# Assessment of Physicochemical and Biological Parameters on the Quality of Water of Madhotal Lake with Various Locations and Suggesting Line of Treatment Accordingly

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**Abstract-Experimental values of various parameters were obtained by adopting standard procedures. These obtained experimental values were compared with the standard values proposed by international bodies such as the World Health Organization. The values were then substituted into the mathematical expression to calculate the WQI. Water quality indexing is a simple and convenient way of expressing water quality that results in a single numerical value from which it can easily be suggested whether the water is fit for human consumption. India has a great cultural heritage. Its civilizations are recorded in world history. Samples were collected from Jabalpur, Madhya Pradesh, according to standard procedures. Various physical and chemical parameters such as pH, alkalinity, total dissolved solids, electrical conductivity, calcium and magnesium ions and total hardness were analyzed and the results were compared with WHO and ISI standards.**

**Keywords- Waste water, Physicochemical Parameters; Biological Parameters; Effluent treatment plants (ETP).**

## 1 INTRODUCTION

Surface water quality control policies should, in general, keep current pollution limits below certain levels and ensure minimum dissolved oxygen concentrations in aquatic organisms. The primary pollutant parameters considered when monitoring surface water quality generally include water. Dissolved oxygen detects changes in biological parameters due to aerobic or anaerobic activity and indicates the condition of river/stream water for aquatic and human life (Chang, 2005).

Aquatic life is becoming disturbed due to the low value of dissolved oxygen. Domestic and industrial waste pollution in surface and groundwater Water quality that can be assessed by determining biological oxygen demand. It is important to remember that potable and non-potable water require separate systems and pipes to avoid contamination. Each system should be clearly identified using different colored tubes. Water used for drinking, cleaning fish, and making ice must be free of disease-causing bacteria and may require secondary or even complete treatment depending on the chemicals to be removed. For some needs, such as general cleaning, the water may require only basic treatment. Both types of buildings are susceptible to bacterial growth if they have low levels of chlorine or no residue. If washing is done only occasionally, testing may not be necessary. In general, an annual tank inspection is performed. However, in areas where monsoons are more active, it may be better to test during the dry season when water points are concentrated and again during the rainy season when agricultural activity is high. It's possible. Another important time for ports is the main fishing season when the port is busy and pollution from ships is at its highest levels.

Figure 1 Surface water

With population growth and economic development, India faces a major problem of scarcity of natural resources, especially water. Most of the world's freshwater sources are polluted, reducing water

availability. All living organisms depend on water and it exists in nature in many forms such as sea, river, lake, cloud, rain, snow, fog, etc. But frankly, there is no chemically pure water in nature for any significant period of time. The lake is a source of abundant water and surrounded by land, it is home to a wide variety of aquatic life. In practical terms, fresh water is water that has solids and gases dissolved or suspended in it and are therefore biologically healthy. less. Such high water quality may only be required for drinking purposes and for other purposes such as agriculture and industry, water quality may fluctuate and water that is somewhat polluted in a general sense may be considered pure. The health of lakes and their biodiversity can be directly linked to the health of almost all parts of the ecosystem.

## 2. LITERATURE REVIEW

Hasina, Maneb, et al. (2012), in the present work we reported and compared the physicochemical properties such as pH, conductivity, turbidity, TDS, fluoride, chloride, sodium, sulfate, etc. The value between treated and untreated. Water samples were taken. The samples were collected from the treatment plant at Ahmedpur, Latur district. The values change significantly after water treatment. Wanda et al. (2012) could increase fish populations. However, if the algae becomes too wild, oxygen levels will drop and the fish will die. The nitrate water quality guidelines set by CCME for Aquatic Life Safety are 13 mg/L. Phosphate levels at all sampling points exceeded the WHO limit of 5 mg/L. Polyphosphates are harmful because they interfere with water coagulation, flocculation, and soda lime curing. Further study of phosphate levels may lead to eutrophication and create problems for other uses. , e The highest concentration of phosphate was observed at site P1, while the lowest concentration was observed at site P4. Phosphates come mostly from fertilizers, pesticides, and industrial and cleaning compounds.

V. Sasane (2013), the aim of the present work is to evaluate the groundwater quality in and around Lonar Lake. Water quality is determined by collecting groundwater samples and subjecting the samples to extensive physical and chemical analysis. pH, total hardness, calcium, magnesium, bicarbonate, chloride, nitrate, sulfate, total dissolved solids, iron, manganese and fluoride are taken into account to evaluate water quality.

M. Gurav (2014) reported that two lakes in Thane Kalwa city and Jeel Lake are saturated with nutrients, hence a study was conducted to determine the water quality for 6 months for various physical and chemical parameters. Study of the state of pollution in lakes. The lake was found to be relatively more biologically polluted and more eutrophic than Lake Kalua. Among water quality parameters, a positive relationship was found between chlorophyll and temperature, suspended solids, pH, dissolved oxygen (not with chlorophyll c), and carbon dioxide (only with chlorophyll c). A negative relationship was observed between chlorophyll and light penetration. Chlorophyll a and b showed a negative relationship with silicate carbon dioxide and phosphate.

IR Ustad (2014) reported that to understand the water quality of Lake Treveni, physical and chemical parameters were studied and analyzed for one year from December 2010 to November 2011. Such as water temperature, air temperature, pH, humidity, conductivity, and free carbon dioxide Total solids, dissolved oxygen, total alkalinity, total hardness, CaCO3, Ca++, mg++ were studied. The results showed a large seasonal variation in some physical and chemical parameters, and most indicators were within normal limits and indicated an improvement in the quality of the lake's water. It has been found that it is better to drink water in winter and summer.

