CIV5881/6881 Groundwater Hydraulics Assignment 2

You are a consultant investigating the possibility of developing a well field for a large-scale water supply. The groundwater is to be pumped from the unconfined aquifer shown in Fig. 1 below. In the first phase of the project (i.e., in Assignment 1), you did a preliminary analysis. In the second phase of the project - what you will do in this Assignment - you will develop a numerical model for the aquifer, and discuss possible remediation strategies should the aquifer be contaminated.

The model provided to you may in part be incomplete or have incorrect parameter settings. You will need to verify that the settings are as they should be before undertaking the calibration.

Please provide your client with a preliminary report (structured as a technical engineering report) presenting each of the steps outlined below. The report must be no more than five pages including plots and maps.

1. Steady-state ModFlow modelling

To understand the long-term impacts of the proposed groundwater extractions, a ModFlow model is to be built and calibrated to the pre-pumping head observations. In this task you are required to:

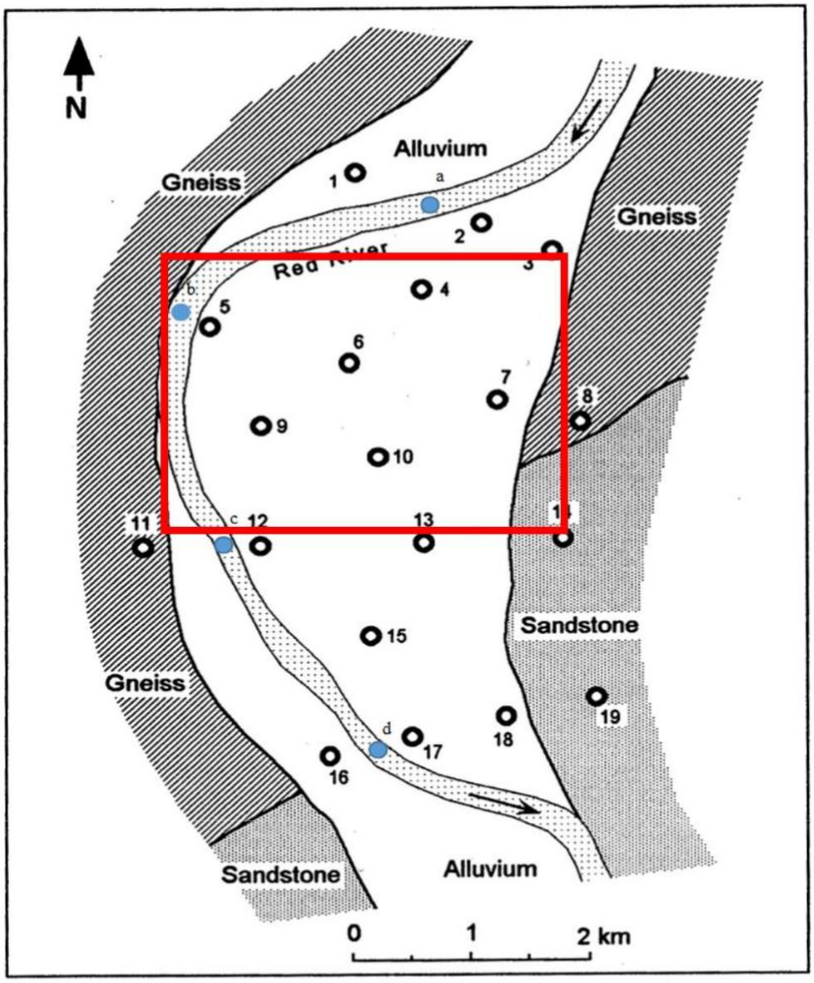
(a) Check that your model has the characteristics and parameters as shown in Fig. 2 below and with the following parameters:

- 30 columns, 25 rows, 100m horizontal cell size, surface elevation constant at 572m;
- Three model layers with a thickness, from the surface, of 5, 10, and 10m, layers in parallel to the surface;
- Northern/southern constant boundaries with the following general head boundaries settings:
    - northern boundary : 571m (boundary head), 1.58×10^{-5} s^{-1} (conductance)
    - southern boundary : 569.4m, 7.9×10^{-8} s^{-1}
- River boundary, a fixed-head boundary simulating the river with a constant head of 570m;
- A westerly boundary behind the river with a no-flow boundary;
- Easterly boundary with a fixed hydraulic conductivity (a plausible range is 0.0025-0.0040 m/hr).
- Hydraulic conductivity of all three layers of the aquifer (select a value between 0.15-0.40 m/hr).

