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Flow zone characterisation in a fractured aquifer using spring and open-well T and EC monitoring.

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Abstract

The Cretaceous Chalk is a very important aquifer in England, and its relatively high transmissivity derives essentially from a well-developed network of solutionally-enhanced fractures and conduits. Like other fractured aquifers, characterisation and delineation of flow pathways and hence catchment boundaries is important. Determination of flow pathways for source catchment delineation (e.g. identification of safeguarding zones around wells) is critical for the effective management and protection of the groundwater resource. It also determines the areal extent of contamination from known sources, and enables the targeted sampling of flow zones e.g. for monitored natural attenuation (MNA). A rather simplistic conceptualisation of the unconfined chalk aquifer of East Yorkshire is currently used as a basis for numerical simulations: linearly reducing hydraulic conductivity (K) with depth below the maximum groundwater elevation, reducing to a minimum value below the zone of groundwater table fluctuation. This study represents an attempt to improve this conceptualisation via improved characterisation of permeable zones within the aquifer. The methods used are: pumping test drawdown analyses for transmissivity, ambient open-well dilution testing; rainfall, groundwater head, and spring / open-well specific electrical conductance (SEC) and temperature monitoring. Pumping test analyses yield overall well transmissivity; the open-well dilution/monitoring approach identifies inflow, outflow, crossflow zones and direction and rate of flow in wells; seasonal changes in flows in wells and springs reflect the annual recharge and recession cycle and the impact of seasonal hydraulic head variation on the activation/deactivation of permeable pathways. Variations in spring and well-water electrical conductivity / temperature provide insight into groundwater residence times and the degree of isolation of groundwater from atmospheric and soil zone sources of CO_2. The results of the study combined with stratigraphic information on the aquifer, allows the characterisation of the development of bedding-controlled features such as solutionally-enhanced fractures or conduits, and the role of steeply inclined normal faults. The results have implications for catchment management because it will inform a refinement and improvement of the regulatory body) groundwater model for assessment, evaluation and protection of groundwater resource. The method and techniques used can be applicable for characterising fractured aquifers in other jurisdictions.