The PFAS Challenge

From Science to Policy: Understanding PFAS and Biosolids

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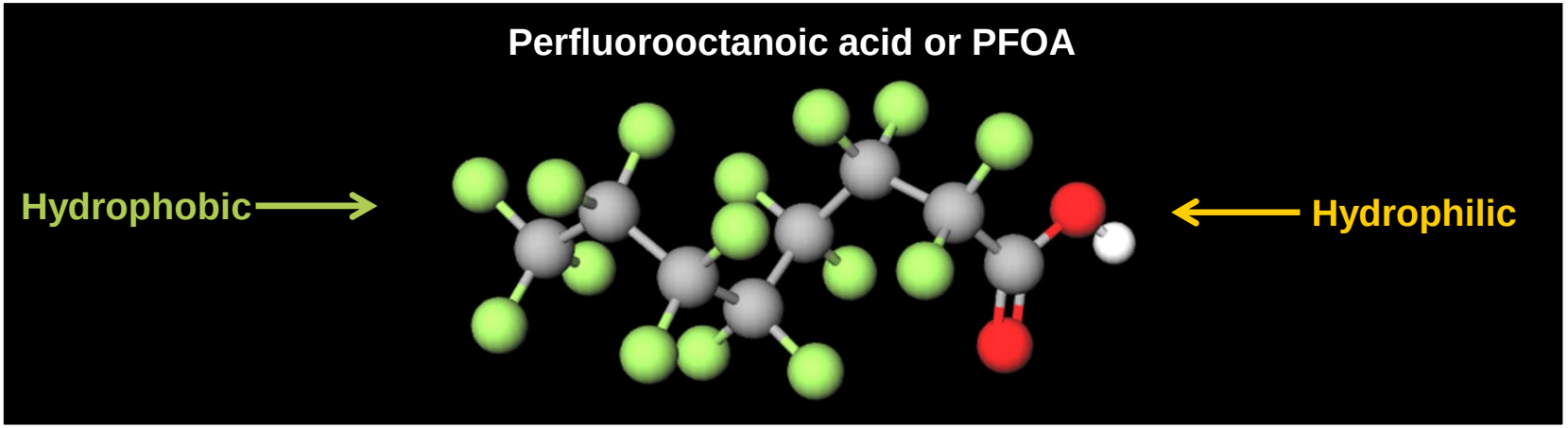
Metropolitan Washington Council of Governments

Rosa Gwinn, PhD, PG
Global PFAS Technical Lead

What are per- and polyfluoroalkyl substances or PFAS?

- Family of thousands of synthetic compounds
- Linear and branched chains of carbon bonded to fluorine in place of hydrogen
- C-F is one of the strongest chemical bonds
- Many resist thermal, chemical, and biological degradation
- Many act as surfactants by reducing surface tension
- Some are toxic at low concentrations



Source: Molecular models: www.molview.org; Outside resource: ITRC PFAS: https://pfas-1.itrcweb.org/2-2-chemistry-terminology-and-acronyms/

PFAS Sources and Concerns

Firefighting

Metals Plating

Production

Personal Care

Textiles

Food Packaging

Landfills and Leachate

Drinking Water

Agriculture

Waste Treatment

Prevalent

Consumed

Researched

Toxic

Regulated

Costly

Source: (top left) Photo by Lance Cpl. Shawn Valosin USMC; (second from the top left) Source: USEPA; (all other images) Photos licensed under CC BY

PFAS Health Effects

Epidemiological studies suggest exposure to PFAS can have certain health effects:

Increases in cholesterol levels (PFOA, PFOS, PFNA, PFDA)

Changes in liver enzymes (PFOA, PFOS, PFHxS)

Small decreases in birth weight (PFOA, PFOS)

Lower antibody response to some vaccines (PFOA, PFOS, PFHxS, PFDA)

Pregnancy induced hypertension and preeclampsia (PFOA, PFOS)

