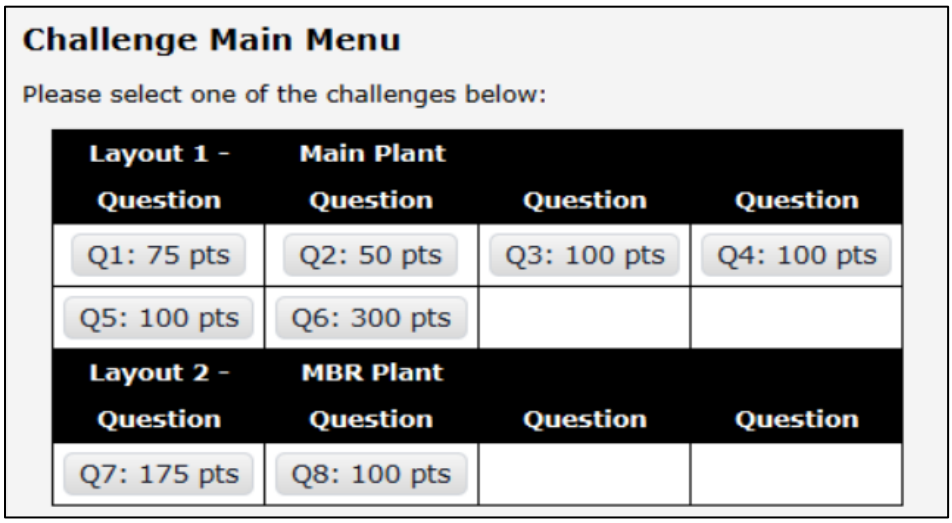
Operations Challenge Process Control Event – Simulator Question Background Information

The 2025 Operations Challenge simulator contains 2 plant layouts:

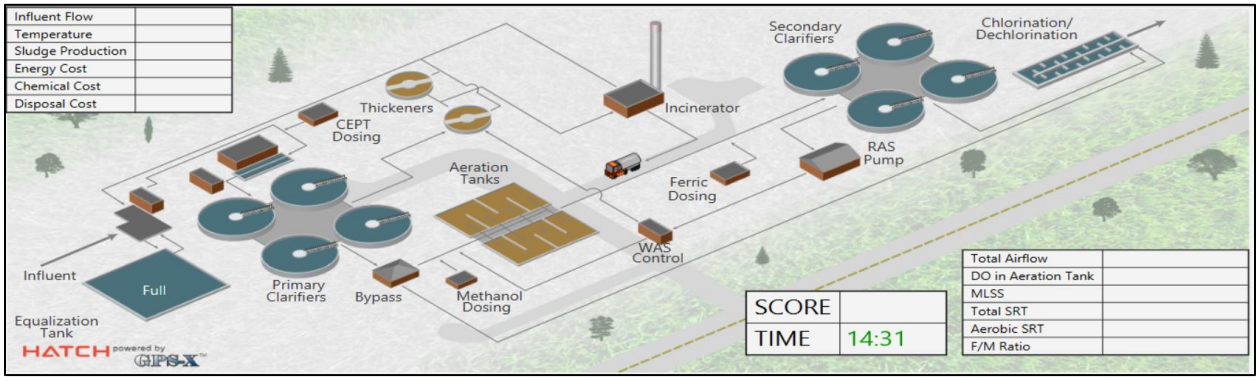
- Layout #1 – Conventional Activated Sludge Plant
- Layout #2 – Combined Activated Sludge / Membrane Bioreactor (MBR) Plant

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



Layout #1 – Main Plant

Layout #1 contains a conventional BNR wastewater treatment plant, as 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

- a CEPT dosage point (for iron and polymer addition for chemically enhanced primary treatment and chemical phosphorus precipitation)
- 2 ferric 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
- a sludge incinerator
- a chlorine disinfection tank, with chlorination/dichlorination options

The Challenge Questions for Layout #1

Teams will be presented with a total of 6 challenge questions for Layout #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.

Please note that Question 6 involves running a 30-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)
- Starting pumped flow settings (RAS flow, WAS flow)
- Starting aeration conditions (airflow, DO controllers, etc.)
- Starting chemical addition settings (methanol, ferric, chlorine, sodium hydroxide, sulfur dioxide)

In questions 1 through 6, 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	Plant Maintenance	50
3	Chemically Enhanced Primary Treatment	100
4	Biological Phosphorus Removal	100
5	High Strength Wastewater	100
6	Dynamic Cyanide and Wet Weather	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, $gBOD_5/gVSS/d$).

