

PCBs and PFAS and the Mississippi River Basin

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November 8, 2023



Agenda



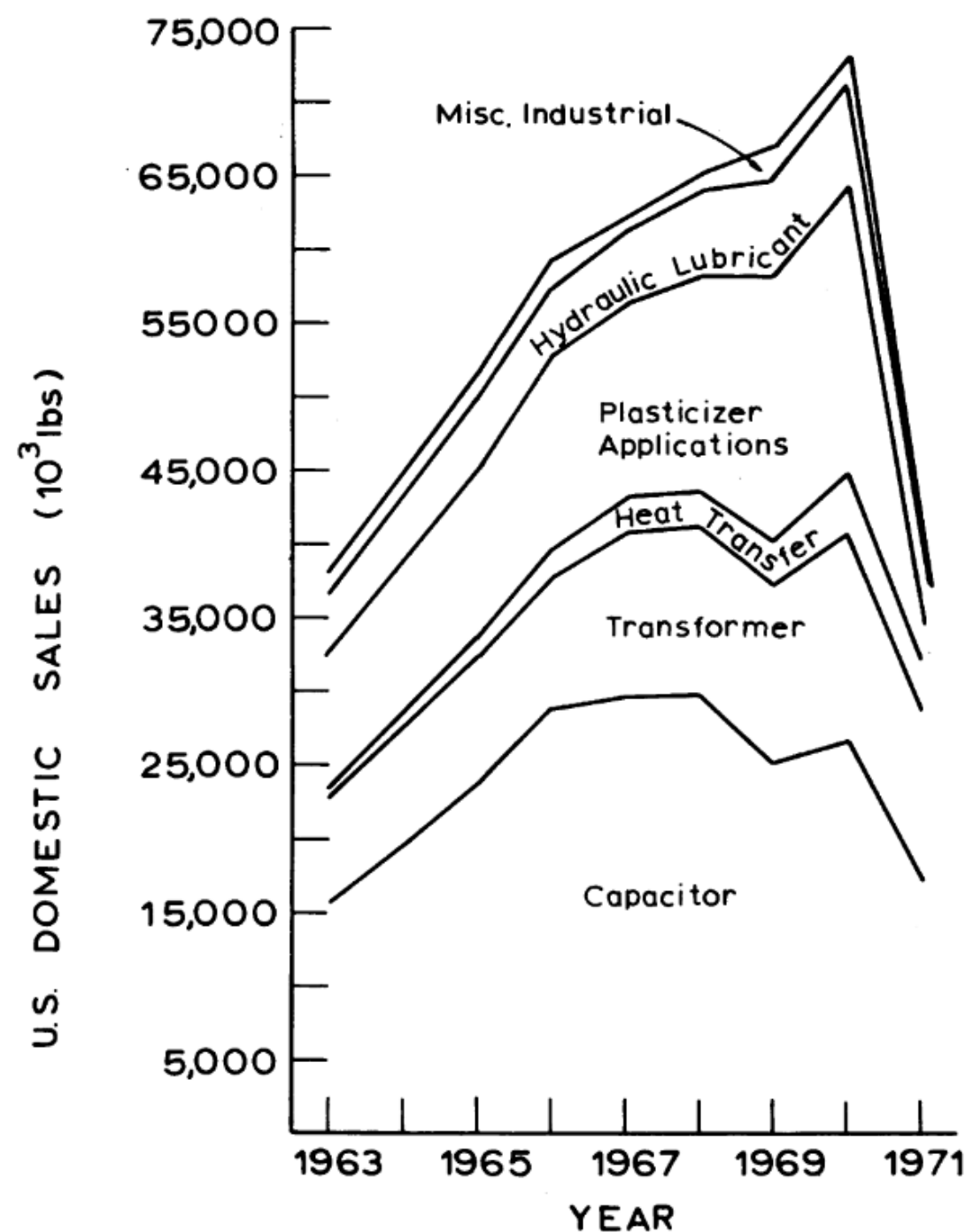
- What are PCBs and where do they come from
- What are PFAS and where do they come from
- Potential Sinks in the Mississippi River Watershed today

What are PCBs and where do they come from?

