

**Guideline for  
Implementing Disinfection  
in Drinking Water Supply  
Systems**



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**Funded by  
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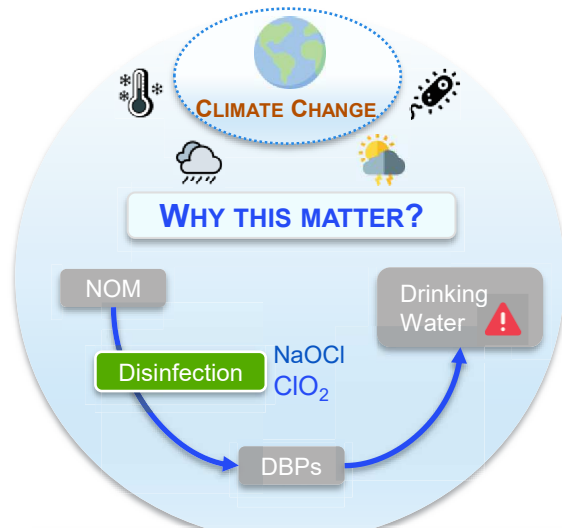
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# Guideline for Implementing Disinfection in Drinking Water Supply Systems

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## Why Regulation Matters



Disinfection is necessary to maintain microbial water safety, but can form DBPs

No centrally harmonized EU-wide list of national standards governing the use of disinfectant in DW

## EU Framework


 EU Drinking Water Directive (EU) 2020/2184  
Sets out general quality and hygiene requirements

## Implementation by Member States

Directive transposed into national laws and regulations

Drinking Water must be “wholesome and clean” – DWD (EU) 2020/2184



 Member States decide how to achieve microbial safety

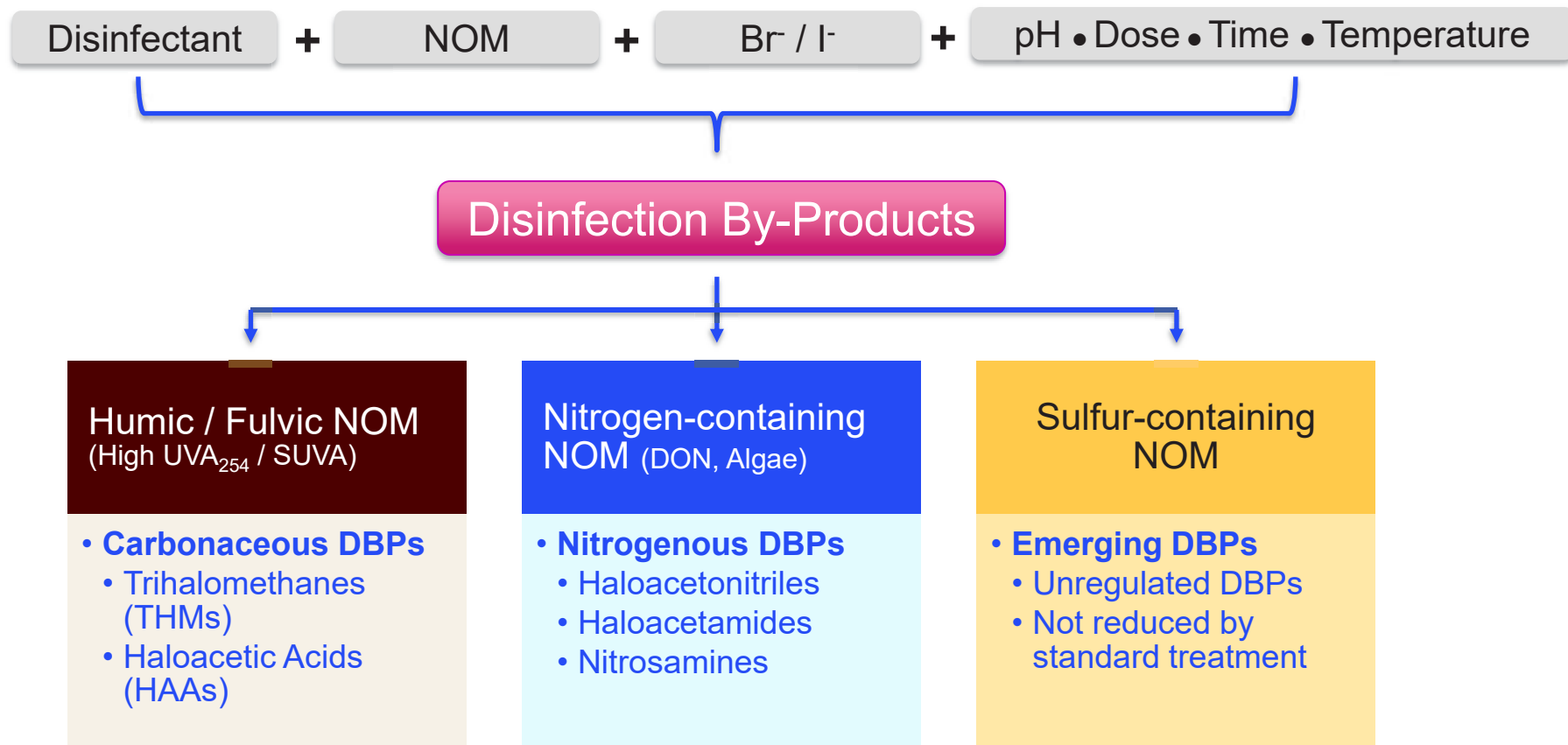
Disinfectants must comply with EU Regulation No 528/2012 (Biocides)