M. Pondhe (2014), in this research, an attempt was made to evaluate the seasonal variation in the physical and chemical properties and water quality of the Pravara River for irrigation purposes during the year 2008. The study reveals that the physical and chemical parameters of most of the river water indicators at the five selected sites showed moderate variation in their concentrations for all seasons.

S. M. Gawande (2014) worked on water quality which is generally described in terms of its physical, chemical and biological properties. Therefore, it becomes necessary to ensure the suitability of water for drinking, irrigation and industrial purposes. The quality of groundwater based on sodium content, sodium absorption rate and residual sodium carbonate will help determine the suitability of water for irrigation purposes.

Anju Bhatia (2015) studied drinking water quality at the household level in Jaipur, Rajasthan. Groundwater

is the main source of water supply in Jaipur. It is either supplied through a pipeline by the Public Health and Engineering Department (PHED) or homes have their own wells on their premises. For this study, 20 samples were collected from 10 randomly selected wards; One borehole each and piped water supply. Water samples were collected from homes for physical and chemical analysis and comparison with standards.
R.C. Angasaria (2017) Surface water is increasingly explored as a drinking water source due to its scarcity, unavailability and bacterial contamination. Their work describes significant findings of physical and chemical analysis of groundwater samples from open wells, tubewells and hand pumps in urban areas of Pilani, Jhunjhunu district, Rajasthan. The various parameters specified are pH, dissolved solids, fluoride, chloride, nitrate, sulphate, total alkalinity and total hardness. It is noted that the nitrate value is higher than ICMR standards. Other parameters are found to be within required limits. The interesting fact is that nitrates are what make groundwater drinkable.
PJ Puri, MKN. Yankey, et al. (2017) studied that Water Quality Index (WQI) was calculated for various surface water bodies especially lakes of Nagpur city, Maharashtra (India) for January to December 2008 season; It includes three seasons, summer, winter and monsoon. Sampling points were chosen based on their importance. Water quality indices were calculated using the water quality index calculator provided by the National Sanitation Foundation (NSF) information system.
Ankita Mathur and Umesh Gupta (2017) explored the assessment of water quality parameters and calculation of the water quality index in Jaipur, Rajasthan. It is determined by collecting groundwater samples for comprehensive physical and chemical analysis. In this study, 70 water samples were taken from different areas of Jaipur and 9 water quality parameters were taken into consideration: pH, total hardness, chloride, fluoride, and dissolved solids. The analysis shows that Jaipur is in need of groundwater. It also requires some treatment and protection from contamination before consumption.
B. N. Tindall, D.J. McEwan, C.K. Soni (2017), the water quality index is a single number that represents water quality by combining water quality variables. Its purpose is to provide a simple and concise method for characterizing water quality for various uses. The current work deals with monitoring variation in seasonal water quality indicators for some strategically selected surface water bodies.

## 3 WATER QUALITY INDICATORS

To determine the quality of a water body, the chemical, biological and physical conditions of the water body must be measured. Chemical measurements, biological surveys, and visual (physical) observations provide the “big picture” of what is happening in bodies of water. Below is a list of indicators (physical, chemical, and biological) that are often measured to evaluate water quality.

## 4 PROPERTIES OF WATER

A view of the Earth taken from space will show it in blue. This blue color is actually water, and most of the Earth is covered in water. We need water for almost everything, for example: drinking, bathing, cooking, etc., so we should know the properties of water. 65% of the human body consists of water. Water is essential for the existence of life on Earth. Water is unevenly distributed over the Earth's surface. It makes a master solvent and dissolves almost all polar solutes. So let's take a look at its features and understand why it is important:

Physical properties of water
Water is a colorless, tasteless liquid. Water molecules have extensive hydrogen bonds resulting in unusual properties in the condensed form. It also has high melting and boiling points. Compared with other liquids, water has higher specific heat, thermal conductivity, surface tension, dipole moment, etc. These characteristics indicate its importance in the biosphere. Water is an excellent solvent and thus helps in transporting ions and molecules needed for metabolism. It has a high latent heat of evaporation which helps in regulating body temperature.

Chemical properties of water
Water reacts with many substances to form different compounds. Some of the important reactions are as follows: Water can act as both an acid and a base, which means it is amphoteric in nature.

### 4.1 Turbidity

Although less commonly used than some of the other water quality parameters on this list, turbidity indicates how dirty the water is. When using a turbidity sensor, these devices are designed to measure the ability of light to pass through the water. High concentrations of silt, clay, and organic matter can lead to high levels of pollution. The main problem with water turbidity is that the water will look dirty. No one wants to drink dirty water. Additional problems caused by high pollution include:

1. The cost of water treatment will be high
2. High levels of particulate matter can act as a shield for harmful microorganisms, making it more difficult to eliminate these contaminants.
3. Suspended materials can damage fish gills, reduce growth and reduce disease resistance.
4. Various suspended particles can act as a medium for adsorption of mercury, cadmium, lead and other heavy metals.
5. The dissolved oxygen concentration is likely to decrease
6. When the sensors give you a reading higher than 5 NTU, the water contains visible impurities. For dirty water, it may have a turbidity reading of over 100 NTU.

4.2 Temperature

Some aspects of water quality that are affected by water temperature include odor, chemical reactions, solubility, palatability, and viscosity. As such, BOD, sedimentation and chlorine depend on water temperature. The ideal water temperature is 50-60 degrees Fahrenheit.

4.3 Colour

Water colour can be changed by decomposition of organic matter including vegetation. Inorganic materials such as rocks, soil, and stone can also affect the colour of the water. Although these changes in water colour can cause aesthetic problems with the water, they do not change the taste of the water. It can effectively measure colour by comparing water samples to colours glass discs or standard colour solutions.

