Activated Sludge Math - Answer Key

The Division of Water Quality makes no claim as the accuracy of any answers provided herein.

PRACTICE PROBLEMS 12.1: Aeration Tank, Secondary Clarifier and Oxidation Ditch Volume

1. An aeration tank is 70 ft long, 30 ft wide and operates at an average depth of 15 ft. What is the capacity of the tank, in gallons?

$$\text{Volume} = 70\ ft \cdot 30\ ft \cdot 15\ ft = 31{,}500\ ft^3$$

$$\text{Volume} = 31{,}500\ ft^3 \cdot 7.48\ \frac{gal}{ft^3}$$

ANS 235,620 gal

2. What is the gallon capacity of an aeration tank that is 90 ft long, 35 ft wide, and operates at an average depth of 14 ft?

$$\text{Volume} = 90\ ft \cdot 35\ ft \cdot 14\ ft = 44{,}100\ ft^3$$

$$\text{Volume} = 44{,}100\ ft^3 \cdot 7.48\ \frac{gal}{ft^3}$$

ANS 329,868 gal

3. A secondary clarifier has a diameter of 70 ft and an average depth of 12 ft. What is the volume of water in the clarifier, in gallons?

$$\text{Volume} = \frac{\pi}{4}(70\ ft)^2 \cdot 12\ ft = 46{,}181\ ft^3$$

$$\text{Volume} = 46{,}181\ ft^3 \cdot 7.48\ \frac{gal}{ft^3}$$

ANS 345,437 gal

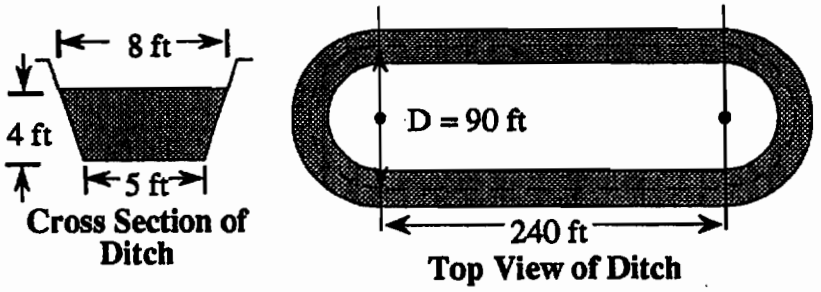
4. A clarifier has a diameter of 60 ft and an average depth of 14 ft. What is the volume of water in the clarifier, in gallons?

$$\text{Volume} = \frac{\pi}{4}(60\ ft)^2 \cdot 14\ ft = 39{,}584\ ft^3$$

$$\text{Volume} = 39{,}584\ ft^3 \cdot 7.48\ \frac{gal}{ft^3}$$

ANS 296,089 gal

5. Calculate the cu ft volume of water in the oxidation ditch shown below. The cross section of the ditch is trapezoidal.



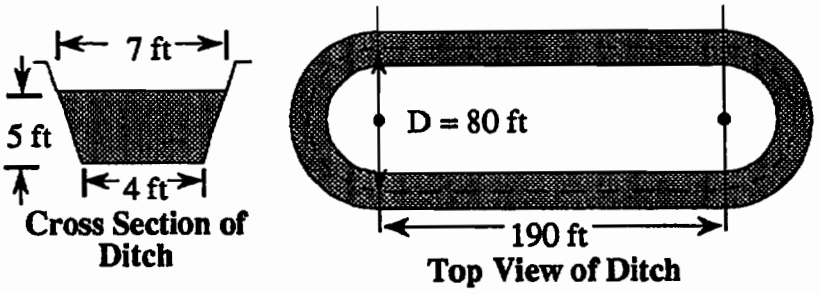
Average Cross Section $= 4\text{ ft}\left[\frac{8\text{ ft} + 5\text{ ft}}{2}\right] = 26\text{ ft}^2$

Length $= 2(240\text{ ft}) + \pi(90\text{ ft}) = 762.7\text{ ft}$

Volume $= 26\text{ ft}^2 \cdot 762.7\text{ ft}$

ANS 19,831 ft^3

6. Calculate the cu ft volume of water in the oxidation ditch shown below. The cross section of the ditch is trapezoidal.



