



June 3, 2025

To: The New York Senate Agriculture Committee and New York Assembly Committee on Environmental Conservation

From: Mary Baker, Executive Director of the Mid-Atlantic Biosolids Association, mbaker@mabiosolids.org

RE: Opposition of Senate Bill S5759A/Assembly Bill A6192B  
– Management of PFAS in biosolids

The Mid-Atlantic Biosolids Association is writing to express our strong opposition to Senate Bill S5759 and Assembly Bill A6192.

MABA advocates for biosolids resource recovery that results in sustainable solutions on behalf of the wastewater profession. We envision biosolids being recognized everywhere as a valuable community resource, and our mission is to communicate the benefits of biosolids resources within the biosolids community and the communities we serve.

These proposed measures threaten to upend a proven and sustainable biosolids management system in New York State, replacing it with costly, impractical disposal methods that will burden municipalities, farmers, and taxpayers alike. While environmental protection is paramount, these bills fail to consider the full scope of their consequences, including the lack of disposal capacity, skyrocketing costs, and misrepresentation of biosolids-related PFAS risks.

**A Looming Disposal Crisis:** New York State is already struggling to manage wet waste such as biosolids due to insufficient disposal capacity. With limited landfill space and incineration facilities, a moratorium on land application would create an urgent crisis, forcing municipalities to transport biosolids out of state at excessive costs. This is an unsustainable approach that jeopardizes local waste management, strains municipal budgets, and undermines New York's ability to address organic waste responsibly. No legislation should be enacted to limit biosolids beneficial use until the legislature has studied the available landfill capacity including the additional waste streams needed to sufficiently bulk biosolids.

**Economic Consequences: More Costs, No Benefits:** The beneficial use of biosolids for agriculture is not only safe but financially responsible. Farmers rely on biosolids as an effective soil amendment that improves soil health and reduces the need for synthetic fertilizers. If land application is prohibited, municipalities will be forced to turn to expensive alternatives such as landfilling and incineration, leading to increased transportation costs, disposal fees, and regulatory expenses, all of which will ultimately be passed down to taxpayers. Why shift from an efficient, beneficial system to one that is costly and unsustainable?

**Biosolids Recycling: A Proven Practice:** New York State plays a vital role in biosolids recycling, contributing to the **53% of biosolids** that are beneficially

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reused nationwide, according to data from the National Biosolids Data Project (NBDP). This practice supports soil health, reduces reliance on synthetic fertilizers, and aligns sustainable waste management goals. A moratorium on land application would disrupt this well-established system, forcing municipalities to seek costly and environmentally harmful disposal alternatives.

**PFAS Risks in Context: Biosolids Are Not the Culprit:** It is essential to consider the broader picture when addressing PFAS concerns. Studies show that PFAS concentrations in biosolids—measured in parts per billion (ppb)—are often lower than those found in common household items such as makeup, food packaging, and even household dust. A moratorium on biosolids land application will do little to reduce overall PFAS exposure when everyday consumer products remain a more significant source. Instead of unnecessary bans, we should focus on evidence-based solutions that address PFAS pollution at its true sources.

**Existing Regulatory Frameworks: A Smarter Path Forward:** New York State has already enacted an interim policy to regulate PFAS and PFOA in biosolids management, ensuring environmental safety through responsible oversight. The existing framework allows for continued biosolids recycling while maintaining necessary safeguards. Rather than imposing a sweeping moratorium, lawmakers should work with industry professionals to refine policies that balance environmental protection with economic feasibility.

**Climate Change Goals: Biosolids Use by NY Farmers Reduces Greenhouse Gas (GHG) Production:** A ban of biosolids beneficial reuse will make it difficult for New York to meet its Climate Leadership and Community Protection Act (CLCPA) emissions reduction targets.

Biosolids provide nutrient-rich organic matter that supports soil health and reduces the need for synthetic fertilizers. Without them, NY farmers will have an increased reliance on chemical fertilizers, which require significant energy to produce and whose production contributes to GHG production and environmental degradation.

While the ban aims to protect public health and water quality, policymakers will need to find alternative sustainable solutions to manage biosolids without undermining the state's climate goals.

The passage of Senate Bill S5759 and Assembly Bill A6192 would be a step backward for sustainable waste management in New York State. We urge you to reject these proposals and instead support science-driven policies that protect public health without undermining a crucial component of waste recycling and soil enrichment.

We have included for your consideration the MABA comment letter regarding the USEPA Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS).

We welcome the opportunity to discuss this matter further and provide expert insights into the value of biosolids recycling. Thank you for your time and consideration. We look forward to engaging in a constructive dialogue to find solutions that work for all stakeholders.



Mary Baker  
Executive Director



April 2, 2025

Administrator Zeldin  
U.S. Environmental Protection Agency  
1201 Pennsylvania Avenue, N.W.  
Washington, D.C. 20460

**Subject: MABA Comments on EPA-HQ-OW-2024-0504, USEPA Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS)**

Dear Administrator Zeldin:

MABA is writing to submit comments regarding the Draft Sewage Sludge Risk Assessment for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS). We are concerned that the risk assessment and its release have created uncertainty and confusion, potentially jeopardizing the practice of land applying biosolids on agricultural land.

MABA advocates for biosolids resource recovery that results in sustainable solutions on behalf of the wastewater profession. We envision biosolids being recognized everywhere as a valuable community resource, and our mission is to communicate the benefits of biosolids resources within the biosolids community and the communities we serve.

We request the immediate withdrawal of the draft risk assessment for the following reasons:

- The assessment should be redone using relevant research that is new or soon to be published.
- The agency must consider the empirical data on the everyday and known pathways of exposure to PFAS, which is consistent with understanding the complete impacts on human health.
- Immediate communication should be released withdrawing this assessment, as well as the accompanying fact sheets, noting that they grossly overestimated risk.
- Risk management should be done in advance of releasing a revised risk assessment.
- It should be acknowledged that indirect exposures to PFAS from land-applied biosolids are a fraction of everyday exposures from common household products.
- The EPA released the draft assessment without first conducting a risk management component, which is unprecedented and gives the false impression that biosolids pose a substantial risk from land application or surface disposal and likely when incinerated.
- The risk management analysis is critical for putting the actual risk in perspective and for providing context. Landfill and incineration were explicitly excluded from the models because the research is ongoing and currently unavailable to contribute to the risk assessment. There is ongoing field research for land-application, both crop uptake as well as groundwater transmission, that was not considered or included as one of the reference data inputs for the risk assessment.

