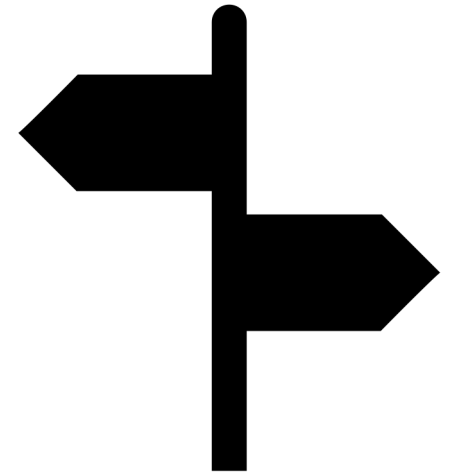


# Removal of micropollutants HDSR WWTP Houten



- 1 Impact of WWTP on surfacewater – ranking all WWTP's in the Netherlands from high to low impact
- 1 4 WWTP's of HDSR with a high score: Woerden, Nieuwegein, Utrecht en Houten
- 1 And WWTP Zeist – large project to improve nitrogen removal and include removal of micropollutants before 2027
- 1 Financial support from the Ministry of Infrastructure and Watermanagement for removal of micropollutants/medicines on WWTP's owned bij the Dutch waterboards



# First experiences with removal of micropollutants on WWTP Houten

- 1 Limited experience in the Netherlands with additional techniques for the removal of micropollutants on full scale WWTP
- 1 'Learning by implementing' at one of the smaller hotspot WWTP's
- 1 No additional requirements for nitrogen and phosphate at this WWTP
- 1 Impact on drinking water quality in the Lek canal via discharge to Amsterdam-Rijnkanaal (in addition to medicine residues also attention to substances such as AMPA, Glyphosate and Bisphenol A)

WWTP:  
72.000 ie  
RWA: 2850 m<sup>3</sup>/h  
DWA: 580 m<sup>3</sup>/h



# Techniques for the removal of medicine residues

## 1 Exploration (proven) techniques:

Oxidation effluent with ozone

Pulverized carbon dosing to activated sludge (PACAS)

GAK filtration

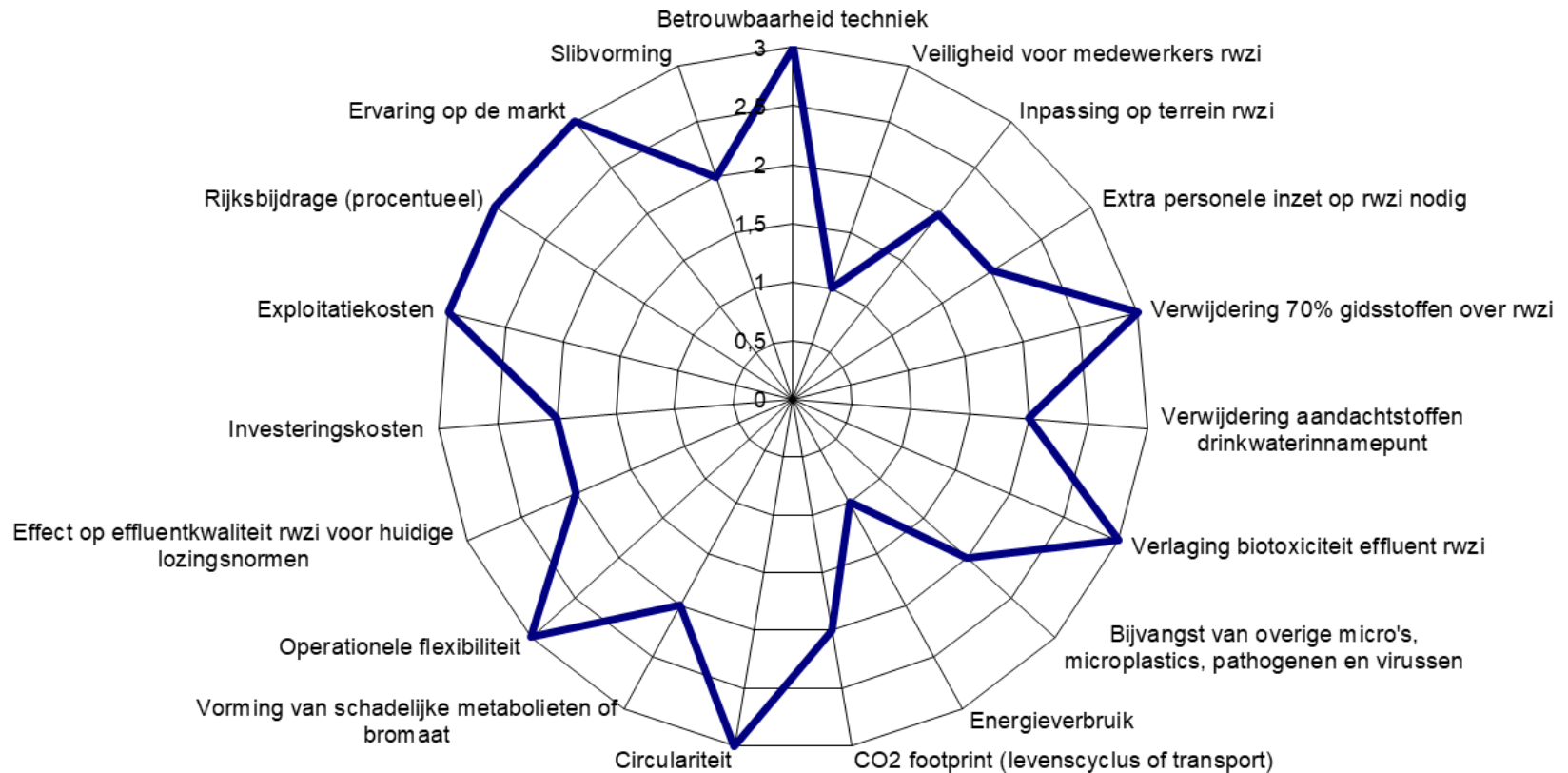
Combination of O<sub>3</sub> oxidation with GAK filtration





