

# Section 17

## Transient Modeling Simulations

### 17.1 Evaluation of Groundwater Level Recovery

Ranges of sustainable yield were determined using steady state modeling. During a drought, pumping above the upper end of the range of sustainable yield may occur. Groundwater levels during drought periods of increased pumping would be lower than those simulated at the upper end of the range of sustainable yield. A transient simulation was done to determine how lower groundwater levels during a drought would recover when pumping returned to the upper end of the range of sustainable yield.

The calibrated sub-regional transient Claiborne Aquifer groundwater model was modified to evaluate how long it may take for groundwater levels to recover after increased pumping in the aquifer above the upper end of the sustainable yield range. The three prioritized aquifers are confined except in the outcrop areas, and the transient responses to increased pumping should be similar. The sub-regional model for the Claiborne Aquifer was selected for a transient analysis of recovery of groundwater levels. The Claiborne Aquifer was selected because it is not spatially extensive like the Upper Floridan and Cretaceous Aquifers and should therefore represent the most conservative condition for recovery of groundwater levels.

**Figure 17-1** shows the monthly and average pumping rates for an 11 year transient simulation of the Claiborne aquifer. The 11 years included 4 years of pumping at the upper end of the range of sustainable yield (250 mgd), 3 years of increased pumping such as during a drought, followed by 4 years of pumping at the upper end of the range of sustainable yield. The average pumping during the simulated drought was about 32 percent higher than the upper end of the range of sustainable yield (330 mgd), consistent with the agricultural groundwater demands tabulated in Hook (2010). The transient model simulation used the monthly and not the average pumping data.

**Figure 17-2** is a simulated groundwater level hydrograph for USGS monitor well 12L019 in response to the 11 year pumping pattern. The location of this well is presented on **Figure M-2** in Appendix M. Seasonally, groundwater levels at the well declined during the growing season and recovered during the non-growing season. The difference in groundwater levels was about 10 feet between the growing and non-growing season in average rainfall years and about 15 feet in drought years.

