Leveraging Environmental Sequence Stratigraphy to Refine Mass Discharge Estimates: Magothy Aquifer, New Jersey Coastal Plain

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Background/Objectives. Sound conceptual site models (CSMs) and estimates of mass discharge (mass/time) are essential for developing a comprehensive understanding of natural attenuation processes and preferential groundwater flow pathways at contaminated sites. However, as groundwater remediation projects are commonly challenged by inherent geologic complexity in the subsurface, the development of CSMs and a quantification of the associated uncertainties often tend to be less accurate than desired. In this study, we use detailed facies analysis within an environmental sequence stratigraphic framework to better understand the subsurface geology and define preferential flow pathways within a complex groundwater remediation site. This information is then used to refine contaminant mass discharge estimates with the goal of optimizing remediation strategies at both the source and the dilute fringe of a tert-butyl alcohol (TBA)-impacted groundwater plume.

Approach/Activities. We correlate depositional sequences from continuous geophysical data to trace strike and dip cross sections throughout the subject site (Hercules LLC, Parlin, New Jersey). This information is then combined with detailed facies models, developed within the context of modern analogs, whereby the Site data are recognized to be fully consistent with regional-scale facies interpretations of the Turonian sequence.

Results/Lessons Learned. Correlation of existing CPT and complementary well logs from the Site reveals four high-frequency, depositional sequences of the Turonian Magothy Formation, consisting of fluvial and deltaic deposits during an overall fall of the sea level. Each sequence boundary is marked by subaerial exposure (paleosol) or fluvial incision in a coastal setting. A detailed analysis of the facies architecture within the established sequence stratigraphic framework indicates a seaward progradation of channel bars and muddy bay-fill deposits behind wave-dominated deltaic deposits (mouthbars and/or barrier bars). In light of this high resolution stratigraphic interpretation, re-examination of the impacted groundwater data shows significant stratigraphic constraints on the plume migration pathway and corresponding contaminant mass discharge. Although the basic geometry of groundwater flow and contaminant transport was recognized previously through conventional investigative approaches, the present study reveals important and unique new insights into the dependencies between groundwater contamination and facies architecture within the Magothy aquifer.