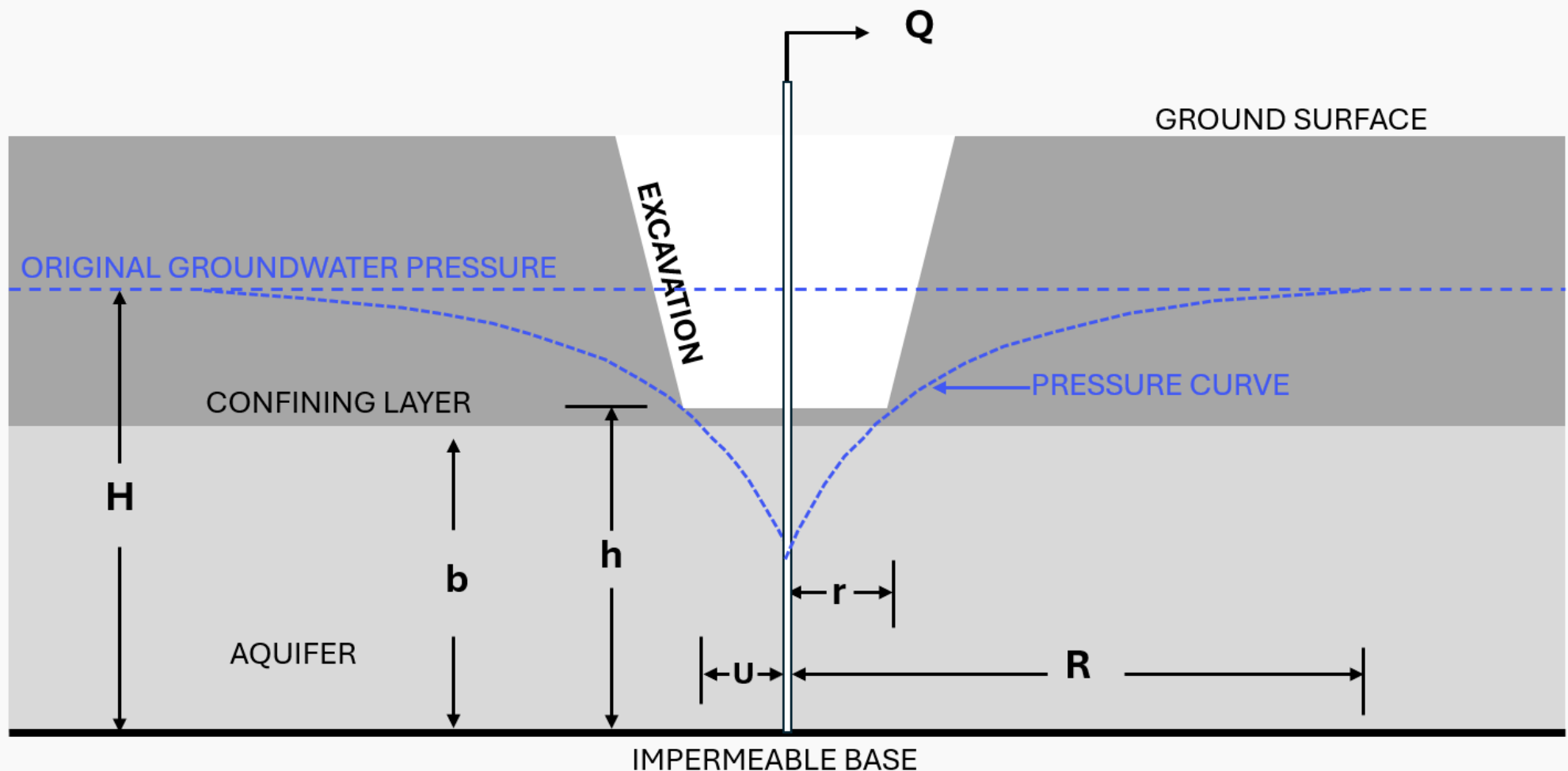


# Aquifer Dewatering Model by Equivalent Well Method

## Application: Mixed Aquifer



$$Q = \frac{\pi K(2bH - b^2 - h^2)}{\ln\left(\frac{R}{r}\right)}$$

### Flow Rate (Q)

Estimate the pumping rate needed to lower groundwater head around an excavation or pit.

