**ABBREVIATIONS**

**English**
- ac-ft. = acre-foot or acre-feet
- b = base (of right triangle)
- °C = degrees Celsius
- cfs or ft³/sec = cubic feet per second
- cfm or ft³/min = cubic feet per minute
- cfd or ft³/day = cubic feet per day
- D = diameter (circle)
- °F = degrees Fahrenheit
- fps or ft./sec = feet per second
- ft. = feet
- ft² or sq. ft. = square feet
- ft³ or cu. ft. = cubic feet
- gpd = gallons per day
- gpg = grains per gallon
- gpm = gallons per minute
- gps = gallons per second
- h = height
- hp = horsepower
- hr = hour
- hrs/day = hours per day
- in = inches
- in² = square inches
- in³ = cubic inches
- lbs. = pounds
- mi = miles
- min = minute
- MG = million gallons
- mgd or MGD = million gallons per day
- oz = ounces
- ppb = parts per billion
- ppm = parts per million
- ppt = parts per trillion
- psi = pounds per square inch
- Q = flow
- r = radius (circle)
- sec = second
- V = volume
- W = watts

**Metric**
- cm = centimeters
- g = gram
- Ha = Hectare
- kg = kilogram
- km = kilometer
- kW = kilowatt
- L or l = liters
- m = meter
- m³ = cubic meter
- mg = milligram
- mg/L or mg/l = milligrams per liter
- mL = ml or milliliter
- mm = millimeter

**CONVERSION FACTORS**

**LENGTH**

**English**
- 1 foot = 12 in.
- 1 foot = 0.305 m
- 1 inch = 2.54 cm
- 1 mile = 5,280 ft.
- 1 mile = 1.609 km
- 1 yard = 3 ft.

**Metric**
- 1 centimeter = 0.3937 in.
- 1 kilometer = 0.6214 mi.
- 1 meter = 39.37 in.

**AREA**

**English**
- 1 acre (ac) = 43,560 ft²
- 1 acre = 0.405 Hectare (Ha)
- 1 ft² = 144 in²
- 1 in² = 6.45 cm²
- 1yd² = 9 ft²

**Metric**
- 1 Hectare = 2.47 acres
**VOLUME**

**English**
- 1 acre-ft. = 325,828.8 gallons
- 1 acre-ft. = 43,560 ft³
- 1 cfs = 0.646 MGD
- 1 ft³ = 7.48 gallons
- 1 ft³ = 1,728 in³
- 1 gallon = 231 in³
- 1 gallon = 0.1337 ft³
- 1 gallon = 0.000001 MG
- 1 gallon = 3.785 liter
- 1 gallon = 3,785 mL
- 1 yd³ = 27 ft³

**Metric**
- 1 liter = 1,000 mL
- 1 liter = 0.2642 gallons
- 1 m³ = 264.2 gallons
- 1 m³ = 35.315 ft³

**FLOW**

**English**
- 1 ft³/sec = 646,300 gpd
- 1 ft³/sec = 0.6463 MGD
- 1 ft³/sec = 448.8 gpm
- 1 gpm = 0.00144 MGD

**Metric**
- 1 MGD = 694.4 gpm
- 1 MGD = 1.545 cfs
- 1 MGD = 3.07 acre-ft/day

**WEIGHT & MASS**

**English**
- 1 ft³ water = 62.4 lbs.
- 1 gallon water = 8.34 lbs.
- 1 gpg = 17.118 mg/L
- 1 lb. = 16 oz
- 1 lb. = 7,000 grains
- 1 lb. = 453.6 g
- 1 lb. = 0.4536 kg
- 1 ton = 2,000 lbs.

**Metric**
- 1 g = 1,000 mg
- 1 kg = 1,000 g
- 1 kg = 2.2 lbs.
- 1 mg/L = 0.0584 gpg
- 1% = 10,000 mg/L

**DOSAGE**

**English**
- 1% = 10,000 mg/L
- 1 gpg = 17.1 ppm
- 1 ppm = 1 mg/L
- 1 ppm = 8.34 lbs. per million gal

**PRESSURE**

**English**
- 1 ft. water = 0.433 psi
- 1 psi = 2.31 ft. water

**TIME**

**English**
- 1 min = 60 sec
- 1 hr. = 60 min
- 1 day = 24 hrs
- 1 day = 1,440 min
FORMULAS

For the operator’s convenience, both equation formulas and pie wheel formulas are included in this document. When using the pie wheel formula to solve a problem, multiply together the pie wedges below the horizontal line to solve for the quantity above the horizontal line. To solve for one of the pie wedges below the horizontal line, cover the pie wedge for which you are solving and divide the remaining pie wedge(s) below the horizontal line into the quantity above the horizontal line.

Area Formulas

Circle = (0.785) \times (D^2)

Where:
Circle = area of circle
D = diameter of circle

Circle = (\pi) \times (r^2)

Where:
Circle = area of circle
r = radius of circle
\pi = 3.1416

Cone (lateral area) = (\pi) \times (r) \times (\sqrt{r^2 + h^2})

Where:
\pi = 3.1416
r = radius of circle
h = height of cone

Cone (area) = (b) \times (h)/2

Where:
b = circumference
h = height

Cone (surface area) = (\pi) \times (r) \times (r + \sqrt{r^2 + h^2})

Where:
\pi = 3.1416
r = radius of circle
h = height of cone
Sphere (area) = $\pi \times (D^2)$ or Sphere (area) = $4 \times \pi \times (r^2)$

$\pi = 3.1416$

$r = \text{radius of circle}$

$D = \text{diameter of circle}$

---

Rectangle = $l \times w$

$l = \text{length of rectangle}$

$w = \text{width of rectangle}$

---

Triangle (area) = $[(b) \times (h)]/2$

$b = \text{base of triangle}$

$h = \text{height of triangle}$
**Circumference of Circle**

\[
\text{Circumference} = (\pi) \times (D) \\
\text{Where:} \\
\pi = 3.1416 \\
D = \text{diameter of circle}
\]

\[
\text{Circumference} = (2) \times (\pi) \times (r) \\
\text{Where:} \\
\pi = 3.1416 \\
r = \text{radius of circle}
\]

**Volume Formulas**

\[
\text{Cone} = (1/3) \times (0.785) \times (D^2) \times (h) \\
\text{Where:} \\
D = \text{diameter of cone} \\
h = \text{height of cone}
\]

\[
\text{Cone} = 1/3 \times [(\pi) \times (r^2) \times (h)] \\
\text{Where:} \\
\pi = 3.1416 \\
r = \text{radius of cone} \\
h = \text{height of cone}
\]

\[
\text{Cylinder} = (0.785) \times (d^2) \times (h) \\
\text{Where:} \\
D = \text{diameter of cylinder} \\
h = \text{length of cylinder}
\]
Cylinder = \((\pi) \times (r^2) \times (h)\)