When trying to identify the colour of water, it is important to understand the difference between the apparent colour of water and its true colour. Transparent colour consists of suspended solids and dissolved solids. The true colour of water can be identified after filtering all suspended materials from the water. Keep in mind that colour can be rated on a scale from 0 to 70 colour units. Pure water does not contain any colour units because it is essentially colourless.

4.4 Taste and Odor

The taste of water and the formation of odors can change as a result of adding foreign substances to the water. This material may include organic materials, dissolved gases, and inorganic compounds. Most of this material is obtained from agricultural, natural and local sources.

4.5 Solids

Solids can be in suspension or solution when they move through water. If you take a water sample through a fiberglass filter, the suspended solids will remain on top of the filter. On the other hand, any dissolved solids will pass through the water and remain in the water. When measuring the number of solids in water, it is common to measure total dissolved solids. You can find out how much organic matter is in the water by measuring total dissolved solids. Three different classifications of water for total soluble solids include:

1.Freshwater – Less than 1,500 mg/L TDS
2.Brackish water – 1,500-5,000 mg/L TDS
3.Saline water – More than 5,000 mg/L TDS

4.6 Electrical Conductivity

Another key physical parameter to be aware of is electrical conductivity, which measures the extent to which water or a similar solution can conduct or conduct electrical currents. Increasing the amount of ions in the water will increase the conductivity level.

This is one of the key factors when measuring water quality due to how easily levels of contaminants in water can be detected when measuring water conductivity. High conductivity means that there are a lot of impurities in the water. On the other hand, potable water and ultra-pure water are practically incapable of conducting electrical current. The main units of measurement for electrical conductivity are microohms/cm. It includes millisiemens/m, which is then abbreviated as mS/m.

4.7 pH

When measuring water quality, pH is one of the first measurements you should make. Water pH is measured using a simple pH sensor or test kit, which will tell you how acidic or alkaline the water is. Acidic water is always composed of hydrogen ions. On the other hand, basic water contains more hydroxyl ions.
The pH level can be between 0-14. If you get a reading of 7.0, it means the water is neutral. Any reading below 7.0 is considered acidic, while any reading above 7.0 is considered alkaline. The pH of pure water is neutral. However, rain is slightly more acidic, usually having a pH of 5.6. Water is considered safe to drink if its pH is between 6.5-8.5. Changing pH levels can have a number of effects on plants and animals:
1. Most aquatic plants and animals are able to live in water with a specific pH, which means that a slight change can impair the quality of life.
2. Slightly acidic water can irritate the gills of fish, damage membranes and reduce the number of eggs in fish.
3. Water with too high or too low pH is harmful to aquatic plants and animals
4. Low pH can kill amphibians because their skin is sensitive to contamination

4.8 Acidity
It is a measure of the amount of acid present in a given solution. The acidity of water is the quantitative ability to neutralize a base at a given pH level. Acidity is usually due to the presence of mineral acids, decomposed salts and carbon dioxide. When acids are introduced into water, they can affect many different processes, including everything from biological activity and chemical reactions to corrosion. The acidity of water is measured using a pH sensor.

4.9 Alkalinity
Alkalinity refers to the ability of water to neutralize acids. The most common reason to measure the alkalinity of a water sample is to determine how much soda and lime should be added to the water to soften it. Water softening is particularly useful for reducing corrosion in boilers. Alkalinity is the sum of those components in water that tend to raise the pH toward the alkaline side of neutrality. It is measured by titration with a standard acid at a pH value of 4.5 and is usually expressed in milligrams per liter of calcium carbonate (mg/L CaCO3). Alkalinity is a measure of the buffering capacity (ability to resist changes in pH) of water, and since pH has a direct effect on living organisms as well as an indirect effect on the toxicity of some other contaminants in water, this buffering capacity is... Common substances in water that increase alkalinity are carbonates, bicarbonates, phosphates, and hydroxides. Thick limestone deposits and glaciers are good sources of carbonate storage. Lakes in such areas are usually well isolated.

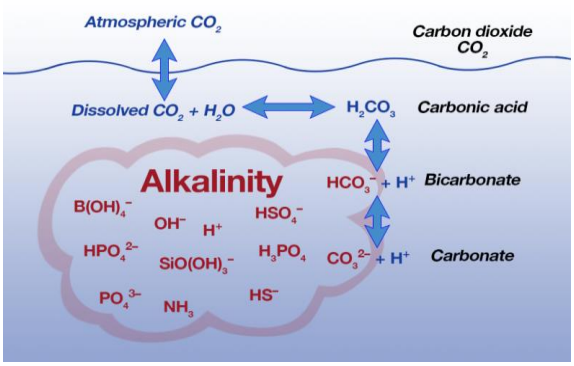

Figure 2 Alkalinity

If the water is alkaline, this means that its pH is at least greater than 7.0. The presence of bicarbonate ion, carbonate ion and hydroxide ion increases the alkalinity of the water. If you notice that your water samples have high alkalinity or acidity, this indicates that the water is contaminated in some way.

4.10 Chlorine
Although chlorine does not occur naturally in water, it is commonly added to wastewater for disinfection purposes. Although basic chlorine is a toxic gas, the aqueous solution is completely harmless to humans. If you find a small amount of chlorine in the water, this indicates that the water is basically clean and free of impurities. You can measure residual chlorine using a spectrophotometer or color comparison test kit.

4.11 Hardness
Hardness occurs when mineral levels in the water are high. If left unchecked, minerals dissolved in water can cause deposits on hot water pipes. If you bathe in water with a high mineral content, the soap you use may have trouble lathering. Water hardness is mainly due to the presence of magnesium and calcium ions, which can reach the water from rocks and soil. In most cases, the hardness of groundwater is higher than that of surface water.

