APPENDIX B

Calculated Travel Times

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CALCULATED TRAVEL TIMES

Hydro Geo Chem (2004) presented estimated rates of perched groundwater travel time in the Burro Canyon formation. Hydraulic conductivities used in the calculation were based on estimates by Hydro Geo Chem, 2002; Hydro Geo Chem, 2004; and UMETCO, 1994. To determine travel time Hydro Geo Chem used the formula:

$$Rate = \frac{Hydraulic\ Conductivity \times Hydraulic\ Gradient}{Porosity}$$

The calculated rates of perched water movement represent interstitial velocities with an average porosity of 0.18. This porosity is an average porosity based on samples collected from monitor wells in the Burro Canyon formation immediately downgradient of the tailing cells. Porosities ranged from 0.02 to 0.291, averaging 0.183. Hydraulic conductivities for each well represent the geometric average of the range of estimates based on well tests performed by Hydro Geo Chem. in 2002. These calculations represent highly conservative assumptions.

Estimated Rates of Perched Water Movement

Well	Hydraulic Conductivity (cm/s)	Hydraulic Conductivity (ft/yr)	Hydraulic Gradient (ft/ft)	Rate (ft/yr)
MW-01	8.0×10^{-7}	0.82	0.0057	0.026
MW-02	4.7×10^{-5}	48	0.014	3.6
MW-03	6.4×10^{-6}	6.54	0.009	0.33
MW-04	5.4×10^{-5}	55	0.031	9.4
MW-05	7.8×10^{-6}	7.97	0.01	0.44
MW-11	1.4×10^{-3}	1430	0.017	135
MW-12	2.2×10^{-5}	22.5	0.011	1.4
MW-14	7.5×10^{-4}	766	0.015	62
MW-15	1.9×10^{-5}	19.4	0.012	1.3
MW-17	2.7×10^{-5}	27.6	0.015	2.3
MW-18	3.6×10^{-4}	368	0.044	90
MW-19	1.4×10^{-5}	14.3	0.039	3.1
MW-20	7.7×10^{-6}	7.86	0.0077	0.34
MW-22	3.5×10^{-6}	3.58	0.019	0.38

As demonstrated in the above table, downgradient monitor well permeability is generally low with the exception of MW-11 and MW-14. The permeabilities measured in these wells are consistent with a zone of higher permeability found east to northeast of the tailings cells at the site. This zone was identified during installation of temporary monitoring wells in the perched zone used for investigation of chloroform discovered in MW-4 in 1999 (IUSA and Hydro Geo Chem, 2001). This zone is hydraulically cross-gradient to upgradient of the tailings cells with respect to perched groundwater flow, and the higher permeability of MW-11 and MW-14 suggest that this zone may extend beneath the southeastern margin of the cells. This zone of higher permeability is not evident in downgradient monitoring wells MW-3, MW-5, MW-12, MW-15, MW-20, MW-21, or MW-22 based on lithologic log or hydraulic testing of the wells.

It is possible to calculate travel times between various points on White Mesa using these estimated rates. For example, Ruin Spring is approximately 10,000 feet down gradient of Cell 3. Wells MW-03, 05, 12, 15, and 20 are all between Cell 3 and Ruin Spring. The average rate for these five wells is 0.76 ft/yr, producing a total travel time of 7,620 years over 10,000 feet. Using the upper and lower rate values (0.33 and 1.4 ft/yr), travels times could vary from 3,300 years to 14,000 years between Cell 3 and Ruin Spring.

Well MW-05 is approximately 1000 feet down gradient of Cell 2. Using a travel time of 0.44 ft/yr for MW-05, total travel time between Cell 2 and MW-05 would be approximately 440 years.

These calculated travel times do not include a calculation for vertical movement from the base of either Cell 2 or Cell 3 to the perched aquifer.