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- A risk-benefit analysis should consider the risk of PFOA and PFOS from all other exposures (carpeting, food packaging, etc.) and the additional incremental risk from an indirect biosolids exposure.
- The benefits of biosolids land application such as improved soil tilth, increased crop yields, reduced need for irrigation, and increased soil organic carbon should be evaluated.

The EPA should consider what current and available alternatives exist for biosolids management if all options pose an unacceptable risk.

The EPA used flawed assumptions and science in the risk assessment. For example, the modeled farm family was the focus in the assessment to consume food crops grown every year on land where biosolids with PFOA and PFOS were applied. The existing regulation as part of its risk management assessment included waiting periods between biosolids application and harvest. The assessment also assumes runoff to a pond used for fishing even though the existing regulation requires use of best management practices to control runoff into water bodies. In summary, the model used in the assessment was not congruent with real-world practices.

There is an abundance of research nearing completion conducted on typical biosolids application which must be utilized in the revised assessment. The scant research used in the draft assessment was largely based on highly contaminated biosolids from an industrial source, and/or used an unrealistically high application rate and/or misrepresentative greenhouse pot studies.

As noted in the reviews by expert research scientists attached to this comment letter, the EPA used flawed assumptions and science in the risk assessment.

In conclusion and to reiterate, we request the immediate withdrawal of the draft risk assessment as well as the accompanying fact sheets.

We look forward to working with you and agency staff to ensure that federal programs and policies are issued based upon validated and current data.

Sincerely,



Anne V. Marek  
President



Sean Fallon  
Vice President



Al Razik  
Treasurer



John K. Leslie  
Secretary



Mary Baker  
Executive Director

CC: EPA Docket Center

David Tobias, USEPA, Office of Science & Technology, Office of Water



# U.S. EPA DRAFT SEWAGE SLUDGE RISK ASSESSMENT FOR PFOA AND PFOS

## Expert Review from Research Scientists

Please find below six expert reviews of the Draft Sewage Sludge Risk Assessment for PFOA and PFOS presented by research scientists from the United States Department of Agriculture (USDA) W-5170 Multi-State Research Team specializing in risk assessment, modeling, reference dose and toxicity, bioavailability, and fate and transport to surface water, groundwater, and plant uptake. This Multi-State Research approach leverages the research expertise from land grant universities across the United States to explore the environmental impacts and benefits of utilizing biosolids in land-based systems. The team approach also offers an added level of rigor to their independent research projects as these are critiqued annually by the collective. The following team members have presented their review of the Draft Risk Assessment:

- **Dr. Sally Brown, University of Washington**
- **Dr. Jay Gan, University of California-Riverside**
- **Dr. Ganga Hettiarachchi, Kansas State University**
- **Dr. Drew McAvoy, University of Cincinnati**
- **Dr. Ian Pepper, University of Arizona**
- **Dr. Tom Young, University of California-Davis**

These research-specific comments clearly demonstrate the necessity for additional field-based studies that utilize realistic application scenarios, environmental conditions, and existing regulatory limits to improve the model used in this assessment. These studies along with consideration of the multitude of PFAS pathways that may impact the model will bolster the efficacy of what the draft risk assessment is seeking to achieve.

Thank you for welcoming comments on the Draft Risk Assessment.

## Comments to the EPA Draft Biosolids Risk Assessment

Dr. Sally Brown, University of Washington

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The study shows toxicity values for both RfD and CSF. The assessment is focused on increased cancer risk but here there is a several order of magnitude difference between the RfD and CSF values for both PFOA and PFOS

**Table 3. Toxicity Values for PFOA**

| Toxicity Value Type                 | Value                              | Critical Effect(s), Critical Study/Studies                                                                                                                                                                                |
|-------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RfD (based on epidemiological data) | $3 \times 10^{-8}$ mg/kg/day       | Reduced antibody response to vaccinations in children (diphtheria and tetanus) (Budtz-Jorgensen & Grandjean, 2018); decreased birth weight (Wikstrom et al., 2019); increased serum total cholesterol (Dong et al., 2019) |
| CSF (based on epidemiological data) | $29,300$ (mg/kg/day) <sup>-1</sup> | Renal cell carcinoma (RCC) (Shearer et al., 2021)                                                                                                                                                                         |

**Table 4. Toxicity Values for PFOS**

| Toxicity Value Type                      | Value                            | Critical Effect(s), Critical Study/Studies                                                                       |
|------------------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------|
| RfD (based on epidemiological data)      | $1 \times 10^{-7}$ mg/kg/day     | Decreased birth weight (Wikstrom et al., 2019); increased serum total cholesterol (Dong et al., 2019)            |
| CSF (based on animal toxicological data) | $39.5$ (mg/kg/day) <sup>-1</sup> | Combined hepatocellular adenomas and carcinomas in female rats (Thomford, 2002; Butenhoff et al., 2012, 1276144) |

PFAS is unlike the other compounds/ elements that EPA has conducted risk assessments for in relation to biosolids. Daily exposure to PFAS across a wide range of products/ pathways is ongoing for all people. Surveys have indicated that exposure to these compounds in the US is universal (Calafat, 2019). This is evidenced by PFAS concentration in blood and the presence of PFAS in other body parts (Jian et al., 2018, Nielsen et al., 2024). In addition, it is likely that a significant portion of the PFAS entering WWTP comes from fecal matter and, to a lesser extent, urine. A study used animal (cat and dog) feces as surrogates for human feces and found that there were high concentrations of a range of PFAS compounds in the feces ( $\Sigma 13$  PFAS, mean value  $85.4 \pm 94.5$  ng/g for dogs,  $54.7 \pm 26.9$  ng/g for cats)(Ma et al., 2020). This suggests that people are a significant source of PFAS into WWTP.

