# LINKING SCIENCE AND POLICY

## DERIVING THRESHOLD LEVELS AND STANDARDS

K. Touchant & M. Van Holderbeke (VITO)

# LINK BETWEEN SCIENCE & POLICY – INTERNATIONAL & NATIONAL

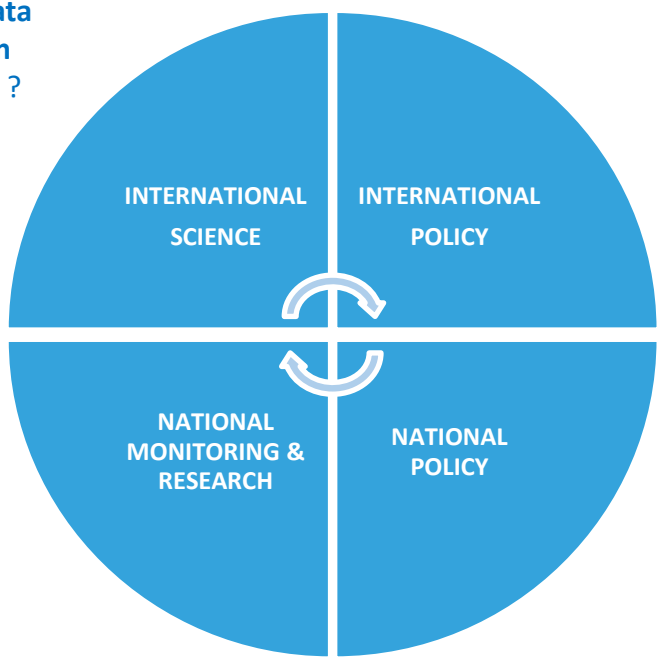
**Widespread occurrence**

**Legally recognized hazards for some substances**

**Biomonitoring data**
**- impact is proven**
- additive effect = ?

**EFSA**
**Exposure to PFAS through food**

Growing number of environment and health publications
Grandjean et al, 2018



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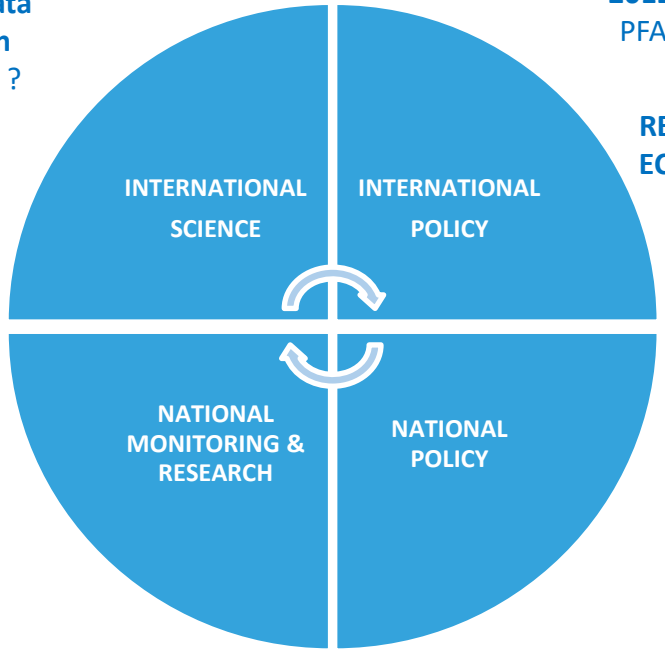


