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**RESEARCH ARTICLE**

# WATER QUALITY INDEX ASSESSMENT OF BHALSWA LAKE, NEW DELHI

**Deepika [1] and S. K. Singh [2]**

**1.** Research Scholar, Department of Environmental Engineering, Delhi Technological University, New Delhi, India[1]
**2.** Professor, Department of Environmental Engineering, Delhi Technological University, New Delhi, India[2]

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***Corresponding Author***

**Deepika**

## *Abstract*

The aim of Present study is to estimate the WQI of an urbanized water body, Bhalswa Lake in New Delhi. The WQI of any water body is a single number that indicates the weighted average of selected parameters linked to water quality classes. It gives an indication of water quality of whole water body in form of single value of WQI. To determine WQI of Bhalswa Lake, study of physio-chemical parameters has been analysed such as pH, TDS, TSS, alkalinity, hardness, calcium, magnesium, sulphate, chloride, nitrate, BOD and DO. However WQI values of Bhalswa Lake reported as 107.72 and 119.67 of pre-monsoon and post monsoon respectively. It shows trend of change of WQI is almost similar and in pre-monsoon season lake is having less pollution as compare to post monsoon season. The WQI of present study reveals lake water is highly contaminated and not suitable for drinking purpose.



## 1. INTRODUCTION

The term water quality comprises the water column and the physical channel required to maintain and sustain aquatic life. The goal of the federal Clean Water Act, "To protect and maintain the chemical, physical and biological strength of the nation's waters," establishes the importance of assessing both water quality and the habitat required for maintaining other aquatic organisms (Kankal et. al., 2012). Water is the precious gift of nature to human being and pure water is an important resource of mankind, because it is directly related to human well being. Now a day's water is going to be polluted day-by-day with increasing urbanization. Although three fourth part of earth is being surrounded by water but a little portion of it may be used for significant purposes. This little portion of water is not even safe due to increased pollution. The surface water bodies are the abundant and important sources of biological life. These are unfortunately under lots of environmental stress and getting polluted as consequence of manmade activities. There is a fact about the water bodies as they are the mirror of their environment as well as they reflect the society exists around surface water bodies and collect all Sins of humanity. Surface water is the most common source of consumers in most of the cities through municipal water supply. In this manner, more stringent treatments would-be required to make the surface water potable. The prominent source of surface water pollution is domestic sewage, industrial wastewater and agricultural run-off. There is an importance and need to study about surface water bodies. In many cases, application of fertilizers agricultural lands, pesticides, manure, and lime refuse dumps etc. are the main source of surface water and ground water pollution. Surface water is generally using for drinking and irrigation purposes in India. Therefore, we carried out studies of physicochemical parameters of surface water in Bhalswa lake whether it is fit for drinking or some other purposes of various parts of North-Central Delhi (Pandit and Oza, 2004; Joshi *et al.*, 2004; Bhoi *et al.*, 2005). Universal access to safe drinking water and sanitation has been promoted as an essential step in reducing the preventable diseases (WHO, 1994; 2001). The major hazard in drinking water supplies is microbial contamination, which is due to agricultural land wash, domestic sewage, industrial effluents, improper storage and handling (WHO, 2006; Saha *et al.*, 2006). Primary contamination in

drinking water is improper storage of water supply, water storage and leakage of pipes and secondary contamination due to manmade such as improper handling, storage, distribution and serving methods (Tambekar *et al*., 2005). A water quality index is a means to summarize large amounts of water quality data into simple terms for reporting to management and the public in a consistent manner. In the present study water quality index of Bhalswa lake shows that the lake is highly contaminated and not safe for drinking and domestic purpose.

