Sensors Data Integrity Monitoring

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Challenge Statement

How might we identify drifts or inaccuracies in sensor readings required for the monitoring of Water Treatment process?

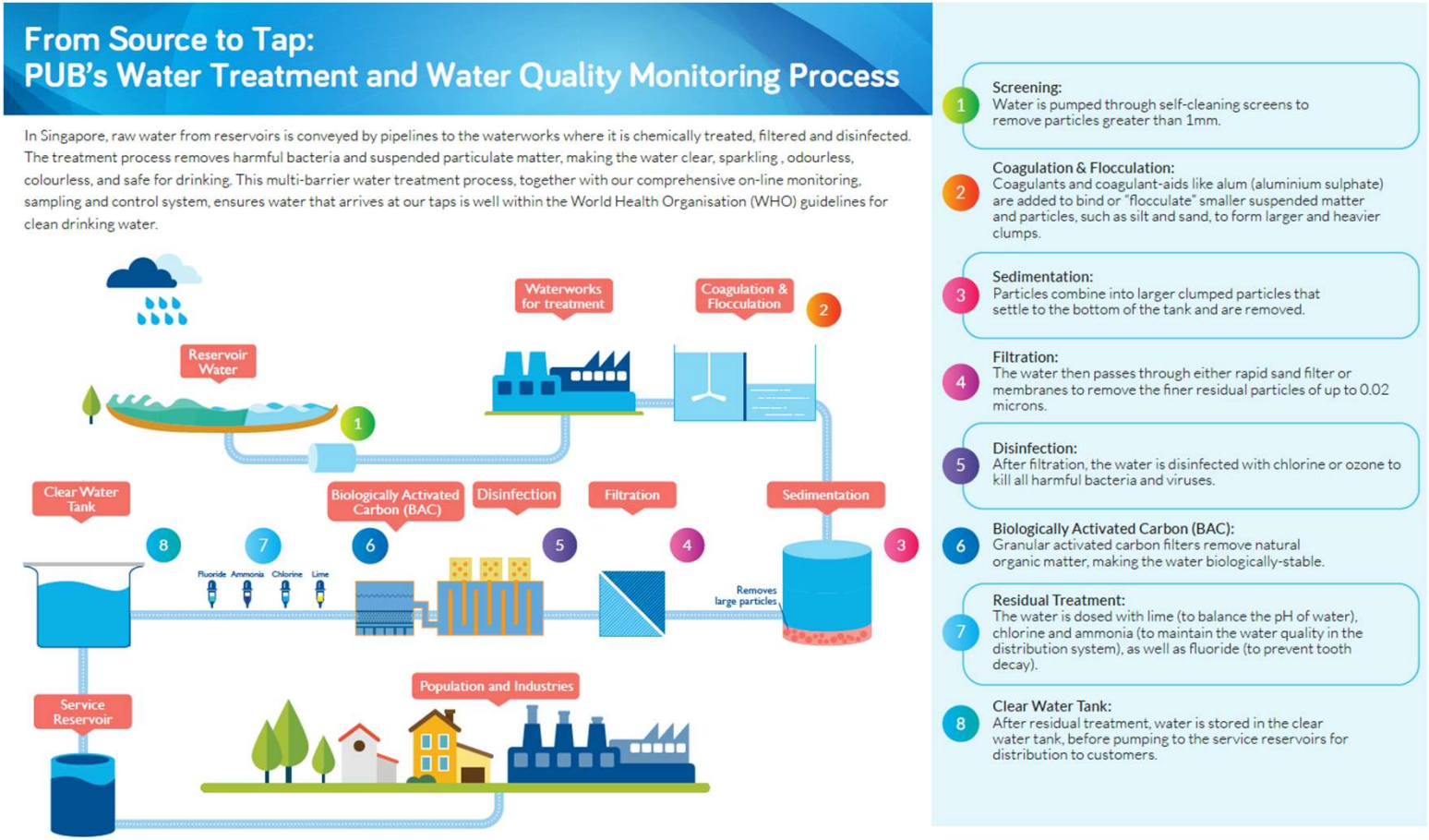

Figure: PUB's Water Treatment Process and Water Quality Process, reference from www.pub.gov.sg

Background & Current Practice

- Accurate & well-calibrated sensors are critical for the operation of water treatment plants run by PUB, especially for water quality control.

- Sensors measuring crucial parameters, such as pH & total residual chlorine, could drift over time, which makes it difficult for operators to detect these changes.

- Sensor drifts when not detected can affect the operators' decision making and even the process control systems.

- Current Practice to mitigate sensor drift is through calibrations at predetermined interval.
  - All sensors are assigned a calibration frequency, which follows the instrument manufacturer’s recommendations.
  - The calibration frequency may be adjusted from time to time, based on experience gained through use over a period of time.

Background & Current Practice (Con't)

Methods of Detection for Sensor drift or inaccuracies

Cross check between the two online sensors*	• Compare the two readings • More detailed analysis will be to compare the data trending of the two online sensors
Verify readings through lab tests	• Collect sample for analysis at the plant's laboratory for verification
Manual analysis of sensor data	• Analyzing data of the past calibration records

*There are two online sensors for each critical water quality parameter that is monitored

Background & Current Practice (Con't)

Scenarios where sensors drift or inaccurate data

Aging of sensor	• E.g. when a pH sensor age, the performance drops, we may see pH readings going higher or lower with respect to the benchmark reading
Variations in water quality or process flow	• E.g. the sensor may not be able to respond quickly to variations in water quality or process flow
Improper calibration that is not noticed by staff	• E.g. a wrong standard was used for the calibration, resulting in inaccurate reading

Opportunities Areas & Key Considerations

- Solutions that can help to identify inaccurate sensor readings in near real-time and verify if calibration has been done properly.

- Open to various solutions such as soft sensors to model sensor readings by processing the combined historical data of multiple adjacent and associated sensors in that part of the water treatment process
  - Computational or statistical correlation-based methods
  - Pattern-based matching methods
  - E.g. If the lime dosing pump is faulty, both pH and conductivity readings will be affected
  - Soft sensors would assist to validate the readings produced by the physical sensors and pinpoint those that require calibration or further checks.

- Proposals to consider secured methods of extracting the data from the existing supervisory control and data acquisition (SCADA) system, if this is required.

Key Challenges

- The solution should model the behaviour of many different types of online sensors.
  - >200 online sensors for physical & chemical water quality parameters (e.g. pH, turbidity, conductivity, chlorine concentration, etc.) in a typical water treatment plant.

- The solution must learn and develop its own mathematical or network models and identify the relationships or patterns of data with little or no prior knowledge.
  - The inter-relationships between different physical or chemical parameters are not always known.

- The solution must operate in the absence of a parallel sensor
  - But solution could make use of the data from a parallel sensor to validate whether a particular sensor is drifting.

- The solution should be intuitive, requiring little operator intervention.

Thank you