



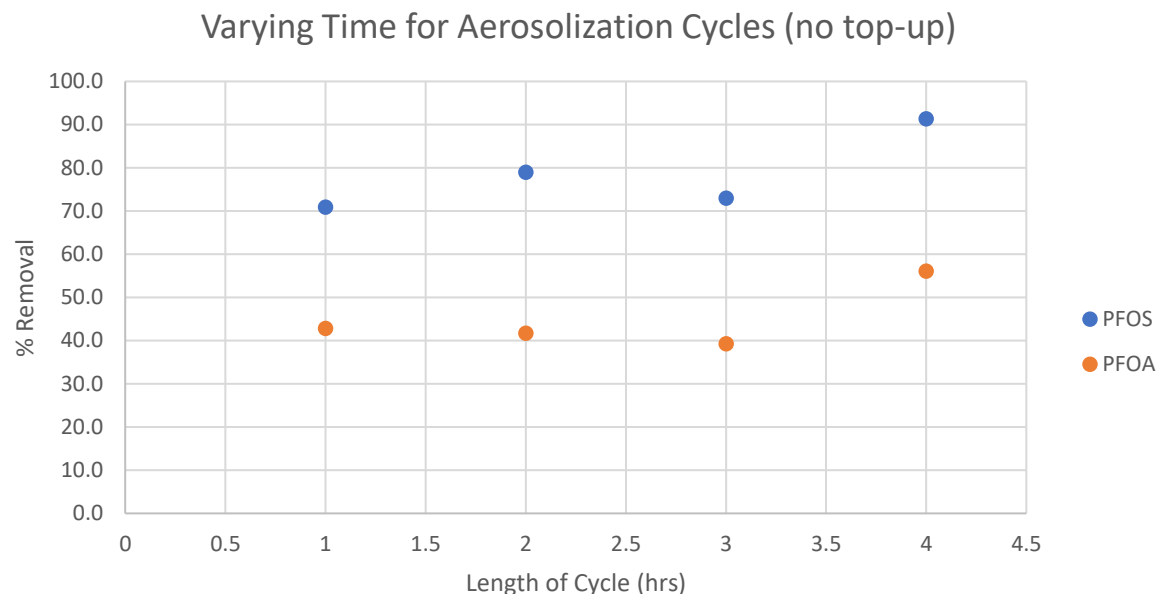
Defining the Scale and Complexity of the Per- and Polyfluoroalkyl Substances (PFAS) Problem in Solid Waste

Peter Murphy
Managing Director - EPOC Enviro

www.epocenviro.com

Aerosolization of PFAS – How much is disappearing into thin air?

- SAFF using ‘aerosol fractionation’ process
- No liquid phase transition into fractionate
- 90%+ removal of PFOS and 50+% removal of PFOA using aerosolization alone
- This has significant Fate and Transport Implications
- May explain why PFAS mass balance rarely works in the ‘real world’.
- Important safety considerations for remediators and operators.



Landfill Leachate Dams / SBR's / MBR's



The aerobic activated sludge process for treating leachate includes sequencing batch reactors (SBR) – removes Ammonia & BOD.



Everyday goods

	PFOS (ppb)	PFOA (ppb)	Total PFAS (ppb)
Eye Pencil	< 5	40	480
Makeup	< 5	20	160
Plumber's Tape	< 5	25	400
Dishwasher Tablet	< 1	< 1	1
Fry Pan	< 1	< 1	8



*Many thanks to Dave Springer from EnviroLab, Australia for sharing this data

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TOPA (Total Oxidizable Precursor Assay)

- Labs typically determine 28 PFAS chemicals (from an approx. 15,000 Chemicals)
- TOPA is a treatment to expose the hidden PFAS (oxidizes some of these 15,000 compounds to the 28 reportable compounds)
- Samples are oxidized with alkali at 85 deg for 6hrs
- So, the lab would then report:
- Pre TOPA PFAS: just the normal PFAS test
- Post TOPA PFAS: an after oxidation PFAS

TOPA on cosmetics

	PFAS	PFAS TOPA	PFAS	PFAS TOPA
	Makeup	Makeup	Eye Pencil	Eye Pencil
	(ppb)	(ppb)	(ppb)	(ppb)
PFOS	<5	<20	<5	<20
PFBA	20	90	30	90
PFPeA	30	70	30	90
PFHxA	20	70	30	100
PFHpA	10	90	40	100
PFOA	20	700	40	600
PFNA	<20	50	40	100
PFUnDA	50	60	80	200
PFDODA	<20	60	80	200



PFAS all around us – How can we plug the dike?



