Groundwater Hydraulics

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1d Solutions of groundwater flow

Exercise #6

Consider a semi-infinite aquifer that is bounded by impermeable rock on the right-hand side. At a distance l from the rock formation, the aquifer is underneath a reservoir (see figure). In the region between the mountains and the lake, the aquifer is phreatic. Here, the rate of groundwater recharge is $N=10^{-7}$ m/s. The configuration shown in the Figure does not change in the direction vertical to the drawing.

It is planned to lower the water level in the reservoir onto a value of 15m above the ground of the reservoir. This will lead to a drawdown in the aquifer which may impact the agricultural use of the land. In order to prevent excessive drawdown, the bottom of the reservoir should be sealed with a semi-pervious, silty layer. The shore-line will be secured by sheet piles, so that water exchange between the reservoir and the aquifer is restricted to the semi-pervious layer.

1d Solutions of groundwater flow

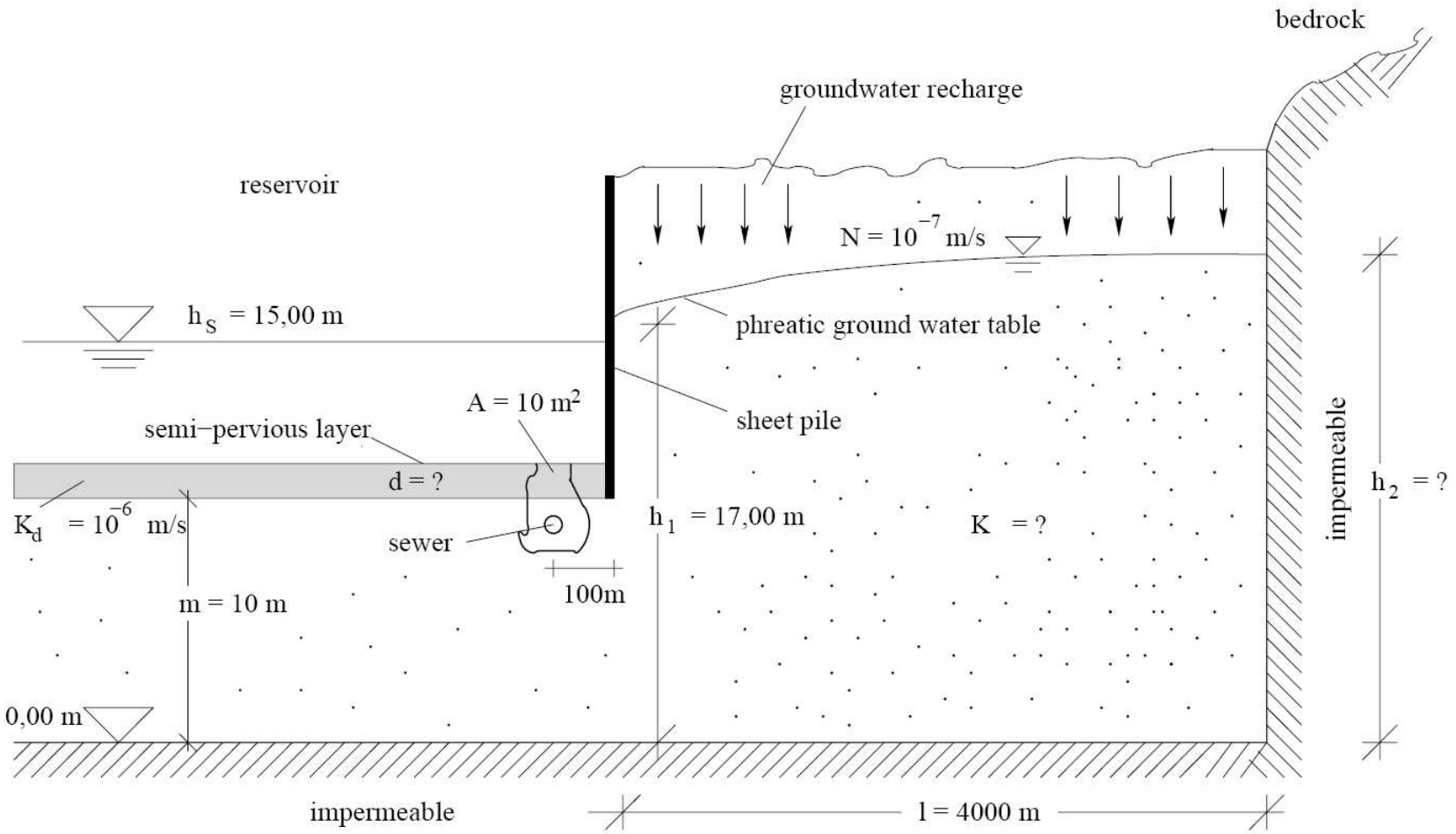

Figure 1: Schematic illustration for exercise 7.

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1. In order to determine soil parameters of the aquifer material, a grainsize analysis has been performed (see Table). Estimate the hydraulic conductivity K of the aquifer using the equation of Hazen (1892). Estimate the porosity.
2. Perform a water balance to determine the total discharge from the aquifer into the reservoir.
3. Design the thickness of the semi-pervious layer such that the piezometric head h_1 in the aquifer directly at the shore remains 17m. The hydraulic conductivity of the semi-permeable material is $K_d=10^{-6}$ m/s.
4. Determine the corresponding hydraulic head h_2 at the right-hand side boundary of the aquifer.
5. A sewage pipe 100m from the shore beneath the semi-pervious layer leaks, leading to a contamination of the groundwater at a cross-section of $10m^2$. How large is the total discharge of contaminated water into the reservoir?