WQI of water can tell us whether the overall quality of water bodies possess a potential threat to various uses of water, such as habitat for aquatic life, irrigation water for agriculture and livestock, recreation and aesthetics, and drinking water supplies. Water quality index (WQI) is a single value indicator to the water quality. It integrates the data pool generated after collecting due weights to the different parameters. The present study is based on the analyses of physiochemical characteristics of lake water as samples of water collected from various locations of Bhalswa Lake. The advantages of an index include its ability to single number, its ability to combine various measurements in a variety of different measurement units in a single metric and its effectiveness as a communication tool. Water intended for human consumption should be both safe and wholesome. It should also be easily accessible, adequate in quantity, free from contamination and readily available (CCME WQI, 2005).

**Study Area**

Bhalswa Lake is in north-central Delhi and surrounded by Bhalswa dairy colony. Bhalswa lake complex is in 92 hectares area. Length of Bhalswa lake is 350 m (dda.org.in). Lake is covered by residential area of Bhalswa dairy colony and dairy effluent is also coming to Bhalswa lake. Bhalswa dairy and nearby residential area are the main source of influent in Bhalswa lake. In monsoon season supplementary drain which is coming from najafgarh over flows and that wastewater mix with lake water. High organic matter is present in lake and suspended matter and high algal growth exist at the sides of lake.

Bhalswa lake is present near to Bhalswa Landfill. Many of researches indicate that Lakes are connected to groundwater of that area. So that Bhalswa lake also gets polluted from groundwater contamination of that area Groundwater of Bhalswa area has been deteriorated by leachate contamination. It is also reported that groundwater contains high concentration of chloride as well as other heavy metal concentration (Ni, Cu, Zn) has also been determined (Jhamnani & Singh, 2009).

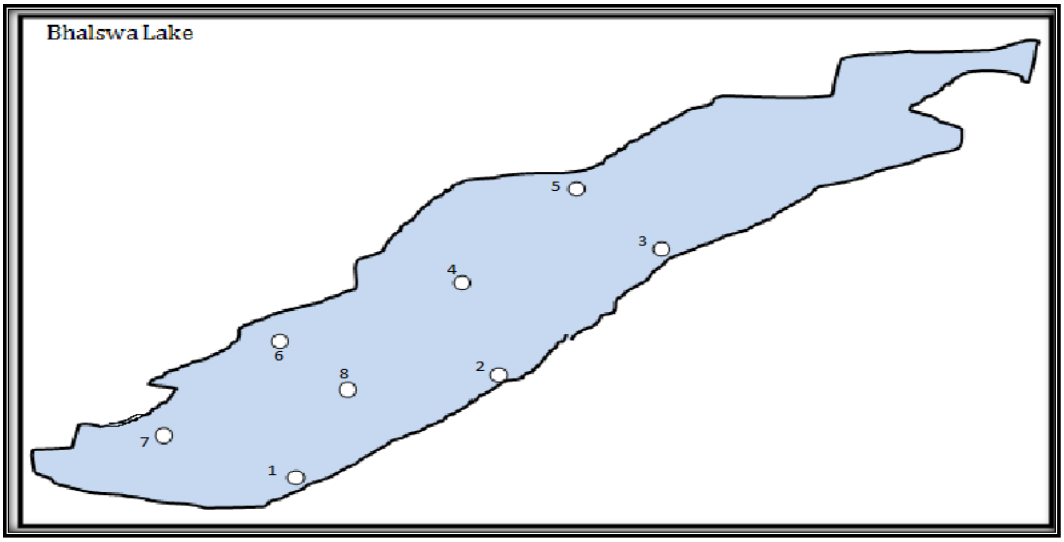


Fig.1 Bhalswa Lake Sampling Locations

## 2. MATERIAL AND METHODOLOGY

The methodology of present study is according to the procedure recommended in APHA (1992) and NEERI (1991) guidelines for water quality. The physical, chemical characteristics of Bhalswa Lake were evaluated and sampling was done for estimate the quality of lake water from different site of Bhalswa Lake. In this study eight grab samples

were collected from Bhalswa Lake. Determination of concentration of different parameters is followed by estimation of water quality index of lake water.