Average Cross Section $= 5\text{ ft} \cdot \left[\frac{4\text{ ft} + 7\text{ ft}}{2}\right] = 27.5\text{ ft}^2$

Length $= 2(190\text{ ft}) + \pi(80\text{ ft}) = 631.3\text{ ft}$

Volume $= 27.5\text{ ft}^2 \cdot 631.3\text{ ft}$

ANS 17,362 ft^3

PRACTICE PROBLEMS 12.2: BOD or COD Loading , lbs/day

1. The flow to an aeration tank is 890,000 gpd. If the BOD content of the wastewater entering the aerator is 230 mg/*L*, what is the lbs/day BOD loading?

$$\text{Load} = 8.34\,(230\ \text{mg/L})\ \frac{890{,}000\ \text{gpd}}{1{,}000{,}000}$$

ANS 1,707 $\frac{\text{lbs}}{\text{day}}$

2. The flow to an aeration tank is 2940 gpm. If the COD concentration of the wastewater is 150 mg/*L*, how many pounds of COD are applied to the aeration tank daily? (Round the flow to the nearest ten thousand.)

$$\text{Flow} = 2{,}940\ \text{gpm} \cdot 60\ \tfrac{\text{m}}{\text{hr}} \cdot 24\ \tfrac{\text{hr}}{\text{day}} = 4{,}233{,}600\ \text{gpd}$$

$$\text{Load} = 8.34\,(150\ \text{mg/L})\ \frac{4{,}233{,}600\ \text{gpd}}{1{,}000{,}000}$$

ANS 5,296 $\frac{\text{lbs}}{\text{day}}$

3. The BOD content of the wastewater entering an aeration tank is 155 mg/*L*. If the flow to the aeration tank is 3,120,000 gpd, what is the lbs/day BOD loading?

$$\text{Load} = 8.34\,(155\ \text{mg/L})\ \frac{3{,}120{,}000\ \text{gpd}}{1{,}000{,}000}$$

ANS 4,033 $\frac{\text{lbs}}{\text{day}}$

4. The daily flow to an aeration tank is 4,720,000 gpd. If the COD concentration of the influent wastewater is 140 mg/*L*, how many pounds of COD are applied to the aeration tank daily?

$$\text{Load} = 8.34\ (140\ \text{mg/L})\ \frac{4{,}720{,}000\ \text{gpd}}{1{,}000{,}000}$$

ANS 5,511 $\frac{\text{lbs}}{\text{day}}$

PRACTICE PROBLEMS 12.3: Solids Inventory in the Aeration Tank

1. If the mixed liquor suspended solids concentration is 2040 mg/*L* and the aeration tank has a volume of 450,000 gallons, how many pounds of suspended solids are in the aeration tank?

$$\text{Mass} = 8.34\ (2040\ \text{mg/L})\ \frac{450{,}000\ \text{gal}}{1{,}000{,}000}$$

ANS 7,656 lbs

2. The volume of an aeration basin is 180,000 gallons. If the MLVSS concentration is 2160 mg/*L*, how many pounds of volatile solids are under aeration?

$$\text{Mass} = 8.34\ (2160\ \text{mg/L})\ \frac{180{,}000\ \text{gal}}{1{,}000{,}000}$$

ANS 3,243 lbs

3. The aeration tank of a conventional activated sludge plant has a mixed liquor volatile suspended solids concentration of 2340 mg/*L*. If the aeration tank is 90 ft long, 40 ft wide, and has wastewater to a depth of 15 ft, how many pounds of MLVSS are under aeration?

$$\text{Volume} = 90\ \text{ft} \cdot 40\ \text{ft} \cdot 15\ \text{ft} = 54{,}000\ \text{ft}^3$$

$$\text{Volume} = 54{,}000\ \text{ft}^3 \cdot 7.48\ \frac{\text{gal}}{\text{ft}^3} = 403{,}920\ \text{gal}$$

$$\text{Mass} = 8.34\ (2340\ \text{mg/L})\ \frac{403{,}920\ \text{gal}}{1{,}000{,}000}$$

ANS 7,883 lbs

4. The aeration basin is 120 ft long, 40 ft wide, and has wastewater to a depth of 15 ft. If the aeration basin of a conventional activated sludge plant has a mixed liquor suspended solids concentration of 2710 mg/*L*, how many pounds of MLSS are under aeration?

Volume = 120 ft · 40 ft · 15 ft = 72,000 ft^3

Volume = 72,000 ft^3 · 7.48 $\frac{gal}{ft^3}$ = 538,560 gal

M... = 8.34 (2710 mg/L) 538,560 gal

ANS 12,172 lbs

PRACTICE PROBLEMS 12.4: Food/Microorganism Ratio

- An activated sludge aeration tank receives a primary effluent flow of 2.61 MGD with a BOD concentration of 195 mg/L. The mixed liquor volatile suspended solids concentration is 2560 mg/L and the aeration tank volume is 470,000 gallons. What is the current F/M ratio? (Round to the nearest hundredth.)

