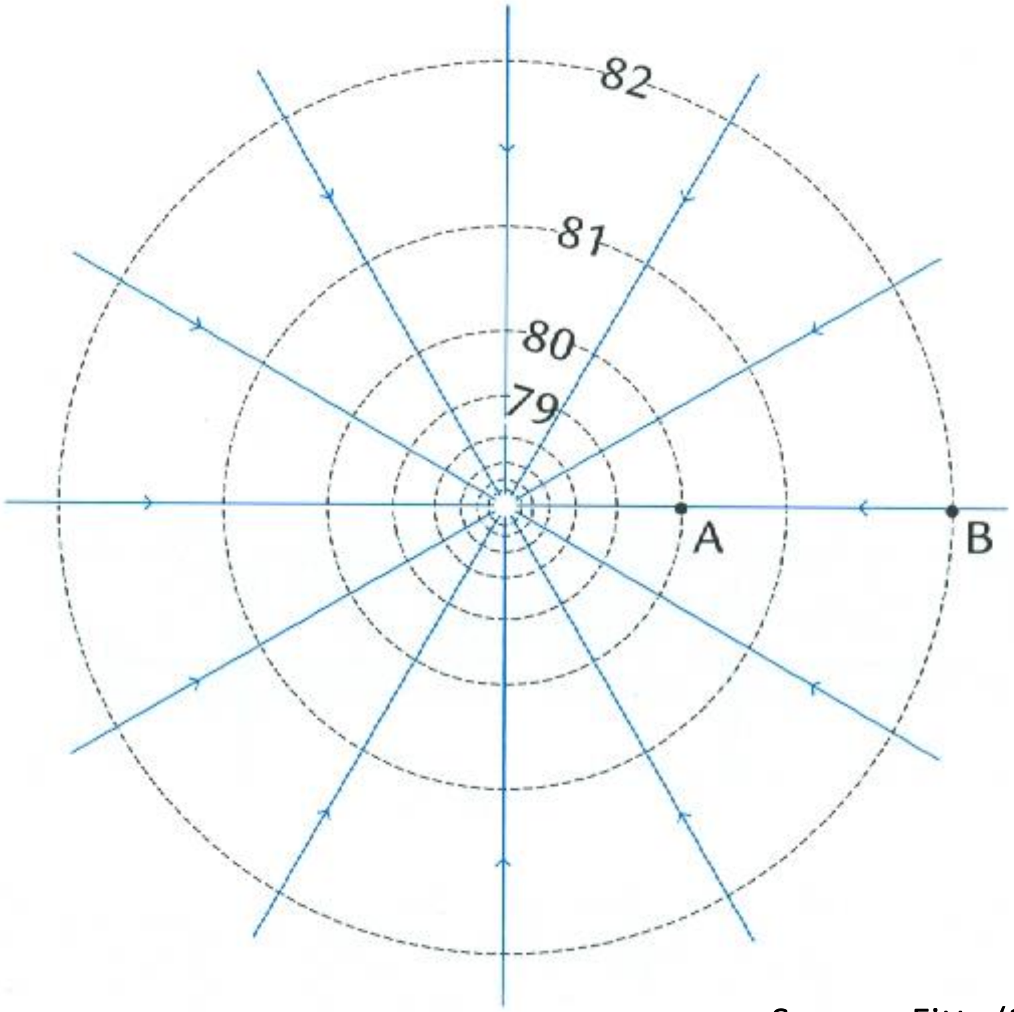
Radial groundwater flow in plan view

https://www.youtube.com/user/MartinRHendriks/videos



Source: Fitts (2002)

