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# Hydrogeology Home work Set 3 # Flow Nets

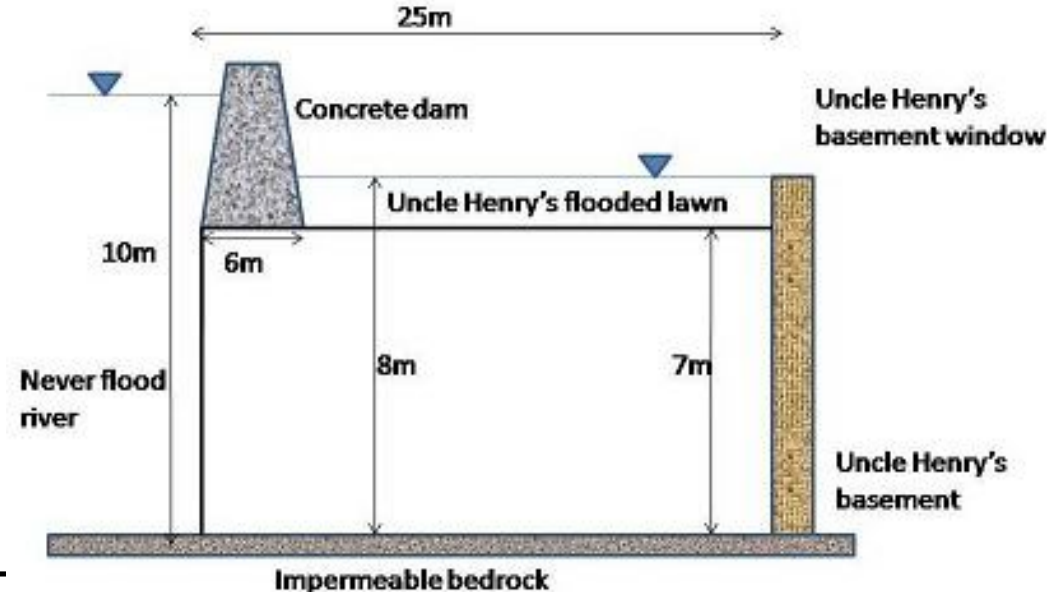
Date: **Wednesday, 10 Ordibehesht 1393** Due Date: **Wednesday, 24 Ordibehesht, 1393**

1. Your uncle Henry from the Darcy side of family has reached retirement age. After a long career as a civil servant in the city of Dijan, he is looking forward to spending his days fishing - a life-long passion. With this in mind, he decides to buy a nice piece of property along never flood river .This is fine piece real estate, with a quaint little house set on a large lot with extensive river frontage.

   A couple of years pass and uncle Henry couldn't be happier with his property, but after a particularly snowy winter, local authorities are warning of the potential for devastating spring floods on the normally peaceful never flood river. Fearing the worst, uncle Henry decide to build concrete dam around his house to protect it from rising waters .He contracts German concrete and masonry firm ,Siemendaat Vilneferleek Inc, to pour the low-permeability concrete to form the dam.

   The authorities were right about the potential for floods .That spring, the river level rises higher and higher .Completely astonished, uncle Henry can only watch helplessly as the water seeps up through his lawn and floods his yard .The water keeps rising and eventually starts entering his house through the basement window sills. The flood water level finally stabilities in the river and the yard reaches steady state conditions, as your uncle scramble to pump out his basement .Knowing that you took this excellent course ,he calls you up to figure out what is happening. You examine the situation, and construct the cross-section below .At the end of this handout you will find the same sketch but without the labels (there are actually 2 copies, one is for practice, and the other is good copy). On the unlabeled sketch, (k =10e-3 m/s).

   a) Label the boundary condition for this system, and
   b) Draw a flow net by hand using interval of 0.2 m for the equipotential lines.