Mass = 8.34 (2560 mg/L) $\frac{470,000 \text{ gal}}{1,000,000}$ = 10,035 lbs

Load = 8.34 (195 mg/L) 2.61 MGD = 4,245 $\frac{\text{lbs}}{\text{day}}$

F/M = $\frac{4,245 \frac{\text{lbs}}{\text{day}}}{10,035 \text{ lbs}}$

ANS 0.42

- An activated sludge aeration tank receives a primary effluent flow of 3,260,000 gpd with a BOD of 145 mg/L. The mixed liquor volatile suspended solids is 2490 mg/L and the aeration tank volume is 470,000 gallons. What is the current F/M ratio? (Round to the nearest hundredth.)

Mass = 8.34 (2490 mg/L) $\frac{470,000 \text{ gal}}{1,000,000}$ = 9,760 lbs

Load = 8.34 (145 mg/L) $\frac{3,260,000 \text{ gpd}}{1,000,000}$ = 3,942 $\frac{\text{lbs}}{\text{day}}$

F/M = $\frac{3,942 \frac{\text{lbs}}{\text{day}}}{9,760 \text{ lbs}}$

ANS 0.40

- The flow to a 190,000-gallon oxidation ditch is 310,000 gpd. The BOD concentration of the wastewater is 175 mg/L. If the mixed liquor suspended solids concentration is 2576 mg/L with a volatile solids content of 70%, what is the F/M ratio? (Round to the nearest hundredth.)

Mass = 8.34 (2576 mg/L) $\frac{190,000 \text{ gal}}{1,000,000}$ = 4,082 lbs

Load = 8.34 (175 mg/L) $\frac{310,000 \text{ gpd}}{1,000,000}$ = 452 $\frac{\text{lbs}}{\text{day}}$

F/M = $\frac{452 \text{ lbs/day}}{4,082 \text{ lbs/day} \cdot 0.70}$

ANS 0.16

4. The desired F/M ratio at an extended aeration activated sludge plant is 0.7 lbs BOD/lb MLVSS. If the 3.1 MGD primary effluent flow has a BOD of 178 mg/*L*, how many lbs of MLVSS should be maintained in the aeration tank? (Round to the nearest hundredth.)

$$\text{Load} = 8.34\ (178\ \text{mg/L})\ 3.1\ \text{MGD} = 4{,}602\ \frac{\text{lbs}}{\text{day}}$$

$$F/M = 0.7$$

$$F = 0.7\ M$$

$$M = \frac{F}{0.7}$$

$$M = \frac{4{,}602\ \text{lbs}}{0.7}$$

ANS 6,574 lbs

5. The desired F/M ratio at a particular activated sludge plant is 0.3 lbs BOD/lb MLVSS. If the 2,460,000-gpd primary effluent flow has a BOD concentration of 139 mg/*L*, how many lbs of MLVSS should be maintained in the aeration tank? (Round to the nearest hundredth.)

$$\text{Load} = 8.34\ (139\ \text{mg/L})\ \frac{2{,}460{,}000\ \text{gpd}}{1{,}000{,}000} = 2{,}852\ \frac{\text{lbs}}{\text{day}}$$

$$F/M = 0.3$$

$$F = 0.3\ M$$

$$M = \frac{F}{0.3}$$

$$M = \frac{2{,}852\ \frac{\text{lbs}}{\text{day}}}{0.3}$$

ANS 9,506 lbs

PRACTICE PROBLEMS 12.5: Sludge Age (Gould)

1. An aeration tank has a total of 15,600 lbs of mixed liquor suspended solids. If a total of 2520 lbs/day suspended solids enter the aeration tank in the primary effluent flow, what is the sludge age in the aeration tank? (Round to the nearest tenth.)

$$\text{Sludge Age} = \frac{15{,}600 \text{ lbs}}{2{,}520 \frac{\text{lbs}}{\text{day}}}$$

ANS 6.2 days

2. An aeration tank contains 470,000 gallons of wastewater with a MLSS concentration of 2740 mg/*L*. If the primary effluent flow is 2.8 MGD with a suspended solids concentration of 108 mg/*L*, what is the sludge age? (Round to the nearest tenth.)

