

Formulas for Land-Based Water Pollution Control Systems

Area of Square or Rectangle (ft²) = length x width

Area of Circle (ft²) = 3.14 x radius² = π x radius² = πr^2

Volume of Rectangular Tank (ft³) = length x width x depth

Volume of Cylindrical Tank (ft³) = area x height = πr^2 x h

Volume of Tank (gal) = volume of tank (ft³) x 7.48 gal/ft³

Detention Time (unit of time) =
$$\frac{\text{volume (gallons or ft}^3\text{)}}{\text{flow (volume/unit of time)}}$$

Pounds per day (lbs/day) = concentration (mg/L) x flow (MGD) x 8.34 lb/gal

Pounds per year (lbs/year) = mg/L x MGY (annual effluent application) x 8.34 lb/gal

Concentration (mg/L) =
$$\frac{\text{lbs}}{\text{flow (MGD)} \times 8.34 \text{ lb/gal}}$$

Dry weight concentration (mg/kg) =
$$\frac{\text{mg/L}}{\% \text{ solids}}$$

Wet weight concentration (mg/L) = mg/kg x % solids

Pounds per dry ton = mg/kg x .002

Gallons =
$$\frac{\text{Dry tons} \times 2000 \text{ lbs/ton}}{8.34 \text{ lbs/gal} \times \% \text{ solids}}$$
 Dry tons =
$$\frac{\text{Gallons} \times 8.34 \text{ lbs/gal} \times \% \text{ solids}}{2000 \text{ lbs/ton}}$$

Flow Rate (volume/unit time) = area (ft²) x velocity (feet per minute)

Hydraulic Loading Rate (gpd/ft²) =
$$\frac{\text{flow (gpd)}}{\text{area (ft}^2\text{)}}$$

Hydraulic Soils Loading Rate (in/day) =
$$\frac{\text{flow (gpd)}}{27,152 \text{ gal/acre-inch} \times \text{area (acres)}}$$

Horsepower =
$$\frac{\text{flow (gpm)} \times \text{total dynamic head (TDH)}}{3960 \times \text{pump efficiency} \times \text{motor efficiency}}$$

Pump Delivery Rate =
$$\frac{\text{volume pumped (gal)}}{\text{pump run time}}$$

Pump Delivery Rate Efficiency (%) =
$$\frac{\text{Measured pump delivery rate (gpd)}}{\text{design pump delivery rate (gpd)}} \times 100$$

Plant Available Nitrogen (PAN)

$$\text{Surface application} = [\text{MR} \times (\text{TKN} - \text{NH}_3)] + (.5 \times \text{NH}_3) + (\text{NO}_3 + \text{NO}_2)$$

$$\text{Subsurface application} = [\text{MR} \times (\text{TKN} - \text{NH}_3)] + \text{NH}_3 + \text{NO}_3 + \text{NO}_2$$

where: MR = Mineralization Rate
TKN = Total Kjeldhal Nitrogen

$$\text{Sodium Adsorption Ratio (SAR)} = \frac{\text{Na (meq)}}{\sqrt{0.5 \times (\text{Ca (meq)} + \text{Mg (meq)})}}$$

$$\text{Exchangeable Sodium Percentage (ESP)} = \frac{\text{Na (meq)} \times 100}{\text{CEC (meq)}}$$

$$\text{Meq} = \frac{\text{concentration}}{\text{equivalent weight}}$$

$$\text{ALE} = \frac{\text{tons sludge}}{\text{tons ag-lime}} \times \frac{\text{tons ag-lime}}{\text{acre}}$$

$$\text{Site Life} = \frac{\text{Allowable Cumulative Pollutant Loading}}{\text{Annual Pollutant Loading}}$$

$$\text{Travel speed for spreader (mph)} = \frac{\text{spreader load (gallons or tons)} \times 495}{\text{time (min)} \times \text{width (ft)} \times \text{application rate (gal or tons/acre)}}$$

$$\text{Precipitation rate for stationary sprinklers (in/hr)} = \frac{96.3 \times \text{discharge rate (gpm)}}{\text{sprinkler spacing (ft)} \times \text{lateral spacing (ft)}}$$

$$\text{Application depth for traveling gun sprinkler (in)} = \frac{19.3 \times \text{sprinkler discharge rate (gpm)}}{\text{lane spacing (ft)} \times \text{travel speed (in/min)}}$$

$$\text{Time of operation (hours)} = \frac{\text{target application depth (in)}}{\text{precipitation rate (in/hr)}}$$

$$\text{Precipitation rate for traveling gun sprinklers (in/hr)} = \frac{96.3 \times \text{discharge rate (gpm)}}{3.14 \times [0.9 \times \text{sprinkler radius (ft)}]^2} \times \frac{360}{w}$$

$$\text{Travel speed for traveling gun sprinkler (in/min)} = \frac{19.3 \times \text{sprinkler discharge rate (gpm)}}{\text{lane spacing (ft)} \times \text{application depth (in)}}$$