EVALUATION OF TREATMENT METHODS FOR THE ELIMINATION OF PFAS PRESENT IN REVERSE OSMOSIS BRINES IN DRINKING WATER TREATMENT

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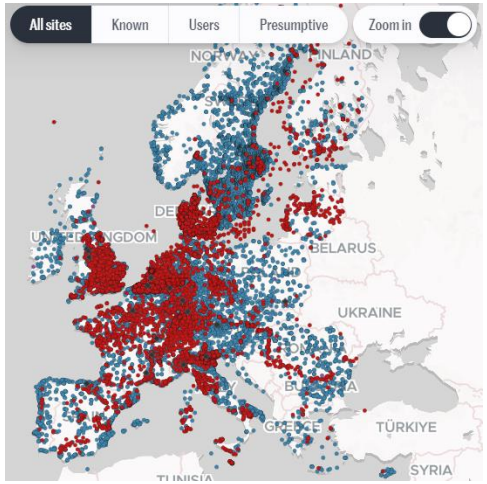
Agenda

1. Context & objectives
2. Methods
3. Media performance results & matrix influence
4. Foam fractionation results
5. Conclusion & perspectives

1. Context

- **PFAS**
  - *Global pollution*
  - *Drinking water regulation*



European Union drinking water regulation

- Σ20 < 100 ng/L
- Σ4 < 20 ng/L ? , 4,4 ng/L ?

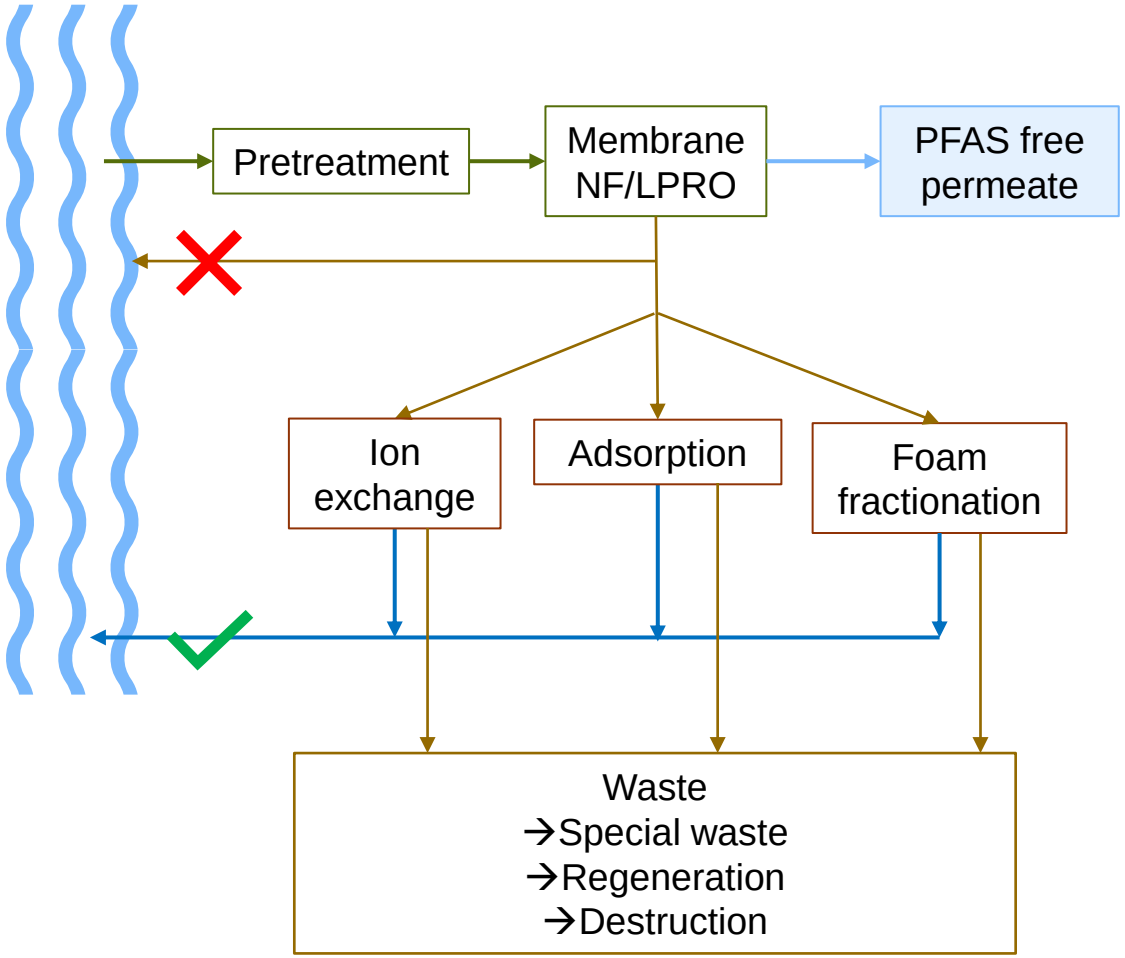
- **Membrane = performant solution for PFAS removal**

