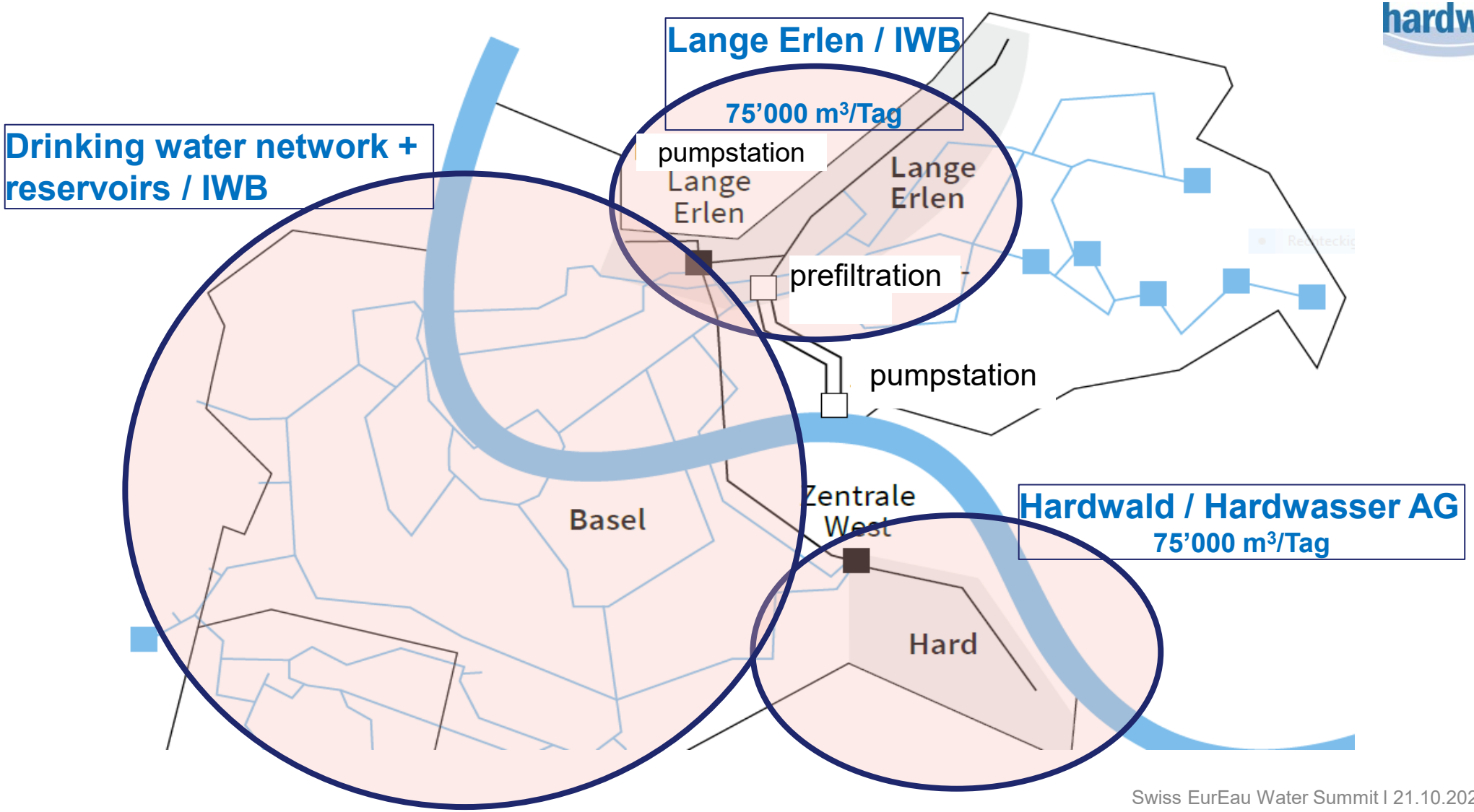
von natur aus klimafreundlich IWB

hardwasser ag

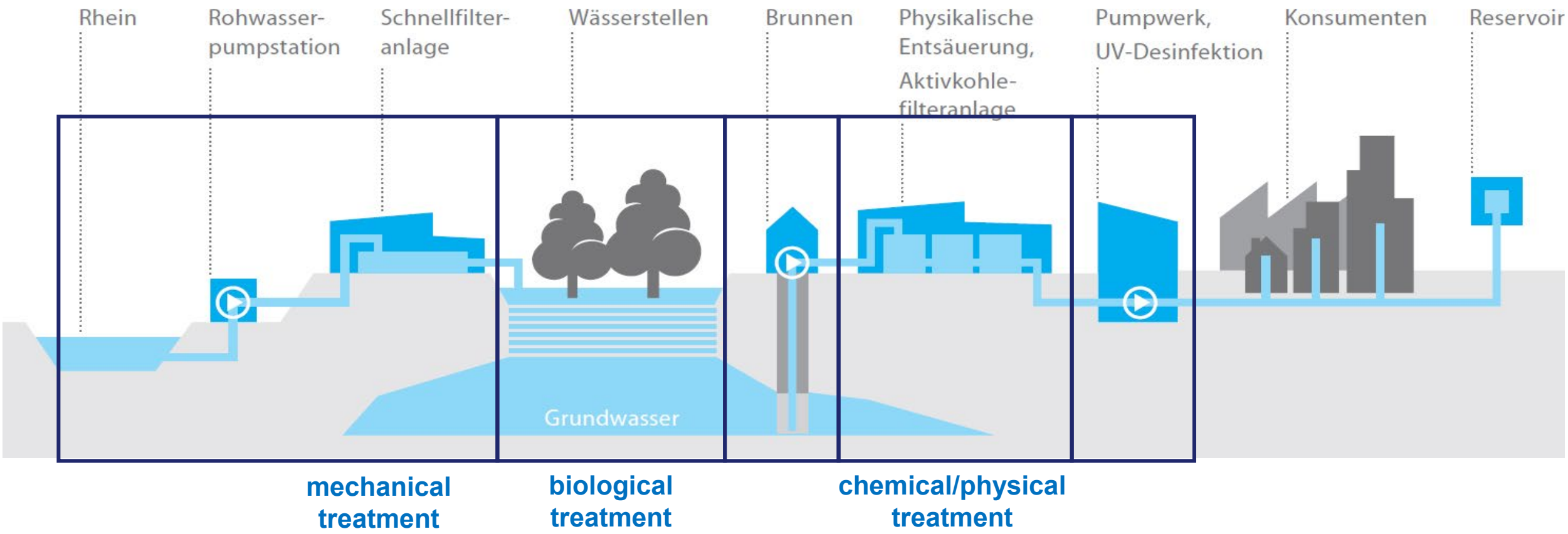
End-of-pipe removal of micropollutants – not everything that is technically possible is necessarily sensible

Thomas Meier I Swiss EurEau Water Summit I 21.10.26

Drinking water supply for the city of Basel:



The Basel Model – naturebased drinking water treatment in Lange Erlen and Hardwald



Basis for investigating further treatment stages

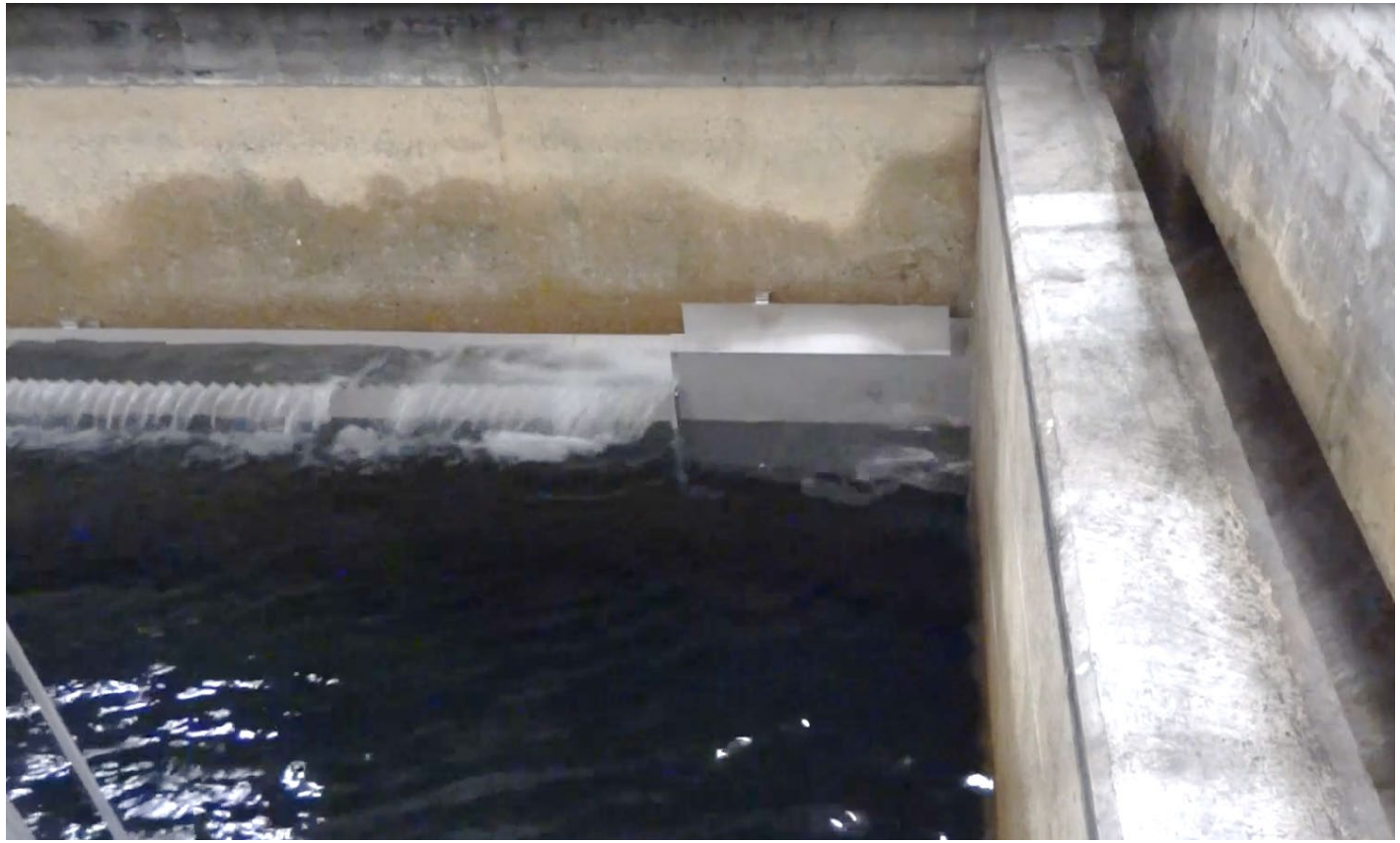
- Micropollutants can enter the groundwater through the infiltration of water from the river Rhine
- Due to advancements in analytics, micropollutants are detected in ever-lower concentrations (ng/l).
- Currently, all legal drinking water requirements are met by IWB and Hardwasser AG, but drinking water legislation may change in the future.
- Societal and political demands for the purity of drinking water are steadily increasing; therefore, a tightening of requirements is to be expected.
- An additional or alternative treatment stage could increase process reliability.

