











temperature levels between stations and between the sampling times (ANOVA,  $p < 0.05$ ,  $p < 0.05$ ). The temperature values were recorded at the Cempaka Lake, Bangi and were classified as normal based on the NWQS and classified as Class I.

#### N. pH

The mean pH value of the Cempaka Lake is indicated as slightly acidic. The acidity of the Cempaka Lake may also be due to the free carbon dioxide as well as the various acids and alkalis which can penetrate the water bodies that came along with the industrial wastewater. Low pH at stations 1 and 2 was probably due to the rainfall and runoffs from the nearby roads and surrounding areas and attributed to the presence of high organic matter resulting from the discharge of organic matter into the lake from the food processing industries [21]. The pH values of the lake in this study are not different compared to the values that have been by [21] in the study of Varsity Lake, University of Malaya, Kuala Lumpur which was from 5.8 to 6.9. This could be contributed by the water from the engineering faculty that recorded as the lowest pH.

The pH value was ideal when compared to the NWQS and classified as Class I. The statistical analysis showed that there were no significant differences in the mean pH levels between stations and between the sampling times (ANOVA,  $p > 0.05$ ,  $p > 0.05$ ).

#### O. DO

The DO value was higher during the first sampling compared to the second sampling and there was raining during the first sampling. In [16] reported lower values of dissolved oxygen in summer months due to a higher rate of decomposition of organic matter and limited flow of water in low oxygen holding environment due to the high temperature. The DO values of the lake in this study are higher compared to the values that have been by [8] in the study of Tasik Chini, Pahang, Malaysia which was from 0.6 to 6.4 mg/L.

According to NWQS, Cempaka Lake falls under Class III. The statistical analysis of this study showed that there were no significant differences of the mean DO levels with the sampling stations, but there were significant differences between the sampling times (ANOVA,  $p > 0.05$ ,  $p < 0.05$ ).

#### P. EC

The average of two samplings of conductivity in the study area was  $161\mu\text{S}/\text{cm} \pm 38.56$ . The conductivity values at the first sampling were higher than the second sampling and this showed the effect of rain which decreases the concentration of all minerals, salts or any other factors which can increase the conductivity. The higher conductivity values for Cempaka Lake might be due to the discharge from factories and settlements located along Air Hitam River.

Based on the NWQS, the level of conductivity in the study area is classified as Class I. The results showed that the lake has a higher concentration of conductivity compared to the lake Putrajaya by [4], which was from 40.7 to 152.6  $\mu\text{S}/\text{cm}$ . The statistical analysis showed that there were no significant differences of the mean of conductivity levels with the

sampling stations and between the sampling times (ANOVA,  $p > 0.05$ ,  $p > 0.05$ ).

#### Q. COD

The Chemical Oxygen Demand is useful as an indicator of organic pollution for surface water [20]. In this study, the level of COD conducted in all samplings was high especially at station 7 during the first sampling. Increases in the COD levels in waters are attributed to the increase of organic matter and inorganic chemicals [21] due to runoff from the restaurants, food waste and wastewater from areas around the lake. Station 7 was located at the end of the lake and received water, which comes from the entire lake. The statistical analysis in this study showed that there were significant differences of the mean of COD concentration levels within the sampling stations and the sampling times (ANOVA,  $p < 0.05$ ,  $p < 0.05$ ). Based on the NWQS, the level of COD measured at all the stations in the lake was classified as Class II. Yet, the COD values of the lake in this study are not different compared to the values that have been by [22] Lake Engineering in Universiti Kebangsaan Malaysia, which was from 51.09 to 64.37 mg/L. The high COD values reflect as a result from wastes disposal.

#### R. BOD

The amount of BOD exerted depends on the type and amount of organic chemicals present, numbers and types of organisms in the water, temperature, pH, presence of nutrients and trace elements that are necessary for growth and many other environmental factors. The higher BOD, there are more organic matters in the water. At station 1, there was no rain as well as the fast movement of the water in the lake. This provided more chances for the microorganism to decompose the organic matter and this would increase the population of the microorganism.

In this case, the level of the microorganism was less than the other. The statistical analysis in this study showed that there were no significant differences of the mean of BOD concentration levels with the sampling stations, but there were significant differences of the mean of BOD concentration levels between the sampling times (ANOVA,  $p > 0.05$ ,  $p < 0.05$ ). Based on the NWQS, the BOD of the Cempaka Lake, Bangi was classified as Class I. It is an empirical test to measure the amount of oxygen used by the microorganisms in the aerobic oxidation, or breakdown of organic matter in the lake. However, when comparing the obtained result in the current study with data obtained from other studies such as a study which was done by [19]. A study of Engineering Lake the value of BOD 0.49 to 3.48 mg/L, classified as class II.

#### S. TSS

The average of two samplings of the total suspended solids in the study area was  $6.75\text{ mg}/\text{L} \pm 2.50$  as shown in Fig. 4c. The statistical analysis showed that there were no significant differences of the mean of TSS concentration levels with the sampling stations, and between the sampling times (ANOVA,  $p > 0.05$ ,  $p > 0.05$ ). The results of TSS are low during the second sampling but high at station 1 and 2 during the first sampling, because there was raining, was stimulated runoff and lead to a strong rate of soil erosion and

contributing to the increase in solid suspended in the area of flat land. Based on the NWQS, the level of TSS in the study area is classified as Class I. However, the results showed that the lake has a convergent concentration of TSS compared to the Tasik Chini, Pahang, Malaysia by [8], which was from 1.2 to 34.0 mg/L.