The screenshot shows the BioPak website's product page for BioCane Trays. The BioPak logo is at the top left, and a search bar is at the top right. A green navigation bar contains links for Cups, Containers & Lids, Plates & Trays, Cutlery & Straws, Bags, and Napkins. Below this, a breadcrumb trail reads: Home > Plates & Trays > Trays > BioCane. The main heading is "BIOCANE TRAYS". The text below states: "Our BioCane trays are a more eco-friendly alternative to conventional plastic food trays. These plant fibre trays are made from rapidly-renewable plant fibre, with no added PFAS. They are available in various sizes with the option of single, five or six compartments. You can make a positive change by switching to BioPak trays!". At the bottom, there are two circular icons: one for BioCane (a white tray) and one for BioBoard (a brown tray).

BioPak

Search entire store here...

Cups ▾ Containers & Lids ▾ Plates & Trays ▾ Cutlery & Straws ▾ Bags ▾ Napkins ▾

Home > Plates & Trays > Trays > BioCane

BIOCANE TRAYS

Our BioCane trays are a more eco-friendly alternative to conventional plastic food trays. These plant fibre trays are made from rapidly-renewable plant fibre, with no added PFAS. They are available in various sizes with the option of single, five or six compartments. You can make a positive change by switching to BioPak trays!

BioCane BioBoard



Sugarcane Clam Shell = 50,000ppb (50ppm) TOPA



PFAS Analyte	PFAS (ppb)	PFAS TOPA (ppb)
PFBA	< 2	10,000
PFPeA	< 2	23,000
PFHxA	7	15,000
PFHpA	< 1	2,400
PFOA	2	5

PFAS all around us – How can we plug the dike?

Uni project (Cara Roberts Macquarie) After 7 weeks – whole v ripped up



- This is the ripped up clam shell plate
- Untreated = normal composting
- Treated = weekly spray with 100ml potassium persulfate
- Trying to simulate various chemicals that could be in compost piles (ie TOPA....)
- Can't get it above 35 deg though

	PFAS untreated	TOPA untreated
Total PFAS	8 ppb	49 ppb

	PFAS treated	TOPA treated
Total PFAS	8 ppb	200 ppb

PFAS all around us – How can we plug the dike?

Worms & Mushrooms feeding on clam shell plates



Mushroom after 3 weeks PFAS	
5:3 FTCA (Fluorotelomer carboxylic acid)	41 ppb



Background	Worm PFAS	Worm TOPA
Total PFAS	1 ppb	1 ppb

After 3 weeks	Worm PFAS	Worm TOPA
Total PFAS	22 ppb	53 ppb

* Not surprisingly, green waste containing food packaging is 10X more likely to contain high levels of PFAS

Does 'PFAS or PFOA Free' Mean No Risk for Landfills?

