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Assessment of Water Quality Indices in Chouksey Group Campus Against IS: 10500 - An Analytical Study

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Abstract

This work summarizes the findings of a comprehensive water quality assessment conducted in lalkhadan bilaspur. The assessment aimed to evaluate various parameters including Temperature, Total Suspended Solids (TSS), Hardness, pH, Turbidity, Chloride, Iron, Nitrate, and Fluoride in campus water sources as well as three other sources were selected just to know the variations and for comparison between our college campus samples and other three samples. Samples were collected from multiple locations and analyzed using standard methods to assess the suitability of water for human consumption and environmental health. Results indicated that the water temperature was within acceptable ranges for human use. TSS levels were found to be low, indicating good water clarity. Hardness measurements showed moderate levels of calcium and magnesium, potentially affecting water quality but remaining within permissible limits. pH values were suitable an within the range of 6.5-8.5 as per IS:10500.2012 for drinking purpose. Turbidity levels were low, indicating minimal suspended solids, only Arpa river sample showed slightly high value than the permissible limit. Chloride concentrations were within recommended limits, posing minimal risk of salinity impacts.

Keywords : Water quality, IS:10500.2012, pH, Total Hardness, TSS, Temperature, Turbidity, Fluoride.

1. INTRODUCTION

Water is a fundamental resource essential for sustaining life and supporting ecosystems. As members of our college community, it's imperative to ensure the quality of water within our campus boundaries. This initiative aims to comprehensively assess water quality parameters within our college campus, contributing to both environmental stewardship and the well-being of our community.

All biological reactions occur in water and it is the integrated system of biological metabolic reactions in an aqueous solution that is essential for the maintenance of life. Most human activities involve the use of water in one way or other. It may be noted that man's early habitation and civilization sprang up along the banks of rivers. Although the surface of our planet is nearly 71% water, only 3% of it is fresh. Of these 3% about 75% is tied up in glaciers and polar icebergs, 24% in groundwater and 1% is available in the form of fresh water in rivers, lakes and ponds suitable for human consumption(Error! Reference source not found.).

Due to increasing industrialization on one hand and exploding population on the other, the demands of water supply have been increasing tremendously. Moreover, considerable part of this limited quality of water is polluted by sewage, industrial waste and a wide range of synthetic chemicals. Fresh water which is a precious and limited vital resource needs to be protected, conserved and used wisely by man.

Assessment of water quality can be defined as the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use. Water can be used for recreation, drinking, fisheries, agriculture or industry. Each of these designated uses has different defined chemical, physical and

biological standards necessary to fulfil the respective purpose. For example, there are stringent standards for water to be used for drinking or swimming compared to that used in agriculture or industry[1].
After many years of research, water quality standards are put in place to ensure the suitability of efficient use of water for a designated purpose. Water quality analysis is to measure the required parameters of water, following standard methods, to check whether they are in accordance with the standard. Water quality analysis is required mainly for monitoring purpose. Some importance of such assessment includes:
(i) To check whether the water quality is in compliance with the standards, and hence, suitable or not for the designated use.
(ii) To monitor the efficiency of a system, working for water quality maintenance.
(iii)To check whether upgradation / change of an existing system is required and to decide what changes should take place.
(iv)To monitor whether water quality is in compliance with rules and regulations.

