

**NEWEA Operations Challenge  
Process Control Event 2022**

|               |
|---------------|
| Team Name:    |
| Team Number:  |
| Team Captain: |

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

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| <b>Simulator - Computer</b><br>9 total questions<br>50 to 300 points per question<br>1000 max points available |
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| <b>Multiple Choice - Computer</b><br>48 total questions<br>10 to 20 points per question<br>720 max points available |
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| <b>Multiple Choice Math - Pages 2 - 5 (4)</b><br>20 total questions<br>40 to 60 full credit points per question<br>50% partial credit if math is correct but answer is incorrect<br>0 points is work is not shown<br>1000 max points available |
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| <b>Process Scenarios - Pages 6 - 26 (21)</b><br>17 total questions<br>100 full credit points per question<br>50% partial credit if math is correct but answer is incorrect<br>0 points is work is not shown<br>1700 max points available |
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## 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 corresponding to the answer provided for for each question

| #        | question   | Choices  |                     |
|----------|--|----------|---------------------|
| <b>1</b> | What is the loading BOD loading rate to a WWTF if the influent BOD is 250 mg/l and the the flow is 450,000 gpd?                                | <b>A</b> | <b>1055 lbs/day</b> |
|          |  | <b>B</b> | <b>938 lbs/Day</b>  |
|          |  | <b>C</b> | <b>112 lbs/day</b>  |
|          |  | <b>D</b> | <b>555 lbs/day</b>  |
| <b>2</b> | What is the percent removal of a primary clarifier if the raw TSS is 210 ppm, the primary EFF TSS is 39 ppm, and the final EFF TSS is 4.5 ppm? | <b>A</b> | <b>97.80%</b>       |
|          |  | <b>B</b> | <b>18.60%</b>       |
|          |  | <b>C</b> | <b>81.40%</b>       |
|          |  | <b>D</b> | <b>55.20%</b>       |
| <b>3</b> | How many million gallons does a circular tank that is 120 ft in diameter and 16 ft deep hold?  | <b>A</b> | <b>5.41 MG</b>      |
|          |  | <b>B</b> | <b>0.08 MG</b>      |
|          |  | <b>C</b> | <b>0.18 MG</b>      |
|          |  | <b>D</b> | <b>1.35 MG</b>      |
| <b>4</b> | What does a sludge that is 2% solids equal in ppm?   | <b>A</b> | <b>20,000 ppm</b>   |
|          |  | <b>B</b> | <b>2,000 ppm</b>    |
|          |  | <b>C</b> | <b>200,000 ppm</b>  |
|          |  | <b>D</b> | <b>200 ppm</b>      |
| <b>5</b> | What is the chlorine demand if the influent contact basin is dosed at 3 mg/l and the effluent contains 1.2 mg/l?                               | <b>A</b> | <b>4.2 mg/l</b>     |
|          |  | <b>B</b> | <b>1.8 mg/l</b>     |
|          |  | <b>C</b> | <b>3 mg/l</b>       |
|          |  | <b>D</b> | <b>1.2 mg/l</b>     |

| For graders use only                           |       |       |
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| work shown=20 points<br>correct+work=40 points |       |       |
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## 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 corresponding to the answer provided for for each question

