Groundwater exercise:

Task1: Soil Characteristics

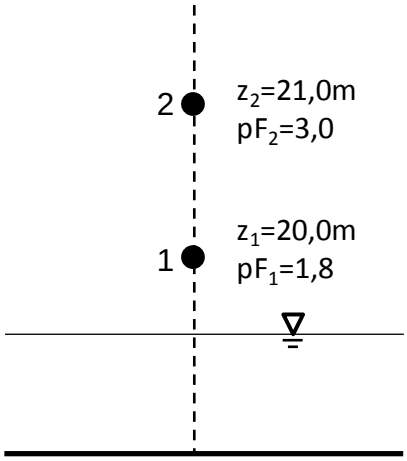
A soil sample with the volume of $\mathbf{V_g = 100cm^3}$ is taken. The weight of the bulk is measured $\mathbf{m_g = 198g}$. After drying at 105 °C to a constant mass, the soil weighed $\mathbf{m_{tr} = 176g}$. In a measuring cylinder filled with water the dried sample displaces a volume of $\mathbf{V_{tr} = 61cm^3}$.

Determine the following soil properties

a) The soil porosity, n
b) The bulk density, ρ_{tr}
c) The particle density, ρ
d) The gravimetric water content, Θ_m
e) The volumetric water content, Θ_v
f) The soil water content Θ of a soil with a thickness of 30cm
g) The degree of saturation, s

Task2: Potential Head

According to the figure below, by using the hydraulic gradient, determine whether water vertically penetrates through the soil or rises by the capillary forces. The geodetic heights z (above sea level) of the points is known and the water potential of the points is given in the figure.



'pF' is the decadic logarithm of the pressure in centimeters of water column.

Task 3: Available water capacity

Determine for a medium sand, loam and clay the available water capacity (AWC) and the root zone available water capacity (RZAWC). Use the field capacity, permanent wilting point and the effective rooting depth of crops for your calculations.

Task 4: Water Availability

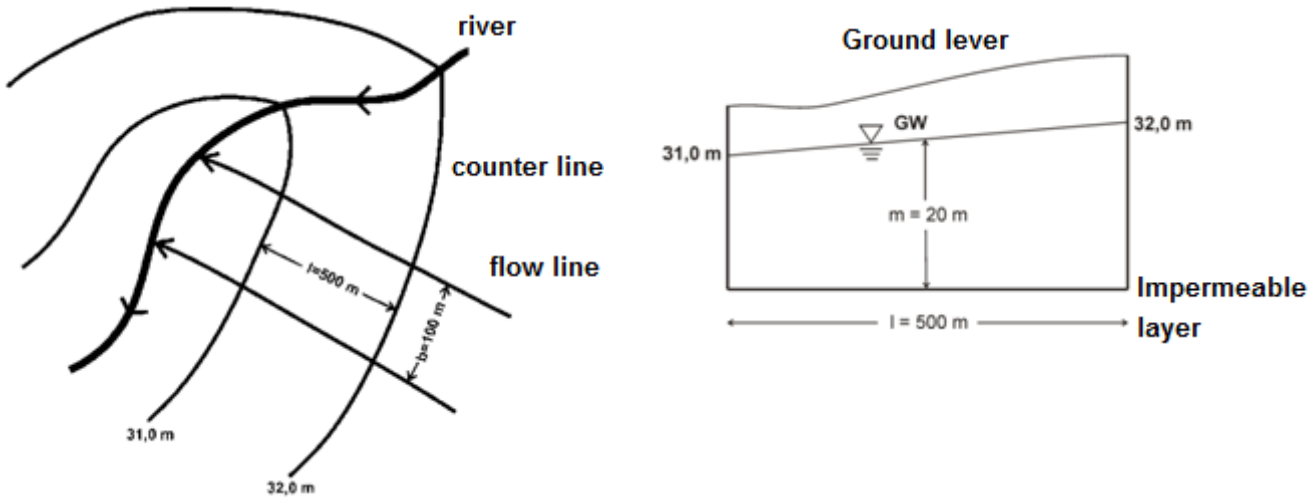
A farmer wants to know for how long he can manage his field area, with a sandy loam soil and winter wheat as the crop, without irrigating during the growing season when no rainfall occurs.

Assumptions: actual evaporation 7mm / d
at the beginning, the soil is said to be at field capacity
vadose zone > 5m

In order to prevent yield losses, the water content should not drop below 50% of the root zone available water capacity (RZAWC). In this case, how long can irrigating be waived?

Task 5: Groundwater flow

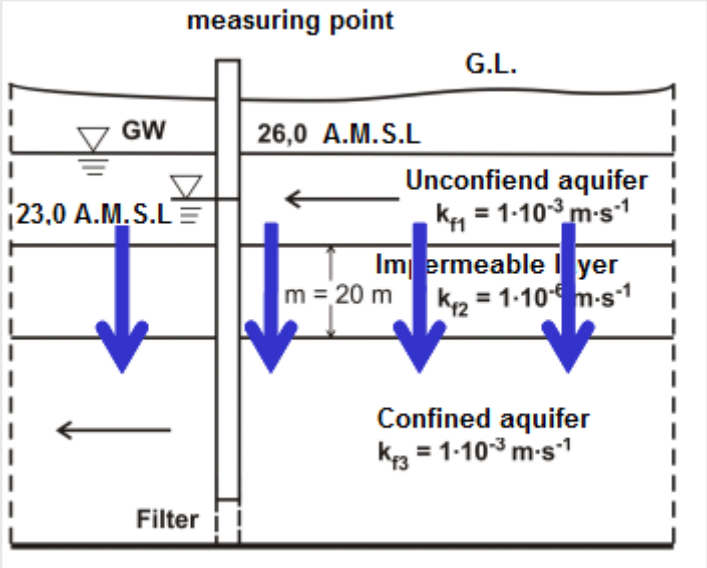
Predominantly the groundwater flows horizontally to the river and feeds it as the base flow. This discharge can be estimated using water table contour lines. How big is the runoff according to the following sketches between the two given flow lines? The hydraulic conductivity of the aquifer is $k_f = 1.0 \bullet 10^{-5}$ m • s^{-1}. Determine also the flow time between the two water table contour lines (500 m) with the porosity of n = 20%



Longitudinal and cross-sectional view of the flow setting

Task 6: Groundwater System

A groundwater system consists of three layers of rock. The middle layer is an aquitard with a significantly lower permeability than the adjacent layers. The flow in the upper and lower layers exists, and the piezometric heads are known in the figure. How big is the flow through the aquitard?



Longitudinal section of the GW system

Task 7: Groundwater flow time

Determine the time that the groundwater flows in a relatively homogeneous aquifer (drawing in longitudinal section) between the two monitoring points! Hydraulic conductivity of $k_f = 3 \bullet 10^{-3}$ m • s^{-1} and the effective porosity of $n_f = 0.15$ (-) have been estimated.