**WATER FORMULA & CONVERSION SHEET**

### GENERAL

1. **Mass, Lbs/Day =** (Vol, MGD) x (Cone.,mg/l) x (8.34 lbs/gal)
2. **Dosage, Mg/L =** (Feed, lbs/day) / (Vol, MGD) x (8.34 lbs/gal)
3. **Rectangular Tank**
   - **Volume, cu.ft. =** (Length, ft) x (Width, ft) x (Height, ft)
   - Vol, Gals = Multiply the above by the factor 7.48 gal/cu.ft
4. **Circular Tank**
   - **Volume, cu.ft. =** (D/2, ft) x (Height, ft)
   - Vol, Gals = Multiply the above by the factor 7.48 gal/cu.ft
5. **Conical Base**
   - **Volume, cu.ft. =** (0.785) x (D/2, ft) x (Height, ft)
   - Vol, Gals = Multiply the above by the factor 7.48 gal/cu.ft
6. **Trapezoid, Volume, cu.ft. =** (B1, ft) + (B2, ft) x Height, ft x Length, ft.
7. **Removal, % =** (In - Out) / In x 100
8. **Decimal Fraction =** (Percent) / 100

**GPCD** means Gallons Per Capita Per Day. A capita is one (1) person.

9. **Gals/Day of Water Consumption =** (Population) x (Gals/Capita/Day)
   - **Consumption Averages, per capita:**
     - Winter = -170 GPCD
     - Spring = -225 GPCD
     - Summer = -325 GPCD

### Chlorine Feed, Dosage / Demand / Residual:

**Gas Chlorine Feed, Lbs/day**

1. **Lbs/Day =** (Vol, MGD) x (Cone., mg/l) x (8.34 lbs/gal)
2. **Dosage, mg/l =** (Lbs/day) / (MGD) x (8.34 lbs/gal)
3. **65% HTH FEED, Lbs/day - Calcium Hypochlorite**
   - HTH, lbs/Day = (Vol, MGD) x (Cone., mg/l) x (8.34 lbs/gal)
   - Dosage, mg/l = (Lbs/day) x (65/8.34)
4. **5-1/4% Liquid Chlorine - Sodium Hypochlorite**
   - Lbs/Gal = (Solution Percentage) x (8.34 lbs/gal)
   - GPD = (Vol, MGD) x (Cone., mg/l) x (8.34 lbs/gal)
   - Dosage, mg/l = (Demand, mg/l) + (Residual, mg/l)
5. **Demand, mg/l =** (Dosage, mg/l) - (Residual, mg/l)
6. **Residual, mg/L =** (Dosage, mg/l) - (Demand, mg/l)

### CHEMICAL FEED & STRENGTH OF SOLUTION

5. **Chemical Feed Pumps:**
   - **GPD =** ml/min x 1,440 min/day
   - 1,000 ml/L x 3.785 L/gal

6. **Chemical Feed rate:**
   - **ml/min =** GPD x 1,000 ml/L x 3.785 L/gal
   - 1,440 min/day

7. **% Percent of Chemical in**
   - Solution from Water Consumption x (Dry wt.,lbs.)
   - Dry Stock

8. **Mixture Strength, %**
   - (Vol 1, Gals) x (Strength 1, %) + (Vol 2, Gals) x (Strength 2, %)
   - (Volume 1, Gals + Volume 2, Gals)

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### PUMPS & PUMPING

1. **Hydraulics:**
   - Head, Ft. = (2.31 ft/psi) x (psi)
   - Force, Lbs = (0.433 psi/ft) x (Head, ft)
2. **Pumping Rate:**
   - Fill rate, GPM = (Tank Volume, Gals) / (time, minutes)
   - Fill Time, min = (Tank Volume, Gals) / (Fill Rate, GPM)
3. **Pumping:**
   - Water Hp = (GPM) x (Head, ft)
   - Brake Hp = (GPM) x (Head, ft) x (3,960 x %, Effic.)
   - %, Effic. = (GPM) x (Head, ft) x 100 / (3,960 x Brake Hp)
4. **GPM =** (Brake Hp) x (3,960) x (%, Effic.) x (Head, ft)
5. **% Overall Effic. =** (Motor, % Effic. x Pump % Effic.)

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**WATER FORMULA & CONVERSION SHEET**

1. **Supply, Days**
   - **(Full to Tank Dry) =** (Vol, Gals / day) / (Population Served) x (GPCD)
2. **GPM =** (Volume, gallons) / (Pumping Time, min.)
3. **Time, min =** (Volume, gallons) / (Pumping Rate, GPM)
4. **Supply, Hrs.**
   - **(Full to Tank Dry) =** (Storage Volume, Gals) / (Flow In, GPM - Flow out, GPM) x 60 min/hr.

