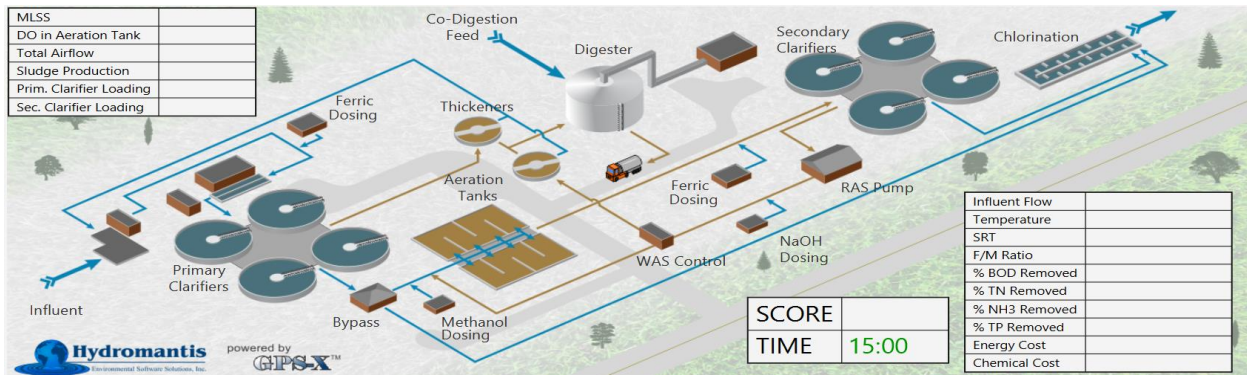


## Operations Challenge Process Control Event – Simulator Question Background Information

### 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 11 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 Question 11 at the end of the document.

Please note that Question 11 involves 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<sub>5</sub> ammonia, temperature, pH)
- Starting pumped flow settings (RAS flow, WAS flow)
- Starting aeration conditions (airflow, DO controllers, etc.)
- Starting chemical addition settings (methanol, ferric, chlorine, sodium hydroxide)

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 Tank Maintenance	75
2	pH and Alkalinity	100
3	High Influent COD	50
4	Cold Weather Operation	50
5	Biological Phosphorus Removal	50
6	Total Nitrogen Removal	50
7	Cost Management	125
8	Aeration Control	50
9	Process Control	75
10	Nutrient Removal	75
11	Dynamic Wet Weather	300

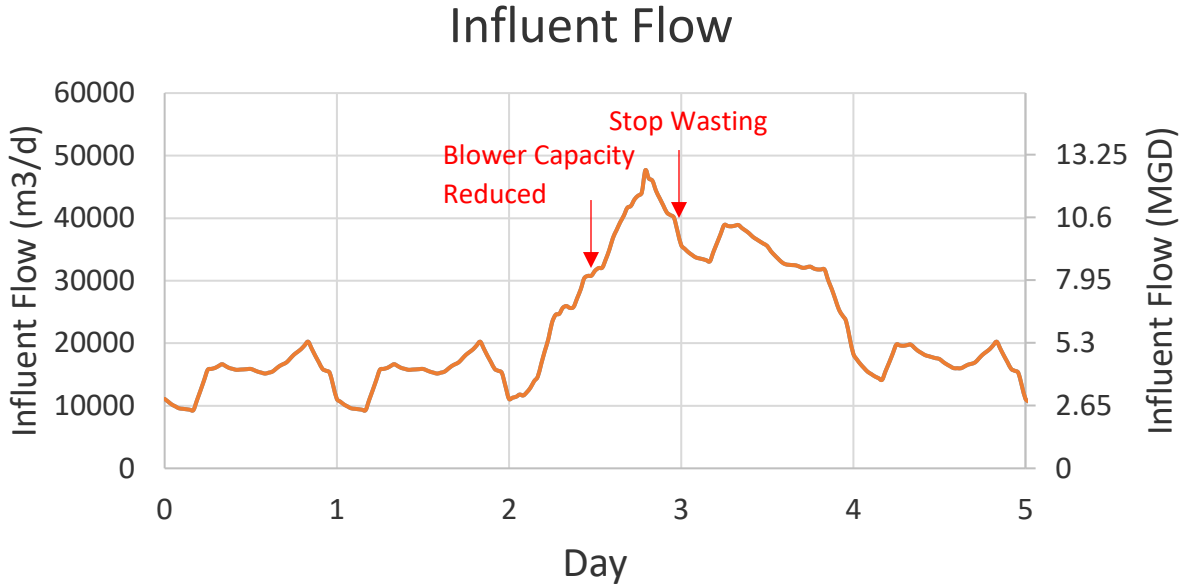
### Notes for All Questions

Please note that all Food-to-Microorganism (F/M) ratio calculations are calculated as lbBOD<sub>5</sub>/lbVSS/d (or in SI units, gBOD<sub>5</sub>/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 11: Dynamic Wet Weather

In Question 11, 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 3<sup>rd</sup> day. All influent concentrations will be kept constant – only the flow rate changes over time. Also, the plant blower capacity is reduced to half and the wasting stops due to sludge disposal problem on the 3<sup>rd</sup> day, as marked on the graph above. **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:

Day Number	Nutrients		
	Effluent TSS <15.0 mg/L	Effluent BOD5 Target <10.0 mg/L	Effluent Ammonia <2.0 mg/L
1	✓ 12.3	92.3	29.9
2	✓ 12.8	93.2	29.9
3	21.8	90.2	29.6
4	22.4	109	29.9
5	15.2	139	30.7

Composite Sample Concentration

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, 100 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, 100, 200 or 300 points on this question, depending on the operational choices made.

**Additional Data for Question 11:**

Parameter	Value
<b>Influent Concentrations:</b>	
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
<b>Influent Flow</b>	Daily diurnal pattern average = 4MGD (15,000 m <sup>3</sup> /d)  During storm event, clean water is mixed with influent flow, peaking at ~7.5 MGD (28,600 m <sup>3</sup> /d) additional flow (see graph above).
<b>Influent Temperature</b>	62.6 °F 17 °C
<b>Aeration Tank Volume</b>	2 tanks @ 0.53 MGal (2000 m <sup>3</sup> ) each
<b>Blower Capacity</b>	Full capacity = 4,220 ft <sup>3</sup> /min (172,000 m <sup>3</sup> /d)
<b>Clarifier Surface Area</b>	<i>*Some units may not be available</i>
Primary Clarifiers	4 clarifiers @ 3,875 ft <sup>2</sup> (360 m <sup>2</sup> ) each
Secondary Clarifiers	4 clarifiers @ 3,660 ft <sup>2</sup> (340 m <sup>2</sup> ) each

Optimal Process Parameter Ranges	
<b>Aerobic Solids Retention Time (SRT)</b>	3 – 10 days
<b>Secondary Clarifier Solids Loading Rate (SLR)</b>	<2.0 lb/ft <sup>2</sup> /hr <10.0 kg/m <sup>2</sup> /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.

October 2020