# Multi criteria analysis

Variant 1 Ozonreactor op effluent NBT's



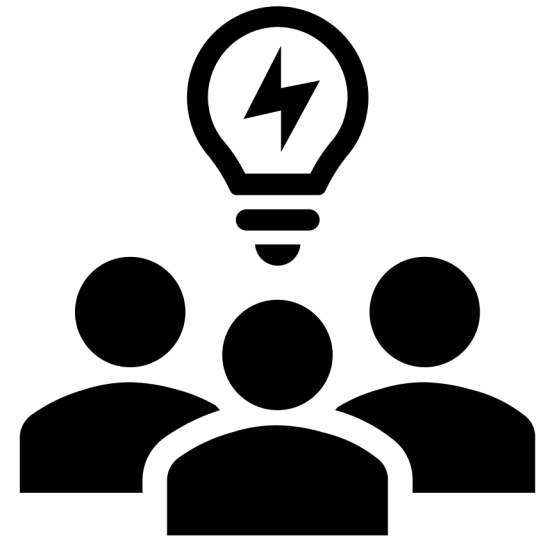
Score 1: laag, ongunstig, negatief, hoog verbruik, grote nadelige invloed.

Score 2: gemiddeld, niet hoog, niet laag.

Score 3: hoog, gunstig, positief, laag verbruik, geen nadelige invloed, positieve invloed.

# Oxidation with ozone effluent WWTP Houten

- Opted for construction team construction, bringing all knowledge of the party's together
- Market party  
Nijhuis/Witteveen&Bos/Pannenkoek
- Design phase October 2020 to June 2021 – DO phase
- Start of construction October 2021, ready in April 2022

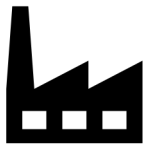


# Experiences ozone design phase (1)

- 1 DOC in effluent – starting point in study approximately 8 mg DOC/l average, later also higher values up to 12 measured (measuring over a longer period is advisable)
- 1 Limiting bromate (low requirement 5 µg/l from Waternet as manager drinking water source), choice for insertion of ozone with diffusers
- 1 Reactor with partitions for efficient ozone input and reduced risk of bromate formation
- 1 Desired variation in ozone dosage between 0.2 and 1 mg/mg DOC for operational flexibility (expected average 0.5)

# Experiences ozone design phase (2)

- 1 Reactor shape (round, square, rectangular, U-shaped)
- 1 At least 10 years in operation (condition Ministry of I&W)
- 1 'Functionally representative'
- 1 Choice of reactor material (wood, steel, concrete)
- 1 Production of ozone – Lox (with pure oxygen) or PSA (from air)





# Experiences ozone design phase (3)

- 1 Choice of 1 or 2 ozone generators due to availability - 1 generator, maintenance low
- 1 or 2 ozone reactors in parallel – 1 U-shaped reactor
- 1 Choice of location on the site - next to NBT where all the water of the WWTP passes