| #         | question   | Choices  |                  |
|-----------|--|----------|------------------|
| <b>6</b>  | Calculate the sludge volume index if the 30 min settling volume is 210 and the MLSS is 2800 mg/l.                    | <b>A</b> | <b>250</b>       |
|           |  | <b>B</b> | <b>85</b>        |
|           |  | <b>C</b> | <b>75</b>        |
|           |  | <b>D</b> | <b>200</b>       |
| <b>7</b>  | Calculate the BOD from the following:<br>Volume = 15 ml<br>Initial DO = 9.2 mg/l<br>Final DO = 3.1 mg/l              | <b>A</b> | <b>122 mg/l</b>  |
|           |  | <b>B</b> | <b>152 mg/l</b>  |
|           |  | <b>C</b> | <b>75 mg/l</b>   |
|           |  | <b>D</b> | <b>132 mg/l</b>  |
| <b>8</b>  | If a pump at 100% efficient can produce 27 PSI, how many vertical feet can it pump if it is 85% efficient?           | <b>A</b> | <b>62 ft</b>     |
|           |  | <b>B</b> | <b>33 ft</b>     |
|           |  | <b>C</b> | <b>11 ft</b>     |
|           |  | <b>D</b> | <b>53 Ft</b>     |
| <b>9</b>  | If a lift station pumps 2.7 MGD and the pumps run for 10.5 hours per day, what is the flow rate for the pump in GPM? | <b>A</b> | <b>3,952 gpm</b> |
|           |  | <b>B</b> | <b>4,286 gpm</b> |
|           |  | <b>C</b> | <b>2,572 gpm</b> |
|           |  | <b>D</b> | <b>3642 gpm</b>  |
| <b>10</b> | What HP motor is needed to pump 1,500 gpm at 39 ft of head?  | <b>A</b> | <b>10 HP</b>     |
|           |  | <b>B</b> | <b>15 HP</b>     |
|           |  | <b>C</b> | <b>12 HP</b>     |
|           |  | <b>D</b> | <b>50 HP</b>     |

| For graders use only                           |       |       |
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| work shown=20 points<br>correct+work=40 points |       |       |
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## 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 corresponding to the answer provided for for each question

| #         | question  | Choices  |   |
|-----------|---|----------|---|
| <b>11</b> | A WWTF treats an annual average flow of 2.3 MGD. If the average sewer user produces 100 gpd per person and the town has 18,000 people, what percentage of the treated flow is assumed to be I/I?                                | <b>A</b> | <b>21.7%</b>  |
|           |   | <b>B</b> | <b>18.5%</b>  |
|           |   | <b>C</b> | <b>42.1%</b>  |
|           |   | <b>D</b> | <b>78.2%</b>  |
| <b>12</b> | If a stabilization pond is 30 acres, how long will it take to raise the level by 3 feet at a flow rate of 0.35 MGD?   | <b>A</b> | <b>14.7 Days</b>  |
|           |   | <b>B</b> | <b>10.2 Days</b>  |
|           |   | <b>C</b> | <b>83.7 Days</b>  |
|           |   | <b>D</b> | <b>97.6 Days</b>  |
| <b>13</b> | What is the velocity in ft/sec in an 8" force main carrying a flow of 1250 gpm?   | <b>A</b> | <b>10.51 ft/sec</b>                                     |
|           |   | <b>B</b> | <b>4.97 ft/sec</b>                                      |
|           |   | <b>C</b> | <b>6.54 ft/sec</b>                                      |
|           |   | <b>D</b> | <b>7.94 ft/sec</b>                                      |
| <b>14</b> | What is the organic loading rate in lbs/1000 ft <sup>2</sup> on a 10 ft deep, 80 ft diameter trickling filter if the influent flow is 2.2 MGD, the BOD is 195, and the media contains 5.5 ft <sup>2</sup> per ft <sup>3</sup> ? | <b>A</b> | <b><sup>13</sup><br/>lbs/d/1,000<br/>ft<sup>2</sup></b> |
|           |   | <b>B</b> | <b><sup>71</sup><br/>lbs/d/1,000<br/>ft<sup>2</sup></b> |
|           |   | <b>C</b> | <b><sup>45</sup><br/>lbs/d/1,000<br/>ft<sup>2</sup></b> |
|           |   | <b>D</b> | <b><sup>56</sup><br/>lbs/d/1,000<br/>ft<sup>2</sup></b> |
| <b>15</b> | A WWTF plant treats 2 MGD with 50 lbs/day of sodium hypochlorite. If the effluent Cl <sub>2</sub> residual is 1.2 mg/l, what is the demand?   | <b>A</b> | <b>2.2 mg/l</b>   |
|           |   | <b>B</b> | <b>1.8 mg/l</b>   |
|           |   | <b>C</b> | <b>48.8 mg/l</b>  |
|           |   | <b>D</b> | <b>3.0 mg/l</b>   |