Where:
- \(\pi = 3.1416\)
- \(r\) = radius of cylinder
- \(h\) = length of cylinder

Rectangular Tank = \((l) \times (w) \times (h)\)

Where:
- \(l\) = length of tank
- \(w\) = width of tank
- \(h\) = height of tank

Flow Formulas

\[ Q = (A) \times (V) \]

Where:
- \(Q = \) flow (ft\(^3\)/sec)
- \(A = \) cross-section area (ft\(^2\))
- \(V = \) water velocity (ft./sec)

\[ Q = (w) \times (d) \times (V) \]

Where:
- \(Q = \) flow in channel (ft\(^3\)/sec)
- \(w = \) width (ft.)
- \(d = \) depth (ft.)
- \(V = \) velocity (ft./sec)

\[ Q = (0.785) \times (D)^2 \times (V) \]

Where:
- \(Q = \) flow in full pipe (ft\(^3\)/sec)
- \(D = \) diameter (ft.)
- \(V = \) velocity (ft./sec)
\[ Q = \{1.333 \times (h)^2 \times \sqrt{(D/h) - 0.608}\} \times (V) \]

Where:
- \( Q \) = flow in partially full pipe (ft\(^3\)/sec)
- \( h \) = height (ft.)
- \( D \) = diameter (ft.)
- \( V \) = velocity (ft./sec)

See also **Appendix A: Flow Through a Partially Full Pipe** (table)

\[ V = \frac{(Q)}{(0.785 \times (D)^2)} \]

Where:
- \( V \) = velocity (ft./sec)
- \( Q \) = flow (ft\(^3\)/sec)
- \( D \) = diameter (ft.)

\[ V = \frac{(d)}{(T)} \]

Where:
- \( V \) = velocity (ft./sec)
- \( d \) = distance (ft.)
- \( T \) = time (sec)

\[ Q = \frac{(\sum Q_{\text{daily}})}{(n_{\text{daily}})} \]

Where:
- \( Q \) = avg. daily flow (MGD)
- \( \sum Q_{\text{daily}} \) = sum all daily flows (MGD)
- \( n_{\text{daily}} \) = number of daily flows

\[ Q = \frac{(\sum Q_{\text{monthly}})}{(n_{\text{monthly}})} \]

Where:
- \( Q \) = avg. daily flow (MGD)
- \( \sum Q_{\text{monthly}} \) = sum all monthly avg. daily flows (MGD)
- \( n_{\text{monthly}} \) = number of monthly avg. daily flows

\[ Q = \frac{(\text{Water used})}{(\text{Population})} \]

Where:
- \( Q \) = daily flow (gal/capita/day)
- water used or produced = gal/day
- population = total # people served

\[ \text{Overflow rate} = \frac{(Q)}{(L)} \]

Where:
- overflow rate = weir overflow rate (gpd/ft.)
- \( Q \) = flow (gpd)
- \( L \) = weir length (ft.)

**Dosage Formulas**

\[ \text{Dosage} = \frac{\text{Feed rate}}{(Q) \times (8.34 \text{ lbs./gal})} \]

Where:
- dosage = mg/L
- feed rate = chemical feed rate (lbs./day)
- \( Q \) = flow rate (MGD)
Dosage = \( \frac{(\text{Feed rate}) \times (\text{Purity})}{(Q) \times (8.34 \text{ lbs./gal})} \)

Where:
- \( \text{dosage} = \text{mg/L} \)
- \( \text{feed rate} = \text{chemical feed rate (lbs./day)} \)
- \( \text{purity} = \text{chemical purity, } \% \text{ expressed as decimal} \)
- \( Q = \text{flow rate (gal/min.)} \)

Dosage = \( \frac{(\text{Feed rate}) \times (1,000 \text{ mg/g})}{(Q) \times (3.785 \text{ L/gal})} \)

Where:
- \( \text{dosage} = \text{mg/L} \)
- \( \text{feed rate} = \text{chemical feed rate (lbs./day)} \)
- \( Q = \text{flow rate (gal/min.)} \)

Dose = Demand + Residual

---

**Chemical Feed/Feed Rate Formulas (aka pounds)**

Chemical feed = \( (d) \times (V) \times (8.34 \text{ lbs./gal}) \)

Where:
- \( \text{chemical fee} = \text{lbs.} \)
- \( d = \text{dose (mg/L)} \)
- \( V = \text{volume (MG)} \)

Chemical feed = \( (d) \times (V) \times (8.34 \text{ lbs./gal}) \) *Chemical purity*

Where:
- \( \text{chemical fee} = \text{lbs.} \)
- \( d = \text{dose (mg/L)} \)
- \( V = \text{volume (MG)} \)
- \( \text{Chemical purity} = \% \), expressed as decimal

Feed rate = \( (d) \times (Q) \times (8.34 \text{ lbs./gal}) \)

Where:
- \( \text{feed rate} = \text{lbs./day} \)
- \( d = \text{dose (mg/L)} \)
- \( Q = \text{flow (MGD)} \)

Feed rate = \( (d) \times (Q) \times 8.34 \text{ lbs./gal} \) *Chemical Purity*

Where:
- \( \text{feed rate} = \text{lbs./day} \)
- \( d = \text{dose (mg/L)} \)
- \( Q = \text{flow (MGD)} \)
- \( \text{Chemical purity} = \% \), expressed as decimal
Feed rate = \( \frac{(C \times V \times (1,440 \text{ min/day}) \times (T \times (1,000 \text{ mg/g}) \times (453.6 \text{ g/lb.})}{\text{feed rate}} \)

Where:
- \( C = \text{concentration (mg/mL)} \)
- \( V = \text{volume pumped (mL)} \)
- \( T = \text{time pumped (min.)} \)

---

**Chemical Feed Pump Formulas**

Chemical Feed Stroke = \( \frac{Q_d}{Q_m} \times 100\% \)

Where:
- chemical feed stroke, expressed as \( \% \)
- \( Q_d = \text{desired flow} \)
- \( Q_m = \text{maximum flow} \)

---

Feed pump rate = \( \frac{Q \times d \times (3.785 \text{ L/gal}) \times (1,000,000 \text{ gal/MG}) \times (L \times (24 \text{ hr./day}) \times (60 \text{ min/hr.})}{\text{feed pump rate}} \)

