Benefits of an "Evergreen" Conceptual Site Model for Remedy Optimization at a Rural Northeast Superfund Site

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Background/Objectives. We review the development and ongoing refinement of a conceptual site model (CSM) throughout a remediation program at a challenging site, and illustrate how this "evergreen" CSM has been used to support strategic decision making over almost 20 years of remedy implementation. Drums and waste material containing chlorinated solvents were disposed in trenches at a rural northeastern U.S. Superfund site in the late 1970s. Cleanup actions at the site included source remedies (excavation and multi-phase extraction) with groundwater pump and treat for management of migration (MOM). Multiple source areas were identified, and the plume is distributed within a challenging hydrogeological setting consisting of glacial till and fractured rock in a private drinking water residential area. Significant contraction in the size and mass of the plume has been achieved as a result of the remedies to date, but residual volatile organic compounds are present in isolated areas within the low permeability glacial till and weathered bedrock, resulting in groundwater concentrations above site cleanup standards.

Approach/Activities. A CSM was initially developed during the 30% design based on data collected during remedial and pre-design investigations. The 30% design CSM was used as the basis for design of a multi-phase extraction (MPE) and groundwater pump and treat (P&T) system that began operating in 2001. Initial refinement of the CSM was based primarily on physical and chemical monitoring data obtained from the MPE and P&T from about 2001 to 2004. The original groundwater flow model was refined and enhanced with a contaminant fate and transport model in 2004. These models were linked with system operating data and confirmatory soil and groundwater data collected from 2004 to 2006. This compiled information set was then utilized to refine both the hydrogeological and source area elements of the CSM, which provided a basis for phased shutdown of the MPE system in 2006. The updated CSM was also used to optimize a groundwater pumping configuration following shutdown of the MPE system. A one year shut down test implemented in 2012 was utilized to assess an isolated remaining source area and the remaining groundwater plume architecture under non- pumping conditions. Results of this test were again used to revise the CSM with an emphasis on definition of the residual source area and preferential flow pathways. This CSM refinement provided the basis for the performance of a comprehensive optimization study, which is ongoing and will provide the basis for an exit strategy for the site.

Results/Lessons Learned. CSMs are fundamentally important components of any remedial design. However, it is important to continually refine and update the CSM based on new information as site operations progress, particularly at complex sites with multiple remedial components. The benefit to this approach often leads to streamlined remedial timeframes, system optimization, reduced operational costs, and definable exit strategies. Our results demonstrate how data from a variety of sources can be integrated to update the CSM, including routine system operating data, site-wide monitoring data, focused investigation results, groundwater models, and pilot programs. We also found site assessment under static conditions was particularly beneficial at this site. The CSM evolved to include both macro- and micro-level considerations as the remedy progressed and as warranted to support stakeholder engagement, remedy optimization decisions, and development of the exit strategy.