NEWEA/NYWEA Operations Challenge
Process Control Event 2023

Team Name:
Team Number:
Team Captain:

Written Test points awarded:
MC points awarded:
Simulator points awarded:
Total Event Points:

Simulator - Computer
- 50 to 300 points per question
- 1000 max points available

Multiple Choice - Computer
- 10 to 20 points per question
- 450 max points available

Multiple Choice Math - Pages 2 - 6 (5)
- 25 total questions
- 40 full credit points per question
- 50% partial credit if math is correct but answer is incorrect
- 0 points is work is not shown
- 1000 max points available

Process Scenarios - Pages 7 - 25 (19)
- 19 total questions
- 50-100 full credit points per question
- Bonus SPA question worth 500 full credit points
- 50% partial credit if math is correct but answer is incorrect
- 0 points is work is not shown
- 1700 max points available

Math Multiple Choice

You must show your work(i.e Formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Circle the letter coresponding to the answer provided for for each question

#	Questions	Choices	
1	A pump runs continously for 8 hours and delivers 9,350 gallons. What is the capacity (pumping rate) of the pump in gallons per minute? **8 hrs * (60 min) = 480 mins 9,350 gals/480 mins = 19.5 gpm**	A	**195 gpm**
		B	**19.5 gpm**
		C	**21 gpm**
		D	**30 gpm**
2	The influent BOD is 231 mg/L, and the effluent BOD is 6.1 mg/L. What is the percent removal? **(231 mg/L - 6.1 mg/L)/231 mg/L = 0.974 * 100 = 97.4%**	A	**36.9%**
		B	**93.2%**
		C	**97.4%**
		D	**33.3%**
3	A sewer pipe is 265 ft long and has a diameter of 10 inches. The pipe is to be treated with a root-killing chemical containing a 250 mg/L concentration. How many pounds of chemical are needed? **10 in./12 = 0.83 ft * 0.83 ft *0.785 = 0.54 ft^2 * 265 ft = 143.1 ft3 * 7.48 = 1070.4 gals 250 mg/L * 0.00107 mgd * 8.34 = 2.23 lbs**	A	**324 lbs**
		B	**22.3 lbs**
		C	**23.4 lbs**
		D	**2.23 lbs**
4	A circular tank is 60 ft diameter and 12 ft deep. If the tank is completely full and an 850 gpm pump is supplied, how long will it take (in minutes) to remove 7 ft of water from the tank? **60 ft * 60 ft * 0.785 * 7 ft = 19782 ft^3 * 7.48 = 147979.36 gals** **147979.36 gals / 850 gpm = 174.1 mins**	A	**298.4 min**
		B	**174.1 min**
		C	**124.3 min**
		D	**135.4 min**
5	The sludge feed to a belt filter press is 150 gpm. If the total suspended solids concentration of the feed is 4.2%, what is the solids loading rate. **TSS = 42000 mg/l** **Flow = 150 gpm*60min/hr = 9000 gal/hr = 0.009 MG/hr** **Mass loading = 0.009 MG/hr*42000mg/l*8.34 = 3152.52 lb /hr** **or Mass loading = 150gal/min*60min/hr*.042*8.34=3152.52 lb/hr**	A	**53 lb/hr**
		B	**3150 lb/hr**
		C	**5250 lb/hr**
		D	**7600 lb/hr**

For graders use only

work shown=20 points
correct+work=40 points

#	correct	work?	total
1			
	B		
2			
	C		
3			
	D		
4			
	B		
5			
	B		

Math Multiple Choice

You must show your work(i.e Formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Circle the letter coresponding to the answer provided for for each question

#	Questions	Choices		For graders use only (work shown=20 points; correct+work=40 points)		
6	If a 50ft diameter secondary clarifier receives a flow of 2.5 MGD with a MLSS 2500 mg/l, calculate the solids loading rate on the clarifier **25' X 25' X 3.14 = 1962 ft2** **2.5 MGD X 2500 mg/l X 8.34 = 52125 lbs/day** **52125 lbs/day / 1962 ft2 = 26.6 lb/d/ft2**	**A**	**21.7 lb/d/ft2**	correct	work?	total
		B	**26.6 lb/d/ft2**			
		C	**36 lb/d/ft2**	**B**		
		D	**49.5 lbd/ft2**			
7	Calculate the time to reduce the water level from 18 feet to 3 feet in a 30ft diameter circular tank using a 180 gpm withdrawal rate. **(15' X 15' X 3.14 X (18' - 3') X 7.48 = 79269 Gal** **79269 Gal / 180 GPM = 440 Min** **440 Min / 60 min/hour = 7.3 hours**	**A**	**6.5 hours**	correct	work?	total
		B	**7.3 hours**			
		C	**8.2 hours**	**B**		
		D	**5.5 hours**			
8	Calculate the average filtration rate during a 72 hour filter run for a sand filter 15 feet long and 7 feet wide that produces 2.5 million gallons during the run. **Filter area = 15 ft*7ft = 105 ft2** **Water Treated = 2500000 gal** **Run Time = 72 hours = 4320 min** **Filtration rate = 2,500,000gal/4320min/105 ft2 = 5.5 gpm/ft2**	**A**	**4.2 gpm/ft2**	correct	work?	total
		B	**4.9 gpm/ft2**			
		C	**5.5 gpm/ft2**	**C**		
		D	**7.3 gpm/ft2**			
9	The concentration of the flocculant for a belt filter press is 0.8%. If the flocculant feed rate is 3 gpm, what is the flocculant feed rate in lbs/hr? **Mass flocculant - 3 gal/min*60 min/hr*0.8/100* 8.34 = 12.01**	**A**	**3 lb/hr**	correct	work?	total
		B	**6 lb/hr**			
		C	**8 lb/hr**	**D**		
		D	**12 lb/hr**			
10	What was the average daily flow (in MGD) for this three month period given the total monthly flows for the following months: March: 197.3 ft3/sec; April: 100,186.2 gpm; May: 255.7 MGD **March: 197.3 ft^3 / sec * 60 sec * 60 mins * 24 hr = 17,046,720 ft^3/day = 127.51 MGD * 31 = 3952.81 MG April: 100,186.2 gpm * 1440 = 144.27 MGD * 30 = 4328.1 MG May: 255.7 MGD * 31 = 7926.7 MG (3952.81 mg + 4328.1 mg + 7926.7 mg) / 92 days = 176.17 MGD**	**A**	**181.4 MGD**	correct	work?	total
		B	**192.5 MGD**			
		C	**176.2 MGD**	**C**		
		D	**170.8 MGD**			