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## 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 corresponding to the answer provided for for each question

| #         | question   | Choices  |                                |
|-----------|--|----------|--------------------------------|
| <b>16</b> | What percent capacity of a 8 ft stick of 12" pipe is an 12 ft stick of 8" pipe?  | <b>A</b> | <b>100%</b>                    |
|           |  | <b>B</b> | <b>50%</b>                     |
|           |  | <b>C</b> | <b>65%</b>                     |
|           |  | <b>D</b> | <b>112%</b>                    |
| <b>17</b> | 1,500 gpm is needed at 17 psi. Motor eff = 91%, pump eff = 89%. What HP motor is needed?   | <b>A</b> | <b>18 HP</b>                   |
|           |  | <b>B</b> | <b>15 HP</b>                   |
|           |  | <b>C</b> | <b>12 HP</b>                   |
|           |  | <b>D</b> | <b>25 HP</b>                   |
| <b>18</b> | What is the detentions time of a 60 ft circular clarifier with a sidewall depth of 11 ft and a center depth of 16 ft if the flow is 1.6 MGD?   | <b>A</b> | <b>8 hours</b>                 |
|           |  | <b>B</b> | <b>4 hours</b>                 |
|           |  | <b>C</b> | <b>3 hours</b>                 |
|           |  | <b>D</b> | <b>6 hours</b>                 |
| <b>19</b> | An aeration tank is 1.2 MG in volume and has an MLSS concentration of 2,600 mg/L. If the WAS concentration is 2.2%, how many gallons need to be wasted daily to achieve an MRCT of 8 days? | <b>A</b> | <b>16,752 gpd</b>              |
|           |  | <b>B</b> | <b>19,442 gpd</b>              |
|           |  | <b>C</b> | <b>18,455 gpd</b>              |
|           |  | <b>D</b> | <b>17,729 gpd</b>              |
| <b>20</b> | A WWTF has two circular secondary clarifiers. A 65ft and an 85 ft. What is the solids loading rate if the flow is 833 gpm and the MLSS is 0.25%?   | <b>A</b> | <b>3.0 lb/d/ft<sup>2</sup></b> |
|           |  | <b>B</b> | <b>0.8 lb/d/ft<sup>2</sup></b> |
|           |  | <b>C</b> | <b>2.8 lb/d/ft<sup>2</sup></b> |
|           |  | <b>D</b> | <b>1.2 lb/d/ft<sup>2</sup></b> |

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**Process Scenario 1: Activated Sludge**

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

**Operational Data**

|            | <b>Influent Avg:</b> | <b>Permit Limit:</b> | <b>Aeration Data</b> |           | <b>Clarifier Data</b> |            |
|------------|----------------------|----------------------|----------------------|-----------|-----------------------|------------|
| Flow       | 2.98 MGD             | 6.5 MGD              | # of Tanks           | 2         | # of Tanks            | 2          |
| Temp       | 15 Deg C             | NA                   | Length               | 120 Ft    | Diameter              | 85 Ft      |
| BOD        | 215 mg/l             | 50 mg/l              | Width                | 40 Ft     | Depth                 | 16 Ft      |
| TSS        | 210 mg/l             | 50 mg/l              | Depth                | 16 Ft     | Blanket Dept          | 2 Ft       |
| NH3        | 26 mg/l              | 5 mg/l               | MLSS                 | 2650 mg/l | RAS Conc              | 6500 mg/l  |
| pH         | 7.3 s.u.             | 6.0 - 8.0 s.u.       | MLVSS                | 77%       | WAS Conc              | 2.10%      |
| Alkalinity | 150 mg/l             | NA                   | 30 Min Sett          | 210       | WAS Rate              | 32,000 gpd |

**Process Scenario 1: Activated Sludge**

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

|   |  |     |  |                  |        |
|---|--|-----|--|------------------|--------|
| 1 | Based on the provided data, calculate the following. Enter numerical answers. Total solids inventory, F/M ratio, MCRT (assume effluent TSS is at permit limit) Must get all three correct and show work for full credit. | TSI |  | For Graders Only |        |
|   |  |     |  | Points 50/100    | Answer |
|   |  | F/M |  |                  |        |
|   | MCRT   |     |  |                  |        |
|   |  |     |  |                  |        |