(b) Using one of the objective functions provided on Moodle, manually calibrate the model's hydraulic conductivities (aquifer, eastern boundary) using the six observation wells as a reference. Make the following assumption:

Kx = Ky = 10Kz

(c) Provide relevant outputs from the calibration of the model. This should include that from 1b but also results that inform how reliable, or otherwise, the calibration was - and which could include, but is not limited to: (i) plots of the observed vs modelled depth to water table, (ii) plots of the observed vs modelled head and (iii) maps of the difference between the observed and modelled heads, iv) plots of your objective function results. In undertaking the calibration, it is acceptable to use local calibration methods. There is no need to calibrate the recharge (it is 10% of the 600mm annual precipitation over the alluvium), only calibrate the saturated hydraulic conductivity within the alluvium and sandstone (the gneiss is the impermeable layer to the West).



	Well 5	Well 4	Well 6	Well 7	Well 9	Well 10
Head [m]	570.21	571.73	571.37	572.04	570.87	571.43
Row	6	4	10	12	20	22
Col	5	18	13	27	9	15

Figure 1: Case study and well details

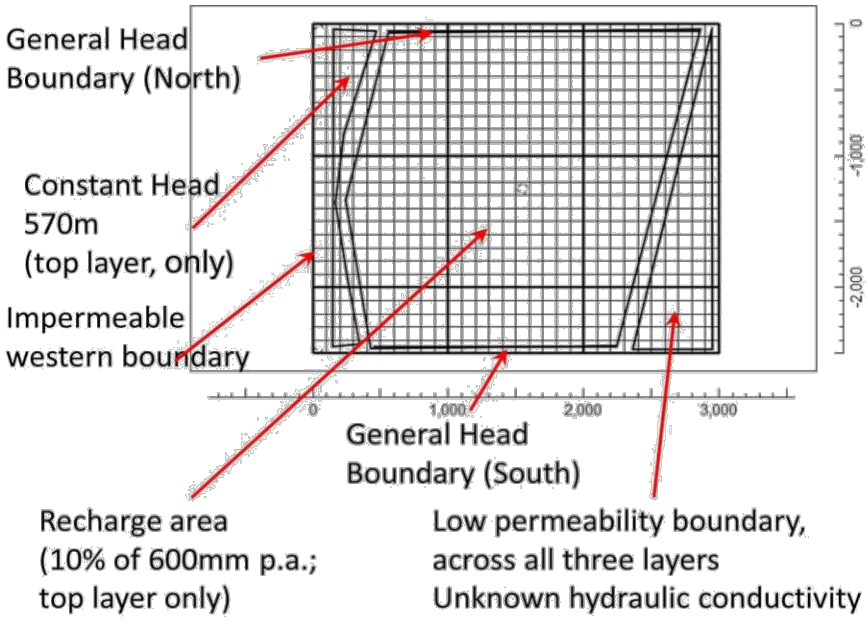


Figure 2: ModFlow model geometry

2. Simulation of the proposed well configurations

In assignment 1 you proposed two well configurations. In this task you are required to implement one of the two configurations into your ModFlow model and assess the impacts from the groundwater pumping. Specifically, you are required to:

(a) Implement the well configuration into ModFlow and produce relevant outputs from ModFlow that demonstrate (i) the impacts from the pumping and (ii) the validity of the model when pumping is included.

(b) Provide a critical examination of the entire model within this assignment. If major modelling problems occur, then detail how you would revise the conceptual model and its implementation.

3. Remediating a potential contamination event

Due to nearby industrial activities, there is a risk of future contamination of the groundwater by chromium 6 (hexavalent chromium). In no more than 1 page (including figures), discuss potential strategies that could be implemented to:

(a) ensure that the groundwater is not contaminated by chromium 6.
(b) remediate the groundwater should it be contaminated by chromium 6.

Refer to case studies and literature in your answer to justify the strategies that you propose.

Assessment Criteria

Structure and clarity of the report	20%
Steady-state ModFlow calibration and modelling	40%
Simulation of the proposed well configurations	20%
Discussion of remediation strategies	20%