Math Multiple Choice

You must show your work(i.e Formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Circle the letter coresponding to the answer provided for for each question

#	Questions	Choices	
11	A WWTP uses 1-ton cylinders of chlorine for disinfection. The average daily chlorine demand is 9 mg/L requiring an average daily dosage of 11 mg/L. How many cylinders will the plant need for the month of May? The average daily plant flow for the month is 12 mgd. **11 mg/L * 12 mgd * 8.34 = 1100.88 lbs/day 31 * 1100.88 lbs/day = 34127.28 lbs / 2000 lbs = 17.1 cylinders, so 18.**	A	18
		B	17
		C	19
		D	21
12	A pump has an efficiency of 94% and a motor has a power factor of 0.82. If the water horsepower is 302 hp and electricity has a cost of 11.0 cents per KWH, how much will it cost to run the pump for one month (31 days) at 12 hrs/day? **302 hp / 0.94 = 321.3 hp 321.3 hp / 0.82 = 391.8 hp 391.8 hp * 0.746 kW = 292.3 kW 292.3 kW * 12 hrs/day * 0.11 cents * 31 days = $11960.92**	A	$386
		B	$11,961
		C	$16,032
		D	$9,808
13	Gived the following data, determine the excess solids in (lbs) that should be wasted from the activated sludge system given the following data: Target F:M = 0.6, MLSS = 2,500 mg/L, BOD loading = 1,140 lbs/day, Aeration Basin = 60 ft x 20 ft x 12 ft. **60 ft * 20 ft * 12 ft = 14400 ft^3 * 7.48 = 107712 gals 2500 mg/L * 0.107712 mg * 8.34 = 2245. 8 lbs in system 1,140 lbs BOD/day / 0.6 = 1900 lbs 2245.8 lbs - 1900 lbs = 345.8 lbs to be removed**	A	345.8 lbs
		B	2245.8 lbs
		C	1900 lbs
		D	521.2 lbs
14	Given the following data, determine the percent volatile suspended solids of this sample given the following data: Weight of dish = 21.01 g, Weight of dish and wet sample = 53.71 g, Weight of dish and dry sample = 21.48 g, Weight of dish and ash = 21.11 g. **((21.48 g - 21.01 g) - (21.11g - 21.01 g)) / (21.48 g - 21.01 g) = 0.787 x 100 = 78.7%**	A	99.7%
		B	82.1%
		C	65.4%
		D	78.7%
15	If a pump outputs 625 gpm against a TDH of 198 ft, and the pump is 74% efficient, what is the brake HP? **(625 gpm * 198 ft) / (3960 * 0.74) = 42.2 hp**	A	42.2 HP
		B	41.5 HP
		C	44.8 HP
		D	52.1 HP

For graders use only		
work shown=20 points correct+work=40 points		
correct	work?	total
A		
correct	work?	total
B		
correct	work?	total
A		
correct	work?	total
D		
correct	work?	total
A		

Math Multiple Choice

You must show your work(i.e Formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Circle the letter coresponding to the answer provided for for each question

#	Questions	Choices	
16	Given a feed sludge TSS of 3.7% to a belt filter press, a return flow TSS of 0.039%, and a Cake TS of 15%, calculate the solids recovery **Solids Capture (%)= 15*(3.7-.039)*100 / 3.7*(15-.039) = 99.2%**	A	96.0%
		B	97.2%
		C	98.8%
		D	99.2%
17	Calcualte the F/M for an activated sludge plant with two aeration tanks, each 92,000 gallons, primary effluent of 260 mg/l, aeration tank MLSS of 1900 mg/l in each tank, volatile content of 82%, and an influent flow of 152,000 gpd. **lb MLVSS = 2*.092MG*.82*1900*8.34 = 2390.8448 lb** **Loading = .152MG*260mg/l*8.34 = 329.5968 lb/d** **F/M = 329.5968 lb/d/2332.5312lb = 0.14 lb/d/lb**	A	0.11 lb/d/lb
		B	0.14 lb/d/lb
		C	0.17 lb/d/lb
		D	0.2 lb/d/lb
18	Compost is to be blended from wood chips and dewatered sludge. The wood chips are mixed with 10 yd3 of dewatered sludge at a ratio (by volume) of 3:1. The solids content of the sludge is 15% and the solids content of the wood chips is 54%. If the buld density of the sludge is 1685 lb/yd3 and 750 lb/yd3 for the wood chips, what is the percent solids content of the compost blend? **(Lb Dry Sludge + Lb dry chips) / (Lb Sludge + Lb Chips) *100** **(10*1685*.15+3*10*750*.54)*100 / (10*1685 + 3*10*750) 37.30%**	A	17%
		B	27%
		C	37%
		D	54%
19	Flow = 186,000 gpd, Influent BOD=254 mg/l, Effluent BOD = 9 mg/l, Influent TSS=299 mg/l, Effluent TSS = 8 mg/l, Influent Nitrogen (all Ammonia) = 25 mg/l, The facility does not have primary treatment. Calculate the theoretical alkalinity **BOD reduction = 254-9 = 245 mg/l** **Ammonia consumpion during BOD reduction = 5/100*245 = 12.25 mg/l** **#1b Ammonia to be nitrified = (25-(12.25+1.5))*.186*8.34=17.45 lb/d** **Theoretical Alkalinity consumption = 17.45 * 7.14 = 124.6 lb/d**	A	124.6 lb/d
		B	141.2 lb/d
		C	174.5 lb/d
		D	260.0 lb/d
20	A RBC treatments systems has two RBC's each with 100,000 ft2 of standard density media. The RBC's are operated in parallel for with an influent flow of 100,000 gpd, influent BOD = 240 mg/l, primary effluent BOD = 145 mg/l. For an even flow slpplit, calculate the organic loading to each RBC. **OLR = (50,000 gpd*145mg/l*8.34)/100(1000 ft2) = 0.605 gpd/1000ft2**	A	0.605 lb/1000 ft2
		B	1.0 lb/1000 ft2
		C	1.2 lb/1000 ft2
		D	2.0 lb/1000 ft2

