Assessment of Irrigation-Influenced Groundwater Flow and Transport Pathways Along a Stream Reach

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Abstract. Stream water quality continues to grow as a concern throughout the world, with over half of rivers in the United States now classified as 'poor' by the U.S. Environmental Protection Agency. Irrigated agriculture is a leading contributor to this problem due to the large amounts of nutrients, salts, trace elements, and other pollutants that drain into waterways. The Arkansas River Valley in Colorado contains large-scale agricultural activity involving intensive fertilization and irrigation practices as well as underlying geology composed of salts, selenium, and uranium, resulting in regionally poor water quality and the violation of regulatory standards. Additionally, recent studies have concluded that stream reaches are not simply gaining or losing to groundwater but are best described as a mosaic of exchanges that contrast between flow paths of varying lengths which inherently influence solute residence times. These residence times directly affect chemical speciation as solutes such as NO_3, SeO_4, and U(VI) have the opportunity to undergo microbial dissimilatory reduction in the shallow riparian zone and the deeper sub-surface. To improve water quality and the overall health of these natural systems requires engineering intervention supported by reliable data and calibrated models. A three-dimensional numerical flow model (MODFLOW-UZF2) is used to simulate groundwater flow for a 5-km reach of the Arkansas River near Rocky Ford, Colorado. The reach-scale model provides increased discretization of previous regional-scale models developed for the Arkansas River Basin, using 50 x 50 m grid cells and dividing the Quaternary alluvium that represents the unconfined aquifer into 6 layers. This discretization facilitates an enhanced view of groundwater pathways near the river which is essential for future solute transport evaluation and best management practice implementation. Model calibration is achieved using ensemble Kalman filtering with observed hydraulic head, streamflow, and groundwater return flow data. Results will be used to aid decision makers in the implementation of best management practices and to further understand contaminant sources.