Example

In laying water mains, utilities are concerned about the possibility of freezing during cold periods. What minimum burial depth would you recommend for a water main under the following conditions: Soil, initially at a uniform temperature of 20°C, is subjected to a constant surface temperature of –15°C for 60 days. Assume the properties of soil to be $\rho = 2050$ kg/m³, $k = 0.52$ W/m-°C, $c = 1840$ J/kg-°C and $\alpha = (k/\rho c) = 0.138 \times 10^{-6}$ m²/s.