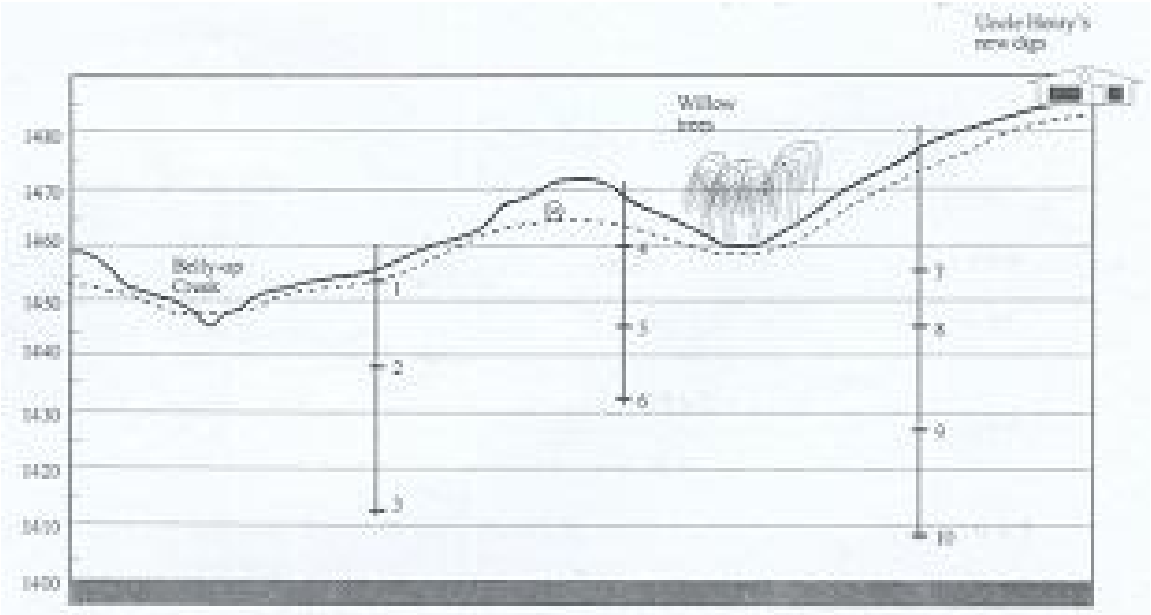


2. Following your advice, your uncle Henry decides to relocate -it's cheaper than trying to fix the by-now breached concrete dam or than raising the house on 3-meter peers. After some shopping he buys a house with a view. Just for fun, you install 10 piezometers on his property, at the location shown in the cross section in the figure below .The diagram also shows the water table profile and location of a creek and a depression with willow trees. The bottom of the section is an impermeable boundary and both sides are regional ground water divides .Uncle Henry's new house is shown at the top of the hill.

   a) Using the following pizeometer reading ,draw in and clearly label the approximate equipotentential lines and flow lines for the flow system in the cross section .I've included a couple of the diagram for practice and good copies.

   b) Label different flow system as regional, intermediate and local (which ever are applicable).Label the recharge, discharge and hinge zone .Draw approximate stagnation zones .If any exists.

| Piezometer number | Hydrulic Head |
|---|---|
| 1 | 1453 |
| 2 | 1450 |
| 3 | 1452 |
| 4 | 1461 |
| 5 | 1457 |
| 6 | 1454 |
| 7 | 1464 |
| 8 | 1460 |
| 9 | 1459 |
| 10 | 1458 |



3. Consider the area shown in the map and cross section in the map Shawn on the following page .The thick line give the ground surface elevation contour lines .The location of piezometer installed in the sand aquifer are indicated (some piezometers are off the map).The piezometer are all screened in the sand aquifer and their reading are listed below .The sand is medium grained, well sorted and Relatively homogenous, with porosity of 0.4.The Granit can be considered to have in significant hydraulic conductivity .The hydraulic conductivity of the till, clay and silt are very low compared to the sand aquifer of conductivity of 3×10-2 cm/s.

   a) Prepare a map of the potentiometric surface of the sand aquifer in the instrumented area. Sketch the probable flow lines on the map. Assume that the hydraulic conductivity of the sand is isotropic .There is an extra copy of this map and section at the end of the assignment .Use one of this copy as a rough copy and other as the copy to hand in .

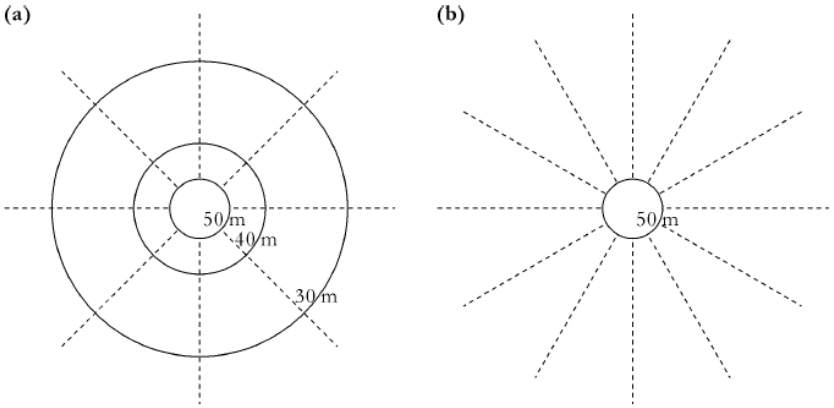
   b) Estimate how long it would take(in year)for water to flow from point B indicated on the map to the point where it, passes beneath the north south road .How far off would your calculation be if you used Darcy velocity instead of the average linear pore water velocity.

