

# Extension of Leakage Theory to Unconfined Aquifer Flow

## Details

**Meeting** [2007 Joint Assembly](#)

**Section** [Hydrology](#)

**Session** [Groundwater Hydrology: Posters](#)

**Identifier** H53E-04

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**Index Terms** [Groundwater hydraulics \[1828\]](#) [Groundwater hydrology \[1829\]](#)

## Abstract

Semi-analytical solutions for the problem of leakage in an unconfined aquifer bounded below by an aquitard of finite or semi-infinite extent are presented. The homogeneous anisotropic unconfined aquifer of infinite radial extent is pumped continuously at a constant rate from a well of infinitesimal radius. The aquitard is also homogeneous, anisotropic and of infinite radial extent. Flow in both the aquifer and the aquitard is allowed to occur both vertically and horizontally. Exact solutions in the double Laplace-Hankel transform space for drawdown response in the unconfined aquifer using assumptions for leakage from classical and general leakage theory are developed. The latter also yields a solution for drawdown response in the underlying aquitard. The inverse transforms of the solutions are obtained numerically. Theoretical results are presented. They show that leakage can cause significant departure, at both early- and late-times, from the solution with no leakage. In the classical leakage theory case, the aquifer drawdown response reaches steady-state at late-time, whereas such a state is not attained in the general leakage theory case. These results conform to published results for leakage in confined aquifers.

**Cite as:** Author(s) (2007), Title, *Eos Trans. AGU*, 88(23), Jt. Assem. Suppl., Abstract H53E-04

