HWRS 582 – Groundwater modeling

HM4 - Challenge

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1. For the initial well location, plot the flow into the left (constant head = 20) and out of the right (contant head = 10) boundaries. (The code, as provided, makes this plot for you.) Explain why the values are not constant along the boundary (relate to the definition of a Type I boundary). Explain the shapes of the flow distributions and why they are not the same for the left (inflow) and right (outflow) boundaries.

The flow in the boundaries is different because we are applying a local extraction which has a non-uniform effect in the boundaries. Each cell of the transect has a different distance from the well and the closest cells transport (left side) or is stolen (right side) more water to supply the requirement of the well. Given the steady-state condition, the difference between the 2 transects is exactly the flow extracted from the well, any change in storage is allowed in this condition.

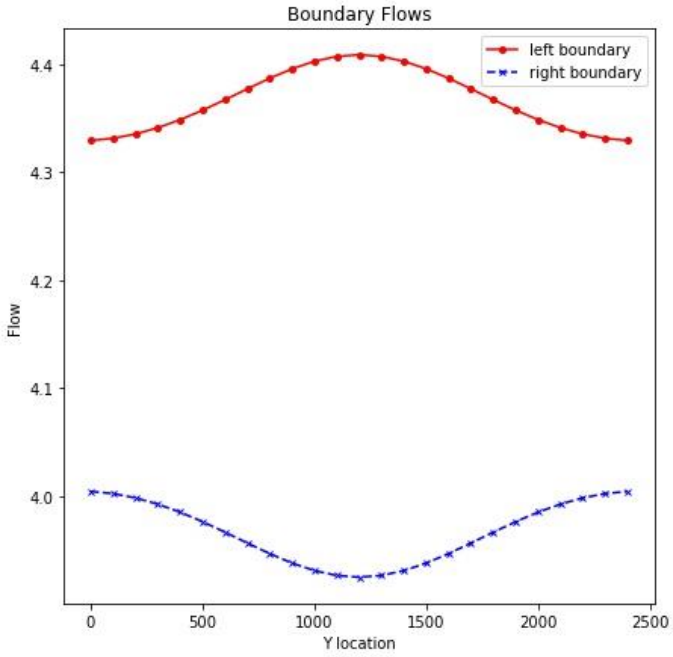

Figure 1. Transect in the boundary conditions.

2. Add a series of the left-to-right flow along a line that passes through the center of the well [:,12]. How do you interpret the flow along this transect? Hint, also look at the flow along a transect just upgradient from the well [:,11].

The shape of the center and before the center transect are associated with the local extraction of the well. Immediately before the well, the flow paths tend to concentrate close to the well. Given that between flow paths we transport equal flow, when we have more flow paths, we have more total flow. That is the reason for the peak before the well. On the other hand, the transect in the center already discounted the flow extracted from the well, therefore less concentration of flow path exists after the well which is represented as lower flow in the center than the borders.

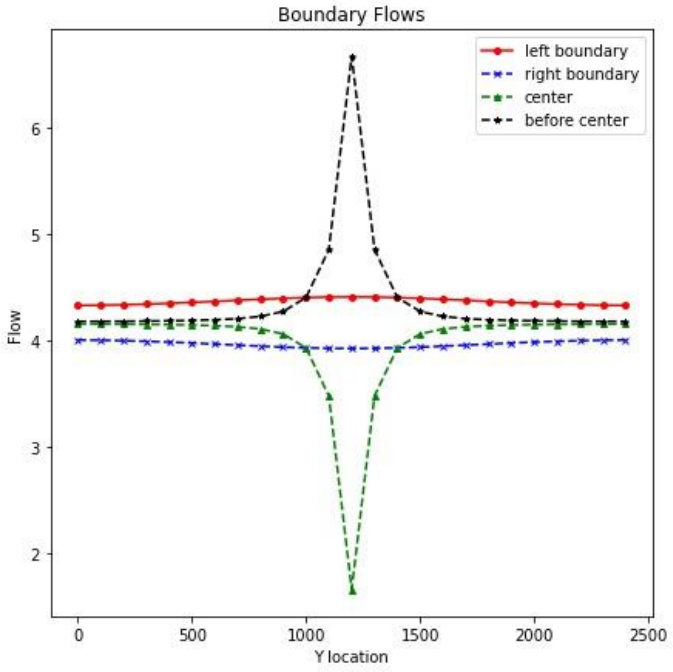

Figure 2. Transect in the boundary conditions and close to the well.