In this study, twelve important parameters considered for calculation of quality index of lake water. The WQI used in this study has been taken from the recommendation giving the drinking water quality standards Bureau of Indian Standards (BIS). In the present study weighted arithmetic index method has been used to fix the WQI of the water body (Brown et. al.).
In this method, quality rating is determined first and it can also write as sub index.
It is calculated by using following expression:

$$\mathbf{Q_n = 100*[V_n - V_{io}] / [S_n - V_{io}]} \quad \textbf{..... (i)}$$

(Let there are **n** water quality parameters which have been taken and quality rating or sub index ($\mathbf{Q_n}$) corresponding to **nth** parameter is a number a value or number indicates the respectively evaluated value of nth parameter in the corresponding polluted water body with respect to the standard permissible value of that parameter.)
$\mathbf{Q_n}$= Parameter quality rating of nth parameter of water
$\mathbf{V_n}$= Observed value of nth parameter at sampling station
$\mathbf{S_n}$= Standard value of parameter within permissible limit
$\mathbf{V_{io}}$= ideally predicted value of nth parameter (i.e., for DO and pH it is 14.6 mg/l and 7 respectively. For all other parameters it should be zero.)

After calculating quality rating, unit weight of water quality parameter should be calculated. It is the ratio of coefficient of proportionality of nth parameter to standard value of that parameter. It is also called relative of water quality parameter.

$$\mathbf{W_n = K_p / S_n} \quad \textbf{.....(ii)}$$

$\mathbf{W_n}$= relative weight of parameter
$\mathbf{S_n}$= Standard value of parameter within permissible limit
$\mathbf{K_p}$= Coefficient for proportionality.

**Finally the Water Quality Index** of water body can be calculated by the following equation:

$$\mathbf{WQI = \Sigma Q_n W_n / \Sigma W_n} \quad \textbf{.....(iii)}$$

After estimation of WQI of Bhalswa Lake, compare it with the standard WQI values given by Chatterji and Raziuddin, 2002 and fix the status of Water Quality on the basis of estimated WQI.

**Table 1.** WQI Range and water quality on the basis of range (Chatterji and Raziuddin, 2002)

| Water Quality Index Range | Water Quality |
|---|---|
| 0-25 | Excellent Water Quality |
| 26-50 | Good Water Quality |
| 51-75 | Poor Water Quality |
| 76-100 | Very Poor Water Quality |
| >100 | Unsuitable for Drinking |

In this study, different water quality parameters have been analysed and twelve important parameters were taken to determine WQI of Bhalswa lake. Standards limit of parameters introduced by recommending agencies BIS, WHO and ICMR. Following table contains parameters, their standard limits and unit weights for assessing the WQI.

**Table 2.** Standards for drinking water and Relative weight of parameter (all values are in mg/l, except pH)

| Sr. No. | Parameters | Standards | Concerned Agencies | Relative Weight |
|---|---|---|---|---|
| 1 | pH | 6.5-8.5 | BIS | 0.2190 |
| 2 | TDS | 500 | BIS | 0.0037 |
| 3 | TSS | 500 | WHO | 0.0037 |
| 4 | Alkalinity | 120 | ICMR | 0.0155 |
| 5 | Hardness | 300 | BIS | 0.0062 |
| 6 | Calcium | 75 | BIS | 0.025 |
| 7 | Magnesium | 30 | BIS | 0.061 |
| 8 | Chloride | 250 | BIS | 0.0074 |
| 9 | Nitrate | 45 | BIS | 0.0412 |
| 10 | Sulphate | 150 | BIS | 0.01236 |
| 11 | BOD | 5 | ICMR | 0.3723 |
| 12 | DO | 5 | ICMR | 0.3723 |

## 3. RESULTS & DISCUSSION

In this study, samples have been collected in pre monsoon, rainy and post monsoon season. The study also shows variation in WQI of different season. Important parameters were evaluated from the collected samples in laboratory.