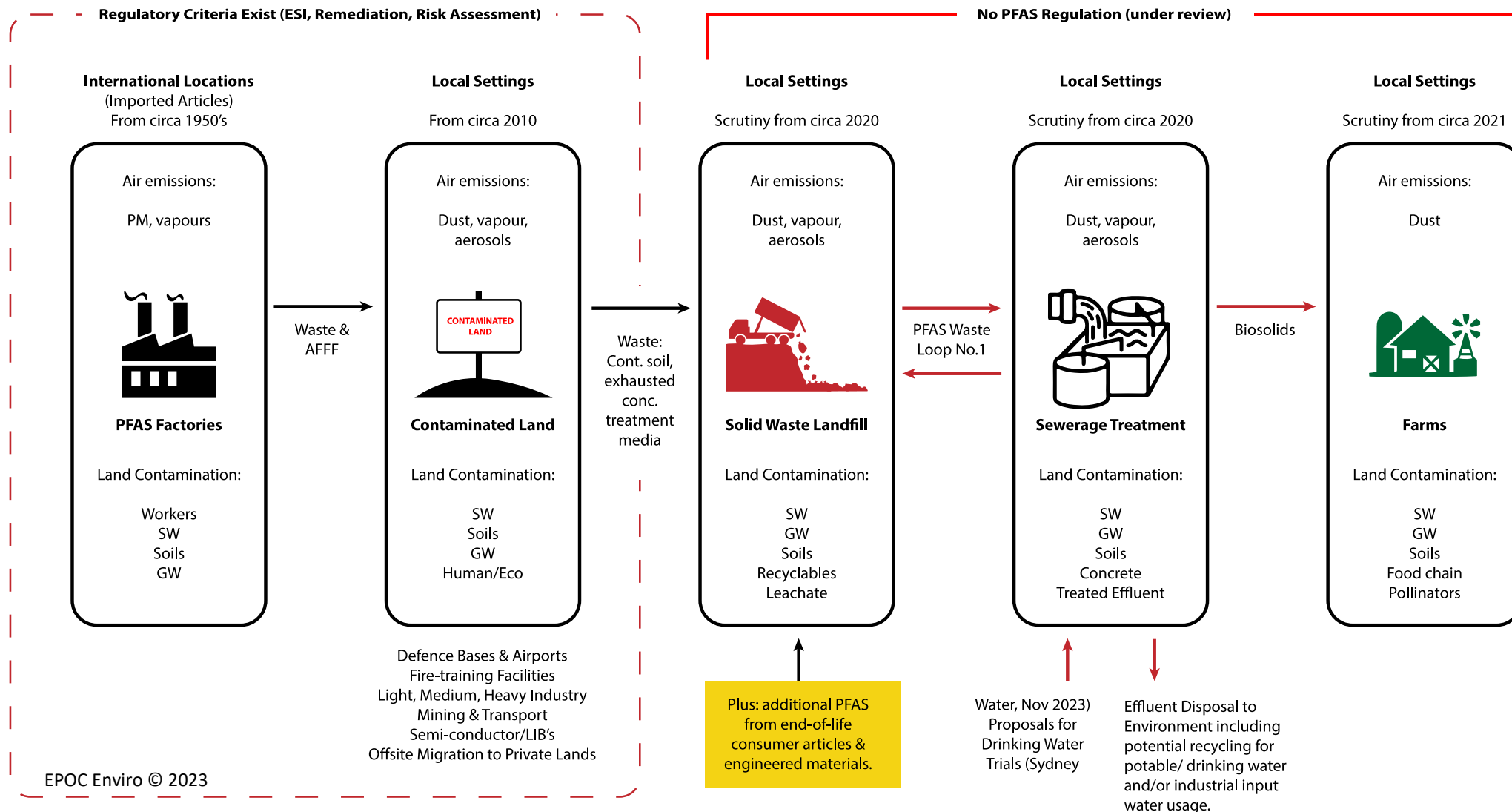


- PFOA and PFOS free means these compounds aren't intentionally added but may still be present with other PFAS.
- PFAS free (products) means <100 ppm:
 - Compared to PFAS in contaminated water (LOR ppt/ppq), 'PFAS Free' articles can be 100 Million to 100 Billion times higher and likely to result in PFAS always being detectable in landfill leachate which is generally disposed to sewer.
