GroMore: Scenario One and Two Report

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Domain Setup

First, the domain for the project was set up. The domain has a resolution of 1km x 1km in the x and y direction, a variable dz elevation and three subsurface layers, the top and bottom having the same properties and the middle having a low k region in the right 30 columns of the domain. A river was created which runs through the middle of the model. Recharge, ET zones and wells were also placed in the domain. See figure 1 for the surface with ET zones, figure 2 for the surface with the recharge zone and figure 3 for the bottom layer set up.

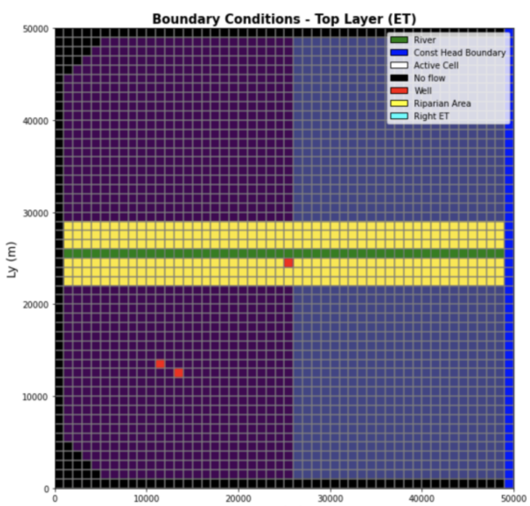


Figure 1

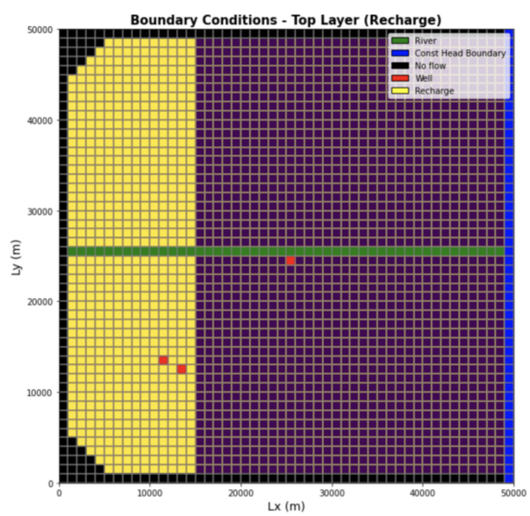


Figure 2

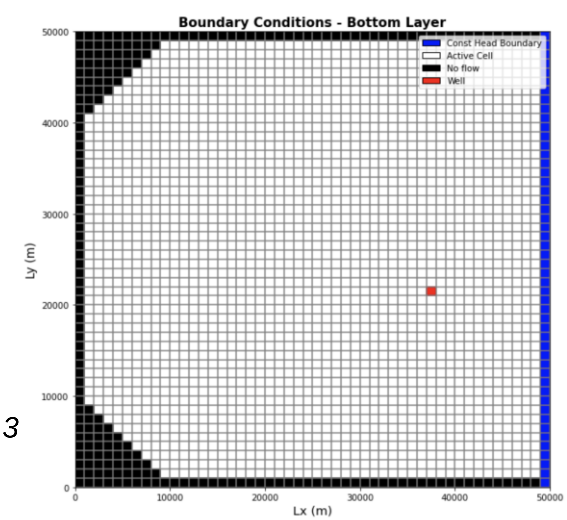
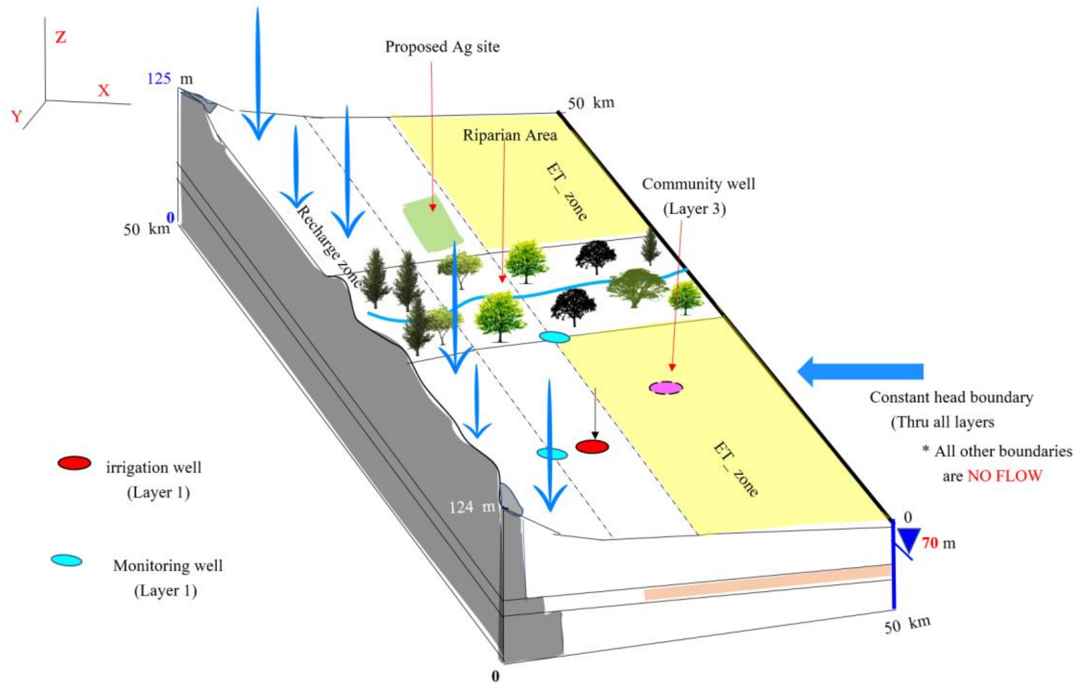


Figure 3

Figure 4 shows a conceptual model of our domain, to help with interpreting results and to get a better feel for our study area.

Figure 4



Scenario 1: Pre-Development Model, No Seasonality

For scenario one, the model was run to show the state of the system in predevelopment, that is with no human impacts and with no seasonality, that is no conditions change depending on the time of year.

The head below the river along row 25 is shown in figure 5. The head decreases as it moves from the no flow boundary towards the 70 m constant head boundary on the right side of the domain. There is a divergence in the head values over the area where the low k middle layer starts. The head is slightly higher in the bottom layer, lower in the top layer, and the middle layer between them. They come back together before hitting the constant head boundary.