### Groundwater Head ( $h_2$ )

Approximate the new aquifer head at any radial distance ( $r_2$ ) beyond the pit.

$$h_2 = \frac{H - b}{\ln\left(\frac{R}{r}\right)} \ln\left(\frac{r_2}{r}\right) + \sqrt{b^2 - \frac{b^2 - h^2}{\ln\left(\frac{R}{r}\right)} \ln\left(\frac{R}{r_2}\right)}$$

## When to use it

Use this method when you need a quick estimate of flow and groundwater head change around an excavation.

Typical applications include:

- Construction dewatering
- Quarries
- Open-Pit Mines

## What you need

### Aquifer properties:

- Hydraulic conductivity
- Storativity for the transient calculation
- Aquifer thickness, initial head, & target head

### Excavation properties:

- Length, width, and depth

## Limitations

- Applicable when pumping from a confined aquifer lowers head below the top of the aquifer near the excavation, creating mixed confined-to-unconfined flow.
- It is best suited to excavations with a length-to-width ratio of about 1.5 or less.
- It can estimate groundwater head change around the excavation, but not inside it.
- A radius of influence must be defined, but that is not always straightforward because it changes with time and can be estimated in several ways.

# Equivalent Well Method

This method simplifies an excavation or pit as a large-diameter well inside a drawdown cone. While that geometry is not physically realistic, it can still give results that are close to actual field performance.

The method is usually presented only in steady-state form. Here, we extend it to transient conditions by introducing a time-dependent radius of influence, which makes it more useful for short-term dewatering problems.

## Model Variables

Symbol	Units	Description
H	L	The initial aquifer head.
$h_2$	L	The resulting (depressurized) aquifer head at distance ' $r_2$ ' from centre of excavation.
h	L	The target depressurized aquifer head at the equivalent well radius (i.e. the excavation edge)
r	L	Radius of the 'equivalent well' representing the excavation or pit.
$r_2$	L	Radial distance from the excavation centre to the point where $h_2$ is calculated.
R	L	Radius of influence due to pumping.
K	L/T	Hydraulic conductivity of the aquifer.
b	L	Aquifer thickness.
Q	L <sup>3</sup> /T	Pumping rate.

# Transition from Confined to Unconfined

The radial distance ( $U$ ) where the aquifer transitions from confined to unconfined can be estimated as:

$$U = \exp \left[ \frac{(b^2 - h^2) \ln R + 2b(H - b) \ln r}{2bH - b^2 - h^2} \right]$$

## Model Variables

Symbol	Units	Description
<b>U</b>	L	Radial distance to the confined-to-unconfined transition point.
<b>H</b>	L	The initial aquifer head.
<b>h</b>	L	The target depressurized aquifer head at the equivalent well radius (i.e. the excavation edge)
<b>r</b>	L	Radius of the 'equivalent well' representing the excavation or pit.
<b>R</b>	L	Radius of influence due to pumping.
<b>b</b>	L	Aquifer thickness.

# Notes

## Radius of influence (R)

There are many equations available to calculate the radius of influence. Exactly what the radius of influence represents in the real world is debatable, but in this dewatering model it is simply a mathematical boundary required for the calculation.

The following R equations are common:

$$\textit{Sichardt Equation [Steady State]: } R = 3000 h_w \sqrt{K}$$

$$\textit{Theis Equation [Transient]: } R = 1.5 \sqrt{\frac{tKb}{S}}$$

### Where:

K = hydraulic conductivity

$h_w$  = aquifer head at the excavation edge

b = aquifer thickness

t = time

S = aquifer storativity