Evaluated treatment processes

Option	Solution	Explanation	Optimization or Substitution
V0	Existing GAC filters	Fixed-bed GAC filters in current operation with alternating activated carbon replacement after approx. 70m³ drinking water per kg GAC	-
V1	Optimization of existing GAC filters	Adjustment and optimization of operating conditions. More frequent carbon replacement.	Optimization of current GAC filter
V2	Fluidized bed process	Micro-GAC in a fluidized bed: CarboPlus® process.	Substitution of current GAC filter
V3	Ultrafiltration with powdered activated carbon (PAC)	Super-fine PAC followed by ultrafiltration. Alternative to existing GAC filter and UV disinfection.	Substitution of current GAC filter
V4	Nanofiltration (Reverse Osmosis)	Treatment stage with hollow-fiber nanofiltration.	Substitution of current GAC filter

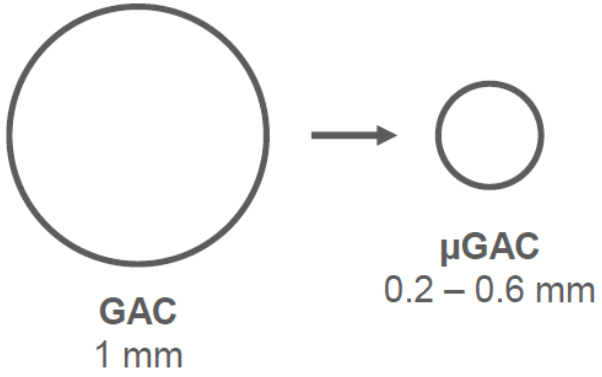
V0: Granular Activated Carbon (GAC)

