Adaptive Use of Models and Data Collection to Improve Model Predictions for the Purpose of Decision Making

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Background/Objectives. Numerical models are widely used to support decision-making at contaminated sediment sites, and the uncertainty in model predictions is a complication that managers regularly deal with in making decisions. In 2017, EPA issued a recommendation to regions to “Consider the limitations of models in predicting future conditions for purpose of decision-making”. Because framework and parameter uncertainty can limit the accuracy of predictions, EPA recommended “a high degree of caution” in making use and comparisons among quantitative endpoints, because the accuracy and uncertainty of future projections are generally not known.

Approach/Activities. Models are tools that use science to inform data collection, help interpret data, test hypotheses, and make predictions. They can be more or less complex, but there is no obvious substitute for the predictive science that models embody to support these planning activities. The critical role of data in the accuracy of model predictions not always appreciated. A model’s accuracy depends not only on the way that it represents important processes, but also on the sufficiency of data available to constrain those representations. Contaminated sediment models are usually calibrated with data collected under monitored natural attenuation (MNR)-like conditions. Predicted MNR trends will deviate from actual trends when calibration data are unrepresentative and/or highly variable. Simulation of active remedies without site-specific historical monitoring data for those remedies adds another layer of uncertainty to forecasting. Further, systems are altered by active remedies, and until experience has been gathered on the behavior of those altered systems, predictions of post-remedial MNR must rely on pre-remedial data, with stylized process modifications to reflect the anticipated performance of the remedy. In all of these cases, outcomes will deviate from predictions, regardless of the complexity and sophistication of the predictive tool employed, and errors cannot be known a priori. Errors can, however, be minimized through rational data collection, and model are critical to planning that data collection. Comprehensive baseline time series data for modeled media can be collected using consistent methods over long enough periods to constrain modeled time trends. Short- and medium-term effects of active remedies can be quantified through pilot studies, and used to improve representations of effectiveness, including stability, recontamination, etc. to improve predictive accuracy. For longer-term model assessment and improvement, post-remedial data can be used to identify what may be missing in conceptual models and numerical model representations, so that models or simpler trending tools can be updated to improve accuracy. Through ongoing comparisons of models to data, site understanding can be continually improved. Specific case study examples will be discussed.

Results/Lessons Learned. Data collection is critical whenever models diverge from the conditions to which they were calibrated. Models can be used to guide data collection to augment and refine modeling, by testing the completeness of the conceptual site model and identifying processes that are most important to monitor. Synergistic improvement of predictive tools and the datasets that inform them should have an important and beneficial role in adaptive site management.