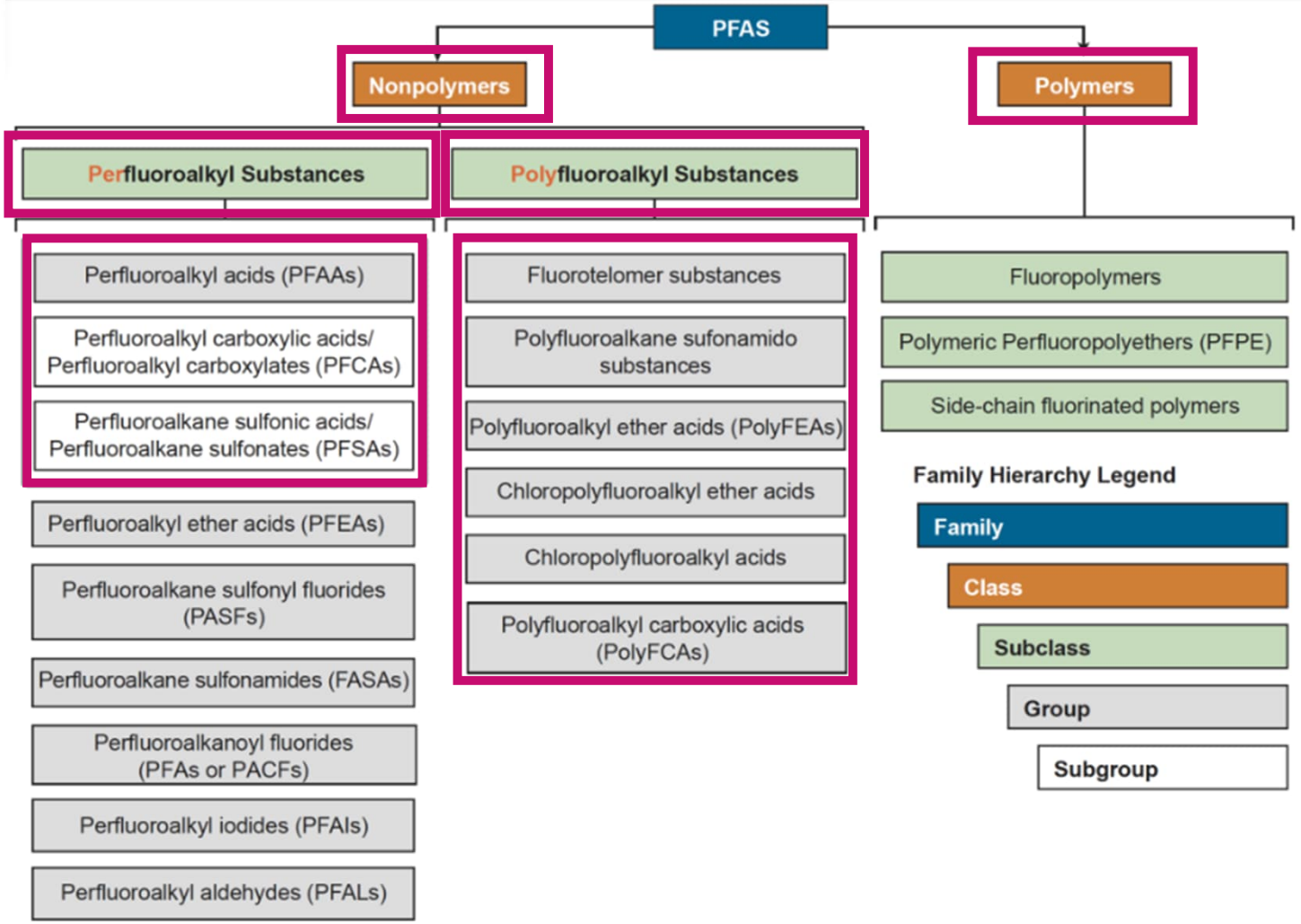
Kidney and testicular cancer (PFOA)

Source: https://www.atsdr.cdc.gov/pfas/health-effects/index.html

Resource: Agency for Toxic Substance and Disease Registry https://www.atsdr.cdc.gov/pfas/index.html

PFAS Family

- Polymers are *currently* not a focus of concern
- Nonpolymers include per and polyfluoroalkyl substances
- PFAAs receive the greatest scrutiny (now)
- Differing chemistries enable broad range of commercial applications
- Some polyfluorinated compounds will transform in the environment – some become PFAAs



