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Authors
Zhou, Quanlin
Birkholzer, Jens T.
Javandel, Iraj
et al.

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Refining a Three-Dimensional Groundwater Flow Model at a Heterogeneous Site in Support of Remediation

Quanlin Zhou, Jens T. Birkholzer, Iraj Javandel, and Preston D. Jordan

Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720

Abstract

Restoring a contaminated site often requires collection of a large amount of data on the soil properties, hydraulic heads and flow rates, and contaminant plumes. Making full use of these data is crucial to the calibration of a groundwater flow model developed in support of remediation.

We developed a three-dimensional transient groundwater flow model for a contaminated site in the Berkeley Hill at which interim corrective measures were initiated to limit further spreading of contaminants. The flow model accounts for complex geologic units that vary considerably in thickness, slope, and hydrogeologic properties, as well as large seasonal fluctuations of the groundwater table and flow rates. Other significant factors are local recharge from leaking underground storm drains and recharge from steep uphill areas. A zonation approach was employed to account for the clustering of high and low hydraulic conductivities measured in a geologic unit. A composite model was used to represent the bulk effect of thin layers of relatively high hydraulic conductivity found within bedrock of otherwise low conductivity.

The distribution of rock properties and net recharge were calibrated using the inverse simulator iTOUGH2. The data used in the calibration were hydraulic conductivity measurements, water levels at 41 monitoring wells, flow rates at two trenches, and rainfall rates. The model was initially calibrated using data collected between 1994 and 1996. To check the validity of the model, it was subsequently used to predict groundwater level fluctuations and groundwater fluxes between 1996 and 1998. Comparison of simulated and measured data demonstrated that the model is capable of predicting the complex flow reasonably well. The model was further validated using advective transport represented by pathways of particles originating from source areas of the plumes. The advective transport approximation was in good agreement with the trend of contaminant plumes observed over the years.