4.12 Dissolved Oxygen

This is an important measure of water quality and can help you determine how polluted your rivers, lakes and streams are. When the amount of dissolved oxygen in the water is high, you can be sure that the water quality is high. Dissolved oxygen is due to the dissolution of oxygen. The amount of oxygen in water depends on a number of factors, the first of which are water salinity, pressure, and temperature. Dissolved oxygen levels can be measured by colorimetric or electrometric methods. a job. Oxygen is a dissolved gaseous form. It is necessary for the breathing of fish and other aquatic organisms.

The DO concentration in Epilimnetic water is 100% DO. It is constantly balanced with the atmospheric oxygen concentration to maintain saturation. Excessive algae growth D.O. Water can become supersaturated (more than 100% saturation) when the rate of photosynthesis exceeds the rate of diffusion of oxygen into the atmosphere. Hypokinetic D.O. Concentrations are usually low because there is no mechanism to compensate for the oxygen consumed through respiration and decomposition. Fish require at least 3-5 mg/L of dissolved water.

4.13 Biological Oxygen Demand

Microorganisms such as bacteria use organic matter as a food source. When this substance is metabolized, oxygen is consumed. If this process occurs in water, the dissolved oxygen in the water sample will be consumed. If there is a large amount of organic matter in the water, a large amount of dissolved oxygen will be consumed to ensure the decomposition of the organic matter. However, this creates problems because aquatic plants and animals need dissolved oxygen to survive.

4.14 Biological Parameters of Water

Bacteria are single-celled plants that can eat food and can reproduce quickly if the pH, food supply, and water temperature are ideal. Because bacteria can reproduce rapidly, it is almost impossible to count bacteria in a water sample. In most cases, bacteria reproduce more slowly in cold water. There are many harmful water-borne diseases that can be caused by high levels of bacteria in water, including cholera, tularemia, and typhoid.

## 5 TREATMENT PROCESSES

The collection system in the service area is a combined sewer system covering one-third of the area, while separate sewer systems cover the remaining area. Under normal operating conditions when the strong flow is less than the treatment capacity of the plant, two different main effects are directly discharged. Large particles are first removed from the untreated wastewater using screens and gravity settling vessels. The organic materials in the wastewater are then used for biological treatment (secondary treatment) via aeration. After this step, microorganisms convert ammonia into nitrate and nitrite through the process of nitrification.

## 6 SAMPLING AND ANALYSIS

The samples tested in this study were collected from two wastewater discharges: One was the bypass waste (intermittent wastewater) after the primary treatment process, and the other was from the regular treated water (continuous wastewater). Samples from bypass debris were collected during rainfall events as catch samples. The sample is pumped from the dechlorination tank to the sample bottle after the pump has been running for at least 15 minutes before sampling to remove the old volume from the pipe.

6.1 Types of Samples

There are two types of water sampling strategies regarding the time frame when the samples are collected:

6.1.1 Discrete samples

A discrete sample, also known as a grab sample, is a single sample collected in an individual container. The sample is only representative of the chemistry at the time and place where the sample was taken. The time period is usually defined as less than 15 minutes. Thus, discrete samples are appropriate when the sample composition is not time dependent.

6.1.2 Composite samples

Composite sampling consists of a series of small samples collected at a predetermined time or after a predetermined flow and mixed in a single container.

6.2 Water sampling points

These points should include points that give representative samples of conditions at the most unfavorable sources or locations in the supply system, particularly points of potential contamination, such as

loops, reservoirs, low pressure areas, ends of the system, thus, we are considering eight points for water sample collection

## 7 METHODOLOGY

Although more than 75% of the world's area is covered by water, the availability of fresh water is limited. There are places in India where people face difficulty in obtaining clean water for their daily needs. Therefore, it is important to use what we have carefully. Traditional wastewater treatment helps reduce the negative environmental and health problems resulting from it, but the quality of clean water does not reach the level of clean water. Various human activities have also created new pollutants in wastewater called emerging pollutants. Their presence poses a challenge to traditional methods of wastewater treatment. The current study examines the effectiveness of modern technology in treating wastewater

1. Screen Chamber: Remove relatively large solids to avoid wear of mechanical equipment and blockage of the hydraulic system.

2. Collection Tank: The collection tank collects the wastewater from the screening and storage room and then pumps it to the equalization tank.

3. Equalization tank: Effluents do not have the same concentration at all times; The pH will vary from time to time. The effluent is stored in equalization tanks for 8 to 12 hours which results in homogeneous mixing of the effluent and helps in equalization. This eliminates shock loading on the post-processing system. Continuous mixing also prevents solids from accumulating inside the equalization tank. SS reduces TSS.

4. Flash Mixer: Coagulants are added to the flux: 1. Lime: (800-1000 ppm) to correct the pH to 8-9 2. Alum: (200-300 ppm) to remove color 3. Polyelectrolyte: (0.2 ppm) To precipitate suspended matter and reduce SS, TSS. The addition of the above chemicals by effective rapid mixing facilitates homogeneous combination of flocculants to produce fine flocculants.

5. Clarifloculator: In the Clarifloculator, water is continuously circulated by an agitator. Surplus water is transferred to the aeration tank. Solid particles settle to the bottom, are collected separately and dried; It reduces SS, TSS. Flocculation provides slow mixing that results in the formation of large flocs, which are then ejected into the clarification area. The frozen solids, i.e. primary sludge, are pumped to the sludge drying beds. ETP plant operation

6. Aeration Tank: The water is passed as a thin layer over various ladder-shaped arrangements. Urea and DAP dosing is performed.