For graders use only

work shown=20 points
correct+work=40 points

#	correct	work?	total	Answer
16				D
17				B
18				C
19				A
20				A

Math Multiple Choice

You must show your work(i.e Formulas, intermediate calculations, etc.) to receive full credit even if the answer is correct.

Circle the letter coresponding to the answer provided for for each question

#	Questions	Choices	
21	If the feed rate of 0.8% flocculant cncentration is 12 lb/hr for a 4.2% sludge fed at a rate of 2700 lb/hr to a belt filter press, calculate the flocculant dose in lb flocculant/ton solids treated. **sludge feed = 2700 lb/hr/2000 lb/ton = 1.35 ton/hr** **Flocullant dose = 12 lb/hr/1.35 ton sludge/hr = 8.89lb floccula**	A	**4.2 lb flocculant/ton sludge**
		B	**5.2 lb flocculant/ton sludge**
		C	**7.1 lb flocculant/ton sludge**
		D	**8.9 lb flocculant/ton sludge**
22	Calculate the water horsepower for a pump to move water for an elevation change of 21.59 feet with pipe friction losses of 1.98 ft and minor losses of 6.92 ft for a flow of 800 gpm. **Head = 21.59ft = 1.98ft = 6.92 ft = 30.49 ft** **WHP = 800*30.49/3960 = 6.1596hp**	A	**4.3 hp**
		B	**1.8 hp**
		C	**6.2 hp**
		D	**8.2 hp**
23	Calculate the pounds of air needed in an aeration tank to reduce the tank influent BOD from 145 mg/l to 15 mg/l at a flow of 1.2 MGD. Assume an oxygen requirement of 1.1 lb oxygen/lb BOD and that the facility is at sea level elevation. **lb BOD removed = 1.2*(145-15)=*8.34=1301.04 lb/d** **Oxygen required = 1.1 lbO2/lbBOD * 1301.04lb/d = 1431.144 lb O2/d** **Air required = 1431.144/.21 = 6814.97 lb/d**	A	**7600 lb/d**
		B	**6810 lb/d**
		C	**1600 lb/d**
		D	**1430 lb/d**
24	Calculate the flow velocity in a grit channel that is 9 ft long, 18 inches wide, and 18 inches deep at a flow 200,000 gpd. **Area = 1.5 ft*1.5ft= 2.25 ft2** velocity = $\frac{200{,}000\frac{gal}{day}}{2.25ft^2} * \frac{1\ ft^3}{7.47\ gal} * \frac{1\ day}{1440\ min} * \frac{1\ min}{60\ sec} = 0.138\ \frac{ft}{sec}$	A	**0.069 ft/sc**
		B	**0.14 ft/sec**
		C	**0.2 ft/sec**
		D	**1.1 ft/sec**
25	A alum jar test on secondary effluent using an alum test solution of 20 mg Alum/ml had an optimum dose at 1.4 ml of test solution in a 2 liter test beaker. Using the results of this test, calculate the daily alum required for a flow rate of 3.4 MGD. **Optimum dose = 1.4 ml*20 mg/ml/2 liter =14 mg/l** **lb Alum = 3.4 MGD *14 mg/l * 8.34 = 396.98 lb/d**	A	**284 lb**
		B	**397 lb**
		C	**560 lb**
		D	**794 lb**

For graders use only

work shown=20 points
correct+work=40 points

correct	work?	total
D		

correct	work?	total
C		

correct	work?	total
B		

correct	work?	total
B		

correct	work?	total
B		

Process Scenario #1: Primary Clarification

You must show your work to receive full credit even if the answer is correct

Operational Data

You are designing a new Wastewater Treatment Plant that will be built with a 200 MGD design dry weather flow. The plant influent TSS is expected to average 150 mg/L. The design standards being used are as follows:

Hydraulic Loading Rate - 2000 gpd/sqft
TSS Removal - 65%
Number of Tanks - 8
Passes per Tank - 4
Weir Overflow Rate - 40,000 gpd/sqft
Primary Tank Flow Velocity = 2 ft/min

Process Scenario #1: Primary Clarification

You must show your work to receive full credit even if the answer is correct

1

Given the above data and that the initial settling tests indicate an average primary sludge concentration of 2500 mg/L what size pumps are needed if each tank will have a dedicated sludge pump?

For Graders Only	
Points 50/100	Answer
	B

A	400 gpm
B	700 gpm
C	1000 gmp
D	1400 gpm

Influent Loading Rate

lbs/day = 200 MGD * 150 mg/L * 8.34

lbs/day = 250200

Lbs removed

250200 * 0.65 = 162630 lbs/day

Sludge Volume Removed

$$\text{MGD} = \frac{162630}{2500\text{ mg/L} * 8.34}$$

MGD = 7.8

7.8 * 694 gpm/MGD = 5413 gpm

5413 gpm / 8 = 676 gpm

Process Scenario #1: Primary Clarification

You must show your work to receive full credit even if the answer is correct

		For Graders Only	
		Points 50/100	Answer
2	Determine the minimum width of each pass if they will be 125ft long.		**A**