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**CHEMICAL FEED & STRENGTH OF SOLUTION**

5. **Chemical Feed Pumps:**
   - **GPD =** ml/min x 1,440 min/day
   - 1,000 ml/L x 3.785 L/gal

6. **Chemical Feed rate:**
   - **ml/min =** GPD x 1,000 ml/L x 3.785 L/gal
   - 1,440 min/day

7. **% Percent of Chemical in**
   - Solution from Water Consumption x (Dry wt.,lbs.)
   - Dry Stock

8. **Mixture Strength, %**
   - (Vol 1, Gals) x (Strength 1, %) + (Vol 2, Gals) x (Strength 2, %)
   - (Volume 1, Gals + Volume 2, Gals)
9. Two Normal Equations
   a) \( C_1 V_1 = C_2 V_2 \)
   b) \( \frac{Q_1}{V_1} = \frac{Q_2}{V_2} \) (Ratio and Proportion)

10. Three Normal Equation
    a) \( (V_1 C_1) + (V_2 C_2) = (V_3 C_3) \)
    b) \( \frac{Q_1}{V_1} = \frac{Q_2}{V_2} \) (Ratio and Proportion)

SEDIMENTATION TANKS & CLARIFIERS:
1. Surface Loading
   Rate, GPD/sq. ft. = \( \frac{(Total \ Flow, \ GPD)}{(Surface \ Area, \ sq.ft.)} \)

2. Detention
   Time, Hrs. = \( \frac{(Volume, \ gals) \times (24 \ hrs./day)}{Total \ 24 \ hrs. \ Flow, \ Gals/day} \)

3. Flow, GPD = \( (Volume, \ Gals) \times (24 \ hrs./day) \)
   (Detention Time, Hrs.)

4. Circumference, ft. = \( 3.141 \pi \times \text{Diameter, ft.} \)

5. Weir Overflow
   Rate, GPD/ft = \( \frac{(Flow, \ GPD)}{(Weir, \ Length, \ ft)} \)

6. Solids Loading
   Rate, lbs/day/sq.ft = \( \frac{(Solids \ into \ Clarifier, \ lbs/day)}{(Surface \ Area, \ sq.ft.)} \)

7. Sludge Solids, Lbs = \( (Flow, \ gals \times \ 8.34 \ lbs/gal) \times \text{Sludge,\ %} \)

8. Raw Sludge
   Pumping, GPM = \( (Settleable \ Solids, \ m/s/l) \times (Plant \ Flow, \ GPM \times (1,000 \ ml/L)) \)

9. Sludge Volume = \( (Settled \ Sludge \ Volume, \ ml/l) \times (1,000 \ mg/G) \)
   Index, mg/l (SVI)

10. mg/l = \( \frac{(ml \ x \ 1,000,000)}{(Sample \ ml)} \)

FILTERATION:
1. Filter Flow Rate:
   Rate, GPM = \( \frac{(Filter \ Area, \ sq.ft. \times (Velocity, \ fps))}{\text{Filter Area, square ft.}} \)

2. filtration Rate, Gpm/sq.ft = \( \frac{(Flow \ Rate, \ GPM)}{(Filter \ Area, \ sq.ft)} \)

3. Filtration Rate, GPD = \( (Filter \ Area, \ sq.ft.) \times \text{GPM/sq.ft.} \times \text{1,440 Min/day} \)

4. Backwash Rate:
   Backwash Pumping = \( (Filter \ Area, \ sq.ft.) \times \text{Backwash Rate, GPM/sq.ft.} \)

5. Filter Backwash:
   Backwash Volume, \( = \frac{(Filter \ Area, \ sq.ft.) \times \text{Backwash Rate, gpm} \times \text{(time, min)}}{\text{Backwash Volume, GPM}} \)
   Backwash Rate = \( \frac{(Backwash Volume, GPM)}{(Filter \ Area, \ sq.ft)} \)
   Backwash, GPM = \( (Area, \ sq.ft.) \times \text{(Height, Rise/Falldrop, ft/Min)} \times \text{(7.48 gals/cu.ft.)} \)

