$$N_{tOL} = \int_{x_2}^{x_1} \frac{dx}{x^* - x}$$

Henry's law, $y = m x^*$

Operating line, $y = \frac{L}{G}(x - x_1) + y_1$

$$x^* = \frac{L}{G m}(x - x_1) + \frac{y_1}{m}$$

Now, $A = \frac{L}{mG}$

$$x^* = A(x - x_1) + \frac{y_1}{m}$$

$$x^* - x = (A-1)x + \frac{y_1}{m} - A x_1$$

$$N_{toL} = \int_{x_2}^{x_1} \frac{dx}{(A-1)x + \frac{y_1}{m} - A x_1} = \frac{-1}{1-A}\left[\ln\left(\frac{y_1}{m} - A x_1 - (1-A)x\right)\right]_{x_2}^{x_1}$$

$$= \frac{1}{1-A} \ln\left[\frac{\frac{y_1}{m} - A x_1 - (1-A)x_2}{\frac{y_1}{m} - x_1}\right]$$

$$= \frac{1}{1-A} \ln\left[\frac{(1-A)y_1/m - (1-A)x_2 + A\left(\frac{y_1}{m} - x_1\right)}{\frac{y_1}{m} - x_1}\right]$$

$$\therefore \quad N_{tOL} = \frac{1}{1-A} \ln\left[\frac{x_2 - y_1/m}{x_1 - y_1/m}[1-A] + A\right]$$