NAPL Migration and Plume Geometry at Former Manufactured Gas Plant Sites Controlled by the Depositional Environment of Site Stratigraphy

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Background/Objectives. At former manufactured gas plant (MGP) facilities nationwide, utility operators and regulators alike face considerable uncertainty in the remediation of subsurface contaminants. However, while every site has some unique characteristics it is ultimately the arrangement of fine- and coarse-grained layers the defines the “subsurface plumbing” through which the contaminants move. Understanding the typical characteristics of the stratigraphy produced in common geologic scenarios is an efficient way to predict contaminant migration pathways and areas of contaminant storage or accumulation, thus reducing remediation uncertainty and costs. We use physical models to demonstrate how commonly observed sediment body geometries control contaminant storage, diffusion, and transport.

Approach/Activities. Many MGP sites are located in riverine settings due to the need for water during the manufacturing process and ease of raw materials transportation. Fluvial sedimentary deposits are well understood in terms of their typical dimensions, geometry, lateral and vertical trends in grain size, and stratigraphic framework. Using a physical model, we assess NAPL migration in three common scenarios: (1) Sands over clay (analogous to glaciofluvial outwash over till), (2) Cross-bedded sands (analogous to point-bar deposits in rivers), and (3) Sand lenses encapsulated within clays (analogous to “cut-and-fill” stratigraphy common in river valley sediments). NAPL behavior and migration, captured in time-lapse photography is presented for each of these scenarios. Comparison of resulting plume geometries allows us to ascertain the relative impact of geology on NAPL migration, storage, and successful remediation strategies. Each model scenario is related to actual field sites and case studies.

Results/Lessons Learned. The understanding of complex pathways into and through the subsurface gained using physical models can ultimately be used to improve conceptual site models (CSMs), optimize remediation design, and guide monitoring well or exploratory boring placement. Project teams must be able to use the stratigraphic clues present in lithologic logs and high-resolution characterization data to recognize site position relative to the elements of fluvial stratigraphy presented here. Techniques such as Environmental Sequence Stratigraphy (ESS), that use vertical grain size trends, knowledge of depositional settings, and reasonable modern analogues can be particularly effective in this relating bench-scale results presented here to site-scale lithologies and analytical trends. Recent trends in applying concepts of multiphase fluid flow through porous media point to the growing importance of understanding and conceptualizing the architecture of site porosity and permeability in the subsurface