Where:
- feed pump rate = \( \text{mL/min} \)
- \( Q = \text{flow (MDG)} \)
- \( d = \text{dose (mg/L)} \)
- \( L = \text{liquid (mg/mL)} \)

---

**Power Formulas**

\( AC \text{ circuit} = V \times A \times PF \)

Where:
- \( AC = \text{AC circuit} \)
- \( V = \text{volts} \)
- \( A = \text{amps} \)
- \( PF = \text{power factor} \)

---

\( \text{Amps} (A) = \frac{V}{O} \)

Where:
- \( A = \text{amps} \)
- \( V = \text{volts} \)
- \( O = \text{ohms} \)

---

\( \text{Amps} = \frac{(746 \text{ watts/hp}) \times (hp) \times (V \times (Eff) \times (Pf)}{(V \times (Eff) \times (Pf)} \)

Where:
- \( \text{Amps is single phase} \)
- \( hp = \text{horsepower} \)
- \( V = \text{volts} \)
- \( Eff = \text{efficiency (\%), as decimal} \)
- \( Pf = \text{power factor} \)

---

\( \text{Amps} = \frac{(746 \text{ watts/hp}) \times (hp) \times (V \times (Eff) \times (Pf)}{(1.732) \times (V) \times (Eff) \times (Pf)} \)

Where:
- \( \text{Amps is three-phase} \)
- \( hp = \text{horsepower} \)
- \( V = \text{volts} \)
- \( Eff = \text{efficiency (\%), as decimal} \)
- \( Pf = \text{power factor} \)
Watts = \( V \times A \)

Where:
- Watts = DC or AC circuit
- \( V \) = volts
- \( A \) = amps

Electromotive Force (EMF) = \( I \times R \)

Where:
- EMF = electromotive force
- \( I \) = current (amps)
- \( R \) = resistance (ohms)

**PUMPS**

**Pumping Formulas**

Pumping Rate = \( \frac{V}{T} \)

Where:
- pumping rate in gal/min
- \( V \) = volume (gal.)
- \( T \) = time (min.)

Pumping Rate = \( L \times W \times D \times \frac{7.48 \text{ gal/ft}^3}{T} \)

Where:
- pumping rate in gal/min
- \( L \) = length (ft.)
- \( W \) = width (ft.)
- \( D \) = depth (ft.)
- \( T \) = time (min.)

Pumping Rate = \( \frac{0.785 \times d^2 \times D \times 7.48 \text{ gal/ft}^3}{T} \)

Where:
- pumping rate in gal/min
- \( d \) = diameter (ft.)
- \( D \) = depth (ft.)
- \( T \) = time (min.)

Time to Fill = \( \frac{\text{Tank volume}}{\text{Flow Rate}} \)

Where:
- time to fill in min.
- tank volume in gal.
- flow rate in gal/min.
**Horsepower, Motor & Pump Efficiency**

\[
\text{whp} = \frac{F \times H}{3,960}
\]

Where:
- \( \text{whp} \) = water horsepower
- \( F \) = flow (gpm)
- \( H \) = head (ft.)

\[
\text{bhp} = \frac{F \times H}{3,960 \times PE}
\]

Where:
- \( \text{bhp} \) = brake horsepower
- \( F \) = flow (gpm)
- \( H \) = head (ft.)
- \( \text{PE} \) = pump efficiency (%), as decimal

\[
\text{bhp} = \frac{\text{whp}}{\text{PE}}
\]

Where:
- \( \text{bhp} \) = brake horsepower
- \( \text{whp} \) = water horsepower
- \( \text{PE} \) = pump efficiency (%), as decimal

\[
\text{mhp} = \frac{F \times H}{3,960 \times \text{PE} \times \text{ME}}
\]

Where:
- \( \text{mhp} \) = motor horse power
- \( F \) = flow (gpm)
- \( H \) = head (ft.)
- \( \text{PE} \) = pump efficiency (%), as decimal
- \( \text{ME} \) = motor efficiency (%), as decimal

\[
\text{mhp} = \frac{\text{bhp}}{\text{ME}}
\]

Where:
- \( \text{mhp} \) = motor horse power
- \( \text{Bhp} \) = brake horsepower
- \( \text{ME} \) = motor efficiency (%), as decimal

\[
\text{ME} = \frac{\text{bhp}}{\text{mhp}} \times 100\%
\]

Where:
- \( \text{ME} \) = motor efficiency (%)
- \( \text{bhp} \) = brake horsepower
- \( \text{mhp} \) = motor horse power

\[
\text{PE} = \frac{\text{whp}}{\text{bhp}} \times 100\%
\]

Where:
- \( \text{PE} \) = pump efficiency (%)
- \( \text{whp} \) = water horsepower
- \( \text{bhp} \) = brake horsepower
Efficiency = $\frac{\text{hp output}}{\text{hp supplied}} \times 100\%$

Where: efficiency is \%

Overall Efficiency = $(\text{whp}/\text{mhp}) \times 100\%$

Where: overall efficiency is \%
whp = water horsepower
mhp = motor horse power

Wire to water efficiency = $\frac{\text{whp}}{\text{Power input or mhp}}$

Where: wire to water efficiency is \%
whp = water horsepower
mhp = motor horse power
power input is hp

Wire to water efficiency = $(\text{PE} \times \text{ME}) \times 100\%$

Where: wire to water efficiency is \%
PE = pump efficiency (\%)
ME = motor efficiency (\%)

Static Head = Suction lift + Discharge Head

Where: Static Head in ft.
Suction Lift in ft.
Discharge Head in ft.

Static Head = Discharge Head – Suction Head

Where: Static Head in ft.
Discharge Head in ft.
Suction Head in ft.

Friction Loss = $(0.1) \times (\text{Static Head})$

** use this formula in absence of other data

Where: Friction Loss is ft.
Static Head is ft.

Total Dynamic Head = Static Head + Friction Loss

Where: Total Dynamic Head is ft.
Static Head is ft.
Friction Loss is ft.

