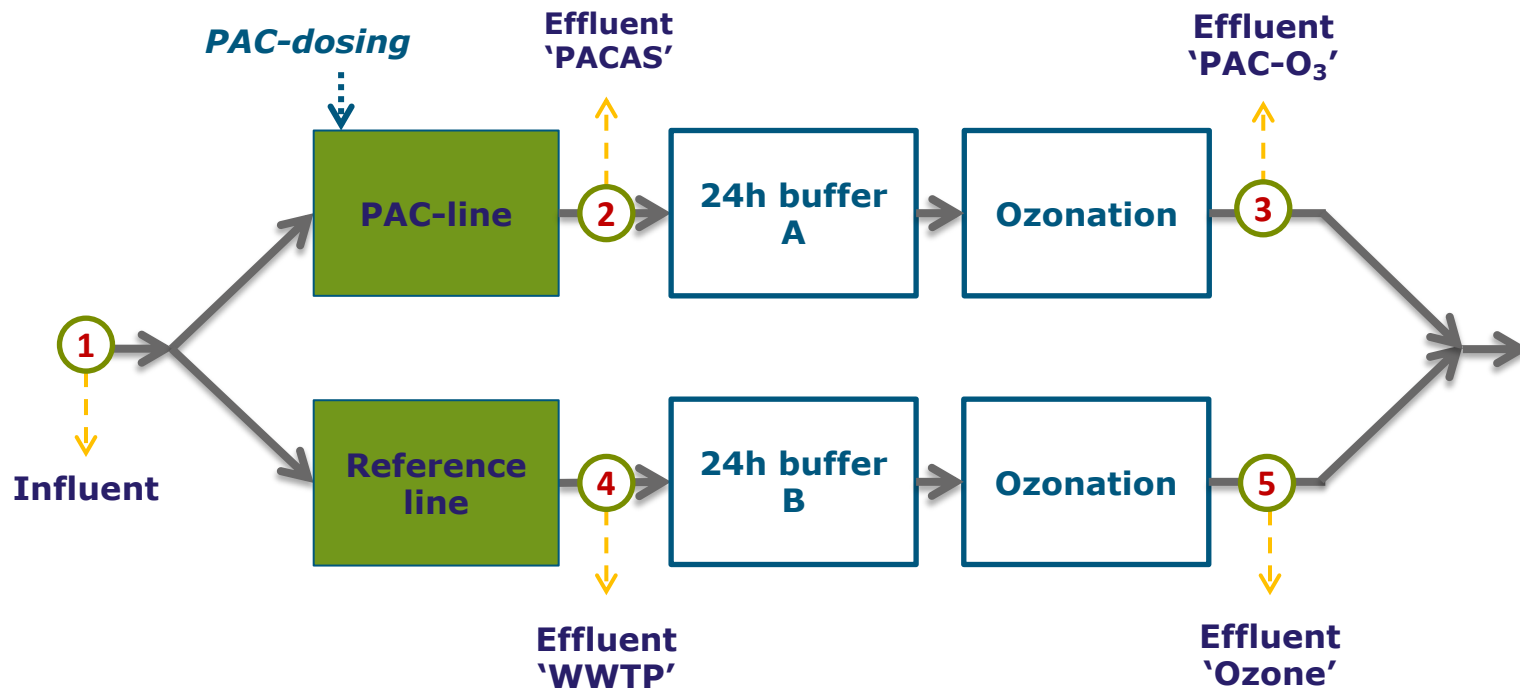
¹ Per m³ treated wastewater

² Removal efficiency of 7 out of 11 “gidsstoffen”: benzotriazool, claritromycine, carbamazepine, diclofenac, metoprolol, hydrochloorthiazide, mengsel van 4- en 5-methylbenzotriazool, propranolol, sotalol, sulfamethoxazol, trimethoprim.

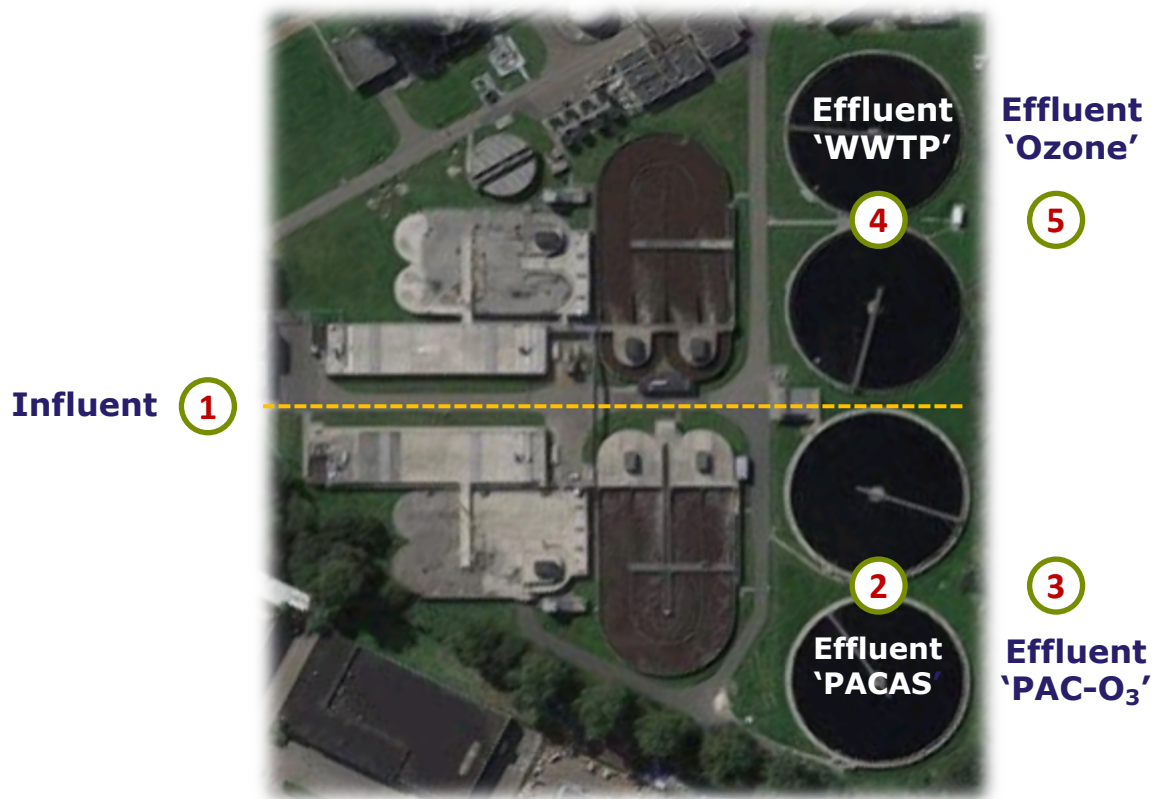
The removal is calculated as effluent (after additional treatment) over influent of the WWTP



Pilot study PAC-O₃



Pilot @ WWTP Leiden-Noord



Hoogheemraadschap van
Rijnland

WATERSCHAP
ZUIDERZEE LAND

Waterschap
Aa en Maas

Waterschap
Brabantse Delta

Hoogheemraadschap van
Schieland en de Krimpenerwaard

LOGISTICON
WATER TREATMENT

**PURE
BLUE**



Thank you for your attention!



Hoogheemraadschap van
Rijnland

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Tackling Micropollutants in Wastewater
Approaches on Implementation and Innovation in Europe and The Netherlands



Rijkswaterstaat
Ministry of Infrastructure
and Water Management

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Aquatech Amsterdam