- Other sources of PFAS in solid landfill cells creating contaminated leachate includes exhausted GAC, AIX from contaminated sites.
- Aspirations of 80% Landfill Diversion by 2030 (how if PFAS in everything)?
- Could America become a dumping ground for PFAS containing articles resulting in more PFAS entering the pervasive landfill/STP loop?
- Corporate ESG positions on where hazardous chemicals in waste aggregate?

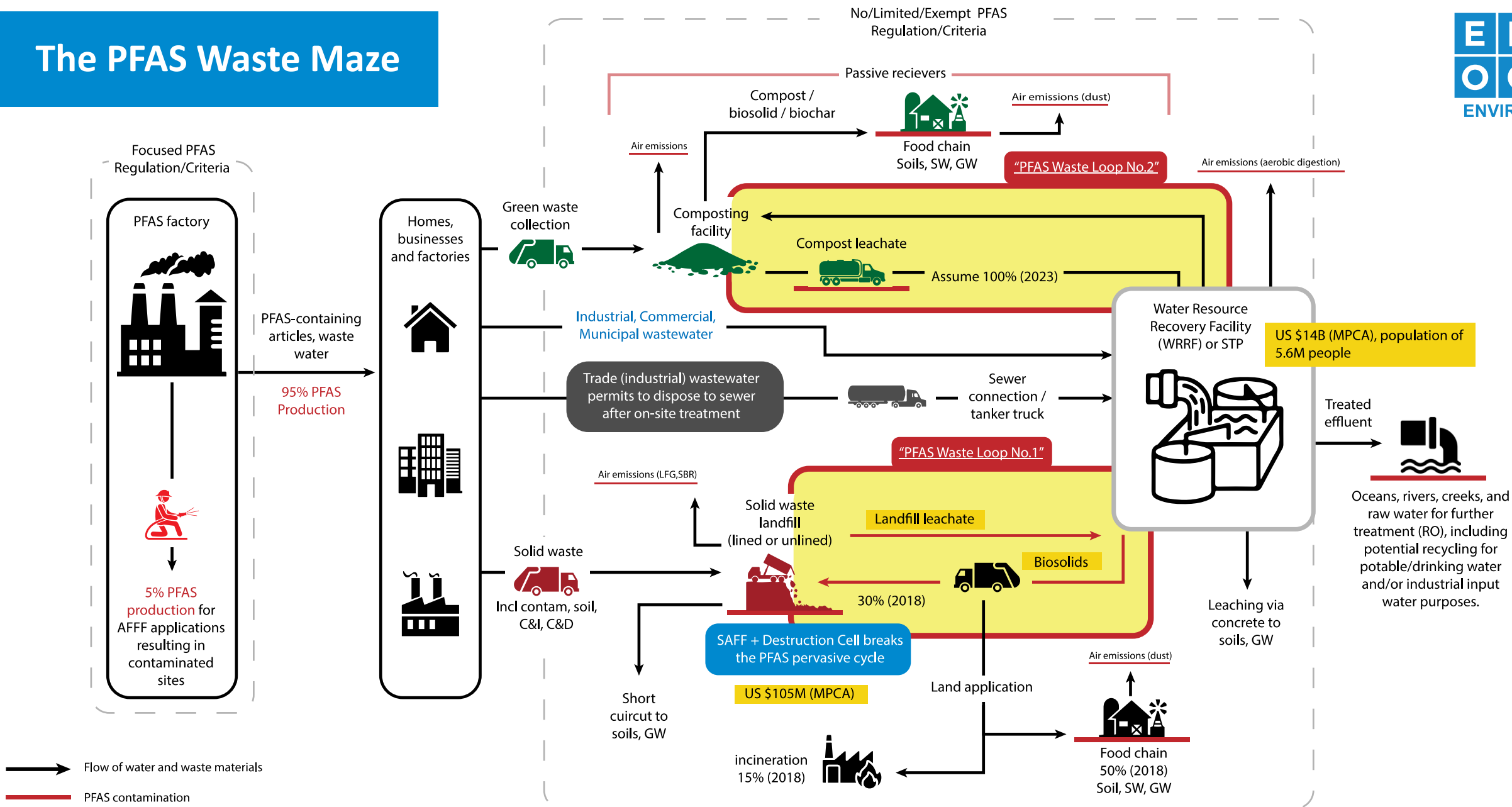
Unfair Application of PFAS Criteria across Connected Market Sectors