**Table 3:** Seasonally analysed results of the physiochemical parameters of the water body

| Sr. No. | Parameters | Pre-Monsoon | Rainy Season | Post-Monsoon |
|---|---|---|---|---|
| 1 | pH | 8.58 | 8.6 | 8.78 |
| 2 | TDS | 3334 | 3317 | 3298 |
| 3 | TSS | 719 | 678 | 699 |
| 4 | Alkalinity | 606 | 563 | 580 |
| 5 | Hardness | 78 | 67 | 72 |
| 6 | Calcium | 66 | 58 | 61 |
| 7 | Magnesium | 12 | 9 | 11 |
| 8 | Chloride | 1768 | 1698 | 1749 |
| 9 | Nitrate | 3.1 | 2.89 | 2.907 |
| 10 | Sulphate | 154 | 143 | 145.72 |
| 11 | BOD | 9.94 | 9.4 | 9.57 |
| 12 | DO | 10.02 | 10.58 | 10.17 |

After assessing the concentration of physiochemical parameters, calculation of quality rating and water quality index has been determined. All important steps of determination of WQI in different seasons are given in following tables.

(i) Water Quality Index of Bhalswa Lake has been calculated for pre-monsoon season and given in Table 4.

**Table 4:** Water Quality Index calculation of Bhalswa Lake in Pre-Monsoon season

| Sr. No. | Parametes | Observed Value | Standard Value | Unit Wt. ($W_n$) | Quality Rating $Q_i$ | $Q_i \times W_i$ |
|---|---|---|---|---|---|---|
| 1 | pH | 8.58 | 6.5-8.5 | 0.2188 | 105.33 | 23.0462 |
| 2 | TDS | 3334 | 500 | 0.0037 | 666.8 | 2.502 |
| 3 | TSS | 719 | 500 | 0.0037 | 143.8 | 0.53206 |
| 4 | T. Alkalinity | 606 | 120 | 0.0155 | 505 | 7.8275 |
| 5 | T. Hardness | 78 | 300 | 0.0062 | 26 | 0.1612 |
| 6 | C. Hardness | 66 | 75 | 0.025 | 88 | 2.2 |
| 7 | M. Hardness | 12 | 30 | 0.061 | 40 | 2.44 |
| 8 | Chloride | 1768 | 250 | 0.0074 | 707.2 | 5.23328 |
| 9 | Nitrate | 3.1 | 45 | 0.0413 | 6.88 | 0.284144 |
| 10 | Sulphate | 154 | 150 | 0.0124 | 102.667 | 1.273071 |
| 11 | BOD | 9.94 | 5 | 0.3723 | 198.8 | 74.01324 |
| 12 | DO | 10.02 | 5 | 0.3723 | 47.708 | 17.76169 |
| | | | | $\Sigma W_n$ =1.1396 | $\Sigma Q_n$ = 2638.185 | $\Sigma Q_n W_n$ =137.2744 |

Water Quality Index of Bhalswa lake in pre monsoon season,
WQI= $\Sigma Q_n W_n / \Sigma W_n$= 137.2744/1.1396 = **120.45**

(ii) Water Quality Index of Bhalswa Lake has been calculated for rainy season and given in Table 5.

**Table 5:** Water Quality Index calculation of Bhalswa Lake in rainy season

| Sr. No. | Parametes | Observed Value | Standard Value | Unit Wt. (Wn) | Quality Rating Qi | Qi×Wi |
|---|---|---|---|---|---|---|
| 1 | pH | 8.6 | 6.5-8.5 | 0.2188 | 106.67 | 23.3394 |
| 2 | TDS | 3317 | 500 | 0.0037 | 663.4 | 2.45458 |
| 3 | TSS | 678 | 500 | 0.0037 | 135.6 | 0.50172 |
| 4 | T. Alkalinity | 563 | 120 | 0.0155 | 469.167 | 7.272089 |
| 5 | T. Hardness | 67 | 300 | 0.0062 | 22.33 | 0.138446 |
| 6 | C. Hardness | 58 | 75 | 0.025 | 77.33 | 1.93325 |
| 7 | M. Hardness | 9 | 30 | 0.061 | 30 | 1.83 |
| 8 | Chloride | 1698 | 250 | 0.0074 | 679.2 | 5.02608 |
| 9 | Nitrate | 2.89 | 45 | 0.0413 | 6.42 | 0.265146 |
| 10 | Sulphate | 143 | 150 | 0.0124 | 95.33 | 1.182092 |
| 11 | BOD | 9.4 | 5 | 0.3723 | 188 | 69.9924 |
| 12 | DO | 10.58 | 5 | 0.3723 | 41.87 | 15.5882 |
| | | | | $\Sigma W_n$ =1.1396 | $\Sigma Q_n$ =2515.317 | $\Sigma Q_n W_n$ =129.5234 |

