

Evaluation of water leakage from a lined reservoir

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This example demonstrates the use of HYDRUS to evaluate water movement in a complex multilayer (24 layers of 12 different soil materials) system under a lined reservoir. It is assumed that there is a very little break in the lining of a radius of 0.52 cm and that the pressure head here is 3 m. Water flows through this opening into the soil profile that has the initial pressure head of -5 m. The water table is at a depth of 90 m. The transport domain is 30 * 90 m (horizontal * vertical) and is discretized using regular FE mesh. A constant pressure head (300 cm) representing the leak is specified at a left upper corner to a very small part of the boundary of 0.52 cm. A constant pressure head (0 cm) is also used at the bottom to represent ground water.

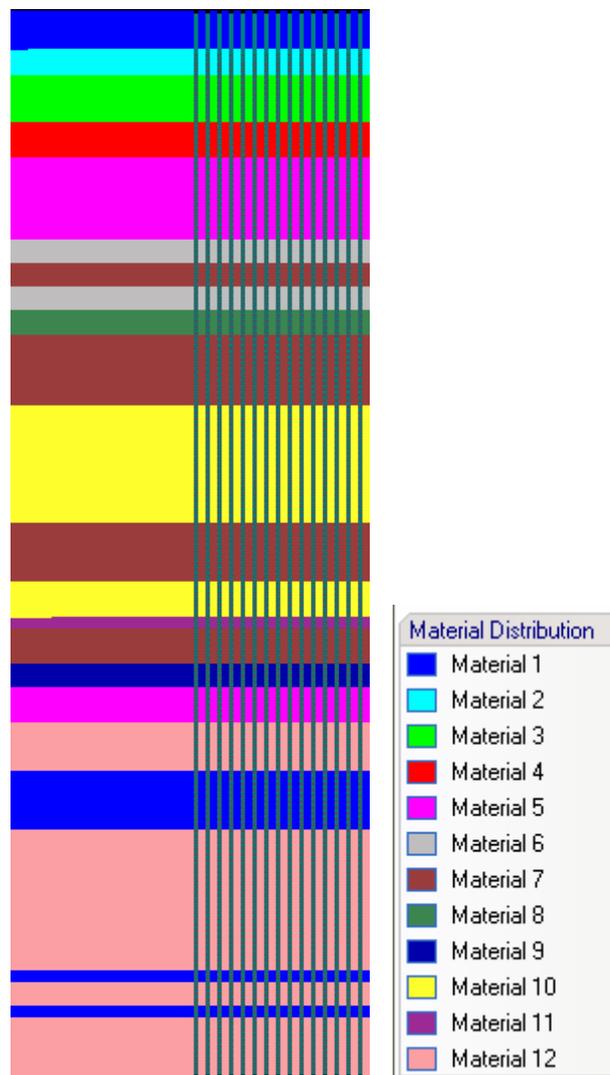


Figure 1. Material distribution in the transport domain.

Table 1. Soil hydraulic parameters used in simulations.

Mat	θ_r	θ_s	α [cm ⁻¹]	n	K_s [cm d ⁻¹]	l
1	0.045	0.43	0.145	2.68	103.68	0.5
2	0.1	0.39	0.059	1.48	33.3504	0.5
3	0.057	0.41	0.124	2.28	34.2144	0.5
4	0.095	0.41	0.019	1.31	1.0368	0.5
5	0.065	0.41	0.075	1.89	106.272	0.5
6	0.1	0.39	0.059	1.48	28.8576	0.5
7	0.057	0.41	0.124	2.28	349.92	0.5
8	0.095	0.41	0.019	1.31	0.091584	0.5
9	0.067	0.45	0.02	1.41	10.8	0.5
10	0.1	0.39	0.059	1.48	0.416448	0.5
11	0.095	0.41	0.019	1.31	2.73888	0.5
12	0.1	0.39	0.059	1.48	17.28	0.5

The problem is numerically rather complex, since due to a sequence of different layers with different saturated hydraulic conductivities, perched water layers develop above less permeable soil layers. Such cases that involve both saturated and unsaturated domains are often numerically unstable and require relatively small time steps. Notice that the computational time for this problem is over 1 day on a 3GHz PC.