Confined aquifer

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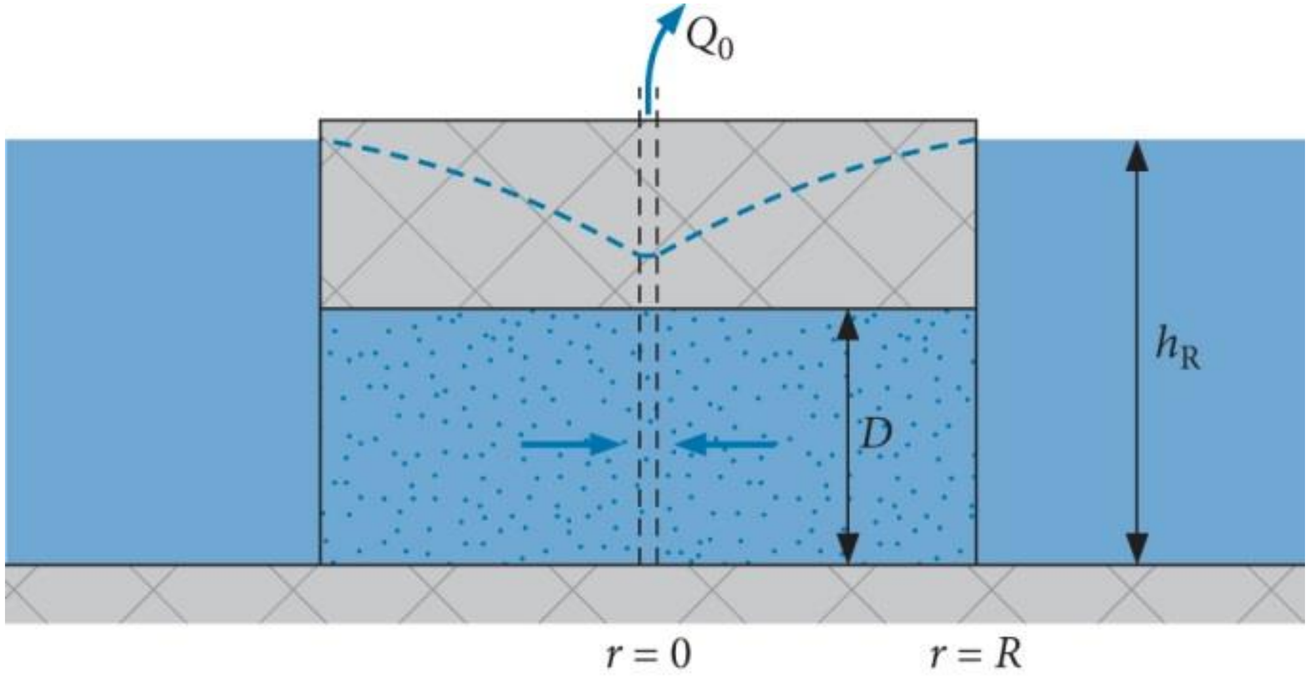

Dupuit equation

$$q_r = K \frac{dh}{dr} \qquad Q_0 = q_r 2\pi r D \qquad h = h_R + \frac{Q_0}{2\pi KD} \ln \frac{r}{R}$$

Earlier steady flow: hydraulic head *h* decreases with increasing *x* – minus sign in Darcy's law, linking *Q'* > 0 with *dh/dx* < 0
Radial-symmetric flow: hydraulic head *h* decreases with decreasing *r* – no minus sign in Darcy's law, linking *Q'* > 0 to pumping

Dupuit equation

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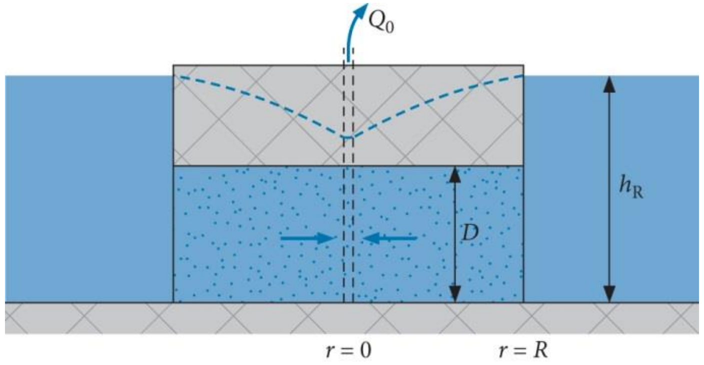
$$q_r = K\frac{dh}{dr}$$



