CE 3354 Engineering Hydrology
Exercise Set 9

Exercises

1. Table **??** is a list piezometric heads measured simultaneously in 13 wells penetrating an isotropic confined aquifer of thickness $B = 50\ m$, hydraulic conductivity $K = 20\ \frac{m}{day}$, and effective porosity $n = 0.23$.

Table 1: Somewhere USA Aquifer Data

Well ID	Easting (m)	Northing (m)	Head (m)
MW-01	4300	1000	34.6
MW-02	16500	3500	35.1
MW-03	7000	5100	32.8
MW-04	3000	6500	32.1
MW-05	11000	7000	31.5
MW-06	22000	6500	34.5
MW-07	8000	9000	33.3
MW-08	3200	11800	34.4
MW-09	18100	10000	34.3
MW-10	13500	12900	35.2
MW-11	4000	15500	35.2
MW-12	8700	16100	37.3
MW-12	19500	16300	36.3

Determine:

a) A contour map of the head distribution (1-meter contour intervals)

b) Specific discharge (direction and magnitude) at location $A = (10000, 4000)$

c) Specific discharge (direction and magnitude) at location $B = (16000, 11000)$

d) An estimate of total flow through the aquifer between wells MW-10 and MW-9.

e) An estimate of travel time for a conservative tracer introduced near well MW-12 to reach MW-5

2. a 50-acre single-family residential subdivision receives a rainfall intensity of 3 inches per hour for one hour. The average runoff coefficient is 0.50. Using the NRCS triangular hydrograph [1]

   Determine:

   a) Maximum (peak) discharge rate for the watershed.

   b) A plot of the discharge hydrograph in 6-minute intervals.

   c) The total volume of runoff from the subdivision for the entire storm.

[1] t_c is set equal to the storm duration

3. A watershed is comprised of sandy soil with a 500 foot path to an outlet. The slope on that path is 5-percent. The soil has a high water table limiting the potential watershed storage to 0.5 inches. Using the NRCS Lag Equation method[2]

$$T_c = L^{0.8} \frac{(S_r + 1)^{0.7}}{1140 Y^{0.5}} \tag{1}$$

where:

T_c = time of concentration, hr
L = flow length, ft
S_r = Potential storage (in.); $S_r = \frac{1000}{CN} - 10$
CN = NRCS runoff curve number
Y = average watershed slope, %

Determine:

a) Time of concentration (T_c).

[2] https://directives.nrcs.usda.gov/sites/default/files2/1712930818/31754.pdf

4. The runoff hydrograph below was produced by a 100 acre watershed.

Table 2: Somewhere USA Runoff Data

Time (hours)	Runoff (CFS)
0.0	0.0
1.0	70.0
2.0	160.
3.0	110.
4.0	80.0
5.0	60.0
6.0	45.0
7.0	30.0
8.0	20.0
9.0	12.0
10.	5.0
11.	0.0

Determine:

a) Excess precipitation in watershed inches for the hydrograph.

b) A unit hydrograph for the watershed.

c) A plot of the unit hydrograph.

5. Figure **??** is a profile (elevation) view of an aquifer system.

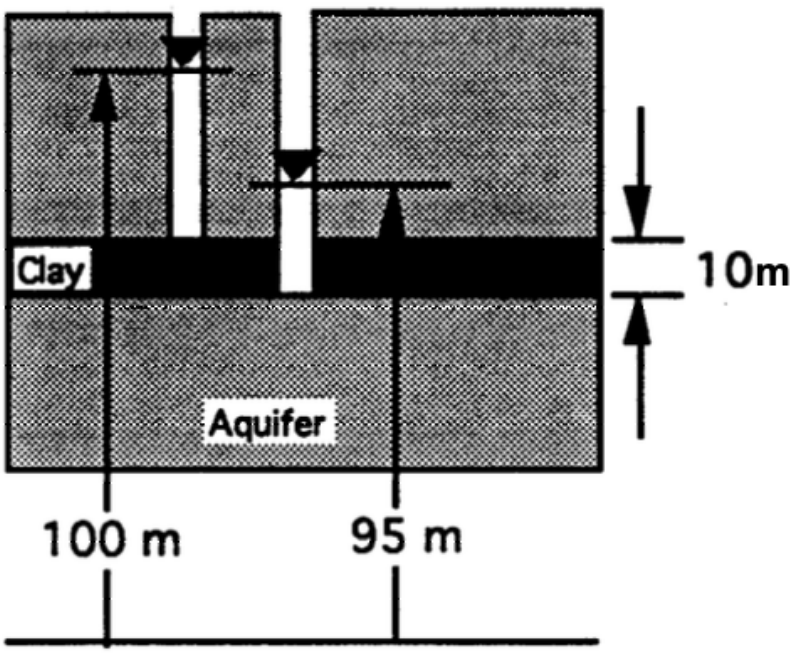

Figure 1: Elevation View of an Aquifer

The vertical hydraulic conductivity of the clay layer is $K_v = 1 \times 10^{-7}\ \frac{cm}{sec}$

Determine:

a) The distance (in meters) from the datum to the water level in the left piezometer.

b) The distance (in meters) from the datum to the water level in the right piezometer.

c) The vertical hydraulic gradient in the clay layer.

d) The specific discharge across the clay layer in cm/sec.

e) The direction of leakage.