ECHA: list of authorized biocidal products for each Member State



# DISINFECTION BY-PRODUCTS (DBPs): FORMATION AND KEY PRECURSORS



## Robust Risk Assessment

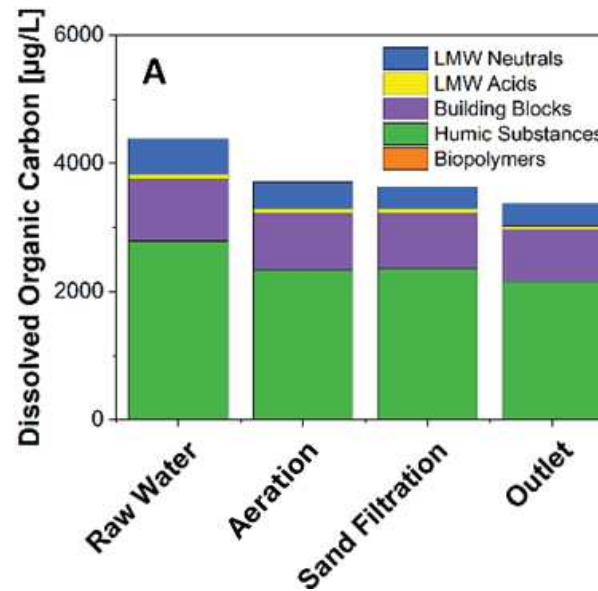
- Characterize Water Matrix (TOC, UVA<sub>254</sub>)
- Monitor Seasonal NOM Variation
- Conduct DBP Formation tests
- Select Optimal Disinfection Strategy



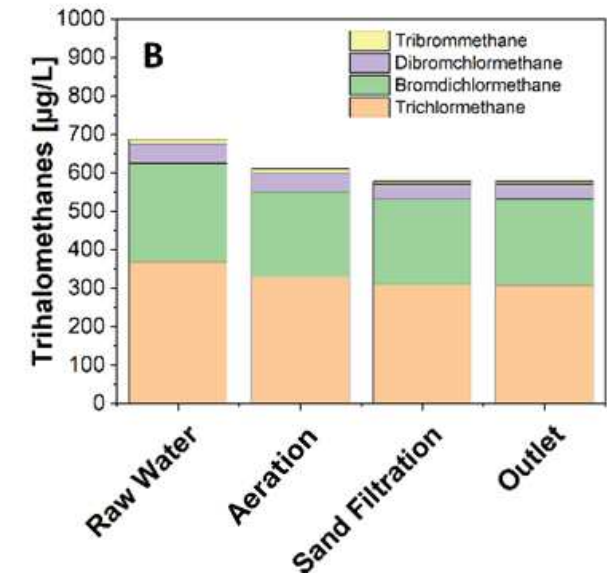
## Case Study – Hamburg (Germany)

NOM composition and concentration vary significantly depending on the source water and treatment configuration → **strongly influencing the DBP-FP in DWTPs.**

Hamburg: Groundwater without routine disinfection: NOM removal was limited and mainly associated with aeration and co-precipitation processes.