3. Then, look at the plot of equipotentials and flow vectors. Describe how water flows through the domain. To aid in your description, draw a line through all of the flow vectors that terminate in the well. This approximates the capture zone of the well. Use this to refine your description of the flow system, being as specific as possible about where water that ends up being extracted by the well originates on the inflow boundary.

Given that the extraction is not so high, the flow vectors are affected just very close to the well. For that reason, I drew horizontal lines that change the direction only in the cell before the well. Outside of the capture zone, the flow vector changes the direction to fill the vacuum created for the lack of the flow extracted from the well, for that reason we can see a big change in the direction above and under the well.

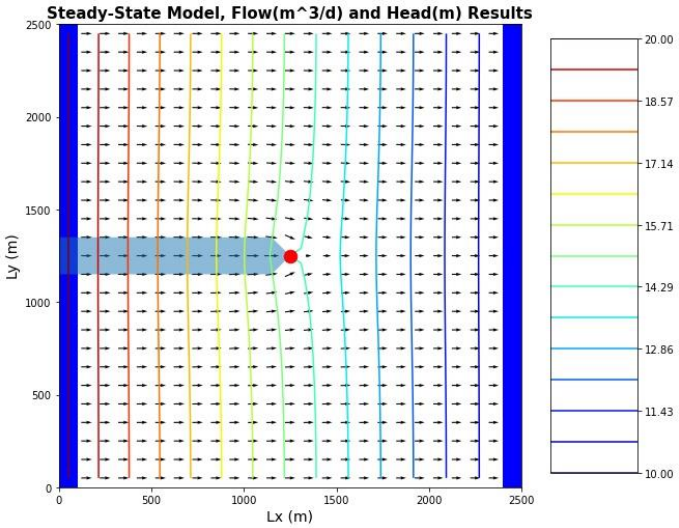

Figure 3. Approximation of the capture zone of the well.

4. Then, look at the plan view drawdown plot. Why aren't the drawdown contours circles? Either explain why this is correct or fix the plot.

The lines in the drawdown are not circles, because the influence of the well is not the same in all the direction. Only in the case that the boundaries are very far away from the well we could see circles. That happens because the upper and lower boundaries are feeling the gradient produced by the well but, they cannot allow flux through the boundary. In response to that, the cells close to the boundary have more influence from the well than in a normal situation which distorts the drawdown lines.

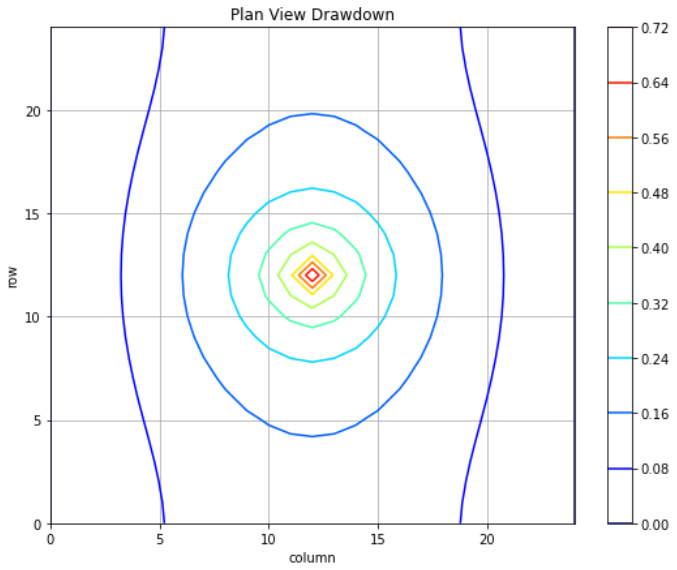

Figure 4. Drawdown for the well.

5. Move the well to [0,5,5]. Use all plots necessary to describe fully how water is flowing through the domain with the well in this location. Be sure to include the drawdown plot in your discussion - compare this plot to the equipotentials and flow vectors. Something is not right about how the well location is shown. Fix it and explain what was wrong!!

Similar to figure 3, the capture zone is mainly the two rows on the left of the well, and only near the extraction, the vectors change the direction toward the well. In the case of the transects in the boundaries (Figure 6), the flow is concentrated in the cells above and immediately under the well showing us that the top boundary concentrates the effect of the well in the top left region. The drawdown lines are not circles because each of the 4 boundaries (Top, bottom, left, and right) are at a different distance of the well. Moreover, each kind of boundary (Type I and II) has a different effect in the drawdown as shown in the top left of figure 7.

