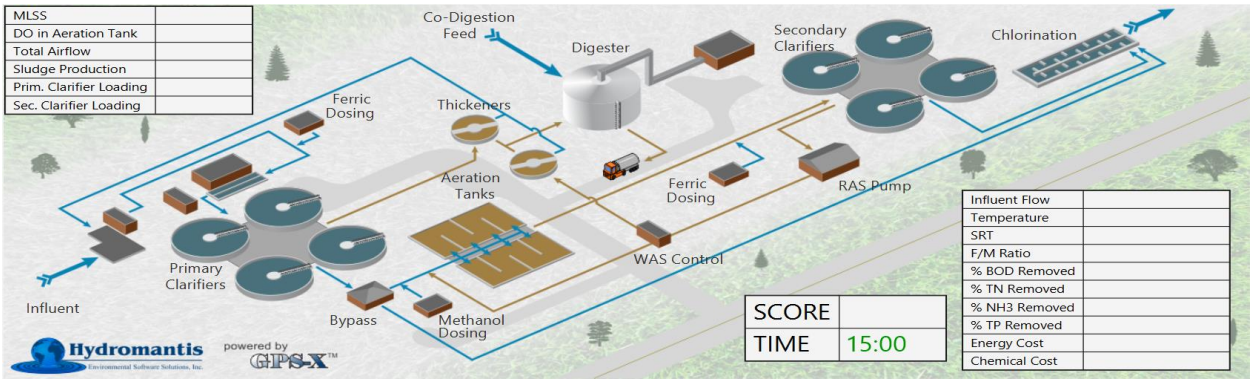
Operations Challenge Process Control Event – Simulator Question Background Information

The Plant

The wastewater treatment plant operations simulator (OpTool) contains a mathematical model of the conventional wastewater treatment plant shown below:



The plant consists of:

- an influent pumping station
- 4 circular primary clarifiers
- 2 parallel plug-flow activated sludge aeration tanks (4 zones in series)
- 4 circular secondary clarifiers
- 2 chemical dosage points (for iron addition for chemical phosphorus precipitation)
- a methanol dosage point (for denitrification)
- a NaOH (sodium hydroxide) dosage point
- a recycled activated sludge (RAS) pumping station
- a waste activated sludge (WAS) pumping station
- 2 gravity sludge thickeners
- an anaerobic digester (with co-digestion feed point)
- a chlorine disinfection tank

The Challenge Questions

Teams will be presented with a total of 9 challenge questions. Teams can answer the questions in any order they like, and can do any question over as many times as needed. Make sure to click on the red SUBMIT button to register your answer each time you complete the question. Clicking on the SUBMIT button erases the previous answer for that question, so if you do a question several times, it will only remember the last answer that you submitted.

The questions cover a wide range of operational situations, and require teams to make operational changes to the plant to achieve a given set of targets. See special notes about Questions 8 and 9 at the end of the document.

Please note that Questions 8 and 9 involve running a 5-day dynamic simulation, which takes approximately 2 minutes to complete. Please make sure to leave enough time to complete the simulation before clicking on the SUBMIT button.

The following aspects of the plant can change from question to question:

- Sizes of the aeration tanks
- Surface areas of the clarifiers
- Number of primary clarifiers in service
- Number of aeration tanks in service
- Number of secondary clarifiers in service
- Influent loading (flow, COD, BOD_5, ammonia, temperature, pH)
- Food waste loading (flow, TSS, ammonia, temperature, pH)
- Starting pumped flow settings (RAS flow, WAS flow)
- Starting aeration conditions (airflow, DO controllers, etc.)
- Starting digester condition (temperature)
- Starting chemical addition settings (methanol, ferric, chlorine, sodium hydroxide, sulfur dioxide)

In each question, the teams will receive 25 points per target achieved. Some questions have more targets than others. The table below summarizes the points for each question:

#	Question	Maximum Possible Points
1	Chlorination & Dechlorination	75
2	Biological Phosphorus Removal	50
3	pH & Alkalinity	75
4	Nutrient Removal	100
5	Cold Weather	50
6	Energy Cost Management	75
7	Digester Operation	50
8	Dynamic Wet Weather	225
9	Industrial Waste	300