$$\text{Mass} = 8.34\,(2740 \text{ mg/L})\ \frac{470{,}000 \text{ gpd}}{1{,}000{,}000} = 10{,}740 \text{ lbs}$$

$$\text{Load} = 8.34\,(108 \text{ mg/L})\ 2.8 \text{ MGD} = 2{,}522 \frac{\text{lbs}}{\text{day}}$$

$$\text{Sludge Age} = \frac{10{,}740 \text{ lbs}}{2{,}522 \frac{\text{lbs}}{\text{day}}}$$

ANS 4.3 days

3. An aeration tank is 100 ft long, 40 ft wide, and operates at a depth of 15 ft. The MLSS concentration in the aeration tank is 2480 mg/*L*. If the influent flow to the tank is 2.72 MGD with a suspended solids concentration of 110 mg/*L*, what is the sludge age? (Round to the nearest tenth.)

$$\text{Volume} = 100 \text{ ft} \cdot 40 \text{ ft} \cdot 15 \text{ ft} = 60{,}000 \text{ ft}^3$$

$$\text{Volume} = 60{,}000 \text{ ft}^3 \cdot 7.48 \frac{\text{gal}}{\text{ft}^3} = 448{,}800 \text{ gal}$$

$$\text{Mass} = 8.34\,(2480 \text{ mg/L})\ \frac{448{,}800 \text{ gal}}{1{,}000{,}000} = 9{,}263 \text{ lbs}$$

$$\text{Load} = 8.34\,(110 \text{ mg/L})\ 2.72 \text{ MGD} = 2{,}495 \frac{\text{lbs}}{\text{day}}$$

$$\text{Sludge Age} = \frac{9{,}263 \text{ lbs}}{2{,}495 \frac{\text{lbs}}{\text{day}}}$$

ANS 3.7 days

4. The MLSS concentration in the aeration tank is 2940 mg/*L*. The aeration tank is 100 ft long, 45 ft wide, and operates at a depth of 15 ft. If the influent flow to the tank is 1.94 MGD and has a suspended solids concentration of 105 mg/*L*, what is the sludge age? (Round to the nearest tenth.)

Volume = 100 ft · 45 ft · 15 ft = 67,500 ft3

Volume = 67,500 ft3 · 7.48 $\frac{gal}{ft^3}$ = 504,900 gal

Mass = 8.34 (2940 mg/L) $\frac{504,900 \text{ gal}}{1,000,000}$ = 12,380 lbs

Load = 8.34 (105 mg/L) 1.94 MGD = 1,699 $\frac{lbs}{day}$, ANS 7.3 days

Sludge Age = $\frac{12,380 \text{ lbs}}{1,699 \frac{lbs}{day}}$

5. An oxidation ditch has a volume of 210,000 gallons. The 260,000-gpd flow to the oxidation ditch has a suspended solids concentration of 201 mg/*L*. If the MLSS concentration is 3720 mg/*L*, what is the sludge age in the oxidation ditch? (Round to the nearest tenth.)

Mass = 8.34 (3720 mg/L) $\frac{210,000 \text{ gal}}{1,000,000}$ = 6,515 lbs

Load = 8.34 (201 mg/L) $\frac{260,000 \text{ gpd}}{1,000,000}$ = 436 $\frac{lbs}{day}$

Sludge Age = $\frac{6,515 \text{ lbs}}{436 \frac{lb}{day}}$

ANS 15.0 days

PRACTICE PROBLEMS 12.6: Solids Retention Time

1. An activated sludge system has a total of 28,600 lbs of mixed liquor suspended solids. The suspended solids leaving the final clarifier in the effluent is calculated to be 390 lbs/day. The pounds suspended solids wasted from the final clarifier is 2860 lbs/day. What is the solids retention time, in days?

Mass = 28,600 lbs

Load = $2860 \frac{lbs}{day} + 390 \frac{lbs}{day} = 3,250 \frac{lbs}{day}$

$SRT = \frac{28,600 \text{ lbs}}{3250 \frac{lbs}{day}}$

ANS 8.8 days

2. Determine the solids retention time (SRT) given the following data: (Use the "core sampler" method of calculating SRT.)