Cost = $(\text{Motor hp}) \times (0.746 \text{ kW/hp}) \times (\text{Cost, } \$/\text{kW-hr})$

Where: Cost is \$/hr.
**Sedimentation Formulas**

Where:  
**DT** = detention time (hr.)  
**V** = volume of tank or basin (gal)  
**Q** = flow rate (gal/day)

\[
DT = \frac{V \times (24 \text{ hr./day})}{Q}
\]

Where:  
**DT** = detention time (days)  
**V** = volume of tank or basin (gal)  
**Q** = flow rate (gal/day)

\[
DT = \frac{V}{Q}
\]

Where:  
weir overflow rate = gal/day/ft.  
**Q** = flow rate (gal/day)  
**L** = total weir length (ft.)

\[
\text{Weir Overflow Rate} = \frac{Q}{L}
\]

Where:  
weir overflow rate = gal/day/ft.  
**Q** = flow rate (gal/day)  
**l** = weir length (ft.)  
**w** = weir width (ft.)

\[
\text{Weir Overflow Rate} = \frac{Q}{2l + 2w}
\]

Where:  
weir overflow rate = gal/day/ft.  
**Q** = flow rate (gal/day)  
**D** = weir diameter (ft.)

\[
\text{Weir Overflow Rate} = \frac{Q}{(3.14) \times D}
\]

Where:  
surface overflow rate = gal/day/ft\(^2\)  
**Q** = flow rate (gal/day)  
**A** = surface area (ft\(^2\))

\[
\text{Surface Overflow Rate} = \frac{Q}{A}
\]

**TRICKLING FILTERS**

Where:  
**HLR** = hydraulic loading rate (gpd/ft\(^2\))  
**Q\(_1\)** = primary effluent flow (gpd)  
**Q\(_2\)** = recirculated flow (gpd)  
**A** = surface area (ft\(^2\))

\[
HLR = \frac{(Q_1 + Q_2)}{A}
\]

Where:  
**BOD\(_5\)** of RBC = lbs./day/1,000 ft\(^2\)  
**BOD\(_5\)** = lbs./day  
**A** = surface area of media (1,000ft\(^2\))

\[
\text{BOD}\(_5\) \text{ of RBC} = \frac{\text{BOD}\(_5\)}{A}
\]
BOD₅ = (BOD₃)/(V)  
Where:  
BOD₅ = lbs./day/1,000 ft³  
BOD₃ = lbs./day  
V = volume of media (1,000 ft³)

V = [(0.785) x (D)² x (d)]/1,000  
Where:  
V = volume of media (1,000 ft³)  
D = diameter of trickling filter (ft)  
d = media depth (ft)

PE = (Q) x (BOD₅) x (8.34 lbs./gal) / BOD  
Where:  
PE = population equivalent  
Q = flow (MGD)  
BOD₅ = mg/L  
BOD = lbs./day/person

Recirculation Ratio = (Q₂)/(Q₁)  
Where:  
Q₂ = recirculated flow (MGD)  
Q₁ = primary effluent flow (MGD)

Recirculation Rate, % = [(Q₂)/Q₁] x 100%  
Where:  
Q₂ = recirculated flow (MGD)  
Q₁ = primary effluent flow (MGD)

Reduction in flow, % = [(Q_{original} – Q_{reduced})/(Q_{original})] x 100%  
Where:  
Q_{original} = original flow  
Q_{reduced} = reduced flow

Reduction of volatile solids, % = {(In – Out)/[In – (In x Out)]} x 100%  
Where:  
VS = volatile solids, expressed as %  
All information (In & Out) must be in decimal form

Efficiency, % = [(In – Out)/In] x 100%

BOD removed (lbs./day) = [BOD removed (mg/L)] x (Q) x (8.34 lbs./gal)  
Where:  
Q = flow (MGD)
SS removed (lbs./day) = [SS removed (mg/L)] \times (Q) \times (8.34 \text{ lbs./gal})

Where:
- SS = suspended solids
- Q = flow (MGD)

---

**ACTIVATED SLUDGE**

\[
\text{BOD}_5 = \frac{(\text{DO}_t - \text{DO}_f) \times 300}{V_{\text{sample}}}
\]

Where:
- \(\text{BOD}_5\) = mg/L.
- DO\(_t\) = initial DO (mg/L)
- DO\(_f\) = final DO (mg/L)
- \(V_{\text{sample}}\) = sample volume (mL)
- BOD bottle = 300 mL.

---

BOD loading = (BOD\(_5\)) \times (Q) \times (8.34 \text{ lbs./gal})

Where:
- BOD loading = lbs./day
- BOD\(_5\) = biological oxygen demand (mg/L)
- Q = flow (MGD)

---

COD loading = (COD) \times (Q) \times (8.34 \text{ lbs./gal})

Where:
- COD loading = lbs./day
- COD = chemical oxygen demand (mg/L)
- Q = flow (MGD)

---

MLSS (lbs.) = (MLSS, mg/L) \times (V) \times (8.34 \text{ lbs./gal})

Where:
- MLSS = mixed liquor suspended solids
- V = aerator volume (MG)

---

MLVSS = (MLSS) \times (V) \times (8.34 \text{ lbs./gal}) \times (VS)

Where:
- MLVSS = lbs.
- MLSS = mixed liquor suspended solids (mg/L)
- V = aerator volume (MG)
- VS = volatile solids % (expressed as decimal)

---

SVI = \frac{(SSV_{\text{wet}}) \times (1,000)}{SSM_{\text{dried}}}

Where:
- SVI = sludge volume index (mL/g)
- SSV\(_{\text{wet}}\) = wet settled sludge volume (mL)
- SSM\(_{\text{dried}}\) = dried sludge solids mass (mg)
SVI = \((SSC) \times (1,000,000)\) / \(MLSS\)

Where:
- \(SVI\) = sludge volume index (mL/g)
- \(SSC\) = settleable solids concentration % (expressed as decimal)
- \(MLSS\) = mixed liquor suspended solids (mg/L)

SVI = \((SSV) \times (1,000 \text{ mg/g})\) / \(MLSS\)

Where:
- \(SVI\) = sludge volume index (mL/g)
- \(SSV\) = settled sludge volume (mL/L)
- \(MLSS\) = mixed liquor suspended solids (mg/L)

SDI = \((100)/(SVI)\)

Where:
- \(SDI\) = sludge density index
- \(SVI\) = sludge volume index (mL/g)

**Seeded BOD**

\[
BOD_5 = \frac{(D_1 - D_2) - (S) \times (V_S)}{P}
\]

Where:
- \(BOD_5\) = lbs./day
- \(D_1\) = DO of sample after prep (mg/L)
- \(D_2\) = DO of sample after 5-day incubation at 20°C (mg/L)
- \(S\) = oxygen uptake of seed \((S = 0\) if sample not seeded\)
- \(V_S\) = volume of seed in test bottle (mL)
- \(P\) = decimal volumetric fraction of sample used \((1/P = \text{dilution factor})\)

