

Operations Challenge Process Control Event – Simulator Question Background Information

The 2024 Operations Challenge simulator contains 2 plant layouts:

- Layout #1 – Main plant
- Layout #2 – Biosolids Treatment Plant

There are 7 challenge questions from layout 1 and 2 challenge question from layout 2. The simulator interface will switch to the appropriate layout when a challenge question is selected.

Challenge Main Menu

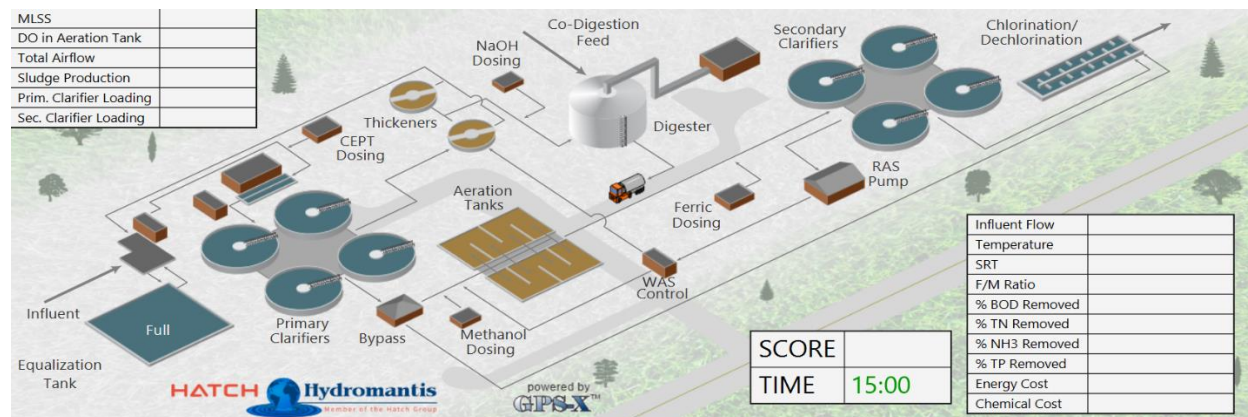
Please select one of the challenges below:

Layout 1 - Main Plant			
Question	Question	Question	Question
Q1: 75 pts	Q2: 100 pts	Q3: 100 pts	Q4: 50 pts
Q5: 100 pts	Q6: 75 pts	Q7: 300 pts	

Layout 2 - Biosolids			
Question	Question	Question	Question
Q8: 100 pts	Q9: 100 pts		

Layout #1 – Main Plant

Layout #1 is the wastewater treatment plant operations simulator (OpTool), where it contains a mathematical model of the conventional wastewater treatment plant shown below:



The plant consists of:

- an influent pumping station
- an Equalization (EQ) Tank

- 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 for layout #1

Teams will be presented with a total of 7 challenge questions in plant #1. 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 a 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 7 at the end of the document.

Please note that Question 7 involves running a 30-day dynamic simulation, which takes approximately 3 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, BOD₅, 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	Aeration Control	75
2	Chemical Cost Management	100
3	Biological Phosphorus Removal	100
4	Plant Maintenance	50
5	Chemically Enhanced Primary Treatment	100
6	Nutrient Removal	75
7	Dynamic Wet Weather	300

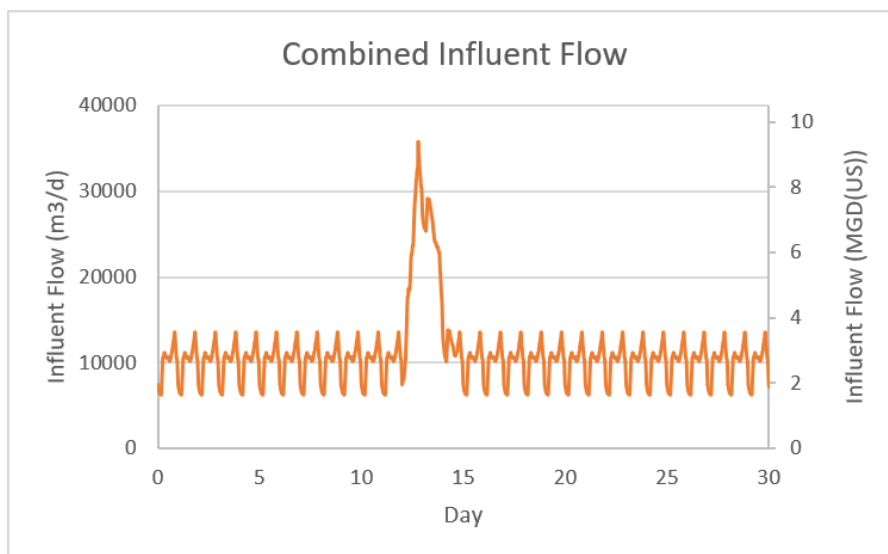
Notes for All Questions

Please note that all Food-to-Microorganism (F/M) ratio calculations are calculated as $\text{lbBOD}_5/\text{lbVSS}/\text{d}$ (or in SI units, $\text{gBOD}_5/\text{gVSS}/\text{d}$).





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 7: Dynamic Wet Weather

In Question 7, you will run a 30-day dynamic simulation where the influent follows a diurnal pattern. A wet weather event occurs on Day 12. All influent concentrations will be kept constant – only the flow rate changes over time. The combined influent flow in the 30-day dynamic simulation is as shown in the graph below.