Molar weight	MM < 300 g/mol **XS**	MM = 300-400 g/mol **S**	MM > 400 g/mol **M & L**
Rejection	From 50% to >90%	80 to >90%	>90%

- **Membrane concentrate generation**
  - ➔ **Pollution displacement**
  - ➔ **No regulation on membrane concentrates reject**

To implement membrane technology, brine treatment must be studied

1. Objectives



➢ OBJECTIVE 1:

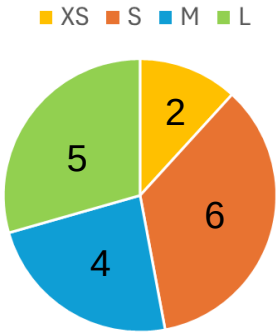
Evaluate and compare PFAS removal performance by **different processes** (adsorption, resin, foam fractionation)

➢ OBJECTIVE 2:

Evaluate and compare PFAS removal performance of different media **depending on matrix** (organic matter, salinity)

2. Methods (1/2)

17 **PFAS**



UHPLC MS MS (WATERS)

41 **Matrices**

Brines produced from groundwater with 2 types of membrane and spiked				
	Surface water	Ground water	Brine #1	Brine #2
Conducitivity (mS/cm)	~ 0,5	~ 0,5	3,5 – 4	1,5 – 2
TOC (mg/L)	~ 1	~ 2	5 – 10	10 – 20

3 **Processes**

Adsorption
GAC
Non activated biochar
Clay

Ion Exchange
2 resins

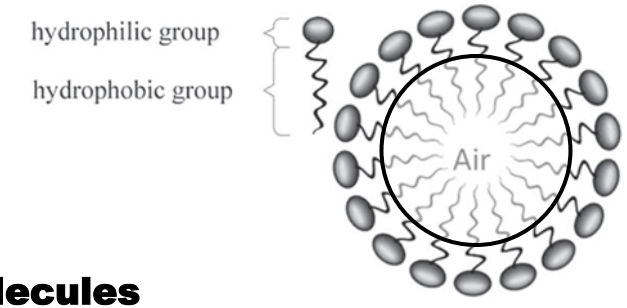
Foam Fractionation
Multi-parameters experimental plan

Brine production

Laboratory & pilot evaluation

Treatment efficiency in controlled conditions

2. Methods (2/2)



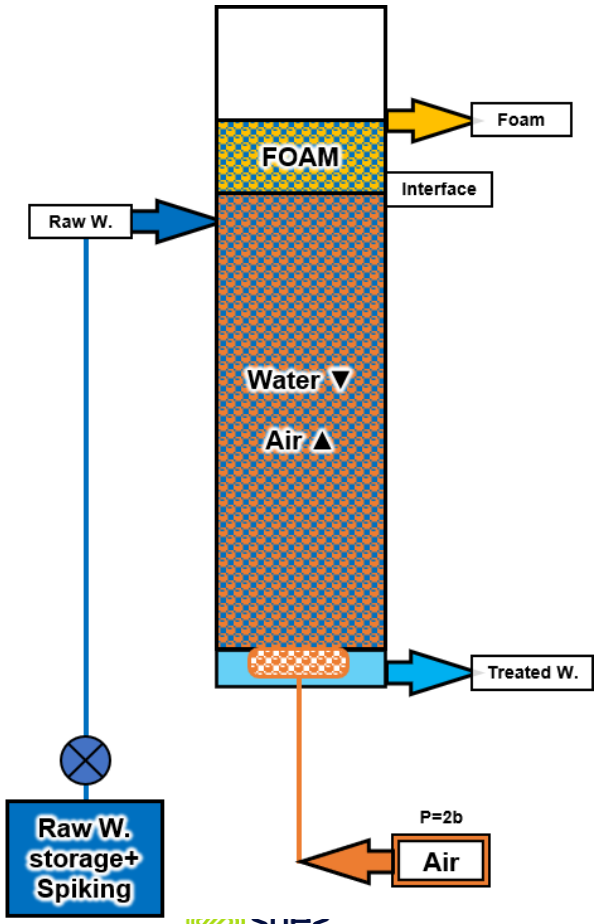
Technical principle

- Specific property of PFAS: **amphiphilic molecules**
- Known technology taking advantage of this characteristic: **Foam Fractionation**