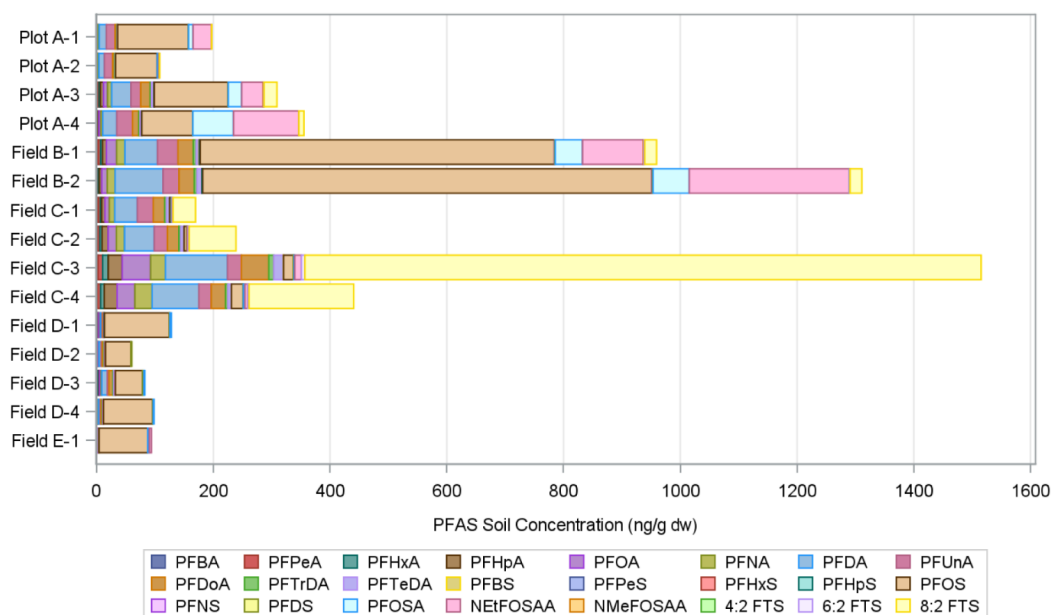
This reviewer recognizes that there are a small number of cases where industrial discharge into municipal systems had resulted in biosolids with highly elevated concentrations of PFAS. Pre- treatment can effectively reduce PFAS in wastewater influent. The report notes that efforts in MI to reduce PFAS via source control resulted in significant reductions in PFAS concentrations in biosolids. With those sources eliminated, flows into treatment plants are primarily from domestic sources (Lin et al., 2024). With this context, how is it possible to conduct a risk assessment for PFAS related to exposure from biosolids in isolation without a consideration of existing body burden and daily home exposure? Considering how wide- spread exposure is to the general population, it also begs the question of whether biosolids without industrial enrichment of these compounds, are a realistic exposure concern.

The write up suggests that the decision not to conduct a Monte Carlo modeling is evidence that this is a not a conservative exercise. It is also highly likely that including

the myriad of other exposures to PFAS for everyone would indicate that the potential for additional exposure via land application of biosolids is minimal.

For concerns related specifically to agricultural communities, this assessment considers a wide range of assumptions over time in the model. As PFOS and PFOA have been phased out of use, would it make more sense to begin this process by examining the data from long-term application sites? The biosolids control used in Blaine et al., 2013 is one example of a long term application sites. Use of these types of sites would also allow for an evaluation of the benefits associated with biosolids application including changes in soil carbon storage, water holding capacity, yields and evaluation of soil health. These sites would also likely provide examples of moderately (as material was applied before the bans of PFOS and PFOA) contaminated biosolids at typically high loading rates. They would also allow for an evaluation of behavior over time, something that was a concern for metal availability.

The sites that were used to validate the model were primarily or all (depending on category) sites with highly contaminated biosolids or contaminated with PFAS from other sources. For example, the single study used to model uptake into forage which ended up as one of the pathways of concern was a survey sampling of grasses grown in soils where biosolids contaminated by industrial discharges from a 3M plant had been applied (Yoo et al., 2011). Another study mentioned was forage uptake for plants grown in historically contaminated soils in Maine (PFOS concentrations ranging from 44-232 ng/g) (Simones et al., 2024) Data from that study is shown below.



**Figure 1.** Mean plot study and field survey study soil PFAS concentrations. See Table 1 for plot/field study notation.

Behavior of the PFAS at a contaminated site is potentially different from behavior from a conventional site. The linear assumptions here re bioaccumulation factors, plant uptake and other risk calculations are highly unlikely to be linear at lower levels of

contamination. The Blaine studies showed no detectable PFOA or PFAS for many of the plants measured. In fact, the authors (2014) only show data from the industrially impacted biosolids as:

**Low PFAA concentrations in the municipal and control soils limited the ability to determine accumulation trends, and thus the remainder of the results and discussion focuses on the crops grown in the industrially impacted soil.**

In their initial study (Blaine et al., 2013), the non linear response is clear in Figure 1. Uptake into lettuce was higher in the industrially impacted soil where biosolids compost was added at a 10% by volume rate (250 Mg ha) in comparison to the high loading rate of regular biosolids (>1500 Mg ha) for PFOA and about equal for PFOS. The PFOA and PFOS concentrations in the industrially contaminated soil were 78.5 and 49.7 ng g, respectively. The PFOS concentration in the regular biosolids was 319.5 ng g with PFOA not reported but based on data that was provided was less than 54 ng g. Further, in the field portion of this study, most soils had PFAS concentrations below quantifiable limits with no reportable plant uptake. The BAF for PFOA in lettuce varied from below quantifiable limits (field) to 2.52, with the BAF in the municipal biosolids at 1.34. For PFOS, despite a much higher soil PFOS concentration in the municipal treatment, the BAF was 0.32 whereas in the industrial treatment it was 1.67 and in the field study it measured 0.1. Assuming a linear response based on soil PFOS and PFOA concentrations from limited trials and no trials using modern day biosolids is clearly problematic.