During the 30-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. Monthly averages are calculated on all 30 composite samples. The red or green background will indicate whether the sample meets the specified target:

		Monthly Average Target		Monthly Average Concentration	
Monthly Average					
Monthly Avg. TSS			<10.0	14.4	mg/L
Monthly Avg. Ammonia			<1.0	18.3	mg/L
Monthly Avg. TN			<10.0	22.7	mg/L
Daily Composite Samples					
Effluent TSS		Effluent Ammonia		Effluent TN	
mg/L					
		<2.0			
		mg/L		mg/L	
1	14.4	2.6	12.7	Daily Max Target	
2	14.4	3.3	13.2	Composite Sample Concentration	
3	14.4	3.7	13.3		
4	14.4	4.7	13.5		
5	14.5	5.3	13.6		

In order to score points for the monthly average targets, the monthly average concentration for that parameter **must meet the target at the end of the 30-day simulation**. If the target is met at the end of the simulation, **75 points** are scored. In the example above, since the monthly average TSS concentration is above 10.0 mg/L at the end of the simulation, zero points would be scored.

In order to score points for the daily max target, **all 30 composite samples must meet the target**. If the target is met for all 30 days, **75 points** are scored. For example, all 30 ammonia composite samples must be below 2.0 mg/L in the example above, and since the samples do not meet the target, zero points would be scored for Daily Max Ammonia.

The four different parameters (in the above example, Monthly Average TSS, BOD5, ammonia and Daily Max ammonia) are scored independently, so it is possible to get any points between 0 and 300 on this question, depending on the operational choices made.

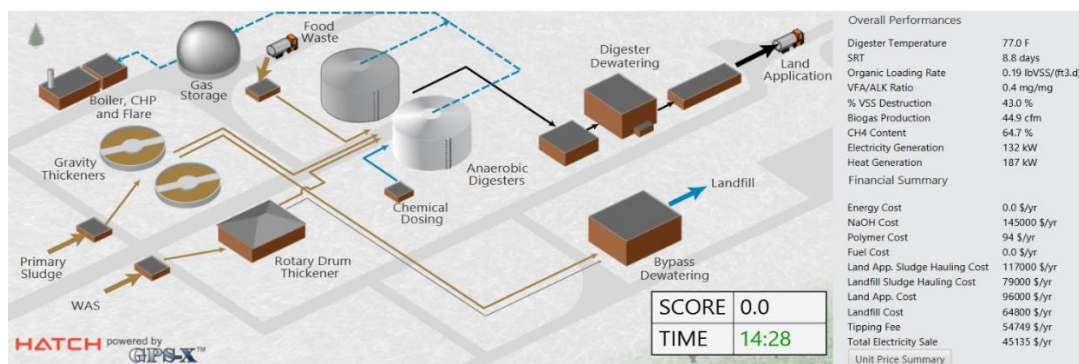
Additional Data for Question 8:

Parameter	Value
Influent Concentrations:	
COD	416 mg/L
TKN	42 mg/L
Ammonia	32 mg/L
Total Phosphorus	13 mg/L
Soluble Ortho-P	10 mg/L
pH	7 mg/L
Temperature	64.4 °F (18 °C)
Influent Flow	Daily diurnal pattern average = 2.6MGD (10,000 m3/d) During storm event, clean water is mixed with influent flow, peaking at ~6.4 MGD (22,330 m3/d) additional flow (see graph above).
Equalization Tank Volume	1 tank @ 2.64 MGal (10,000 m3)
Aeration Tank Volume	2 tanks @ 0.53 MGal (2,000 m3) each
Clarifier Surface Area	
Primary Clarifiers	4 clarifiers @ 3,875 ft2 (360 m2) each
Secondary Clarifiers	4 clarifiers @ 2,153 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

Layout #2 – Biosolids Treatment Plant

Layout #2 focuses on the biosolids treatment operations, the simulator contains a mathematical model of the conventional anaerobic digestion plant shown below:



The biosolids plant consists of:

- an influent pumping station for primary sludge
- an influent pumping station for WAS
- an influent pumping station for food waste
- 2 gravity thickeners
- a rotary drum thickener
- 2 anaerobic digesters
- A Boiler, CHP and Flare building
- a NaOH (sodium hydroxide) dosage point
- a dewatering system for digested sludge with polymer dosing option
- a dewatering system for bypassed sludge with polymer dosing option
- Land application
- Landfill

The Challenge Questions for Layout #2

Teams will be presented with a total of 2 challenge questions in plant #2. Teams can do the questions over as many times as needed. Make sure to click on the red SUBMIT button to register your answer each time you complete a question. Clicking on the SUBMIT button erases the previous answer for the question, so if you do the question several times, it will only remember the last answer that you submitted.

The questions can cover a wide range of operational situations and require teams to make operational changes to the plant to achieve a given set of targets.

The following aspects of the plant can change in the questions:

- Sizes of the anaerobic digesters
- Number of anaerobic digesters in service
- Surface areas of the thickeners
- Number of gravity thickeners in service
- Bypass percentage for thickened sludges
- Influent sludge loading (flow, TSS, ammonia, temperature, pH)
- Food waste loading (flow, TSS, ammonia, temperature, pH)
- Starting digester condition (temperature)
- Starting chemical addition settings (sodium hydroxide, polymer)
- Energy recovery settings (percentage of methane for boiler, CHP and other)
- Percentage of electricity sold to the grid

Teams will receive **25 points** per target achieved in a question. The table below summarizes the points:

#	Question	Maximum Possible Points
8	Chemical Cost Management	100
9	Anaerobic Co-Digestion	100

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.

February 2024