



## **Hydraulic characteristics of artificial gravel beds derived from results of tracer tests**

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Constructed wetlands are man-made areas inundated or saturated with water used to treat wastewaters. A complex interplay of biological and physicochemical processes that occur in constructed wetlands results in improvement of water quality. Constructed wetland in Nowa Słupia, Poland is a typical subsurface flow system where wastewaters flow through porous medium (gravel) overgrown with common reed. The wetland treating municipal wastewaters consists of three parallel gravel cells (78 m x 24 m x 1.2 m). Characterization of flows in such systems is significant for the assessment of their purification capacity. Comparison of the actual and expected flow patterns is also important for improvements in constructed wetland design, construction and maintenance practices.

Two tracer tests with instantaneously injected bromide and tritium were performed in order to assess flow paths through the wetland and the related hydraulic parameters. Tests gave residence time distributions (RTD) of wastewaters in three parallel inhomogeneous gravel cells of the wetland. The Multi Flow Dispersion Model (MFDM) was used to fit the experimental tracer breakthrough curves to the RTDs. The applied model assumes the existence of multi-flowpaths with different hydraulic characteristics and consists of the respective parallel combination of analytical solutions to the one-dimensional advection-dispersion equation. Different flow components were identified and their hydraulic characteristics: wastewater volumes, water saturated porosity, mean wastewater travel times, longitudinal dispersivities as well as hydraulic conductivity of wetland cells were derived. Three identical wetland cells differ in their hydraulic characteristics mainly due to inaccurate maintenance practices. Uneven distribution of wastewater flow into parallel cells and improper water levels in cells might worsen overall performance of the wetland. Bromide and tritium

proved equally useful for tracing of wastewater flow in the wetland as hydraulic characteristics derived from TBCs of both tracers do not differ significantly. Simultaneous use of bromide and tritium tracers allowed for the rough estimation of the overall evapotranspirative loss of water from the wetland.