6. Rate of Rise,
   GPM/sq.ft. = \( (Height, \ Rise/Falldrop, \ ft/min) \times (7.48 \ gals/cu.ft.) \)

Velocity:
1. Q, cfs = \( (Area, \ sq.ft.) \times \text{(Velocity, fps)} \)
2. Velocity, fps = \( \frac{Q, cfs}{(Area, \ sq.ft.)} \)
3. Area, sq.ft = \( \frac{Q, cfs}{(Velocity, \ fps)} \)

4. Flow Conversions
   Flow, GPM = \( (Q, cfs) \times (448.8 \ GPM/cfs) \)

5. Q, cfs = \( \frac{(Flow, \ GPM)}{(448.8 \ GPM/cfs)} \)

6. Pipe Diameter, Inches = \( \sqrt{\left(\frac{\text{Area, sq.ft.}}{0.785}\right) \times 12 \ inches/ft} \)

Ion Exchange:
1. Calcium Hardness as mg/l CaCO3 = \( 2.5 \times \text{Calcium, mg/l} \)
2. Magnesium Hardness as mg/l CaCO3 = \( 4.1 \times \text{Magnesium,mg/l} \)
3. Total Hardness = \( \text{Calcium + Magnesium Hardness as CaCO3} \)
4. Convert Hardness from mg/l to grains/gallon:
   \( \frac{(Total \ Hardness, \ mg/l)}{17.1 \ mg/l/Grain} \)

5. Total Exchange Capacity,
   Kilograms = \( (Resin \ Cap., \ kg/\ cm^3) \times \text{Vol, \ cu.ft.)} \)

6. Total Grains capacity = Kilograms x 1,000

7. Gals of Soft Water
   per Service Run = \( \frac{(Total \ Exchange \ Capacity, \ Kilograms)}{\text{(Total Hardness as CaCO3, Grains/gallon)}} \)

8. By-Pass Water, GPD = \( (\text{Flow, GPD} \times \text{(Effluent Harness, Gr/Cal)} \)
   \( \frac{(\text{Influent Harness}, \ Gr/Cal)}{(Initial \ Hardness, \ mg/l)} \)

9. by-pass Water, % = \( \frac{\text{Discharge hardness, mg/l}}{100} \)
   \( \text{Initial hardness, mg/l} \)

10. Salt, lbs = \( \frac{(Capacity, \ Grains)}{\text{Salt, lbs}} \)
   \( (1,000 \ Grains) \)

11. Brine, Gals = \( \frac{(Salt \ Needed, \ lbs)}{(Salt, \ lbs \ / \ gallon)} \)

12. Hardness Removed,
   Grains = \( \frac{(Influent, \ hardness, \ mg/l \ - \text{Effluent hardness, mg/l})}{(17.1 \ mg/l/Grain)} \)

Jar Testing:
1. Dosage, mg/l = \( (Stock \ ml) \times (1,000 \ mg/gram \times \text{(Conc., Grams/L)}) \)
   \( \text{(Sample Size, ml)} \)

2. Grams/Liter = \( \frac{(mg/l \times 1,000 \ ml)}{(ml \times 1,000 \ mg/l)} \)

3. Alum Reacting,
   mg/l = \( \frac{(1.0 \ mg/l \ Alum \times \text{Raw Alk., mg/l - Alk. Present, mg/l})}{(0.45 \ mg/l \ Alkalinity)} \)

4. Alkalinity Dosage,
   mg/l = \( \frac{(Total, \ mg/l \ - \text{Alum Reacting, mg/l})}{(ml \ Sample)} \)

Laboratory:
1. TSS (mg/l) = \( \frac{(ml \ of \ sample \ x \ normalcy \ x \ 50,000)}{(ml \ of \ sample)} \)

2. Concentrations:
   (Conc. 1) \times (Volume 1) = (Conc. 2) \times (Volume 2)

3. Temperature:
   \( F^\circ = \frac{C^\circ \times 1.8 + 32^\circ}{1.8} \)

CONVERSION FACTORS:
7.48 gallons / cu.ft = 1,000 mL / liter
1 cubic foot of water = 62.4 lbs. = 1,000 mg / mL
8.34 lbs / gallon = 12 inches / foot
1,440 minutes / day = 2.31 ft / psi
448.8 GPM / CFS = 0.433 psi / 1 ft water
1.55 cfs / MGD = 694.4 GPM/MGD
Ac-ft = 325,851 gallons = 0.746 Kw / BHp
1,000 mg / gram = 33,000 lbs / min per 1 Hp
3.785 liters / gallon = 746 watts / 1 Hp
10,000 mg/L = 1% = 27 cubic feet = 1 cubic yard