**2012**: **ICCM3**
PFAS as EPI

**Stockholm Convention**
**2009** - **PFOS** in annex B
**2019** - **PFOA** in annex A

**2017 – 2019**
**REACH**: **ind. substances**
**ECHA**: **groups approach**

**2019**
**PFAS strategy to the EU Commission**

**2020**
**EU Green Deal**
**CSS - Toxic Free Environment**

*2018: case in Minessota*
*2019: scandal in the NL*
*Tensions US Defense-ATSDR*

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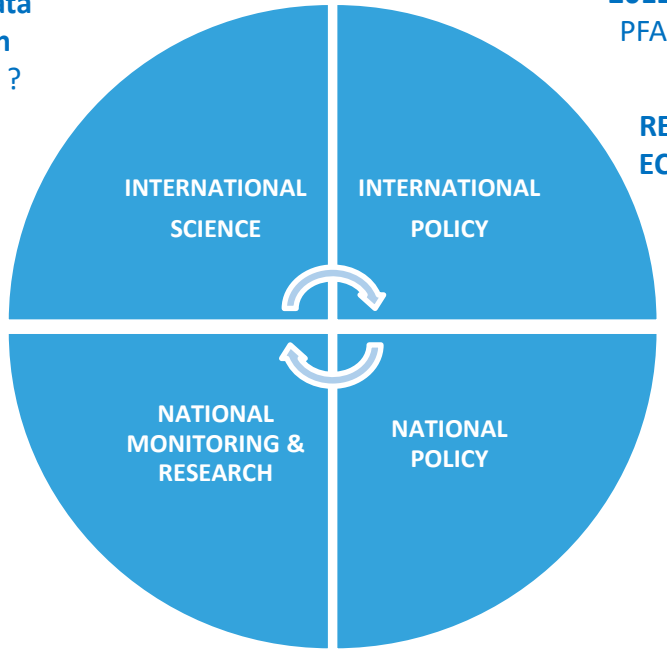


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**18/02/2020**
**PFAS action plan for Flanders**

**REGULATION by the regions**

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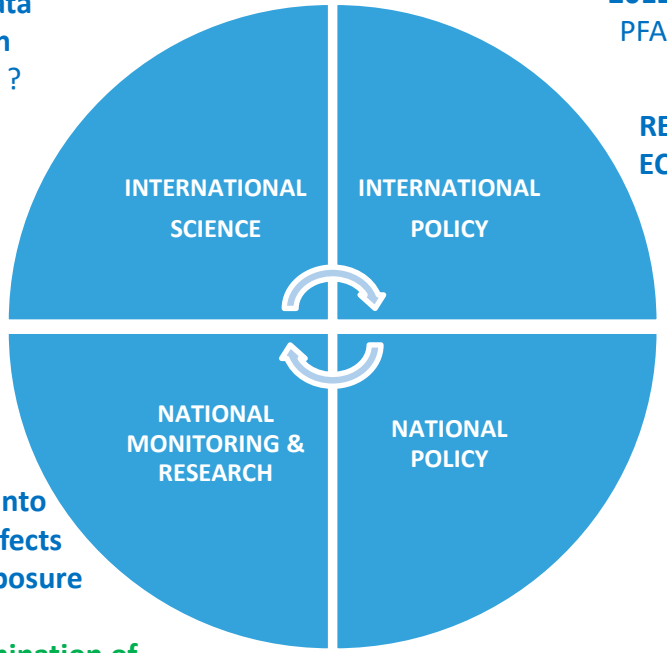


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**Environmental monitoring**

**HBM**

**Soil pollution**

**Emission to water**

**PFAS safe drinking water**

**Insight into health effects human exposure**

**Determination of guideline values & measurement methods**

**Implementing EU regulations in BE**

**18/02/2020**
**PFAS action plan for Flanders**

**REGULATION by the regions**

# PFAS IN THE (FLEMISH) SOIL DECREE

**Suspicious risk locations ≠ licensed establishments**

- firefighter areas
- ***locations where PFAS are produced***
- PFAS processing industry (paint industry, textile industry, paper industry, galvanic industry)
- landfills
- water treatment plants

➢ **NOT mandatory to investigate until 2020**

- **DRAFT GUIDELINE PFAS for RE-USE of soils/sediments** (**OVAM: 2/12/2019**; 01/09/2020)
- based on **PRELIMINARY STANDARD for re-use for PFOS** (also for **∑ PFAS**)

➢ 2 exploratory studies at risk locations (OVAM, **2018** & **2019**)

- highest C at firefighter training areas ➔ PFOS, PFOA, PFHxA, PFHxS, PFNA, PFDA, n: 2 FTS