This clearly shows the importance of matrix and the use of non- industrially contaminated biosolids. There is a national survey underway with Phase I results (Pepper) as well as a publication of groundwater in IN (Lee). There is a dearth of data on plant uptake from biosolids amended fields, for movement to groundwater and surface waters for biosolids that are not excessively and historically contaminated by PFOA and PFOS. For metals, it was clear that there was a No observed adverse effect level or NOAEL. Studies showed that plant uptake of metals (Cd in particular) was similar to control soils at what would now be considered to be high levels of biosolids Cd (Brown et al., 1996). This persisted for well over a decade after biosolids were first applied.

## Comments to the EPA Draft Biosolids Risk Assessment

Dr. Jay Gan, University of California-Riverside

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**Sorption and chemical availability for leaching and runoff.** The draft report provides a strong foundation for assessing PFOA and PFOS mobility in biosolids-amended soils. As acknowledged in the report, PFOA and PFOS transport is often retarded in the vadose zone due to electrostatic sorption and/or complexation to soil minerals but can later migrate into aquifers.<sup>1</sup> However, hydrophobic adsorption with soil organic matter and clay minerals also play a critical role in the retention of PFOA and PFOS in soils, with  $K_d$  increasing with both increasing soil organic matter content and cation-exchange capacity of the clay minerals.<sup>2</sup> Furthermore, non-extractable residues of PFAS embedded or locked by the synergism of pore filling and sorption by soil organic matter as well as the organic-mineral complex will also impact the soil retention of PFOA and PFOS. The desorption of PFOA and PFOS from soil matrices has been found to take up to several decades.<sup>3</sup> Therefore, ignoring the role of adsorption and hysteresis in desorption would grossly over-predict the mobility of PFOA and PFOS in soil after land applications of biosolids, and consequently, the risk for their off-site movement such as contamination to groundwater.

In addition, the laboratory-derived, equilibrium-based, adsorption coefficients have been found to underestimate sorption of biosolids-amended soils under field conditions.<sup>4</sup> As a result, applying lab-based  $K_d$  or  $K_{oc}$  values may further lead to overestimated PFOA and PFOS concentrations in groundwater and surface water. In general, the report downplayed the influence of adsorption in reducing chemical mobility, which, when coupled with the absence of field observations, undermine the credibility of the suggested ground- and surface water contamination potentials of PFOA and PFOS following biosolids land-applications.

<sup>1</sup> Cogorno, J., & Rolle, M. (2024). Impact of Variable Water Chemistry on PFOS-Goethite Interactions: Experimental Evidence and Surface Complexation Modeling. *Environmental Science & Technology*, 58(3), 1731-1740.

<sup>2</sup> Ahmad, A., Tian, K., Tanyu, B., & Foster, G. D. (2023). Effect of Clay Mineralogy on the Partition Coefficients of Perfluoroalkyl Substances. *ACS ES&T Water*, 3(9), 2899-2909.

<sup>3</sup> Gellrich, V., Stahl, T., & Knepper, T. P. (2012). Behavior of perfluorinated compounds in soils during leaching experiments. *Chemosphere*, 87(9), 1052-1056.

<sup>4</sup> Zareitalabad, P., Siemens, J., Hamer, M., & Amelung, W. (2013). Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) in surface waters, sediments, soils and wastewater—A review on concentrations and distribution coefficients. *Chemosphere*, 91(6), 725-732.

**Bioavailability and relative effectiveness of exposure.** Since no data is available on PFOA and PFOS bioavailability to livestock from feed, water, or soil, the assessment assumes 100% bioavailability using a bioavailability factor of 1. However, it is important to note that the dissolved fraction in soil porewater most accurately represents the bioavailable fraction.<sup>1</sup> Due to the significant sorption of PFOA and PFOS to soil particles, porewater concentrations are likely only a fraction of the total chemical concentration, and the reduced bioavailability limits crop uptake.<sup>1</sup> Their large molecular size and hydrophobicity also contribute to their sequestration in roots, restricting translocation to aboveground tissues. Consequently, assuming 100% bioavailability for soil-to-plant transfer grossly overestimates the risk when considering exposure to livestock from feed and subsequent human exposure through contaminated animal products.

Similarly, in surface aquatic systems (e.g., ponds), bioavailability of PFOA and PFOS is initially influenced by runoff potential and adsorption to particulate and dissolved organic matter. In aquatic systems, the bioaccumulation of PFOA and PFOS by aquatic organisms (e.g., fish) is further governed by their bioavailability in the environment. In addition, once inside the body, the relative effectiveness of this exposure is influenced by several factors, including protein binding, biotransformation, enterohepatic recirculation, and the rate and pathways of elimination. Though these factors are discussed in the problem formulation section of the report, their consideration and influence in the risk assessment itself is not clear. Additionally, PFOA and PFOS exposures and risks are considered separately, though several studies have reported interactive effects with co-exposure.<sup>2,3</sup> These limitations underscore the urgent need for field-based monitoring under realistic conditions to (in)validate the model predictions.

<sup>1</sup> Mei, W., Sun, H., Song, M., Jiang, L., Li, Y., Lu, W., ... & Zhang, G. (2021). Per- and polyfluoroalkyl substances (PFASs) in the soil-plant system: Sorption, root uptake, and translocation. *Environment International*, 156, 106642.

<sup>2</sup> Ojo, A. F., Peng, C., & Ng, J. C. (2020). Combined effects and toxicological interactions of perfluoroalkyl and polyfluoroalkyl substances mixtures in human liver cells (HepG2). *Environmental Pollution*, 263, 114182.

<sup>3</sup> Pierozan, P., Kosnik, M., & Karlsson, O. (2023). High-content analysis shows synergistic effects of low perfluorooctanoic acid (PFOS) and perfluorooctane sulfonic acid (PFOA) mixture concentrations on human breast epithelial cell carcinogenesis. *Environment International*, 172, 107746.