2. LITERATURE REVIEW

Drinking water quality is paramount for public health. Despite improvements in recent decades, access to good quality drinking water remains a critical issue. The World Health Organization estimates that almost 10% of the population in the world do not have access to improved drinking water sources [1]. Drinking water quality is one of the greatest factors affecting human health. However, drinking water quality in many countries, especially in developing countries is not desirable and poor drinking water quality has induced many waterborne diseases. This special issue of Exposure and Health was edited to gain a better understanding of the impacts of drinking water quality on public health so that proper actions can be taken to improve the drinking water quality conditions [2]. The health troubles due to poor drinking water quality are huge. The impact of increasing developmental activities, pollution and over-exploitation are altering the distribution of safe water. Besides this, the non-uniform distribution of rainfall due to changing climatic conditions aggravated the trouble. Both point and nonpoint sources of pollution affect the drinking water quality dominantly. The lack of education and awareness among community people and students about the drinking water quality are also key issues for health problems due to the consumption of contaminated water. Therefore, the knowledge of drinking water quality including health hygiene and sanitation aspects among students and community people is an urgent need [3]. An effort has been made to comprehend the groundwater quality of Raipur city for drinking purpose utilizing Water Quality Index (WQI) and Geographic Information System (GIS) techniques. In this study thirty four groundwater samples were collected during May, 2015.This study reveals that 76% area is falling under excellent, very good and good category and 24% area is falling under poor, very poor and unfit category as per the WQI classification. The predicted accuracy of the obtained result is around 97.05% reflecting capability of adopted techniques [4].

In Bilaspur the source of disposal of municipal as well as industrial waste water is Arpa River (Non perennial) which is known as life line of Bilaspur city [5]. According, to the investigation done on Evaluation of Physico-Chemical Quality of Drinking Water in Bilaspur District of Chhattisgarh State by T.P Chandra (2014), the Physico-chemical properties of drinking water used by the public of Bilaspur district and findings reveal the fact that the drinking water of this area, especially in urban area and few patches of semi urban area of this district is not suitable for public health. So far the source of drinking water is concerned mostly tap water and hand pump water at some extant is not suitable for human society [6]. Across the city of Bilaspur, India six strategic sampling stations were collected over a period of six months-starting from March to August 2013 to evaluate the qualitative status of the groundwater of the city. Seven key diagnostic parameters were selected as indicators of the groundwater quality and these are pH, conductivity, TDS, chlorides, sulphates, nitrates and fluorides. The analysis of the results indicates that the groundwater quality is pathetic and far from the standards lay down by various international agencies [7].

❖ Limited studies address how specific factors such as campus infrastructure, population density, and land use within college campuses impact water quality parameters.
❖ With an increasing emphasis on sustainability and green practices within campuses, there is a gap in understanding how such initiatives influence water quality and treatment requirements.

❖ The physico-chemical properties of drinking water used by the public of Bilaspur district reveal the fact that the drinking water of this area, especially in urban area and few patches of semi urban area of this district is not suitable for public health. But the water quality parameters of any college campus in the region has not been analyzed making it a serious issue that should be looked into.

3. OBJECTIVE OF WORK

❖ Measure and analyze key water quality parameters including pH, turbidity, chloride, total suspended solids, hardness, nitrate, fluoride, iron across different campus water sources.
❖ Investigate the impact of water quality on the campus ecosystem and potential risks to human health and ecological balance.
❖ Based on findings, propose remedial measures and management strategies to address identified water quality challenges, integrating sustainable practices and innovative technologies wherever possible.

3. DETAILS OF SAMPLING SITES

Sampling sites for water quality assessment were selected with a focus on the accessibility, safety, and the availability of facilities for sample collection and analysis. Moreover, these sites may be utilized for drinking water, gardening, sanitation, laboratory experiments and various ongoing constructions in the campus. Samples were taken from almost every groundwater sources available in campus and also a sample from nearby Arpa river was taken due to its presence being not so far from the college campus and a sample from nearby Lalkhadan village just to analyse the groundwater parameters are same or not and also for comparison purpose tapwater samples were also taken.
Total 12 samples were taken for the assessment which were :-
a) BHMS Building (Bore)
b) EMEC Building (Bore)
c) Girls Hostel (Bore)
d) Boys Hostel (Bore)
e) Arpa River water from nearby JK college
f) School of Pharmacy (Tap)
g) School of Pharmacy (Bore)
h) Sample from Lalkhadan village (Bore)
i) CEC Main Building (Tap)
j) CEC Mahakaleshwar Temple (Bore)
k) Industry drinking water from Tifra, Industrial Area (Bore)
l) EMEC Building (Tap)