Simple strategy => provide a large volume of air to promote **micelle conformation**

Experimental plan

- Air/water ratio
- Contact time
- Use and dose of surfactant



Laboratory & pilot evaluation

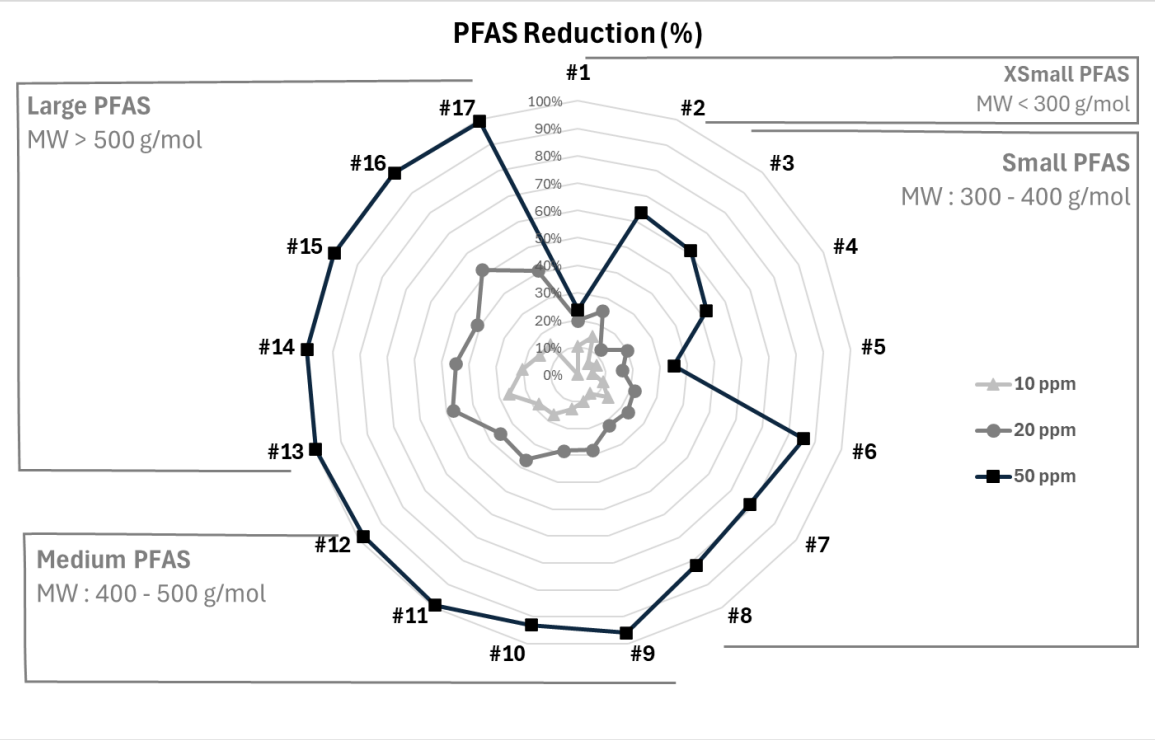
Treatment efficiency in controlled conditions