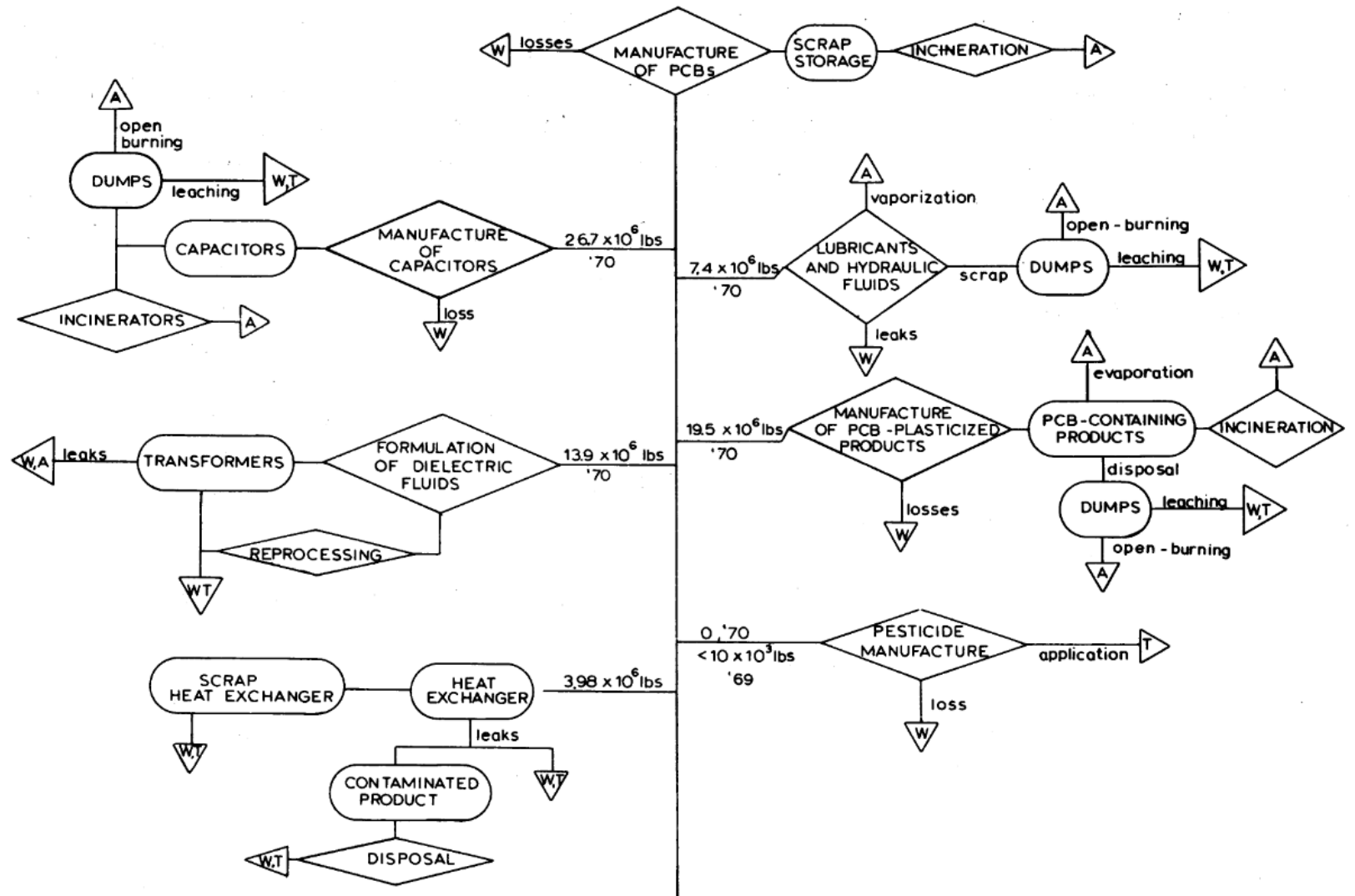


PCB Uses

- Monsanto sole producer in North America starting 1929
- Phase-out started in 1970
- Banned in 1979 in US
- Still produced elsewhere.



PCB Release



80% of all PCBs produced are still in the environment (Othman, 2022)

In the 1970's, release rates estimated around 10,000 tons/year (1/3 of production)