Water Quality Index of Bhalswa lake in rainy season,
WQI= $\Sigma Q_n W_n / \Sigma W_n$= 129.5234/1.1396 = **113.65**

(iii) Water Quality Index of Bhalswa Lake has been calculated for post-monsoon season and given in Table 6.

**Table 6:** Water Quality Index calculation of Bhalswa Lake in Post-Monsoon season

| Sr. No. | Parametes | Observed Value | Standard Value | Unit Wt. (Wn) | Quality Rating Qi | Qi×Wi |
|---|---|---|---|---|---|---|
| 1 | pH | 8.78 | 6.5-8.5 | 0.2188 | 118.67 | 25.965 |
| 2 | TDS | 3298 | 500 | 0.0037 | 659.6 | 2.44052 |
| 3 | TSS | 699 | 500 | 0.0037 | 139.8 | 0.51726 |
| 4 | T. Alkalinity | 580 | 120 | 0.0155 | 483.33 | 7.491615 |
| 5 | T. Hardness | 72 | 300 | 0.0062 | 24 | 0.1488 |
| 6 | C. Hardness | 61 | 75 | 0.025 | 81.33 | 2.03325 |
| 7 | M. Hardness | 11 | 30 | 0.061 | 36.67 | 2.23687 |
| 8 | Chloride | 1749 | 250 | 0.0074 | 699.6 | 5.17704 |
| 9 | Nitrate | 2.907 | 45 | 0.0413 | 6.46 | 0.266798 |
| 10 | Sulphate | 145.72 | 150 | 0.0124 | 97.14 | 1.204536 |
| 11 | BOD | 9.57 | 5 | 0.3723 | 191.4 | 71.25822 |
| 12 | DO | 10.17 | 5 | 0.3723 | 46.14 | 17.17792 |
| | | | | $\Sigma W_n$ =1.1396 | $\Sigma Q_n$ =2584.14 | $\Sigma Q_n W_n$ =135.9178 |

Water Quality Index of Bhalswa lake in post monsoon season,
WQI= $\Sigma Q_n W_n / \Sigma W_n$= 135.9178/1.1396 = **119.267**

Quality Index of Bhalswa Lake water is established from assessment of water quality in different seasons. In this manner various physiochemical parameters has been calculated. The concentration of various physiochemical parameters for calculation of WQI are presented in Table no 3. The water quality indices that were found in three different seasons have been estimated. Table no. 4, 5, 6 shows WQI calculations in Pre Monsoon, Rainy and Post Monsoon season respectively. The water quality index estimated for Bhalswa lake in Pre Monsoon, Rainy and Post Monsoon seasons are 120.45, 113.65 and 119.267 respectively. High values of water quality index of Bhalswa lake indicates the poor water quality. The water quality index value of this study exhibits that, the water body contains high organic matter and eutrophic conditions. The pale yellow color of lake makes water body aesthetically poor. The values of water quality index also indicate water quality is very poor in pre-monsoon season as compared to rainy and post-monsoon season (Yogendra & Puttaiah, 2008).

pH is an important parameter among all other parameters because on the basis of pH we can decide the different uses of water. In the present study, lake is alkaline in nature as the pH of water ranged 8.58 to 8.78 (Ambasht, 1971; Petre, 1975; Shardendu and Ambasht, 1988; Swarnalatha and Narasinga rao, 1993 and Sinha, 1995). Chloride is an important parameter of the status of water quality. In this study, chloride was present in higher concentration which shows lake is having high level of organic pollution (Munawar, 1970). In the present study chloride ranged 1698 to 1890 mg/l. There is an observation that chloride was high in pre monsoon season as compared to rainy and post monsoon season (Shastry et. al., 1970 and Sinha, 1995).