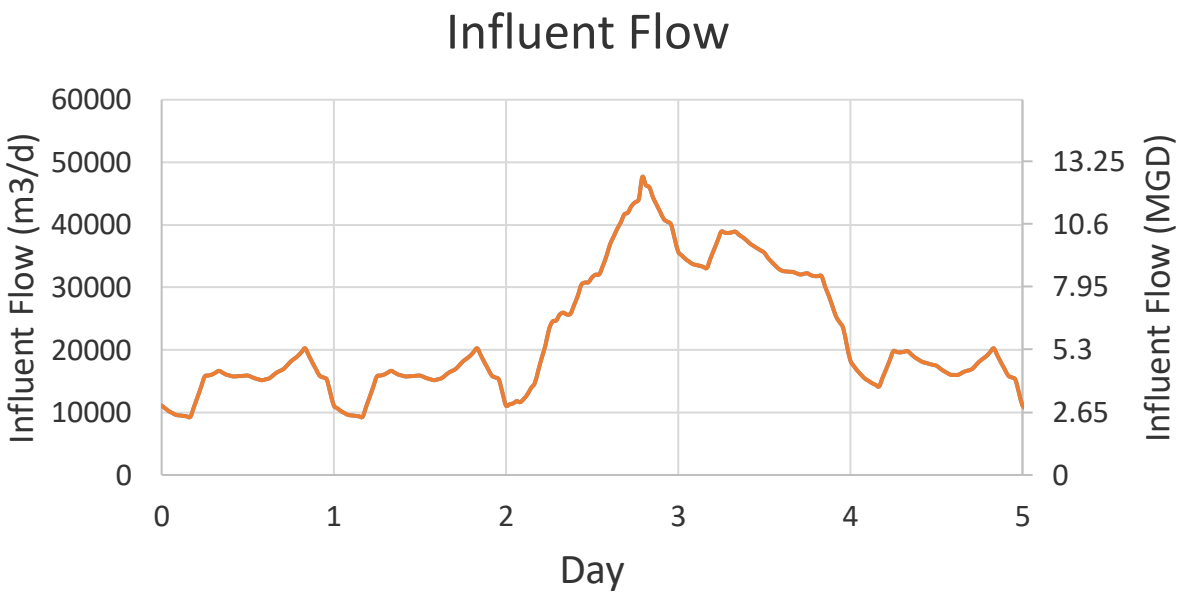
Notes for All Questions

Please note that all Food-to-Microorganism (F/M) ratio calculations are calculated as $lbBOD_5/lbVSS/d$ (or in SI units, $gBOD_5/gVSS/d$).

The input settings are bounded. If you set the value outside of the respective input range, the simulator will set it back to the limit.

Special Notes for Question 8: Dynamic Wet Weather

In Question 8, you will run a 5-day dynamic simulation where the influent flow changes during the 5-days, as shown in the graph below:



Note that a large wet weather event happens at the end of the 3rd day. All influent concentrations will be kept constant – only the flow rate changes over time. **In this question, one secondary clarifier is out of service for maintenance purpose and DO controller is unavailable for use.**

During the 5-day simulation, a 24-hour composite sample (one sample taken each hour) will be reported at the end of each day in the table in the lower-right corner of the screen. The red or green background will indicate whether the sample meets the specified target:

In order to score points, **all 5 composite samples must meet the target** (for one particular parameter, such as TSS). If the target is met for all 5 days, 75 points are scored. For example, all 5 TSS composite samples must be below 15 mg/L in the example above, and since the samples on days 3,4 and 5 do not meet the target, zero points would be score for TSS.

The three different parameters (in the above example, TSS, BOD5 and ammonia) are scored independently, so it is possible to get 0, 75, 150 or 225 points on this question, depending on the operational choices made.

Additional Data for Question 8:

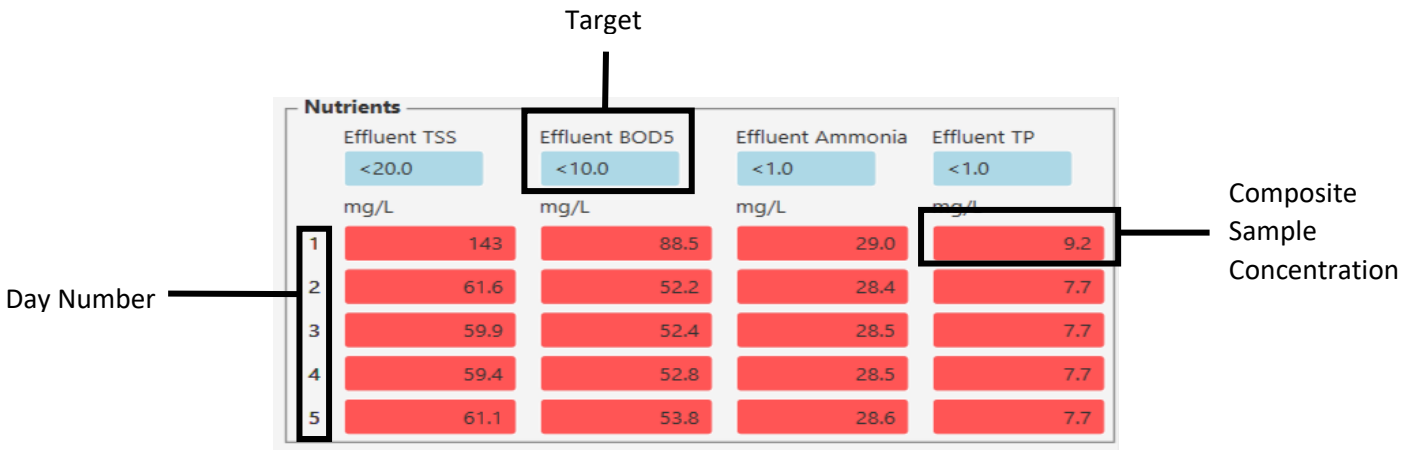
Parameter	Value
Influent Concentrations:	
COD	450 mg/L
TKN	44 mg/L
Ammonia	32 mg/L
Total Phosphorus	12 mg/L
Soluble Ortho-P	10 mg/L
pH	7 mg/L
Influent Flow	Daily diurnal pattern average = 4MGD (15,000 m3/d) During storm event, clean water is mixed with influent flow, peaking at ~7.5 MGD (28,600 m3/d) additional flow (see graph above).
Influent Temperature	68 °F 20 °C
Aeration Tank Volume	2 tanks @ 0.53 MGal (2000 m3) each
Clarifier Surface Area	**Some units may not be available*
Primary Clarifiers	4 clarifiers @ 3,875 ft2 (360 m2) each
Secondary Clarifiers	4 clarifiers @ 3,550 ft2 (330 m2) each

Optimal Process Parameter Ranges	
Aerobic Solids Retention Time (SRT)	3 – 10 days
Secondary Clarifier Solids Loading Rate (SLR)	<2.0 lb/ft2/hr <10.0 kg/m2/hr

Special Notes for Question 9: Industrial Waste

In Question 9, you will run a 5-day dynamic simulation with a constant brewery waste discharged to the sewer system.

During the 5-day simulation, a 24-hour composite sample (one sample taken each hour) will be reported at the end of each day in the table in the lower-right corner of the screen. The red or green background will indicate whether the sample meets the specified target:



In order to score points, **all 5 composite samples must meet the target** (for one particular parameter, such as TSS). If the target is met for all 5 days, 75 points are scored. For example, all 5 TSS composite samples must be below 20 mg/L in the example above, and since the samples do not meet the target, zero points would be score for TSS.

The four different parameters (in the above example, TSS, BOD5, ammonia and TP) are scored independently, so it is possible to get 0, 75, 150, 225 or 300 points on this question, depending on the operational choices made.

Additional Data for Question 9:

Parameter	Value
Influent Concentrations:	
COD	410 mg/L
TKN	42 mg/L
Ammonia	32 mg/L
Total Phosphorus	10 mg/L
Soluble Ortho-P	8 mg/L
pH	7
Influent Flow	Daily diurnal pattern average = 2.6 MGD (10,000 m3/d)
Influent Temperature	64.4 °F 18 °C
Industrial Waste Concentrations:	
TSS	100,000 mg/L
TKN	2,300 mg/L
Ammonia	200 mg/L
Total Phosphorus	600 mg/L
Soluble Ortho-P	10 mg/L
pH	7
Industrial Waste Flow	Daily average = 13,200 gpd (70 m3/d)
Aeration Tank Volume	2 tanks @ 0.40 MGal (1,500 m3) each
Clarifier Surface Area	
Primary Clarifiers	4 clarifiers @ 3,875 ft2 (360 m2) each
Secondary Clarifiers	4 clarifiers @ 2,150 ft2 (200 m2) each

Optimal Process Parameter Ranges	
Aerobic Solids Retention Time (SRT)	3 – 10 days
Secondary Clarifier Solids Loading Rate (SLR)	<2.0 lb/ft2/hr <10.0 kg/m2/hr

Final Scoring

When the timer expires, the team's final score will be displayed. The final score will be the sum of all the points earned in all questions. **A perfect score is 1000 points.** There are no penalties for trying questions.