MODFLOW APPLICATION IN THE OJOS NEGROS VALLEY,

BAJA CALIFORNIA, MEXICO

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1. INITIAL INFORMATION

Ojos Negros Data from Report:

IN		OUT		OVERDRAFT
LATERAL FLOW RAIN AND IRRIGATION	11.8 hm^3 6.8 hm^3	PUMPING	25.1 hm^3	6.5 hm^3

Aquifer volume	388 hm^3
Mean aquifer thickness	78.2 m

Considering the amount of water withdraw from the aquifer as being **6.5 hm^3** (the overdraft), the aquifer volume **388 hm^3** and the mean aquifer thickness **80m**, the simulation followed the scheme:

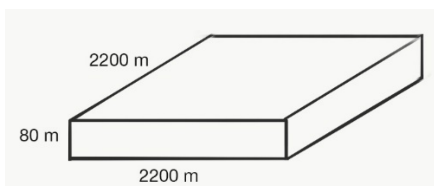

Figure 1: Dimensions of the aquifer

The grid configuration is:

50 cells X 50 cells, 44 m each = 220mm X 2200m.

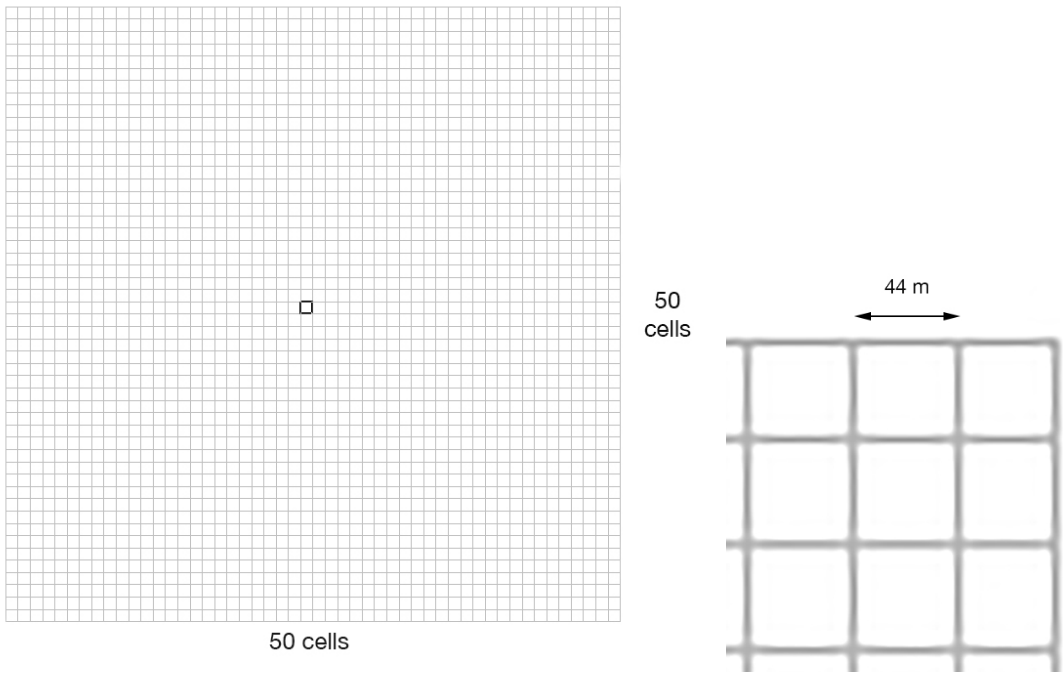

Figure 2: Grid configuration

Figure 3 shows the approximate location of the grid in the area of interest.