A	25 ft
B	50 ft
C	100 ft
D	125 ft

$$\frac{200{,}000{,}000 \text{ gal/day}}{2000 \text{ gpd/sqft}} = 100000 \text{ sqft}$$

$$\frac{100{,}000 \text{ sqft}}{8} = 12{,}500 \text{ sqft/ tank}$$

$$\frac{12{,}500 \text{ sqft}}{4} = 3125 \text{ sqft/ pass}$$

$$\frac{3125 \text{ sqft}}{125 \text{ ft}} = 25 \text{ ft/ pass}$$

Process Scenario #1: Primary Clarification

You must show your work to receive full credit even if the answer is correct

		For Graders Only	
3	Based on the design primary tank flow velocity and width from question 3, determine the minimum average height of each tank.	Points 50/100	Answer
			C

A	10 ft
B	11 ft
C	12 ft
D	14 ft

200 MGD * 1.55 cuft/s / MGD = 310 cuft/s

$$\frac{310 \text{ cuft/s}}{2 \text{ ft/min} / 60} = 9300 \text{ sqft}$$

$$\frac{9300 \text{ sqft}}{8*4*25\text{ft}} = 11.6 \text{ ft}$$

Process Scenario #1: Primary Clarification

You must show your work to receive full credit even if the answer is correct

4

Determine the length of weir needed for each pass based on the design dry weather flow and the design weir overflow rate. Draw out a possible weir layout based on your answer and the design information. Be sure to label the dimensions of the drawings for full credit.

For Graders Only	
Points 50/100	Answer
	D

A	120 ft
B	140 ft
C	150 ft
D	160 ft

$$\frac{200{,}000{,}000 \text{ gal/day}}{40{,}000 \text{ gpd/sqft}} = 5000 \text{ ft}$$

$$\frac{5000 \text{ ft}}{8 * 4} = 156 \text{ ft}$$

Any weir layout that has a total of 160 ft of weir so long as it is less than 25 ft wide is acceptable since that is the maximum width of each pass.

Process Scenario #2: MBR

MBR Plant Characteristics

Influent Characteristics	
Flow:	1.2 MGD
BOD:	225 mg/L
TSS:	272 mg/L
Alkalinity:	140 mg/L
TKN:	50 mg/L
pH:	6.8 s.u.

Effluent Characteristics	
cBOD:	8.0 mg/L
TSS:	2.0 mg/L
NH3:	1.0 mg/L
TN:	4.0 mg/L

Permit Limits	
cBOD:	45 mg/L
TSS:	45 mg/L
NH3:	4.0 mg/L
TN:	8.0 mg/L
pH	6.9 s.u.

Process Information:

The MBR consisit of two paralell trains that receive even flows. The membranes are hollow fiber. There are 19 membrane racks per tank and 42 membrane modules per rack. Each module in the rack has a surface area of 65 ft^2.

Tanks Volumes		MLSS
Anoxic:	86,830 Gallons	5,350 mg/L
Aerobic:	256,700 Gallons	5,350 mg/L
Membrane:	120,000 Gallons	7,100 mg/L
		75% volatile

Process Scenario #2: MBR

1

B. For a SRT of 10.2 days calculate the WAS rate. Include the mass in the MBR Tank.

Anoxic MLVSS = 2*.086830*8.34*.75 = 5811.401655 lb

Aerobic MLVSS = 2*.2567*5350*8.34*.75=17180.54595 lb

F/M = $\dfrac{2251.8 \text{ lb/d}}{5811.401655\text{lb}+17180.54954\text{lb}}$ 0.098

A	**0.10 lb/d/lb**
B	**0.14 lb/d/lb**
C	**0.15 lb/d/lb**
D	**0.16 lb/d/lb**

For Graders Only	
Points 25/50	Proper Answer
	A

B. For a SRT of 10.2 days calculate the WAS rate.

Anoxic MLSS = 2*.08683*5350*8.34 = 7750.32 lb

Aerobic MLSS = 2*.2567*5350*8.34=22924.52 lb

MBR MLSS = 2*.12*7100*8.34 = 14211.36 lb

Effluent TSS = 1.2*2*i.34=20.016 lb/d

WAS = $\dfrac{\text{Anoxic+Aerobic+MBR}}{\text{SRT}}$ - EFFTSS = 4206.134 lb/d

A	**2235 lb/d**
B	**2980 lb/d**
C	**3280 lb/d**
D	**4200 lb/d**

For Graders Only	
Points 25/50	Proper Answer
	D

Process Scenario #2: MBR

2

A. If the membrane module has a flux rate of 34.3 gpd/ft^2, calculate the membrane area required for a peak daily flow of 2.7 MGD.

Flux = Q/A
Area = 2,700,000 gpd/34.3 gpd/ft^2 = 78,717.202 ft^2

A	**35000 ft^2**
B	**50000 ft^2**
C	**78720 ft^2**
D	**82300 ft^2**

For Graders Only	
Points 25/50	Proper Answer
	C

B. Calculate the number of membrane racks for each treatment train, if each membrane module has an area of 65 ft^2.

modules required = 78717.202/65 = 1211
racks = 1211/42 = 28.8
#racks/train = 28.8/2 = 14.4 - round to 15 racks/train

A	**10**
B	**15**
C	**16**
D	**19**

For Graders Only	
Points 25/50	Proper Answer
	B

Process Scenario #2: MBR

3

A. Given that the nitrogen content of the volatile solids is 12 %, calculate the amount of nitrogen converted into nitrogen gas, assuming a sludge wasting rate of 4380 lb/d.

A	**60 lb/d**
B	**66 lb/d**
C	**106 lb/d**
D	**110 lb/d**

Eff N = 1.2MGD*4mg/l*8.34 = 40.032 lb/d
WAS N = 4380.59lb/d*.75*.12 = lb/d
Influent N = 1.2MGD*50mg/l*8.34=500.4 lb/d

lb/d N2 = 500.4-(394.25+40.032) = 66.1 lb/d

For Graders Only	
Points 25/50	Proper Answer
	B

B. Calculate the theoretical alkalinity consumption in the aerobic zone during nitrification. Assume all the influent TKN is converted to Ammonia and nitrification. Ignore recycle streams and assume that nitrification in the aerobic zone reduces the ammonia to 1 mg/l following BOD removal.