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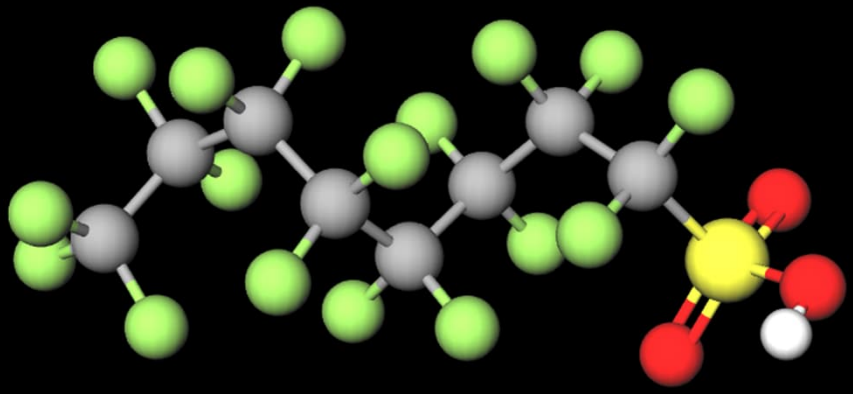
PFAS Fundamentals

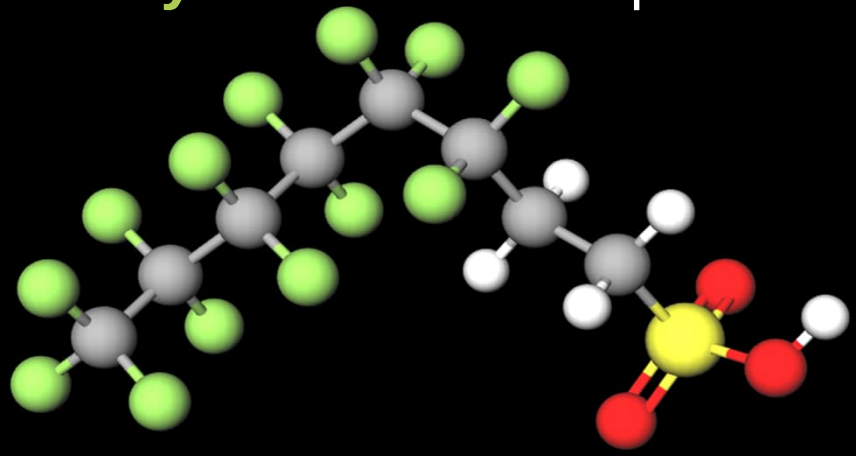
Perfluorinated Compound



Fully fluorinated carbon chain "tail

Functional group "head"

Polyfluorinated Compound



Fully fluorinated carbon chain "tail

Unfluorinated spacer

Functional group "head"

Carbon Fluorine Sulfur Hydrogen Oxygen

Source: Molecular models: www.molview.org; Outside resource: ITRC PFAS: https://pfas-1.itrcweb.org/2-2-chemistry-terminology-and-acronyms/

One Water Perspective

Legend:

PFAS Sources

PFAS Impacts

Source: All art prepared by and property of AECOM

PFAS US Regulatory Landscape

In effect:

- Federal and state-specific drinking water standards
- Federal designations as hazardous substances
- U.S. Environmental Protection Agency (USEPA) interim disposal guidance
- State-specific biosolids and surface water standards

In development:

- USEPA hazardous waste designation
- Effluent Limitation Guidelines - Plan 15
- National Pollution Discharge Elimination System (NPDES) monitoring and discharge requirements

Publicly Owned Treatment Works (POTW)-specific:

- Industrial pretreatment programs

Regulatory Ripple Effects for POTWs

Drinking Water Maximum Contaminant Levels (MCLs) for PFOS and PFOA:

- Identifies POTWs that receive influent PFAS concentrations > MCLs
- Discharges may impact drinking water sources downstream

Hazardous Substance Designations PFOS and PFOA:

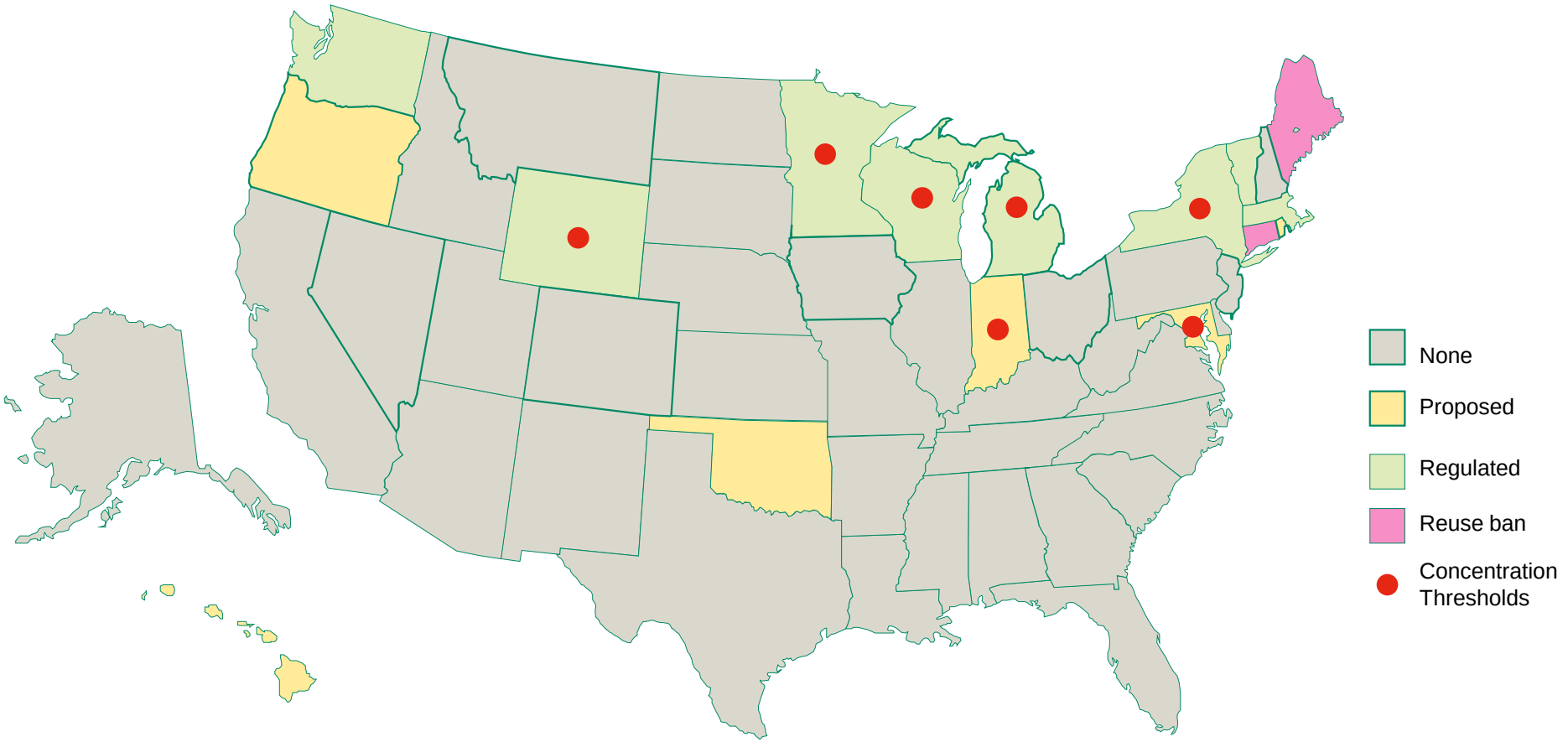
- POTWs may dispose of biosolids rather than reuse
- Past PFAS releases into the environment from POTWs are exempt from CERCLA actions

Effluent Limitation Guidelines and NPDES requirements

- Affect PFAS discharge limits—especially for reuse
- Limit PFAS concentrations in influent to wastewater treatment plants

Option **for industrial source control** and / or **pretreatment** to limit PFAS influent concentrations as a means of lowering PFAS concentrations in effluent and biosolids

Biosolids Regulations by State



Source: All art prepared by and property of AECOM

USEPA Biosolids Risk Assessment

Reference: USEPA, 2025. Draft Sewage Sludge Risk Assessment for Perfluorooctanoic acid (PFOA) CASRN 335-67-1 and Perfluorooctane Sulfonic Acid (PFOS) CASRN 1763-23-1, January 2025, EPA-820P25001