**Plant uptake and translocation.** In the report, the assessment of crop concentrations due to root uptake from biosolids-amended soils relies on soil-to-plant bioconcentration factors (BCFs). However, due to limited data on crop uptake of PFOA and PFOS from biosolids, the current approach uses a single field-derived BCF value from lettuce for PFOS for aboveground vegetables, while using the median of detected greenhouse values for PFOA in aboveground vegetables and for both PFOS and PFOA in fruits and root vegetables. The mean BCF of several grasses is used for forage and silage. The use of a single BCF value from lettuce to estimate crop concentrations of PFOS, and the subsequent cancer risk levels and hazard quotients, introduces great uncertainties as plants exhibit species-specific bioaccumulation tendencies influenced by factors such as tissue protein content, transpiration rates, and biological barriers like Casparian strips.<sup>1,2</sup> While the draft describes the uncertainty introduced by using greenhouse-derived data rather than field-derived data (i.e. the tendency to overestimate risk), it could more thoroughly acknowledge the uncertainty introduced with such limited field-derived data and preferably refrain from making overarching assumptions before more field-based observations are available.

Due to the strong adsorption of long-chain PFAS to soils and sediments, and the root retention of larger, more hydrophobic molecules by Casparian strips, the accumulation of PFOS and PFOA by aboveground plant tissues is likely negligible under realistic conditions. This is particularly relevant for fruiting crops, grain crops, corn, and fruit trees with more biological barriers and requiring long-range translocation from the roots to edible tissues. This again suggests that the risk assessment presented in the draft is premature in the absence of adequate field-based values, along with the lack of consideration of other major food and feed crops.

<sup>1</sup> Mei, W., Sun, H., Song, M., Jiang, L., Li, Y., Lu, W., ... & Zhang, G. (2021). Per- and polyfluoroalkyl substances (PFASs) in the soil-plant system: Sorption, root uptake, and translocation. *Environment International*, 156, 106642.

<sup>2</sup> Wen, B., Wu, Y., Zhang, H., Liu, Y., Hu, X., Huang, H., & Zhang, S. (2016). The roles of protein and lipid in the accumulation and distribution of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in plants grown in biosolids-amended soils. *Environmental Pollution*, 216, 682-688.

## **Comments to the EPA Draft Biosolids Risk Assessment**

**Dr. Ganga Hettiarachchi, Kansas State University**

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As the EPA Draft Risk Assessment document correctly pointed out, only a few studies had measured plant uptake of select PFAS compounds for biosolids-amended soil at field sites. Further, the document discussed many of the issues associated with measuring true BCF values. For example, in some studies conducted on PFAS plant uptake, calculated bioconcentration factors (BCF) could have been impacted due to multiple exposure pathways in addition to biosolids-amended soil (e.g., contaminated water or air deposition) (Fig. 2 in Li et al. 2022, showing Zhang et al. 2020 data), emphasizing that measuring true biosolid amended-soil-to-plant transfer is a difficult and complex task.

All selected BCF values used in the Draft Risk Assessment process were based on biosolids-amended soil studies. However, field data were only available for forage, silage, and aboveground vegetables for PFOS. Therefore, for the draft risk assessment, they used values of BCFs for PFOA and PFOS data from the biosolids-specific field studies or a median of greenhouse values (for which field data were unavailable). The studies used for this purpose were as follows. For forage and silage, the mean BCF calculated across all the grasses in the Yoo et al. (2011) field study was used. For aboveground vegetables, the single field value (for lettuce) available for PFOS from the study of Blaine et al. (2013), and a median of greenhouse values from Blaine et al. (2013, 2014) for PFOA, for which no field data were available. For fruits (whether exposed or protected), the median of detected greenhouse values from Blaine et al. (2013, 2014) and Lechner and Knapp (2011) were used. For root vegetables, the median of detected greenhouse values from Blaine et al. (2014), Lechner and Knapp (2011), and Wen et al. (2016) were used.

In addition to the significant uncertainties mentioned (pages 53-54) with regard to the two field studies used (Blaine et al. 2013; Yoo et al. 2011), uncertainties associated with measured mean BCF values due to possible soil contamination should also be considered. Previous plant uptake studies for metal(loid)s have clearly shown significant surface dust accumulation in plant materials is possible (McBride et al., 2014), even after washing plant materials using kitchen-style washing (i.e., washing plant materials to remove all visible soil particles, Attanayake et al., 2014). Attanayake et al. (2014) found up to about 2.6 to 4.6 times greater lead concentration in Swiss chard cleaned with the kitchen cleaning method than that cleaned with the lab cleaning method. The magnitude of the difference between kitchen-cleaned tomatoes and lab-cleaned tomatoes was about 3x. It is worth noting that the two field studies (Blaine et al., 2013; Yoo et al., 2011) have not attempted to determine possible soil/biosolid contamination of plant materials. Blaine et al. (2013) did not mention any specific cleaning protocol for their samples. Yoo et al. (2011), washed the aboveground portion of grasses that were

collected immediately three times in Optima-grade methanol and then stored the samples in certified-clean plastic bags, which they had spot-checked to ensure they were not contaminated with the analytes. Further, they inspected plant material for dust, dirt, or stains on the plant exteriors for contamination to eliminate those samples for further analysis. They also mentioned that the plants were not washed for fear of contamination with fluorotelomer alcohols by sorption from laboratory air. Previously, researchers have shown that measuring aluminum (Al) (Fig. 3, McBride et al. 2014) or titanium (Ti) (Table 3, Cary et al., 1994) concentrations of the crop as a way to determine the extent of physical contamination of plant tissue by soil particles or soil inclusion in plant samples (either adhered to plant surfaces or incorporated into plant tissue) (Cary and Kubota, 1990).