PCB Fate and Transport

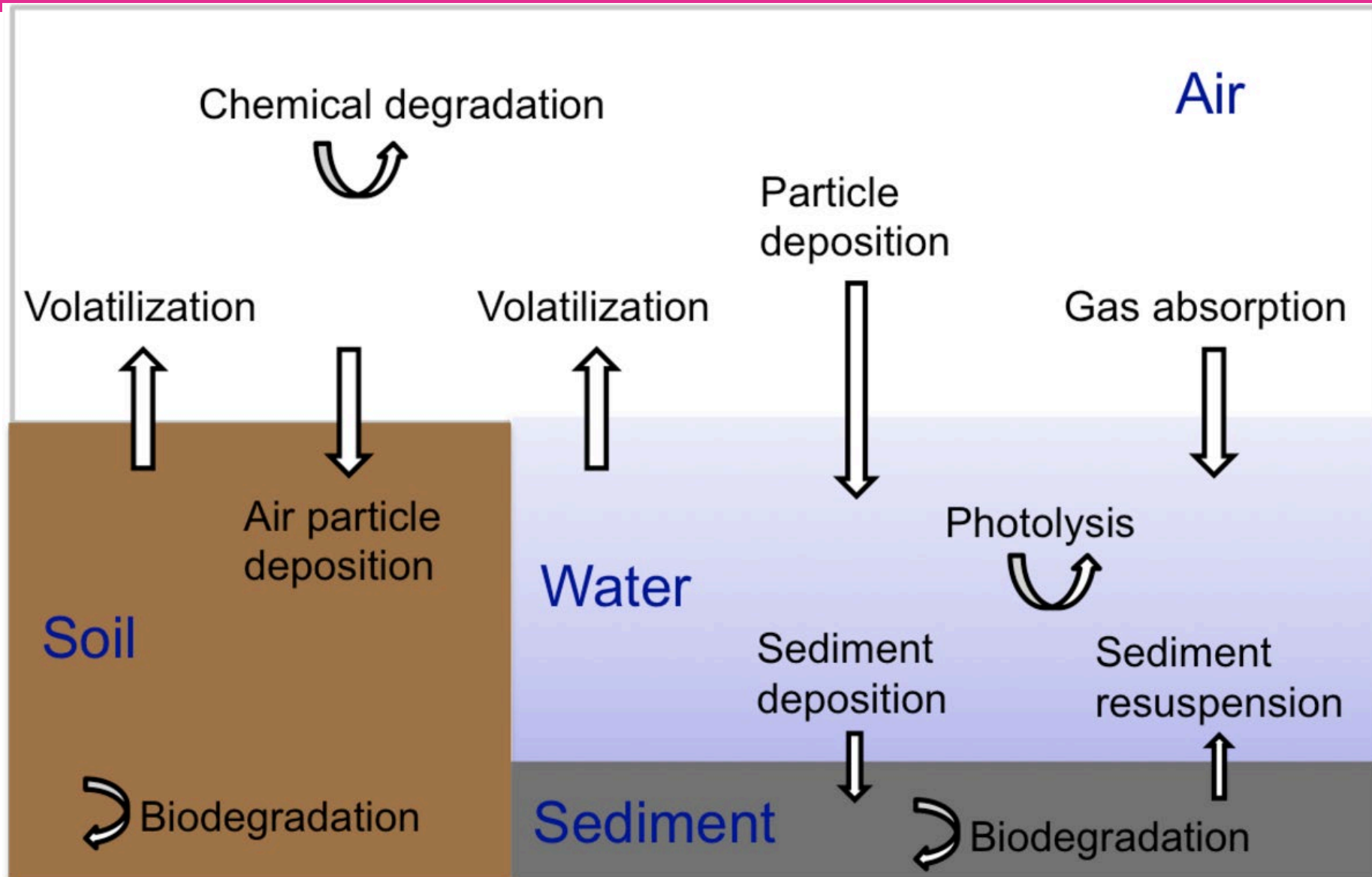


Figure PNNL

Major PCB Sinks

Aquatic Food Webs

- Small mass of PCBs in animals and plants compared to total in environment.
- But impacts environmental and human health

Freshwater Sediments

- PCBs in water sticks to solids and eventually sediments out

Marine Sediments

- Sediments washed out from rivers
- Dredged soils and sediments dumped to ocean

What are PFAS and where do they come from?



PFAS Use and Emission Sources

Production and Manufacturing

- Direct emissions to air and subsequent transport and deposition
- Discharges to wastewater treatment
- Discharges to surface waters



PFAS Use and Emission Sources



Product Use

- Air emissions during use
- Weathering to local environment
- Weathering to wastewater