**Process Scenario 1: Activated Sludge**

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

|   |  |                  |          |
|---|--|------------------|----------|
| 2 | The operator has determined that the reason why the effluent TSS quality is poor and the facility is unable to meet its effluent requirements for NH <sub>3</sub> is that the MCRT is too low. The operator determines that adjusting the MCRT to meet the requirement for nitrification will also improve the TSS and assumes the new effluent TSS value will be 10 mg/l. If the facility runs wasting at a constant speed 24/7, what flow rate should the WAS pump flow rate be set at to achieve a 20 day MCRT? | For Graders Only |          |
|   |  | Points 50/100    | Answer   |
|   |  | A                | 8450 GPM |
|   |  | B                | 6 GPM    |
|   |  | C                | 12 GPM   |
|   |  | D                | 32 GPM   |



Process Scenario 1: Activated Sludge

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

|   |  |                  |              |             |
|---|--|------------------|--------------|-------------|
| 3 | <p>After making the change to the MCRT, effluent quality improved, but the facility is still not meeting its permit for NH<sub>3</sub>. The operator determined that the reason must be an alkalinity deficiency. If the operator's goal is to maintain an effluent alkalinity of at least 50 mg/l CaCo<sub>3</sub>, how many lbs per day of suplimental alkalinity need to be added in order to get the NH<sub>3</sub> down to the limit?</p> | For Graders Only |              |             |
|   |  | Points 50/100    | Answer       |             |
|   |  |                  |              |             |
|   |  |                  | A            | 500 lbs/day |
|   |  |                  | B            | 755 lbs/day |
|   |  | C                | 1250 lbs/day |             |
|   |  | D                | 2550 lbs/day |             |

Process Scenario 1: Activated Sludge

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

|   |  |                  |           |
|---|--|------------------|-----------|
| 4 | <p>Increasing the target MCRT has improved nitrification, but the increase in total system lbs has created a new challenge when it comes to settling solids in the clarifier during periods of high flow caused by rain events. The facility is now violating its permit for TSS every time it rains. At an MRCT of 20 days, the MLSS has increased to 3,800 mg/l and the clarifier blanket has risen to 4 ft (at the same concentration). The facility is considering installing a biomag system to introduce magnetite into the process to increase settling rates. The magnetite will increase the volume of wasted solids by 7%, but 95% will be recovered from the waste stream before dewatering. How many more lbs of solids will have to be dewatered yearly with the biomag system?</p> | For Graders Only |           |
|   |  | Points 50/100    | Answer    |
|   |  | A                | 2,290 lbs |
|   |  | B                | 5,550 lbs |
|   |  | C                | 7,540 lbs |
|   |  | D                | 3,650 lbs |

**Process Scenario 2: Anaerobic Digestion and Energy Recovery**

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

**Operational Data**

The Lewiston Auburn Water Pollution Control Authority operates two (2) mesophilic anaerobic digesters, each with a volume of 92,245 cubic feet. On average, the facility pumps 50,000 gallons per day of combined Primary and Thickened Waste Activated Sludge (TWAS) with a 5.5% solids concentration and 70% Volatile Solids. The digester feed solids average 212 mg/l of Volatile Acids and 1255 mg/l of Alkalinity. The facility averages 50% Volatile Solids destruction, and produces 12.5 cubic feet of biogas for every pound of Volatile Solids it destroys. The biogas fuels two (2) Combined Heating & Power (CHP) units capable of producing 230 kW of power. The engines require 1 Cubic Feet per Minute (CFM) of biogas for every 3-kW of power produced.

**Process Scenario 2: Anaerobic Digestion and Energy Recovery**

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

|   |  |                  |                |
|---|--|------------------|----------------|
|   | How many average pounds of total volatile solids are pumped to the digester daily? | For Graders Only |                |
|   |  | Points 50/100    | Answer         |
| 1 |  | A                | 22,935 lbs/day |
|   |  | B                | 45,870 lbs/day |
|   |  | C                | 18,420 lbs/day |
|   |  | D                | 16,055 lbs/day |
|   |  | E                | 7,868 lbs/day  |
|   |  |                  |                |

**Process Scenario 2: Anaerobic Digestion and Energy Recovery**

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

|   |                                   |                  |           |
|---|-----------------------------------|------------------|-----------|
|   | What is the total detention time? | For Graders Only |           |
|   |                                   | Points 50/100    | Answer    |
| 2 |                                   | A                | 13.8 days |
|   |                                   | B                | 6.5 days  |
|   |                                   | C                | 10.7 days |
|   |                                   | D                | 38.5 days |
|   |                                   | E                | 27.6 days |
|   |                                   |                  |           |