Not only that, but it is also hard to say whether the observed lack of significant or consistent correlations between PFOA and PFOS uptake factors and soil concentration, pH, organic matter content, or cation exchange capacity (mentioned in Page 16, based on the study by Simones et al., 2023) truly represents lacking correlations between soil factors and PFAS uptake by plants or because varying levels of surface contamination with contaminated soil or dust and other pathways of PFOA and PFOS might have impacted the plant samples. The study by Simones et al. (2023) in the draft document is now published in a peer-reviewed journal, providing more information about their sample handling (Simones et al., 2024). Based on the information given by Simones et al. (2024), it is hard to guarantee that the plant sample surfaces were not contaminated with soil/dust. Their sampling approach included collecting sward samples from the entire quadrat, cutting approximately 5 to 8 cm above the ground, inspecting for any visible signs of soil adherence to the surface of the plants, and placing in bags and sending those for analysis.

Further, Blaine et al. (2013) showed that the only field that produced measurable data for PFOA and PFOS was a pilot field with biosolids applied at four times the agronomic rate. Using BCF associated with an unrealistic/high biosolids application rate can be problematic for many reasons, such as its impact on soil pH, EC, competition by other soluble ions and nutrient concentrations on the observed BCF.

Similarly, using median BCF values from greenhouse experiments is problematic for several reasons, as pointed out in the Draft Risk Assessment document (for example, See Page 54) and also due to soil inclusion. In summary, the BCF of PFOA and PFOS could be significantly plagued by issues. Therefore, it is worthwhile to wait for comprehensive field-based plant uptake data from studies funded by the EPA and other funding agencies.

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## **Comments to the EPA Draft Biosolids Risk Assessment**

**Dr. Drew McAvoy, University of Cincinnati**

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Since this is an important risk assessment that could impact wastewater treatment plants across the entire US, it is imperative that the USEPA spend more time to obtain appropriate data for the risk assessment of PFOA and PFOS. Several well-designed field studies are currently underway and some even being funded by the USEPA. Finalizing the risk assessment before these data are available seems premature. These studies will help reduce the uncertainty of the risk assessment.

The USEPA has identified three areas of high concern, i.e., groundwater concentrations, fish tissue concentrations, and fruit and vegetable concentrations. Suggestions for improving the risk assessments for these areas of high concern are provided below, as well as recommendation for future study.

### **High Concern – Groundwater Concentrations (farm crop and pasture)**

Field studies are needed to assess leaching potential of PFOA and PFOS under field conditions. Transport in the vadose zone is highly dependent on the sorption distribution coefficients ( $K_d$  values), which depend on soil type. Thus, better field data is need for vadose zone transport.

The  $K_d$  values are being predicted from  $K_{oc}$  and  $f_{oc}$  values. However,  $K_{oc}$  values are not typically measured but estimated from  $K_{ow}$ , which is not valid for PFOA and PFOS, or calculated from measured  $K_d$  and  $f_{oc}$  values. It is not clear how the  $K_{oc}$  values are determined for the risk assessment. Thus, more measured  $K_d$  data are need on a variety of different soil types to improve the predicted transport of PFOA and PFOS in the vadose and saturated zones. Moreover, to help understand the mechanisms of sorption, the organic carbon content and aluminum and iron oxide content should be measured in the tested soil.

With the modeling risk assessment focused on central tendency simulations, the median (50<sup>th</sup> percentile)  $K_{oc}$  value should be used. In the current assessment, though, only extreme low and high  $K_{oc}$  values were used in the simulations. Also, the  $f_{oc}$  in the till layer seems low for an agricultural soil. The  $f_{oc}$  in the till layer would have to be much higher than vadose zone and groundwater soils.

In addition, a bulk density of 0.7 g/cm<sup>3</sup> seems low for most agricultural soils. This new bulk density value used in the assessment is less than half the old value 1.6 g/cm<sup>3</sup>. Is the new bulk density the median value used in the central tendency simulation? More bulk density data are needed for a variety of biosolids amendment sites.

### **High Concern – Fish Tissue Concentrations (farm pond)**

The farm pond concentrations of PFOA and PFOS will highly depend on the size of the pond (volume) and the area of the field that is being amended. For example, if the size of the pond increases or the size of the amended field decreases, then the concentrations in the pond will decrease and the fish tissue concentration will decrease. Also, if the pond is more than 10 m from the amended field, then the pond concentration would be less. Better field data is needed for predicting transport from the amended field to surface waters (erosion and runoff) with an adequate buffer zone. A sensitivity analysis on the size of the amended field and pond should

also be conducted. Moreover, it appears that the fish tissue concentration of PFOS was greater than the MRL only in the low Koc simulation. What would be the result if a median Koc value is simulated since this was a central tendency assessment. The fish tissue concentration for PFOA was always less than the MRL for low Koc simulations. Net, simulating a central tendency Koc value may demonstrate that the fish tissue concentration is safe.

### **High Concern – Fruit and Vegetables (farm crop)**

There is a high degree of uncertainty when predicting the fruit and vegetable PFOA and PFOS concentrations. This is due to the lack of high-quality data on plant concentrations and uptake factors. Thus, additional field data is needed for the uptake of PFOA and PFOS into fruits and vegetables. Several field studies are currently being conducted and their results should be used in the risk assessment. Some of these studies are being funded by the USEPA.

The draft risk assessment states that the lettuce, radish, celery, tomato, pea, carrot, cucumber and potato studies were grown in greenhouses. Due to the recognized pot effect of greenhouse studies, these crops should be retested in field studies. If greenhouse study results are used, then they should be adjusted for the pot effect.

### **Other Concerns with the Risk Assessment**

Contaminated Sites - The risk assessment uses data from highly contaminated sites in Maine, Michigan and Alabama that are not relevant to the application of municipal biosolids. For example, the Alabama study with grass is highly contaminated site with industrial releases. Thus, field studies using non-municipal biosolids should not be used in the biosolids risk assessment.

Eggs and Chicken - There were issues with all the chicken and egg studies used in the risk assessment. Wilson et al. (2020) conducted a laboratory study using layer hens with drinking water concentrations of PFOA and PFOS as high as 300 µg/L, which is unrealistic. Also, the chick exposure was only via water. Kowalczyk et al. (2020) conducted a laboratory study to assess the concentration of PFOA and PFOS in chicken muscle (meat), but they used layer hens instead of broilers. Exposure was only via the feed, which was derived from a paper compost. The RAAF Military Base study in Australia report concentrations in chicken eggs, but exposure was from a highly contaminated AFFF site. Thus, additional data from well designed studies are needed to assess the concentrations of PFOA and PFOS in boiler meat and in layer eggs.

