CONTAMINANT TRANSPORT IN HIGH-CAPACITY PUMPING SETTING WITH A VERTICAL GROUNDWATER FLOW COMPONENT: FIELD TRACER EXPERIMENTS AND NUMERICAL MODELING

by

Vikas Tandon

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DISSERTATION TITLE

Contaminant Transport In High-Capacity Pumping Setting With A Vertical Groundwater Flow Component: Field Tracer Experiments And Numerical Modeling

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Vikas Tandon, Ph.D.

University of Nebraska, 2000

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This study investigates the extent and impact of vertical flow on solute transport in groundwater at the Nebraska MSEA site. Three tracer tests, designed with a geometrical configuration suitable for the detection of vertical flow, were conducted. As the tracer plume moved towards the extraction wells, it bifurcated into two plumes, with the deeper plume travelling at a velocity two to four times higher than the shallow plume. The deeper plume exhibited a vertical displacement of 4 m over a horizontal distance of 13 m.

Multilevel slug tests, grain size analyses, and pumping tests were performed to produce a three-dimensional hydraulic conductivity data base. Preferential pathways for contaminant movement were identified. A low conductivity zone was observed above the 7.3 m depth; while a high conductivity zone was observed towards the aquifer base. The inverse distance weighted technique was used to interpolate hydraulic conductivity values at locations for which measured values were not available.

Three-dimensional flow and transport modeling was used to simulate tracer test 3. The model predictions were found to be strongly sensitive to the variability of hydraulic conductivity and the anisotropy ratio, moderately sensitive to porosity, and least sensitive to dispersivity. The quality of simulations was similar to those reported by Yeh et al. (1995). Peak arrival time was better replicated by the MSEA model, while Yeh et al. model replicated peak relative concentration more accurately. Simulation results were also compared with observed data using temporal moments. The model predicted average travel time more accurately as compared to the absolute integral area.

The MSEA model was able to replicate the bulk movement of the plume with higher degree of certainty than the predictions at individual measurement points. The magnitude of vertical mixing observed implies that the prediction of contaminant transport in agricultural settings must incorporate two key factors: a) vertical displacement of contaminant trajectories due to pumping for irrigation, and b) preferential pathways created by aquifer heterogeneity.

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