

State of the Practice: Risk Assessment and Management of Metabolites and Degradation Products from Total Petroleum Hydrocarbons

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Background/Objectives. Just as the consideration of the degradation products from chlorinated solvents needed to be taken into account when evaluating natural attenuation as a remedial alternative for chlorinated solvent spills, there is a growing awareness that hydrocarbon degradation products and metabolites need to be considered when evaluating natural attenuation as a remedial alternative for petroleum release sites. Even though the management of petroleum releases has long involved the concept of Total Petroleum Hydrocarbons (TPH), the science and policies surrounding the issue of hydrocarbon degradation products is changing; and new ways of approaching petroleum release sites is clearly under way.

Approach/Activities. It has long been known that TPH “weathers” in the environment. There is a growing body of science showing that the chemical degradation products and biological metabolites produced by the weathering of crude or refined petroleum released to groundwater, surface water, or soil can have a very different lateral and vertical distribution than that of the parent hydrocarbons. This difference is primarily attributed to the fact that the chemical degradation products and biological metabolites of hydrocarbons are predominantly polar compounds with fate and transport properties very different from the parent hydrocarbons. The fact that the degradation products and metabolites are made largely up of different classes of chemicals than the parent hydrocarbons also suggests that the weathered residues would have different aquatic and mammalian toxicity properties than the parent hydrocarbons. At many release sites, the degradation products and metabolites can comprise the predominant, if not the entire, mass of the residues.

Results/Lessons Learned. Recent findings about TPH degradation products and metabolites clearly point to the need for changes in some of the fundamental approaches we have been using for the investigation and management of TPH sites. Recent findings have also exposed critical data gaps we must address in any ongoing investigation and management of petroleum release sites and as well as research needs to help us improve the efficiency and effectiveness of future investigation and management.

In this session, we will address the research that has been done on releases of crude and refined petroleum products that have led to the realization that the nature and extent of virtually any petroleum release site cannot be understood without considering the nature and extent of the polar degradation products and metabolites. We will also address the fact that the lifecycle of a petroleum release site cannot be understood without considering the lifecycle of the degradation products and metabolites. Much of this understanding has come from research using sophisticated analytical chemistry methods that are not practical for the routine investigation of petroleum release sites, and our recently expanded understanding of the life cycle of petroleum in the environment poses difficult challenges in the selection of appropriate analytical methods and in the design of sampling strategies. Perhaps, the most difficult and controversial challenge posed by our expanded understanding of the chemistry and lifecycle of petroleum release sites is the assignment of toxicity factors to the mixture of degradation products and metabolites that we now know are very different from the mixture of hydrocarbons we have been assuming to comprise TPH.