Chouksey Engineering College is located at 22.0456N latitude and 82.2072E longitude in Bilaspur district of Chhattisgarh at an elevation of 260 metres above mean sea level. It is situated on the banks of the rain-fed Arpa River, which originates from the Maikal Range of Central India. It is a dolomite rich region surrounded by dense forests in the north and the coal mines of the Hasdeo Valley in the east. Bilaspur District is surrounded by Koria District in the north, Anuppur District of Madhya Pradesh, Mungeli and, Baloda Bazar-Bhatapara District in the south and Korba and Janjgir-Champa District in the east. The climate in Bilaspur, Chhattisgarh has been colder than the Raipur region for the winters in December (minimum temperature 6 °C, 42 °F in the last week of December annually, while some areas have even reported temperature going down as low as 3-4 °C, 37 °F), which resembles northern Chhattisgarh. However most of the winter goes mild and pleasant. The city experiences moderate rains in the monsoon. The summers are relatively hot and dry, with maximum temperature 48+ °C, 113 °F. The groundwater availability in the campus area is abundant due to the presence of nearby Arpa river and also there is a Sangam or joining of two rivers Arpa and Kharung nearby. Samples from arpa river, lalkhadan village and industry was taken for the reference or comparison. However, the campus is situated at outskirts of Bilaspur it is still easily accessible.

Figure 1

Figure 2

Figure 3

Figure 1-CEC Campus, School of Pharmacy, Boys Hostel
Figure 2- Sangam of Arpa and Kharung River amd CEC Campus
Figure 3-Mahakaleshwar Temple, BHMS Building

4. WATER SAMPLING PROCEDURE AND ANALYSIS

The water samples were analyzed for various parameters in the Environment lab of civil engineering department, Chouksey Engineering College, Bilaspur and Public Health Engineering Department, Bilaspur. Various physical and chemical parameters like Temperature, pH, Turbidity, Total Suspended Solids (TSS), Hardness, Chloride, Nitrate, Fluoride, Iron have been monitored for the groundwater and tap water of different locations. Plastic bottles of 1 liter capacity were used for collecting samples. Each bottle was washed with same water and then rinsed three times with distilled water. The bottles were then preserved in a clean place. The bottles were filled leaving no air space, and then the bottle was sealed to prevent any leakage. Each container was clearly marked with the name and date of sampling. Sampling was done according to IS:3025 (PART 1):1987

a) BHMS Building (Bore)
b) EMEC Building (Bore)
c) Girls Hostel (Bore)
d) Boys Hostel (Bore)
e) Arpa River water from nearby JK college
f) School of Pharmacy (Tap)
g) School of Pharmacy (Bore)
h) Sample from Lalkhadan village (Bore)
i) CEC Main Building (Tap)
j) CEC Mahakaleshwar Temple (Bore)
k) Industry drinking water from Tifra, Industrial Area (Bore)
l) EMEC Building (Tap)

Figure 4

Figure 5

Figure 6

Figure 7

Figure 4 - Collected Samples
Figure 5 - Sample Collection from School of Pharmacy
Figure 6 - Sample Collection from Arpa River
Figure 7- Sample Collection from Mahakaleshwar Temple CEC

DRINKING WATER STANDARDS (IS:10500)

Table 1-DRINKING WATER STANDARDS

Sl No.	Parameters	Permissible value	Standard
1.	Colour	Unobjectionable	IS: 10500
2.	Taste	Agreeable	IS: 10500
3.	pH	6.5-7.5	IS: 10500
4.	Turbidity (Max NTU)	5	IS: 10500
5.	TSS	30	EPA
6.	Total Hardness	300	IS: 10500
7.	Chloride	250	IS: 10500
8.	Nitrate	45	IS: 10500
9.	Fluoride	1	IS: 10500
10.	Iron	0.3	IS: 10500

(Except pH and turbidity other parameters are in mg/l)
EPA stands for Environment Protection Agency.