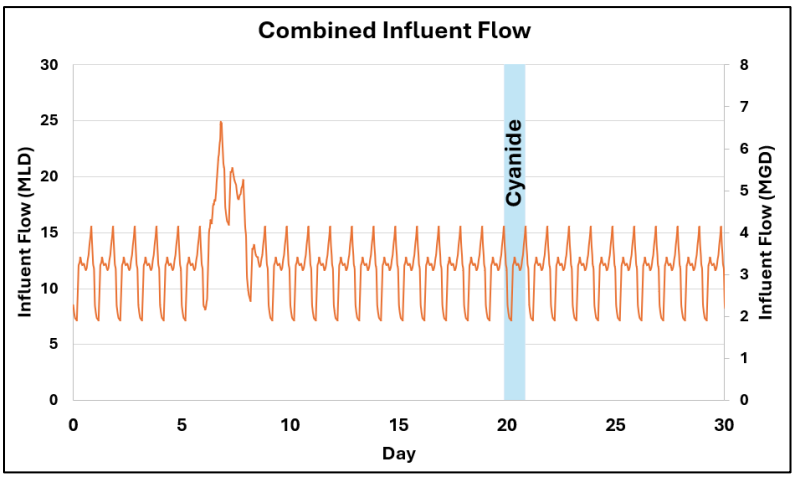
The input settings are bounded. If you set the value outside of the respective input range, the simulator will set it back to the limit.

Special Notes for Question 6: Dynamic: Consecutive Wet Weather Events

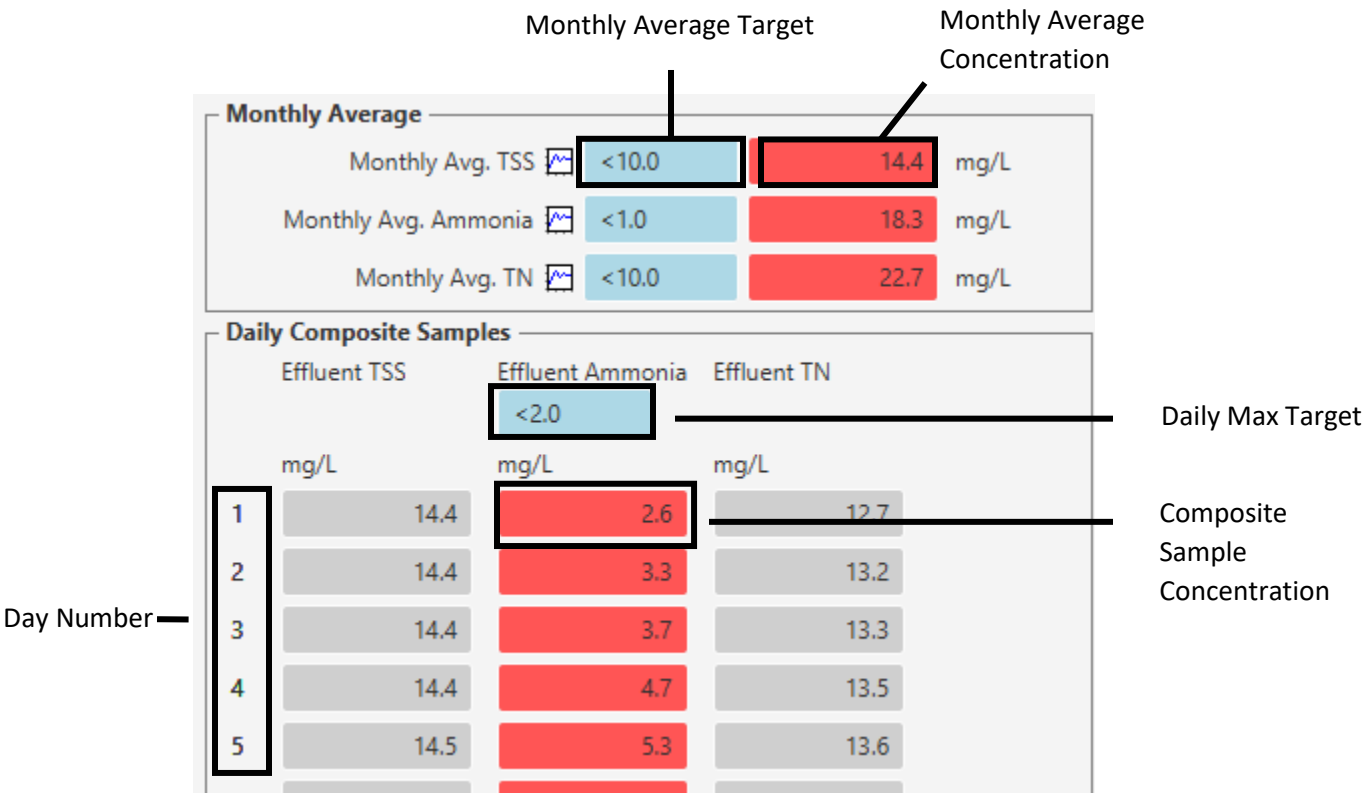
In Question 6, you will run a 30-day dynamic simulation where the influent follows a diurnal pattern. A wet weather event occurs on Day 6. The wastewater influent concentrations will be kept constant – only the flow rate changes over time.