3. Relevant results on GAC

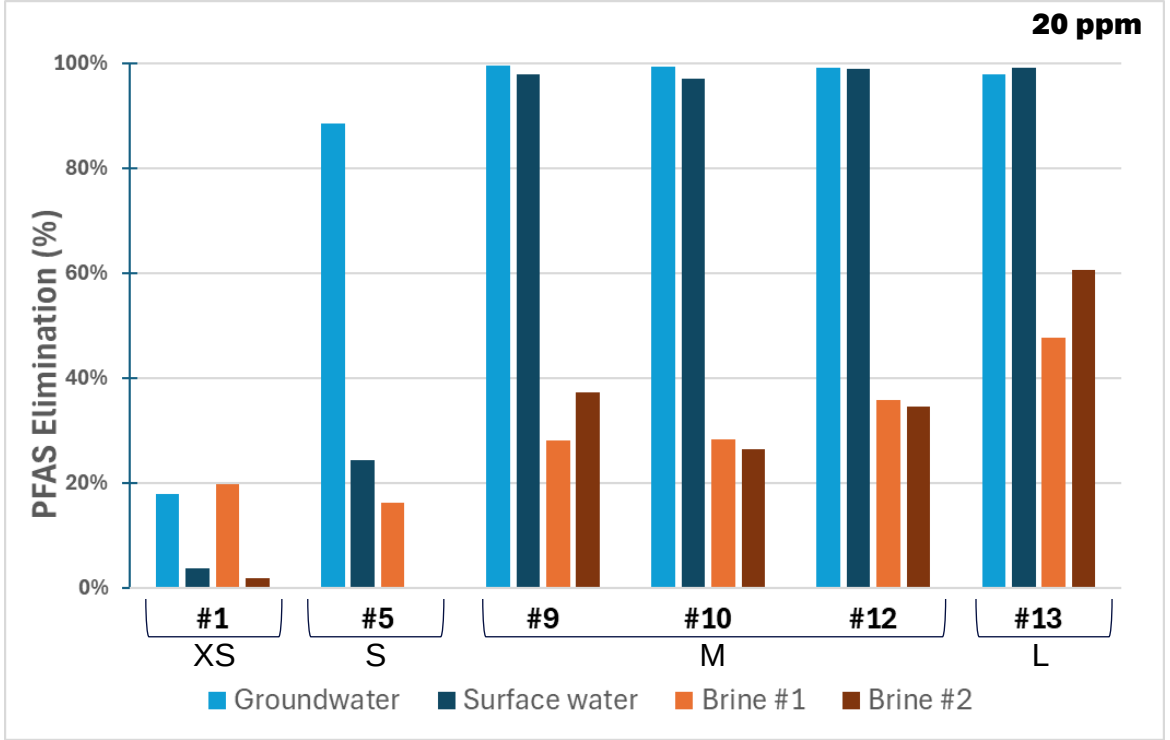
	GW	SW	Brine #1	Brine #2
NOM	C1	C2	C3	C4
Salinity	C1	C2	C4	C3

(C1 < C2 < C3 < C4)

Media performance



Matrix influence



- Elimination correlated to PFAS size
- PFAS elimination possible at high dosing rates
- Trials with unactivated biochar → **very limited adsorption of L PFAS / no elimination of XS/S/M PFAS**

- High competition of NOM with PFAS
- Impact for large PFAS

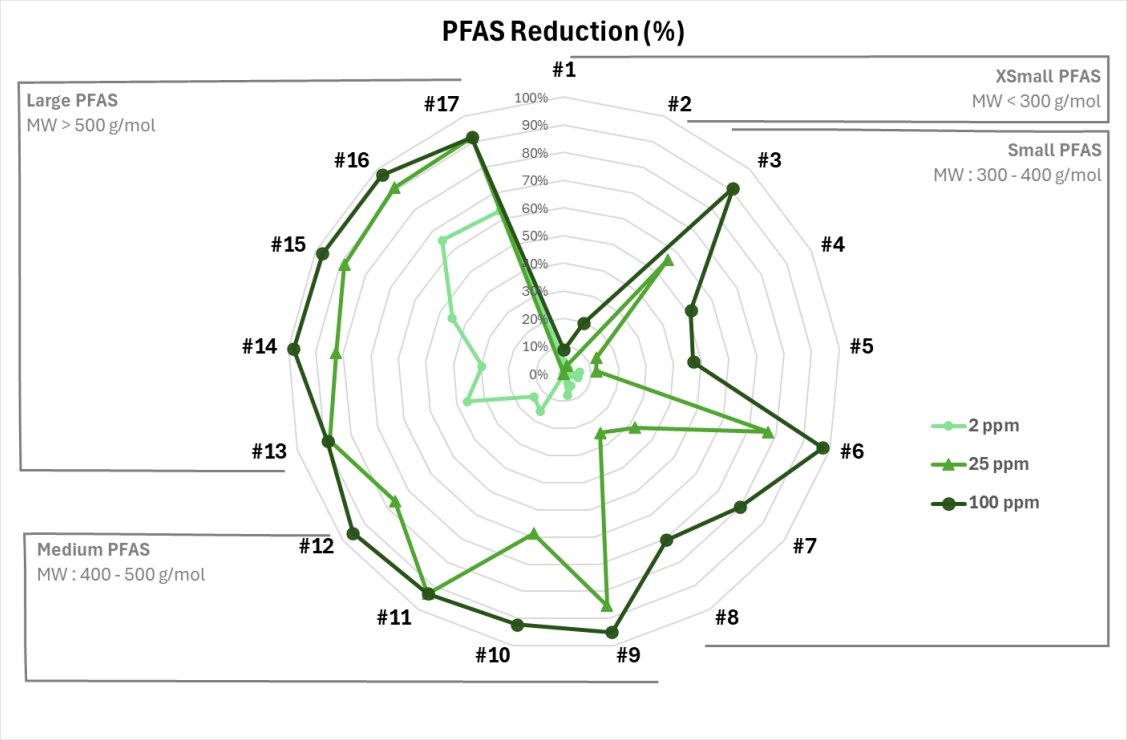
→ GAC is efficient for large PFAS elimination in brine matrixes, but competition occurs with NOM