Procedure

Temperature was measured with the thermometer immersed directly in the water body, after a period of time sufficient to permit constant reading. water body at a particular depth with the thermometer immersed directly in the water body. After sufficient time has elapsed to allow the thermometer to come to the exact temperature of the water, take a reading. The solids which can't survive the filtration through a filter with 2 micrometer pores are called The amount of chloride present in water can be easily determined by titrating the given water sample with silver nitrate solution. The silver nitrate reacts with chloride ion according to1 mole of AgNO3 reacts with 1 mole of chloride. The titrant concentration is generally 0.02 M. Silver chloride is precipitated quantitatively, before red silver chromate is formed. The end of titration is indicated by formation of red silver chromate from excess silver nitrate.

Chemicals Required
1. Potassium Chromate
2. Phenolphthalein Indicator
3. Sodium Chloride
4. Silver Nitrate

1. Calibration of the spectrophotometer: Set the spectrophotometer to the appropriate wavelength for nitrate determination (usually around 540 nm).Calibrate the instrument using standard nitrate solutions of known concentrations. Prepare a calibration curve by plotting absorbance versus concentration.
2. Sample preparation: Collect drinking water samples in clean, labeled containers. If necessary, filter the samples to remove any particulate matter. Adjust the pH of the samples to around 7 using NaOH or HCl solutions if required.
3. Nitrate determination: Take a small volume (e.g., 10 mL) of each water sample and standard solution into separate cuvettes. Add a few drops of sulfanilamide solution to each cuvette and mix well. After 10 minutes, add a few drops of NED solution to each cuvette and mix thoroughly. Allow the reaction to proceed for another 10 minutes. Measure the absorbance of each sample and standard solution using the spectrophotometer at the predetermined wavelength.
4. Calibration curve: Prepare a calibration curve by plotting absorbance versus concentration using the absorbance readings of the standard nitrate solutions.
5. Quantitative analysis: Use the calibration curve to determine the concentration of nitrates in each water sample based on its absorbance.
6. Perform blank determinations using deionized water to correct for any background absorbance. Repeat the analysis for each sample and standard solution in triplicate to ensure precision and accuracy.

5. RESULTS & DISCUSSION

The World Health Organization (WHO) recommends a maximum temperature of 25°C for drinking water to prevent microbial growth. However, temperature of water may vary due to climatic conditions also. It is found that the temperature of the water samples are within the permissible limit as per IS:10500. As the result shows the temperature of the tap water and bore water collected during summer season in the month of march.

Table 2: Temperature Measurement

Sr. No.	SAMPLING LOCATION	RESULT	ALLOWABLE LIMIT
1	Industry Drinking Water (Bore)	25.9 C	25.0 C
2	BHMS Building (Bore)	26.1 C	25.0 C
3	Main Building (Tap)	28.6 C	25.0 C
4	EMEC Building (Bore)	27.3 C	25.0 C
5	EMEC Building (Tap)	25.9 C	25.0 C
6	Girls Hostel (Bore)	27.6 C	25.0 C
7	Boys Hostel (Bore)	25.9 C	25.0 C
8	Pharmacy Building (Tap)	28.2 C	25.0 C
9	Pharmacy Building (Bore)	27.8 C	25.0 C
10	College Mandir (Bore)	27.3 C	25.0 C
11	Arpa River Water	25.8 C	25.0 C
12	Lalkhadan Drinking Water (Bore)	24.7 C	25.0 C

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse effect on health, however, a low value, below 4.0 will produce sour taste and higher value above 8.5 shows alkaline taste. A pH range of 6.5 – 8.5 is normally acceptable as per guidelines suggested by IS:10500.2012. In the present study, the fluctuation of pH in the samples is from 6.5 to 7.2.