**F/M Ratio (‘Food to Mass’ or ‘Food to Microorganism’ Ratio)**

\[
F/M \text{ ratio} = \frac{(BOD \text{ or } COD)}{MLVSS}
\]

Where:
- \(BOD\) = biological oxygen demand (lbs./day)
- \(COD\) = chemical oxygen demand (lbs./day)
- \(MLVSS\) = mixed liquor volatile suspended solids (lbs.)

\[
F/M \text{ ratio} = \frac{(BOD \text{ or } COD)}{(MLSS \times (VS))}
\]

Where:
- \(BOD\) = biological oxygen demand (lbs./day)
- \(COD\) = chemical oxygen demand (lbs./day)
- \(MLSS\) = mixed liquor suspended solids (lbs.)
- \(VS\) = volatile solids, % (expressed as decimal)
F/M ratio = \( \frac{(BOD \text{ or } COD) \times (Q) \times (8.34 \text{ lbs./gal})}{(MLVSS) \times (V) \times (8.34 \text{ lbs./gal})} \)

Where:
- \( BOD = \) biological oxygen demand (mg/L)
- \( COD = \) chemical oxygen demand (mg/L)
- \( Q = \) flow (MGD)
- \( MLVSS = \) mixed liquor volatile suspended solids (mg/L)
- \( V = \) aerator volume (MG)

F/M ratio = \( \frac{(BOD \text{ or } COD) \times (Q) \times (8.34 \text{ lbs./gal})}{(MLVSS) \times (VS) \times (V) \times (8.34 \text{ lbs./gal})} \)

Where:
- \( BOD = \) biological oxygen demand (mg/L)
- \( COD = \) chemical oxygen demand (mg/L)
- \( Q = \) flow (MGD)
- \( MLVSS = \) mixed liquor volatile suspended solids (mg/L)
- \( VS = \) volatile solids, % (expressed as decimal)
- \( V = \) aerator volume (MG)

MLVSS (desired) = \( \frac{(\text{BOD or COD})}{\text{F/M Ratio (desired)}} \)

Where:
- \( \text{BOD} = \) biological oxygen demand (lbs./day)
- \( \text{COD} = \) chemical oxygen demand (lbs./day)

MLSS (desired) = \( \frac{\text{MLVSS (desired)}}{\text{VS}} \)

Where:
- \( \text{MLSS} = \) mixed liquor suspended solids (lbs.)
- \( \text{MLVSS} = \) mixed liquor volatile suspended solids (lbs.)
- \( \text{VS} = \) volatile solids, % (expressed as decimal)

**RAS (Return Activated Sludge)**

RAS flow = \( \left[ \frac{SSV}{(1000 \text{ mL}) - (SSV)} \right] \times 100\% \)

Where:
- \( \text{RAS flow} \) expressed as %
- \( \text{SSV} = \) settled sludge volume (mL)

RAS flow = \( \left[ \frac{Q_{\text{RAS}}}{Q_{\text{Influent}}} \right] \times 100\% \)

Where:
- \( \text{RAS flow} \) expressed as %
- \( Q_{\text{RAS}} = \) RAS flow (MGD)
- \( Q_{\text{Influent}} = \) influent flow (MGD)

RAS flow_{final} = (RAS flow \%) \times Q

Where:
- \( \text{RAS flow}_{final} = \) final RAS flow (gal/day)
- \( \text{RAS flow \%} \) is expressed as decimal
- \( Q = \) flow (gpd)
RAS flow = \((Q_{\text{Influent}}) \times (\text{MLSS})\) / (RSC) – (MLSS)

Where:
- RAS flow = gal/day
- \(Q_{\text{Influent}}\) = aerator influent flow (gpd)
- MLSS = mixed liquor suspended solids (mg/L)
- RSC = return sludge concentration (mg/L)

\[\text{RSC} = \frac{1,000,000}{SVI}\]

Where:
- RSC = return sludge concentration (mg/L)
- SVI = sludge volume index (mL/g)

RAS (solids balance) = \((\text{MLSS}) \times (Q)\) / (RAS SS) – (MLSS)

Where:
- RAS = return activated sludge
- MLSS = mixed liquor suspended solids
- Q = flow rate
- RAS SS = return activated sludge suspended solids

MCRT or SRT (‘Mean Cell Residence Time’ or ‘Solids Retention Time’)

\[\text{MLSS}_{\text{final}} = (\text{MLSS}_{\text{actual}}) \times (V) \times (8.34 \text{ lbs./gal})\]

Where:
- \(\text{MLSS}_{\text{final}}\) = final actual MLSS (lbs.)
- \(\text{MLSS}_{\text{actual}}\) = actual MLSS (mg/L)
- V = aerator volume (MG)

\[\text{MCRT} = \frac{\text{SS}_{\text{in}}}{\text{SS}_{\text{leaving}}}\]

Where:
- MCRT = days
- \(\text{SS}_{\text{in}}\) = suspended solids in system (lbs.)
- \(\text{SS}_{\text{leaving}}\) = suspended solids leaving system (lbs./day)

\[\text{MCRT} = \frac{\text{SS}_{\text{in}}}{(\text{WAS SS}) + (\text{SE SS})}\]

Where:
- MCRT = days
- \(\text{SS}_{\text{in}}\) = suspended solids in system (lbs.)
- WAS SS = waste activated sludge SS (lbs./day)
- SE SS = secondary effluent SS (lbs./day)

No clarifier info given:

\[\text{MCRT} = \frac{(\text{MLSS}) \times (V) \times (8.34 \text{ lbs./gal})}{[(\text{WAS SS}) \times (Q_{\text{WAS}}) \times (8.34 \text{ lbs./gal})] + [(\text{SE SS}) \times (Q_{\text{Plant}}) \times (8.34 \text{ lbs./gal})]}\]

Where:
- MCRT = days
- MLSS = mixed liquor suspended solids (mg/L)
- V = aerator volume (MG)
- WAS SS = waste activated sludge SS (mg/L)
- Q_{\text{WAS}} = WAS flow (MGD)
- SE SS = secondary effluent SS (mg/L)
- Q_{\text{Plant}} = plant flow (MGD)
**Final clarifier volume given but no clarifier core suspended solids (CCSS):**

\[
MCRT = \frac{(MLSS) \times (V_{aerator}) \times (8.34 \text{ lbs./gal})}{[(WAS \text{ SS}) \times (Q_{WAS}) \times (8.34 \text{ lbs./gal})] + [(SE \text{ SS}) \times (Q_{Plant}) \times (8.34 \text{ lbs./gal})]} + (V_{clarifier}) \times (8.34 \text{ lbs./gal}) .
\]