Hint: Parts 3 to 5 can be solved one-dimensionally!

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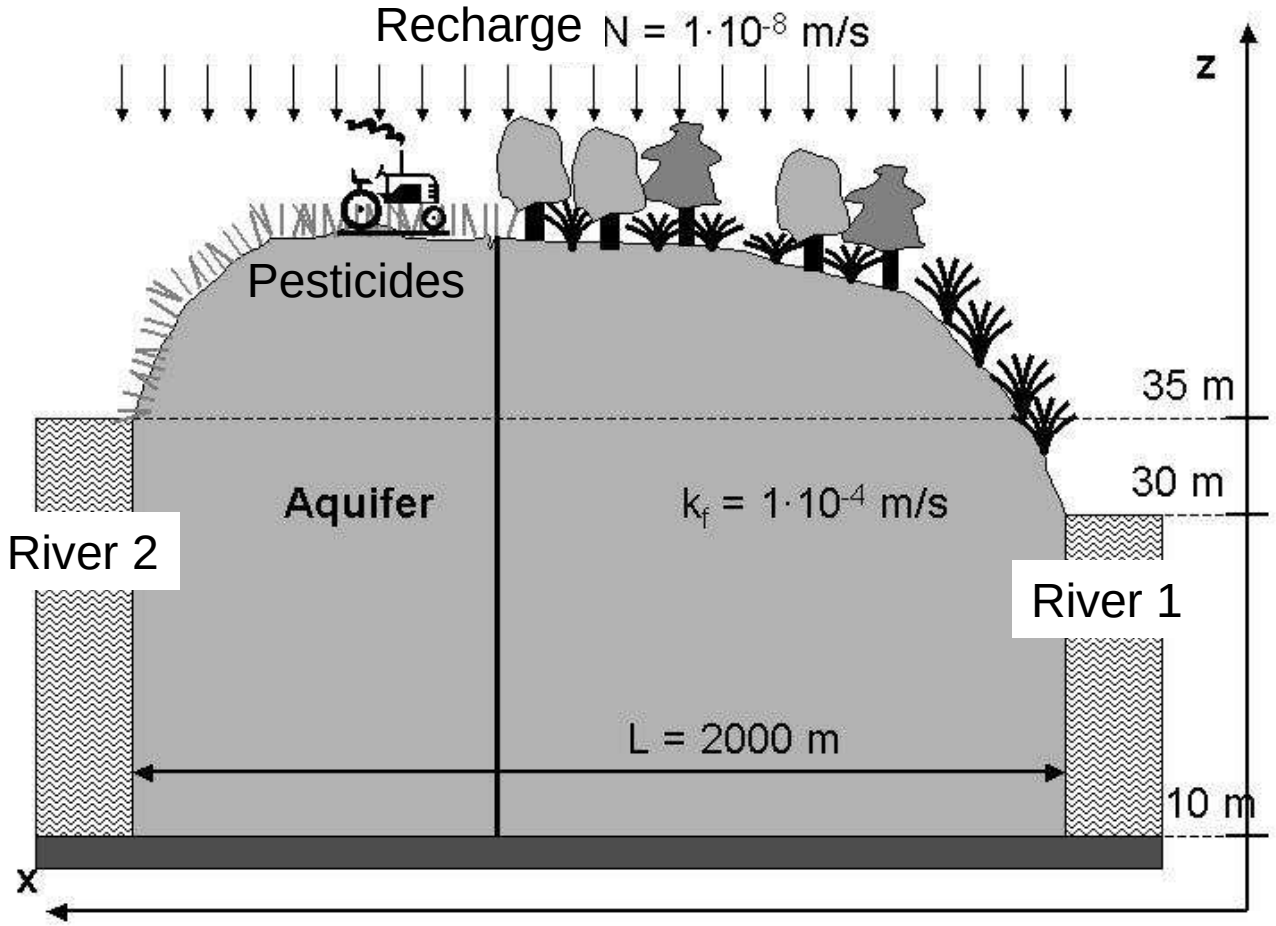
Grain-Size Analysis

Mesh Diameter [mm]	Mass Fraction [%]	Cumulative Mass [%]
0,06	1,2	1,2
0,20	8,8	10,0
0,60	25,7	35,7
2,00	55,6	91,3
6,00	6,2	97,5
20,0	2,5	100,0
60,0	0,0	100,0
100,0	0,0	100,0
200,0	0,0	100,0

1d Solutions of groundwater flow

Exercise #8



1d Solutions of groundwater flow

1. Think how the flow conditions in the aquifer are. In which direction does the water flow at river 1 and at river 2? How big is the discharge Q [m^2 / s] in or to river 1 and river 2?
2. Up to which location from river 2 on could you use pesticides under the condition that no pesticide should reach river 1?
3. The next year is predicted to be very wet (so you expect a larger recharge). Do you expect that you can cultivate a larger or a smaller area? Give either qualitative reasons or calculate the flux.