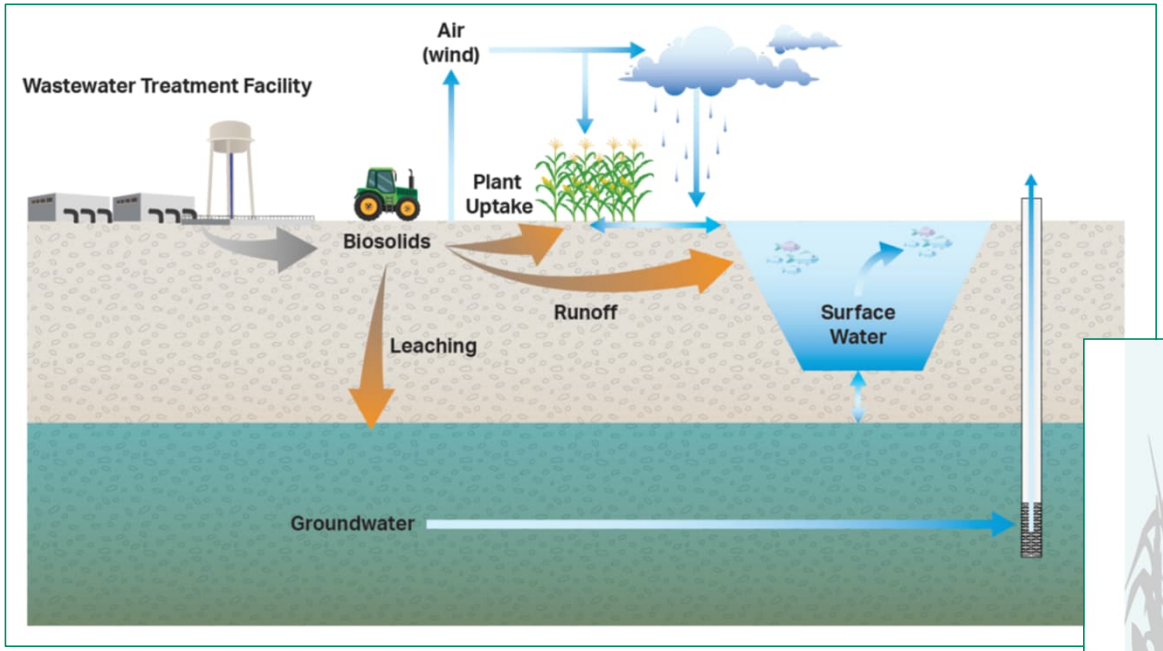
Models human exposure and **risks** or **hazards** associated with specific exposure scenario

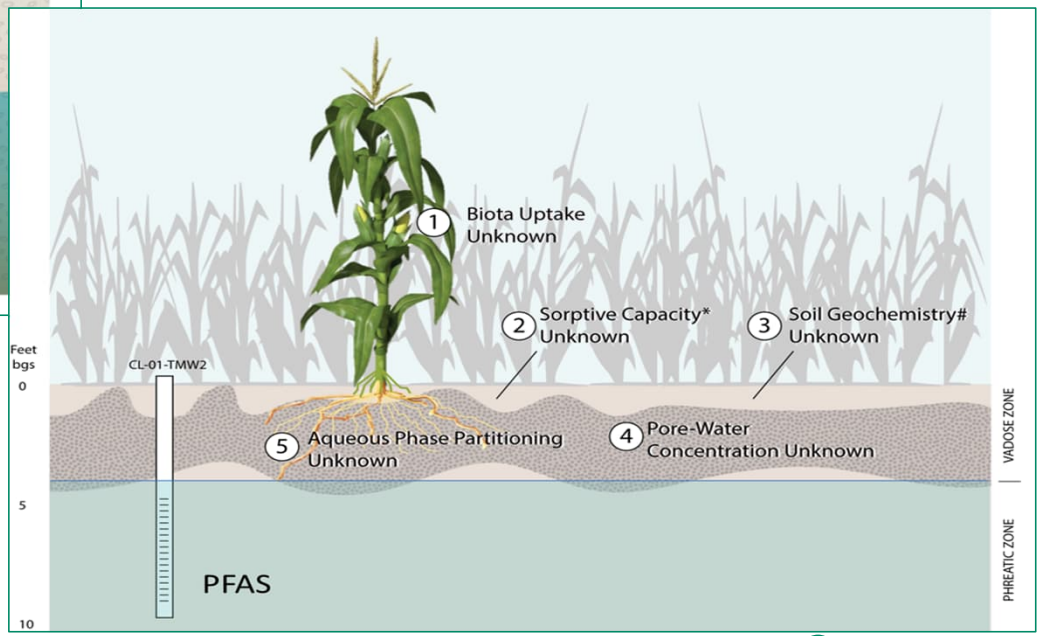
Assumes baseline concentration of 1 µg/kg (part per billion) of PFOA and PFOS in biosolids.