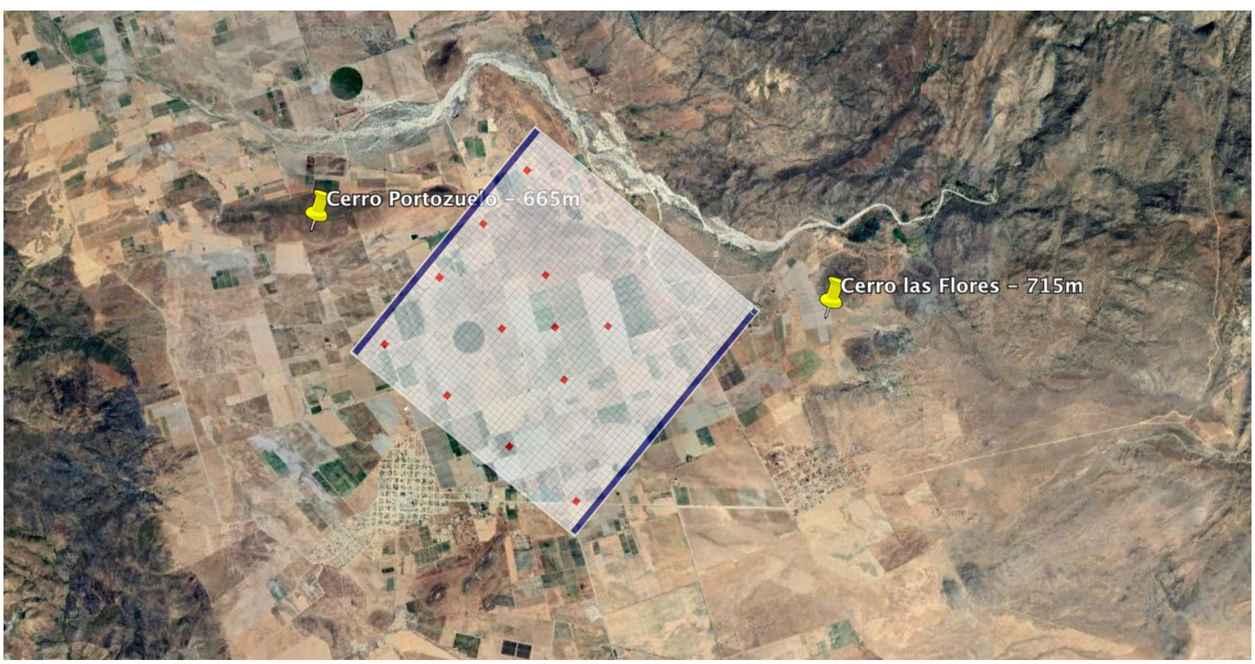

Figure 3: Approximate location of the grid in the actual area

The location of the wells was assumed.

The total discharge (sum of the discharge withdrawn by each one of the 12 wells) was considered to be the overdraft (6.5 hm^3). See Table 1:

$$6.5\ x\ 10^6\ \frac{m^3}{yr} = \frac{6.5\ x\ 10^6}{365\ x\ 24\ x\ 60\ x\ 60}\frac{m^3}{s} = 0.20\ \frac{m^3}{s}$$

Table 1: Discharge withdraw from each well

Well N.	Discharge (m^3/s)
1	0.008
2	0.016
3	0.032
4	0.008
5	0.016
6	0.024
7	0.008
8	0.024
9	0.008
10	0.032
11	0.016
12	0.008
SUM	**0.20**

Figure 4 shows the location of each one of the 12 wells in the grid and Figure 5 gives more details about their location in the actual area.