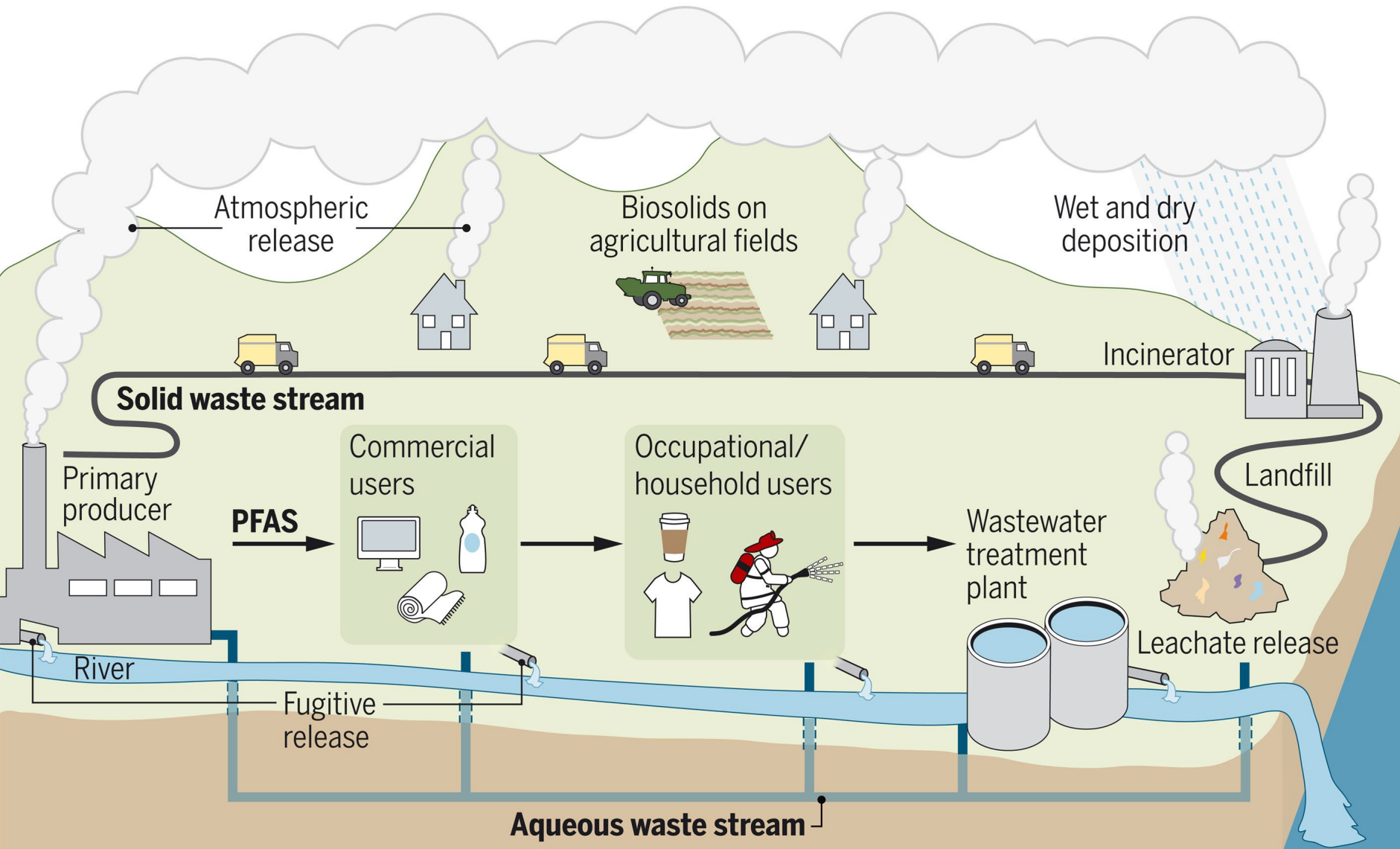
PFAS Use and Emission Sources



Waste Management

- Leaching from landfilled materials
- Leaching from composted materials
- Loss to wastewater and pass through to effluent and biosolids

PFAS Fate and Transport



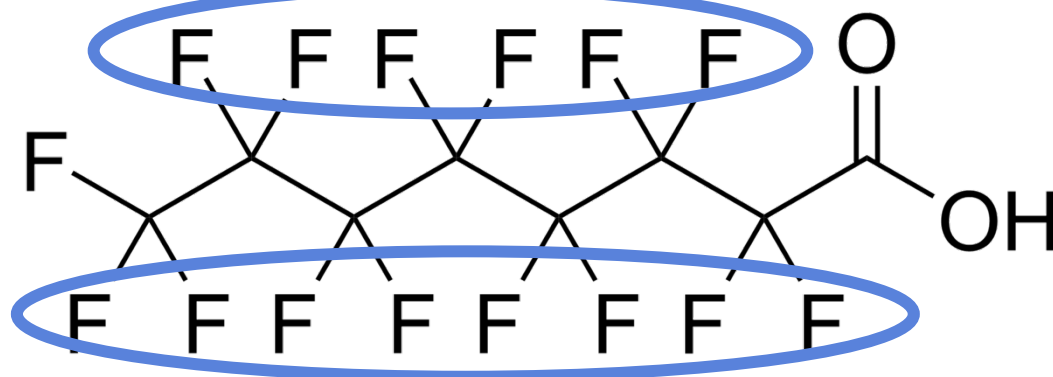
PFAS are:

- Persistent (don't break down to non-PFAS)
- Mobile (continue to cycle)
- Bioaccumulate (some PFAS)

