CONTAMINANT TRAVEL TIMES FROM THE NEVADA TEST SITE TO YUCCA MOUNTAIN: SENSITIVITY TO POROSITY

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ABSTRACT

Yucca Mountain (YM), Nevada, has been proposed by the U.S. Department of Energy as a geologic repository for spent nuclear fuel and high-level radioactive waste. In this study, we investigate the potential for groundwater advective pathways from underground nuclear testing areas on the Nevada Test Site (NTS) to the YM area by estimating the timeframe for advective travel and its uncertainty resulting from porosity value uncertainty for hydrogeologic units (HGUs) in the region. We perform sensitivity analysis to determine the most influential HGUs on advective radionuclide travel times from the NTS to the YM area. Groundwater pathways and advective travel times are obtained using the particle tracking package MODPATH and flow results from the Death Valley Regional Flow System (DVRFS) model by the U.S. Geological Survey. Values and uncertainties of HGU porosities are quantified through evaluation of existing site porosity data and expert professional judgment and are incorporated through Monte Carlo simulations to estimate mean travel times and uncertainties. We base our simulations on two steady state flow scenarios for the purpose of long term prediction and monitoring. The first represents pre-pumping conditions prior to groundwater development in the area in 1912 (the initial stress period of the DVRFS model). The second simulates 1998 pumping (assuming steady state conditions resulting from pumping in the last stress period of the DVRFS model). Considering underground tests in a clustered region around Pahute Mesa on the NTS as initial particle positions, we track these particles forward using MODPATH to identify hydraulically downgradient groundwater discharge zones and to determine which flowpaths will intercept the YM area. Out of the 71 tests in the saturated zone, flowpaths of 23 intercept the YM area under the pre-pumping scenario. For the 1998 pumping scenario, flowpaths from 55 of the 71 tests intercept the YM area. The results illustrate that mean minimum travel time from underground testing areas on the NTS to the YM area can vary from just over 700 to nearly 700,000 years, depending on the locations of the underground tests, the pumping scenarios considered, and the porosity value distributions used. The sensitivity analysis further illustrates that for both pre-pumping and 1998 pumping scenarios, the uncertainties in porosity values for five of the 27 HGUs considered account for well over 90% of the porosity-related travel time uncertainties for the flow paths having the shortest mean travel times to the YM area.