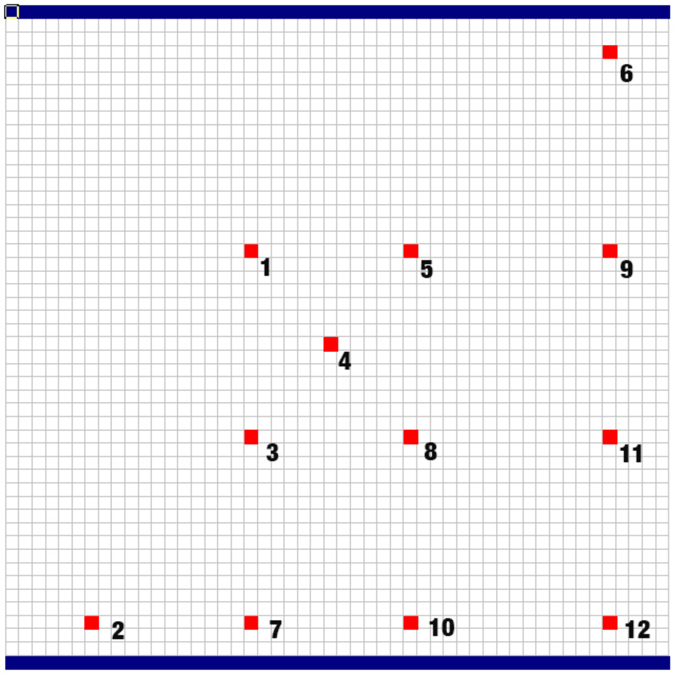

Figure 4: Location of the wells in the grid

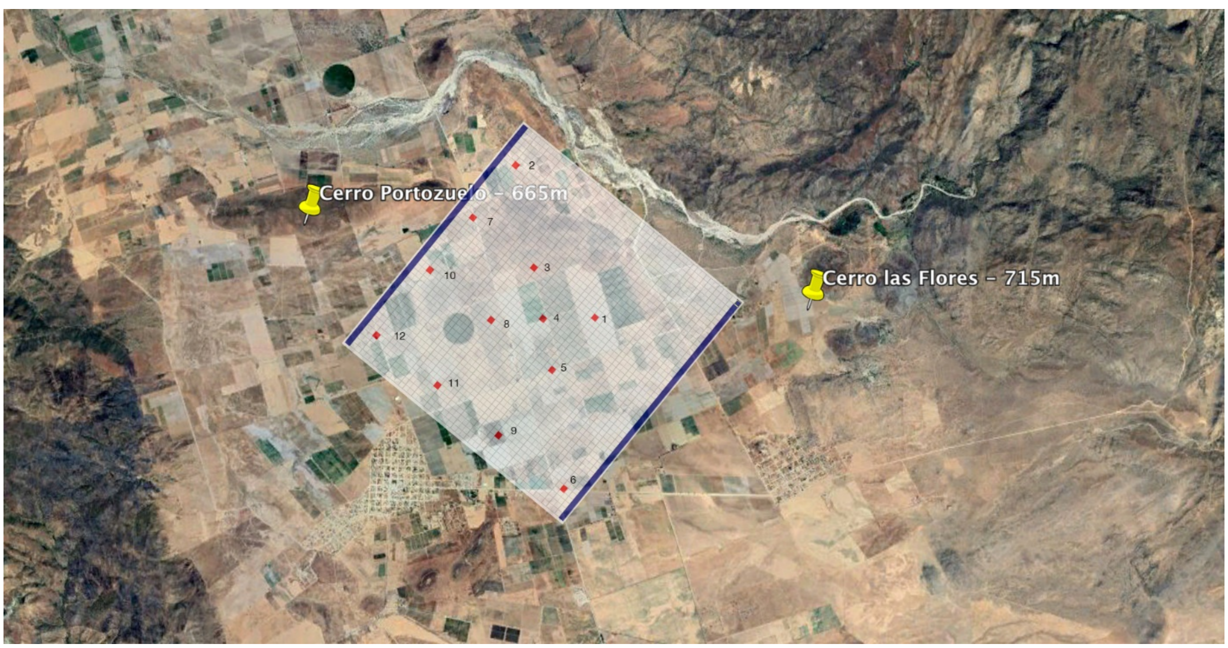

Figure 5: Location of the wells in the actual area

2. MODFLOW

2.1. The first step in the application of ModFlow is to create the grid.

2.2. In the second step we define the time unit and the interval of analysis. In this example: 10 years and 15 years.

In this step we also choose the type of simulation. In this example: Steady flow.

2.3. The third step is to define the hydraulic head. According to data in the report, the water table is approximately 665 in the region close Cerro Portozuelo and 715 close to Cerro Las Flores, what gives a difference of 50 m between the beginning and the end of the grid. Since the aquifer thickness is 80 m, we have:

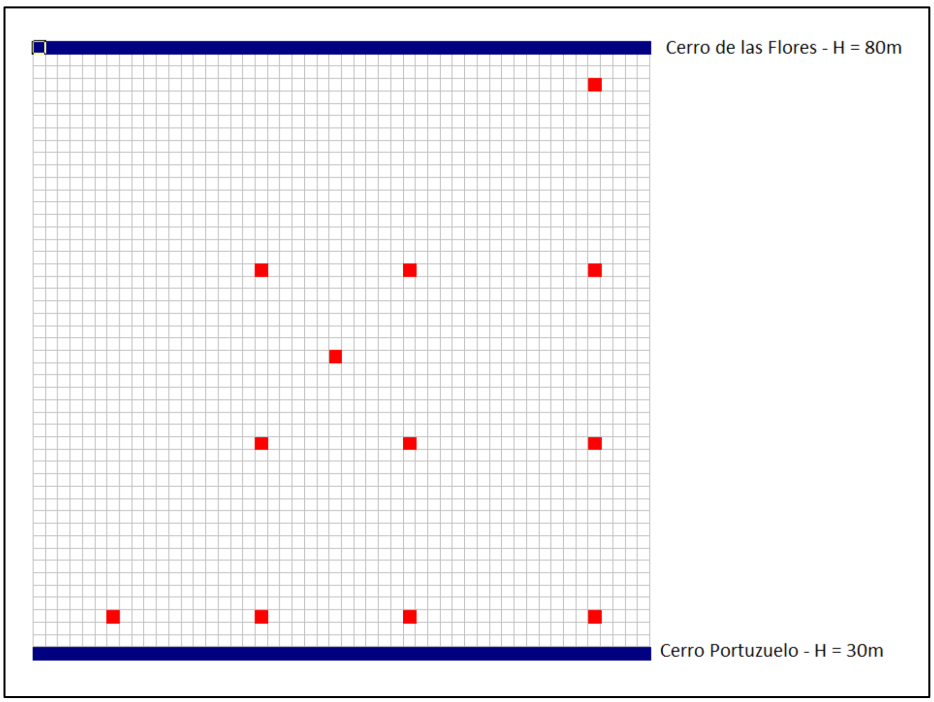

Figure 6: Hydraulic head values

2.4. In the fourth step we define the hydraulic conductivity, which has to be inputted in [L/T] units.

The report gives a value of **0.0091 m^2/s** for transmissivity. With this value and the aquifer thickness we can calculate the hydraulic conductivity in m/s:

$$K = \frac{T\ (transmissivity)}{t\ (thickness)} = \frac{0.0091}{80}\ \frac{\frac{m^2}{s}}{m} = 0.000113\ \frac{m}{s}$$