Regulatory Guidance & Voluntary EPR/ESG Certification Systems		PFOS	PFOA	PFHxS	PFNA	HFPO-DA (Gen-X)	USEPA Haz. Index (PFAS mixtures containing at least 2 of PFHxS, PFNA, HPO-DA, PFBS)
		ng/l	ng/l	ng/l	ng/l	ng/l	(HI)
Consumer Products claiming to be 'PFAS Free' or 'PFOA Free'	<100ppm	<100,000,000	<100,000,000	-	-	-	-
USEPA (99% ECO Species Protection)	2023	-	-	-	-	-	-
USEPA NPDWR (MCL's) - Promulgated	10 April 2024	4.0	4.0	10	10	10	1.0
USEPA CERCLA RQ (Super Fund) - Promulgated	16 th April 2024	1 lb/day (0.45kg/day) requires reporting to USEPA. Proposed Hazardous Substances (potential for Passive Receiver exemptions).		-	-	Under Consideration	-
USEPA RCRA - Proposed	Jan 2024	(9x PFAS; PFOS, PFOA, PFHxS, PFNA, PFDA, PFHxA, Gen-X, PFBS, PFBA) Hazardous Constituents to HH					-
TSCA - Promulgated	13 Nov 2023	Obligation to report added PFAS to articles imported into the USA.					

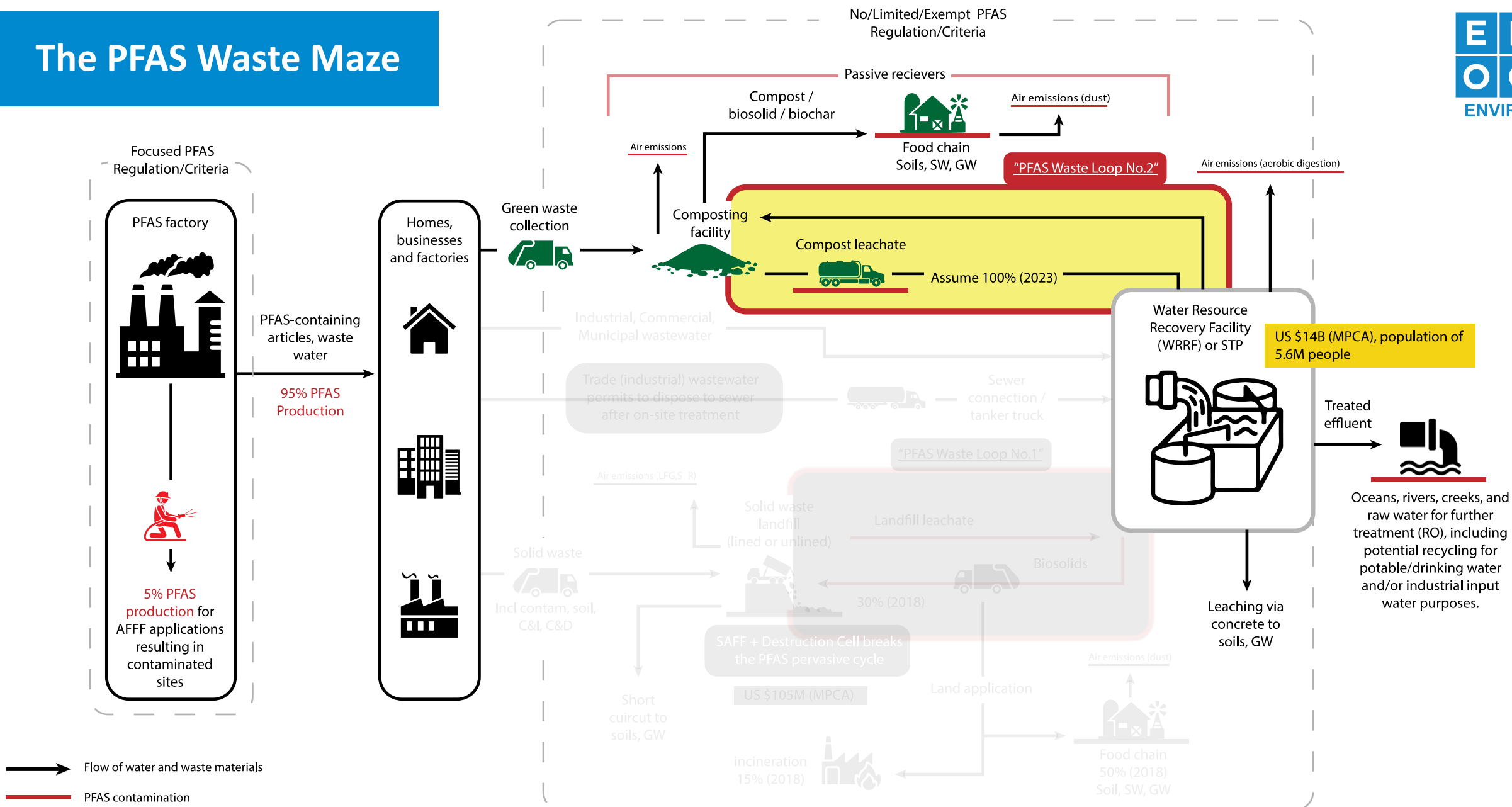
Regulatory Management & Movement of PFAS Through the US Economy