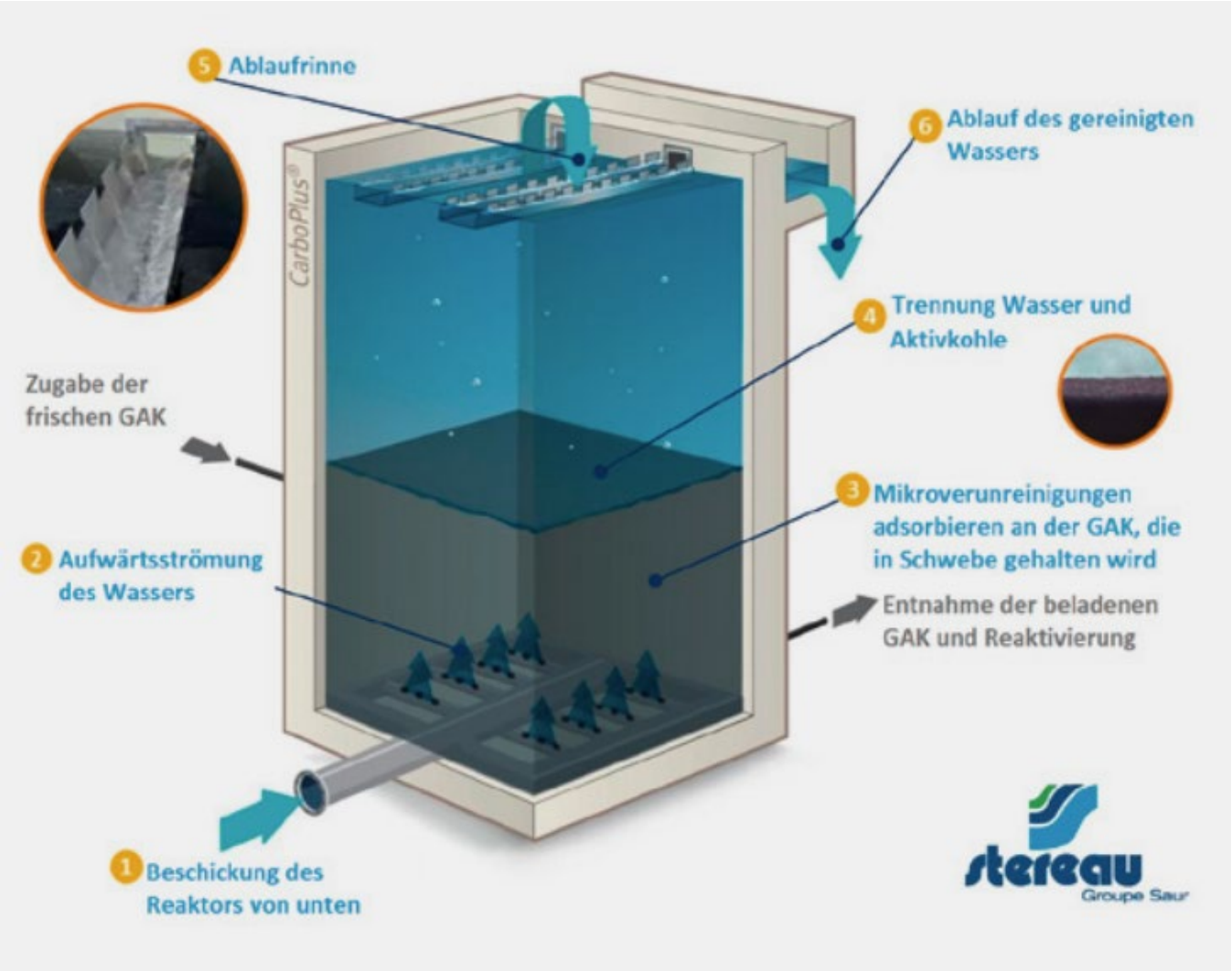
- 3 basins with 2.5 m of activated carbon each
- Area per basin: 75 m²
- Filter velocity: 5 – 10 m/h
- Flow rate per basin: 100 – 300 l/s
- Carbon replacement alternating every **1.5** years
- Approx. **14g** GAC per m³ of drinking water (approx. 70 m³/kg GAC)



V2: Fluidized bed process

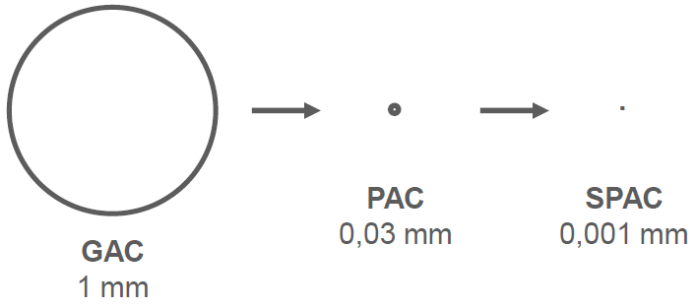
- Fluidized bed process with micro-granular activated carbon.
- Highly flexible: dosage can be adapted to changes in raw water quality.
- Higher production rates with lower facility footprint.