## 8 RESULT AND DISCUSSION

### 8.1 Physical and Chemical Parameters at Different Locations (S1 to S8)

Observations

#### 8.1.1 Physical and Chemical Parameters at Different Locations (S1 to S8)

Table 8.1 The value of Physical Parameters at Different Locations (S1 to S8)

| Sl. No. | Parameters | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | Maximum value observed |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Turbidity (NTU) | 2.4 | 3.7 | 4.2 | 3.6 | 3.2 | 2.9 | 3.1 | 3.5 | 4.2 |
| 2 | Temperature (°C) | 24.5 | 25.0 | 24.3 | 20.4 | 23.5 | 23.7 | 24.1 | 23.1 | 25.0 |

Table 8.2 The value of Chemical Parameters at Different Locations (S1 to S8)

| Sl. No. | Parameters | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | Maximum value observed |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TDS (mg/L) | 254 | 277 | 285 | 273 | 242 | 245 | 201 | 277 | 285 |
| 2 | Alkalinity (mg/L) as $CaCO_3$ | 121 | 145 | 176 | 107 | 108 | 109 | 155 | 161 | 176 |
| 3 | Hardness (mg/L) as $CaCO_3$ | 106.2 | 114.3 | 117.6 | 127.8 | 128.6 | 127.4 | 120.3 | 105.9 | 128.6 |
| 4 | Chloride as $Cl^-$ | 35.29 | 47.77 | 38.10 | 40.19 | 39.2 | 38.4 | 37.9 | 46.3 | 47.77 |
| 5 | BOD (mg $L^{-1}$) at 25.0 °C | 0.12 | 0.23 | 0.72 | 0.65 | 0.28 | 0.62 | 0.87 | 0.45 | 0.87 |
| 6 | DO (mg $L^{-1}$) at 25.0 °C | 7.4 | 8.3 | 8.1 | 8.6 | 8.5 | 8.2 | 7.9 | 7.8 | 8.6 |

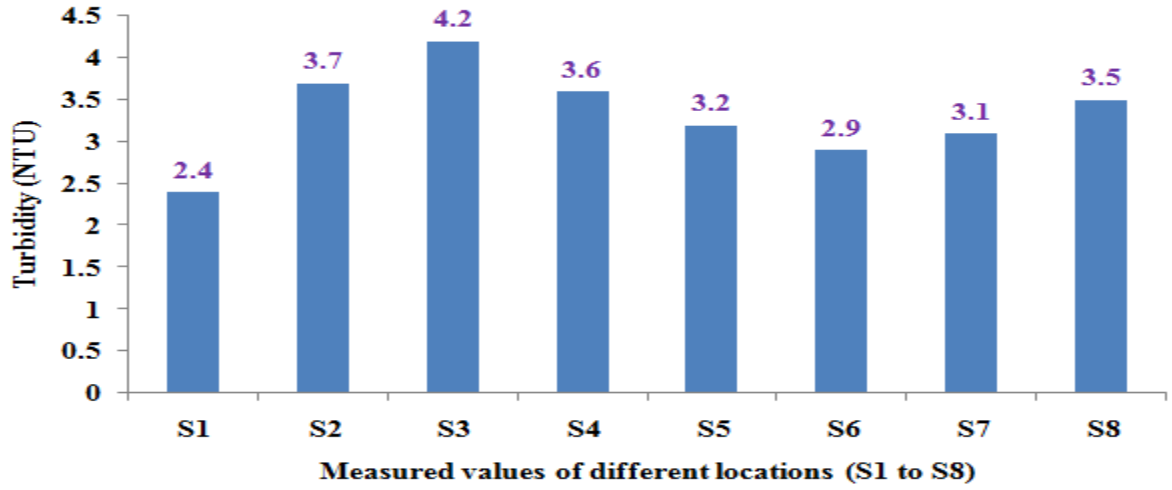


Figure 3 Measured values of Turbidity (NTU)

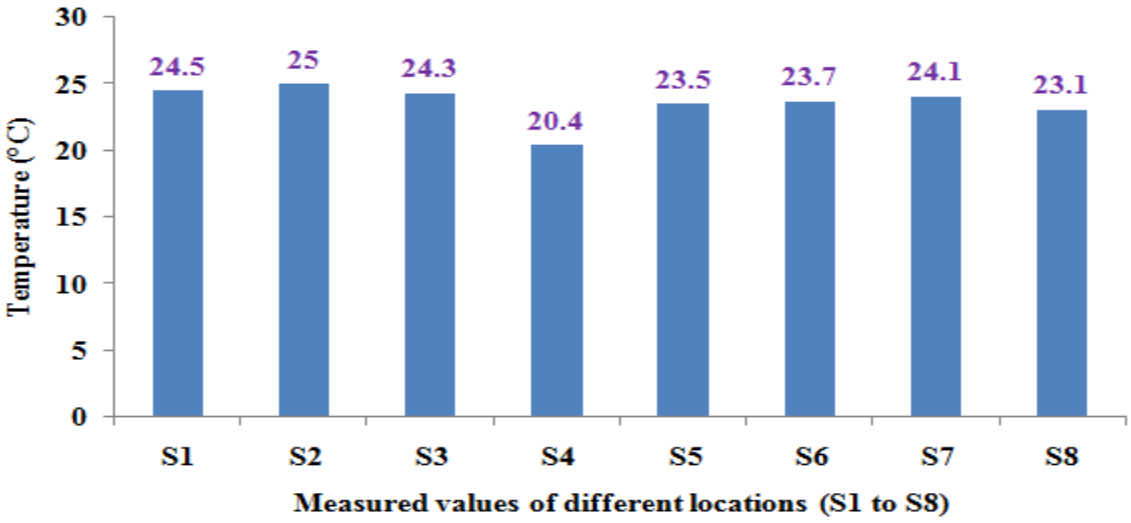


Figure 4 Measured values of Temperature (°C)

