Multiple Lines of Empirical Evidence Demonstrate an Absence of Adverse Effects from MGP Residues at PAH Concentrations Significantly Higher than Regulatory Screening Levels

Laura McWilliams (lmcwilliams@haleyaldrich.com), Helder Costa (hcosta@haleyaldrich.com), and Scott Bodensteiner (sbodensteiner@haleyaldrich.com)
(Haley & Aldrich Inc., San Diego, CA, USA)

To make sediment management recommendations at a former manufactured gas plant (MGP) Site in San Francisco, an empirical sediment evaluation framework has been developed which considers concentration of polycyclic aromatic hydrocarbons (PAHs) in bulk sediment, PAH composition (e.g., source type), and potential impairment of beneficial uses of the waterway. A key component of the framework is an empirical beneficial use evaluation matrix, based on 10 site-specific assessment methods, paired with receptor-appropriate comparison criteria, to evaluate the full spectrum of beneficial uses – from benthic habitat, to prey consumption, to human recreational use.

Assessment methods include laboratory sediment testing (water column toxicity, benthic toxicity, sediment-water interface testing), ex situ bioaccumulation testing, benthic community and habitat surveys (sediment profile imaging and benthic taxonomy), and direct sampling of in situ pore water and surface water. Binary outcomes (no adverse effects vs. potential adverse effects) for each assessment method, and a conservative protocol for combining the results of the assessment methods were developed and approved by the state oversight agency (California Regional Water Quality Control Board, San Francisco Bay Region) prior to application of the framework.

The results of the evaluation demonstrate that Site sediments with total PAH concentrations in excess of 100 mg/kg have no indication of potential impairment to beneficial uses of the waterway. This is consistent with results of nearby sediment dredge characterization studies that find no toxicity in sediment with total PAH concentrations well above the ambient concentration of 4.5 mg/kg for central San Francisco Bay, although this study has broader applicability since it considers all beneficial uses. As a result of this work, large portions of the investigation area with surface sediment total PAH concentrations exceeding ambient concentrations by over an order of magnitude have been shown to not impair beneficial uses of the waterway. Active remediation will focus on those areas with more highly elevated PAH concentrations and PAH compositions consistent with historical MGP sources.

The absence of measurable direct effects on a variety of marine receptors and life stages at total PAH concentrations exceeding 100 mg/kg contrasts with widely used screening levels, such as the effect range-median (ER-M, Long et al., 1995) concentration (44.79 mg/kg), that are commonly used to predict PAH impacts at sediment sites. The difference is attributed to the properties of San Francisco Bay mud, to which PAHs appear strongly adsorbed, and therefore minimally bioavailable. Interestingly, this appears to hold true for PAH compositions attributed to general urban runoff, as well as PAH compositions consistent with MGP residues. We anticipate using these results to prioritize active sediment remediation where conditions indicate adverse biological effects, and support expanding the range of PAH concentrations deemed suitable for the beneficial re-use of sediments in the Bay.