

Seepage in a finite polder

'Horizontal solution'

$$\lambda = \sqrt{K D c} \Rightarrow \lambda^2 = K D c \Rightarrow \frac{\lambda}{c} = \frac{K D}{\lambda}$$

$$h = h_a + C_1 e^{\frac{x}{\lambda}} + C_2 e^{\frac{-x}{\lambda}} \text{ with } \lambda = \sqrt{K D c}$$

$$Q'_{x=0} = -K D \left(\frac{dh}{dx} \right)_{x=0} ; Q'_{x=L} = -K D \left(\frac{dh}{dx} \right)_{x=L}$$

$$Q'_z = |Q'_{x=0}| + |Q'_{x=L}|$$

$$\frac{dh}{dx} = \frac{C_1}{\lambda} e^{\frac{x}{\lambda}} + \frac{C_2}{-\lambda} e^{\frac{-x}{\lambda}}$$

$$Q'_z = -\frac{\lambda}{c} (C_1 - C_1 e^{\frac{L}{\lambda}} - C_2 + C_2 e^{\frac{-L}{\lambda}}) = -\frac{K D}{\lambda} (C_1 - C_1 e^{\frac{L}{\lambda}} - C_2 + C_2 e^{\frac{-L}{\lambda}})$$

Seepage in a finite polder

‘Vertical solution’

$$\lambda = \sqrt{K D c} \Rightarrow \lambda^2 = K D c \Rightarrow \frac{\lambda}{c} = \frac{K D}{\lambda}$$

$$h = h_a + C_1 e^{\frac{x}{\lambda}} + C_2 e^{\frac{-x}{\lambda}} \text{ with } \lambda = \sqrt{K D c}$$