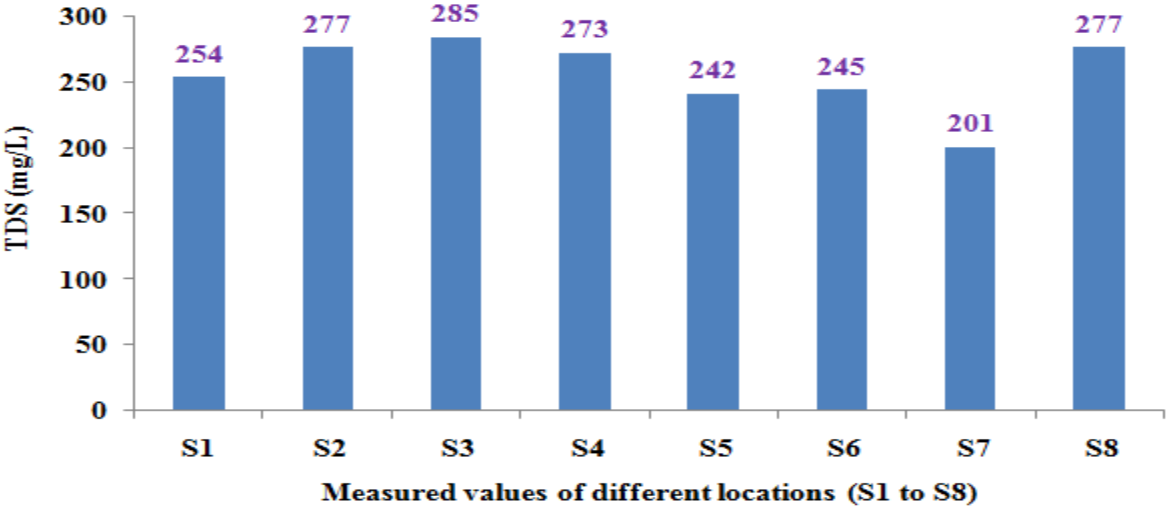


Figure 5 Measured values of TDS (mg/L)

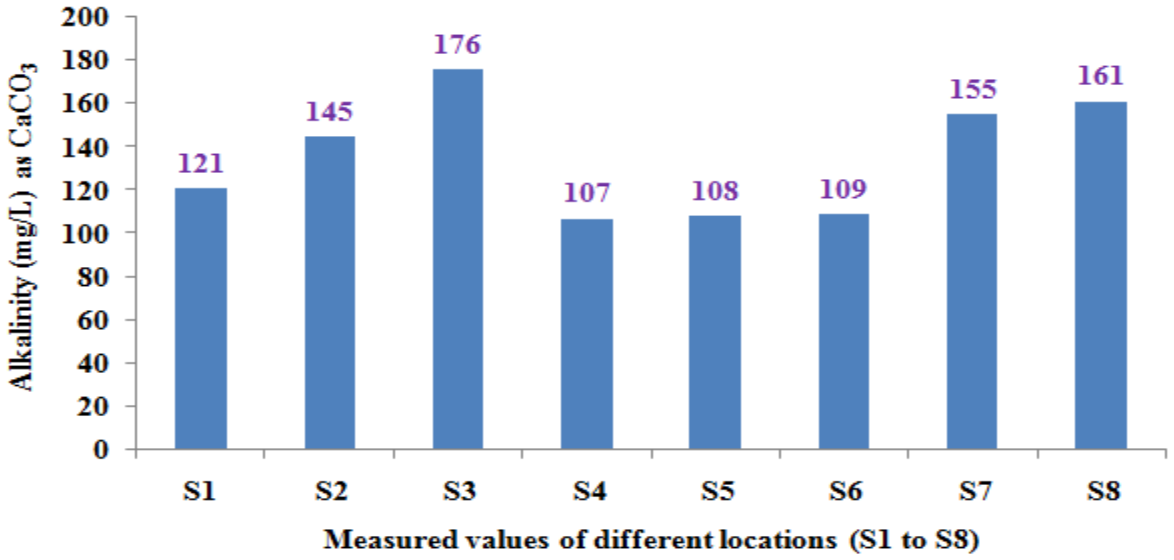


Figure 6 Measured values of Alkalinity (mg/L)