Aer. Tank Vol.—1,400,000 gal	MLSS—2650 mg/L
Fin. Clar.—105,000 gal	WAS—5960 mg/L
P. E. Flow—3.1 MGD	S.E. SS—20 mg/L
WAS Pumping Rate—70,000 gpd	CCSS—1920 mg/L

$Mass = [8.34 (2650 \text{ mg/L}) \frac{1,400,000 \text{ gal}}{1,000,000} + 8.34 (1920 \text{ mg/L}) \frac{105,000 \text{ gal}}{1,000,000}] = 32,623 \text{ lbs}$

$Load = [8.34 (5960 \text{ mg/L}) \frac{70,000 \text{ gpd}}{1,000,000} + 8.34 (20 \text{ mg/L}) 3.1 \text{ MGD}] = 3,997 \frac{lbs}{day}$

$SRT = \frac{32,623 \text{ lbs}}{3997 \frac{lbs}{day}}$

ANS 8.2 day

3. An aeration tank has a volume of 450,000 gallons. The final clarifier has a volume of 175,000 gallons. The MLSS concentration in the aeration tank is 2115 mg/L. If a total of 1570 lbs/day SS are wasted and 230 lbs/day SS are in the secondary effluent, what is the solids retention time for the activated sludge system? (Use the "combined volume" method of calculating system solids.)

Volume = 450,000 gal + 175,000 gal = 625,000 gal

$Mass = 8.34 (2115 \text{ mg/L}) \frac{625,000 \text{ gal}}{1,000,000} = 11,024 \text{ lbs}$

$Load = 230 \frac{lbs}{day} + 1570 \frac{lbs}{day} = 1,800 \frac{lbs}{day}$

$SRT = \frac{11,024 \text{ lbs}}{1800 \frac{lbs}{day}}$

ANS 6.1 days

4. Calculate the solids retention time (SRT) given the following data:
(Use the "combined volume" method of calculating SRT.)

Aer. Tank Vol.—340,000 gal	MLSS—2940 mg/*L*
Fin. Clar.—120,000 gal	WAS—6110 mg/*L*
P.E. Flow—1.2 MGD	S.E. SS—17 mg/*L*
WAS Pumping Rate—25,000 gpd	

Mass = 8.34 (2940 mg/L) $\left(\frac{340{,}000 \text{ gal} + 120{,}000 \text{ gal}}{1{,}000{,}000}\right)$

Mass = 11,279 lbs

Load = 8.34 (17 mg/L) 1.2 MGD + 8.34 (6110 mg/L) $\frac{25{,}000 \text{ gpd}}{1{,}000{,}000}$

Load = 1,444 $\frac{\text{lbs}}{\text{day}}$

SRT = $\frac{11{,}279 \text{ lbs}}{1{,}444 \text{ lbs/day}}$

ANS 7.8 days

5. The volume of an aeration tank is 365,000 gallons and the final clarifier is 105,000 gallons. The desired SRT for a plant is 7.5 days. The primary effluent flow is 1.76 MGD and the WAS pumping rate is 28,400 gpd. If the WAS SS is 5740 mg/*L* and the secondary effluent SS is 18 mg/*L*, what is the desired MLSS mg/L?
(Use the "combined volume" method of calculating SRT.)

Volume = 365,000 gal + 105,000 gal = 470,000 gal

Load = [8.34 (5740 mg/L) $\frac{28{,}400 \text{ gpd}}{1{,}000{,}000}$

+ 8.34 (18 mg/L) 1.76 MGD]

Load = 1624 $\frac{\text{lbs}}{\text{day}}$

SRT = 7.5 = $\frac{x\left(\frac{470{,}000 \text{ gal}}{1{,}000{,}000}\right) 8.34}{1624 \frac{\text{lbs}}{\text{day}}}$

7.5 days · 1624 $\frac{\text{lbs}}{\text{day}}$ = x 0.47 (8.34)

x =

ANS 3,107 mg/L

6. Calculate the solids retention time (SRT) given the following data:
(Use the "core sampler" method of calculating SRT.)

Aer. Tank Vol.—1.5 MG	MLSS—2460 mg/*L*
Fin. Clar.—0.11 MG	WAS—8040 mg/*L*
P.E. Flow—3.4 MGD	S.E. SS—18 mg/*L*
WAS Pumping Rate—60,000 gpd	CCSS—1850 mg/*L*

Mass = [8.34 (2460 mg/L) 1.5 MG

+ 8.34 (1850 mg/L) 0.11 MG]

Mass = 32,472 lbs

Load = 8.34 (18 mg/L) · 3.4 MGD + 8.34 (8040 mg/L) $\frac{60{,}000 \text{ gpd}}{1{,}000{,}000}$