➔ ***little information / monitoring data for soil and groundwater***
➔ ***specific fingerprint for locations with fire fighting foams ?***
➔ ***PFAS mixture on other industrial sites, landfills, … ?***

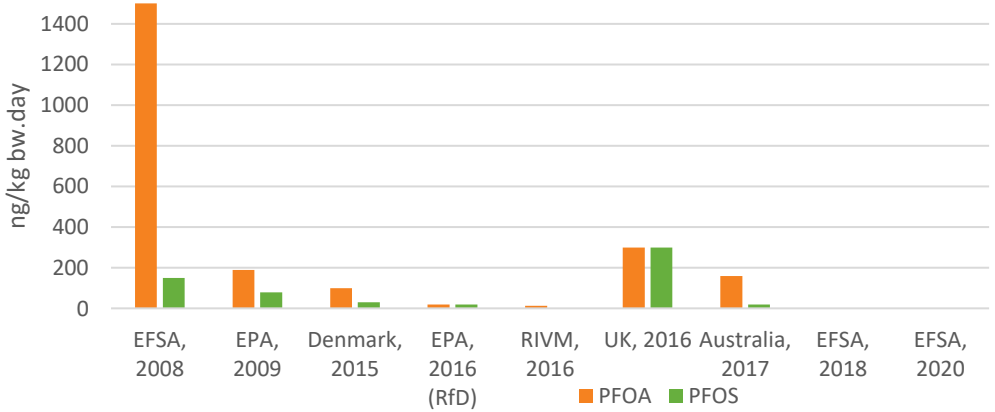
# DO WE NEED THRESHOLDS/LIMIT VALUES TO MAKE POLICY DECISIONS ?

**YES ! (= action 17 in PFAS action plan for Flanders)**

- **Soil remediation standards are necessary for soil policy**
  - ✓ to manage soil and groundwater pollution at contaminated sites
    = risk assessment in soil investigations
- **Limit values for re-use are necessary for soil policy**
  - ✓ to avoid problems with soil re-use
    = disposal opportunities (avoiding stagnation of construction sites)
- **Scientific knowledge is necessary to derive reliable standards, but it is constantly evolving, also internationally**

# SOIL REMEDIATION STANDARDS FOR PFOS AND PFOA

- **Data available for standardization ?**
  - ✓ ecotoxicity ➔ *ecological soil remediation standards*
  - ✓ legal limits ➔ drinking water; **NOT for air, animal products, crops, nutrition & feed**
  - ✓ human toxicity ➔ *human soil remediation standards*
    - **Toxicity reference values**
      - **TDI: downward trend**
      - **Toxicological endpoint is discussion topic between several institutes**



## SOIL REMEDIATION STANDARDS ➔ LIMIT VALUES FOR RE-USE OF SOIL

- **Soil remediation standards for PFOS and PFOA conducted for Flanders**
  - ☺ **data available**
  - ☹ **TDI: discussion on endpoint is still going on**
  - ☹ **LEACHING to groundwater is NOT taken into account**
    - = separate topic in Flemish soil investigations
      - ✓ Human risk assessment
      - ✓ Ecotoxicological risk assessment
      - ✓ **Risk of spreading (leaching and groundwater transport)**

