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Influence of tested interval length on and new shape factors of the multilevel slug test in a vertically heterogeneous aquifer

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As more detailed information on the vertical variation of hydraulic conductivity K(z) can be obtained using a shorter tested interval in a multilevel slug test (MLST), it is important to understand the influence of the tested interval length on the estimation of K(z). A quasi-steady-state, vertically heterogeneous model amenable to the analytical solution techniques is developed to investigate the problem of interest. In this model, K(z) is expressed, based on field data, as an exponential function of depth, and the tested well is stipulated as a mixed-type boundary that is proper to the MLST. Using the flow rates generated by this model, the shape factor of the heterogeneous condition is developed for generating the hypothetical MLST responses, and the shape factor of the homogeneous condition, F_0, is derived for data analysis. The traditional Hvorslev shape factor for a partially penetrating well is found to deviate from F_0 by -20 – 32% under different conditions. The analysis of 85 sets of hypothetical MLST responses at 17 depths of 5 tested interval lengths indicates that the estimates of K(z) using the traditional Hvorslev shape factor change with the tested interval lengths, while these using F_0 approach the specified K(z) as the tested interval length decreases to a limiting value (0.2m in the current study). Therefore, an accurate estimation of K(z) not only depends on the tested interval length but also on the shape factor used in data analysis. For the application of the MLST, it is important that the limiting tested interval length (suggested as 0.2m) is used and the responses measured are analyzed using the appropriate shape factor, such as F_0developed herein.