3. Relevant results on clay

	GW	SW	Brine #1	Brine #2
NOM	C1	C2	C3	C4
Salinity	C1	C2	C4	C3

(C1 < C2 < C3 < C4)

Media performance



- Elimination correlated to PFAS size
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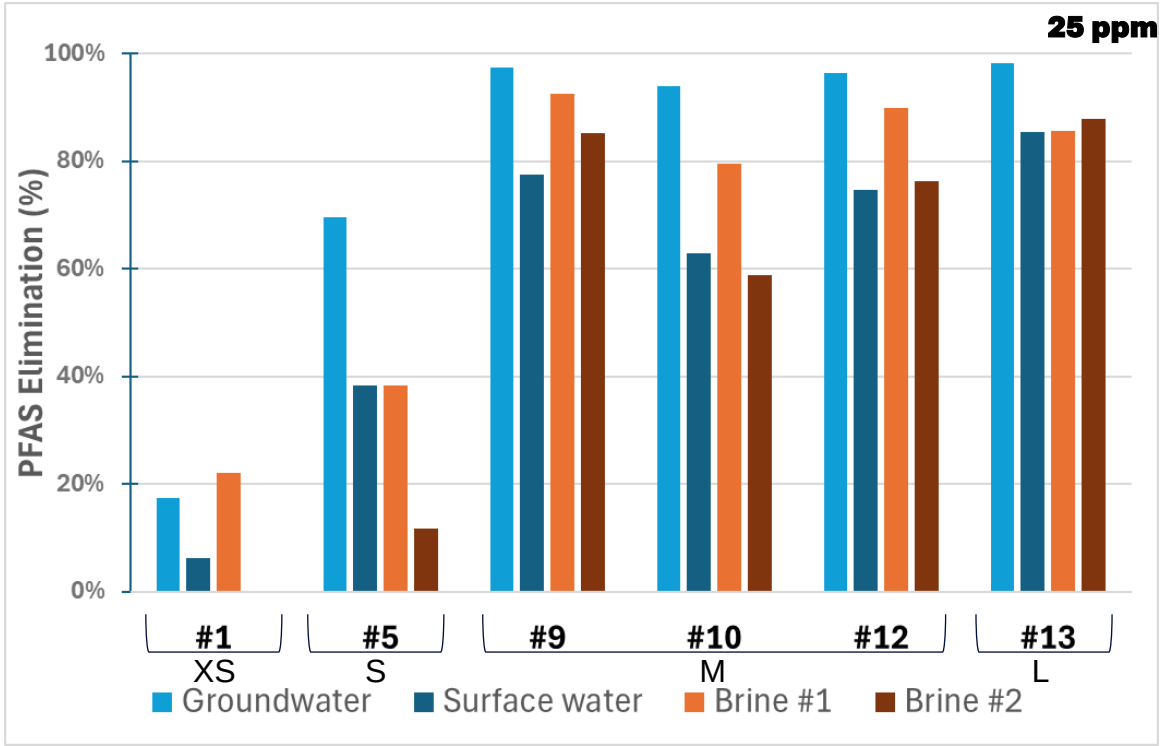
Matrix influence