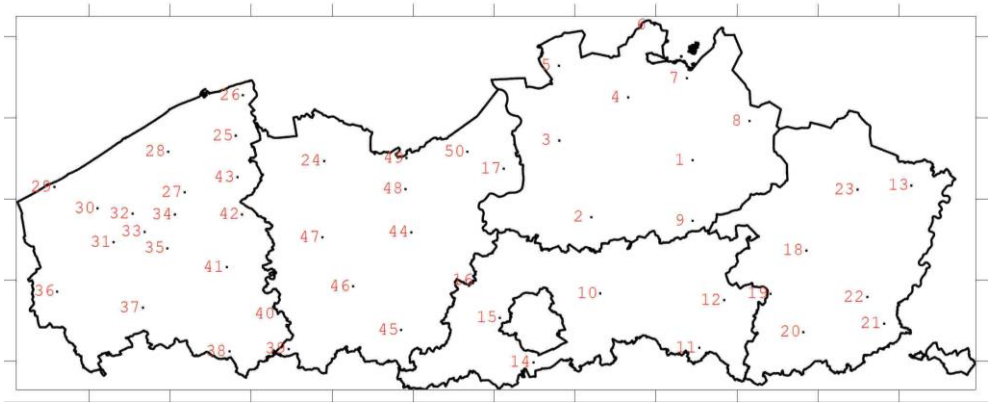
- **Limit values for re-use**

| | Background value | Limit value re-use | SRS I/II |
|---|---|---|---|
| PFOS/PFOA | ? | ? | ☺ |

# PFAS BACKGROUND LEVELS IN THE FLEMISH SOIL = ?

- **Study initiated by OVAM (2020)**
  50 'unpolluted' locations in Flanders topsoil samples (0-20 cm)
  **39 PFAS-compounds**

  **Action 15 in PFAS action plan for Flanders**



- **Occurrence of PFAS in soil ?**

  ➔ **PFOS, PFOA** & **PFBA** structurally found ubiquitous in the top layer (**P90-value** = **background value**)

  ➔ **6:2 FTS** (in **27/50** soil samples)

| | Average (µg/kg dm) | Background values (µg/kg dm) | Quantification limit (µg/kg dm) |
|---|---|---|---|
| PFOS | 0,78 | 1,50 | 0,2 |
| PFOA | 0,56 | 0,96 | 0,2 |
| PFBA | 0,76 | 1,25 | 0,2 |

**In the Netherlands (P95 value)**
**PFOS = 1,4 µg/kg dm** **PFOA = 1,9 µg/kg dm**

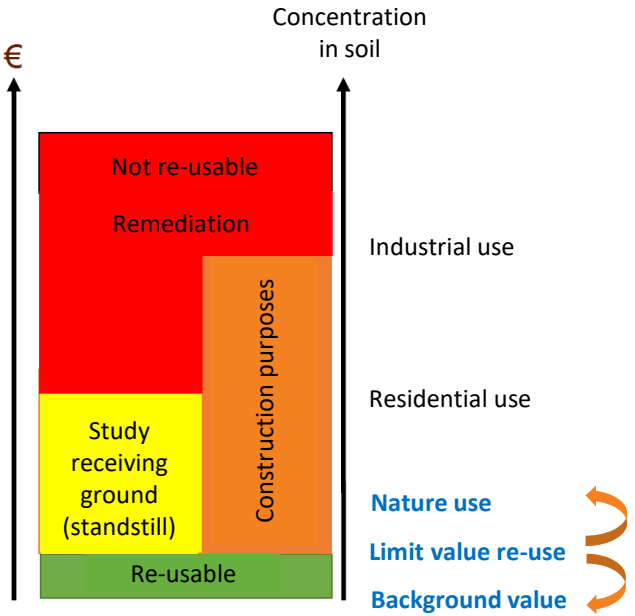
# LIMIT VALUES FOR RE-USE OF SOIL IN FLANDERS - WORK IN PROGRESS

- ✓ soil remediation standards for nature/agriculture
- ✓ background values
- ✓ leaching to groundwater (= protecting groundwater)
- ✓ feasibility

| | Background value | Limit value re-use | SRS I/II |
|---|---|---|---|
| PFOS/PFOA | ☺ | ? | ☺ |

- ➢ *feasibility* to avoid problems with soil re-use
  - concern of soil management organizations
  - disposal opportunities = impact on market for re-usable soil
  - avoiding stagnation on construction sites

- ➢ *leaching to groundwater = work in progress*
  - ➔ *stricter criteria for groundwater protection = ?*
  - ➔ *leaching tests necessary ?*



# ANALYTICAL ASPECTS

- **Flanders - 18 PFAS ➔ 2021 ~ 39 PFAS**
  - PFBS, PFHxS, **PFOS** & PFDS
  - PFOSA
  - PFPA, PFHxA, PFHpA, **PFOA**, PFNA, PFDA, PFUdA & PFDoA
  - PFBA, PFTrDA, PFTeDA, PFHxDA & PFODA (indicative)