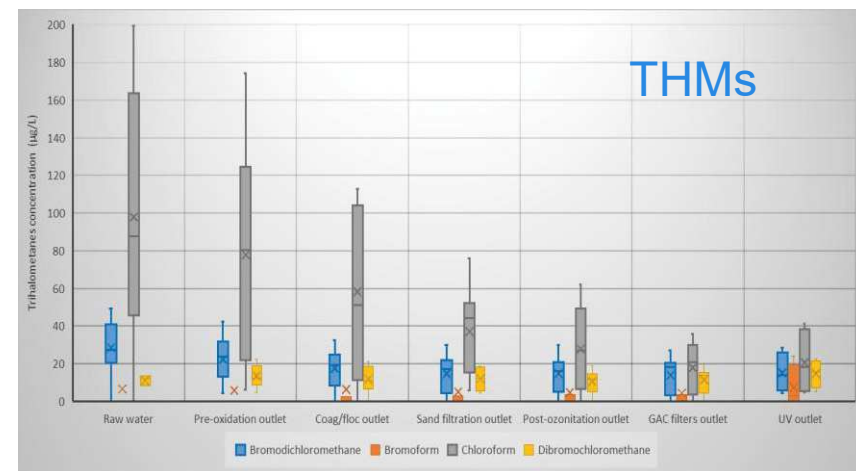
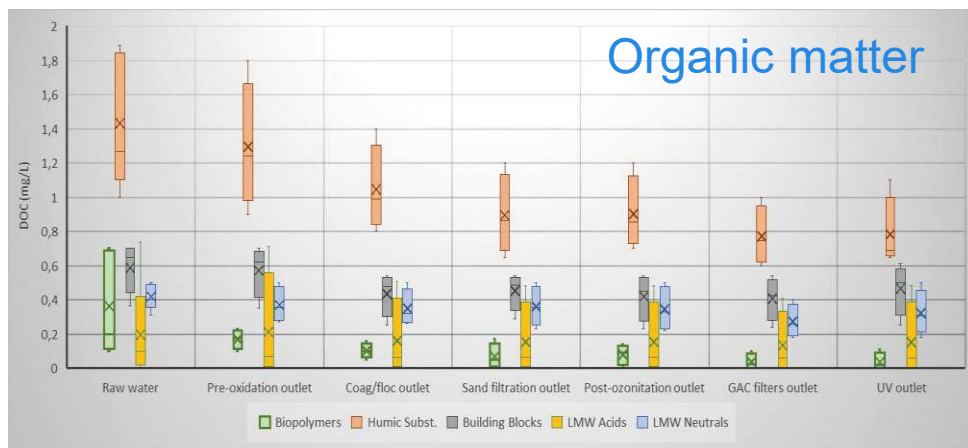
## DBP-Formation Potential



As a result, only modest reductions in DBP formation potential were observed, **highlighting the need for adapted treatment strategies** should chlorine disinfection become necessary in the future.



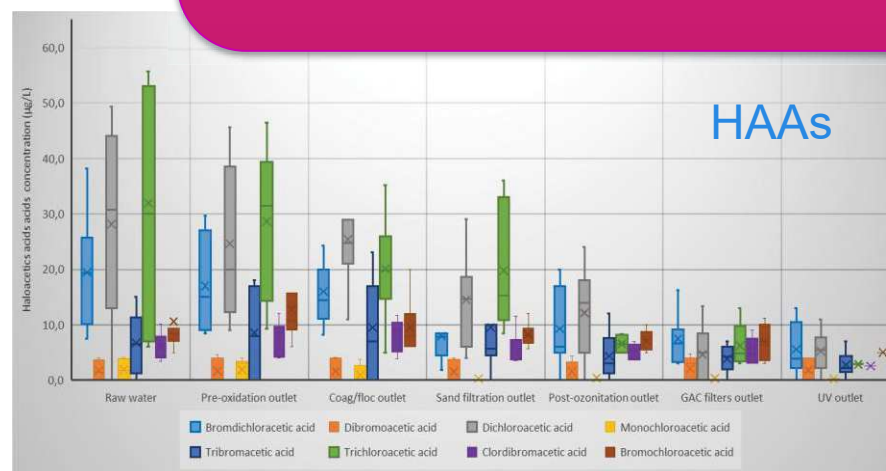
## Case Study – Tarragona (Spain)