A	**77.5 mg/l**
B	**260 mg/l**
C	**280 mg/l**
D	**357 mg/l**

N Consumed w BOD Removal = (225-8)*5/100 = 10.85 mg/l
N remaining after BOD Removal = 50-10.85 = 39.85 mg/l
Alkalinity consumed by nitrification = (39.85-1)*7.14 = 279.531 mg/l

For Graders Only	
Points 25/50	Proper Answer
	C

Process Scenario #2: MBR

4

A. Each membrane rack has a treated flow rate of 60 gpm and an 15 minute operating cycle. The operating cycle is 12 minutes in operation mode and 3 minutes in relaxation mode, calculate the number of gallons treated by a rack in an hour at the influent flow of 1.2 MGD.

A	**2880 gal**
B	**3200 gal**
C	**3600 gal**
D	**4800 gal**

#cycles/hour =4, # minutes operation/hour = 4*12 = 48 minutes

treated water = 60 gpm*48 minutes = 2880 gallons

For Graders Only	
Points 25/50	Proper Answer
	A

B. Each membrane rack goes through a maintenance clean every 4 days. Each maintenance clean lasts for 60 minutes. At the daily flow rate of 1.2 MGD, calculate the number of gallons of wastewater processed by each rack between each maintenance clean event. Each membrane rack has a treated flow rate of 60 gpm with a operating cycle of 12 minutes in operation mode and 3 minutes in relaxation mode.

A	**160,000 gal**
B	**225,000 gal**
C	**276,000 gal**
D	**326,000 gal**

operating cycles = 4*1440/15 = 384

min operating/cycle = 12

min treating water = 384*12 = 4608 min

Treated water = 60*4608=276480 gallons

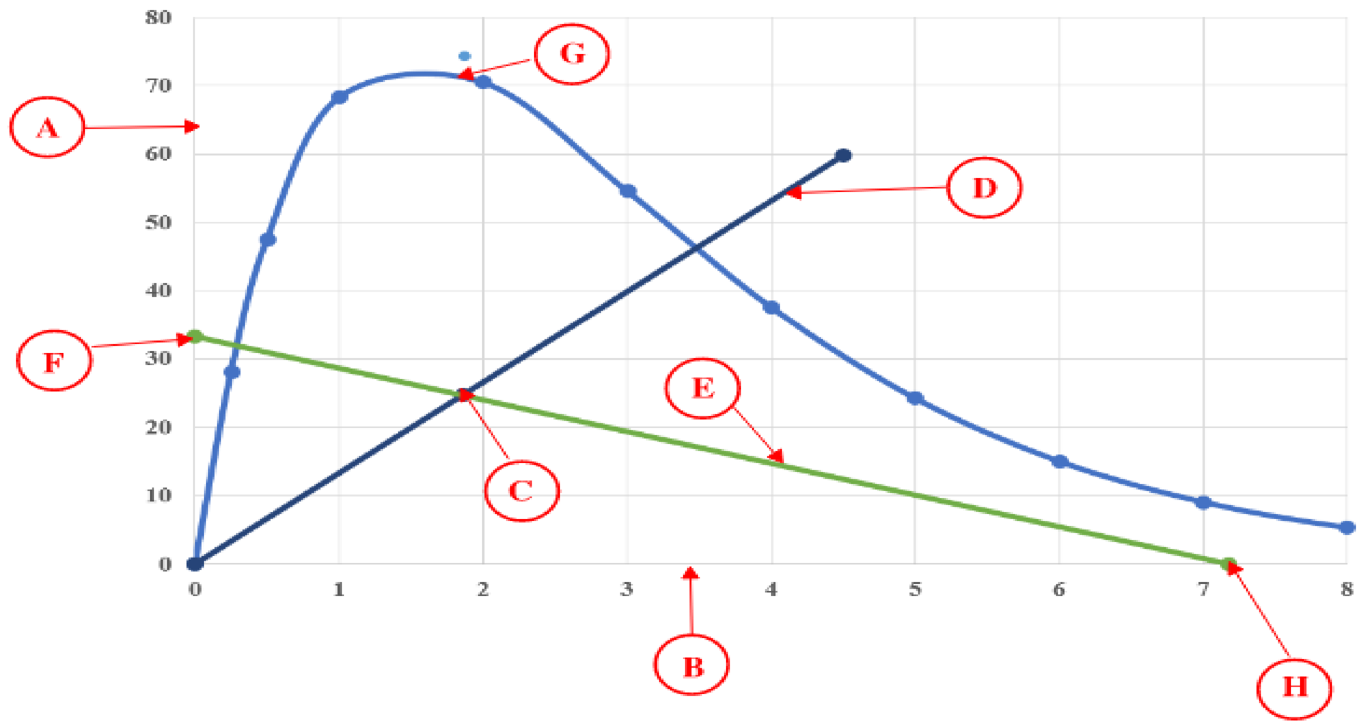
For Graders Only	
Points 25/50	Proper Answer
	C

Process Scenarios #3 - State Point Analysis

1

Label all points of the State Point Diagram shown below. You must get all labels correct for full credit.

Answers	Table 1 - Label SPD	For Graders Only: Answer	Points 50/100
	Solids Flux Axis	A	
	Solids Concentration Axis	B	
	Underflow Line	E	
	State Point	C	
	Overflow Line	D	
	RAS Concentration Estimate	H	
	Settling Flux Curve	G	
	Solids Loading Rate	F	



Process Scenarios #3 - State Point Analysis

Two Part Question. You must answer both question correctly for full credit

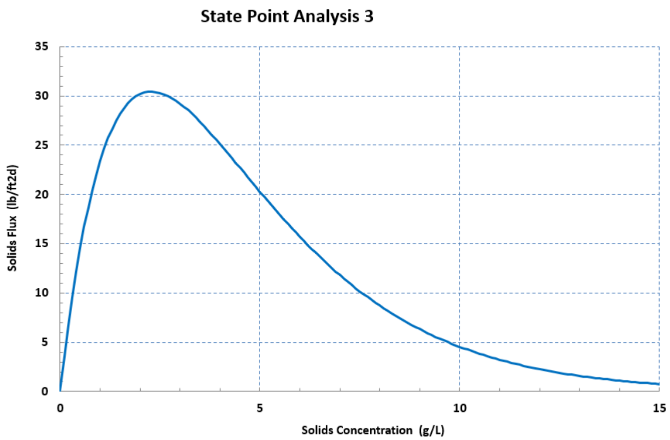
2

Given the following Settling Flux Curves, which has better settling sludge?
Write WHY it is better next to your answer.