Figure 5

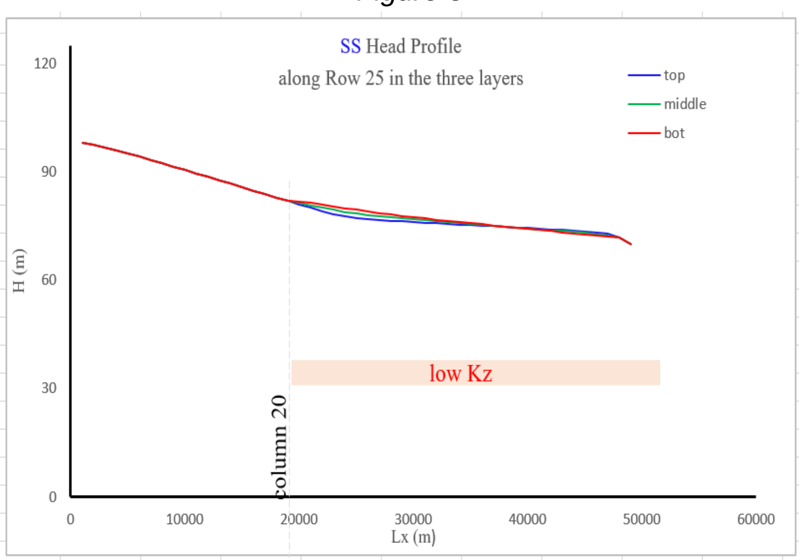
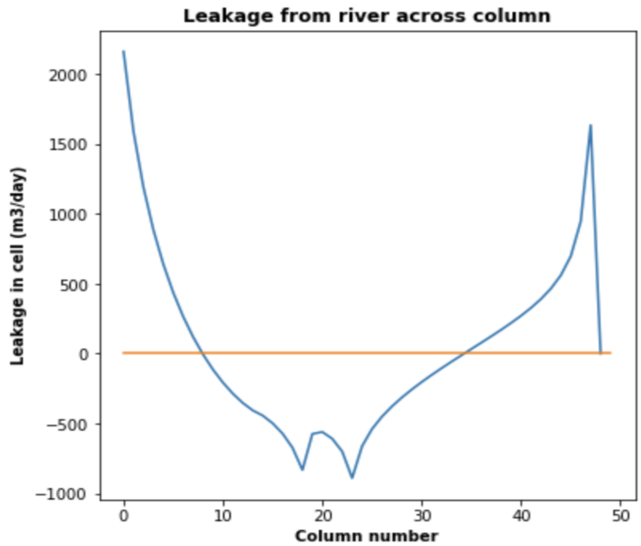
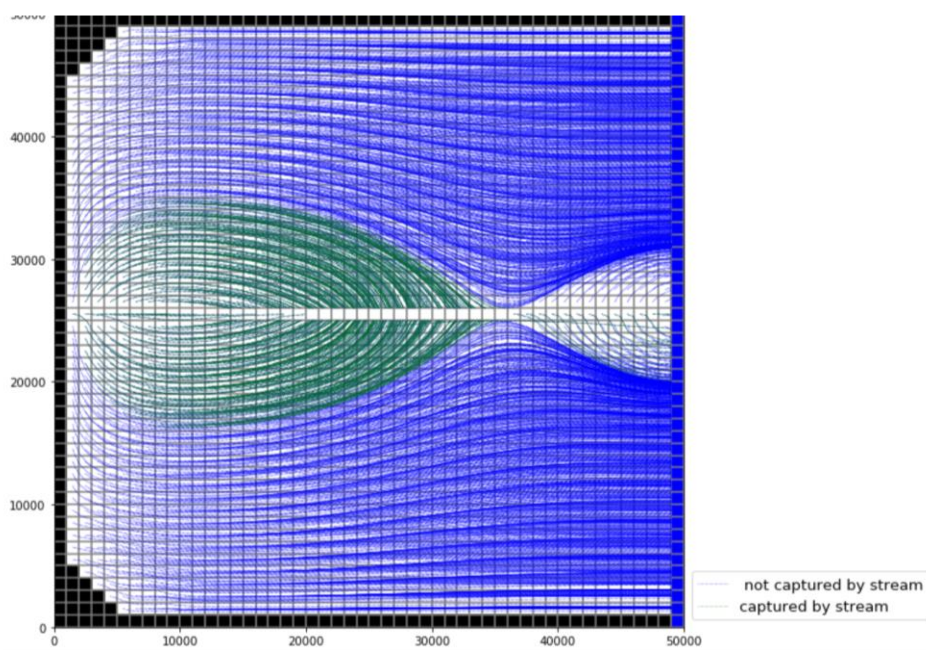


Figure 6



The flux from the stream to groundwater is shown in figure 6. The head in the river starts at 100.5 m and decreases by 1 m every column until column 24, where it's at a value of 77.5 m. From this point on, it drops 0.2 m every column until reaching a value of 75 m in column 49. This is because the river follows the topography. The leakage changes as we move across the domain which makes sense because as the head shifts in the subsurface, and the head of the stream slowly decreases, the head gradient between the stream and the ground beneath it changes. This can change the sign of the leakage (losing or gaining section) as well as the net volume. The total flux is positive, showing it as an overall losing stream. It has a net value of 2360 m^3/day into the subsurface. This is mostly due to the very large positive fluxes at the ends of the stream. This shows that in the middle sections, the head in the river and the subsurface approach each other. As the constant head boundary is approached, as well as ET lowering the head in the right half of the domain, the subsurface heads lowers and the head gradient between the stream and the subsurface diverges again, increasing leakage from the stream into the subsurface.

