

Water Operator Math - Formulas & Conversions

A free cheat sheet from TradeQBank (tradeqbank.com). Every formula and conversion below is one used by the calculation questions in TradeQBank's verified practice banks - 235 calculation questions across seven banks - and traces to the WPI Formula/Conversion Table or the operator references those questions cite. A formula table is provided with the real exam; the skill tested is picking the right formula and applying it cleanly.

Conversions to know cold

1 ft³ = 7.48 gal | 1 gal of water weighs 8.34 lb | 1 MGD = 694 gpm | 1 MGD = 1.547 cfs | 1 cfs = 448.8 gpm | 1 ft of head = 0.433 psi | 1 psi = 2.31 ft of head | Circle area = $0.785 \times d^2$ | Circumference = $3.14 \times d$

The formulas

Pounds formula (chemical feed)

$$\text{lb/day} = \text{flow (MGD)} \times \text{dose (mg/L)} \times 8.34$$

Solve for any one variable: $\text{dose (mg/L)} = \text{lb/day} / (\text{MGD} \times 8.34)$. The most-used formula on the exams.

Pressure and head

$$\text{psi} = \text{head (ft)} \times 0.433 \quad | \quad \text{head (ft)} = \text{psi} \times 2.31$$

Static pressure under an elevated tank, pump head conversions.

Pipe volume

$$V = 0.785 \times d^2 \times L \quad (\text{d and L in ft} = \text{ft}^3) \quad | \quad \text{gal} = \text{ft}^3 \times 7.48$$

Convert inches to feet first: a 6-inch main has $d = 0.5$ ft.

Tank volume

$$\text{Rectangular: } V = L \times W \times H \quad | \quad \text{Cylindrical: } V = 0.785 \times d^2 \times \text{depth} \quad | \quad \text{gal} = \text{ft}^3 \times 7.48$$

Basins, clarifiers, wet wells, storage tanks.

Detention time

$$DT = \text{volume} / \text{flow}$$

Keep units consistent: gal / gpm = minutes; gal / gph = hours.

Velocity

$$V = Q / A$$

Q in ft³/s, A in ft² gives velocity in ft/s.

Surface loading rate

$$\text{gpd/ft}^2 = \text{flow (gpd)} / \text{surface area (ft}^2)$$

Clarifier and sedimentation basin overflow rates.

Weir loading

$$\text{gpd per ft} = \text{flow (gpd)} / \text{weir length (ft)}$$

For a circular clarifier, weir length = $3.14 \times \text{diameter}$.

Horsepower

$$\text{Water hp} = (\text{gpm} \times \text{head in ft}) / 3,960 \quad | \quad \text{Brake hp} = \text{water hp} / \text{efficiency}$$

Efficiency as a decimal (85% = 0.85).

Chlorine dose

$$\text{Dose} = \text{demand} + \text{residual}$$

If you know the dose applied and the residual measured, $\text{demand} = \text{dose} - \text{residual}$.

Dilution / solution strength

$$C1 \times V1 = C2 \times V2$$

Preparing a weaker solution from a stronger stock.

Sewer slope (collection systems)

$$\text{Slope (\%)} = (\text{fall} / \text{run}) \times 100$$

Fall = upstream invert - downstream invert, in feet; run = pipe length in feet.

Worked examples (from TradeQBank's free samples)

- 1) Chlorine feed: $0.75 \text{ MGD} \times 2.0 \text{ mg/L} \times 8.34 = 12.5 \text{ lb/day}$.
- 2) Detention time: $60,000 \text{ gal} / 500 \text{ gpm} = 120 \text{ min} = 2.0 \text{ hr}$.
- 3) Static pressure: $80 \text{ ft of head} \times 0.433 = 34.6 \text{ psi}$, about 35 psi.
- 4) Pipe volume: $0.785 \times (0.5 \text{ ft})^2 \times 500 \text{ ft} = 98.1 \text{ ft}^3$; $98.1 \times 7.48 = 734 \text{ gal}$ in a 500-ft section of 6-inch main.

Sources

WPI (ABC) Formula/Conversion Table - the table administered with the exams. California State University, Sacramento: Water Treatment Plant Operation, Vols. 1-2; Water Distribution System Operation and Maintenance; Operation of Wastewater Treatment Plants; Operation and Maintenance of Wastewater Collection Systems. Full banks with worked explanations for all 235 calculation questions: tradeqbank.com/pricing. Practice questions are study aids; using them does not guarantee a passing score.