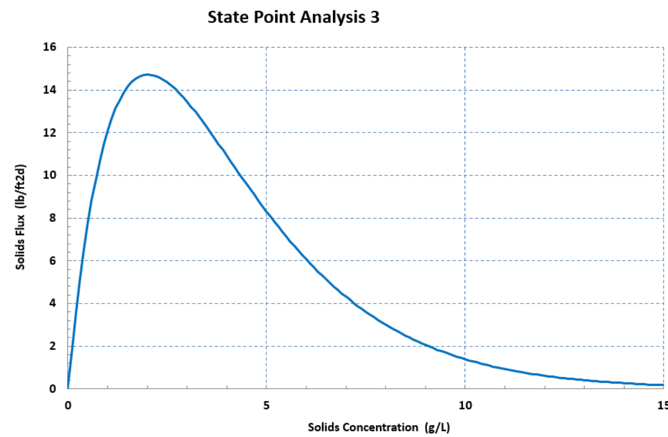
Circle One	
A	Settling Curve 1
B	Settling Curve 2

Why Is it better?

#1 has a higher settling flux and solids loading rate capacity.



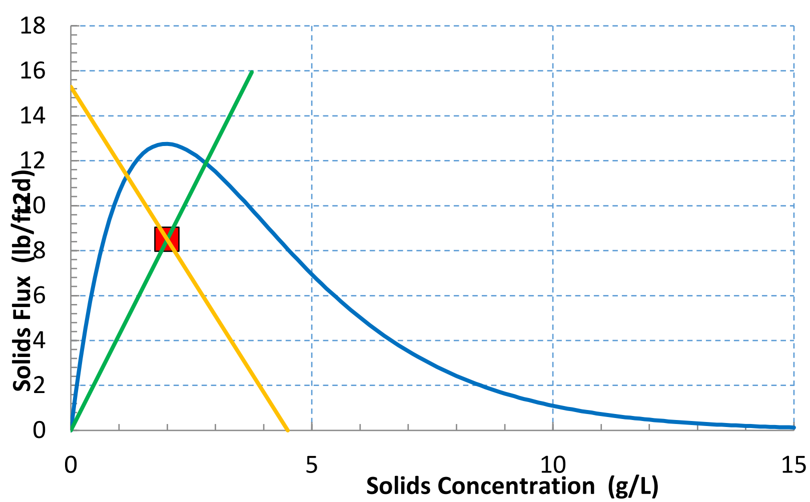
Settling Curve #1



Settling Curve #2

For Graders Only	
Answer	Points 50/100
A	
C	

Lowering the RAS rate will:



Circle One	
A	increase the total solids loading rate
B	decrease the settling flux curve
C	increase the RAS solids concentration
D	lower the state point

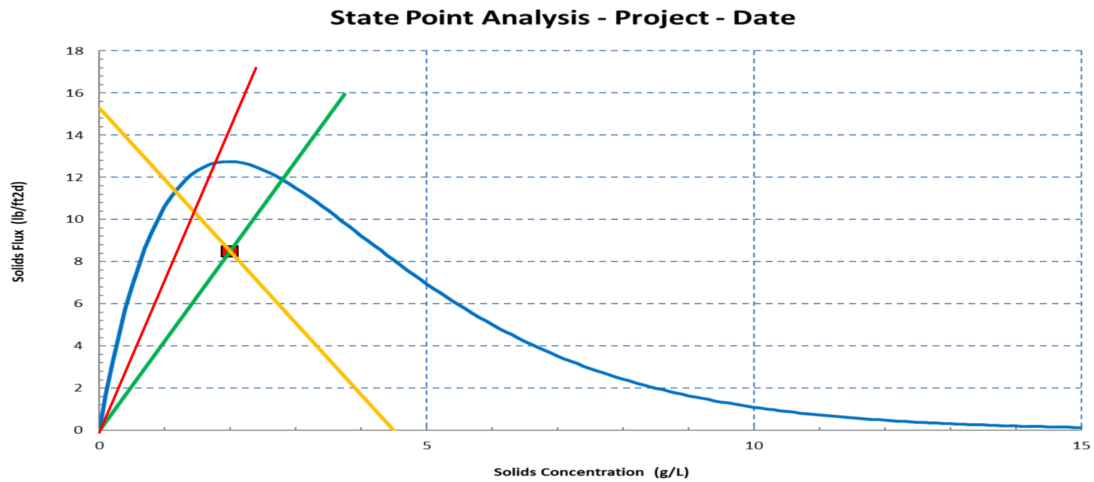
Process Scenarios #3 - State Point Analysis

Two Part Question. You must answer both question correctly for full credit

3

Draw a new overflow line on the SPA diagram below to show what would happen if the influent flow increased.

