

Therefore, their dose per unit of body weight at any particular time is higher than an adult's. To evaluate childhood exposure for this analysis, we evaluated a child whose exposure begins at a random age between one and six years old. We then aged the child for the number of years defined by the randomly selected exposure duration. As children mature, their physical characteristics and behavior patterns change. To capture these changes in the analysis, we divided the life of a resident who moved into the home as a child into several cohorts: cohort 1 (ages 1–5), cohort 2 (ages 6 to 11), cohort 3 (ages 12 to 19), and cohort 4 (ages 20 to 70). Each cohort has a discrete distribution of exposure parameters that are used to calculate exposure to an individual, so our analysis updated the exposure factors as the child aged from one cohort to another.

d. How Did EPA Predict the Release and Transport of Constituents From a Waste Management Unit to Receptor Locations?

We conducted contaminant fate and transport modeling to determine what the concentrations of contaminants will be in the air or groundwater that the receptor comes into contact with. These concentrations are called “exposure point concentrations.” There are a number of computer-based models and sets of equations that we use to predict exposure point concentrations. In the following sections, we briefly discuss these models and equations and their application in the risk analyses.

(i) Predicting Release of Constituents. *Landfill Partitioning Model.* The landfill model is designed to simulate the gradual filling of an active landfill and the long-term releases from the active and closed landfill cells. We also used this model in the February 13, 2001 proposed listing determination for paint production wastes (66 FR 10060). The design assumes that the landfill is composed of a series of vertical cells of equal volume that are filled sequentially. We assumed that each cell requires one year to be filled. The formulation of the landfill model is based on the assumption that the contaminant mass in the landfill cells might be linearly partitioned into the aqueous, vapor, and solid phases. The partitioning coefficients are based on those reported in literature, and are listed in the Risk Assessment Background Document. The model simulates the active lifetime of the landfill (30 years) and continues simulating releases until less than 1 percent of the peak mass is left or for a total of 200 years, whichever occurs first.

We assumed three different liner scenarios, unlined landfills where the underlying substrate is native soil (represented by a national distribution of soil types), landfills with compacted clay liners, and landfills with composite liners. For the unlined and clay-lined scenarios, we used EPA databases of landfill infiltration rates and regional recharge rates (calculated using the Hydrologic Evaluation of Landfill Performance (HELP) water-balance model). For the composite liner scenario, we used empirical distributions of infiltration rates.

The empirical infiltration rates were compiled from measured leak detection system flow rates for composite lined landfill cells.²⁸ There are several broad categories of liner types now in use. A typical composite liner is made up of a geosynthetic liner (GM) and a clay liner of some kind underneath. The clay liner is often a compacted clay liner (CCL). A CCL is composed of natural mineral materials, a bentonite-soil blend, and other materials placed and compacted in layers to build up a thick liner system (typically at least two feet thick). Another clay-based liner is a geosynthetic clay liner (GCL). A GCL is a relatively thin layer of processed clay (typically bentonite) either bonded to a geomembrane or fixed between two layers of geotextile. GCLs were developed relatively recently and are typically used with a GM in a composite liner.

In the composite liner scenario (annotated as SL) we modeled, we used a distribution of composite liners used at MSWLFs, including GM/GCLs, geomembrane/compacted clay liners (GM/CCLs), and a few examples of other combinations of liners. In developing this distribution, we excluded infiltration data from nonmunicipal landfills (Subtitle C landfills and landfills that accepted specialized wastes, such as ash) because our data indicate that all landfills reported to be used by dyes and/or pigments manufacturers are municipal solid waste landfills, and because we believe it is not appropriate to include data from units that accept very different waste (e.g., hazardous wastes) and have different design requirements. In addition, we tried to use infiltration data that represented infiltration through a composite liner, i.e., a combination of synthetic and clay liner that is consistent with the design requirements in § 258.40. For this reason, we excluded infiltration data

that only represented infiltration through a single liner, such as the geomembrane liner by itself. Our evaluation of the results for these different liner assumptions is given in section IV.A.

We also modeled a select group of landfills that used geomembrane/geosynthetic clay liners (GM/GCL). The GM/GCL data set, unlike our composite liner data set, excluded all data from liner systems that included compacted clay liner (CCL). The CCL infiltration rates may include significant amounts of water expelled from the CCL as waste is placed in the landfill (“consolidation water”).²⁹ The consolidation water is difficult to account for and therefore may cause our infiltration rate data to be somewhat overstated. However, we believe that the contribution from consolidation water is not likely to be significant at the higher infiltration rates that are most important to the modeling results (i.e., the 90th percentile probabilistic results are likely to be weighted toward the high end portion of the distribution of infiltration rates where any impact from consolidation water should be minimal). While the modeling results for the composite liner may be slightly higher due to this factor, we do not believe this materially affects the results. We also believe that the larger composite liner data set provides a better distribution of infiltration rates. The data used for the GM/GCL modeling were fairly limited in number and represented only a relatively small subset of the landfill units with data. Therefore, we relied on the composite modeling results (the SL scenario) for setting the listing limits proposed in this notice. The GM/GCL scenario results are provided in the Risk Assessment Background Document in the docket for today's proposal.

As usual for listing landfill modeling, we also assumed that there are adequate controls of runoff and erosion from the unit, preventing releases to groundwater or air from these routes. We assumed that the cover at closure is a soil cover that still permits volatilization. We also assumed that landfills would release leachate to the subsurface.

Based on the design assumptions above, we simulated the annual release of chemical mass by leaching to the unsaturated zone beneath the landfill and volatilization to the air. Within the landfill, we simulated losses of mass through anaerobic biodegradation (i.e., degradation processes that occur in an oxygen-free environment). Hydrolysis

²⁸ “Characterization of Infiltration Rate Data to Support Groundwater Modeling Efforts,” Draft Final. TetraTech, Inc. September 28, 2001.

²⁹ “Characterization of Infiltration Rate Data to Support Groundwater Modeling Efforts,” Draft Final. Tetra Tech, Inc. September 28, 2001.