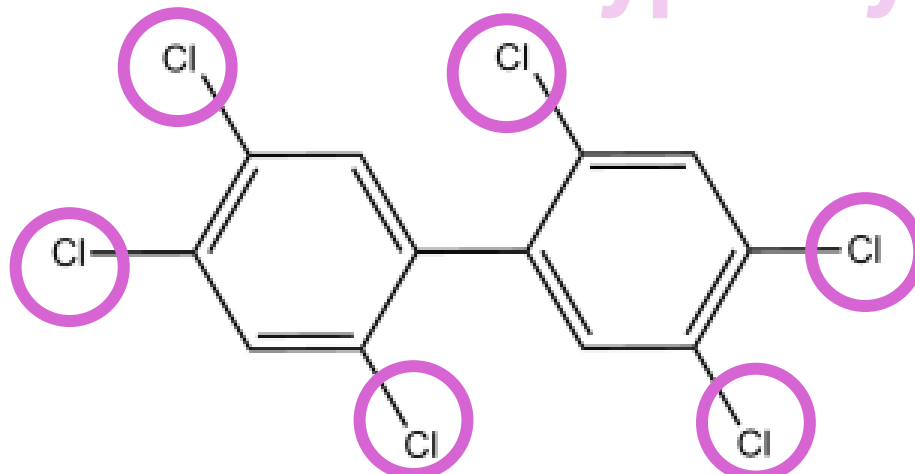
Figure from Evich, M. G. *et al.* (2022). Per- and polyfluoroalkyl substances in the environment. *Science* **375**, 12