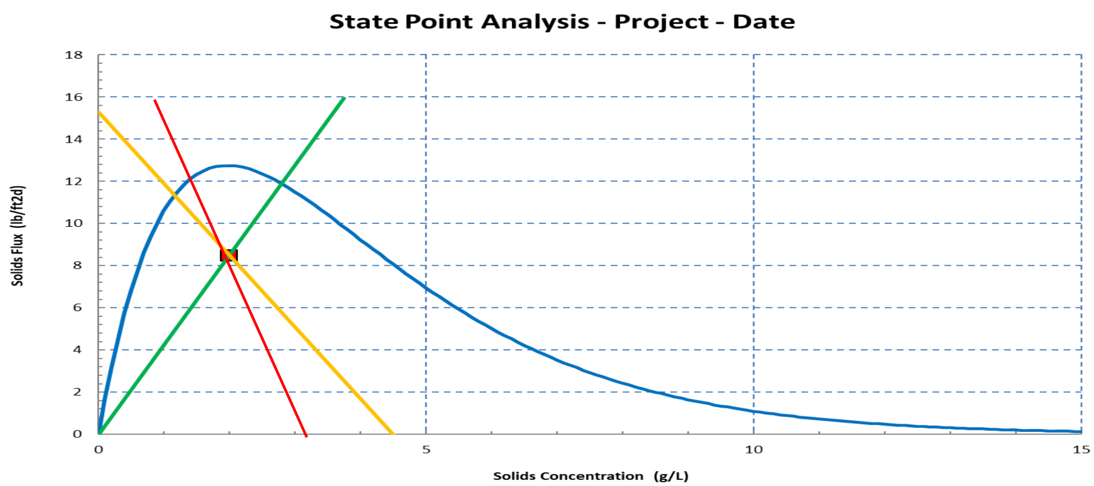
Because no flow data is given, the line you draw does not have to be exact, just demonstrate that you understand the concept



For Graders Only	
Answer	Points 50/100
See lines in red	

Draw a new underflow line on the SPA diagram below to show what would happen if the RAS flow increased.

Because no flow data is given, the line you draw does not have to be exact, just demonstrate that you understand the concept



Process Scenarios #3 - State Point Analysis

Bonus Question 2X Points. You must get all parts correct and show your work for full credit.

Given the following WWTF Data:

Influent Qi	2 MGD
RAS Qras	1.6 MGD
MLSS	2000 mg/L
Clarifier Diameter	50 Ft
# of Clarifiers	2
SLR = Qi/A X MLSS + Qras/A X MLSS	

Question	Enter Answers
3.1	
3.2	
3.3	

For Graders Only

	Answer	Points 100/200
3.1	2.0,8.5 (x/y)	
3.2	15.3 lb/sf-d	
3.3	4.5 g/L	

4

3.1 On the following page, draw the State Point on the blank diagram below. You must show your work for full credit.

SLR = Qi/A x MLSS + Qras/A x MLSS

State Point is the SLR caused by the overflow rate and the MLSS:

State point = Qi/A x MLSS x 8.34
= 2 MGD/(2*pi x (50)^2/4) x 2,000 mg/L x 8.34
= 8.5 lb/sf-d

3.2 Estimate the Total Solids Loading Rate (SLR)

SLR = Qi/A x MLSS + Qras/A x MLSS
= 2 MGD/(2*pi x (50)^2/4) x 2,000 mg/L x 8.34 + 1.6 MGD/(2*pi x (50)^2/4 x 2,000 mg/L x 8.34
= 8.5 + 6.80
= 15.3 lb/sf-d

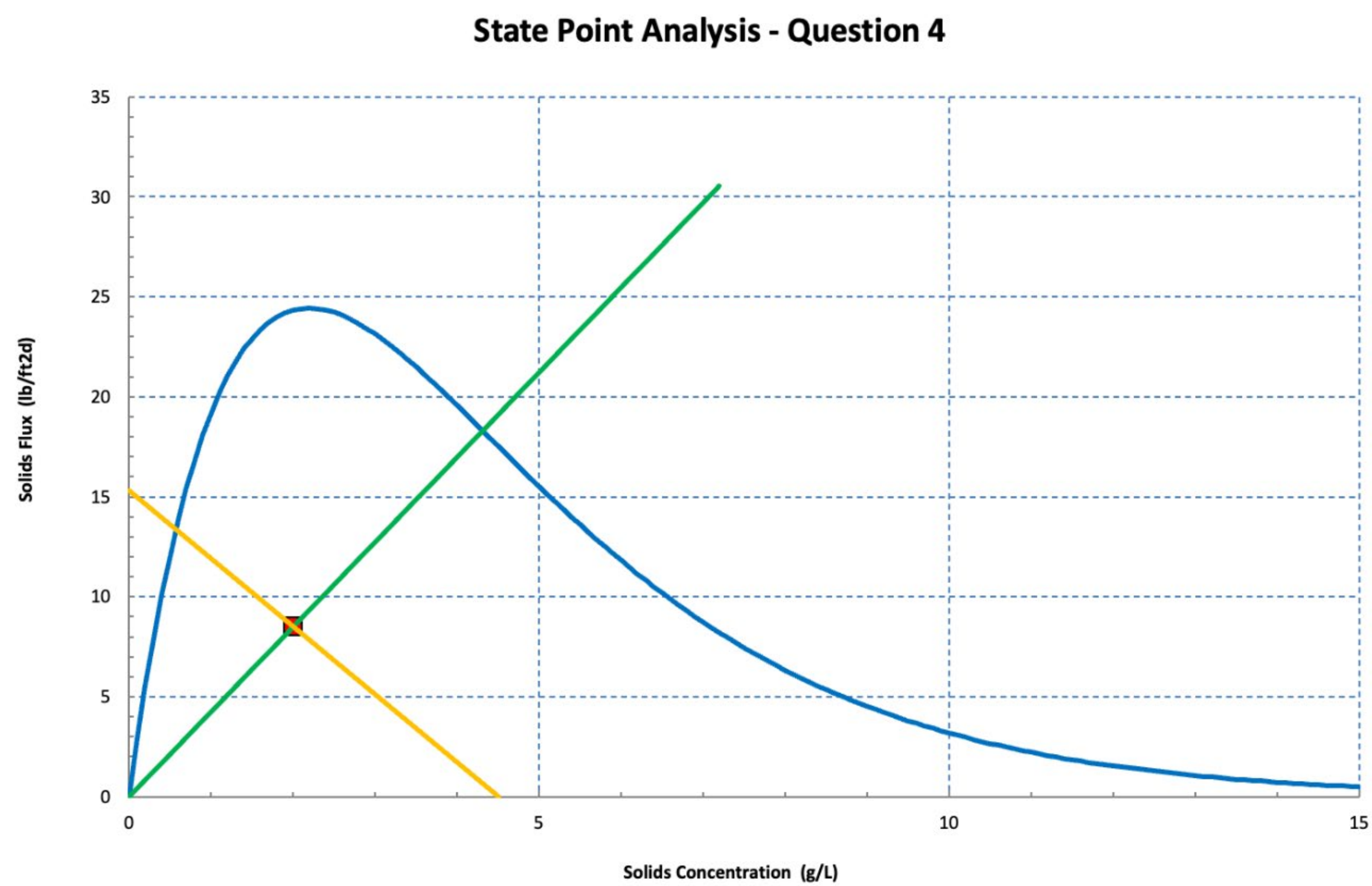
3.3 What is the predicted RAS Concentraiton? Draw the overflow and underflow lines.