- **Netherlands - 30 PFAS**
  - **advisory list – 12/07/2019**
  - Gen X only to be measured in case of suspicion

➔ other countries ?
➔ analytical performance ?

| | | |
|---|---|---|
| **PFBA** | **PFBS** | **MeFOSA** |
| **PFPeA** | **PFPeS** | **EtFOSA** |
| **PFHxA** | **PFHxS** | **FOSAA** |
| **PFHpA** | **PFHpS** | **MeFOSAA** |
| **PFOA** | **PFOS** | **EtFOSAA** |
| **PFNA** | **PFNS** | **6:2 PAP** |
| **PFDA** | **PFDS** | **8:2 PAP** |
| **PFUdA** | **PFDoS** | **6:2 diPAP** |
| **PFDoA** | **4:2 FTS** | **6:2/8:2 diPAP** |
| **PFTrDA** | **6:2 FTS** | **8:2 diPAP** |
| **PFTeDA** | **8:2 FTS** | **HFPO-DA** |
| **PFHxDA** | **10:2 FTS** | **ADONA** |
| **PFODA** | **FOSA** | **PFECHS** |

| # | Compound | Acronym | F |
|---|---|---|---|
| 1 | perfluoro-n-butanoic acid | PFBA | C |
| 2 | perfluoro-n-pentanoic acid | PFPeA | C |
| 3 | perfluoro-n-hexanoic acid | PFHxA | C |
| 4 | perfluoro-n-heptanoic acid | PFHpA | C |
| 5 | perfluoro-n-octanoic acid( lineair) (1) | PFOA | C |
| 6 | perfluoro-n-octanoic acid(branched)(1) | PFOAvertakt | - |
| 7 | perfluoro-n-nonanoic acid | PFNA | C |
| 8 | perfluoro-n-decanoic acid | PFDA | C |
| 9 | perfluoro-n-undecanoic acid | PFUnDA | C |
| 10 | perfluoro-n-dodecanoic acid | PFDoA | C |
| 11 | perfluoro-n-tridecanoic acid | PFTrDA | C |
| 12 | perfluoro-n-tetradecanoic acid | PFTeDA | C |
| 13 | perfluoro-n-hexadecanoic acid | PFHxDA | C |
| 14 | perfluoro-n-octadecanoic acid | PFODA | C |
| 15 | perfluoro-1-butane sulfonic acid | PFBS | C |
| 16 | perfluoro-1-pentane sulfonic acid | PFPeS | C |
| 17 | perfluoro-1-hexane sulfonic acid | PFHxS | C |
| 18 | perfluoro-1-heptane sulfonic acid | PFHpS | C |
| 19 | perfluoro-1-octane sulfonic acid (lineair)(1) | PFOS | C |
| 20 | perfluoro-1-octane sulfonic acid (branched)(1) | PFOSvertakt | - |
| 21 | perfluoro-1-decane sulfonic acid | PFDS | C |
| 22 | 4:2 fluorotelomer sulfonic acid | 4:2 FTS | C |
| 23 | 6:2 fluorotelomer sulfonc acid | 6:2 FTS | C |
| 24 | 8:2 fluorotelomer sulfonic acid | 8:2 FTS | C |
| 25 | 10:2 fluorotelomer sulfonic acid | 10:2 FTS | C |
| 26 | N-methylperfluorooctane sulfonamidoacetic acid | N-MeFOSAA | C |
| 27 | N-ethylperfluorooctane sulfonamidoacetic acid | N-EtFOSAA | C |
| 28 | perfluoro-1-octanesulfonamide | PFOSA | C |
| 29 | N-methylperfluorooctanesulfonamide | N-MeFOSA | C |
| 30 | 8:2 polyfluoroalkyl phosphate diester | 8:2 diPAP | C |

