7-20-2004

Induced Infiltration of Water from the Rio Grande Alluvium to the Hueco Bolson Aquifer: an Isotopic and Numerical Analysis

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This is the abstract of a presentation given on Tuesday, 20 July 2004, in session 3 of the UCOWR conference.

Induced Infiltration of Water From the Rio Grande Alluvium to the Hueco Bolson Aquifer: an Isotopic and Numerical Analysis

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Predevelopment groundwater flow (pre-1900's) in the Hueco Bolson aquifer was south from the northern edge of the bolson toward the international border with Mexico. Groundwater moved toward the Rio Grande alluvial valley, where it discharged to the overlying Rio Grande alluvium by cross-formational flow. In the late 1800's, drillers found that the Hueco Bolson was a very prolific aquifer that provided good quality water. Since then pumping has increased in both the United States and Mexico and has created two large cones of depression beneath El Paso and Juárez. Groundwater now flows along the axis of the basin toward the Rio Grande, except where pumping beneath the twin cities has reversed the natural hydraulic gradient. Pumping has created an artificial groundwater divide just north of the Rio Grande. Drawdowns in the Hueco Bolson aquifer are up to 150 ft (45.7 m) since predevelopment. Municipal wellfields have created focal points of drawdown.

Historical groundwater withdrawals from Juárez and from municipal and military wellfields in the El Paso area have increased from 40,000 acre-ft/year (49.3 cu hm/yr) in the early 1950's to approximately 190,000 acre-ft/year (283.6 cu hm/yr) in 2000. Natural recharge along mountain fronts is only an estimated 6,000 to 15,000 acre-ft/year (7.4 to 18.5 cu hm/yr). However, reversal of the hydraulic gradient because of heavy pumping in the Hueco Bolson has created a significant source of recharge from the Rio Grande and Rio Grande aquifer. The Rio Grande aquifer is recharged along unlined reaches of the Rio Grande. The Hueco Bolson

aquifer, in turn, is recharged by cross-formational leakage from the Rio Grande. Model results presented in this study indicate the quantify of this induced leakage to the Hueco Bolson may exceed 50,000 acre-ft/year (49.3 cu hm/yr).

Cross-formational flows between the Rio Grande, Rio Grande aquifer, and Hueco Bolson aquifer are indicated by isotopic and hydraulic head data collected at multi-level well nests in the El Paso/Juárez Valley. The Rio Grande is unlined at these locations. Wells screened above 200 ft (61 m) are installed in the Rio Grande aquifer and wells screened below 200 ft (61 m) are installed in the Hueco Bolson aquifer. The hydraulic head gradient is oriented vertically downward. Mixing between Rio Grande water, Rio Grande aquifer water, and Hueco Bolson aquifer water is indicated by stable isotope data. Wells at intermediate depths show stable isotope signatures that are intermediate between heavy, evaporated water from the shallowest well in the Rio Grande aquifer and isotopically lighter, meteoric water at the deepest wells. Tritium is highest in intermediate wells between 181 and 358 ft (55 and 109 m), indicating residual “bomb” tritium, probably recharged between 1960 and 1985. All data indicate downward vertical flow and recharge to the bolson aquifer, supporting model simulations that indicate significant cross-formational leakage between the Rio Grande alluvium and the underlying Hueco Bolson aquifer.