A method to estimate hydraulic conductivity while drilling

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Abstract

A field test and analysis method has been developed to estimate the vertical distribution of hydraulic conductivity in shallow unconsolidated aquifers. The field method uses fluid injection ports and pressure transducers in a hollow auger that measure the hydraulic head outside the auger at several distances from the injection point. A constant injection rate is maintained for a duration time sufficient for the system to become steady state. Exploiting the analogy between electrical resistivity in geophysics and hydraulic flow two methods are used to estimate conductivity with depth: a half-space model based on spherical flow from a point injection at each measurement site, and a one-dimensional inversion of an entire dataset.

The injection methodology, conducted in three separate drilling operations, was investigated for repeatability, reproducibility, linearity, and for different injection sources. Repeatability tests, conducted at 10 levels, demonstrated standard deviations of generally less than 10%. Reproducibility tests conducted in three, closely spaced drilling operations generally showed a standard deviation of less than 20%, which is probably due to lateral variations in hydraulic conductivity. Linearity tests, made to determine dependency on flow rates, showed no indication of a flow rate bias. In order to obtain estimates of the hydraulic conductivity by an independent means, a series of measurements were made by injecting water through screens installed at two separate depths in a monitoring pipe near the measurement site. These estimates differed from the corresponding estimates obtained by injection in the hollow auger by a factor of less than 3.5, which can be attributed to variations in geology and the inaccurate estimates of the distance between the measurement and the injection sites at depth.

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