**Process Scenario 2: Anaerobic Digestion and Energy Recovery**

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

|   |  |                  |        |  |
|---|--|------------------|--------|--|
| 3 | What is the Volatile Acid to Alkalinity ratio, and is this acceptable? | For Graders Only |        |  |
|   |  | Points 50/100    | Answer |  |
|   |  |                  |        |  |
|   | A  | 0.16, Yes        |        |  |
|   | B  | 0.16, No         |        |  |
| C | 5.77, Yes  |                  |        |  |
| D | 5.77, No   |                  |        |  |

**Process Scenario 2: Anaerobic Digestion and Energy Recovery**

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

|   |  |                  |                            |
|---|--|------------------|----------------------------|
|   | How much average biogas is produced daily? | For Graders Only |                            |
|   |  | Points 50/100    | Answer                     |
| 4 |  | A                | 8,027 ft <sup>3</sup> /d   |
|   |  | B                | 200,688 ft <sup>3</sup> /d |
|   |  | C                | 100,344 ft <sup>3</sup> /d |
|   |  | D                | 300,587 ft/d               |
|   |  | E                | 355,948 ft/d               |
|   |  |                  |                            |

**Process Scenario 2: Anaerobic Digestion and Energy Recovery**

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

|   |  |                  |            |
|---|--|------------------|------------|
|   | What is the average kW of power that can be produced daily from the two CHP units based on the volume of gas produced at the facility? | For Graders Only |            |
|   |  | Points 50/100    | Answer     |
| 5 |  | A                | 209 kW     |
|   |  | B                | 301,032 kW |
|   |  | C                | 418 kW     |
|   |  | D                | 212,555 kW |
|   |  | E                | 560 kW     |
|   |  |                  |            |