- Limited competition of NOM with PFAS

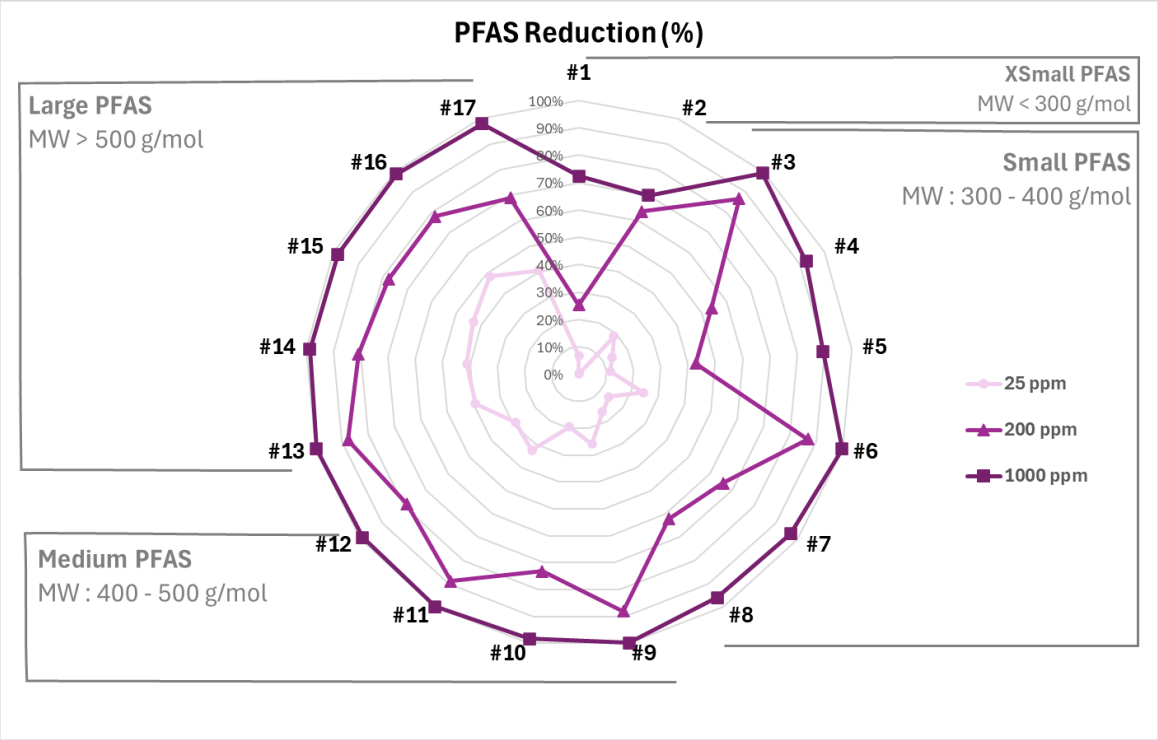
➔ **Clay is a good option for large PFAS elimination in brine matrixes as no competition with NOM**

4. Relevant results on resins

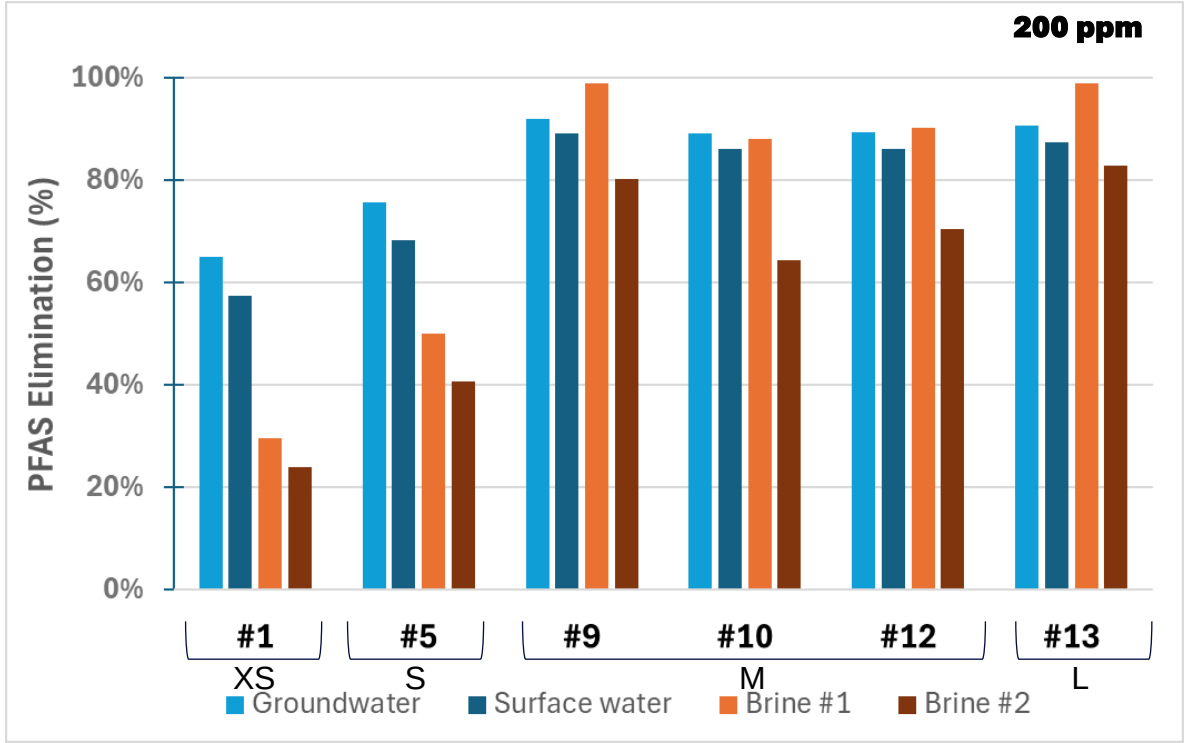
	GW	SW	Brine #1	Brine #2
NOM	C1	C2	C3	C4
Salinity	C1	C2	C4	C3