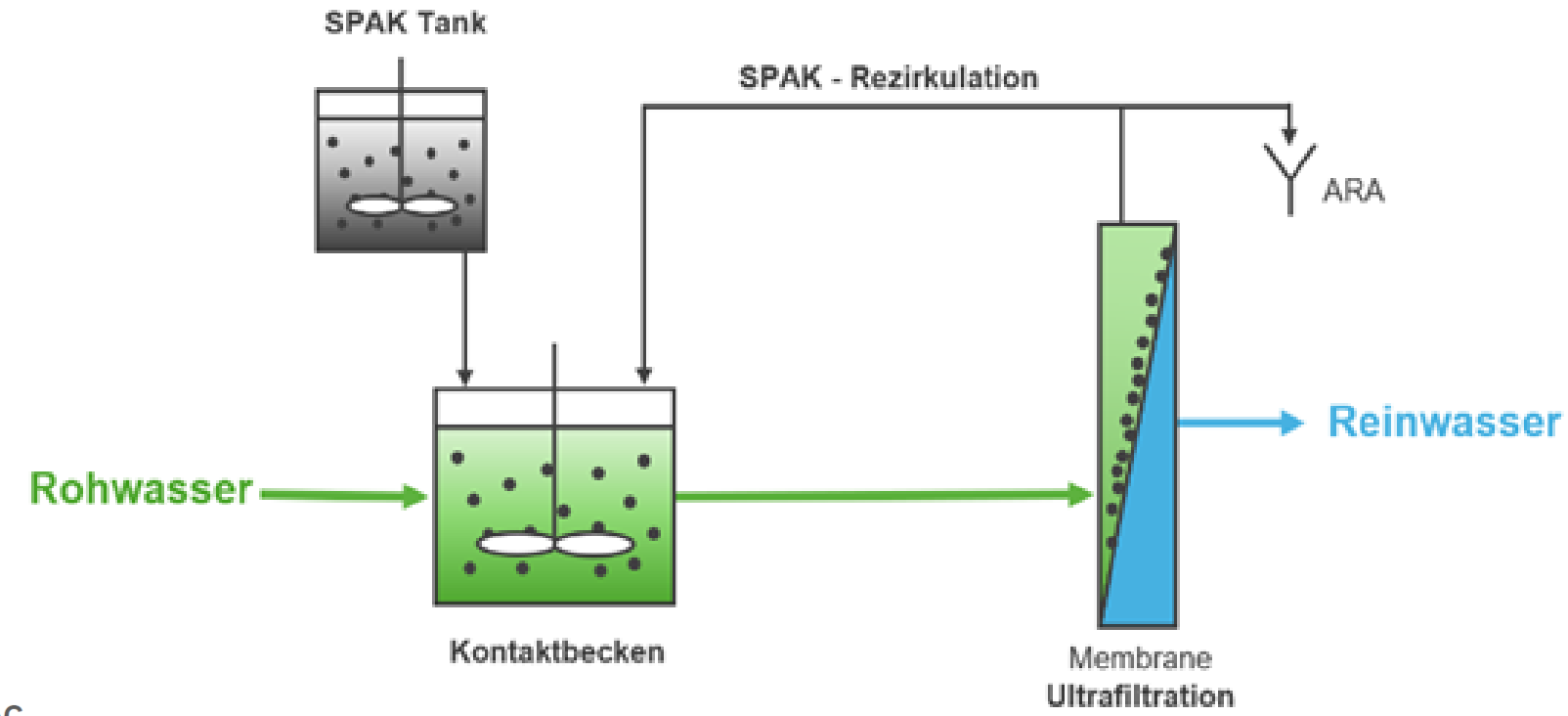




V3: Ultrafiltration with super-fine powdered activated carbon (PAC-UF)

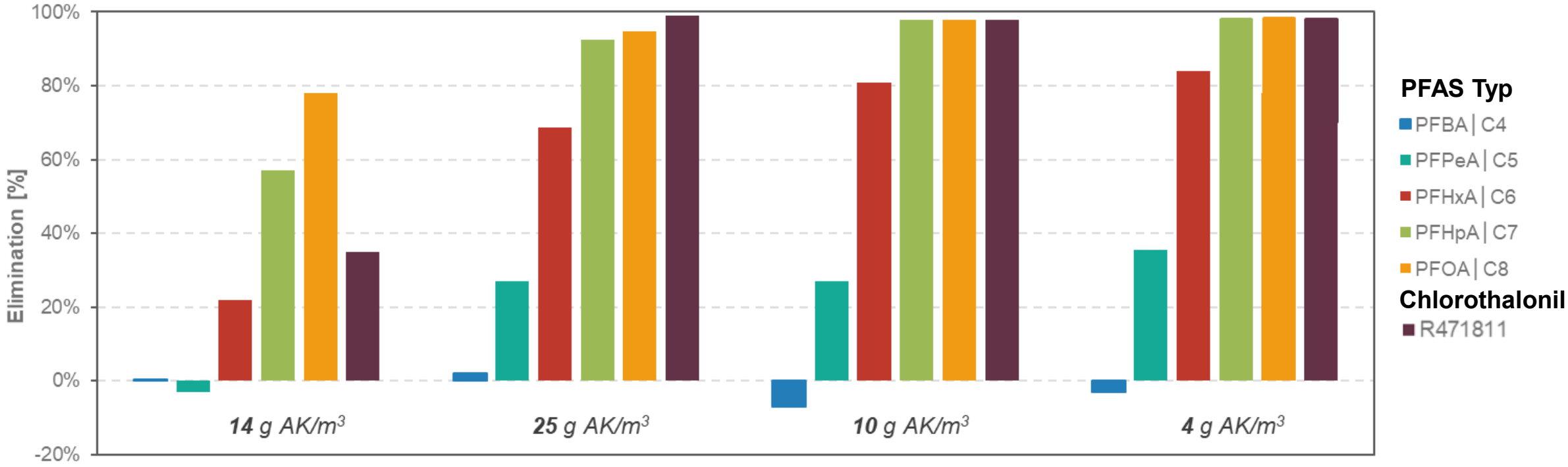
- Carbon is added directly to the raw water.
- Carbon requirement is minimized and efficiency is optimized.