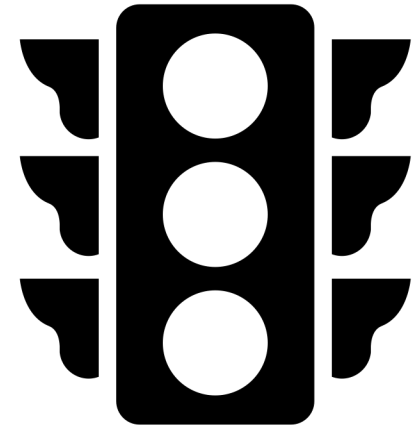


# Experiences ozone design phase (4)

- 1 Reactor with partitions to properly conduct water and ozone input – CFD simulation, capacity 200 m<sup>3</sup>
- 1 14 minutes residence time in reactor at maximum supply of 1.5 x DWA (870 m<sup>3</sup>/h)
- 1 DWA is 580 m<sup>3</sup>/h, then approximately 21 minutes residence time
- 1 Minimum and maximum supply flow ozone reactor 200 to 870 m<sup>3</sup>/h (supply WWTP via discharge pipes so variable flow and low at night)
- 1 Minimum ozone reactor capacity 10% - including temporary shutdown of reactor and clean-up cycle

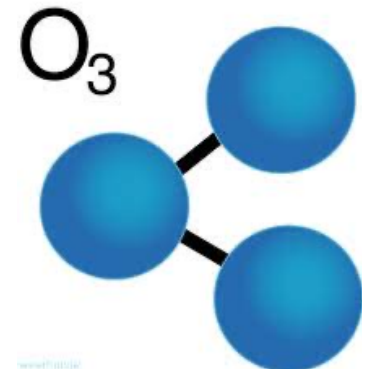
## Experiences ozone design phase (5)

- › Detection of ozone in the air at the top of the reactor, destruction of residual ozone
- › DOC measurement of incoming water flow
- › DOC measurement outgoing flow indication for removal
- › Various safety measurements ozone and oxygen in building ozone generator – traffic light on outside building



# Experiences ozone design phase (6)

- 1 (New) sampling boxes for 48-hour sampling during dry weather conditions
- 1 Influent WWTP, incoming flow ozone reactor and total effluent WWTP
- 1 Rent oxygen storage tank and supply of oxygen



# Monitoring effects

- Conditions Ministry I&W:
- 70% removal of (7 out of 11) guide substances at the WWTP from influent to effluent (biology and additional ozone technique)
- 50% reduction in ecotoxicological risks of treated effluent compared to effluent settlers
- 48-hour sampling, flow proportional
- Choice for 3 new 48-hour sampling boxes at influent WWTP, incoming water flow ozone reactor (= effluent settlers) and total effluent WWTP
- Taking into account residence time in the WWTP – 3 days sampling at mainly dry weather conditions



# Monitoring effects

- Analyses on guide substances (medicines) monthly (12 x per year) in the first 2 years, after that 1 x per 2 months
- Ecotoxicological risks 6 x per year in the first 2 years, then once every six months
- 15 bioassays possible (STOWA key factor toxicity 2016), but not all need to be carried out



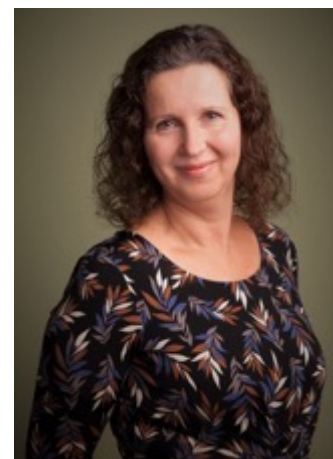
# Monitoring effects - bromate

- 1 Low requirement from Waternet due to drinking water source  
Lekkanaal < 5 µg/l bromate
- 1 In 2019 research into the amount of bromide in wastewater  
WWTP Houten and drinking water in Houten: 50 µg/l
- 1 Ozone tests at different doses by Nijhuis: less than 5 µg/l in  
treated effluent is possible, maybe even lower
- 1 Choice of diffusers and partitions in reactor gives lower risk of  
high ozone concentrations – reduce risk of bromate
- 1 Relatively low dose of ozone 0.5 mg ozone/mg DOC
- 1 Recent new advice from RIVM for 1 µg/l bromate at drinking  
water intake points - end of November decision by Ministry



**Thank you for your attention!**

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Rijkswaterstaat  
Ministry of Infrastructure  
and Water Management

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**Aquatech Amsterdam**