$$Q_0 = q_r 2\pi r D$$

$$Q_0 = K\frac{dh}{dr}2\pi r D \Rightarrow \frac{dh}{dr} = \frac{Q_0}{2\pi KD}\frac{1}{r} \Rightarrow$$

$$\int \frac{dh}{dr}dr = \int \frac{Q_0}{2\pi KD}\frac{1}{r}dr \Rightarrow h = \frac{Q_0}{2\pi KD}\ln r + C$$

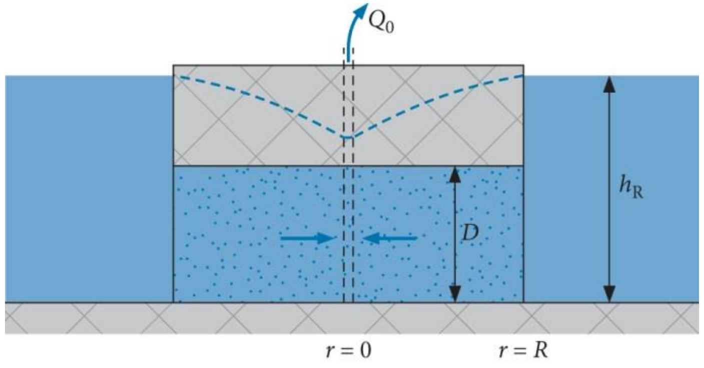
$$r = R \Rightarrow h = h_R + \frac{Q_0}{2\pi KD}\ln\frac{r}{R}$$

Lowering of the hydraulic head: $h_R - h$

Drawdown: $h - h_R$

Thiem equation

$$\frac{dh}{dr} = \frac{Q_0}{2\pi KD} \frac{1}{r}$$

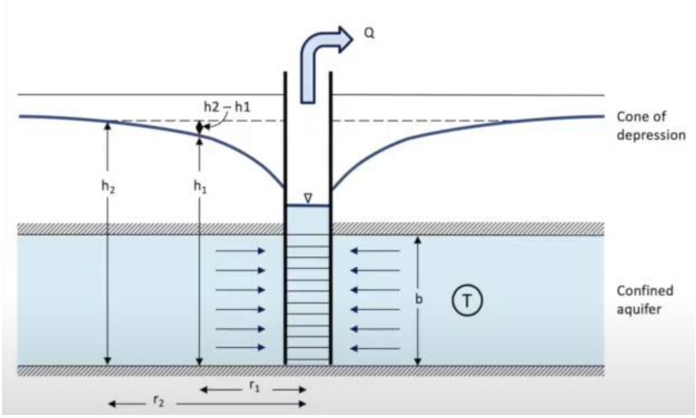


$$\int_{h_1}^{h_2} \frac{dh}{dr} dr = \int_{r_1}^{r_2} \frac{Q_0}{2\pi KD} \frac{1}{r} dr$$

$$[h]_{h_1}^{h_2} = \frac{Q_0}{2\pi KD} [ln\, r]_{r_1}^{r_2} \Rightarrow h_2 - h_1 = \frac{Q_0}{2\pi KD} (\, ln\, r_2 - ln\, r_1) \Rightarrow$$

$$h_2 - h_1 = \frac{Q_0}{2\pi T} \ln \frac{r_2}{r_1}$$

Thiem equation



Source: De Jong (2020)

References

De Jong (2020). Hydrogeology 101: Thiem equation. https://www.youtube.com/watch?app=desktop&v=-tsLFsz-Ncs

Fitts, C.R. (2002). Groundwater Science. Academic Press, Elsevier Science.

Hendriks, M.R. (2010). Introduction to Physical Hydrology. Oxford University Press.