Load = 4,534 $\frac{\text{lbs}}{\text{day}}$

SRT = $\frac{32{,}472 \text{ lbs}}{4534 \frac{\text{lbs}}{\text{day}}}$

ANS 7.2 days

PRACTICE PROBLEMS 12.7: Return Sludge Rate

1. The settleability test after 30 minutes indicates a sludge settling volume of 215 m*L/L*. Calculate the RAS flow as a ratio to the secondary influent flow. (Round to the nearest hundredth.)

$$\text{Ratio} = \frac{215\ mL/L}{1000\ mL/L - 215\ mL/L}$$

ANS 0.27

2. Given the following data, calculate the RAS return rate (Q_{RAS}) using the secondary clarifier solids balance equation.

MLSS—2460 mg/*L* Q_{WAS}—60,000 gpd
RAS SS—7850 mg/*L* Q_{PE}—3.4 MGD
WAS SS—7850 mg/*L*

Solids in = Solids out

Solids in = 8.34 [(2460 mg/L)(3.4 MGD + x)]

Solids in = 69,756 lb + 20,516 x

Solids out = 8.34 [(7850 mg/L)(0.06 MGD + x)

Solids out = 3,928 lb + 65,469 x

44,953 x = 65,828

ANS 1.46 MGD

3. A total of 270 ml/*L* sludge settled during a settleability test after 30 minutes. The secondary influent flow is 3.12 MGD. (a) Calculate the RAS flow as a ratio to the secondary influent flow. (Round to the nearest hundredth.) (b) What is the RAS flow expressed in MGD? (Round to the nearest hundredth.)

a) $\text{Ratio} = \frac{270\ mL/L}{1000\ mL/L - 270\ mL/L}$

b) Flow = 3.12 MGD

RAS = 3.12 MGD · 0.37

ANS a) 0.37

b) 1.15 MGD

4. The secondary influent flow to an aeration tank is 1.67 MGD. If the results of the settleability test after 30 minutes indicate that 285 ml/*L* sludge settled. (a) What is the RAS flow as a ratio to the secondary influent flow? (Round to the nearest hundredth.) (b) What is the RAS flow expressed in MGD? (Round to the nearest hundredth.)

a) $\text{Ratio} = \dfrac{285 \text{ mL/L}}{1000 \text{ mL/L} - 285 \text{ mL/L}}$

b) Flow = 1.67 MGD

RAS = 1.67 MGD · 0.40

ANS a) 0.40

b) 0.67 MGD

5. Given the following data, calculate the RAS return rate using the aeration tank solids balance equation.

MLSS—2100 mg/*L*
RAS SS—7490 mg/*L*
Q_{PE}—6.3 MGD

Solids in = Solids out

Solids in = 8.34 (7490 mg/L) x

Solids in = 62,467 x

Solids out = 8.34 (2100 mg/L) [6.3 MGD + x]

Solids out = 110,338 lbs + 17,514 x

44,953 (x) = 110,338

$x = \dfrac{110,338}{44,953}$

ANS 2.45 MGD

PRACTICE PROBLEMS 12.8: Wasting Rate

1. The desired F/M ratio for an activated sludge system is 0.6 lbs BOD/lb MLVSS. It has been calculated that 3300 lbs of BOD enter the aeration tank daily. If the volatile solids content of the MLSS is 68%, how many lbs MLSS are desired in the aeration tank?

$F/M = 0.6 \frac{\text{BOD lbs}}{\text{MLVSS}}$

$\text{Load} = 3300 \frac{\text{lb}}{\text{day}}$

$\text{MLVSS} = \frac{3300 \frac{\text{lb}}{\text{day}}}{0.6} = 5{,}500 \frac{\text{lbs}}{\text{day}}$

$\frac{\text{MLVSS}}{\text{MLSS}} = 0.68$

$\text{MLSS} = \frac{5{,}500 \frac{\text{lbs}}{\text{day}}}{0.68}$

ANS 8088 $\frac{\text{lbs}}{\text{day}}$

2. Using a desired sludge age, it was calculated that 14,850 lbs MLSS are desired in the aeration tank. If the aeration tank volume is 780,000 gallons and the MLSS concentration is 2670 mg/*L*, how many lbs/day MLSS should be wasted?