Elimination of micropollutants: Comparison of drinking water to groundwater

V0	V1	V2	V3
Fixed-bed GAC filter	Optimized GAC	Fluidized bed process	SPAC-UF



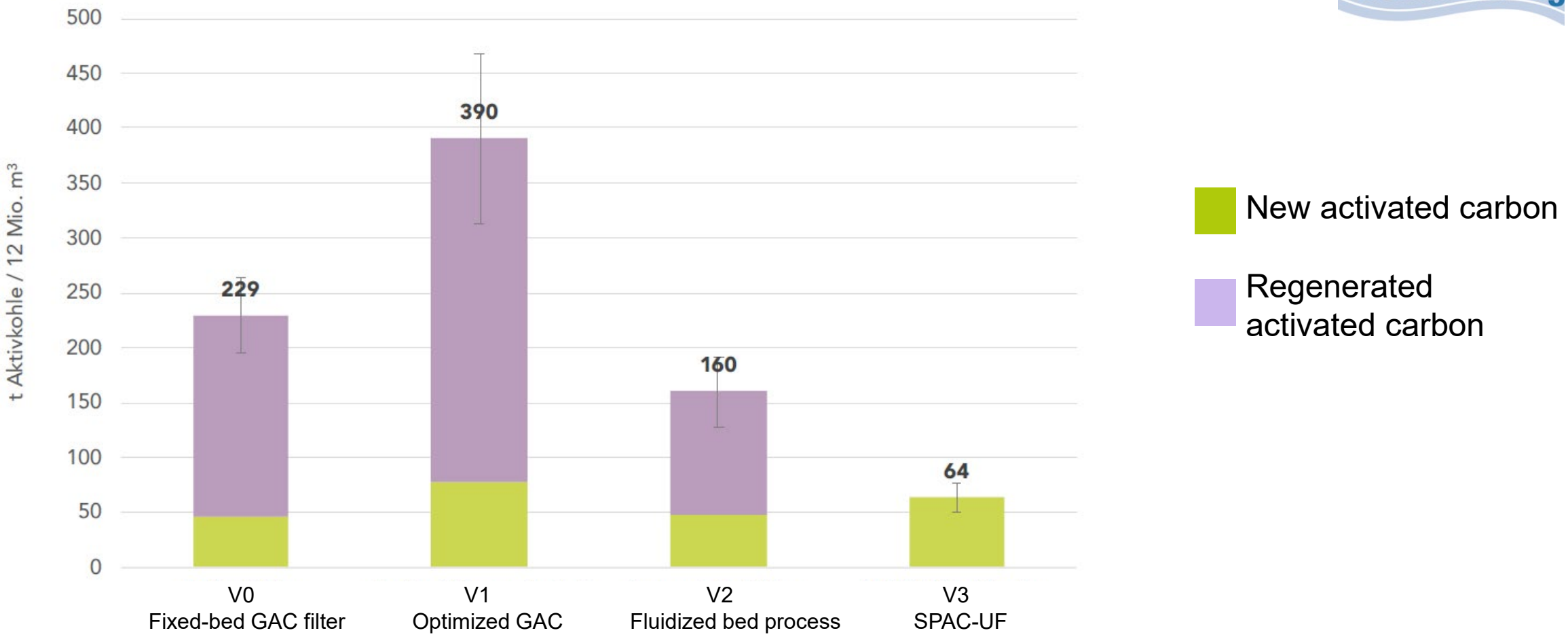
Conclusion from the tests

Feature	V0/V1: GAC	V2: Fluidized Bed	V3: SPAC-UF
AC requirement per m³	14 g / 25 g	10 g	4 g
AC grain size	1.0 mm	0.4 mm	0.0015 mm
Adsorption kinetics	slow	fast	very fast
AC reactivation	possible	possible	not possible
Hydraulic load	low	high	high
Filter type	Fixed-bed filter	Suspended bed	Ultrafiltration

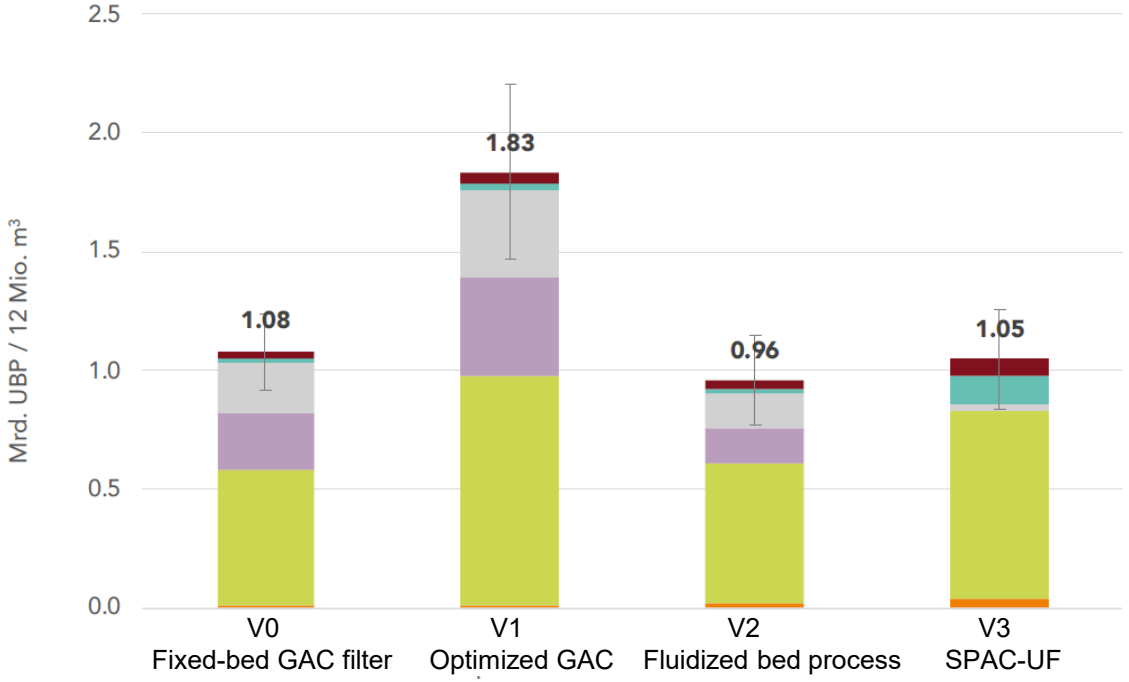
Life cycle costs and ecological balance were calculated based on these values.

