Applications and implications of direct groundwater velocity measurement at the centimetre scale

J. F. DEVLIN¹, P. C. SCHILLIG¹, I. BOWEN¹, D. L. RUDOLPH², N. R. THOMSON³, G. P. TSOFLIAS¹ & J. A. ROBERTS¹

1 University of Kansas, Department of Geology, Lindley Hall rm 120, 1475 Jayhawk Blvd., Lawrence, Kansas 66045, USA
jfdevlin@ku.edu
2 University of Waterloo, Department of Earth and Environmental Sciences, 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada
3 University of Waterloo, Department of Civil and Environmental Engineering, 200 University Avenue West, Waterloo, Ontario N2L 3G1, Canada

Abstract A recently developed probe for measuring groundwater velocity at the centimetre scale in porous media, the Point Velocity Probe (PVP), was deployed in separate projects to measure transient heterogeneity in a sandy aquifer undergoing aerobic bioremediation, as an aquifer characterization tool for the design of an in situ denitrification program, and as a tool for mapping flow in unprecedented detail around a dipole well. In the first project, local flow magnitudes varied in time by up to a factor of 3, and directions varied by over 40° in association with biological activity, which was independently confirmed. In the second project, detailed velocity measurements were made in a glacial outwash aquifer with average groundwater velocities estimated to be about 2–4 m/day. A thin zone of high water flux, with velocities in excess of 10 m/day was detected. This zone was later confirmed by a tracer test and by hydraulic conductivity determinations of core material from the site. In the third project, detailed measurements of flow, in three dimensions, immediately next to a dipole well, agreed well with model predictions in most locations. If PVPs continue to prove reliable in future research, much may be learned about small scale flow phenomena, including flow in reactive treatment zones.

Key words groundwater velocity measurement; transient heterogeneity; bioremediation; dipole well; denitrification