# A SUBSTANCE-BY-SUBSTANCE RISK ASSESSMENT ?

| | Carboxylic acids | | | | | | | | | | | | | | | | Sulfonic acids | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | PFBA | PFPeA | PFHxA | PFHpA | PFOA | PFNA | PFDA | PFUnA | PFDoDA | PFTrDA | PFTeDA | | PFHxDA | | PFODA | | PFBS | PFPeS | PFHxS | PFHpS | PFOS | FFNS | PFDS |
| | | | | | | | | | | | | | | | | | | | | | | | |
| **Analytical protocol** | | | | | | | | | | | | | | | | | | | | | | | |
| CMA | x | x | x | x | x | x | x | x | x | x | x | | x | | x | | x | | x | | x | | x |
| DIN | x | x | x | x | x | x | x | | | | | | | | | | x | | x | | x | | |
| **Fys Chem** | x | x | x | x | x | x | x | x | x | x | x | | | | | | x | | x | | x | | x |
| **Tox** | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| HBV drinking water | x | x | | x | x | x | x | | | | | | | | | | x | | | x | x | | |
| RPF-PFOA | x | (x) | x | (x) | x | x | (x) | x | x | (x) | x | | x | | x | | x | (x) | x | (x) | x | | x |
| RPF-Kinetics | x | x | x | x | x | | | | | | | | | | | | x | x | x | x | x | | |
| **Monitoring data** | x | | x | | x | | | | | | | | | | | | x | | | | x | | |
| biomonitoring | | | | | x | | | | | | | | | | | | | | x | | x | | |
| soil | | | | | | | | | | | | | | | | | | | | | | | |
| drinking water | x | x | x | x | x | | | | | | | | | | | | x | x | x | x | x | | |
| diet | x | x | x | x | x | x | x | x | x | x | x | | 0 | | 0 | | x | | x | LB = 0 | x | | LB = 0 |
| plant | x | x | x | x | x | x | x | (x) | (x) | | | | | | | | x | | x | | x | | |
| transfer cattle | | | | | x | x | x | x | x | | | | | | | | x | | x | | x | | |
| ecotox | | | | | | | | | | | | | | | | | | | | | | | |
| **HBGV** | | | | | x | | | | | | | | | | | | | | (x) | | x | | |

- Large number of PFAS compounds
- Information on their hazardous properties, environmental fate and transport, exposure and toxic effects (& Health based guidance values) is still very limited !

## RPF RIVM (Zeilmaker et al., 2018) ➔ additional RPF in 2020 (Bil et al.)

**RPF approach** = the toxic potencies of a set of PFAS compounds are expressed relative to the toxic potency of the index compound **(= PFOA)**.

**Risk of the PFAS mixture**
= comparing the **∑ PFOA-equivalents <> SRS PFOA**

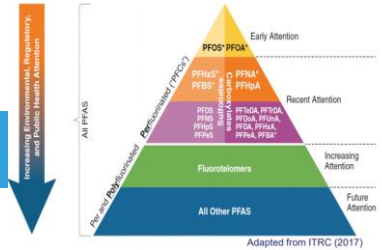
**2018-2020: 23 RPF**

12 based on **liver effects (discussion on endpoint !)**
+ 7 (read-across ➔ range)
+ 4 (HPFO-DA, ADONA, 6:2 FTOH & 8:2 FTOH)

- ***individual SRS for PFOS & PFOA ➔ double test ?***
- ***2 groups: PFSAs & PFCAs ?***

| Per- and polyfluorinated congeners | RPF |
|---|---|
| Sulfonic acids | |
| PFBS | 0.001 |
| PFPeS[b] | 0.001 ≤ RPF ≤ 0.6 |
| PFHxS | 0.6 |
| PFHpS[b] | 0.6 ≤ RPF ≤ 2 |
| PFOS | 2 |
| PFDS[b] | 2 |
| Carboxylic acids | |
| PFBA | 0.05 |
| PFPeA[b] | 0.01 ≤ RPF ≤ 0.05 |
| PFHxA | 0.01 |
| PFHpA[b] | 0.01 ≤ RPF ≤ 1 |
| PFOA | 1 |
| PFNA | 10 |
| PFDA[b] | 4 ≤ RPF ≤ 10 |
| PFUnDA | 4 |
| PFDoDA | 3 |
| PFTrDA[b] | 0.3 ≤ RPF ≤ 3 |
| PFTeDA | 0.3 |
| PFHxDA | 0.02 |
| PFODA | 0.02 |
| Ether carboxylic acids | |
| HFPO-DA | 0.06 |
| ADONA | 0.03 |
| Telomer alcohols | |
| 6:2 FTOH | 0.02 |
| 8:2 FTOH | 0.04 |