Figure 7



In figure 7, reverse particle tracking shows from which areas in the subsurface water is captured by the stream. Between columns 9 and about 35, the stream is actually gaining and, in these areas,, water from the subsurface can enter the stream. It pulls mostly from towards the no-flow boundary where heads are higher, and less so on the constant head side where the heads are lower. Looking at the river head in figure 5, there aren't any areas that have a head lower than 60m, so it doesn't make much sense that any particles flow in from that side of the constant head boundary. There must be a few areas along the river that have a higher head than expected from their proximity to the constant head that enables them to flow into the stream.

In steady state, the heads at the monitoring and community wells are as follows: The head at Monitoring Well 1 is 78.39, the head at Monitoring Well 2 is 91.14 and the head at the Aguaseca Community well is 75.92 m. Monitoring well one is located in the center of the domain, right next to the river. Monitoring well two is in the lower left quadrant of the domain, near the no flow boundary where heads are higher. The community well can be seen in the subsurface domain plot, as it is the only well completed in the lower layer. It is located closer to the influence of the 70m constant head boundary.

Scenario 2: Pre-Development Model With Seasonality

For scenario 2, it is still predevelopment, but now seasonality is added in the form of a bimodal ET. ET is zero from October to March, and then increases to 1e-5 m/day in the right half of the domain and 5e-5 in the riparian area, as opposed to being at a constant rate all year as in scenario 1. This causes seasonal fluctuation in the head values across the domain, illustrated by figure 8 and 9 which show the heads over time at monitoring wells one and two with a run time of 25 years. We expect the model to reach a cyclical steady state, where there are annual trends in head values related to the changes in the ET flux, but no interannual trends. That is the head on the last day of the year, September 30th, should be the same as the head on the first day of the year, October 1st. However, the heads never seem to fully level out, the simulation time was extended to 50 (figure 10 and 11), and out to 75 years (figure 12 and 13), and there were still minor increases in head. As these increases level out at around 25 years, we decided to use that as our burn in time in future scenarios, as moving it out further will only minutely increase the stability of the head profiles in the domain and majorly increase our computational demands.

