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An Updated Site Scale Saturated Zone Ground Water Transport Model for Yucca Mountain

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The Yucca Mountain site scale saturated zone transport model has been revised to incorporate the updated flow model based on a hydrogeologic framework model using the latest lithology data, increased grid resolution that better resolves the geology within the model domain, updated sorption coefficient (K_d) distributions for radionuclides of interest, and updated retardation factor distributions. The resulting numerical transport model is used for performance assessment predictions of radionuclide transport and to guide future data collection and modeling activities. The transport model results are validated by comparing the model transport pathways with those derived from geochemical data, and by comparing the transit times from the repository footprint to the compliance boundary at the accessible environment with those derived from ^{14}C-based age estimates.

The transport model includes the processes of advection, dispersion, fracture flow, matrix diffusion in fractured volcanic formations, sorption, and colloid-facilitated transport. The transport of sorbing radionuclides in the aqueous phase is modeled as a linear, equilibrium process using the K_d model. The colloid-facilitated transport of radionuclides is modeled using two approaches: the colloids with irreversibly embedded radionuclides undergo reversible filtration only, while the migration of radionuclides that reversibly sorb to colloids is modeled with modified values for sorption coefficients and matrix diffusion coefficients.

The base case results predict a transport time of 810 years for the breakthrough of 50% of the mass of a nonreactive radionuclide originating at a point within the footprint of the repository to the compliance boundary of the accessible environment at a distance of ~18 km downstream. The transport time is quite sensitive to the specific discharge through the model, varying between 31 to 52840 years for a range of specific discharge multiplier values between 0.1 to 8.9. Other parameters of importance include radionuclide sorption coefficients onto rock surfaces, diffusion coefficient within the volcanic matrix, sorption coefficient onto colloids and colloid retardation factors. Model breakthrough curves for various radionuclides at the compliance boundary are presented along with their sensitivity to various parameters.