CHLORIDE

In the study area chloride concentration ranged from 59.98 to 184.91 mg/l. Chloride which have been associated with pollution as an index are found below the permissible value set at 250 mg/l in most of the study area. Chloride in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high Chlorides can be subjected to laxative effects. The amount of chloride present in water can be easily determined by titrating the given water sample with silver nitrate solution.

Sr No.	SAMPLING LOCATION	RESULT	ACCEPTABLE LIMIT	PERMISSIBLE LIMIT
1	Industry Drinking Water (Bore)	139.95 mg/l	250 mg/l	1000 mg/l
2	BHMS Building (Bore)	179.94 mg/l	250 mg/l	1000 mg/l
3	Main Building (Tap)	119.96 mg/l	250 mg/l	1000 mg/l
4	EMEC Building (Bore)	184.91 mg/l	250 mg/l	1000 mg/l
5	EMEC Building (Tap)	144.95 mg/l	250 mg/l	1000 mg/l
6	Girls Hostel (Bore)	104.95 mg/l	250 mg/l	1000 mg/l
7	Boys Hostel (Bore)	114.96 mg/l	250 mg/l	1000 mg/l
8	Pharmacy Building (Tap)	134.95 mg/l	250 mg/l	1000 mg/l
9	Pharmacy Building (Bore)	144.95 mg/l	250 mg/l	1000 mg/l
10	College Mandir (Bore)	154.95 mg/l	250 mg/l	1000 mg/l
11	Arpa River Water	59.98 mg/l	250 mg/l	1000 mg/l
12	Lalkhadan Drinking Water (Bore)	164.94 mg/l	250 mg/l	1000 mg/l