Tarragona:

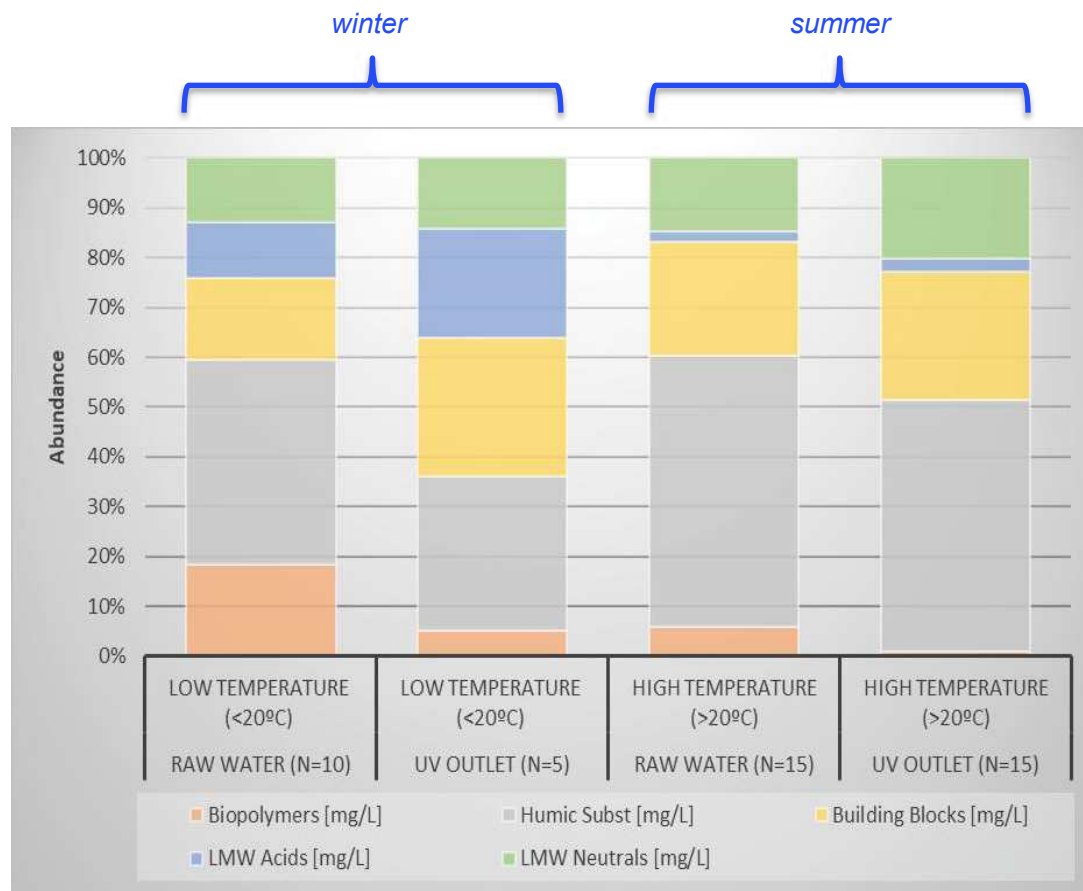
- significant reductions in NOM and DBP-FP occurred mainly during coagulation–flocculation–sedimentation and sand filtration.
- **Ozonation: transformation**

Combination of oxidation and adsorption processes was shown to be essential for effective DBP control in surface water treatment, as oxidation alone can increase NOM reactivity if not followed by adequate downstream removal, such as activated carbon filtration.



## Case Study – Tarragona (Spain)

**Seasonal variability had a strong influence** on organic matter speciation and consequently on DBP speciation and formation potential.





## UV

- Is recommended, if the water distribution network is well-maintained.

## Disinfectant Selection

- Depends on source water and network conditions. Sodium hypochlorite (NaOCl) or chlorine dioxide (ClO<sub>2</sub>) are generally recommended.

## Disinfectant Dosing

- Should be kept at the minimum – maintain microbial water safety. Automated dosing systems can help achieve precise control.