In addition, there is short-term release of cyanide from the incinerator operation that negatively effects the nitrifiers of the activated sludge system. This event happens on days 20 and 21.

The timing of the cyanide event and 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:



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 a score between 0 and 300 points on this question, depending on the operational choices made.

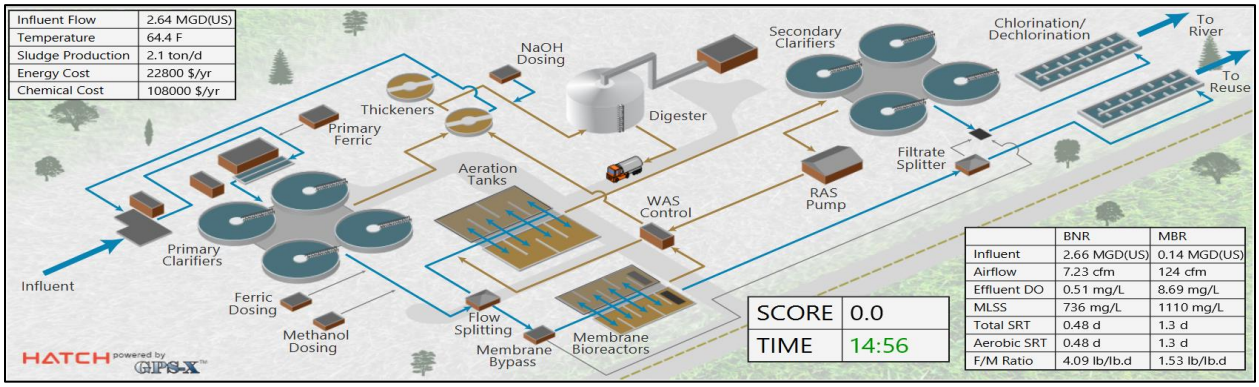
Additional Data for Question 6:

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 ~2.5 MGD (10,000 m3/d) additional flow (see graph above).
Equalization Tank Volume	1 tank @ 2.64 MGal (10,000 m3) The simulation begins with the equalization tank empty.
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 @ 1,885 ft2 (175 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 – Combined Activated Sludge / Membrane Bioreactor (MBR) Plant

Layout #2 contains a treatment facility that has two parallel treatment trains – one conventional activated sludge, and one that uses membrane bioreactor (MBR) technology, as shown below:



Note that there are two effluent points for this plant – one that goes to the river, and one that goes to water reuse. The activated sludge train can only discharge to the river, while the MBR train can discharge to either the river or the water reuse side, as dictated by the challenge question. Note that there will be effluent targets for both effluent points for each challenge.

The plant consists of:

- an influent pumping station
- 4 circular primary clarifiers
- a flow-splitting station, to divide the flow between the activated sludge and MBR sides
- 2 parallel plug-flow activated sludge aeration tanks (4 zones in series)
- 4 circular secondary clarifiers
- 2 parallel membrane bioreactors (MBRs - 5 zones in series, including a small final zone containing the membranes)
- Membrane bypass
- 2 ferric dosage points (for iron addition for chemical phosphorus precipitation) – **note that the 2nd dosage point is in a different location to the plant in Layout #1.**
- 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 – **both the activated sludge and membrane bioreactor WAS flows are controlled from this building.**
- 2 gravity sludge thickeners, and one
- an anaerobic digester
- 2 chlorine disinfection tanks (one each for the river outfall and the water reuse outlet), with chlorination/dichlorination options

The Challenge Questions for Layout #2

Teams will be presented with a total of 2 challenge questions for the plant in Layout #2. Teams can do the 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 the question, so if you do the question several times, it will only remember the last answer that you submitted.

The question 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 question:

- Sizes of the aeration tanks
- Sizes of the MBR reactors and membrane surface area
- Surface areas of the clarifiers
- Number of primary clarifiers in service
- Number of aeration and MBR tanks in service
- Number of secondary clarifiers in service
- Influent loading (flow, COD, BOD_5, ammonia, temperature, pH)
- Starting pumped flow settings (RAS flow, WAS flow for either train)
- Starting aeration conditions (airflow, DO controllers, etc.)
- Starting chemical addition settings (methanol, ferric, chlorine, sodium hydroxide, sulfur dioxide)

Note that the MBR unit has a maximum flow rate that it can receive, and any additional flow above that limit will be bypassed around the MBR unit and sent to the river effluent. The maximum allowable flow rate is a function of the MBR SRT and the MBR MLSS. Lower SRT and higher MLSS values will reduce the maximum allowable flux through the membranes. **Increase the SRT and/or lower the MLSS concentration to allow more flow through the MBR unit.**

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

#	Question	Maximum Possible Points
8	MBR Nutrient Removal	175
9	MBR Operation	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.