The PFAS Waste Maze

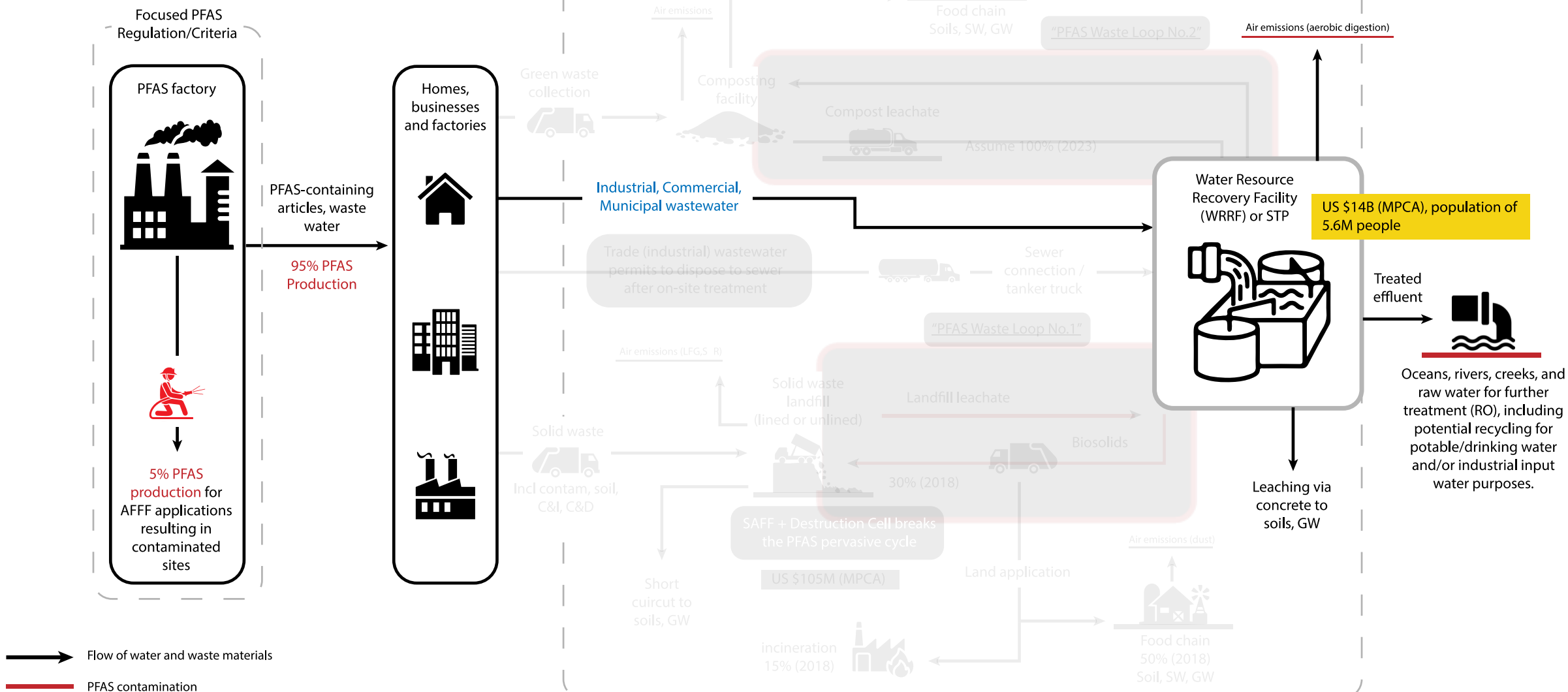


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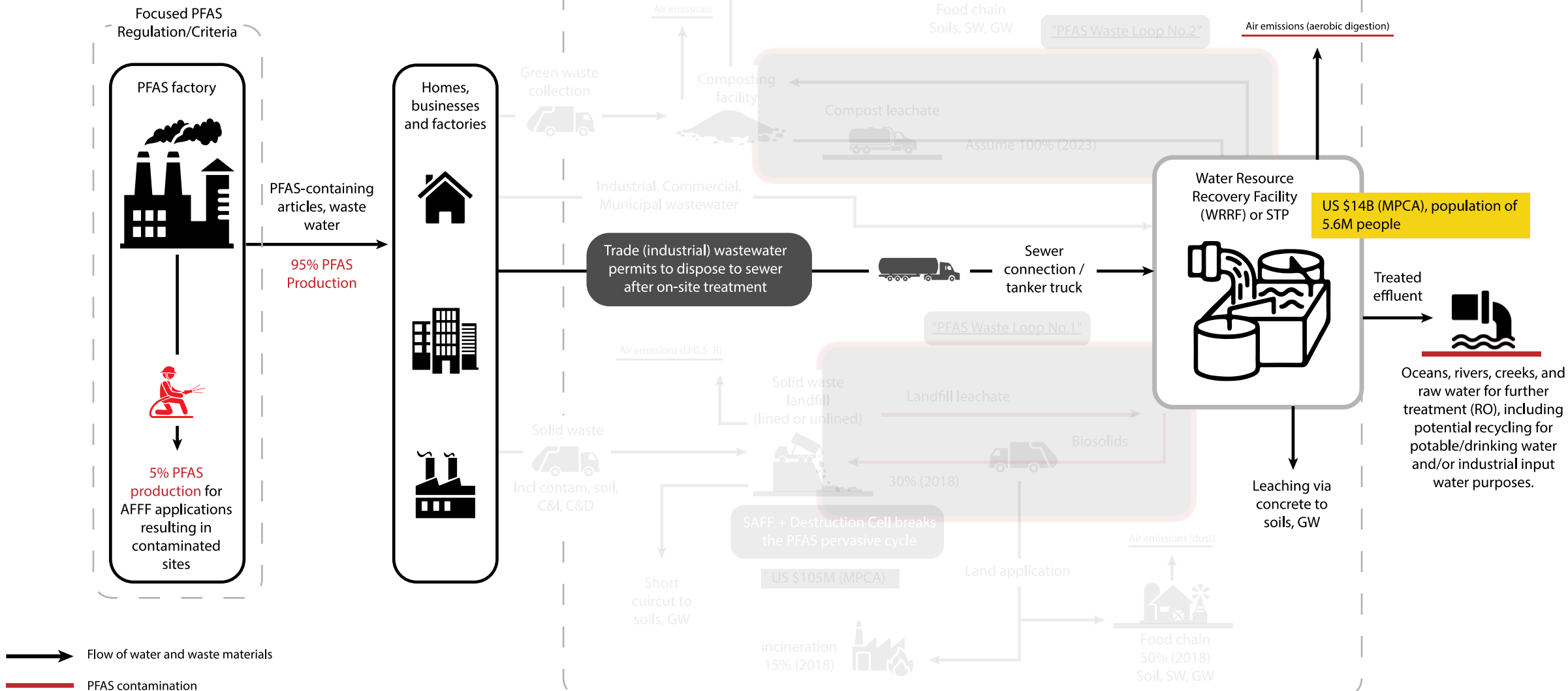
PFAS Waste Flow Diagram
 (modified from MPCA report by Barr Eng, May 2023) & subsequent presentation for Ecoforum (Oct 2023) + Tolaymat et. al. (Sep. 2023)