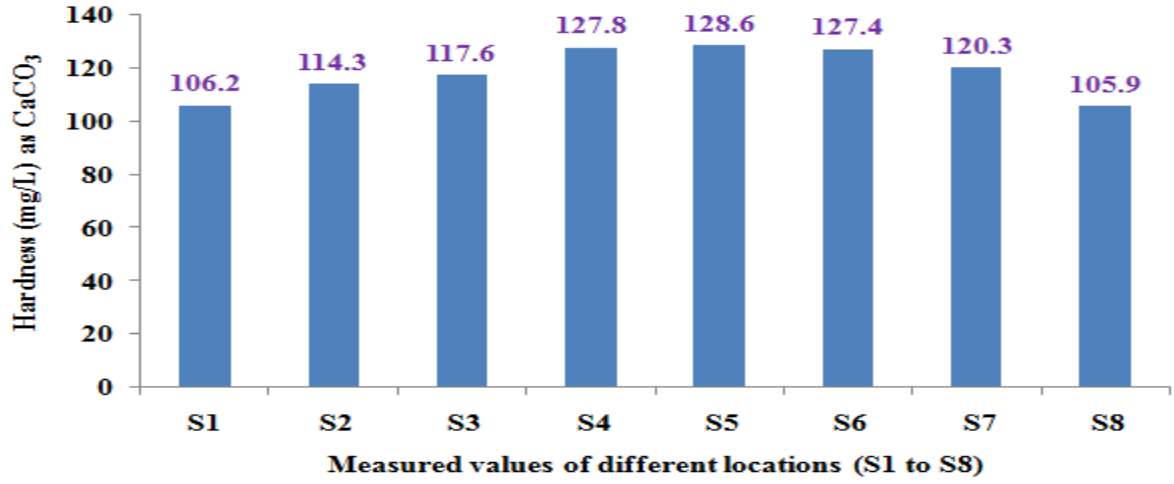


Figure 7 Measured values of Hardness

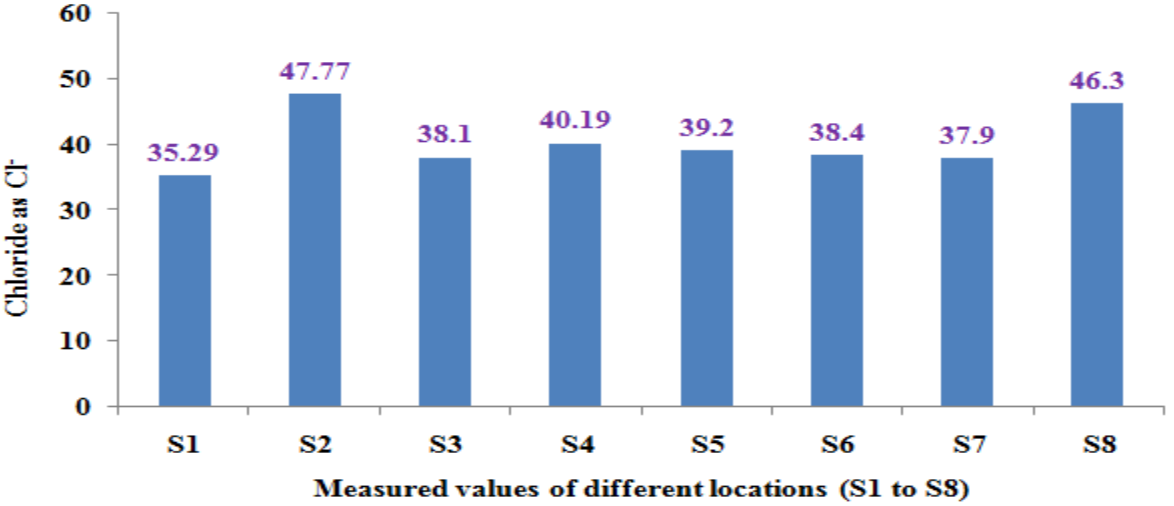


Figure 8 Measured values of Chloride

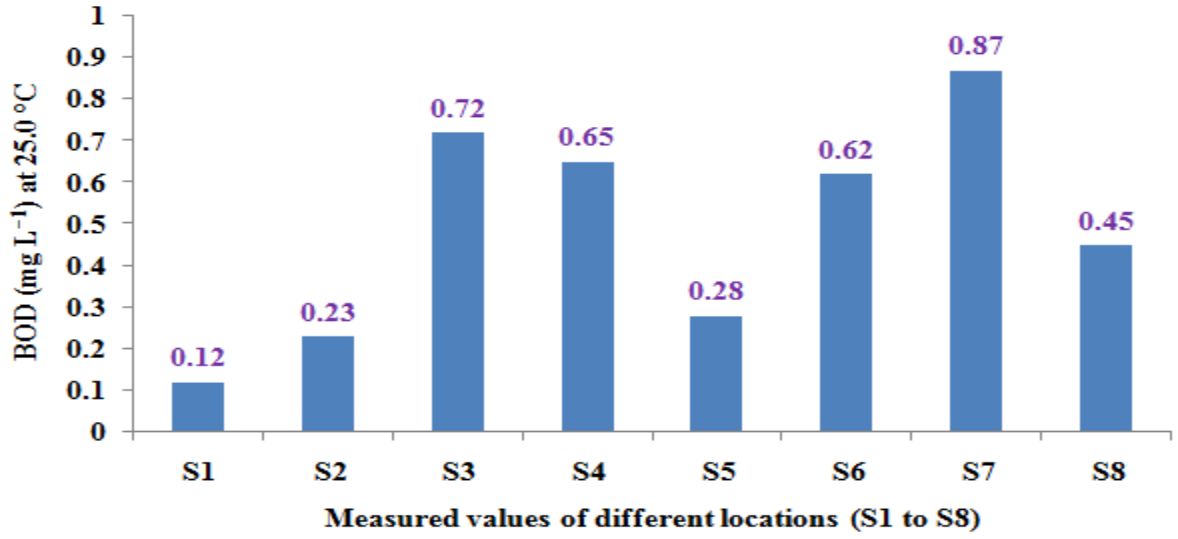


Figure 9 Measured values of BOD (mg $L^{-1}$)