Where:
- \(MCRT\) = days
- \(MLSS\) = mixed liquor suspended solids (mg/L)
- \(V_{aerator}\) = aerator volume (MG)
- \(V_{clarifier}\) = final clarifier volume (MG)
- \(WAS \text{ SS}\) = waste activated sludge SS (mg/L)
- \(Q_{WAS}\) = WAS flow (MGD)
- \(SE \text{ SS}\) = secondary effluent SS (mg/L)
- \(Q_{Plant}\) = plant flow (MGD)

**Final clarifier volume & clarifier core suspended solids (CCSS) given:**

\[
MCRT = \frac{(MLSS) \times (V_{aerator}) \times (8.34 \text{ lbs./gal}) + (CCSS) \times (V_{clarifier}) \times (8.34 \text{ lbs./gal})}{(WAS \text{ SS}) \times (Q_{WAS}) \times (8.34 \text{ lbs./gal}) + (SE \text{ SS}) \times (Q_{Plant}) \times (8.34 \text{ lbs./gal})} .
\]

Where:
- \(MCRT\) = days
- \(MLSS\) = mixed liquor suspended solids (mg/L)
- \(V_{aerator}\) = aerator volume (MG)
- \(CCSS\) = clarifier core suspended solids (mg/L)
- \(V_{clarifier}\) = final clarifier volume (MG)
- \(WAS \text{ SS}\) = waste activated sludge SS (mg/L)
- \(Q_{WAS}\) = WAS flow (MGD)
- \(SE \text{ SS}\) = secondary effluent SS (mg/L)
- \(Q_{Plant}\) = plant flow (MGD)

**Waste Activated Sludge (WAS):**

\[
WAS = \left[\frac{(MLSS) \times (V_{aerator}) \times (8.34 \text{ lbs./gal})}{MCRT}\right] - [(SE \text{ SS}) \times (Q_{Plant}) \times (8.34 \text{ lbs./gal})] .
\]

Where:
- \(WAS\) = lbs./day
- \(MLSS\) = mixed liquor suspended solids (mg/L)
- \(V_{aerator}\) = aerator volume (MG)
- \(MCRT\) = days
- \(SE \text{ SS}\) = secondary effluent SS (mg/L)
- \(Q_{Plant}\) = plant flow (MGD)
MLSS\text{final} = \left[ \frac{\text{MLSS}_{\text{initial}}}{(\text{RAS}) \times (8.34 \text{ lbs./gal})} \right] \times 1,000,000 \quad \text{Where:} \\
\text{MLSS}_{\text{final}} = \text{MLSS to waste (gal)} \\
\text{MLSS}_{\text{initial}} = \text{MLSS to waste (lbs.)} \\
\text{RAS} = \text{RAS concentration (mg/L)} \\

\text{Min. to WS} = \frac{\text{MLSS}}{\text{WS Pump Capacity}} \quad \text{Where:} \\
\text{min. to WS} = \text{minutes to waste sludge} \\
\text{MLSS} = \text{MLSS to waste (gal)} \\
\text{WS pump capacity} = \text{waste sludge pump capacity (gal/min.)} \\

\text{Min/Hr. to WS} = \frac{\text{WS}}{24\text{hrs./day}} \quad \text{Where:} \\
\text{min/hr. to WS} = \text{minutes per hour to waste sludge} \\
\text{WS} = \text{min per day to waste sludge} \\

\textbf{Wastewater Treatment Ponds} \\

\text{PL} = \frac{\text{(Population)}}{A} \\
\text{Where:} \\
\text{PL} = \text{population loading (persons/acre)} \\
\text{Population} = \text{population served (persons)} \\
A = \text{pond area (acres)} \\

V = (A) \times (d) \\
\text{Where:} \\
V = \text{pond volume (ac-ft.)} \\
A = \text{pond area (acres)} \\
d = \text{pond depth (ft.)} \\

V = \frac{(L) \times (W) \times (d)}{(43,560 \text{ ft}^2/\text{ac})} \\
\text{Where:} \\
V = \text{pond volume (ac-ft.)} \\
L = \text{length (ft.)} \\
W = \text{length (ft.)} \\
d = \text{pond depth (ft.)} \\

V (\text{gal}) = [V (\text{ac-ft.})] \times (43,560 \text{ ft}^2/\text{ac}) \times (7.48 \text{ gal/ft}^3) \quad \text{Where:} \\
V = \text{pond volume} \\

A = \frac{(L) \times (W)}{(43,560 \text{ ft}^2/\text{ac})} \\
\text{Where:} \\
A = \text{pond area (acre)} \\
L = \text{length (ft.)} \\
W = \text{length (ft.)}
\[ Q \text{ (ac-ft./day)} = \frac{[Q \text{ (gal/day)}]}{[(7.48 \text{ gal/ft}^3) \times (43,560 \text{ ft}^2/ac)]} \]

Where: \( Q \) = flow

\[ DT = \frac{V}{Q} \]

Where: \( DT \) = detention time (days)
\( V \) = volume (gal)
\( Q \) = flow (gal/day)

\[ DT = \frac{V}{Q} \]

Where: \( DT \) = detention time (days)
\( V \) = volume (ac-ft.)
\( Q \) = flow (ac-ft./day)

BOD loading = \((\text{BOD}_5) \times (Q) \times (8.34 \text{ lbs./gal})\)

Where: \( \text{BOD loading} = \text{lbs./day} \)
\( \text{BOD}_5 = \text{biological oxygen demand (MGD)} \)
\( Q = \text{flow (MGD)} \)

\[ \text{OLR} = \frac{\text{BOD}}{A} \]

Where: \( \text{OLR} = \text{organic loading rate (lbs./day/acre)} \)
\( \text{BOD} = \text{influent BOD (lbs./day)} \)
\( A = \text{pond areas (acres)} \)

\[ \text{OLR} = \frac{\text{[(BOD) \times (Q) \times (8.34 \text{ lbs/gal})]}}{A} \]

Where: \( \text{OLR} = \text{organic loading rate (lbs./day/acre)} \)
\( \text{BOD} = \text{influent BOD (mg/L)} \)
\( Q = \text{flow (MGD)} \)
\( A = \text{pond areas (acres)} \)

BOD removal efficiency, \( \% = \frac{[\text{BOD}_{\text{removed}}]/[\text{BOD}_{\text{total}}]}{\times 100\%} \)