Beef and Milk – There isn't any good studies available to assess livestock BTF for PFOA and PFOS. Vestergren et al. (2013) was the best study for milk, but no soil or feed concentrations were measured. They also measured muscle concentration of PFOA and PFOS in dairy cows and not beef cattle. Kowalczyk et al. (2013) measured food intake and assessed the meat concentration of PFOA and PFOS in dairy cows. Thus, the calculated intake rates are highly uncertain for beef cattle. Drew et al. (2021, 2022) studied beef cattle but they did not report measured soil, grass, and water concentrations. They did report serum concentrations, but PFOA was < LOD. All the other studies had flaws (e.g., dairy cattle drinking AFFF water, using PBPK modeling that was not sufficiently validated, and assuming intake with no measured values). Thus, there are no good data for dairy and cattle intake of food and water. More studies are needed for assessing the uptake of PFOA and PFOS for beef and dairy.

## **Proposed Future Studies**

Additional data are needed for many aspects of the risk assessment. In particular, well designed field studies are needed to acquire data that is lacking for many of the model parameters. It is recommended that three field monitoring sites be implemented by the USEPA to be used to evaluate the three hypothetical modeling sites (Boulder, CO; Chicago, IL; Charleston, SC). Biosolids from nearby municipal wastewater treatment plants could be amended with biosolids to farm fields of similar size as those in the risk assessment tool (crop and pasture). A farm pond with a size similar to the risk assessment tool and a groundwater well near the amended field would also be needed. From these three sites, information of fish tissue from the farm pond, water from the drinking water well, as well as concentrations in beef, milk, chicken and eggs could be monitored. Such a field study could be used to validate the PFOA and PFOS risk assessment modeling results.

Other data needed for the risk assessment are frequency, amount and source of biosolids being amended in the US. The biosolids concentration data for PFOA and PFOS from municipal wastewater treatment plants. Since the biosolids matrix can have a significant effect on mobility and transport, more high-quality data are needed for sorption ( $K_d$  values) from different soil types. A sensitivity analysis should be performed in those compartments that require  $K_d$  values as inputs. The depth to groundwater is also important for transport and should be reported for the three study sites. Lastly, sites that have received highly contaminated sludge from industrial sources should not be used in the assessment.

## Comments to the EPA Draft Biosolids Risk Assessment

Dr. Ian Pepper, University of Arizona

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The EPA report is unacceptable in its current form since there are serious flaws including data omissions, and concurrently, inclusion of bad science. Other major problems with the report are: i) it is premature since several important national field studies are now nearing completion and inclusion of new data from these studies would have greatly benefitted the report; ii) the report focuses on an area where the least amount of data are available, namely ingestion of foodstuffs following crop uptake of PFAS; and iii) conclusions are reached based on speculative assumptions based on minimal data. Examples of all of these criticisms are outlined below.

### *Incidence of PFAS in Soil, and Plant Uptake*

EPA has chosen to utilize three field studies to demonstrate plant, soil and water contamination with PFAS. These studies were at Ottawa, Ontario, Canada (2008); Decatur, Alabama (2011); and Wixom, Michigan (2018). The Ottawa study utilized biosolids with low PFAS concentrations (1.6 ppb PFOA and 7.2 ppb PFOS). The studies in Decatur, utilized biosolids that were industrially contaminated with high PFOA (up to 317 ppb) and high PFOS (up to 325 ppb) concentrations. The third study at Wixom, Michigan utilized biosolids with low PFAS concentrations applied at very high rates (184-521 dry metric tons over 5 years).

These three studies were chosen to compare modelled PFAS concentrations with measured concentrations in plants, soil and water. Clearly, these three studies are not the only research studies available and the question arises as to how these field studies were chosen for analysis, and why other more recent studies omitted. Such omissions include Pepper *et al.* (2021) which studied incidence and mobility of multiple PFAS analytes at land application sites with known biosolid loading rates dating back to 1984. This is one of the few studies with precise information on lifetime loading rates. It also demonstrated background (no biosolid) soil concentrations, and that irrigation water can also be a source of PFAS.

Another important omission is the National Collaborative PFAS project (Pepper *et al.*, 2025). This project evaluated incidence and mobility of biosolid derived PFAS in soils from 23 land application sites across the U.S. This produced the largest dataset on incidence and mobility of PFAS ever assembled. This study resulted in a detailed report documenting this dataset. EPA was well aware of this project, due to personal communications between Dr Pepper (Project PI) and David Tobias (lead author of the EPA Report). These conversations were initiated at the inception of the project, and EPA was briefed throughout the course of the project. The omission of this dataset suggests either incompetence or bias.

An example of a just published article documenting a recently completed study that would have been useful to EPA had they not prematurely published their report, is on uptake of PFAS by dry farmed oats (Black *et al.*, 2025). This study demonstrated that no uptake of PFAS analytes were detected in oats grown on plots with a long history of land application of biosolids with significant PFAS analyte concentrations. This was a critical finding leading the authors to state: “that the likelihood of the PFAS compounds studied here accumulating in similar crops grown under similar conditions is minimal.”

### *Transport of PFAS through soil and vadose zone*

Models are used to predict PFAS transport, but the models utilized do not take into account sorption at the air/water interface. Such sorption would dramatically decrease the amount of PFAS entering groundwater; therefore, the risks calculated by EPA are overestimated. In addition, the EPA report does not have any real world field data on sub-surface soil concentrations. Finally, no mention is made of soil screening levels SSLs that would be protective of groundwater (less than 4 ppt concentration in groundwater) relative to actual PFAS concentrations found in soil at land application sites. Such data are available in Pepper *et al.* (2025) which shows that mean and median soil concentrations at land application sites across the U.S. are less than or close to calculated soil screening levels.

