A methodology for the improved characterisation of organic contaminant fate in fractured aquifers is presented. Using rotary cored boreholes, the methodology combines borehole logging techniques (caliper, gamma, resistivity, digital televiewer logs) and hydraulic testing (1–2 m straddle-packers) with real-time on-site measurement of aquifer lithology, fracture and contaminant distribution in rock core and groundwater samples. The ensemble data are integrated to interpret the fracture network properties, aquifer hydraulic properties and contaminant distribution in vertical profile, which identifies hydraulically significant fractures, vertical flow components and preferential transport pathways supporting the design of a network of level-specific multilevel groundwater sampler monitoring wells. A key feature is the use of discrete-zone monitoring for site characterisation and long-term groundwater quality monitoring, to provide representative data on the spatial and temporal variation in aquifer hydraulic properties and hydrochemistry. This methodology is a cost-effective improvement on current site characterisation practice for fractured aquifers, providing more reliable assessment of contaminant transport and biodegradation processes, peak contaminant concentrations, plume geometry and behaviour for the development and validation of robust conceptual site models. This investment ultimately reduces long-term site management costs owing to less uncertainty in risk assessment and greater confidence in the targeting of more effective remediation. The methodology is demonstrated for the assessment of monitored natural attenuation at a site on the Chalk aquifer contaminated by a release of unleaded petroleum fuel.