2.5. The fifth step asks for the effective porosity, which was assumed as 0.25.

2.6. The next step is to input the location and discharge of each well.

2.7. Then, we run the model.

2.8. Figure 7 shows the moment zero of the modeling.

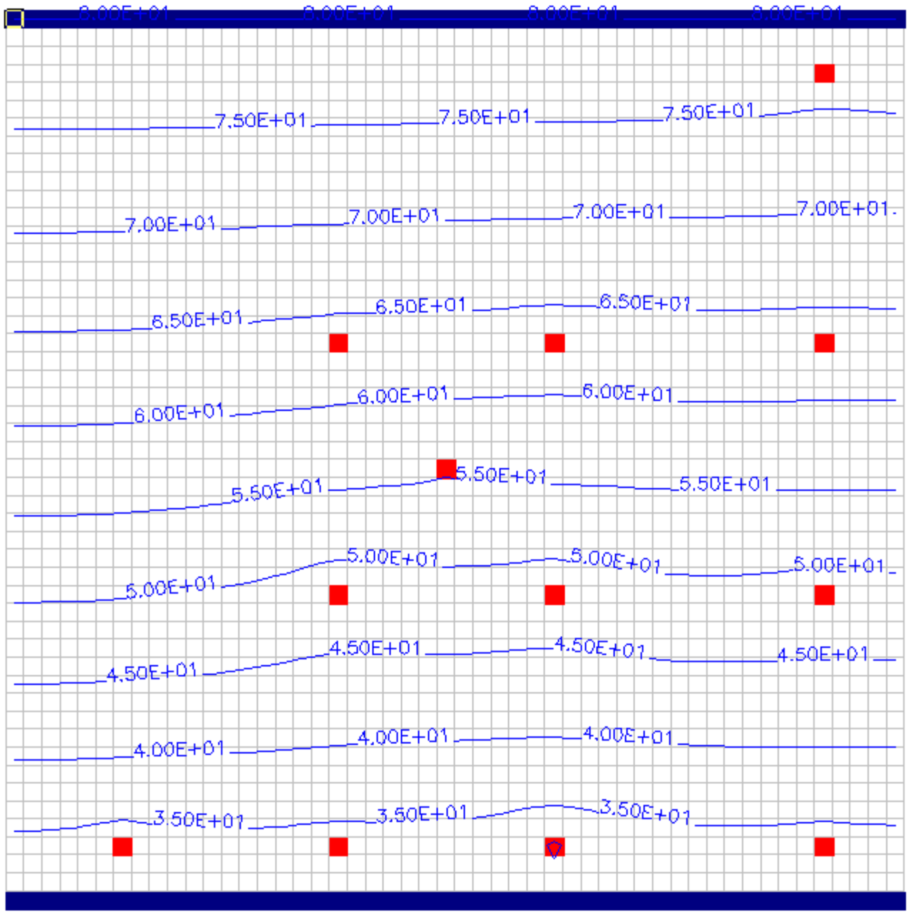

Figure 7: Modeling at time zero

2.9. Figure 8 shows the hydraulic head after 10 years of the currently use of the aquifer.

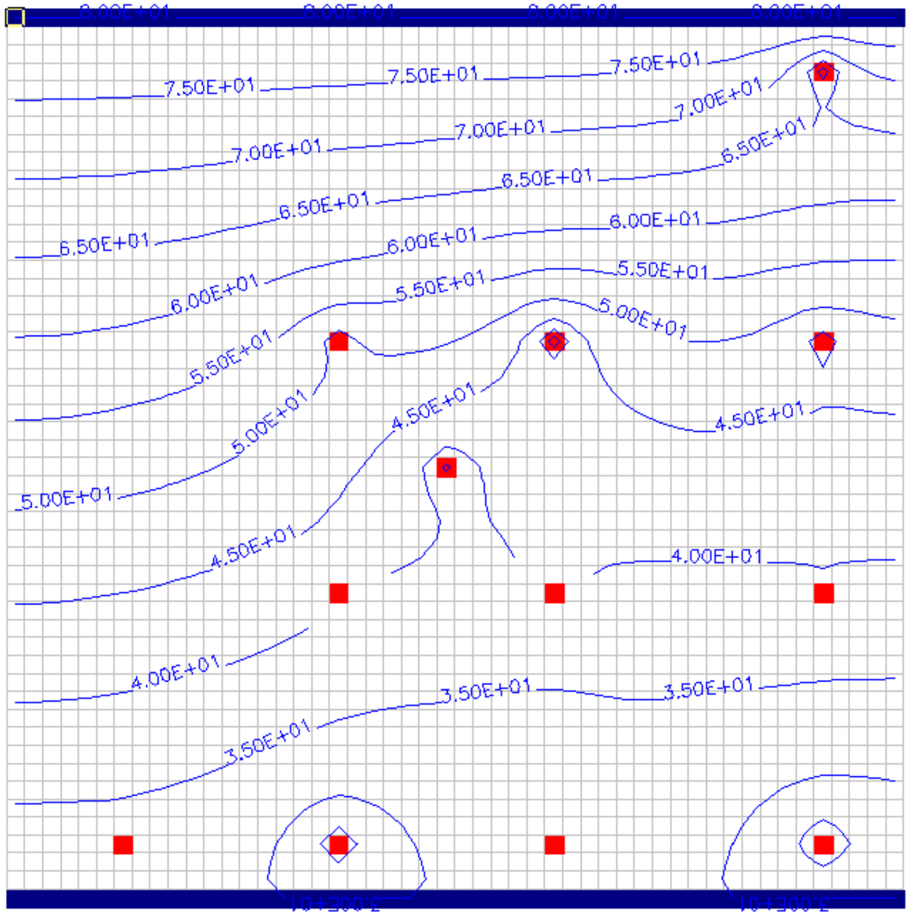

Figure 8: Results for the 10 years modeling

2.10. Figure 9 shows the hydraulic head after 15 years of the currently use of the aquifer.

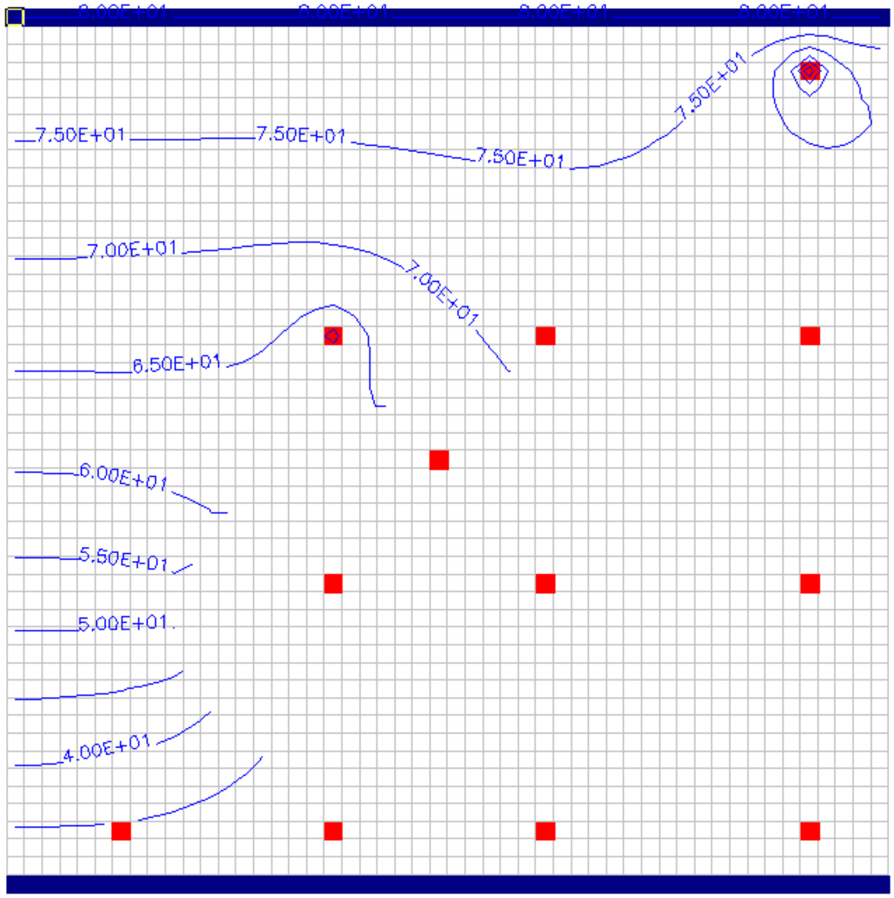

Figure 9: Results for the 15 years modeling