PFAS and PCB chemistry

PFAS: Per- and poly-fluorinated alkyl substances

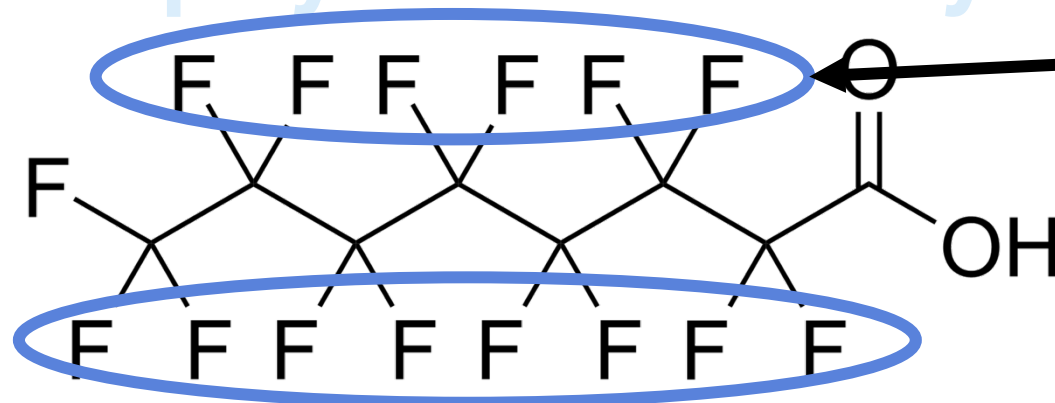


PCBs: Poly-chlorinated byphenyls

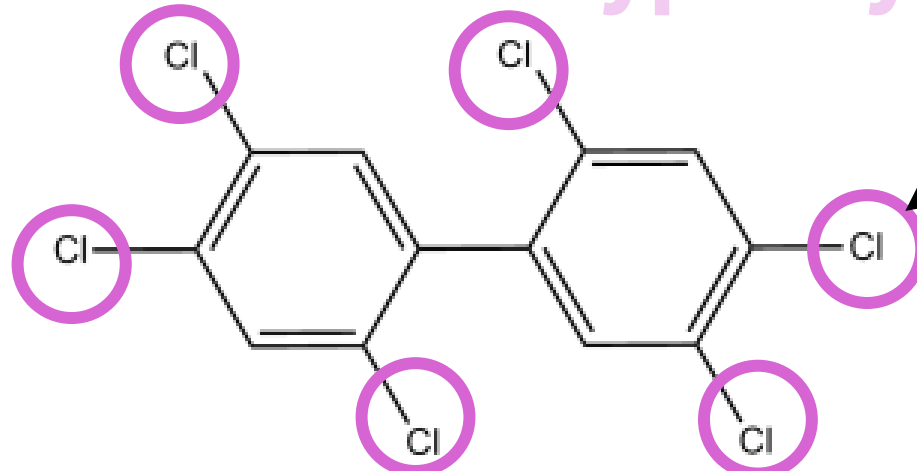


PFAS and PCB chemistry

PFAS: Per- and poly-fluorinated alkyl substances



PCBs: Poly-chlorinated byphenyls

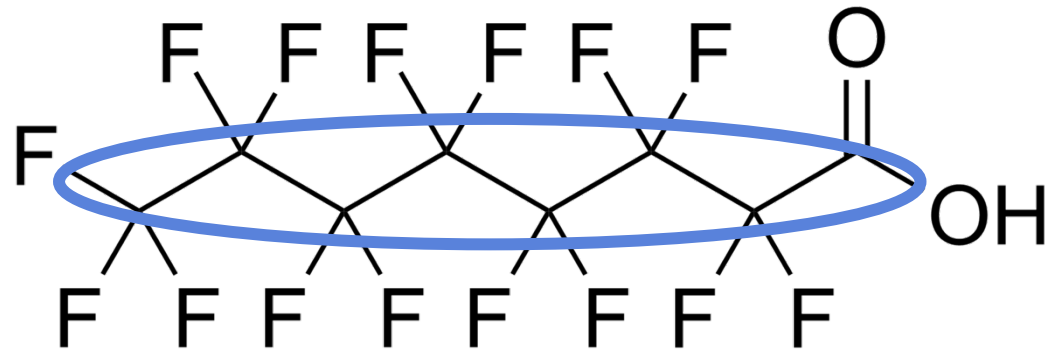


		2 He 4.002602
8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
16 S 32.06	17 Cl 35.4527	18 Ar 39.948
34 Se 78.96	35 Br 79.504	36 Kr 83.80
52 Te 127.60	53 I 126.90447	54 Xe 131.29
84 Po (209)	85 At (210)	86 Rn (222)
116 (289)		118 (293)

9 n 3421	70 Yb 173.04	71 Lu 174.967
