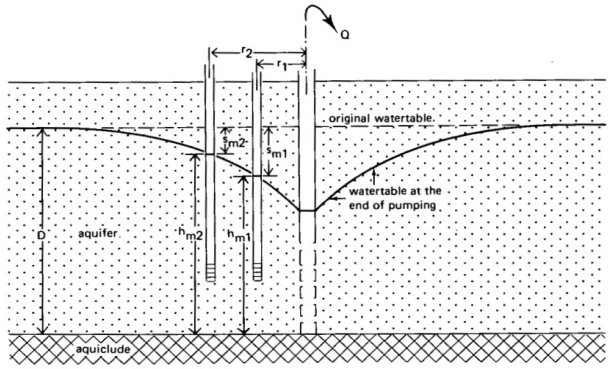
Indicative calculation of the rate of groundwater drawdown

Calculation based on the Thiem-Dupuit equation for steady state flow in an unconfined aquifer.

$$Q = \pi K \frac{h_2^2 - h_1^2}{\ln(\frac{r_2}{r_1})}$$

Where:

Q	is the pumping rate (m^3/s)
K	is the hydraulic conductivity (m/s)
h_2	is the head at radius r_2 (m)
h_1	is the head at radius r_1 (m)



(Reproduced from Kruseman and De Ridder , 2000)

The following assumptions apply:

- the aquifer has infinite areal extent;
- the aquifer is homogeneous, isotropic and of uniform thickness;
- flat initial water table;
- the aquifer is pumped at a constant discharge rate;
- the pumping well is fully penetrating, therefore receiving water; from the entire saturated thickness of the aquifer; and,
- the flow to the well is at steady state.

(from Kruseman & de Ridder, 2000)

Consistent with Section 6.2.1 of CIRIA 750 (Preene et al, 2016) h_2 can be set as the head at the estimated radius of influence (when drawdown is zero) and h_1 can be set at the estimated head in the excavation.

On this basis r_1 is the excavation effective radius and r_2 is the sum of the excavation effective radius (r_1) and the radius of influence (r_0).

The Thiem-Dupuit equation can be rearranged to estimate drawdown at a point within the cone of depression, for example at the excavation effetive radius:

$$h_1 = \sqrt{h_2^2 - \frac{Q \ln(r_2/r_1)}{\pi K}}$$

References

Kruseman, G. P. and De Ridder, N. A., 2000. Analysis and Evaluation of Pumping Test Data, ILRI publication 47, Second Edition, The Netherlands

Preene M., Roberts T. O. L.,& Powrie W. 2016. Groundwater control: design and practice, second edition. CIRIA report C750, London.

Indicative estimate of drawdown in the excavation based on the Thiem-Dupuit equation		
	Eastern Extension area	**Comments**
Hydraulic conductivity, K (m/s)	4.20E-06	Estimated based on Jones *et al*. (2000).
Length (m)	360	Approximate length of the Eastern Extension area.
Width(m)	105	Approximate width of the Eastern Extension area.
Excavation effective radius, r_1 (m)	110	Effective radius of permitted Eastern Extension area is calculated using the formula in Somerville (1986).
Radius of influence to assumed zero drawdown boundary, r_2 (m)	489	Assumed to correspond to the approximate distance from the centre of the Eastern Extension area to groundwater monitoring borehole G4.
Head at excavation edge, h_1 (m)	48.19	Estimated using the Thiem-Dupuit equation rearranged to calculate h_1.
Head at assumed zero drawdown boundary, h_2 (m)	50	Based on an assumed aquifer thickness consistent with Abesser *et al*. (2005).
Abstraction rate, Q (m^3/s)	0.0016	Estimated abstraction rate.
Abstraction rate, Q (m^3/month)	4071	Mean monthly abstraction rate for the period April 2021 to January 2026.
Estimated drawdown in the excavation, s (m)	**1.81**	

Input cells

References

Abesser, C, Shand, P. & Ingram, J, 2005. Baseline Report Series: 22. The Carboniferous Limestone of Northern England. British Geological Survey Commissioned Report No. CR/05/076N

Jones, H K, Morris, B L, Cheney, C S, Brewerton, L J, Merrin, P D, Lewis, M A, MacDonald, A M, Coleby, L M, Talbot, J C, McKenzie, A A, Bird, M J, Cunningham, J, and Robinson, V K. 2000. The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report, WD/00/4. 234pp. Environment Agency R&D Publication 68

Somerville, S. H. 1986. Control of groundwater for temporary works. CIRIA report 113, London. P24.