## Treatment Technologies

- Should be optimized: coagulation / flocculation, ozonation, activated carbon, or selective membrane adsorption to selectively remove the precursors of DBPs.

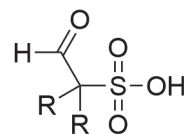
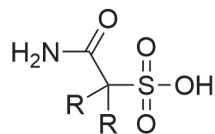
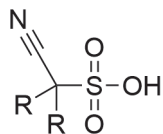
## Model-based Systems

- Should be used to optimize disinfectant dosing and minimize DBPs.



## Novel sulfonated DBPs – UFZ (Germany)

15 novel DBPs were identified for the first time, as the sulfonic acid derivatives of previously known toxic DBPs (e.g., haloacetonitriles, haloacetamides, and haloacetaldehydes)



R: H, Cl, or Br

These compounds are widespread in disinfected water, regardless of water source or treatment methods.

**No analytical standards are currently available**, and therefore **toxicity data are still lacking**. However, preliminary results indicate that mixtures of these compounds exhibit cytotoxicity and induce oxidative stress, highlighting the need for further investigation.



## Material-related contamination – Polimi (Italia)

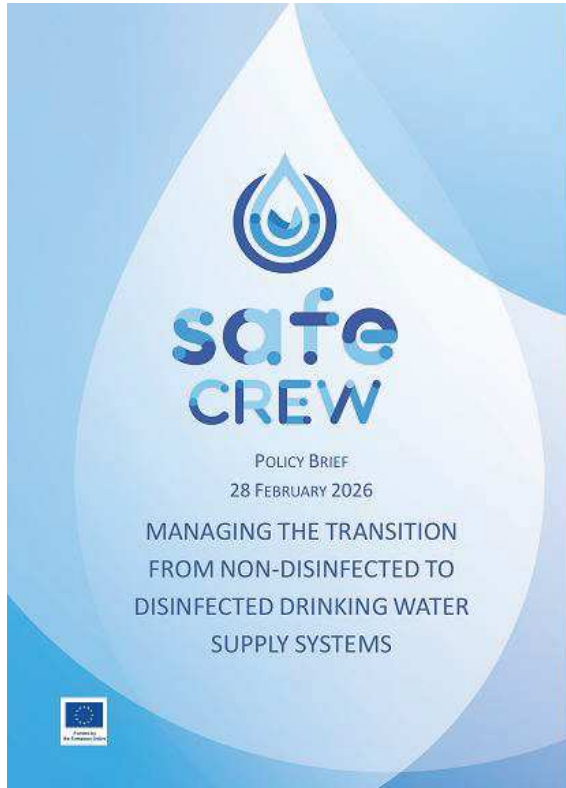
Materials used in drinking water systems (e.g., pipe relining with epoxy resins) can release potentially harmful substances into water – aging water infrastructure

Detection of nitrosamines: Monitoring identified nitrosamines such as NDMA (N-nitrosodimethylamine) and NMOR (N-nitrosomorpholine) both before and after relining, indicating multiple contamination sources.

Some released chemicals may be toxic themselves or react with disinfectants (like sodium hypochlorite) to form harmful by-products.

Contaminants may originate from resins, additives, or other pipe materials; limited toxicity data (e.g., for NMOR) highlights the need for further research.





## Recommendations for disinfection

- If the water distribution network is well-maintained, UV disinfection is highly recommended.
- The selection of disinfectants depends on source water and network conditions. Sodium hypochlorite (NaOCl) or chlorine dioxide (ClO<sub>2</sub>) are generally recommended, while chloramine may be preferred in certain cases. For ClO<sub>2</sub>, on-site generation, cold storage, and frequent monitoring of chlorite and chlorate are required, avoiding long-term storage. For NaOCl, storage time and temperature must be optimized to prevent chlorate formation considering site-specific factors.
- Disinfectant dosing should be kept at the minimum required to maintain microbial water safety. Advanced monitoring and automated dosing systems help achieve precise control, reducing the formation of regulated disinfection by-products (DBPs).
- Water utilities should implement or optimize treatment technologies, such as coagulation/flocculation, ozonation, activated carbon, or selective membrane adsorption, to selectively remove natural organic matter (NOM) that serves as precursor for regulated DBPs.
- Water utilities should use predictive or metamodel-based systems to optimize disinfectant dosing and minimize DBPs.

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