2.11. Figure 10 and 11 show gray spots close to the original location of some of the wells. In these points the hydraulic head hits the bottom of the aquifer (dry wells). Due to this, the simulation was stopped after 15 years, since after this point the model ceases to work properly.

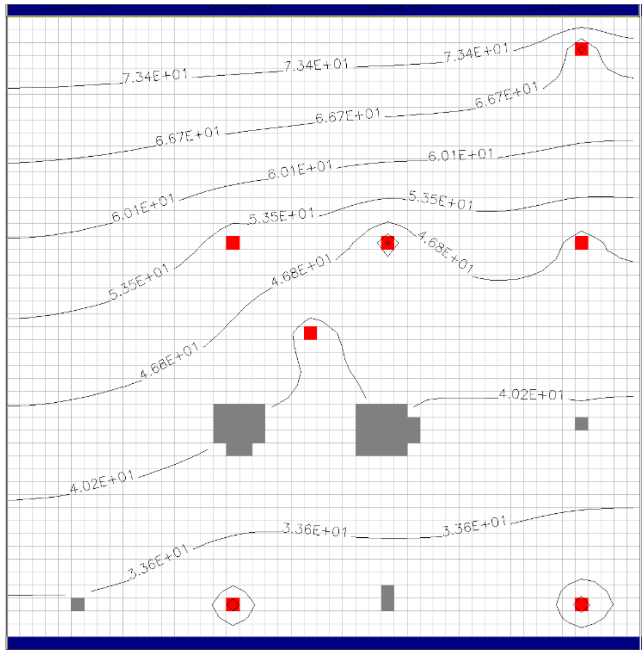

Figure 10: 10 years modeling

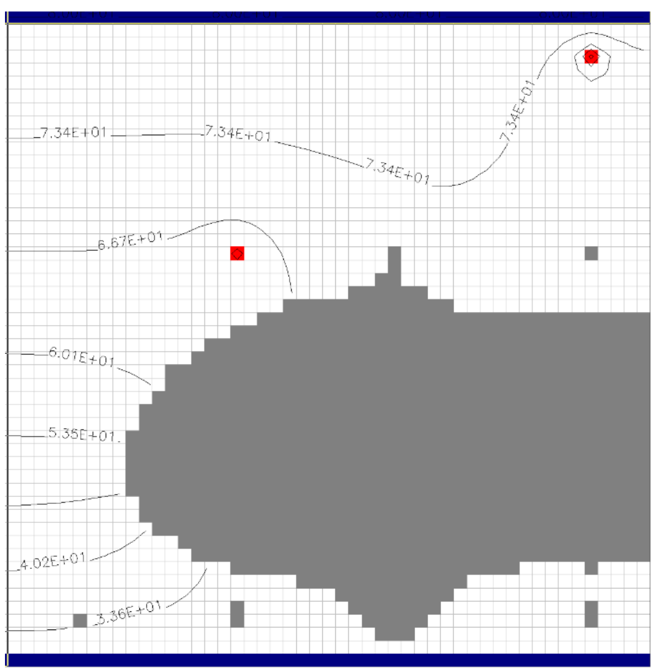

Figure 11: 15 years modeling

3. CONCLUSIONS

The model shows the impact of the use of groundwater in the Ojos Negros Valley. As shown in Figure 11, the groundwater level drops substantially after 10 years of pumping. After 15 years the model shows that almost all wells will have reached the bottom of the aquifer, constituting dry wells (Figure 12).