$\text{Volume} = 780{,}000 \text{ gal}$

$\text{MLSS} = 8.34 (2670 \text{ mg/L}) \cdot 0.78 \text{ MGD} = 17{,}369 \frac{\text{lbs}}{\text{day}}$

$\text{Desired} = 14{,}850 \frac{\text{lb}}{\text{day}}$

$\text{Waste} = 17{,}369 \frac{\text{lb}}{\text{day}} - 14{,}850 \frac{\text{lb}}{\text{day}}$

ANS 2519 $\frac{\text{lbs}}{\text{day}}$

3. Given the following data, determine the lbs/day SS to be wasted:

Aer. Tank Vol.—1,100,000 gal
Influent Flow—2,930,000 gpd
BOD—108 mg/*L*
Desired F/M—0.3 lbs BOD/day/lb MLVSS
MLSS—2100 mg/*L*
% VS—67%

$F/M = 0.3 \frac{\text{lbs}}{\text{MLVSS}}$

$\text{Load} = 8.34 (108 \text{ mg/L}) 2.93 \text{ MGD} = 2{,}639 \text{ lbs}$

$\text{MLVSS} = \frac{2639 \text{ lbs}}{0.3} = 8797 \text{ lbs}$

$\text{Desired} = \frac{8797 \text{ lb}}{0.67} = 13{,}130 \text{ lbs}$

$\text{MLSS} = 8.34 (2100 \text{ mg/L}) 1.1 \text{ MG} = 19{,}265 \text{ lb}$

$\text{Waste} = 19{,}265 \frac{\text{lb}}{\text{day}} - 13{,}130 \frac{\text{lb}}{\text{day}}$

ANS 6135 $\frac{\text{lbs}}{\text{day}}$

4. The desired sludge age for an activated sludge plant is 5.5 days. The aeration tank volume is 850,000 gal. If 3140 lbs/day suspended solids enter the aeration tank and the MLSS concentration is 2920 mg/*L*, how many lbs/day MLSS (suspended solids) should be wasted?

Sludge Age = 5.5 days

Desired = 5.5 days (3140 $\frac{lb}{day}$) = 17,270 lbs

MLSS = 8.34 (2920 mg/L) · 0.85 MGD = 20,700 $\frac{lbs}{day}$

Waste = 20,700 $\frac{lbs}{day}$ − 17,270 $\frac{lbs}{day}$

ANS 3430 $\frac{lbs}{day}$

5. The desired SRT for an activated sludge plant is 8.5 days. There are a total of 32,100 lbs SS in the system. The secondary effluent flow is 3,160,000 gpd with a suspended solids content of 22 mg/*L*. How many lbs/day WAS SS must be wasted to maintain the desired SRT?

SRT = 8.5 days

$$SRT = \frac{32{,}100 \text{ lb}}{x + 8.34(22 \text{ mg/L})\ 3.16 \text{ MGD}}$$

$$8.5 = \frac{32{,}100 \text{ lbs}}{x + 580 \text{ lbs}}$$

$$8.5x + 4930 \text{ lbs} = 32{,}100 \text{ lbs}$$

$$x = \frac{27{,}170 \text{ lbs}}{8.5 \text{ day}}$$

ANS 3196 $\frac{lbs}{day}$

6. Given the following data, calculate the lbs/day WAS SS to be wasted. (Use the "combined volume" method of calculating SRT.)

Desired SRT—10 days
Clarifier + Aerator Vol.—1.33 MG
MLSS—2940 mg/*L*
S.E. SS—15 mg/*L*
Inf. Flow—6.85 MGD

SRT = 10 days

MLSS = 8.34 (2940 mg/L) 1.33 MG = 32,611 lbs

Load = 8.34 (15 mg/L) 6.85 MGD + x

Load = 857 $\frac{lb}{day}$ + x

$$10 \text{ day} = \frac{32{,}611 \text{ lbs}}{857 \frac{lb}{day} + x}$$

$$10x = 24{,}042 \text{ lb}$$

$$x = \frac{24{,}042 \text{ lbs}}{10 \text{ day}}$$

ANS 2404 $\frac{lbs}{day}$

PRACTICE PROBLEMS 12.9: WAS Pumping Rate Calculations

1. It has been determined that 5640 lbs/day of dry solids must be removed from the secondary system. If the RAS SS concentration is 6630 mg/*L*, what must be the WAS pumping rate, in MGD? (Round to the nearest hundredth.)

$5640 \frac{lbs}{day} = 8.34 (6630 \text{ mg/L}) x$

$x = \frac{5640}{55,294}$

ANS 0.10 MGD

2. The WAS suspended solids concentration is 6120 mg/*L*. If 8640 lbs/day dry solids are to be wasted, (a) What must the WAS pumping rate be, in MGD? (Round to the nearest hundredth.) (b) What is this rate expressed in gpm?