#### T. Hardness

The average of two samplings of hardness in the study area was 24.63mg/L  $\pm$  11.22 as shown in Fig. 4d. The statistical analysis showed that there were no significant differences in the mean hardness concentration levels with the sampling stations, but significantly differences between the sampling times (ANOVA,  $p > 0.05$ ,  $p < 0.05$ ).

All sampling stations measured had a similar concentration in the second sampling, but in the first sampling, it recorded a higher value from station 3 to 6. Compared to the NWQS, the level of hardness was very low and it is classified as Class I which represents the natural level of supporting aquatic lives. The results showed that the lake has a higher concentration of hardness compared to the study by [16] in the Gundolav Lake at Kishangarh, which was from 180.6 to 327.2 mg/L.

#### U. O & G

The average of two samplings of oil and grease in the study area was 8.14 mg/L  $\pm$  0.03 as shown in Fig. 4d. Statistical analysis showed that there were significant differences of the mean of oil and grease value between sampling stations, but there were no significant differences between the sampling times (ANOVA,  $p < 0.05$ ,  $p > 0.05$ ) respectively.

A number of potential sources for this contaminant, especially the vehicle service stations, hotels, and restaurants are located close to the lake. Compared to the NWQS, the level of oil and grease was very low and classified as Class I which represents the natural level of supporting aquatic lives. The result of oil and grease in this study was lower when compared to the value obtained by [22] in the study of Varsity Lake, University of Malaya, Kuala Lumpur which ranged from 232 to 291 mg/L. High concentration of the oil and grease particles are washed through kitchens, restaurants or cafeteria sinks or floor drains.

#### V. $NH_3N$

The average of two sampling of  $NH_3N$  in the study area was 2.46mg/L  $\pm$  0.32 as shown in Fig. 5a. The statistical analysis in this study showed that there were no significant differences of the mean of  $NH_3N$  concentration levels within the sampling stations, but significantly differences between the sampling times (ANOVA,  $p > 0.05$ ,  $p < 0.05$ ). The NWQS recommended a threshold level of ammoniacal-nitrogen for the Malaysian surface water is 0.90 mg/L for the support of aquatic life and supply water for potable, industrial and agriculture use.

Based on the NWQS, the ammoniacal-nitrogen in Cempaka Lake, Bangi is classified as Class IV. The potential sources for this contaminant, especially from nearby residential, petrol service stations, hotels, and restaurants are located close to the lake. However, when comparing the obtained result in the current study with data obtained from other studies such as a study which was done by [23]. The value of ammoniacal nitrogen for nine sampling stations in Chini Lake during

different seasons ranged from 0.003 to 0.57 mg/L or at an average of 0.17 mg /L. The highest concentration was during the wet season, the lowest concentration was during the dry season.

#### W. Phosphate

The average of two samplings of phosphate in the study area was 0.30mg/L  $\pm$  0.03 as shown in Fig. 5b. Higher phosphate concentrations were identified at stations 1 and 2 during both samplings, presumably due to the human activities such as residential, restaurants, hotels and clinics. In this study, the statistical analysis showed that there were significant differences of the mean of phosphate concentrations levels within the sampling stations, but no significant differences between the sampling times (ANOVA,  $p < 0.05$ ,  $p > 0.05$ ).

The level of phosphate concentration was low during the second sampling. Based on the NWQS, the level of phosphate measured at the study area is classified as Class I. The result of phosphate in this study was convergent compared to the value obtained by [22] in the study of Varsity Lake, University of Malaya, Kuala Lumpur which ranged from 0.2 to 33 mg/L. The maximum concentration of phosphate in the water comes from the biomedical and chemical engineering departments.

#### X. Sulphate

The average of two samplings of sulphate in the study area was 18.58mg/L  $\pm$  0.46 as shown in Fig. 5c. The statistical analysis showed that there were no significant differences of the mean of sulphate concentration levels with the sampling stations, but significantly differences between the sampling times (ANOVA,  $p > 0.05$ ,  $p < 0.05$ ).

The main source of sulphate was from the domestic, waste discharge such as detergent from the nearby residential and commercial areas [24]-[26]. Based on the NWQS, the concentration of sulphate ( $SO_4$ ) was within the average of natural level and the lake would be classified at Class I. The sulphate values of the lake in this study are higher compared to the value obtained by [8] in the study of the Tasik Chini, Pahang, Malaysia which was from 0.00 to 2.00 mg/L.

## IV. CONCLUSION

Results of the study indicated that the mean concentrations of some parameters such as the pH, conductivity, TSS, BOD, sulphate, phosphate, hardness, oil and grease from two different samplings were within the normal range and are classified under Class I. The mean temperature and COD are classified under Class II, but the DO is classified under Class III and ammoniacal-nitrogen under Class IV. The calculated WQI values were confirmed that the lake can be classified under Class II and III for all sampling stations. The results clearly showed that the majority of the water quality parameters are more polluted during the first sampling compared to the second sampling.

Based on the statistical analysis, pH, EC, and TSS showed no significant differences; temperature and COD show significant differences; DO, BOD, hardness, ammoniacal-nitrogen significant during sampling times, while O & G, phosphate and sulphate significant between sampling stations.

The water body in the study area was contaminated may probably originate from the surrounding area such as from residential, petrol stations especially vehicle service stations, waste discharges, domestic sewage, hotels, commercials and restaurants that are closely located to the lake. These activities were generated both organic and inorganic waste and these wastes are ultimately contaminating the water bodies.

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