| Piezometer number | Hydraulic Head (m) | Piezometer number | Hydraulic |
|---|---|---|---|
| 1 | 266.7 | 16 | 273.1 |
| 2 | 264.9 | 17 | 272.5 |
| 3 | 268.9 | 18 | 270.4 |
| 4 | 271.0 | 19 | 271.9 |
| 5 | 273.1 | 20 | 272.8 |
| 6 | 270.7 | 21 | 273.1 |
| 7 | 263.7 | 22 | 272.2 |
| 8 | 263.7 | 23 | 271.9 |
| 9 | 263.7 | 24 | 272.2 |
| 10 | 265.2 | 25 | 271.6 |
| 11 | 267.3 | 26 | 270.7 |
| 12 | 267.3 | 27 | 267.9 |
| 13 | 269.8 | 28 | 260.3 |
| 14 | 267.9 | 29 | 262.4 |
| 15 | 265.8 | 30 | 262.7 |

4. An earthen dam is constructed on impermeable bedrock layer .It is 750 feet a cross (i.e. the distance from the water in the reservoir to tail water below the dam is 750 feet).The average hydraulic conductivity of the material used in the dam construction is 0.23 foot per day .The water in the reservoir behind the dam is 75 feet and tail water below water are 20 feet deep. Compute the volume of water that seeps from the reservoir, through the dam, and in to the tail waters per a 100-foot-wide strip of the dam in ft3/day.

5. The following diagram ,shows flow net with an injecting well in a homogenous ,isotopic aquifer .An injecting well has been broadly used in storing water under ground ,for example in

Varamin city south of Tehran .the dash lines shows the stream line and the solid line show the equipotential lines. The hydraulic conductivity of the aquifer is 10 m/day.




a) What is the injection rate per unit aquifer thickness in the figure 1?

b) given the news stream lines shown in figure 1(b) and keep the same injection rate as that in figure 1(a).Plot three more equipotentional line for the flow net in figure 1(b).Also write the new hydraulic head for all those lines.

6. Your boss & former teacher in GSI was informed that, you have done well in your uncle property and became so happy to telephone you and order you to do the following items in the following section ,unless you won't see your next birthday party , Cause you are young and love your life you accept to do;

a) Construct a flow net in the following page. The material is homogeneous and isotropic. The top boundary is the water table and other boundaries have no flow. Use 1-m contour interval for equipotentials. The value of hydraulic head at several data points are given in the diagram.

b) The hydraulic conductivity of the material is $4 \times 10^{-6}$ m/s. Count the number of flow tubes in the section and estimates the total flow rate ($m^3/s$) going through a 1-m thick section. Note that the thickness of the section is measured perpendicular to the page.

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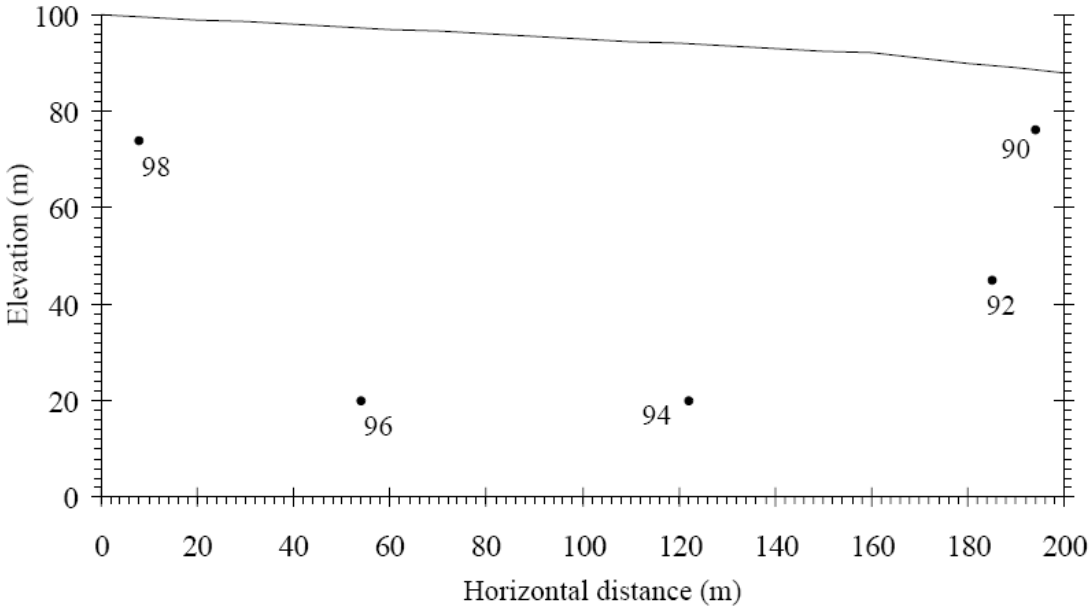
c) Convert the flow rate you calculated in (b) from $m^3/s$ to $m^3/yr$.




7. In an earth dam with 13 meters across and 7.5 meters high .The impounded water is 6.2 meters deep, while the tail water is 2.2 meters deep. The dam is 72 meters long .If hydraulic conductivity is 6.1×10-4 centimeter per second, what is the seepage through the dam?