

# Why Only Some Conceptual Site Models Are Useful: A New Way to Look at the CSM Process

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**Background/Objectives.** In the remediation community, the high value of a “good” conceptual site model (CSM) has become a truism. We have all witnessed examples of well-crafted CSMs that place projects on a clear path to closure. We have also encountered CSMs that contribute nothing and appear as mere exercises to check a box. Though many technical documents provide guidance for CSM preparation, the industry continues to struggle with how to make them truly useful. There is little consistency in how CSMs are integrated within projects, and divergent opinions on what makes a good CSM “good”. The need exists, therefore, to remodel how CSMs should be developed and used most effectively, and to provide a framework for treating CSMs as more than condensed site summaries, but as essential tools that keep projects on a direct path from discovery to closure.

**Approach/Activities.** We took a critical look at what makes CSMs useful; focusing on how CSMs serve project needs, and how that role evolves over a project life cycle. Numerous CSM examples were reviewed to assess what aspects and approaches appear most effective. We also reviewed a range of CSM guidance documents in circulation to assess how the recommended approaches to CSM development vary, and to consider what elements those documents may have overlooked. From this analysis we developed a clearer understanding of how to integrate CSMs within a project framework, developing a matrix of CSM objectives that track the changing data needs and decision points of an evolving project.

**Results/Lessons Learned.** Effective CSMs can vary widely in content and work equally well in a number of forms. A CSM's value stems from how well it provides clarity and direction that enable progress toward closure. It matters much less what form a CSM takes, which exact topics it covers, or what graphics it includes, as long as it provides a basis for making the decisions relevant to the current project stage. In this analysis, we identified a number of common features of useful CSMs that remain true across a project lifecycle and through a spectrum of project complexity. Many aspects of CSMs, however, change as a project advances. In this analysis we track how the fundamental objective of a CSM evolves through four stages, providing real-world project examples for each stage. At the start of project, a CSM *frames* an initial understanding of the site, to set priorities and establish a roadmap for the project. In the second stage, site characterization, a CSM *defines* site conditions, transport processes and potential risks, iteratively whittling down uncertainty to develop a fully coherent understanding of the site. As the project advances to remedy selection and design, a CSM is *refined* by adding detail and nuance where needed based on the requirements of the remedial technologies under consideration. Then in the critical final stage, remedy implementation and optimization, CSMs serve an often overlooked role of *challenging* the remedy performance, assessing if results meet expectations, and critically rethinking old assumptions to find efficiencies or reduce time to closure. Across these project stages, a useful CSM acts as the vehicle to bring meaning to data and observations, to keep focus on the objectives, and deliver the best possible project outcomes.