



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY OF INDUSTRIAL TECHNOLOGY**

**DEPARTMENT OF CIVIL AND WATER ENGINEERING**

**GROUNDWATER HYDRAULICS AND MODELLING**

**TCW 5001**

**Supplementary Examinations Paper**

**July 2017**

This examination paper consists of 4 pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Special Requirements: Log-Log paper**

**Examiner's Name: MrsSakhileNdlovu**

**INSTRUCTIONS**

1. Answer ALL questions
2. Each question carries 25 marks

**MARK ALLOCATION**

<b>QUESTION</b>	<b>MARKS</b>
<b>1</b>	<b>25</b>
<b>2</b>	<b>25</b>
<b>3</b>	<b>25</b>
<b>4</b>	<b>25</b>
<b>TOTAL</b>	<b>100</b>

## **QUESTION 1**

- a) Explain the following terms as they are used in groundwater modelling:
- i. Conceptual model 2 marks
  - ii. Boundary conditions 4 marks
  - iii. Model verification 2 marks
  - iv. Postaudit 2 marks
- b) An unconfined aquifer of clean sand and gravel is located between two fully penetrating rivers and has a hydraulic conductivity of  $K = 1 \times 10^{-2}$  cm/sec. The area is subject to a rainfall of 2.6 m/year and evaporation of 1.0 m/year. The water surface elevation in rivers A and B are 8.5 m and 10 m respectively above the bottom. The distance  $L$  between the two rivers is 460 m. Estimate
- i. the location of the groundwater divide
  - ii. the maximum water table elevation,
  - iii. the travel times from the groundwater divide to both rivers ( $n_e = 0.35$ )
  - iv. the daily discharge per kilometer from the aquifer into both rivers 15 marks

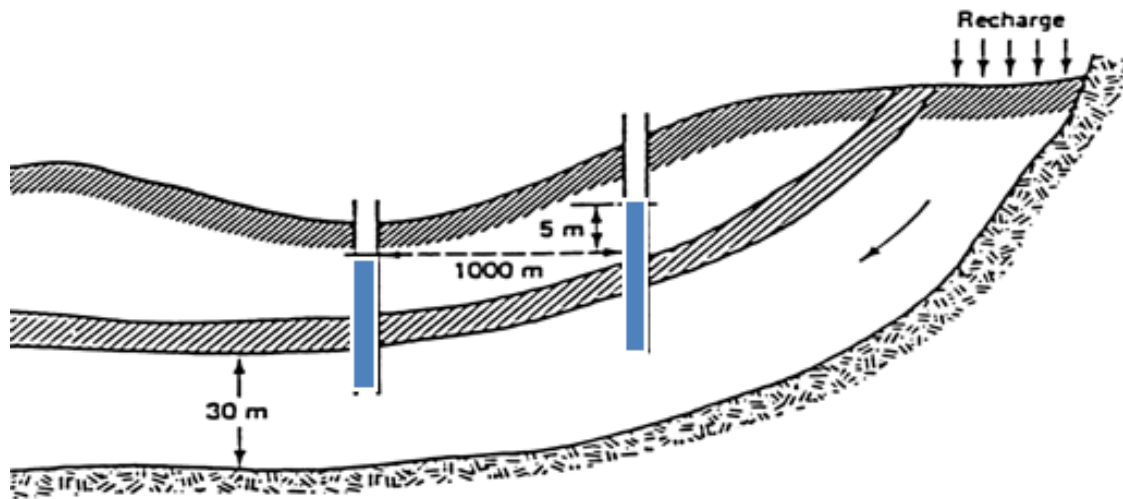
## **QUESTION 2**

A confined aquifer has a source of recharge (Fig. Q2).  $K$  for the aquifer is 50 m/day, and porosity,  $n$  is 0.2. The piezometric head in two wells 1000 m apart is 55 m and 50 m respectively, from a common datum. The average thickness of the aquifer is 30 m, and the average width of the aquifer is 5000m

- a) Compute:
- i. the rate of flow through the aquifer
  - ii. the average time of travel from the head of the aquifer to a point 3 km downstream. (10 marks)
- b) What factors must be considered when designing a groundwater monitoring network for the Nyamandlovu Aquifer that supplies water to the city of Bulawayo? Detail the steps you would follow in designing this network. (10 marks)

- c) What is your understanding of groundwater protection zones? How are they delineated? (5 marks)

Fig Q2



### QUESTION 3

- a) Outline the steps involved in building a groundwater model (10 marks)
- b) You have the opportunity to purchase either MODFLOW or FEFLOW for use in your organization.
- i. Explain to your immediate supervisor the differences between the two and the strengths and weaknesses of each model. Which model would you select? (10 marks)
- c) What are the consequences of excessive groundwater abstraction in an area?(5 marks)

### QUESTION FOUR

Table Q4 shows the data of a pumping test conducted in a confined aquifer having a large spatial extent. The well was pumped at a uniform rate of 2500 m<sup>3</sup>/day. Drawdowns during the pumping period were measured in an observation well 60m away, observations of s and t are listed in Table Q5.

**Table Q4**

t (min)	0	1	1.5	2	2.5	3	4	5	6	8	10	12	14
s (m)	0	0.2	0.27	0.3	0.34	0.37	0.41	0.45	0.48	0.53	0.57	0.6	0.63
t (min)	18	24	30	40	50	60	80	100	120	150	180	210	240
s (m)	0.67	0.72	0.76	0.81	0.85	0.9	0.93	0.96	1	1.04	1.07	1.1	1.112

Estimate T and S using the Theis method. (15 marks)

Suppose the aquifer has a thickness of 8 m what is the hydraulic conductivity of the aquifer material? (2 marks)

Why does the cone of depression of a confined aquifer spread more quickly than the cone of depression of an unconfined aquifer? (3 marks)

Will a pumping test that is run for seven days give more information than a pumping test run for one day? Is so what type of information? Why? (5 marks)