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Estimation of long-term aqueous phase changes in a multi-layer cover using generic soil properties

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To protect near surface disposal facilities from infiltrating rainfall a multi-layer cover is installed consisting of different materials including soil (usually sand- or loam-based) and clay. The function of such layers is to divert infiltrating rainwater and hence minimize water drainage from the cover in the underlying disposal facility. However, the soil and clay materials will change the composition of the infiltrating water due to biogeochemical processes. A methodology is developed to assess changes in water composition as the rain water percolates through the soil and clay layers of a vegetated multi-layer cover. The method is based on a steady-state mass balance approach and uses generic soil physical and chemical properties.

The approach considers weathering of the soil and clay minerals estimated from a pedotransfer function and accounts for the average temperature, the textural class and the depth of the profile. Soil microbiological activity is taken into account by imposing the soil partial pressure of CO2. The latter value is estimated from an empirical model based on the actual evapotranspiration. Eight scenarios were developed that resulted in eight different solution compositions of the drainage water. This approach resulted in a realistic pH range between 3.4 and 4.4 for the scenarios that consider either absence of all soil and clay layers (thus representing rain composition) or presence of a single soil layer only. Scenarios that considered both soil and clay layers to be present produced rather high pH values (around 9.5), probably due to too high estimates of the base cation weathering rates generated with the pedotransfer functions. Alternative methods for dealing with weathering of the clay layer are proposed. These types of water compositions were used to simulate the chemical degradation process of concrete as to produce a lower and upper bound to the durability of concrete engineered barriers.