$8640 \frac{lbs}{day} = 8.34 (6120 \text{ mg/L}) x$

a) $x = \frac{8640}{51,041} =$

b) $0.17 \cdot \frac{MG}{day} \cdot 1,000,000 \frac{gal}{MG} \cdot \frac{1 \text{ day}}{24 \text{ hr}} \cdot \frac{1 \text{ hr}}{60 \text{ min}}$

ANS 0.17 MGD
118 gpm

3. Given the following data, calculate the WAS pumping rate required (in MGD): (Use the "combined volume" method of calculating system solids.) (Round the answer to the nearest thousandth.)

Desired SRT—9.5 days	RAS SS—7410 mg/*L*
Clarifier + Aerator Vol.—1.7 MG	S.E. SS—19 mg/*L*
MLSS—2630 mg/*L*	Inf. Flow—4.1 MGD

SRT = 9.5 days

MLSS = 8.34 (2630 mg/L) 1.7 MG = 37,2588 lbs

Load = 8.34 (19 mg/L) 4.1 MGD + x

$9.5 \text{ day} = \frac{37,2588 \text{ lbs}}{650 \frac{lbs}{day} + x}$

$x = \frac{31,116}{9.5}$

ANS 0.05 MGD

3,275 lb = 8.34 (7410 mg/L) y $y = \frac{3275}{61,799}$

4. Given the following data, calculate the WAS pumping rate required (in MGD):
(Use the "combined volume" method of calculating system solids.)
(Round the answer to the nearest thousandth.)

Desired SRT—8 days
Clarifier + Aerator Vol.—1.6 MG
MLSS—2580 mg/*L*

RAS SS—5990 mg/*L*
S.E. SS—13 mg/*L*
Inf. Flow—3.9 MGD

SRT = 8 days

MLSS = 8.34 (2580 mg/L) 1.6 MG = 34,428 lb

Load = 8.34 (13 mg/L) 3.9 MG + x

Load = 423 $\frac{lb}{day}$ + x

$$8 \text{ day} = \frac{34,428 \text{ lb}}{423 \frac{lb}{day} + x}$$

8x = 31,044

$$x = \frac{31,044}{8}$$

WAS = 3,881 $\frac{lbs}{day}$

3,881 $\frac{lb}{day}$ = 8.34 (5,990 mg/L) y

49,957 y = 3,881

$$y = \frac{3,881}{49,957}$$

ANS 0.078 MGD

PRACTICE PROBLEMS 12.10: Oxidation Ditch Detention Time

1. An oxidation ditch has a volume of 165,000 gallons. If the flow to the oxidation ditch is 180,000 gpd, what is the detention time, in hours?

Volume = 165,000 gal

Flow = 180,000 $\frac{gal}{day}$

Detention Time = $\frac{165,000 \text{ gal}}{180,000 \frac{gal}{day}}$ = 0.92 days

Detention Time = 0.92 day · 24 $\frac{hr}{day}$

ANS 22 hr

2. An oxidation ditch receives a flow of 0.21 MGD. If the volume of the oxidation ditch is 360,000 gallons, what is the detention time in hours?

Volume = 360,000 gal

Flow = 210,000 $\frac{gal}{day}$

Detention Time = $\frac{360,000 \text{ gal}}{210,000 \frac{gal}{day}}$ = 1.71 days

Detention Time = 1.71 days · 24 $\frac{hr}{day}$

ANS 41.1 hr

3. If the volume of the oxidation ditch is 415,000 gallons, and the oxidation ditch receives a flow of 295,000 gpd, what is the detention time in hours?

Volume = 415,000 gal

Flow = 295,000 $\frac{gal}{day}$

Detention Time = $\frac{415,000 \text{ gal}}{295,000 \frac{gal}{day}}$ = 1.41 days

Detention Time = 1.41 days · 24 $\frac{hr}{day}$

ANS 33.8 hr

4. The volume of an oxidation ditch is 190,000 gallons. If the oxidation ditch receives a flow of 305,000 gpd, what is the detention time in hours?

Volume = 190,000 gal

Flow = 305,000 $\frac{gal}{day}$

Detention Time = $\frac{190,000 \text{ gal}}{305,000 \frac{gal}{day}}$ = 0.62 day

Detention Time = 0.62 day · 24 $\frac{hr}{day}$

ANS 15 hr