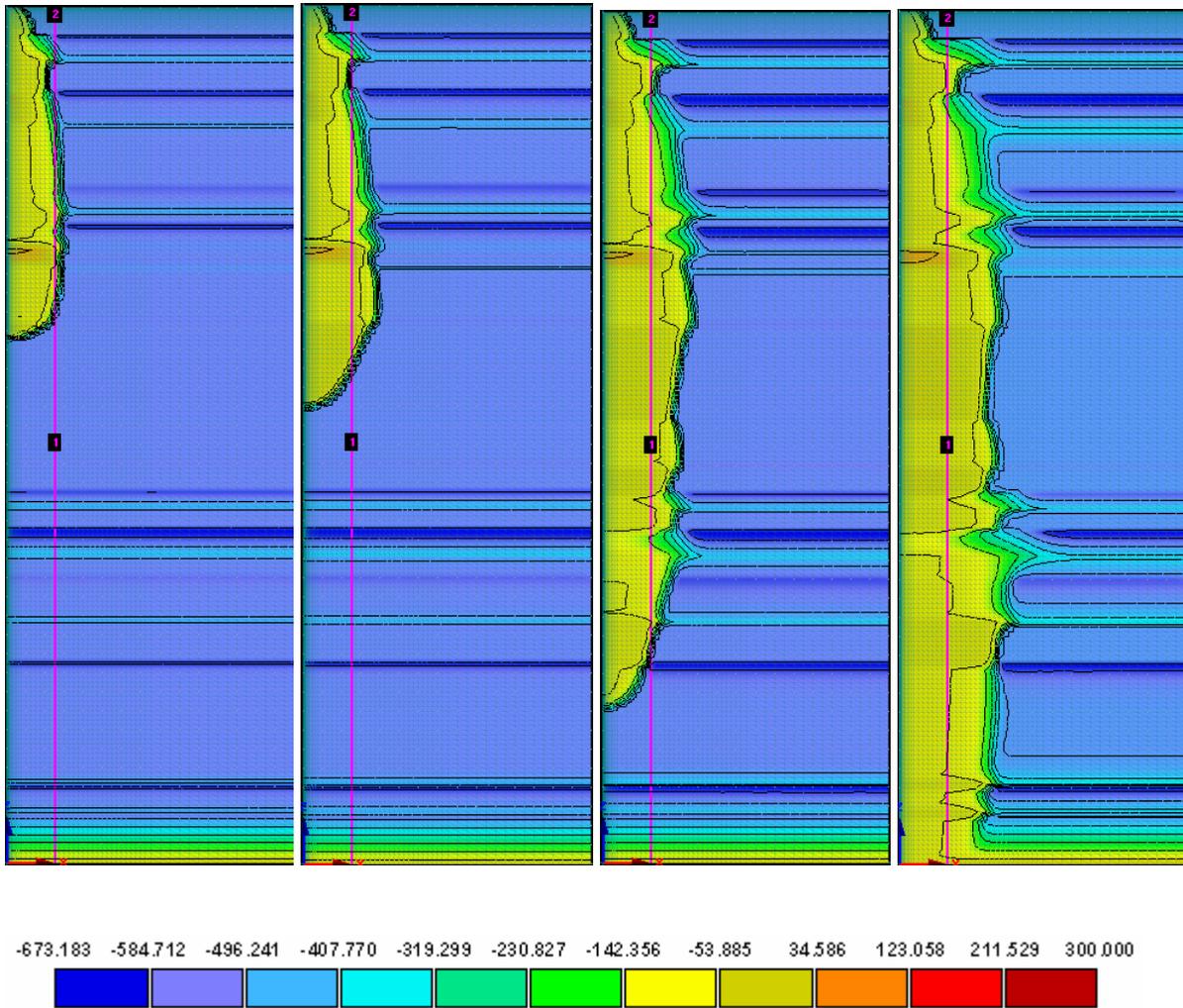


Figure 2. Pressure head profiles after 5, 10, 25, and 50 years for the leak of 11.28 mm diameter.

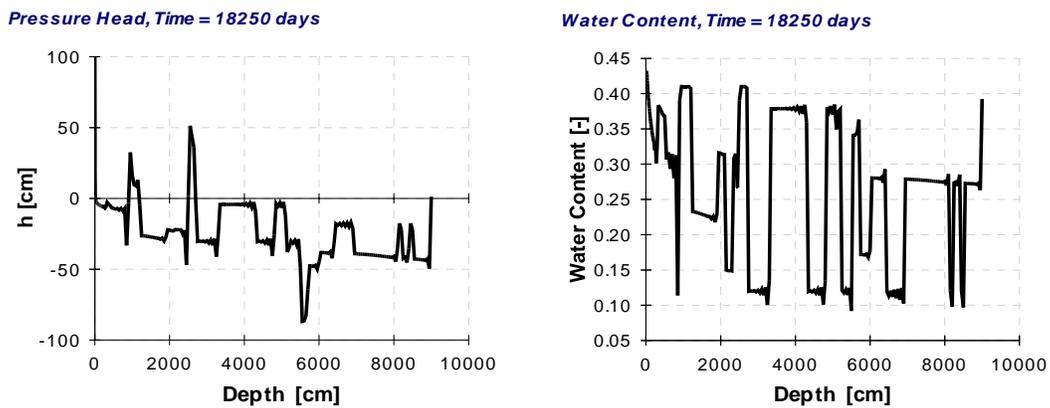


Figure 3. Pressure heads and water contents along the vertical axis. Figure shows dramatically different water contents in different soil horizons, as well as two perched water layers at a depth of about 10 and 25 m.