11 d 8)	102 No (259)	103 Lr (262)

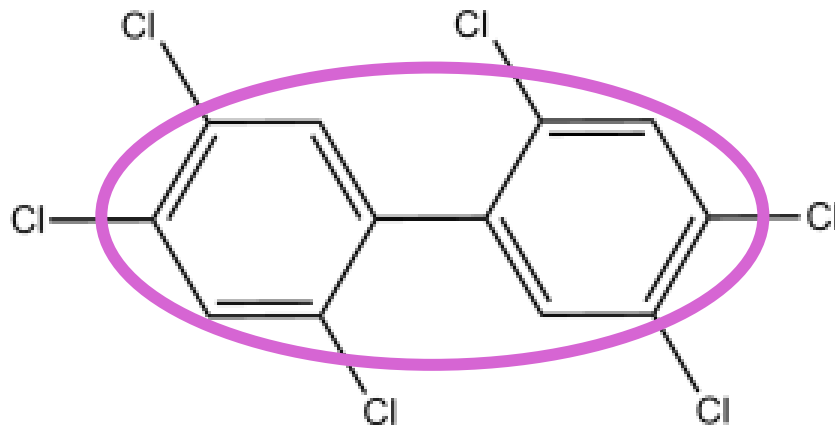
PFAS and PCB chemistry

PFAS: Per- and poly-fluorinated alkyl substances



More water soluble and mobile

PCBs: Poly-chlorinated byphenyls



Likes dirt, not water

PFAS and PCB are numerous

PFAS:

10,000s of
different
chemicals

Differ by size,
structure number
and position of
fluorine

- **Large class of compounds**

PCBs:

209 different
chemicals

Differ by number
and position of
chlorine

PFAS and PCB are persistent

PFAS:

*Effectively
does not
degrade in
environment*

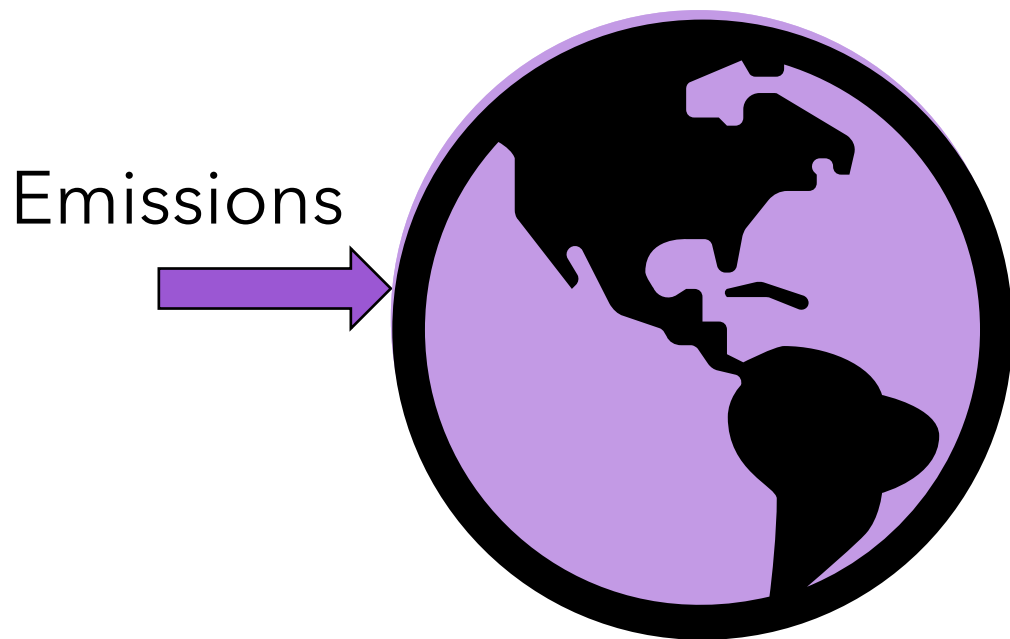
- Large class of compounds
- **Persistent!**