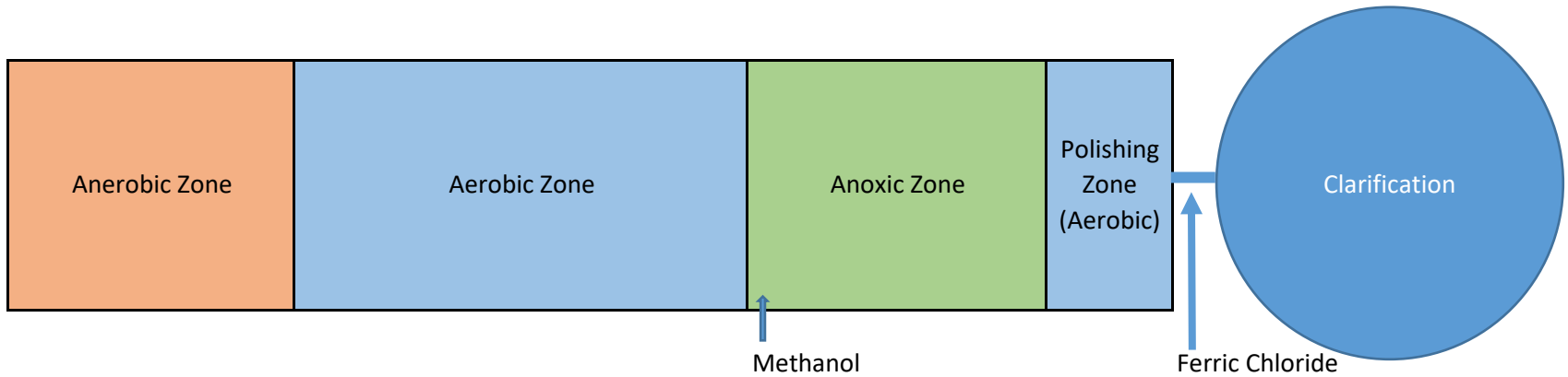


**Process Scenario 3: Chemical Addition for Nutrient Removal**

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

**Operational Data**

|            | Influent Avg: | Aerobic Zone Effluent: | Anoxic Zone Effluent: | Permit Limit:  |
|------------|---------------|------------------------|-----------------------|----------------|
| Flow       | 6.5 MGD       | 6.5                    | 6.5                   | 10 MGD         |
| Temp       | 15 Deg C      | 15.5 Deg C             | 15 Deg C              | NA             |
| BOD        | 215 mg/l      | 5.5 mg/l               | 5.5 mg/l              | 10 mg/l        |
| TSS        | 210 mg/l      | 2,500 mg/l             | 5.5 mg/l              | 10 mg/l        |
| Total N    | 37 mg/l       | 37 mg/l                | 1.5 mg/l              | 542 Lbs/day    |
| TKN        | 35 mg/l       | 1.3 mg/l               | 1.3 mg/l              | NA             |
| NH3        | 33 mg/l       | 0.1 mg/l               | 0.1 ml/l              | 1.0 mg/l       |
| Total P    | 10 mg/l       | 2 mg/l                 | 4 mg/l                | 55 Lbs/day     |
| pH         | 7.3 s.u.      | 6.7 s.u.               | 7.2 s.u.              | 6.0 - 8.0 s.u. |
| Alkalinity | 280 mg/l      | 30 mg/l                | 155 mg/l              | NA             |



**Additional Information:**

|  |
|--|
| Methanol required for denitrification: 1.9 grams per gram of NO <sub>3</sub> |
| BOD required for denitrification: 2.86 grams per gram of NO <sub>3</sub>     |
| Ferric Chloride required to remove Total P: 5.2 pounds per pound of Total P  |
| Ferric Chloride \$0.41 per pound   |

**Process Scenario 3: Chemical Addition for Nutrient Removal**

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

|   |  |                  |              |              |
|---|--|------------------|--------------|--------------|
| 1 | How many lbs/day of methanol are currently being used to to achieve the anoxic effluent nitrogen level? Assume NO2 levels are insignificant. | For Graders Only |              |              |
|   |  | Points 50/100    | Answer       |              |
|   |  |                  |              |              |
|   |  |                  | A            | 589 lbs/day  |
|   |  |                  | B            | 1277 lbs/day |
|   |  | C                | 2265 lbs/day |              |
|   |  | D                | 3675 lbs/day |              |

**Process Scenario 3: Chemical Addition for Nutrient Removal**

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

|   |   |                  |        |  |
|---|---|------------------|--------|--|
| 2 | <p>In an attempt to reduce cost, the operator wants to install a pump to side stream a portion of the influent to use as a carbon source for denitrification. If a pump that operates at 1200 gpm is installed and piped directly from the influent into the anoxic zone, how many lbs per day of methanol will be needed to reach the permit limit for TN at the average daily flow? Assume no changes to nitrification.</p> | For Graders Only |        |  |
|   |   | Points 50/100    | Answer |  |
|   |   |                  |        |  |
|   | A   | 75 lbs/day       |        |  |
|   | B   | 163 lbs/day      |        |  |

**Process Scenario 3: Chemical Addition for Nutrient Removal**

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

|   |  |                  |           |           |
|---|--|------------------|-----------|-----------|
| 3 | What is the dosage rate in mg/L of Ferric Chloride needed to achieve Total P permit limit at average daily flow? | For Graders Only |           |           |
|   |  | Points 50/100    | Answer    |           |
|   |  |                  |           |           |
|   |  |                  | A         | 15.6 mg/L |
|   |  |                  | B         | 20.8 mg/L |
|   |  | C                | 10.4 mg/L |           |
|   |  | D                | 25.7 mg/L |           |

**Process Scenario 3: Chemical Addition for Nutrient Removal**

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

|   |   |                  |            |            |
|---|---|------------------|------------|------------|
| 4 | It has been determined that adding a mixer to the anoxic zone will prevent the phosphorus increase between the aerobic zone effluent and anoxic zone effluent. The cost for adding a mixer will be \$125,000. What will be the mixer cost install pay back be in years with the reduction of ferric chloride required? Assume chemical cost stays the same. | For Graders Only |            |            |
|   |   | Points 50/100    | Answer     |            |
|   |   |                  |            |            |
|   |   |                  | A          | 2.63 Years |
|   |   |                  | B          | 1.95 Years |
|   |   | C                | 1.47 Years |            |
|   |   | D                | 1.25 Years |            |