Overall, EPA claims that drinking groundwater near a surface disposal rate with biosolids containing 1 ppb PFOA or 4-5 ppb PFOS may produce human health risks. The basis for this unsubstantiated statement is not clear.

### *Inclusion of Bad Science*

EPA chose to cite and discuss the study of Blaine et al. (2013). There are several major issues associated with this study:

- 1) Use of a greenhouse study with pots to evaluate plant uptake of PFAS. Data derived in this manner are unacceptable since it has been well established since at least the early 1980s, that pot studies (initially used to evaluate uptake of heavy metals) result in artefacts due to confined root structure.
- 2) In a greenhouse study, composted biosolids impacted by PFAS manufacturing was applied to soil at a rate that was 10 times higher than the average recommended agronomic rate. The authors of the published paper state that the 10X rate represents 10 applications at the 1X rate. The artificially industrially impacted soil had a total of 335 ppb of PFAS including PFOA concentrations of 78.5 ppb and 49.7 ppb of PFOS. Clearly this was incorrect and a great example of bad science and bias against land application, creating an unrealistic worst-case scenario. Use of a 10X rate of application produced data that are not representative of normal land application.
- 3) In field studies the authors state that “municipal biosolids” were land applied. However, these biosolids had a total of 434 ppb PFAAs including 319 ppb of PFOS. This suggests that the biosolids had been industrially contaminated and were not representative of “normal” municipal biosolids. In addition, rates of biosolid application were up to 4X the agronomic recommended rate. Despite this, data showed that field grown lettuce and tomatoes on soil with the agronomic rate of application contained PFAAs at levels below the limit of quantitation (LOQ). Similarly, corn grain grown on biosolid-amended soil also contained PFAAs below the LOQ.

In summary, it is unclear why EPA chose to cite and discuss this paper and omit other studies

Overall, the EPA report has calculated risks using speculative and unrealistic assumptions, even for worst case scenarios associated with land application on small farms. Application of these risks to land application sites affecting the general public is inappropriate and is causing alarm nationally in multiple states including for example, California, Arizona, Texas and Indiana.

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## **Comments to the EPA Draft Biosolids Risk Assessment**

**Dr. Tom Young, University of California-Davis**

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PFAS are an unprecedented class of compounds. Their unique physical chemical properties, the ability of compounds from one subclass to transform to another, their combination of mobility and persistence, the numerous and diverse pathways by which human exposure occurs, and the almost universal human exposure to them make them unlike any class of chemicals that EPA has previously regulated. In developing its Draft Sewage Sludge Risk Assessment for PFOA and PFOS, EPA has nonetheless used approaches that it has applied previously for other organic compounds in biosolids, compounds that lack the above set of characteristics. This approach is problematic for two key reasons: (1) by releasing the risk assessment for land application of biosolids when alternative disposal options (e.g., incineration) lack sufficient information to formulate an equivalent assessment, EPA is unable to determine whether actions taken in response to this assessment will improve or degrade human health, and (2) by ignoring the widespread background exposure to PFAS, particularly PFOA and PFOS, the assessment does not answer questions about whether restricting land application of biosolids will measurably reduce the exposure risks for the majority of the population.

PFOA and PFOS are present at detectable concentrations in virtually all municipal biosolids produced in the US, and that is unlikely to change for some time because the cessation of US production of these compounds has not resulted in similar reductions in production of their precursors and because their environmental persistence ensures continued input to treatment facilities. This makes them very different from the organochlorine compounds previously considered in EPA biosolids risk assessments. Municipal sludges containing PFAS must be disposed of or beneficially applied in some manner. Restrictions on land application that would be expected to result from this assessment will inevitably lead to disposal via other routes. Unless the agency has conducted similar risk assessments for other major disposal routes, there is no way to ensure that regulatory changes instigated by the risk assessment will lead to improved protection of human health. Unless the agency can provide guidance to utilities on how to best manage biosolids, it is irresponsible to release a finalized form of this risk assessment.

A related point is that the Draft Assessment ignores the widespread background exposure to PFAS in the US population. Although this is described as being a non-conservative approach (because the exposures of humans will be higher than the modeled exposures), viewed from another perspective, it is not. The goal of the agency should be to develop policies that have the largest impact on reducing human exposure

to PFAS compounds, rather than focusing on one particular pathway of exposure for two particular PFAS compounds. This approach is being taken largely because this is a set of compounds and an exposure pathway that has received significant research attention. However, the EPA chose not to wait for the conclusion of studies that it funded that have the express goal of better understanding the impacts of PFAS in agricultural settings. Without a more complete understanding of overall exposures in the US population and an ability to model alternative policy approaches and their possible impact on those exposures, the agency is taking actions that have the potential to degrade, rather than to protect, human health with respect to PFAS compounds.

In addition to the “big picture” concerns noted above, there are specific limitations to the analysis that appear to be critical. By choosing to model the two farm scenarios selected, which feature farm families deriving the majority of their food from the same plot of land, the approach largely ignores the way agriculture is conducted virtually everywhere west of the Rocky Mountains. The vast majority of farms in these areas are very large, do not feature the proverbial “farm family”, overlie deep ground water in an arid climate, do not grow or raise a diverse set of crops (making it unlikely that someone would derive diverse food types from the same plot of land), and in my experience do not apply biosolids to the types of crops that have significant (or any) uptake of PFOA and PFOS. Each of these factors make the risk far lower in these environments than is indicated by the modeling. Yet, by considering only two agricultural scenarios, each of which leads to the conclusion that any detectable level of PFOA or PFOS poses unacceptable risks in “all” agricultural scenarios (i.e., the two modeled ones) the agency implies that land application poses unacceptable risks in the western US in the same way as the eastern US. I expect that most state environmental agencies will take this conclusion at face value and restrict all land application as a consequence. The agency argues that the selected modeling approach is “not conservative” because it employs central tendency values instead of more extreme values, but it is likely that the risk difference between a western and eastern US scenario will exceed the difference between using the 10<sup>th</sup> percentile K<sub>OC</sub> value instead of the median value.