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A method for the in-situ determination of the hydraulic conductivity of gravels as used in constructed wetlands for wastewater treatment

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ABSTRACT

A new instrument and method are described that allow the hydraulic conductivities of highly permeable porous materials, such as gravels in constructed wetlands, to be determined in the field. The instrument consists of a Mariotte siphon and a submersible permeameter cell with manometer take-off tubes, to recreate in-situ the constant head permeameter test typically used with excavated samples. It allows permeability to be measured at different depths and positions over the wetland. Repeatability obtained at fixed positions was good (normalised standard deviation of 1–4%), and results obtained for highly homogenous silica sand compared well when the sand was retested in a lab permeameter (0.32 mm.s^{-1} and 0.31 mm.s^{-1} respectively). Practical results have a ±30% associated degree of uncertainty because of the mixed effect of natural variation in gravel core profiles, and interstitial clogging disruption during insertion of the tube into the gravel. This error is small, however, compared to the orders of magnitude spatial variations detected. The technique was used to survey the hydraulic conductivity profile of two constructed wetlands in the UK, aged 1 and 15 years respectively. Measured values were high (up to 900 mm.s^{-1}) and varied by three orders of magnitude, reflecting the immaturity of the wetland. Detailed profiling of the younger system suggested the existence of preferential flow paths at a depth of 200 mm, corresponding to the transition between more coarse and less coarse gravel layers (6–12 mm and 3–6 mm respectively), and transverse drift towards the outlet.

Keywords: Constructed wetlands; Clogging; Hydraulic conductivity; In situ; Measurement

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