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Pool Effects on Longitudinal Dispersion in Streams and Rivers

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ABSTRACT

Surface storage (pools, pockets, and stagnant areas caused by woody debris, bars etc) is very important to solute transport in streams as it attenuates the peak of a spill but releases the solute back to the stream over a long time. The latter results in long exposure time of biota. Pools as fundamental stream morphology unit are commonly found in streams with mixed bed materials in pool-riffle or pool-step sequences. Fitting the transient storage model (TSM) to stream tracer test data may be problematic when pools present. A fully hydrodynamic 2-D, depth averaged advection-dispersion solute transport numerical simulation study on hypothetical stream with pool reveals that a pool can sharply enhance longitudinal spreading, cause a lag in the plume travel-time and radically increase solute residence time in the stream. These effects fade like a "wake" as the solute plume moves downstream of the pool. Further, these effects are strongly influenced by a dimensionless number derived from the 2-D transport equation ? or , which outlines the relative transverse mixing intensity of a stream or river, where, of the stream reach concerned, W is the flow width, Q_0 is the volumetric flow rate, q is the longitudinal flux density, and D_t is the transverse turbulent diffusion coefficient. The breakthrough curves (BTCs) downstream of a pool may be "heavy tailed" which cannot be modeled accurately by the TSM. The internal transport and mixing condition (including the secondary circulations) in a pool together with the pool's dimension determine the pool's storage effects especially when >> 1. Results also suggest that the falling limb of a BTC more accurately characterizes the pool's storage because the corresponding solute has more chance to sample the entire storage area.

KEYWORDS

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