# WHICH PFAS ARE A PRIORITY TO ASSESS = ?




## STUDIES on SOIL CONTAMINATION

| | |
|---|---|
| Fire Fighting areas (21) | PFOS, PFOA, PFHxA, PFHxS, PFNA, PFDA & n: 2 FTS ➔ specific fingerprint? |
| Background values soil (39) | PFOS, PFOA & PFBA - *6:2 FTS* |

## INTERNATIONAL SCIENCE

| | |
|---|---|
| EFSA (∑ 4 PFAS ) | PFOS, PFOA, PFNA & PFHxS |
| RPF RIVM (∑ 19 ➔ 23 PFAS) | PFOS, PFOA, 5 PFSAs, 12 PFCAs, HPFO-DA, ADONA, 6:2 FTOH & 8:2 FTOH |

## ANALYTICAL METHODS

18 PFASs (n:2 FTS not included) ➔ 39 PFASs

## MONITORING in Flanders

| | |
|---|---|
| Human biomonitoring | PFOS, PFOA, PFBS, PFHxS, PFHpS, PFPeA, PFHxA, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA |
| Surface water & biota | PFOS |
| Discharges (licensed) | PFOS, PFOA & ∑PFT |
| PFAS in effluent STP* | PFOS, PFOA, PHxA, PFBA, PFDA, PFHpA, PFPA, PFHxS, PFNA, PFBS, PFUnA, PFOSA |
| PFAS in drinking water (2018, 1st) | PFOS, PFOA, 6:2FTS, PFBS, PFBA, PFDA, PFHpA,PFHxS, PFHxA,PFNA, FOSA, PFPeA |
| Groundwater & air | NOT monitored |

* Sewage Treatment Plant

# WHAT DO WE STILL NEED TO KNOW

## ➢ Sources and distribution of PFAS in the environment

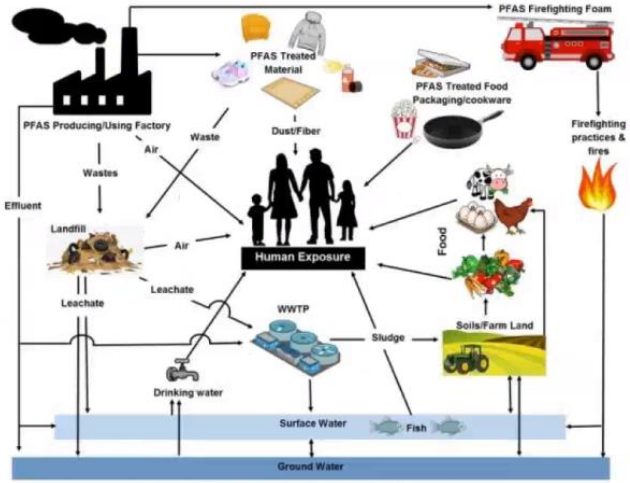
- PFAS in products (fingerprint ?)
- PFAS in water and waste streams
- Background values in groundwater

## ➢ Environmental behavior

- Leaching from soil and sediment
  - ➔ Risk limits in soil protecting groundwater

## ➢ Substance risks and risk limits

- Health based guidance values
- Other PFAS: mixture toxicity OR individual PFAS for limited number of parameters ?




*Human Exposure and sources of PFAS*
*Image: DWP, adapted from Oliaei et al. 2013.*

**International network is VERY IMPORTANT ➔ align with international developments**