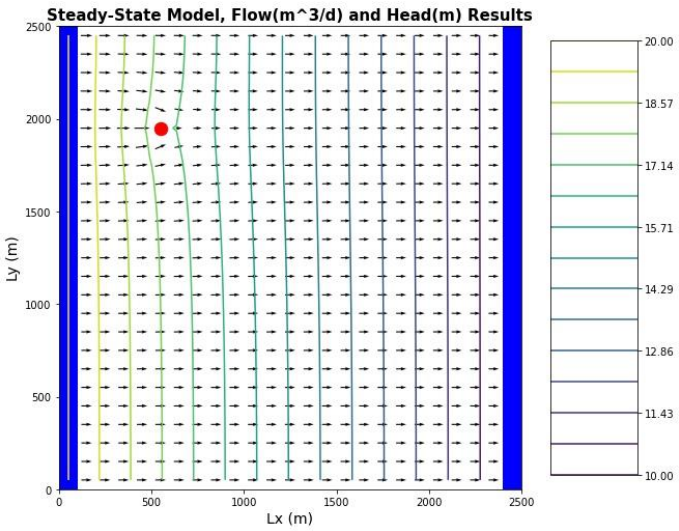

Figure 5. Equipotential and flow vectors for well in the new location.

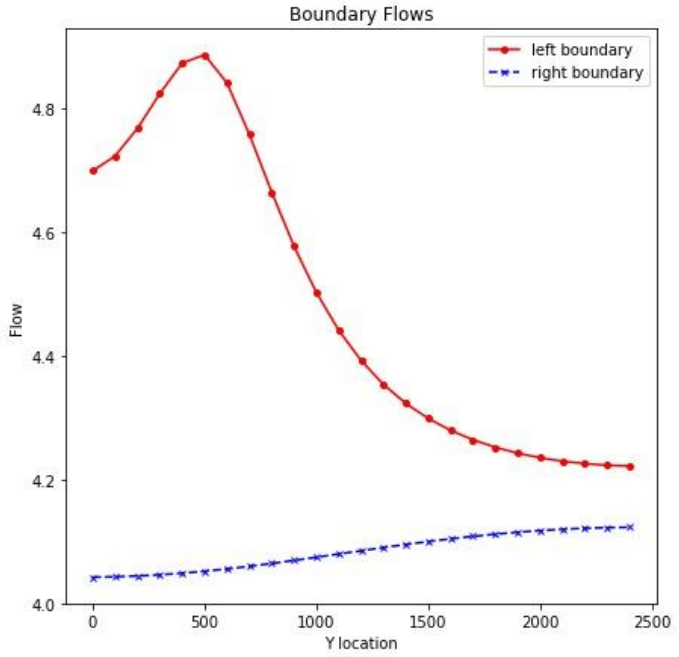

Figure 6. Transect in the boundary conditions for the new well.

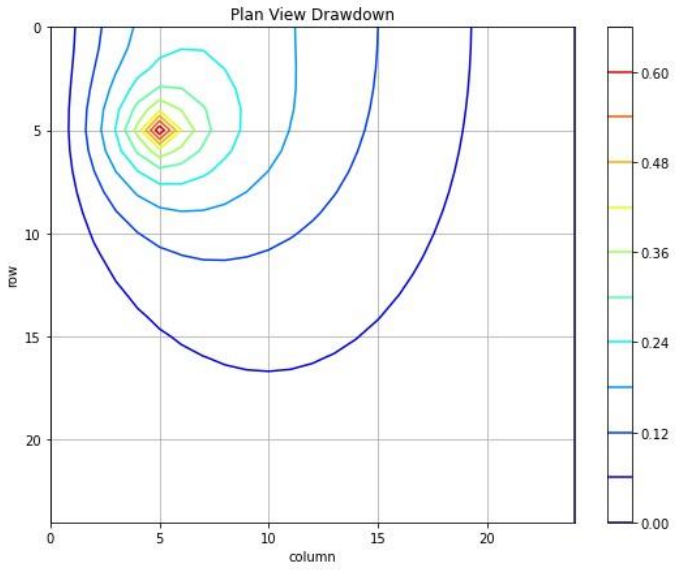

Figure 7. Drawdown for the new well.