Where: \( \text{BOD}_{\text{removed}} = \text{BOD removed (mg/L)} \)
\( \text{BOD}_{\text{total}} = \text{total BOD (mg/L)} \)

\[ \text{HLR} = \frac{[Q]/[A]}{12 \text{ in/ft.}} \]

Where: \( \text{HLR} = \text{hydraulic loading rate (in/day)} \)
\( Q = \text{flow (ac-ft./day)} \)
\( A = \text{pond area (acres)} \)
Loading Formulas (general)

Loading = (Concentration) x (Q) x (8.34 lbs./gal)

Where:
- Loading is TSS or BOD = lbs./day
- Concentration of TSS or BOD = mg/L
- Q = flow

Hydraulic loading rate = Flow/A

Where:
- Hydraulic Loading = gpd/ft²
- Flow = gpd
- A = area (ft²)

Surface loading rate or Surface overflow rate = Flow/A

Where:
- Surface Loading/Surface Overflow rate = gpd/ft²
- Flow = gpd
- A = area (ft²)

LABORATORY FORMULAS

Alkalinity & Hardness

P = (A) x (N) x (50,000) / Vsample

Where:
- P = phenolphthalein alkalinity (mg CaCO₃/L)
- A = titrant volume used to reach 8.3 pH (mL)
- N = acid normality
- Vsample = sample volume (mL)

T = (B) x (N) x (50,000) / Vsample

Where:
- T = total alkalinity (mg CaCO₃/L)
- B = total titrant used (mL)
- N = acid normality
- Vsample = sample volume (mL)

Hardness = (B) x (1,000) / Vsample

Where:
- Hardness = mg CaCO₃/L
- B = titrant volume (mL)
- Vsample = sample volume (mL)

Only when the titration factor is 1.00 of EDTA

Bacteriological

Average (arithmetic mean) = (sum of all terms)/(number of terms)

Average (geometric mean) = \( \sqrt[n]{X_1 X_2 X_3 X_4 \ldots X_n} \)

The nth root of the product of n numbers
BC = \( \frac{(CC \times 100)}{V} \)  

Where:  
BC = bacteriological colonies/100 mL  
CC = number of colonies counted  
V = sample volume filtered (mL)

---

**Laboratory Solutions Formulas**

\( (N_1 \times V_1) + (N_2 \times V_2) = (N_3 \times V_3) \)  

Where:  
\( V_1 + V_2 = V_3 \)  
N = normality  
V = volume or flow

---

Milliequivalent = mL \( \times \) Normality

---

Molarity = \( \frac{\text{Moles of solute}}{\text{Liters of solution}} \)

---

Normality = \( \frac{\text{Number of equivalent weights of solute}}{\text{Liters of solution}} \)

---

Number of equivalent weights = \( \frac{\text{Total Weight}}{\text{Equivalent Weight}} \)

---

Number of Moles = \( \frac{\text{Total Weight}}{\text{Molecular Weight}} \)

---

Specific gravity = \( \frac{\text{Specific weight of substance, lbs./gal}}{\text{Specific weight of water, lbs./gal}} \)

---

**Oxygen Uptake Rate (OUR)**

Respiration Rate = (OUR)/(MLSS)

Where:  
respiration rate = mg/g/hr.  
OUR = oxygen uptake rate (mg/L/hr.)  
MLSS = mixed liquor suspended solids (g/L)

\[
\text{OUR mgL/min} = \left( \frac{\text{DO}_{\text{starting}} - \text{DO}_{\text{ending}}}{T} \right) \times 60 \text{ min/hr.}
\]

Where:  
OUR = mg/L/hr.  
DO_{starting} = starting DO (mg/L)
DO_{ending} = ending DO (mg/L) \hspace{1cm} T = elapsed time (min)

Load Index = \frac{\text{OUR}_{fed}}{\text{OUR}_{unfed}} \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{OUR}_{fed} = fed \text{ OUR (mg/L/hr.)} \hspace{1cm} \text{OUR}_{unfed} = unfed \text{ OUR (mg/L/hr.)}

\text{SOUR} = \frac{(\text{OUR}) \times (1,000 \text{ mg/g})}{\text{MLVSS}} \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{SOUR} = \text{specific OUR (mg O}_2/\text{hr./g)} \hspace{1cm} \text{OUR} = \text{oxygen uptake rate (mg/L/hr.)} \hspace{1cm} \text{MLVSS} = \text{mixed liquor volatile suspended solids (g/L)}

\textbf{Solids}

\text{SS} = \frac{(A - B) \times (1,000,000)}{V_{sample}} \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{SS} = \text{suspended solids (mg/L)} \hspace{1cm} A = \text{final weight of pan, filter & residue (g)} \hspace{1cm} B = \text{weight of prepared filter & pan (g)} \hspace{1cm} V_{sample} = \text{sample volume (mL)}

\text{TS} = \frac{(C - D) \times (1,000,000)}{V_{sample}} \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{TS} = \text{total solids (mg/L)} \hspace{1cm} C = \text{weight of dish & dried solids (g)} \hspace{1cm} D = \text{weight of dish (g)} \hspace{1cm} V_{sample} = \text{sample volume (mL)}

\text{VS} = \frac{(C - E) \times (1,000,000)}{V_{sample}} \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{VS} = \text{volatile solids (mg/L)} \hspace{1cm} C = \text{weight of dish & dried solids (g)} \hspace{1cm} E = \text{weight of dish & ash (g)} \hspace{1cm} V_{sample} = \text{sample volume (mL)}

\text{FS} = \frac{(C - D) \times (1,000,000)}{V_{sample}} \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{FS} = \text{fixed solids (mg/L)} \hspace{1cm} E = \text{weight of dish & ash (g)} \hspace{1cm} D = \text{weight of dish (g)} \hspace{1cm} V_{sample} = \text{sample volume (mL)}

\text{Volatile solids} = \frac{\text{Dry solids} - \text{Fixed solids}}{\text{Dry solids}} \times 100% \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{Volatile solids (as %)} \hspace{1cm} \text{Dry solids in grams} \hspace{1cm} \text{Fixed solids = inorganics (g)}

% \text{VS} = \{(\text{VS})/(\text{TS})\} \times 100% \hspace{1cm} \text{Where:} \hspace{0.5cm} \text{VS} = \text{volatile solids (mg/L)} \hspace{1cm} \text{TS} = \text{total solids (mg/L)}
SC = (W)/(V)  

Where:  
SC = solids concentration (mg/L)  
W = weight (mg)  
V = volume (L)

