

Integrated Chemometric Assessment of PCDD/F Contamination and Sources in the Passaic River

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Background/Objectives. Sediments in the industrialized Lower Passaic River (LPR) are contaminated with PCDD/Fs and other chemicals from a variety of sources. One well documented PCDD/F source is the direct discharge of manufacturing wastes in the late 1940s through at least 1969 from the former Diamond Alkali facility. Ten multivariate PCDD/F studies from 1990 to 2016 have been conducted with LPR sediments, some concluding that a myriad of historical and relatively recent sources could account for river contamination.

Past multivariate studies were typically constrained to a small number of LPR-specific samples (as few as 6), small geographic area, inclusion of the LPR as only one of several regional waterbodies, and/or a focus solely on surface sediments. None of these assessments incorporated contaminated upland soils. We addressed these sample, study scope, time period, and upland issues with review and assessment of thousands of samples collected exclusively from the Passaic River over the past 25 years, as well as soils from two upland sites. Our objective was to build a strong weight-of-evidence approach for identifying and apportioning PCDD/F sources and pertinent environmental pathways in this tidal river system.

Approach/Activities. Our work is based on a compilation of over 3,200 samples subjected to a consistent data treatment and reduction routine to identify a subset of 2,822 samples not impacted by detection limit issues. This subset was then assessed with an integrated application of Robust Soft Independent Modelling of Class Analogies (RSIMCA), polytopic vector analysis (PVA), and visualization with t-distributed Stochastic Neighbor Embedding (t-SNE). The PVA was conducted using a RSIMCA-censored dataset, which improved the statistical accuracy of those findings. t-SNE and geospatial mapping enhanced the RSIMCA and PVA interpretation, providing a sound basis for assessing source relationships.

Results/Lessons Learned. Sediment samples were classified into seven clusters, including several associated with one manufacturing facility and an adjacent sediment removal area. Two clusters contained samples with relatively low 2,3,7,8-TCDD concentrations, including those above a dam more than 17 miles upriver and another near the river mouth.

Seven endmembers identified in the PVA comprise varying proportions of the sediment samples, although all samples above the dam are composed of only two of the endmembers. The geospatial distribution and t-SNE mapping of samples are consistent with transport of PCDD/Fs from identified sources and evolution of associated fingerprints.

Source implications of RSIMCA and PVA results will be addressed based on upland soils from two recently sampled PCDD/F containment cells and river sediments below and above the dam, including in the immediate vicinity of the two sites. The results support contributions to LPR sediments from one of the sites and no association with the other. Other potential sources of river contamination are addressed, including a PCDD/F source above the dam.