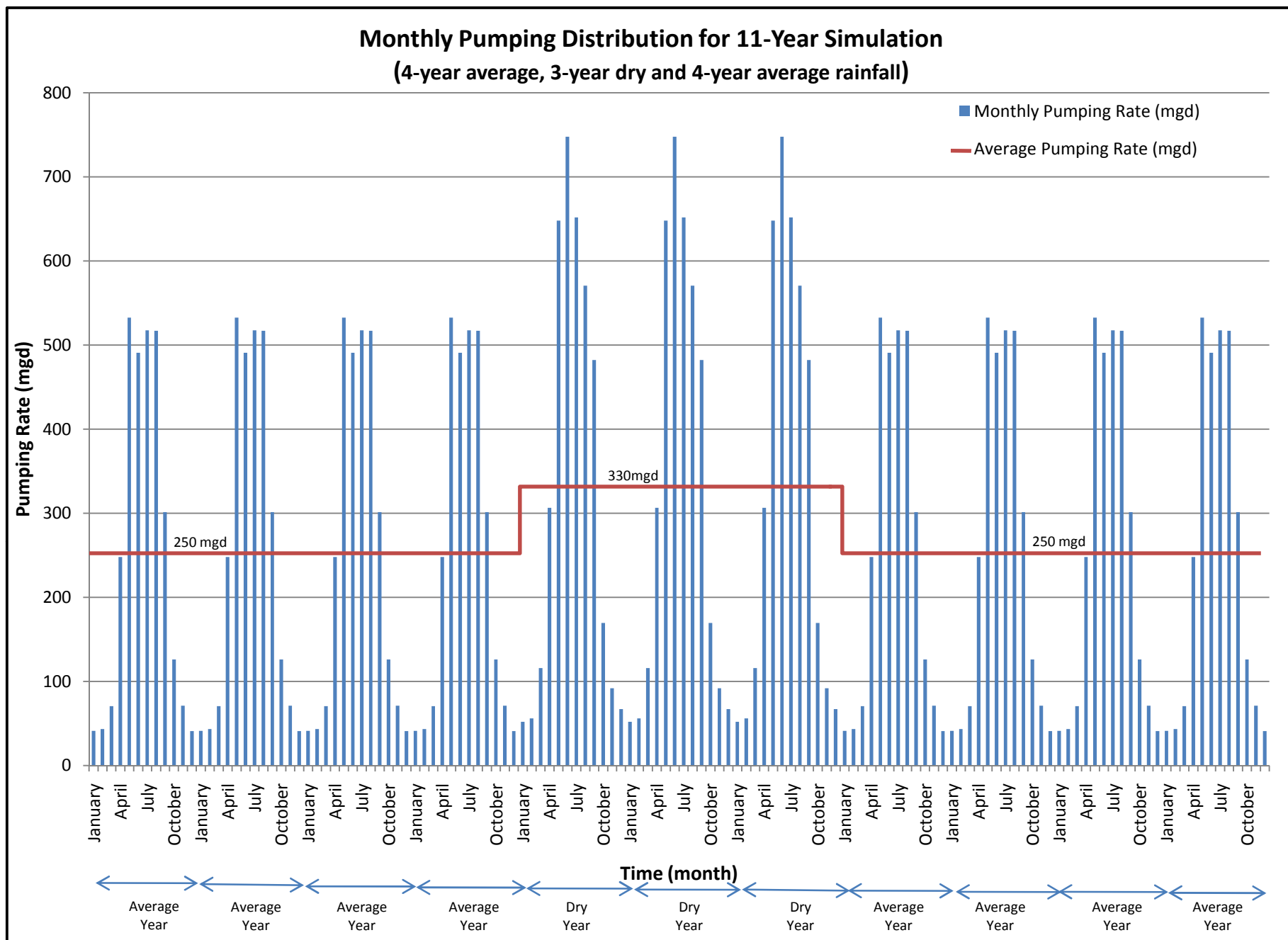
During the simulated three-year drought period, groundwater levels were lower than during the simulated non-drought periods. In the four years of non-drought conditions after the simulated three year drought (years 8 through 11), groundwater levels recovered to nearly 90 percent of their pre-drought levels. The fact that groundwater levels recovered within four years of drought indicated that 250 mgd was not too high for the upper end of the range of sustainable yield of the Claiborne Aquifer.

## 17.2 Changing Sources of Water to Pumping Wells

The source of water to pumping wells is initially groundwater stored in the aquifer. Over time, the contribution from aquifer storage is reduced until a new equilibrium is reached. At equilibrium, sources of water are surface recharge, leakage from overlying / underlying aquifers, horizontal flow from portions of the aquifer at distance from pumping wells, and from groundwater contributions to stream baseflow. Groundwater contributions from stream baseflow may likely be a major source of water at this new equilibrium. Ranges of sustainable yield were modeled using steady state models that represented the final distribution of sources at equilibrium.

A forty year transient simulation was done to illustrate how contributions changed from groundwater storage to other sources of water in response to increased pumping. **Figure 17-3** shows the decrease in contributions from groundwater storage over the forty year transient simulation. Contributions from other sources of water would increase as contributions from groundwater storage decrease. The transient simulation represented the reduction in groundwater storage due to an immediate increase in baseline pumping (67 mgd) to the upper end of the range of sustainable yield (250 mgd).

Contributions from aquifer storage were reduced to about 10 percent of the initial contribution of 100 percent by year 40 of the simulation. Most of the reduction of contribution from aquifer storage occurred in the first 5 years of the simulation. By year 40 of the simulation, 93 percent of the water was supplied from sources other than groundwater storage. The transient simulation demonstrated that it may take a long time for other sources of water to reach their equilibrium contributions, including groundwater contributions to stream baseflow. When recharge from groundwater contribution to stream baseflow reaches equilibrium, it will not exceed the 40 percent of baseflow reduction criterion.