Table 3: Chloride Result

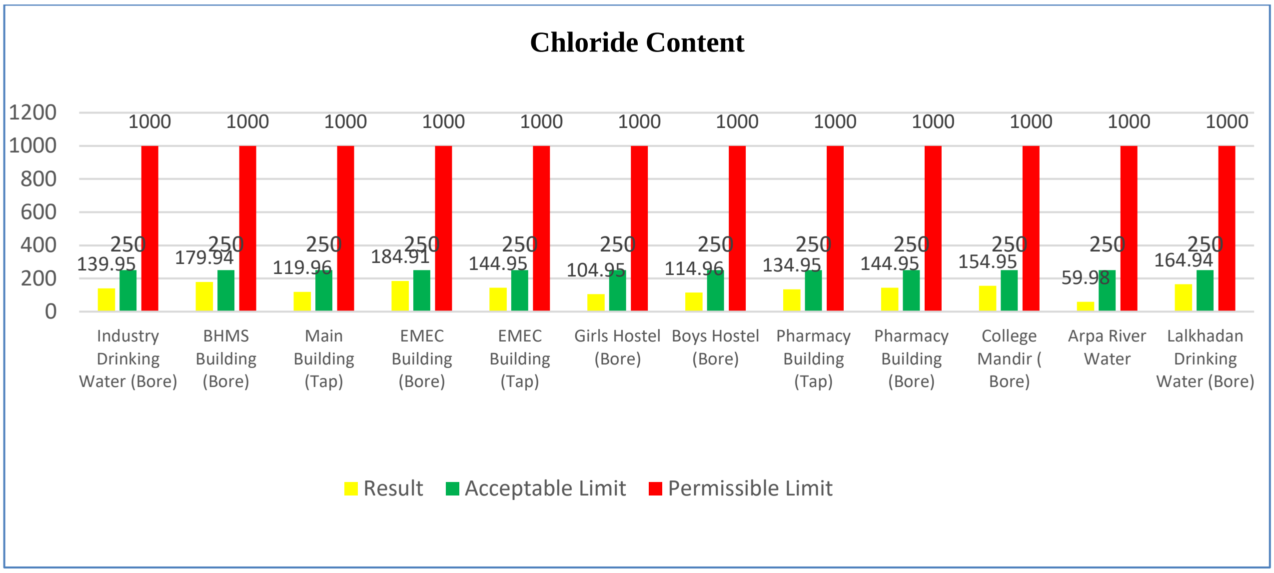

Chart 1

TURBIDITY

Turbidity is the measure of water clarity or the degree to which suspended particles in water decrease the passage of light through the water column. It is measured in (NTU-Nephelometric Turbidity Units). The assessment of turbidity in the water samples revealed varying levels across the sampled sites, with turbidity values ranging from 1.5 NTU to 8 NTU. These findings indicate fluctuations in water clarity, possibly influenced by seasonal variations, precipitation events, or nearby land-use activities. While most of the measured turbidity values are within permissible limits for drinking water (typically below 5 NTU) as per IS:10500.2012.

Sr. No.	SAMPLING LOCATION	RESULT	PERMISSIBLE LIMIT
1	Industry Drinking Water (Bore)	1.8 NTU	5 NTU
2	BHMS Building (Bore)	1.6 NTU	5 NTU
3	Main Building (Tap)	1.9 NTU	5 NTU
4	EMEC Building (Bore)	1.7 NTU	5 NTU
5	EMEC Building (Tap)	2 NTU	5 NTU
6	Girls Hostel (Bore)	1.8 NTU	5 NTU
7	Boys Hostel (Bore)	1.7 NTU	5 NTU
8	Pharmacy Building (Tap)	2 NTU	5 NTU
9	Pharmacy Building (Bore)	1.5 NTU	5 NTU
10	College Mandir (Bore)	1.6 NTU	5 NTU
11	Arpa River Water	8 NTU	5 NTU
12	Lalkhadan Drinking Water (Bore)	1.5 NTU	5 NTU

Table 4: Turbidity Measurement

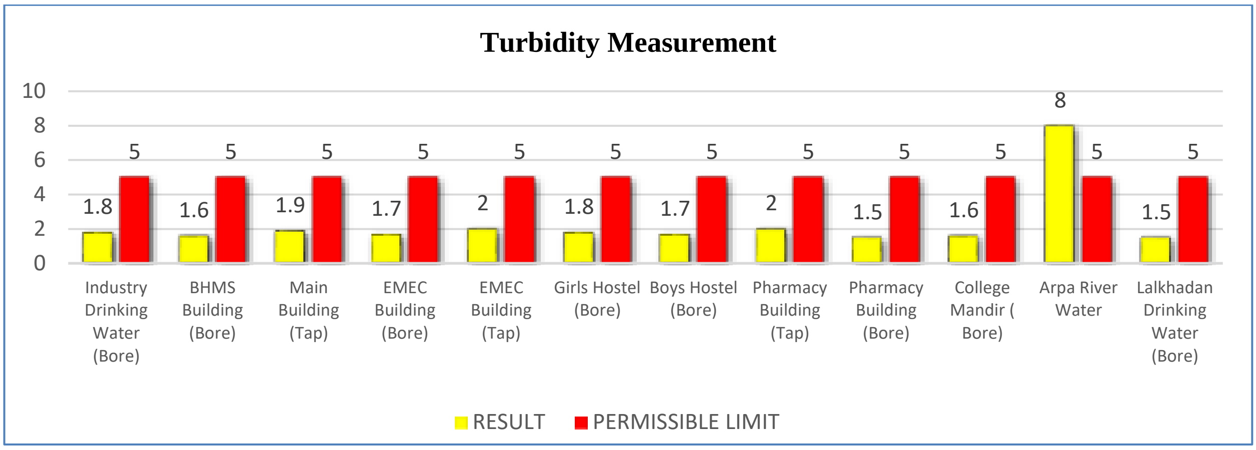

Chart 2

5. COMBINED RESULTS CHART

Analysis of Nitrate, Iron, Fluoride for Arpa River Water was skipped as we found that the water was not suitable for drinking purpose, also the turbidity and microbials present in the water sample can be seen with naked eye making it unsuitable for drinking purpose and also we got these three tests analysed from Public Health department (PHED), Bilaspur and they have a policy of testing only drinking water samples making us skip the particular water sample**.**