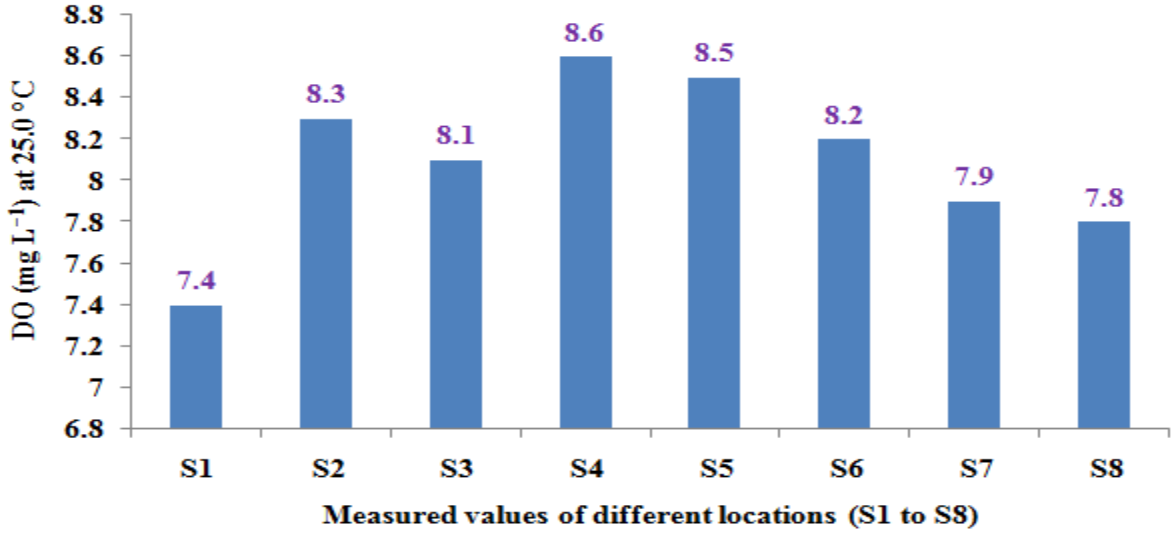


Figure 10 Measured values of DO (mg $L^{-1}$)

## 9 CONCLUSIONS

On a study for development of water quality index using parameters like Physical and Chemical Parameters was found as Turbidity (3.2 NTU), Temperature (25.0°C), TDS (256.8 mg/L), Alkalinity (126mg/L), Hardness (117.6), Chloride (40.4), BOD (0.49 mg L−1) and DO (7.9 mg L−1) , With the development of people, water is regarded as a major necessity. With the increase in population and industrialization, the demand for fresh water has increased over the past decades. This requirement is met by lake which provides water for human life and agricultural purposes.

## REFERENCE

[1] Lanouette, 1972, Removing heavy metals from wastewater Env. Sci. Tech. 6:518

[2] Huang C. P. 1977, Removal of heavy metals from industrial effluents J. Env. Eng. Division, ASCE 118 (EE6): 923-947.

[3] Loomba, K. and G. S. Pandey 1993, Selective removal of some toxic metals ions (Hg(II), pb (II) and Zn(II)) by reduction using steel plants granulated slag. Indian J. Env., Health A:20:105 112.

[4] Shrivastava, A.K., A Review on copper pollution and its removal from water bodies by pollution control Technologies, IJEP 29(6): 552-560, 2009.

[5] Journal of environmental Management, vol. 88, issue 3, August 2008, pp. 437-447.
[6] Industrial wastewater reuses potential – internet (web)
[7] Waste Management Strategies for industries.
[8] U.S. Environmental protection Agency, Design criteria for Mechanical, Electric and Fluid system and Washington, D. C.,1974.
[9] Raj kumar Agrawal and Piyush Kant Pandey, Productive recycling of basic oxygen furnace sludge in integrated steel plant. Journal of scientific and industrial Research, vol. 64, sept. 2005, pp. 702-706.
[10] B. Das, S. Prakash, P.S.R. Reddy, VN Mishra, An overview of utilization of slag and sludge from steel industries, Resources, Conservation and Recycling Vol. 50, Issue1, March 2007, pp. 40-57.
[11] Richard D. Hook, Steel Mill Sludge Recovery, Journal. Water pollution control Federation, vol.33, No. 10 (Oct. 1961) pp.1.
[12] P. K. Bhunia, M. K. Stenstrom, optimal design and operation of wastewater treatment plant, 1986.
[20] Ulf Jeppson, Modeling aspects of wastewater treatment process,
[13] M. Drolka et al., model and wastewater treatment, chem.. Biochem Eng. Q.15 (2) pp. 71-74 (2001)
[14] A. O. Ibeje, B. C. Okoro, mathematical modeling of cassava wastewater treatment using anaerobic Baffled Reactor, AJER, 2(5).2013,pp. 128-134.
[15] M. I. & Worthy, A. L., A mathematical Model for the biological treatment of industrial wastewater in a reactor cascade. CHEMECA 2011(pp. 1-11).
[16] L. D. Robescu et. al., Mathematical modeling of Sharon Biological Wastewater treatment Process, U. P. B. Sci. Bull. Series D, 74(1), 2102, pp. 229-236.
[17] Anonymous. 2004. NATP – MM project report on 'Use of Urban and Industrial Effluent in Agriculture' CSSRI, Karnal 132001, India.
[18] Bhamoriya V. 2004. Wastewater Irrigation in Vadodara, Gujarat, India: Economic Catalyst for Marginalized Communities. In: Scott CA, Faruqui NI and Raschid-Sally L. (Eds). Wastewater Use in Irrigated Agriculture: Confronting Livelihhod and Environmental Realities. CAB International in Association with IWMI: Colmbo, Sri Lanka, and IDRC: Ottawa, Canada.
[19] Billore, S.K., Singh, N., Ram, H.K., Sharma, J.K., Singh, V.P., Nelson, R.M., Dass, P. (2001). Treatment of molasses based distillery effluent in a contructed wetland in Central India. Water Science Technology. 44: 441-448.
[20] Thomas, R., Nelson, R.M., Pare, B. (2002). Treatment performance evaluation of surfactant removal from domestic wastewater in a tropical horizontal subsurface constructed wetland. In: Proceedings of the 8th International Conference on Wetland Systems for Water Pollution Control, University of Dar-es-Salaam, Tanzania and IWA, pp. 393- 399.