Four detailed modeling scenarios are described in this document:

- reuse on a farm growing fruits and vegetables (crop farm scenario),
- reuse on a farm raising livestock (pasture farm scenario),
- disposal in a surface disposal site (surface disposal scenario), and
- reuse to restore over-grazed pastureland (land reclamation scenario).

Potential PFAS Migration Pathways





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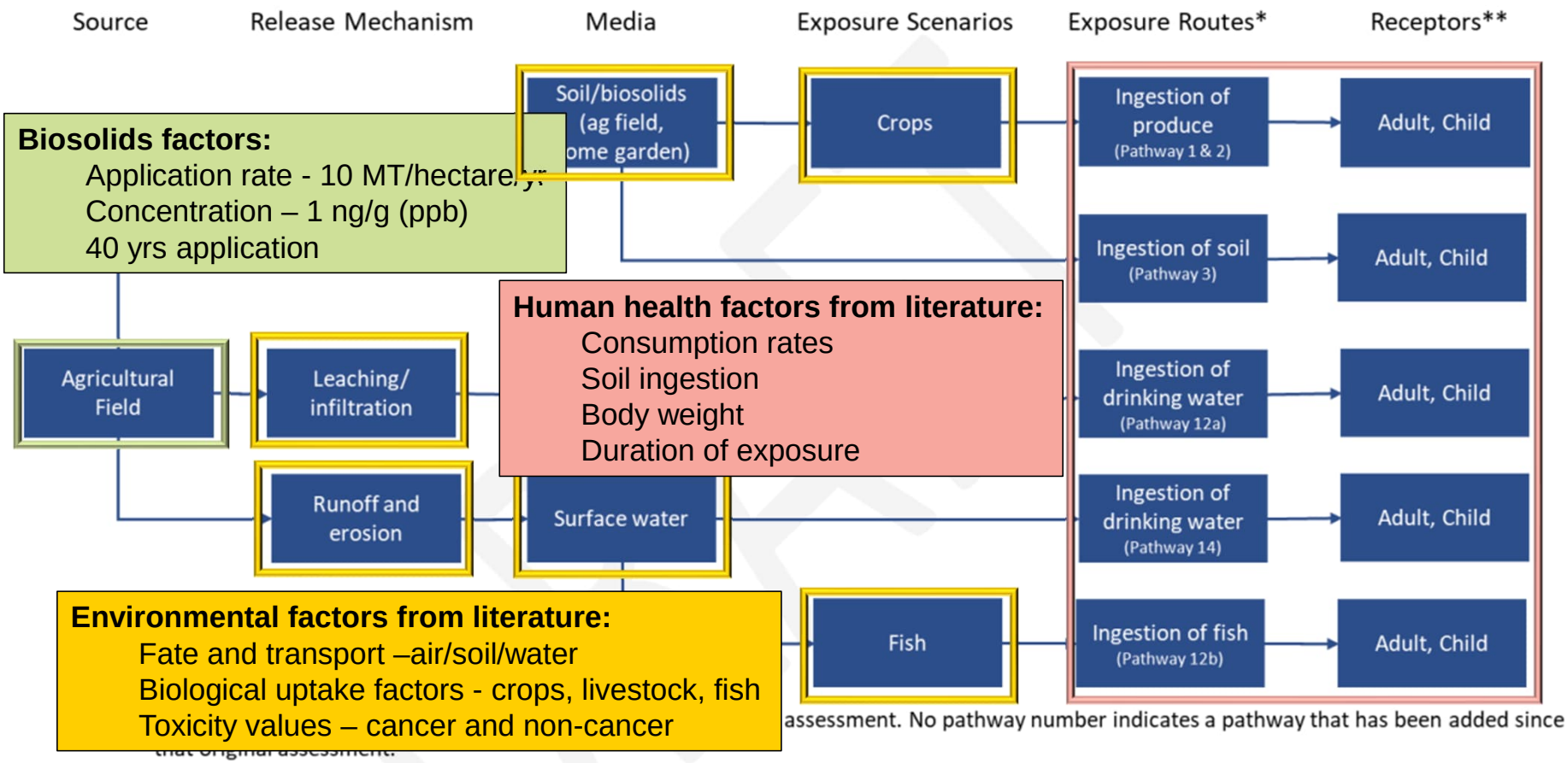
Crop Farm Scenario: Biosolids reuse on a farm growing fruits and vegetables



assessment. No pathway number indicates a pathway that has been added since

** Receptor populations may include farm families, home gardeners, CSA participants, or nearby residents.

Biosolid Risk Assessment Outcomes

Every pathway drove an **unacceptable risk** (compounded exposure is not driving conservatism)