S1 -- BHMS Building (Bore) / (CL Chouksey Homeopathy College, Lalkhadan Bilaspur)
S2 -- EMEC Building (Bore) / (Chouksey Engineering College, Lalkhadan, Bilaspur)
S3 -- Girls Hostel (Bore) / (Chouksey Engineering College, Lalkhadan, Bilaspur)
S4 -- Boys Hostel (Bore) / (Maheshwar Boys Hostel, CEC, Lalkhadan, Bilaspur)
S5 -- CEC Mahakaleshwar Mandir (Bore) (CEC , Lalkhadan, Bilaspur)
S6 -- School of Pharmacy (Bore) / (Chouksey Pharmacy College, Lalkhadan, Bilaspur)
S7 -- Drinking Water Sample (Bore) from a house in (Lalkhadan village, Bilaspur)
S8 -- Tifra Industrial Area drinking water (Bore) (Tifra, Bilaspur)
S9 -- School of Pharmacy (Tap) / (Chouksey Pharmacy College, Lalkhadan, Bilaspur)
S10 -- CEC Main Building (Tap) / (Chouksey Engineering College, Lalkhadan, Bilaspur)
S11 -- EMEC Building (Tap) / (Chouksey Engineering College, Lalkhadan, Bilaspur)
S12 -- Arpa River Water, Bilaspur

Sr.No.	**Parameters**	**Unit**	**Desirable Limit**	**Permissible Limit**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**
1	Temperature	^oC	-	-	26.1	27.3	27.6	25.9	27.3	27.8	24.7	25.9	28.2	28.6	25.9	25.8
2	pH	pH	6.5	8.5	7.1	7	6.9	7	7	7.1	7.1	7.2	7.2	7	7.1	6.7
3	TSS	Mg/l	5	5	1.25	0.75	2.45	1.75	2.5	0.51	0.7	1.8	0.85	1.75	2.1	2.9
4	Chloride	Mg/l	250	1000	179.94	184.91	104.95	114.96	154.95	144.95	164.94	139.95	134.95	119.96	144.95	59.98
5	Turbidity	NTU	-	5	1.6	1.7	1.8	1.7	1.6	1.5	1.5	1.8	2	1.9	2	8
6	Total Hardness	Mg/l	200	600	290	305	315	295	315	335	225	200	300	395	315	150
7	Nitrate	Mg/l	45	45	2.45	2.96	2.70	1.91	3.92	7.91	1.99	12.98	8.04	2.29	2.94	-
8	Iron	Mg/l	0.1	0.3	0.25	0.21	0.22	0.21	0.23	0.24	0.25	0.24	0.24	0.23	0.21	-
9	Fluoride	Mg/l	1.0	1.5	0.151	0.148	0.144	0.123	0.136	0.125	0.122	0.174	0.145	0.128	0.144	-

6. CONCLUSION

The water assessment conducted across the college campus provided a comprehensive understanding of various key parameters influencing water quality.

- Temperature measurements ranged between **24.7**°C and **28.2**°C, reflecting typical seasonal variations. Temperature measurement was done in the month of march.
- Total suspended solids (TSS) concentrations ranged from **0.7** mg/L to **2.9** mg/L, with localized areas showing elevated levels possibly due to runoff from construction or landscaping activities. Managing sources of sedimentation will be important to maintain water clarity.
- The pH values of the water samples fell within a neutral to slightly alkaline range (pH **6.5** to **8.5**), which is favorable for aquatic ecosystems and indicates balanced water chemistry.
- Turbidity levels varied from **1.5** NTU to **8** NTU, with higher readings indicating potential sedimentation issues or infrastructure disturbances. Addressing these localized problems will be crucial for ensuring visually clear and aesthetically pleasing water.

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