All collected data were integrated into a utility analysis and sensitivity analysis.

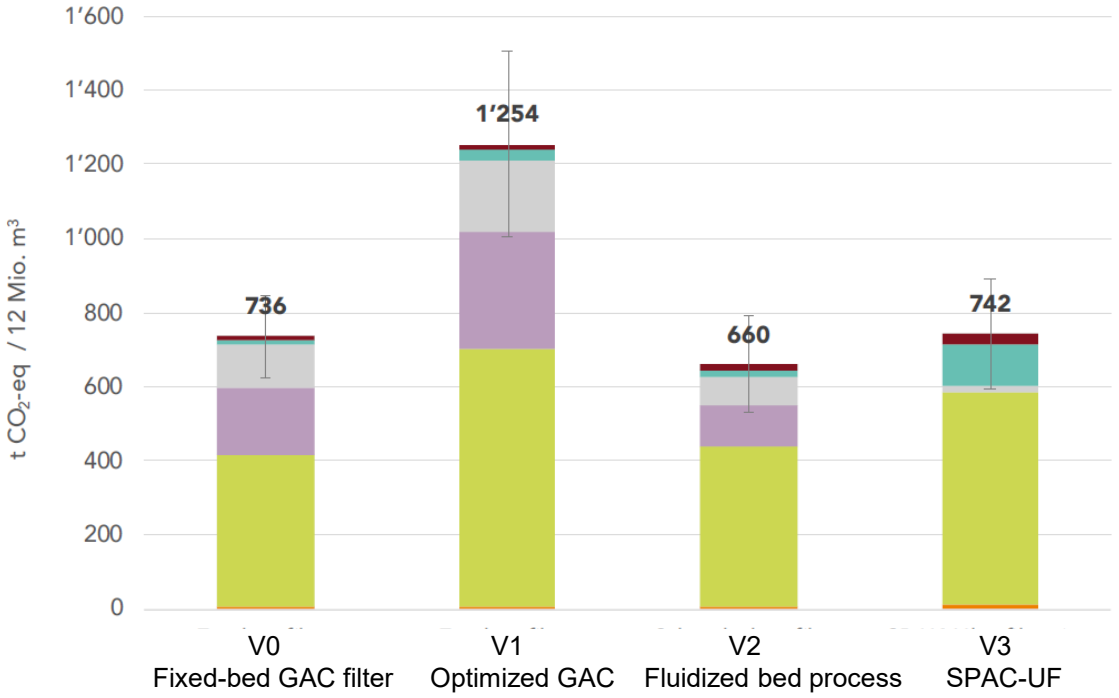
Annual activated carbon requirement:



Ecological balance according to UBP or CO_2 equivalent



- Production of new activated carbon
- Regeneration of used activated carbon
- Loss of activated carbon in the process
- Transport
- Energy input during the operation of the water treatment plant



Utility Analysis:

Utility Analysis: Comparison of the four processes based on the following objectives:
Low life cycle costs →Cost estimation according to DVGW guideline W618.
Optimal operating conditions →Experience values from operators.
Minimal environmental impact →Ecological balance according to UBP and CO_2 equivalent.
Cleaning performance →Measurement data from piloting.

		Variante Nr.			
Ziel	Gewicht	**0**	**1**	**2**	**3**
Low life cycle costs	25%	4.0	2.6	2.7	2.5
Optimal operating conditions	19%	3.3	3.1	2.7	2.6
Minimal environmental impact	26%	3.7	1.9	3.8	3.4
Cleaning performance	30%	2.3	2.5	2.8	3.2
Summe	100%	**3.3**	**2.5**	**3.0**	**3.0**

