Empirical Bioaccumulation Factors for PFAS: Establishing Trends for Guiding Site Assessments

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Background/Objectives. Bioaccumulation of per- and poly- fluoroalkyl substances (PFAS), particularly PFOS, is often a key risk driver when assessing and managing the environmental impacts of these compounds. Given the unique physico-chemical characteristics of these substances, bioaccumulation factors (BAFs) cannot be reliably calculated using theoretical methods applied to other compounds. Rather, empirical data are required to quantify bioaccumulation through the calculation of BAFs such as bioconcentration factors (BCFs), biomagnification factors (BMFs), and biota-sediment/soil accumulation factors (BSAFs). Significant amounts of work have been done within Australia and internationally to quantify the concentrations of PFAS in biota in proximity to major PFAS source sites. Many of the site investigations provide comprehensive datasets of PFAS concentrations within not only soil, surface water and groundwater, but within terrestrial and aquatic flora and fauna.

Approach/Activities. A range of factors for quantifying rates of bioaccumulation of PFAS have been calculated, using a large database of paired biota and environmental data. These factors indicate key trends in rates of bioaccumulation between different site settings, including rates of bioaccumulation from PFAS in soil or water into terrestrial and agricultural receptors, and in freshwater and marine environments.

Results/Lessons Learned. The available data have been used to calculate BCFs for PFOS of approximately 1,000 to 3,000 for surface water into fish pathways in freshwater surface water bodies. These values are comparable with the PFOS BCF of 2,800 adopted by several international agencies for assessing this pathway. Factors calculated for PFOS in marine environments were lower than the freshwater values, with surface water to prawn BCF's of approximately 10 to 60 and surface water to fish BCFs <300.

BSAFs for terrestrial environments indicate much lower rates of accumulation of PFOS from soil to grass or plants, with BSAFs generally <1 calculated. Limited data have been published on poultry uptake, however a BSAF from soil to eggs of <1 was calculated.

BAFs for PFOA and other PFAS have been calculated where published sampling data is available, with additional BAFs and BSAFs presented for additional exposure pathways where data are available.

The database developed to date indicates that while significant variability in bioaccumulation can be observed under different environmental settings, consistent trends can be observed within similar environmental settings. Rates of bioaccumulation were higher in freshwater than marine environments, and were generally less significant in terrestrial and agricultural environments. These findings were consistent with the available international literature which has reported a similar range of values for the bioaccumulation of PFAS.

By identifying site specific environmental transport pathways when investigating a PFAS impacted area, an understanding of these key trends in bioaccumulation can be used to ensure biota and exposure point investigations are appropriately focused.