Quantifying Aquifer Recharge from an Unlined Drainage Ditch Receiving Treated Water

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Background/Objectives. Hydraulic containment remedies must be designed to account for natural and anthropogenic variations, or adjusted as these variations occur, to ensure remedy effectiveness. We report a case study addressing varying site conditions related to a changed flow regime in an alluvial aquifer. The study site is a petroleum storage and distribution terminal located in a semiarid region in southern California, USA. Four hydrostratigraphic units are present, including a localized perched aquifer, regional unconfined and confined aquifers and an aquitard separating the two aquifers. Both light non-aqueous phase liquid (LNAPL) and dissolved hydrocarbon compounds have been found in the perched aquifer and the uppermost 40 feet of the unconfined aquifer. A hydraulic containment system has been operated since 2010 with the treated water discharged into a nearby unlined channel. Recent sampling results indicate the development of water table mounding in the unconfined aquifer that may influence the performance of the remedy. If so, relocating the discharge point may be necessary.

Approach/Activities. The study employs a deconvolution process. Time-series of water level changes between two consecutive sampling events were generated for the monitoring wells and analyzed. Inputs to the water level changes included regional water table fluctuation relating to precipitation, groundwater extraction, and recharge through the drainage bottom. Multiple regression analyses were performed to estimate contributions from regional fluctuation, and aquifer testing analysis was conducted to estimate contributions from groundwater extraction. Any unexplained changes in water levels were attributed to contributions from infiltration of treated water. The resulting time-series of mounding was then used to estimate recharge rates using the Hantush (1967) analytical solution for a groundwater mound under a rectangular recharge area.

Results/Lessons Learned. The analyses were conducted on water level data collected between 2011 and 2013, when the remedy was operated at rates ranging from 188 to 211 gallons per minute. Cumulative water table mounding of approximately 2 feet over 2 years was estimated from the observed water level changes, excluding contributions from regional water level fluctuation and groundwater extraction. A recharge rate of approximately 100 gallons per minute from the unlined channel was calculated from the estimated mounding. Numerical modeling incorporating the estimated recharge rate showed that the mound has minimal impact on the performance of the containment system and that modification of the current system is not needed, saving the client approximately $400K.