$$Q_z' = \int_0^L q_z \, dx$$

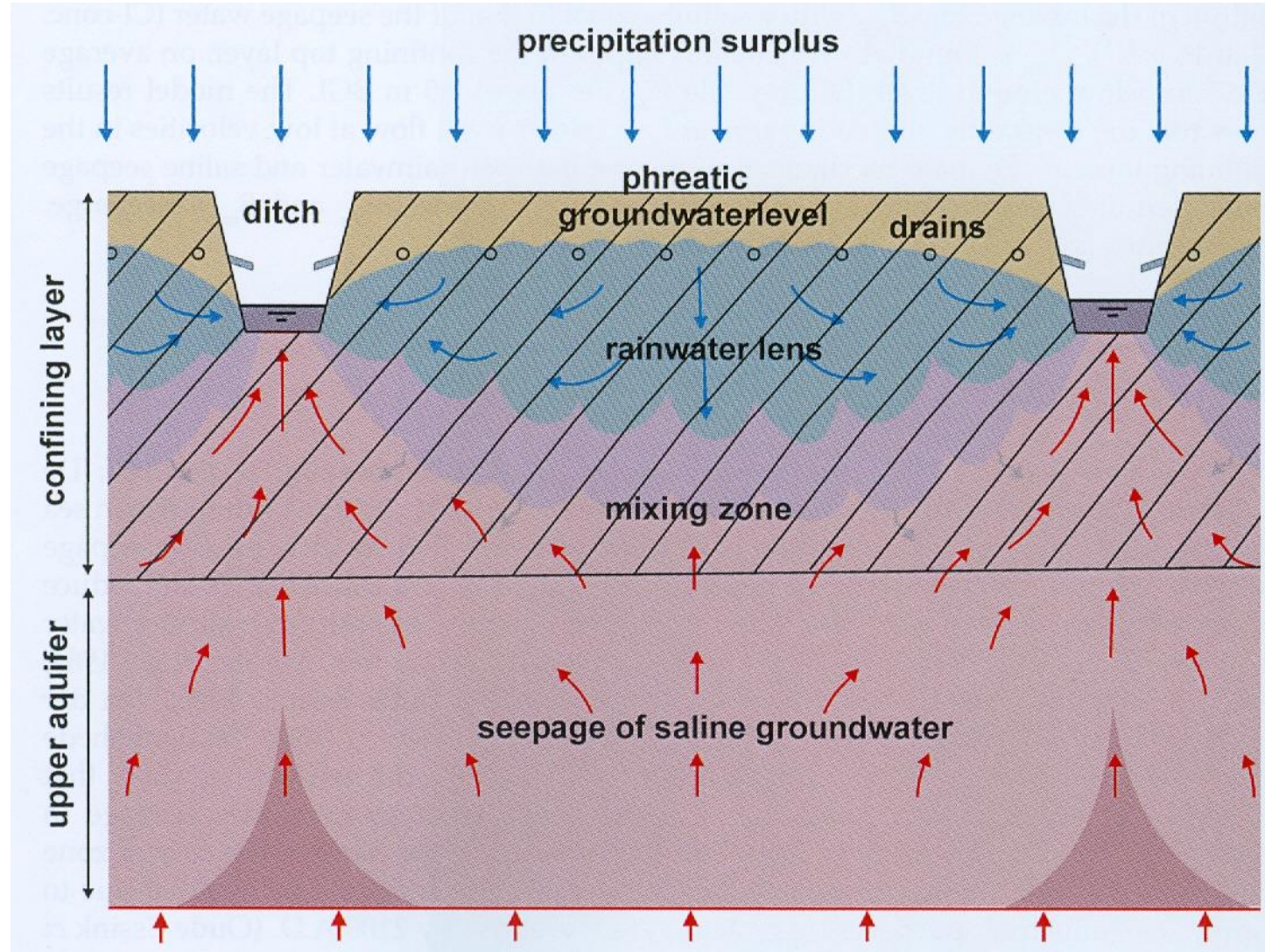
$$q_z = -k \frac{h_a - h}{d}$$

$$Q_z' = \int_0^L -k \frac{h_a - h}{d} \, dx$$

$$h_a - h = -C_1 e^{\frac{x}{\lambda}} - C_2 e^{\frac{-x}{\lambda}}$$

$$Q_z' = -\frac{\lambda}{c} (C_1 - C_1 e^{\frac{L}{\lambda}} - C_2 + C_2 e^{\frac{-L}{\lambda}}) = -\frac{K D}{\lambda} (C_1 - C_1 e^{\frac{L}{\lambda}} - C_2 + C_2 e^{\frac{-L}{\lambda}})$$

Rainwater lens and saline seepage



Source: De Louw (2013)

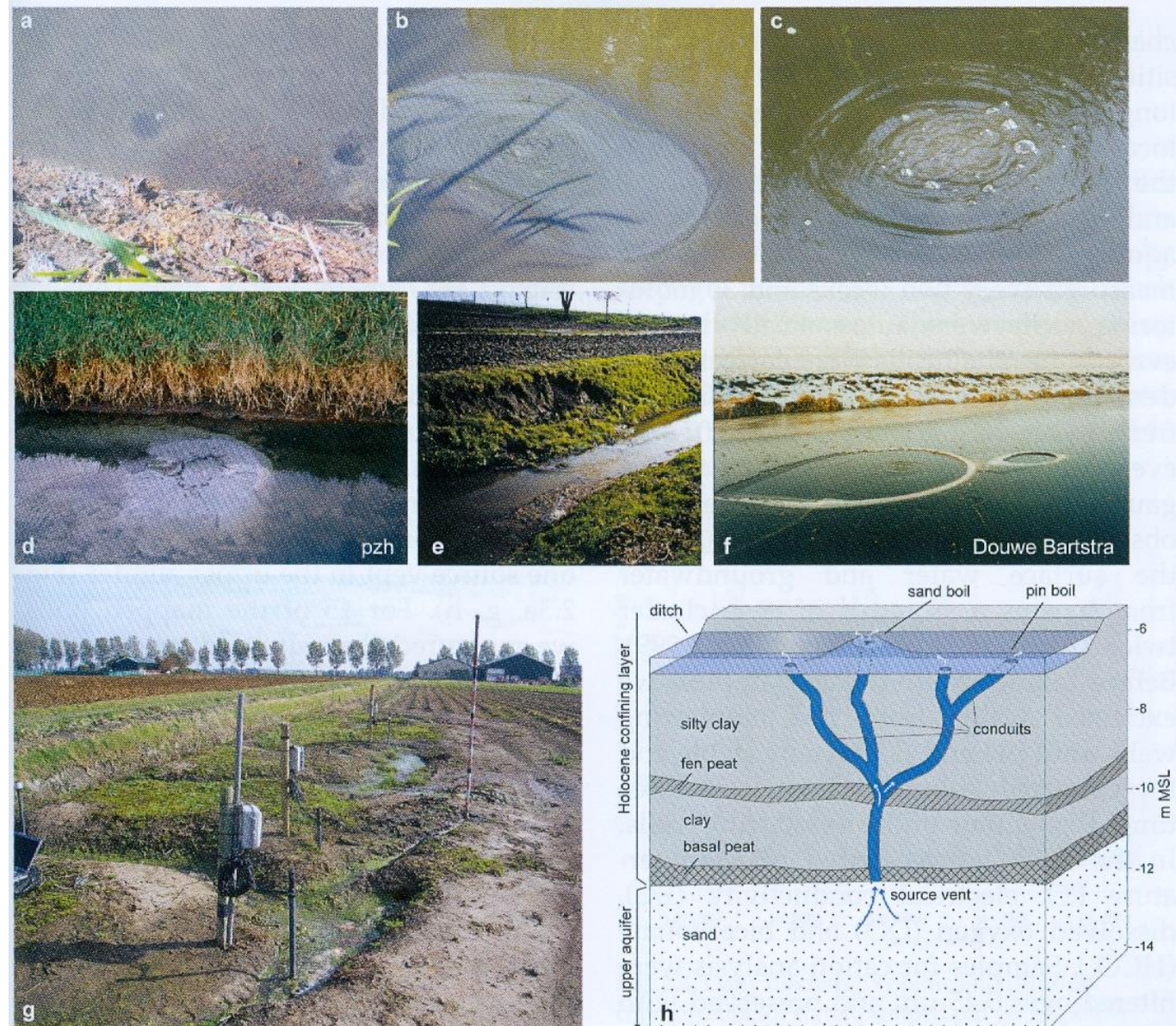
Boils in deep polders

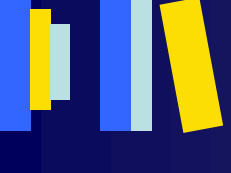
- a pin boil
- b sand boil
- c boil emitting methane
- d sand volcano
- e collapsed ditch bank
- f hole in ice
- g sand boils on land
- h schematic diagram

Saline upward seepage through boils

Zoute kwel via wellen

Source: De Louw (2013)





References

De Louw, P.G.B. (2013). Saline seepage in deltaic areas. Preferential groundwater discharge through boils and interactions between thin rainwater lenses and upward saline seepage. PhD thesis, VU University Amsterdam, The Netherlands.

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