ENGR 326

PDE Lab Assignment 2 – Parabolic PDE

A water district is planning the use of a "natural" filter for treating water from a reservoir prior to disinfection and delivery to customers. The filter consists of a 600 meter by 300 meter earthen basin of uniform properties, bound above, below, and on three sides by a impermeable barrier (Figure 1). The south boundary of the filter is maintained at a 30 meter head level from the reservoir.

Pumps for the two extraction wells were selected based on an assumption that a 4 meter drawdown would be acceptable. Initial simulation results from a groundwater model suggested that pumps optimized for extraction rates between 500 and 650 m^3/day (per pump) were an appropriate choice for the planned operating conditions. After installation of the pumps, the actual drawdown at the design extraction rate was found to be significantly greater than anticipated at the well casing. Testing confirmed that pumps would not reliably operate with a drawdown greater than 3 meters averaged over a 25 $meter^2$ area around the well. Unfortunately, extended use of the pumps simultaneous operating within the range of their optimal pumping rate results in a drawdown greater than 3 meters.

The project engineer has decided to try an alternating pump-rest schedule, with one pump operating for two hours while the other one is off-line, and then reversing the roles for the next two hour period. Determine the maximum pumping rate possible that does not result in exceeding the 3 meter drawdown limit for the given pumping schedule. Use the generalized theta formulation with a successive-over-relaxation (SOR) solution algorithm. Report your results with a value of $\theta = 0.5$, with a time step of 30 minutes and a grid with 5 meter increments in the x and y direction. Be sure to run your model for at least 20 days.

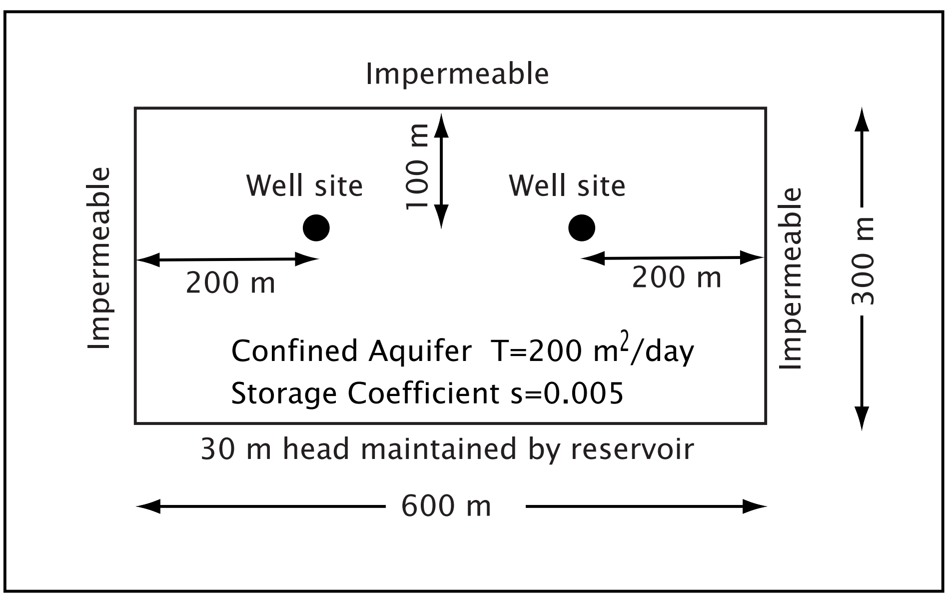

Figure 1. Aerial view of the filtration system.