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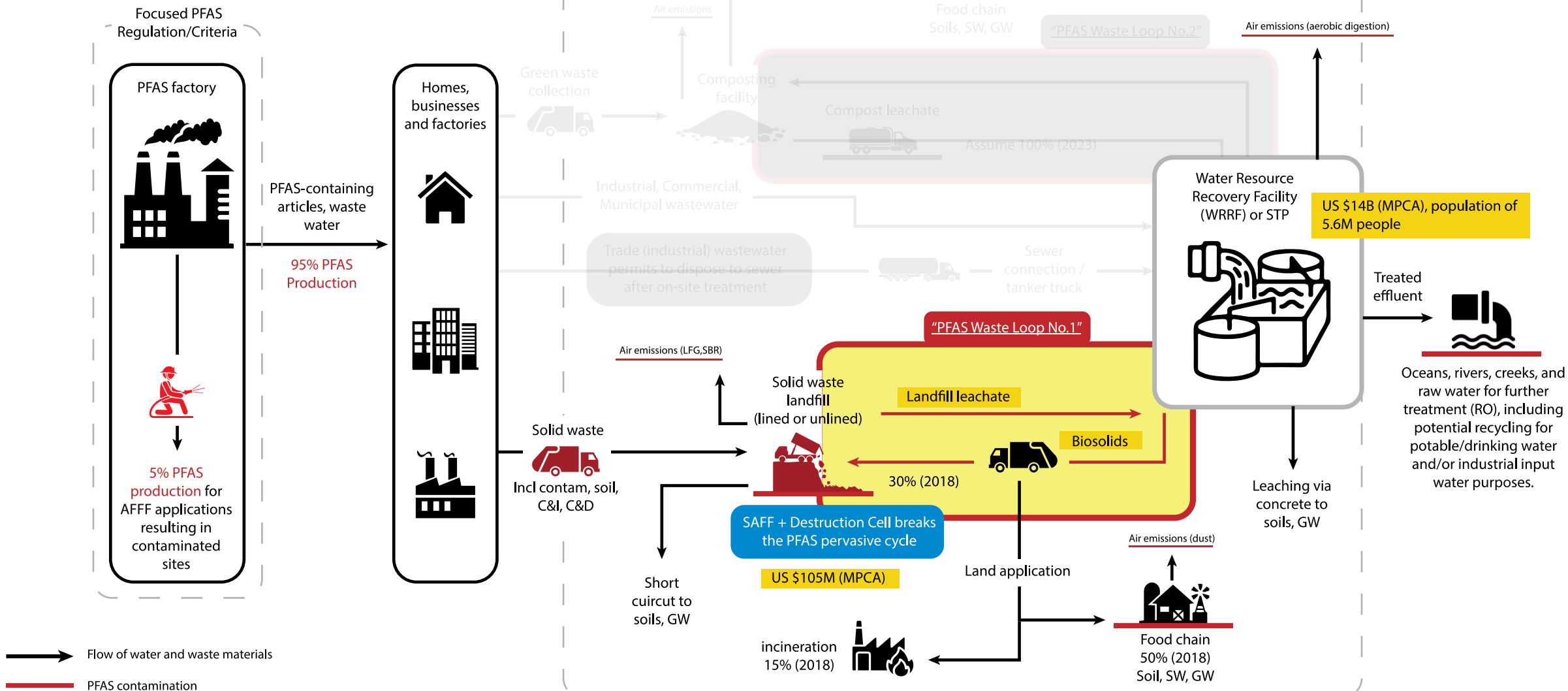
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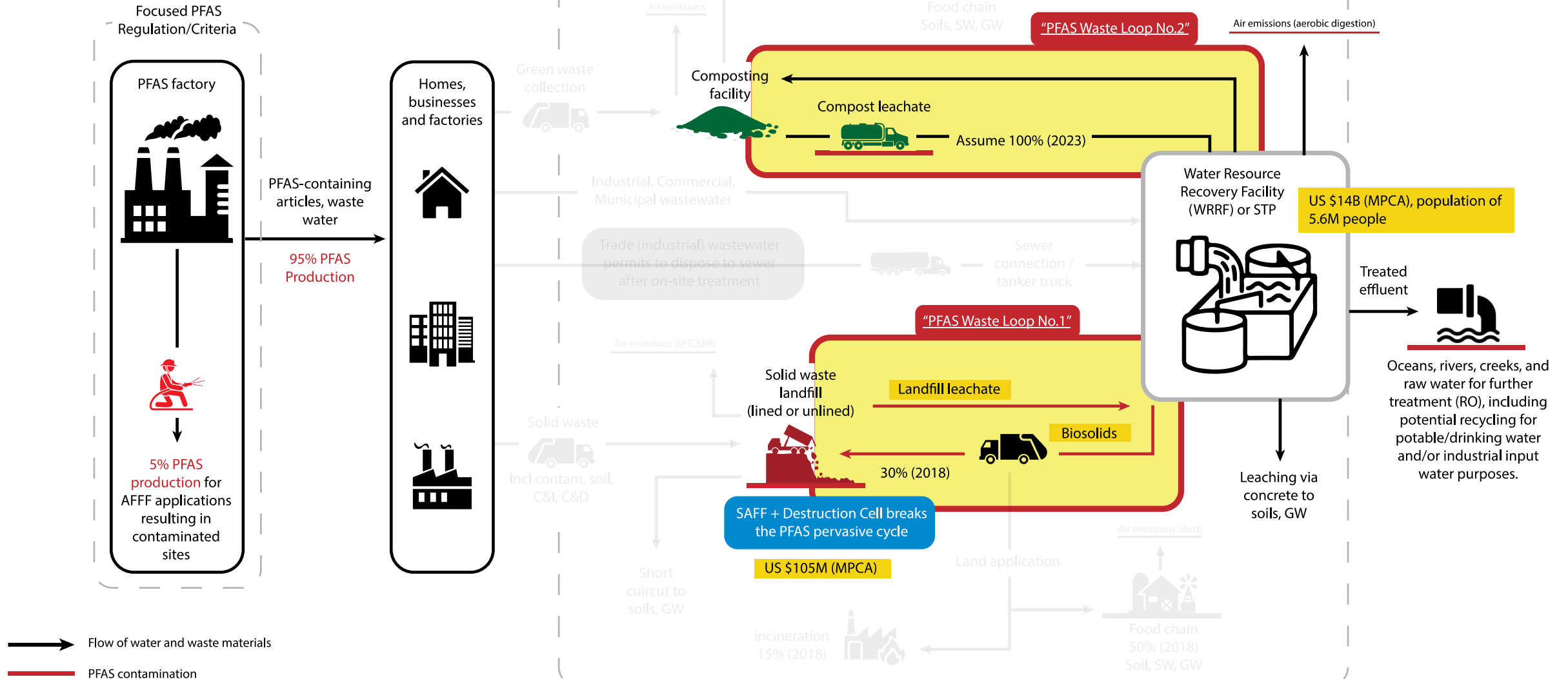