Most inputs used **central tendency**—except for **exposure concentrations** which are:

- Biased high
- Not well correlated with some real-world data

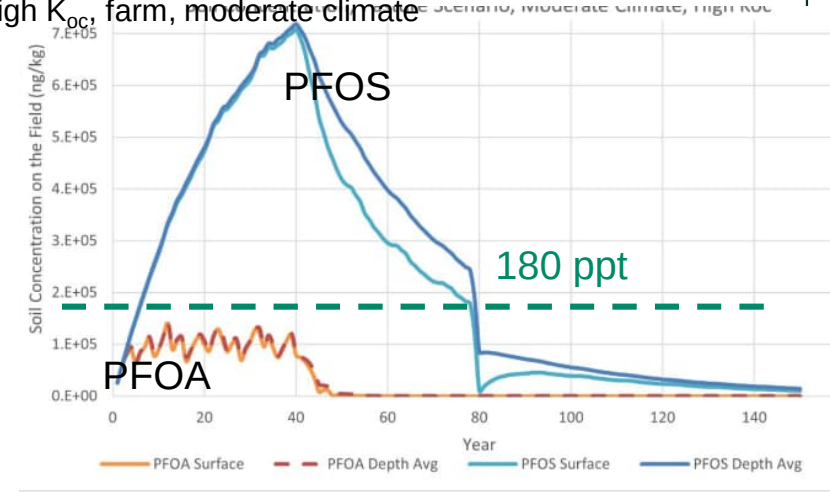
Risk assessment modeling revealed **knowledge gaps**.

More work needed on:

- Fate and transport specific to PFAS
- Soil to plant uptakes
- Models calibrated to site data

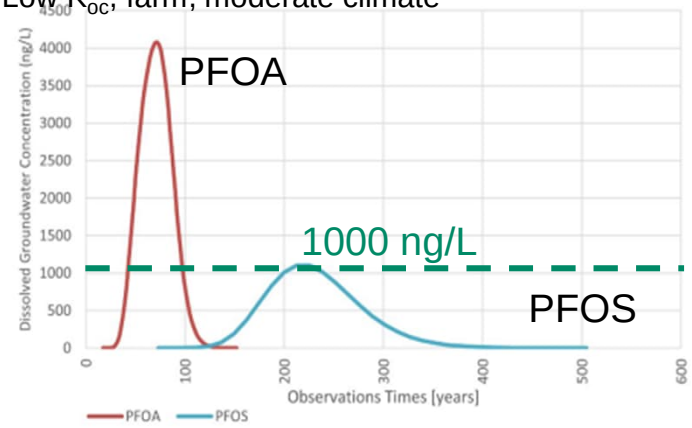
Modeled Soil Concentration (ng/kg)

High K_{oc}, farm, moderate climate



Modeled Groundwater Concentration (ng/L)

Low K_{oc}, farm, moderate climate



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Rosa Gwinn, PhD, PG, AECOM Fellow
Rosa.Gwinn@aecom.com

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Operational landscape

- Product bans and industrial pretreatment are essential for reducing PFAS exposure
- Sleuthing sources possible, strengthened by expanded definition of ‘industrial sources’
- Simplified analysis, potential for field PFAS measurement could reduce monitoring burden on facilities
- Disposal alternatives limited with has cost and capacity limitations and sustainability deficits; destruction technology developing (staffing concern)
- To continue beneficial reuse, consider concentration AND application rate
- Regional treatment solution has benefits, requires collaboration
- Solutions require a social commitment to balancing waste impacts
- Driving PFAS into either liquid or solid stream

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Legislative Considerations

- Bipartisan commitment to mitigating human exposure at federal level
- PFAS solutions will rely on combined federal and state legislative efforts at differing scales
- Comprehensive monitoring ahead of regulatory limits (source trackdown, TRI reporting, IPP)
- Focus on PFAS loading reduction lessens downstream burdens for treatment
- Tiered concentration limits for controlling application rates (MI/WI/MN model) to limit exposure until solutions are commercial
- “Goal is not to get to zero. Goal is to get to better.” ZS reminder to put him last next time
- Lurking in the shadows: pesticides, pharmaceuticals, microplastics