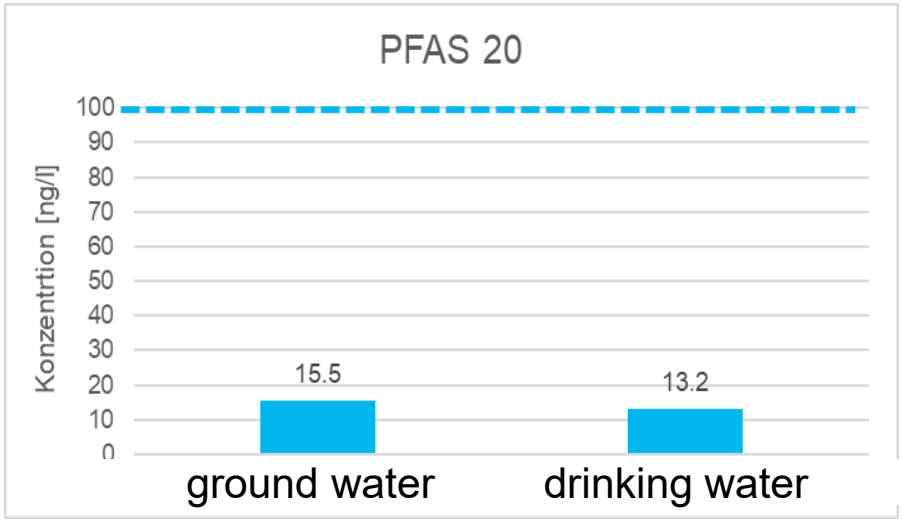
4	very good
3	good
2	bad
1	very bad

Sensitivity Analysis

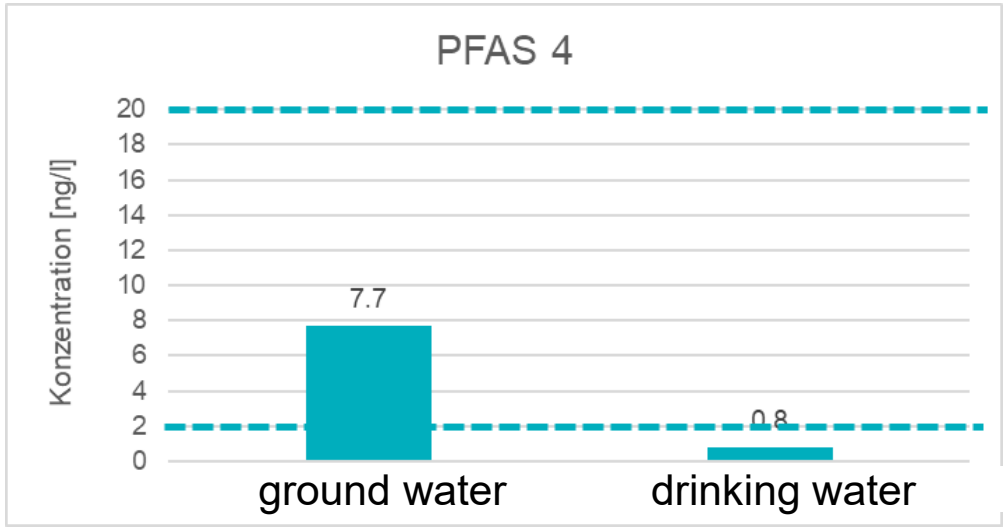
		Costs	Oper.	Quality	Enviro.	Basis
Low life cycle costs		60%	15%	15%	15%	25%
Optimal operating conditions		10%	60%	10%	10%	19%
Minimal environmental impact		15%	15%	15%	60%	26%
Cleaning performance		15%	10%	60%	15%	30%
	Summe	100%	100%	100%	100%	100%
V0: Fixed-bed GAC filter		**3.6**	**3.4**	**2.9**	**3.5**	**3.3**
V1:Optimized GAC		**2.5**	**2.8**	**2.5**	**2.2**	**2.5**
V2: Fluidized bed process		**2.9**	**2.9**	**2.9**	**3.4**	**3.0**
V3: SPAC-UF		**2.7**	**2.8**	**3.0**	**3.2**	**3.0**

4	very good
3	good
2	bad
1	very bad

PFAS removal with current GAC



PFAS 20 < 100 ng/L



PFAS 4 < 20 ng/L*

PFAS 4 < 2 ng/L

For the water treatment of the city of Basel: With the current fixed-bed activated carbon filter (V0), current and future PFAS limit values for the entire EU area are significantly undercut.

** Effective from 12.1.2028*

Conclusion

- The existing fixed-bed activated carbon filter (V0) produces drinking water that:
  - meets current requirements of the Drinking, Bathing and Showering Water Ordinance (TBDV)
  - as well as future EU requirements for PFAS20 and PFAS4.

- Higher cleaning performance is fundamentally always possible; however, based on quality requirements as well as economic and ecological reasons, it is not necessary or recommended in the case investigated. Therefore, no other process currently needs to be added or built instead of the existing activated carbon filter.

- Polar substances such as TFA or EDTA are not or only minimally reduced by all investigated processes. Since such substances will come more into focus in the future, we will continue to monitor the development of effective processes (membrane processes, ion exchangers) for these substance groups.

- Should legislation change or new processes (ion exchangers or membrane plants) enter the market, they shall be examined under the same criteria as applied here.