Temperature Conversions

°C = (°F – 32) x (0.566)  
°F = (°C x 1.8) + 32  

Average Formulas

Average (arithmetic mean) = (sum of all terms)/(number of terms)

Average (geometric mean) = \( \sqrt[n]{X_1X_2X_3...X_n} \)  
The nth root of the product of n numbers

FORCE

F = (P) x (A)  

Where:  
F = force (lbs.)  
P = pressure (psi or lbs./in²)  
A = area (in²)

Coagulation/Flocculation Formulas

DT = \( \frac{V \times (1,440 \text{ min/day}) \times (60 \text{ sec/min})}{Q} \)  

Where:  
DT = detention time (sec)  
V = volume (gal)  
Q = flow rate(gal/day)
DT = \( \frac{V}{Q} \times (1,440 \text{ min/day}) \)

Where:

- DT = detention time (min)
- V = volume (gal)
- Q = flow rate (gal/day)

**Filter Formulas**

Backwash rise rate = Backwash rate \( \times \) 12 in./ft. \( \div \) 7.48 gal/ft\(^3\)

Where:

- backwash rinse rate = in./min.
- backwash rate = gpm/ft\(^2\)

V = (R) \( \times \) (T) \( \times \) (A)

Where:

- V = backwash water volume (gal)
- R = backwash rate (gpm/ft\(^2\))
- T = backwash time (min)
- A = filter area (ft\(^2\))

Yield = \[ \frac{\text{Backwash water}}{\text{Water Filtered}} \] \( \times \) 100%

Where:

- yield = backwash water yield, %
- backwash water = gal
- water filtered = gal

Flow/Backwash rate = \( \frac{Q}{A} \)

Where:

- flow/backwash rate = gpm/ft\(^2\)
- Q = flow (gpm)
- A = filter area (ft\(^2\))

Filtration Rate = \( \frac{V}{T} \)

Where:

- filtration rate = gpm
- V = volume (gal)
- T = average time (min)

T = \( \frac{(\text{test}) + (\text{test}2) + \ldots + (\text{test}_n)}{n} \)

Where:

- T = average time (sec)
- n = number of tests

Filter Production Rate = (R) \( \times \) (A)

Where:

- filter production rate = gal/min
- R = filtration rate (gpm/ft\(^2\))
- A = filter area (ft\(^2\))
Yield = \frac{(\text{Loading}) \times (\text{Recovery})}{(\text{Filter operation}) \times (A)}

Where:
- \text{yield} = \text{lbs./hr.}/\text{ft}^2
- \text{loading} = \text{solids loading (lbs./day)}
- \text{recovery} = \%\text{, expressed as a decimal}
- \text{filter operation} = \text{hr./day}
- \text{A} = \text{area (ft}^2\text{)}

---

**SEDIMENTATION**

\[
\text{DT} = \frac{(\text{Vol} \times 24 \text{ hr./day})}{\text{Q}}
\]

Where:
- \text{DT} = \text{detention time, hr.}
- \text{Vol} = \text{volume of tank (gal)}
- \text{Q} = \text{flow rate (gal/day)}

---

\text{Weir Overflow rate} = \frac{\text{F}}{\text{L}}

Where:
- \text{overflow rate} = \text{gal/day}/\text{ft.}
- \text{F} = \text{flow (gal/day)}
- \text{L} = \text{total weir length (ft.)}

---

\text{Weir Length (Rectangular Basin)}
- \text{Weir length} = (2 \times \text{L}) + (2 \times \text{W})

Where:
- \text{weir length} = \text{ft.}
- \text{L} = \text{length (ft.)}
- \text{W} = \text{width (ft.)}

\text{Weir Length (Circular Basin)}
- \text{Weir length} = 3.14 \times \text{D}

Where:
- \text{D} = \text{diameter (ft.)}

---

\text{Weir Overflow rate (Rectangular Basin)}
- \text{Overflow rate} = \frac{\text{F}}{[2 \times \text{L} + (2 \times \text{W})]}

\text{Weir Overflow rate (Circular Basin)}
- \text{Overflow rate} = \frac{\text{F}}{(3.14 \times \text{D})}

Where:
- \text{overflow rate} = \text{gal/day}/\text{ft.}
- \text{F} = \text{flow (gal/day)}
- \text{L} = \text{length (ft.)}
- \text{W} = \text{width (ft.)}
- \text{D} = \text{diameter (ft.)}

---

\text{Surface Overflow rate} = \frac{\text{F}}{\text{A}}

Where:
- \text{overflow rate} = \text{gal/day}/\text{ft}^2
- \text{F} = \text{flow (gal/day)}
- \text{A} = \text{surface area (ft}^2\text{)}

---

\text{Solids Loading rate} = \frac{\text{Solids Applied}}{\text{A}}

Where:
- \text{loading rate} = \text{lbs./day}/\text{ft}^2
- \text{solids applied} = \text{lbs./day}
- \text{A} = \text{surface area (ft}^2\text{)}

---

\text{Solids Loading rate (Rectangular Basin)}
- \text{Loading rate} = \frac{\text{Solids Applied}}{\text{(L} \times \text{W})}

\text{Solids Loading rate (Circular Basin)}
- \text{Loading rate} = \frac{\text{Solids Applied}}{(0.785 \times \text{D})}

Where:
- \text{loading rate is lbs./day}/\text{ft}^2\text{)}
- \text{solids applied is lbs./day}
- \text{L} = \text{length (ft.)}
- \text{W} = \text{width (ft.)}
- \text{D} = \text{diameter (ft.)}
BOD removed (lbs./day) = 
BOD removed × F × 8.34 lbs./gal

Where:  
BOD removed is mg/L 
F = Flow (MGD)

SS Removed (lbs./day) = 
SS Removed × F × 8.34 lbs./gal

Where:  
SS removed is mg/L 
F = Flow (MGD)

Efficiency = [(In – Out)/In] × 100%

WET WELL

Cycle time (min) = \[\frac{SV}{PC - Inflow}\]

Where:  
SV = storage volume (gal) 
PC = pump capacity (gpm) 
Inflow = wet well inflow (gpm)

COLLECTION SYSTEM

Slope, % = \[\frac{\text{Drop or rise}}{\text{Distance}}\] × 100%

OR

Slope, % = \[\frac{\text{Rise}}{\text{Run}}\] × 100%

Where:  
Velocity is ft./sec 
Flow (ft³/sec)

Velocity = F/A

Velocity = \[\frac{\text{Distance}}{\text{Time}}\] 

Where:  
Velocity is ft./sec 
Distance (ft.) 
Time (sec)