**Figure 17-1**

**Monthly Pumping Distribution for 11-Year Simulation**

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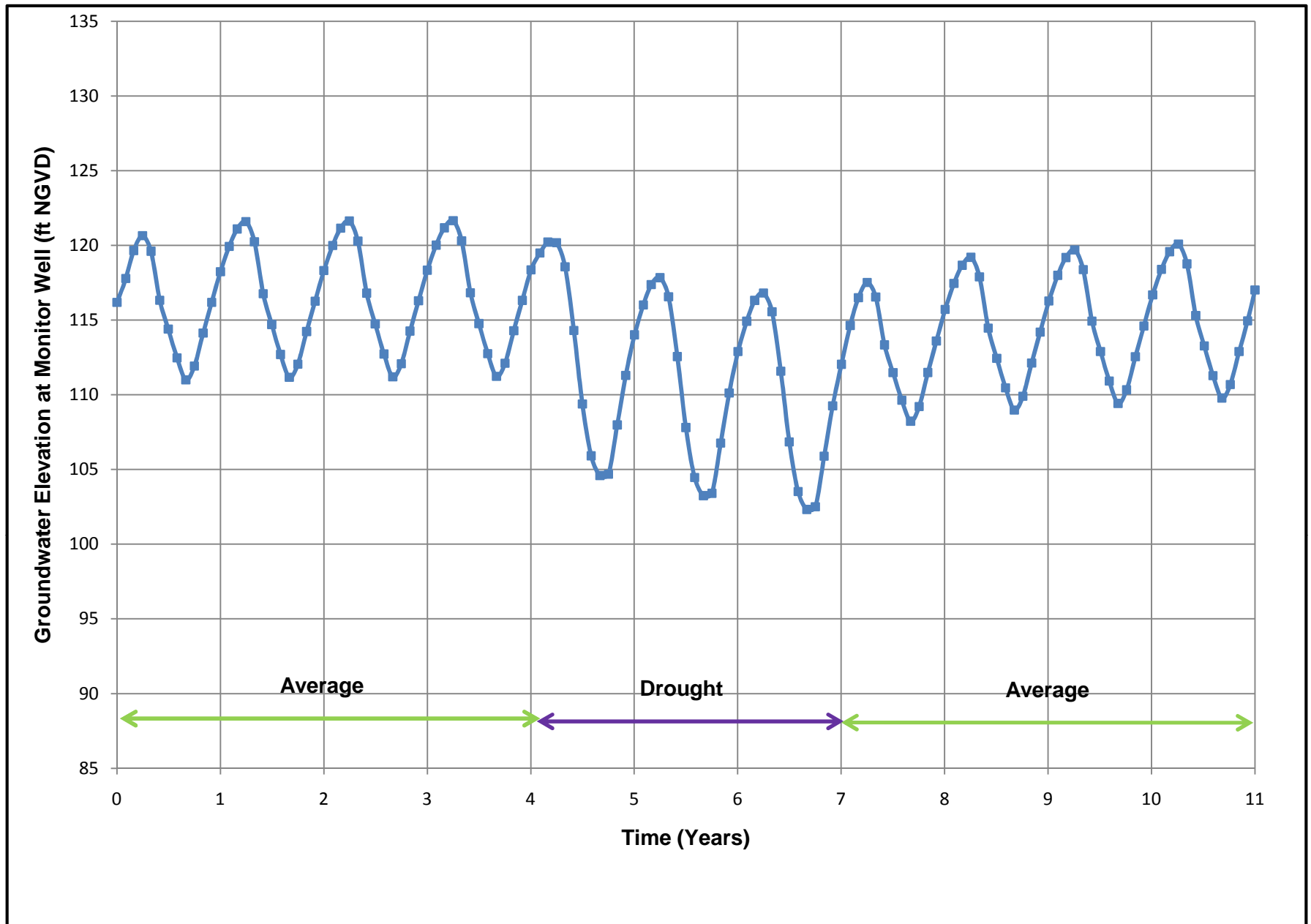
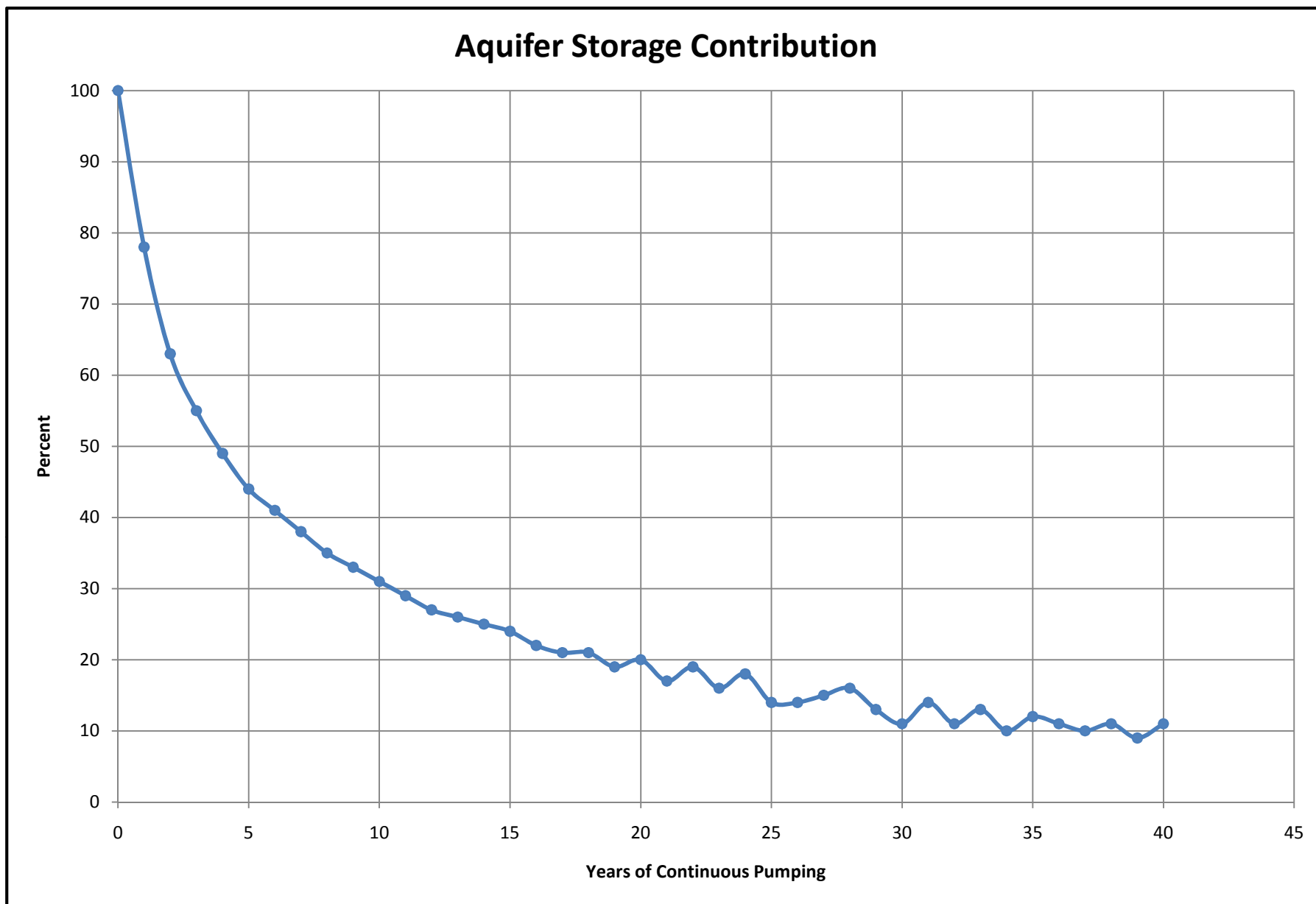


Figure 17-2  
Simulated Groundwater Levels at Monitor Well 12L019  
in the Claiborne Aquifer (Layer 3)



**Figure 17-3**  
**Contribution of Aquifer Storage to Increased**  
**Pumping in Claiborne Aquifer**