Consider steady flow in unconfined aquifers experiencing steady recharge at a rate \( w \) from rainfall or irrigation.

1. \( Q = A \frac{dQ}{dr} = 2\pi rhK \frac{dh}{dr} \) (Note D-F approximation is used here)

2. From mass balance, \( Q \) is also \( \pi r^2 (r_0^2 - r^2) \)

3. Setting \( Q \)'s equal and then solving the resulting DE yields:

   \[ 2\pi rhK \frac{dh}{dr} = \pi r^2 (r_0^2 - r^2) \]

   \[ 2h \frac{dh}{dr} = \frac{r_0^2 - r^2}{K} = \frac{r_0^2 - r}{K} \]

   \[ h_0 = \frac{r_0^2 - r^2}{2K} \]

4. \( \frac{h_0}{r_0} \approx \frac{r_0^2}{2K} \) for small \( r_0 \) compared to \( r_0^2 \), so the RHS is \( \frac{2h_0^2}{K} (r_0^2 - r) \)

5. Note that \( \frac{2h_0^2}{K} \) from mass balance. Thus:

   \[ h_0^2 - h_n^2 = \frac{2h_0^2}{K} (r_0 - r) \]

   or \( h_0 = \frac{2h_0}{K} (r_0 - r) \)
6. Available data and economic considerations suggest that efficient well operation occurs when \( h_w \approx \frac{1}{3} h_o \), thus:

\[
h_o \left(1 - \frac{1}{3}\right) = \frac{\theta}{k} h_o^2 = \frac{\theta}{k} \left( h_o \frac{r_w}{r_o} - \frac{1}{3} \right)
\]

We use a trial & error procedure to solve for the radius of influence \( r_o \), by rearranging the equation above:

\[
r_o^2 \left( h_o \frac{r_w}{r_o} - \frac{1}{3} \right) = \frac{\theta}{k} \frac{K h_o}{w}
\]

Example Problem:

Determine the well spacing required to maintain the WT at a minimum depth of 4 ft in the large study area having the following properties:

\[K = 100 \text{ ft/day} = 36500 \text{ ft/yr} \quad r_w = 1 \text{ ft} \]

\[J = 2 \text{ ft/yr} \quad \text{aquifer @ 40 ft thick} \]

Solution:

\[h_o + \frac{4L - 4'}{4} = 30 \text{ ft} \quad \Rightarrow \quad \frac{\theta}{k} \frac{K h_o}{w} = \frac{\theta}{k} \left(36500 \times 40\right)^2 = 2.3 \times 10^6 \text{ ft}^2\]

Try a series solution for \( r_o \).

\[r_o = 1300 \text{ ft} \]

Distance between rows of wells