Stantec

Insightful

London Basin

Advice

The London Basin aquifer is one of the most densely investigated and data-rich groundwater bodies in the UK. Following consolidation and analysis of the available data and a comprehensive literature review, we developed a detailed conceptual understanding of the key hydrogeological processes, which focused on understanding and quantifying the following key aspects of the hydrogeology of the aquifer:

1 Using the most modern interpretation from the British Geological Survey of geological layering and structure to understand the geometry of the aquifer units and potential influence on groundwater flow – see bgs.ac.uk/research/engineeringGeology/urbanGeoscience/londonAndThames/faultModelling.html

2 Understanding the hydraulic properties of the layered aquifer. Historical interpretations of the Chalk transmissivity distribution were combined with recent pumping tests and depth of burial information to prepare an initial transmissivity map for the model.

3 Understanding groundwater level distributions to identify low permeability barriers (mainly identified as faults or fold axis) and to map areas where the water table was below the base of aquifer units.

4 Quantifying recharge to the North Downs, which contributes almost a half the inflow to the basin; and modelling flows from the springs at the foot of the dip slope which form the upper reaches of the Rivers Hogsmill, Wandle and Ravensbourne.

5 Quantifying other flows into the confined basin, which contribute to most of the abstraction yield. The key source is the unconfined aquifer of the Chilterns, the data for which we obtained from other Environment Agency groundwater models.

6 Assessing interaction with the River Thames where the aquifer is unconfined in East London.

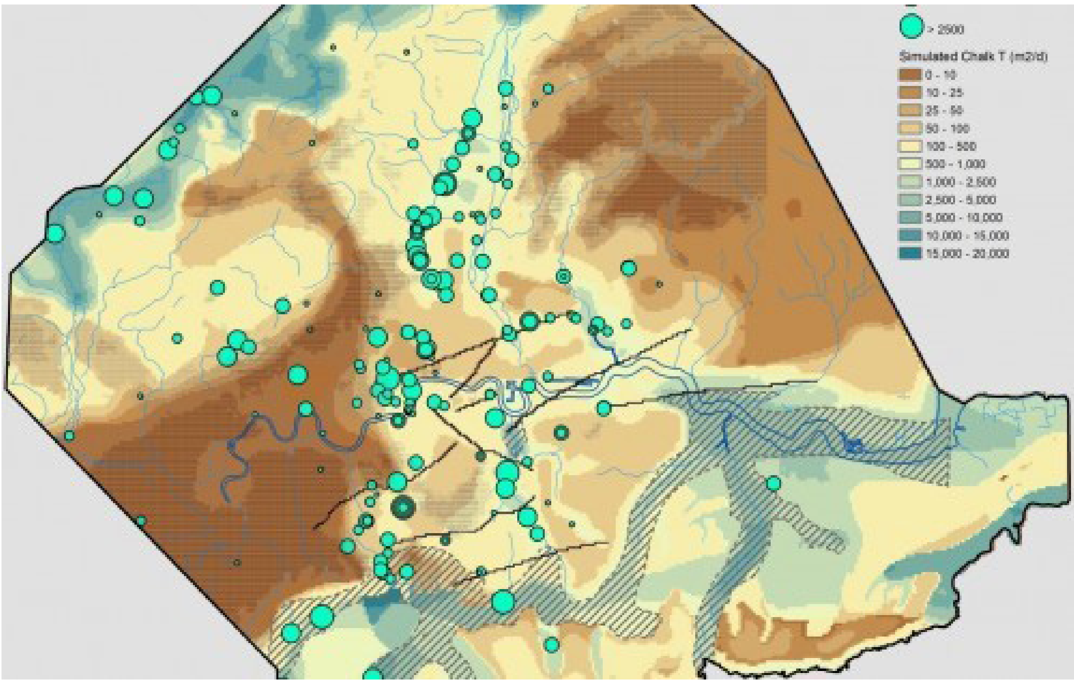
Recommendations were then made for the development of a numerical groundwater model to simulate the hydrogeology of the London Basin.

We developed a numerical model of the London Basin and North Downs aquifer in MODFLOW-VKD. From the original conceptual study, the model area was extended eastwards from the River Cray to the estuary of the River Medway. The key technical challenges were:

1 The extremely large model area: five hydrogeological layers are represented; the active model covers an area of 3175 sq km; the overall model period is 1810 to 2007, with ten-day stress periods from 1965.

2 The model represents a highly stressed system, requiring the development and partial recovery of a regional cone of depression. Such groundwater level decline requires de-saturation of model layers which is inherently unstable to then re-saturate using standard MODFLOW codes. To overcome such stability concerns, a novel version of MODFLOW in which layers do not (numerically) dry out was used(1). Complex geology, particularly at geological outcrop boundaries, can also lead to instability and considerable work was required to translate this geological pattern into a numerically sound model.

3 The model is being used to accurately represent groundwater levels in diverse hydrogeological environments; namely, a confined basin and unconfined Chalk downsland, both with order-of- magnitude transmissivity variations. The figure below shows the final transmissivity distribution for the model area.



4 In the confined aquifer there is equivalence between the effects of linear barriers versus low permeability. Model testing, using manual and automated algorithms (such as PEST) was used to investigate aquifer transmissivity within the confined aquifer, with special emphasis on evaluating the role of faults in controlling rates of drawdown and recovery.