

Radon Flux Calculation: NUREG/CR-3533

| Churchrock Mine Waste Repository                                                                                  |           |           |           |           |
|-------------------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|
|                                                                                                                   |           | Waste     | Cover 1   | Cover 2   |
| Thickness of tailings, cm                                                                                         | $x_t$     | 500       |           |           |
| Thickness of covers, cm                                                                                           | $x_{Ci}$  |           | 53        | 69        |
| Dry bulk mass density of tailings, g cm <sup>-3</sup>                                                             | $\rho_t$  | 1.68      |           |           |
| Dry bulk mass density of covers, g cm <sup>-3</sup>                                                               | $\rho_c$  |           | 1.29      | 1.76      |
| Mass density of water, g cm <sup>-3</sup>                                                                         | $\rho_w$  | 1         | 1         | 1         |
| Specific gravity of tailings, dimensionless                                                                       | $G_t$     | 2.7       |           |           |
| Specific gravity of covers, dimensionless                                                                         | $G_c$     |           | 2.7       | 2.7       |
| Long-term average moisture content of tailings, dry wt %                                                          | $w_t$     | 6         |           |           |
| Long-term average moisture content of covers, dry wt %                                                            | $w_{Ci}$  |           | 5.87      | 3.93      |
| Concentration of radium-226 in tailings, pCi/g                                                                    | $R_t$     | 29.7      |           |           |
| Concentration of radium-226 in covers, pCi/g                                                                      | $R_{Ci}$  |           | 0.0       | 0.0       |
| * Diffusion coefficients for radon in the total pore space of the tailings, cm <sup>2</sup> s <sup>-1</sup> (are) | $D_{ti}$  | 2.254E-02 | 2.713E-02 | 3.189E-02 |
| * Diffusion coefficients for radon in the total pore space of the top cover, cm <sup>2</sup> s <sup>-1</sup>      | $D_{Cn}$  |           | 3.640E-02 | 2.535E-02 |
| Radon emanation coefficient, dimensionless                                                                        | $E$       | 0.35      | 0.35      | 0.35      |
| Radon-222 decay constant, s <sup>-1</sup>                                                                         | $\lambda$ | 2.10E-06  | 2.10E-06  | 2.10E-06  |
| Henry's Law equilibrium distribution coeff., dimensionless                                                        | $k$       | 0.26      | 0.26      | 0.26      |
| Radon flux from the ith cover, pCi m <sup>-2</sup> s <sup>-1</sup>                                                | $J_{Ci}$  |           | 29.38     | 14.94     |
| Porosity of the tailings                                                                                          | $n_t$     | 0.3774    |           |           |
| Porosity of the covers                                                                                            | $n_{Ci}$  |           | 0.5216    | 0.3495    |
| Moisture saturation fractions in tailings                                                                         | $m_t$     | 0.267     |           |           |
| Moisture saturation fractions in covers                                                                           | $m_{Ci}$  |           | 0.145     | 0.198     |
| Radon flux from the bare tailings source, pCi m-2 s-1                                                             | $J_t$     | 38.01     |           |           |
| Inverse relaxation lengths for tailings                                                                           | $b_t$     | 9.65E-03  |           | 8.12E-03  |
| Inverse relaxation lengths for covers                                                                             | $b_{Ci}$  |           | 7.60E-03  | 9.10E-03  |
| Interface constants for tailings                                                                                  | $a_t$     | 2.07E-03  |           | 2.92E-03  |
| Interface constants for covers                                                                                    | $a_{Ci}$  |           | 7.89E-03  | 2.26E-03  |

= input values= not used= intermediate calculation - do not change= acceptable default or constant= calculated value

Calculations from NUREG/CR-3533, "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design"

\* revised diffusion coefficients from V.C. Rogers and K.K. Nielson, Health Physics, Vol. 61, No. 2 (August), pp. 225-230

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