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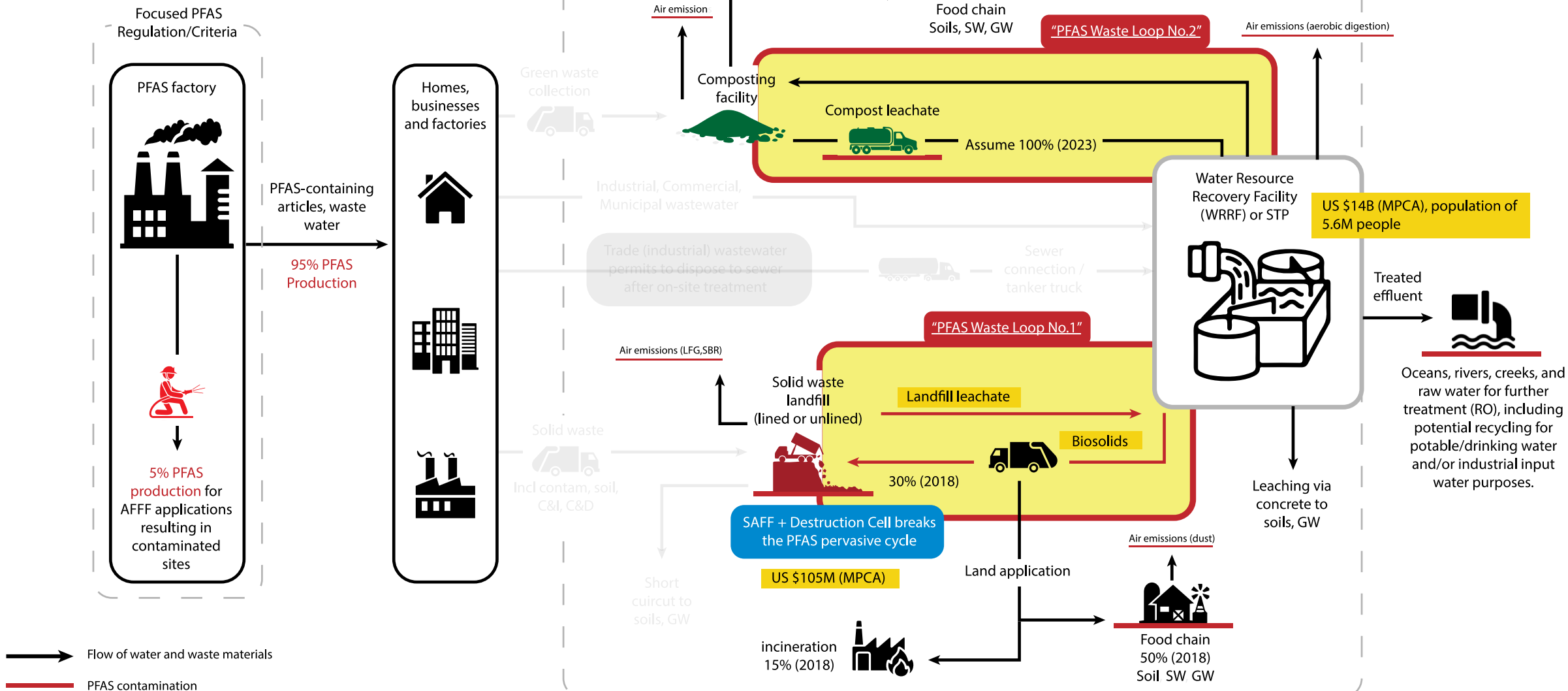
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