(C1 < C2 < C3 < C4)

Media performance



Matrix influence



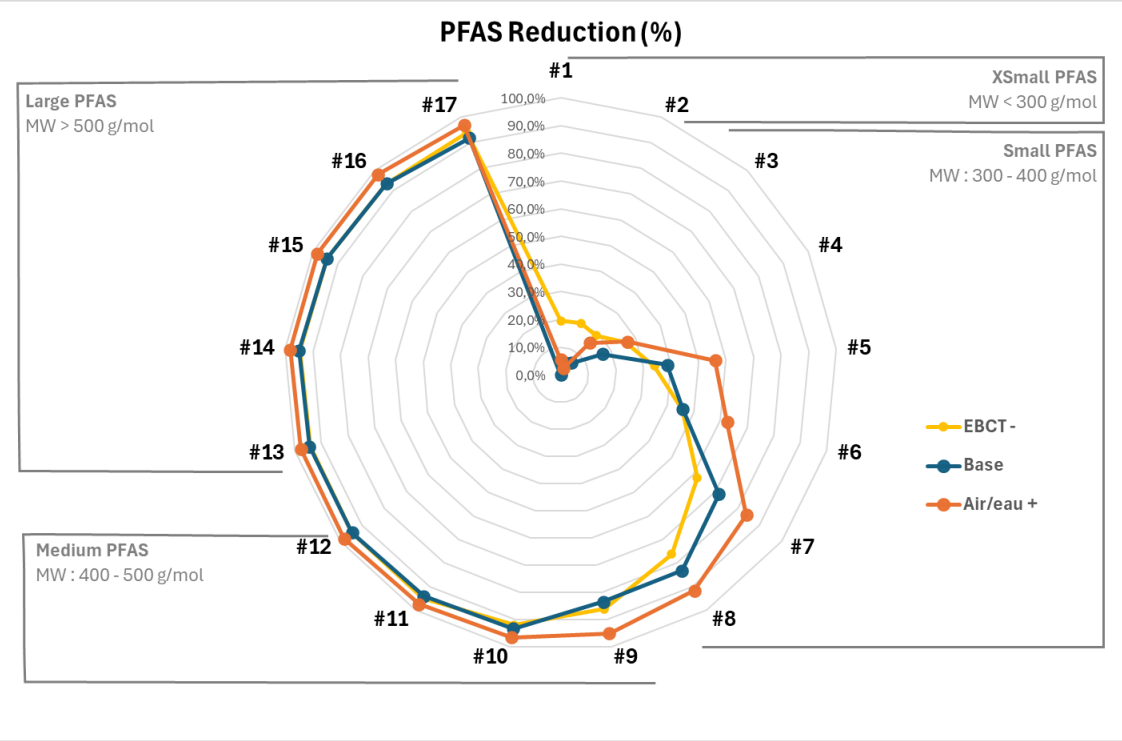
- Best media performances with all-size PFAS elimination
- PFAS elimination possible at high dosing rates

- Competition with ions and organic matter
- No distinction of ions vs organic matter contribution in competition