Bhalswa lake has the concentration of dissolved oxygen is 10.17 to 11.9 mg/l. DO level in any water body is a regulator of distribution of Flora and Fauna. The dissolved oxygen level is high in rainy season. Bio-chemical oxygen demand of any surface water body is an indicator of organic load in the waterbody. Many researches show higher values of BOD in highly polluted Waterbodies. The BOD concentration in Bhalswa lake ranged between 9.57 to 11.7 mg/l. Seasonally it is high during pre monsoon season, which was also observed by Chatterjee (1992). Alkalinity in waterbody ranged as 450 to 617 mg/l which was very high as compare to BIS specifications of 120 mg/l. Higher value of alkalinity in pre-monsoon season indicates existence of free $CO_2$ because high rate of degradation of sewage and domestic sewage takes place at high temperature. Nitrate is an important nutrient for the plant and algal growth. It may enter in lake from surface runoff or groundwater sources. It was within the range in this study as it was observed 2.89 to 3.1 mg/l. Sulphur is present in Waterbodies due to minerals, acid rains, industries releasing sulphur compounds into the atmosphere that are carried into lakes by rainfall. The range of sulphate in lake was 143 to 161 mg/l.

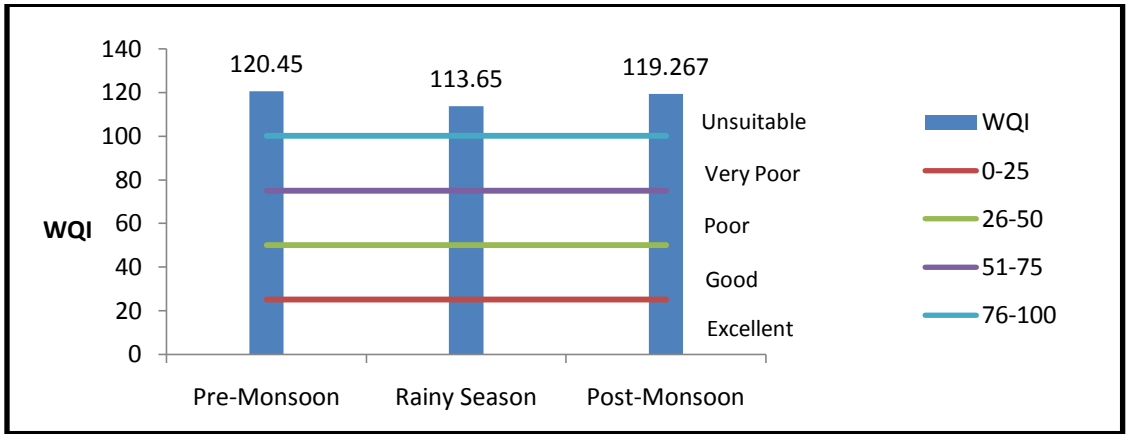


Fig.2 Graphical Representation of WQI

## 4. CONCLUSION

The results obtained from physiochemical parameters which were analysed to calculate WQI, lake is having high organic load due to domestic and dairy effluent coming to the water body. It can also be concluded that lake is eutrophic in nature. The WQI values of Bhalswa lake clearly show the unsuitability of water of human being. Comparatively high level of chloride and sulphate indicates water is not suitable for domestic use. Lake can be used for boating or other recreational activities because of the good dissolved oxygen concentration. Water quality of water body is an important and significant technique for complete assessment of waterbody. It is an important tool and can summarize the water quality status in a single number from which uses can find out about the waterbody.

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