Figure 8

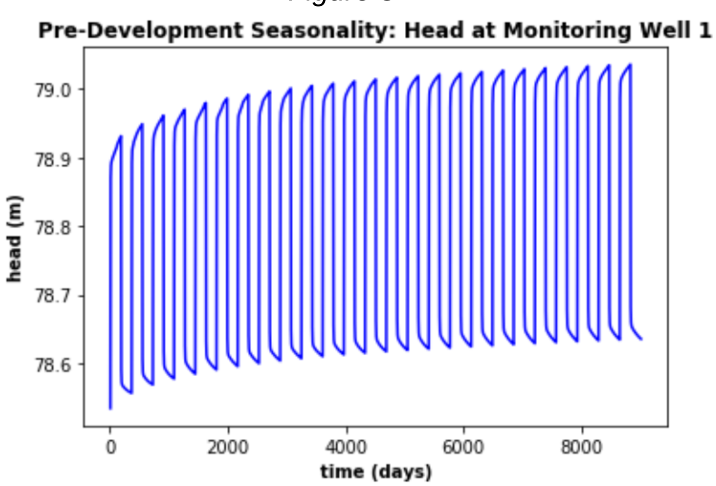


Figure 9

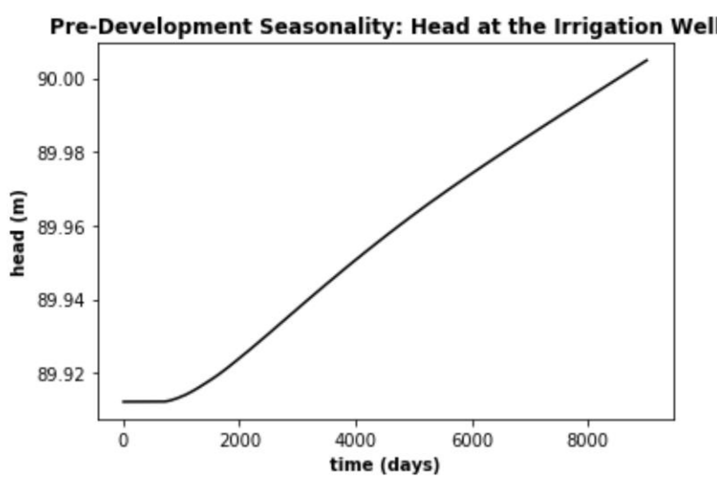


Figure 10

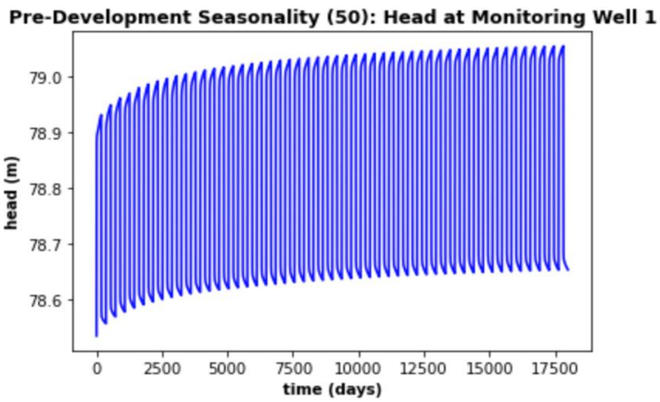


Figure 11

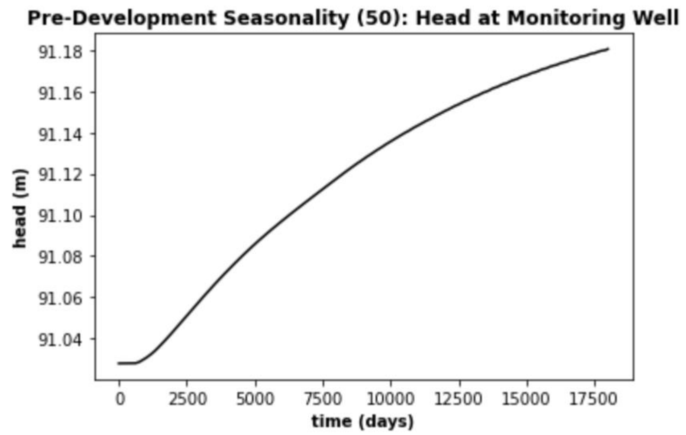


Figure 12

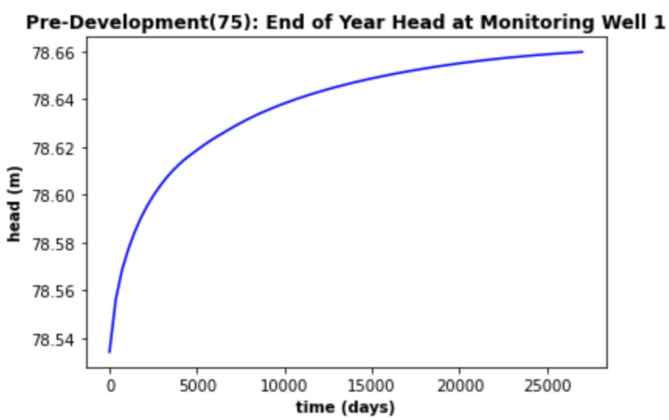


Figure 13