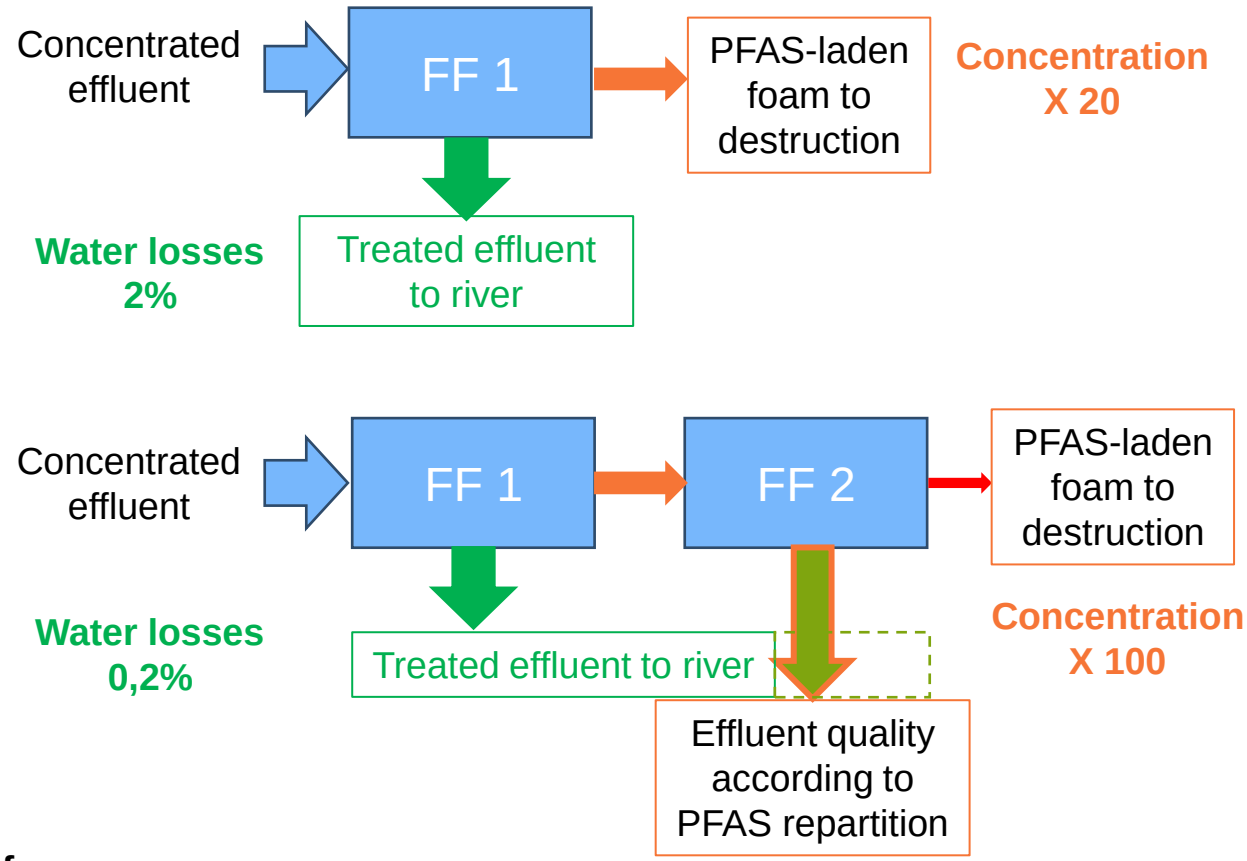
Resins offer a wide spectrum of PFAS removal but is affected by ions and organic matter competition

5. Foam fractionation results

Performance



Process configuration



- **Elimination correlated to PFAS size**
- Slight improvement of elimination by increasing air/water ratio

- **Limited influence of matrix characteristics (salinity, NOM) on FF performance**

PFAS size drives the removal performance, process conditions have a moderate impact

6. Conclusion and perspectives

	Price (€/t)	PFAS treatment in brine effluent				Matrix impact
		XS	S	M	L	
Biochar	0,8 €/kg	No elimination	No elimination	No elimination	Moderate	Not pertinent
Resin	10 €/L	Moderate	Good	Very good	Very good	Ions and NOM impact
GAC	1,5 €/kg	No elimination	Moderate	Very good	Very good	NOM impact
Clay	3 €/kg	No elimination	Moderate	Very good	Very good	No impact
FF	-	No elimination	Moderate	Very good	Very good	No impact

2 OBJECTIVES REACHED

PFAS PURIFICATION
→ NATURAL ENVIRONMENT REJECT

PFAS POLLUTION CONCENTRATED
→ DESTRUCTION STEP

PERSPECTIVES

- **Regulatory follow-up**
- **Pilot scale trials**
- **Technico-economical study**
- **Destruction method evaluation**

THANK YOU FOR YOUR ATTENTION