**Process Scenario 4: Effluent Filtration**

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

**Operational Data**

| <b>Multi- Media Gravity Filter Information</b> |                      | <b>Backwash Flow Rates</b> |                                    |
|--|----------------------|----------------------------|------------------------------------|
| Filter dimensions                              | (4) 11'-10" x 24'-0" | <b>Water TempDegrees F</b> | <b>B/W Rate GPM/FT<sup>2</sup></b> |
| Air Scour Rate                                 | 2.5 SCFM/SQFT        | 50 or less                 | 15                                 |
| Air Scour Time                                 | 120 seconds          | 51-55                      | 16                                 |
| Max. Loading Rate                              | 3500 GPD/SQFT        | 56-60                      | 17                                 |
| Gravel (1" x 5/8")                             | 3"                   | 61-65                      | 18.5                               |
| Gravel (5/8" x 3/8")                           | 3"                   | 66-70                      | 20                                 |
| Gravel (3/8" x 3/16")                          | 3"                   | 71-75                      | 21                                 |
| Gravel (3/16" x #10)                           | 3"                   | Above 75                   | 22.5                               |
| Silica Sand                                    | 12"                  |                            |                                    |
| Anthracite (1.5 g/cm <sup>3</sup> )            | 22"                  |                            |                                    |
| Effluent Temperature                           | 10 – 20 Degrees C    |                            |                                    |
| Backwash Water Source                          | Filtered Effluent    |                            |                                    |

**Process Scenario 4: Effluent Filtration**

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

|   |   |                  |                     |
|---|---|------------------|---------------------|
|   | Ron has been tasked with ordering replacement anthracite that gets lost during backwashes. After further investigation it was determined that the total combined inches of anthracite media loss to be 22". Anthracite media is sold in bags of 1.0 FT3. How many bags will Ron need to order and what will be the shipping weight? | For Graders Only |                     |
|   |   | Points 50/100    | Answer              |
| 1 |   | A                | 488 Bags, 22.8 Tons |
|   |   | B                | 521 Bags, 48.6 Tons |
|   |   | C                | 521 Bags, 24.3 Tons |
|   |   | D                | 544 Bags, 26.7 Tons |
|   |   | E                | 544 Bags, 48.6 Tons |
|   |   |                  |                     |

**Process Scenario 4: Effluent Filtration**

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

|   |  |                  |            |
|---|--|------------------|------------|
|   | The backwash water pumps are due for replacement and Mark has been asked to create specification for the replacement pumps. What will the maximum required GPM need to be when two filters are in backwash at the same time? | For Graders Only |            |
|   |  | Points 50/100    | Answer     |
| 2 |  | A                | 8,520 GPM  |
|   |  | B                | 11,360 GPM |
|   |  | C                | 5,680 GPM  |
|   |  | D                | 4,260 GPM  |
|   |  | E                | 12,780 GPM |
|   |  |                  |            |



**Process Scenario 4: Effluent Filtration**

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

|   |  |                  |                          |
|---|--|------------------|--------------------------|
| 3 | Filter #3 will need to be taken off line for service. Amy is concerned that the remaining online filters will not handle the current effluent flow of 1.7 MGD. What will the online filters have for a surface loading rate at the current flow? | For Graders Only |                          |
|   |  | Points 50/100    | Answer                   |
|   |  | A                | 3063 GPD/FT <sup>2</sup> |
|   |  | B                | 2025 GPD/FT <sup>2</sup> |
|   |  | C                | 1850 GPD/FT <sup>2</sup> |
|   |  | D                | 2560 GPD/FT <sup>2</sup> |
|   |  | E                | 1995 GPD/FT <sup>2</sup> |

**Process Scenario 4: Effluent Filtration**

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

|   |   |                  |          |
|---|---|------------------|----------|
| 4 | Filters have been requiring more backwashes with #3 filter offline, backwashes are up to three per day per filter from one per day per filter. What will be the increased CF total for the day with one filter offline? | For Graders Only |          |
|   |   | Points 50/100    | Answer   |
|   |   |                  |          |
|   |   | A                | 3,720 CF |
|   |   | B                | 5,550 CF |
|   |   | C                | 8,520 CF |
|   |   | D                | 7,100 CF |
|   |   | E                | 4,200 CF |