Draw overflow and underflow line
RAS concentration = 4.5 g/L

Process Scenarios #3 - State Point Analysis

Blank SPA for Bonus Question 4

4



Scenario Description: Actual drawings for a facility were provided to you.

Secondary treatment process consists of two (2) ATs and four (4) secondary clarifiers, with all units in service. The activated sludge system setup in Modified Ludzack-Ettinger (MLE) configuration to maximize total nitrogen (TN) removal. Each AT consists of four (4) zones (1 Anoxic, 1 Swing, and 2 Oxic). Process Air Blowers supply air/oxygen to the oxic zones via fine bubble diffusers. In the MLE mode, both the primary effluent and return activated sludge (RAS) is distributed only into the anoxic (1st) zone.

Process Scenarios #4 - Plant Automation and P&ID

These questions are in reference to the drawings included with the test.

		For Graders Only	
1	Using the legend provided with the P&ID drawings, develop an identification tag for the check valve down stream of IMLR Pump Discharge into Zone 1A of Aeration Tank No. 1, using Sequence Number - 001. Assume it is a standard check valve.	Answer	Points 50/100
	CH - 24" - 812 - 001		

Process Scenarios #4 - Plant Automation and P&ID

These questions are in reference to the drawings included with the test.

		For Graders Only	
	For this scenario - The facility would like to increase nitrification treatment capacity in the Aeration Tanks, which requires aerating the swing zone that follows the anoxic zone. Process Air Blower No. 1 is currently in use. Additional air requirements will need Air Blower No. 2 to be turned on as well. For Aeration Tank 1, using identification tags, what gates, blowers, valves etc., would be changed in making that happen. You can list the steps along with identification number below, or mark the drawing by drawing a SQUARE around the equipment and writing the action taken next to it. If the markings on the drawings are not ledgible to the judges, you will not receive credit.	Answer	Points 50/100
2	The symbol used to mark up drawings for this questions is a SQAURE a. Turn Off Mixer No. 3 & No. 4 b. Open PA-8”-812-1 using E-MD-DNT-812-1101 c. Open BR-14”-814-19 d. Energize Air Blower No. 2 20 Bonus Points - if they called out E-MD-DNT - 812-1101 as Automatic/Actuated Operation? Or properly marked drawings		

Process Scenarios #4 - Plant Automation and P&ID

These questions are in reference to the drawings included with the test.

		For Graders Only	
	For this scenario - During anticipated high flow events, contact stabilization (CS) is practiced at the facility to allow for large biomass inventory in the aeration tanks. In CS mode, RAS is distributed only to the two (2) oxic zones. The primary effluent is distrubuted 10%/20%/70% between the 1st anoxic, 2nd swing and the two (2) oxic (3rd and 4th) zones. For Aeration Tank 1, using identification tags, what gates, blowers, valves etc., would be changed in making this switch from MLE to CS mode happen. You can list the steps along with identification number below, or mark the drawing by drawing a TRIANGLE around the equipment and writing the action taken next to it. If the markings on the drawings are not ledgible to the judges, you will not receive credit.	Answer	Points 50/100
3	The symbol used to mark up drawings for this questions is a TRIANGLE a. Close SG-27"60"-812-501 and SG-27-27"60"-812-502 b. Open SG-27"X60"-812-503 and SG-27-27"X60"-812-504 to send RAS to the 2 Oxic Zones c. Throttle/Adjust Motorized Slide Gates 1, 2, 3 to send 10% of PE flow to the Anoxic (1st) Zone d. Throttle/Adjust Motorized Slide Gates 8 to send 20% of PE flow to the Swing (2nd) Zone e. Throttle/Adjust Motorized Slide Gates 13,14,19,20 to split 70% of PE flow to the 2 Oxic (3rd and 4th) Zones Or properly marked drawings		

Process Scenarios #4 - Plant Automation and P&ID

These questions are in reference to the drawings included with the test.

4	For this scenario, Secondary Clarifiers No.2 and No.4. are in operation. RAS Pump No. 2 is active and dedicated to Clarifier No. 2. Isolate Clarifier No. 4 and drain it back to the two (2) oxic zones of Aeration Tank No. 1. RAS Pump No. 4 is active and dedicated to Clarifier No. 4. Using identification tags, what gates, blowers, valves etc., would be changed in making that happen. You can list the steps along with identification number below, or mark the drawing by drawing a CIRCLE around the equipment and writing the action taken next to it. If the markings on the drawings are not ledgible to the judges, you will not receive credit.	For Graders Only Answer / Points 50/100

The symbol used to mark up drawings for this questions is a CIRCLE

a. Clarifier No. 2 in service (No changes to RAS Pump No. 2)

b. Clarifier No. 4 out of service and drained to AT No. 1:

- i. Close SG-48"X18"-818-33 and SG-48"X18"-818-34
- ii. Close SG-27"X60"-812-501 and SG-27"X60"-812-502
- iii. Open SG-27"X60"-812-503 and SG-27"X60"-812-504
- iv. Close PV-16"-819-59
- v. Open PV-16"-819-64, PV-12"-819-65, PV-12"-819-66
- vi. Energize Pump No. 4

Or properly marked drawings