PCBs:

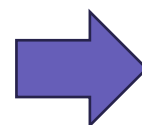
Degrades
over decades

The Problem with Persistence

Global PFAS Stocks
in Environment



Consistently increasing mass
stocks and concentrations in
environmental media



The Risks are too High.

Increased potential to exceed
known and unknown
thresholds to impact human
and environmental health

PFAS and PCB bioaccumulate

PFAS:

- Large class of compounds
- Persistent!
- **Bioaccumulate**

PCBs:

PFAS and PCB behave differently in the environment

PFAS:



- Large class of compounds
- Persistent!
- Bioaccumulate

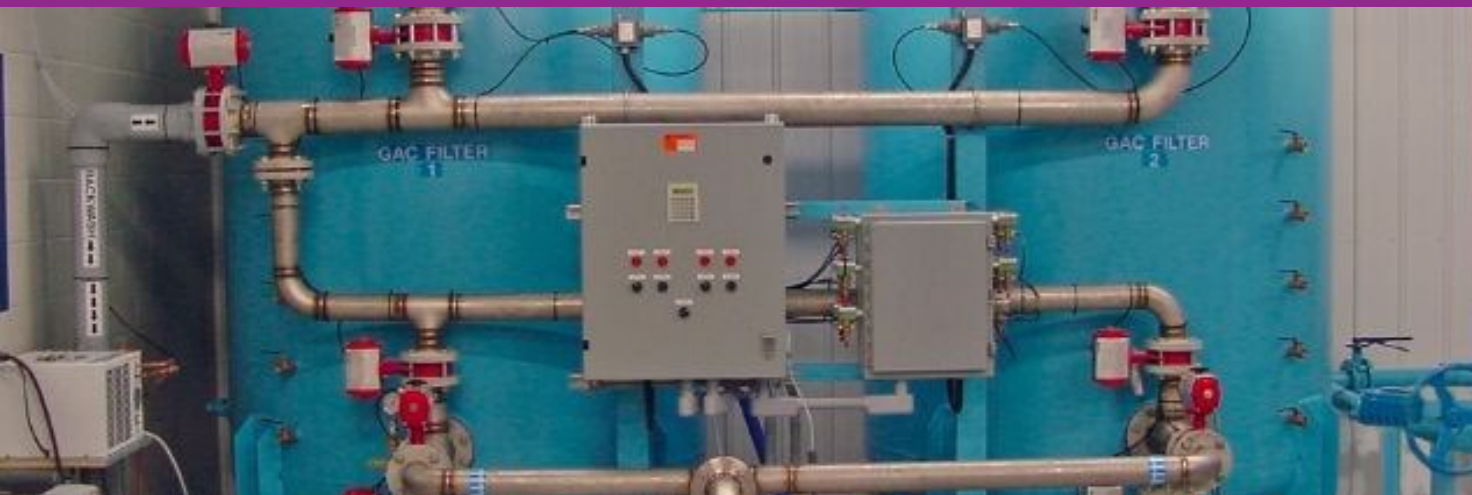
Stick to solids →

← **Mobile**

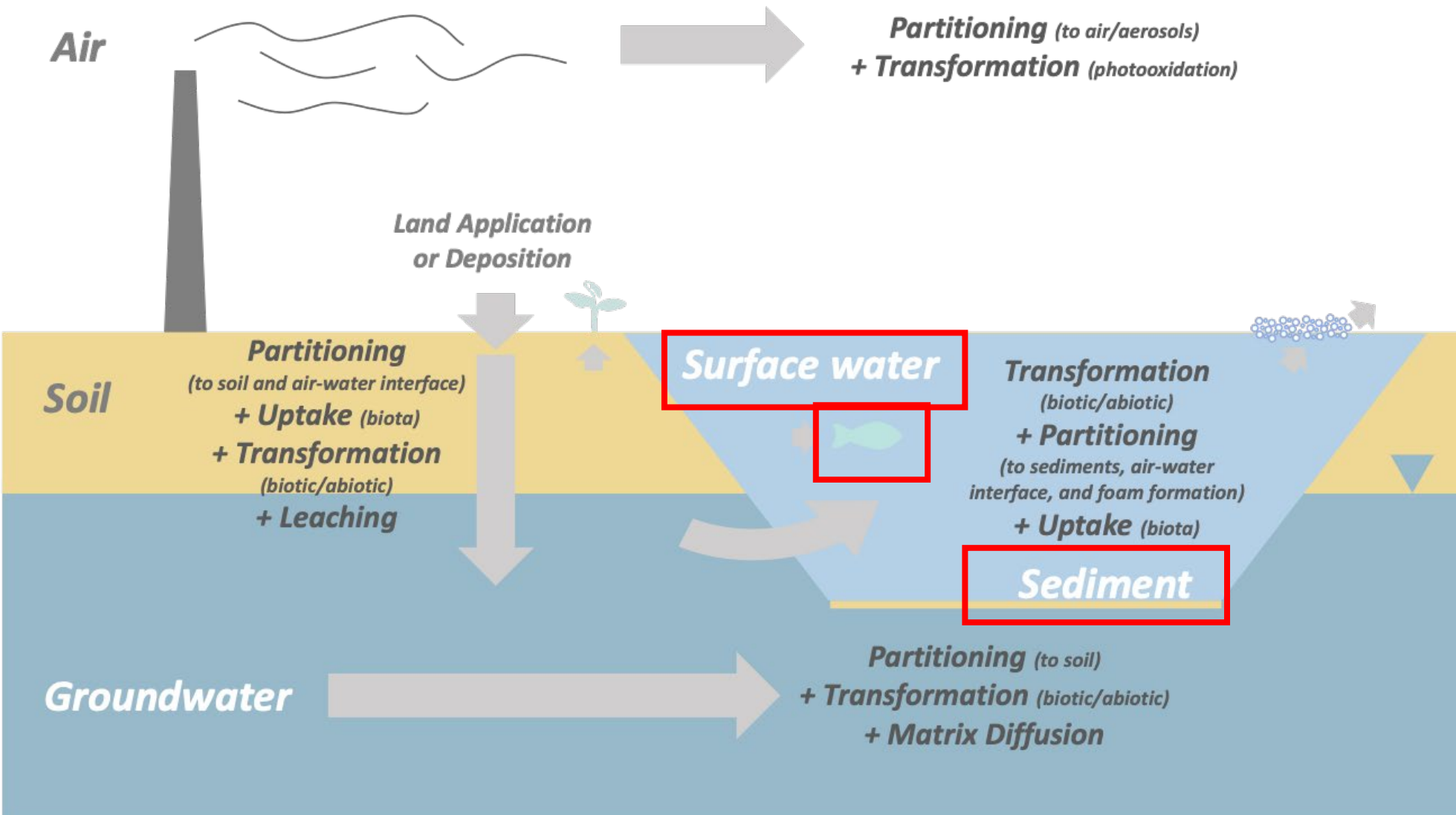
PCBs:



Potential PCB and PFAS in Mississippi River Basin



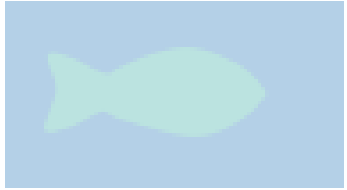
Potential Sinks



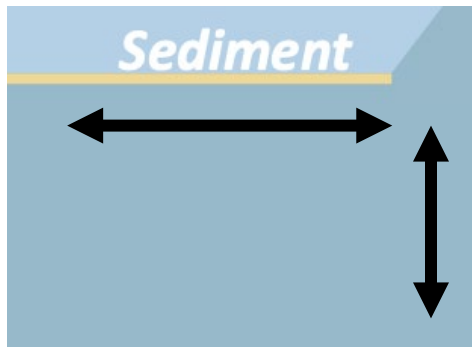
- Sampling options:
- water
 - sediments
 - fish and aquatic life

Potential Sinks

What media to sample, **how** often and **for what** depends on specific questions. For example:



1. Is it safe to eat fish from specific locations?
 - Sample food fish from specific locations
2. Where in the watershed are PCBs still present in sediments?
 - Sample multiple locations at one depth
3. How does the amount of PCBs in sediments change with depth?
 - Sample sediments at specific locations at multiple depths



Sampling Options

PFAS

- Some publicly available data on water, sediments, and wildlife - I'm working on these now
- Sample cost: ~\$500/sample

PCBs

- Likely present in sediments and wildlife
- Sample cost: ~\$300/sample

Sampling options:

- water
- sediments
- fish and aquatic life



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Thank you

