Antelope Valley Groundwater Cases

Phase 3: Status of Aquifer and Issue of Overdraft

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EXHIBIT B

The third phase of the trial in the Antelope Valley Groundwater Cases addresses the state of the aquifer within the previously defined Antelope Valley Area of Adjudication (Phase 1 and Phase 2 of the trial). Addressing the state of the aquifer includes quantifying total pumping and total recharge as well as the volume of imported water on an annual basis. It also includes determining the sustainable yield of the aquifer and whether the groundwater basin is in overdraft, with extraction exceeding recharge so that the basin will suffer serious degradation. I have not performed my own detailed analysis of the status of the aquifer but I have reviewed the *Summary Expert Report* (and accompanying appendices) of Beeby *et al.* (2010) and am in agreement with the methodologies used and conclusions reached in that report. Those methodologies are scientifically sound and appropriate to be used in the determination of the sustainable groundwater yield and the evaluation of a condition of overdraft. The methods and data utilized provide estimates of sustainable groundwater yield and an evaluation of overdraft with a reasonable degree of scientific certainty.

Natural Recharge

The *Summary Expert Report* uses multiple independent methods, relying on distinct data sets, to evaluate the natural recharge to the groundwater basin. Based on my peer review of the report, the data sets utilized are appropriate, with many of them coming from the U.S. Geological Survey, Western Regional Climate Center, or the State of California Department of Water Resources. I am familiar with and have used these and similar data sets in my own scientific work. These data sets are reliable and are widely accepted for use in water resource studies. The analyses performed in the report are rigorous and utilize generally-accepted methodologies, many of which I have used in my own scientific investigations. They provide the best available estimate of natural recharge with a reasonable degree of scientific certainty.

The three most reliable methods utilized in the report are described below.

- A mountain-front, water-balance approach (Appendix C.3.1) included an estimation of precipitation, evapotranspiration, and playa flooding for the time period 1949 to 2005. The resulting estimate of average natural recharge was about 55,000 acre-feet per year (afy).
- A precipitation-yield method (Appendix C.3.3) estimated surface runoff and groundwater inflow from the mountains for the time period 1949 to 2005. The resulting estimate of average natural recharge was about 56,000 afy.
- A groundwater-basin, water-balance approach (Appendix E.3, relying on inputs from Appendix D) included estimations of pumpage, return flows, and change in groundwater storage for the time period 1951 to 2005. The resulting estimate of natural recharge was about 58,000 afy.

The three reliable methods described above provide essentially the same value of about 57,000 afy for natural recharge. That independent methods relying on distinct data sets give such similar estimates for natural recharge increases my confidence in the reliability of the results.

A fourth method estimated natural recharge using a chloride-mass approach (Appendix C.3.2) to be 29,000 afy, a value that appears too low and probably reflects the large uncertainties in the inputs to the chloride methodology.

For comparison, I reviewed earlier estimates of natural recharge developed by the U.S. Geological Survey. Bloyd (1967) estimated a natural recharge of 58,000 afy for an area that included regions outside of the area of adjudication. When that estimate was modified (Leighton and Phillips, 2003) to reflect a smaller area similar to the adjudicated area, the estimate of natural recharge was very similar to the estimate of Durbin (1978) of 40,700 afy. In their groundwater model simulation of a region similar, if not exactly identical, to the adjudicated area, Leighton and Phillips (2003) began with Durbin's estimate of natural recharge but in the course of model calibration reduced that recharge to 30,300 afy. These three estimates from the U.S. Geological Survey predate the current combined groundwater cases and are all lower than the estimates arrived at in the *Summary Expert Report*. While this might argue that the 57,000 afy in the latter report is an overestimate, it is my opinion that Bloyd and Durbin may have underestimated the contribution of groundwater discharge from the mountain range front. In the case of Leighton and Philips' even lower estimate for natural recharge, I would not rely heavily on a value obtained from a numerical model calibration as there are generally multiple solutions to achieving a calibrated model. In my opinion, the additional data presently available and the rigorous evaluation of those data in the *Summary Expert Report* make the estimate of natural recharge in that report more accurate and reliable.

Sustainable Groundwater Yield

The sustainable groundwater yield is determined in the *Summary Expert Report* (Sec. 4.4) several ways. The native sustainable yield is the amount of water that can be pumped from the basin based on a combination of natural recharge and return flows of pumped groundwater. As land use practices change (for instance, a shift from agricultural to urban land use), the amount of return flows will vary. The second sustainable groundwater yield that was calculated was the supplemental sustainable yield which quantifies return flows from imported water. The total sustainable yield is the sum of the supplemental sustainable yield plus the native sustainable yield.

The report calculated first the native yield that would result from a rounded natural recharge rate (60,000 afy) and return flows from groundwater pumpage that would additionally contribute to recharge. That native sustainable yield ranges from 80,000 to 82,300 afy depending on variations in land use. The approach used is appropriate, and the resulting estimates are reasonable. A supplemental sustainable yield was also calculated which represents return flows from imported surface water. That supplemental sustainable yield will vary with time as the quantity of imported water utilized changes and the land use practices change. For current conditions, the report estimates the total sustainable yield, including the native sustainable yield and the supplemental sustainable yield, to be about 110,000 afy. Again, the methodology is appropriate, and the resulting estimate reasonable.

I performed a rough, independent check on the total sustainable yield value during the period of 1985 to 1991 when there was no significant change in the amount of groundwater in storage in the basin according to determinations in the *Summary Expert Report*. Groundwater pumping during that period ranged from 88,000 afy to 146,000 afy and averaged 115,000 afy based upon pumping rates reported in the *Summary Expert Report*. This average pumping rate for a period when the amount of groundwater in storage was stable (1985 to 1991) is very comparable to the estimated sustainable yield under current conditions.

Sensitivity Analysis

The *Summary Expert Report* performed a sensitivity analysis on several critical parameters in the groundwater-basin, water-balance approach. The sensitivity analysis was carried out correctly, and the resulting conclusions, as reiterated below, are reasonable.

- Increasing the agricultural pumpage for alfalfa by 15% to 7.5 ac-ft/ac/yr would produce a 2,100 afy increase in the water budget calculation of natural recharge, raising that estimate to a value similar to the rounded estimate of 60,000 afy.
- Decreasing the agricultural return flows by 15% would result in an increase of 11,000 afy in natural recharge but only a 6,000 afy increase in native sustainable yield.
- Considering all the residential areas to be sewered, rather than a mixture of sewered and non-sewered, would increase the estimate of natural recharge by 6,000 afy, but still put it within the range of the rounded value of 60,000 afy.

The results of the sensitivity analysis show that the water budget is moderately sensitive to changes in the parameters tested. The changes in total sustainable yield produced by varying those parameters as described above are 10% or less of the 110,000 afy calculated, and so do not change the results of the analysis significantly.

Overdraft

The *Summary Expert Report* concludes that the pumping of groundwater has exceeded the sustainable groundwater yield of the basin for prolonged periods of time, including in recent years. I agree with the conclusion in the report that the pumping has exceeded the sustainable groundwater yield by more than 40,000 afy over the last decade. In my opinion, the methods used in the report to evaluate the overdraft and the change in storage of groundwater in the aquifer are reasonable and appropriate. The methods provide an estimate of the change in storage (including the loss in storage observed over the last decade) with a reasonable degree of scientific certainty. The overdraft demonstrates that the current rate of pumping is unsustainable and, if water levels continue to decline as they have over the last decade in many areas, significant land subsidence could be re-initiated and additional negative consequences to the basin be produced.

References

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