

# Assessment of Drinking Water Quality in Gorakhpur

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**Abstract**—Assessment of drinking water quality played a important role to ensure public health and sustainable urban development. This study assesses the physicochemical characteristics of drinking water at fourteen locations in Gorakhpur, Uttar Pradesh, including Nauka Vihar(S1), Taramandal(S2), Nausad(S3), Awas Vikas Colony(S4), Golghar(S5), Betiahata(S6), Rustampur(S7), Transport Nagar(S8), Railway Station(S9), BRD Medical College(S10), Krishi Vidyalaya(S11), City Hospital(S12), Passport Office(S13), and Gida(S14). Locations are divided into four area such as Residential Area (S1to S4), Commercial Area (S5 to S9), Institutional Area (S10 to S13) and Industrial Area (S14). The Key parameters analyzed were pH, Total Dissolved Solids (TDS), and Electrical Conductivity (EC), Alkalinity and Hardness. The observed pH values are from 7.65 to 8.64, indicating slightly alkaline water, with a few samples exceeding the BIS/WHO recommended upper limit of 8.5. TDS values varied between 185 mg/L and 519 mg/L; while most samples were within the acceptable limit of 500 mg/L, certain locations showed marginal exceedance. EC values are from 376 to 998  $\mu$ S/cm, with some samples crossing the desirable WHO range of 200–800  $\mu$ S/cm, suggesting higher ionic concentration. Hardness varies from 130 mg/L to 363 mg/L, while Alkalinity range from 89 mg/L to 255 mg/L. Most of the sample fall within permissible limits prescribed by BIS (Bureau of Indian Standard) and WHO (World Health Organisation). Overall analysis indicates that while the majority of water samples are within permissible limits, some locations exhibit deviations that may affect potability and long-term health. This study highlights the need for regular monitoring and appropriate treatment measures to ensure safe drinking water supply in Gorakhpur.

**Index Terms**—Alkalinity, EC, Hardness, TDS, etc.

## I. INTRODUCTION

Safe and potable drinking water is a basic requirement for human health and socio-economic development. Rapid urbanization, population growth, and unplanned infrastructure expansion have significantly impacted the quality of water resources in many Indian cities, including Gorakhpur, Uttar Pradesh. Groundwater is the primary source of drinking water in this region, 78 % of the earth surface contain water still it is limited for human use.

Water quality assessment involves the analysis of key physicochemical parameters that determine its suitability for drinking purposes. Among these, pH indicates the acidic or alkaline nature of water, Total Dissolved Solids (TDS) reflect the concentration of dissolved inorganic and organic substances, Electrical Conductivity (EC) provides an estimate of ionic content, Hardness reflect the concentration of dissolved multivalent cations, and Alkalinity reflects the water capacity to neutralize acids. These parameters are widely used due to their reliability in indicating overall water quality and their direct relevance to health standards prescribed by organizations such as the Bureau of Indian Standards (BIS) and the World Health Organization (WHO). Gorakhpur, being a rapidly developing urban center, faces challenges related to water quality management due to increasing anthropogenic pressures. Variations in water quality across different locations gives the idea of systematic monitoring and evaluation. In this context, the present study aims to assess the drinking water quality at multiple sites within Gorakhpur by

analyzing pH, TDS, EC, Hardness and Alkalinity values, and comparing the results with standard permissible limits.

## II. OBJECTIVE

To assess the quality of drinking water collected from different area of Gorakhpur.

It evaluates area-wide variations in water quality and give idea about whether it is good for human health.

## III. MATERIALS AND METHODOLOGY

The study was conducted in Gorakhpur, Uttar Pradesh, along the bank of Rapti river in purvanchal region with geographical coordinates approximately 26.76° N latitude and 83.37° E longitude. Fourteen representative sampling locations were choosed across residential, commercial, and institutional areas to obtain a comprehensive assessment of drinking water quality.

Area wise distribution of location are:-

Residential Area

- Nauka Vihar (S1)
- Taramandal (S2)
- Nausad (S3)
- Awas Vikas Colony (S4)

Commercial Area

- Golghar (S5)
- Betiahata (S6)
- Rustampur (S7)
- TransportNagar(S8)
- Railway Station (S9)

Institutional Area

- BRD Medical College (S10)
- Krishi Vidyalaya (S11)
- City Hospital (S12)
- Passport Office (S13)

Industrial Area

- Gida (S14).

Sample Collection

Water samples were collected from hand pumps and tap sources commonly used for drinking purposes. Clean, pre-washed polyethylene bottles of 1-liter capacity were used for sampling. Prior to collection, bottles were rinsed with the respective water sample

to avoid contamination. Samples were collected following standard procedures, ensuring minimal exposure to air and external impurities. Every sample marked properly.

The physicochemical parameters selected for analysis were:

- 1.Power of Hydogen(pH)
- 2.Total Dissolved Solids (TDS)
- 3.Electrical Conductivity (EC)
- 4.Hardness
- 5.Alkalinity

These parameters were chosen due to their significance in determining the suitability of water for drinking purposes. PH Measurement: pH was measured using a calibrated digital pH meter. The instrument was standardized using buffer solutions of known pH values before measurement. TDS Measurement: TDS was determined using a digital TDS meter, which provides readings in mg/L (ppm). Electrical Conductivity (EC): EC was measured using a conductivity meter and expressed in  $\mu\text{S}/\text{cm}$ . Hardness: It is due to  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions. These ions form stable complexes with EDTA and Eriochrome Black T (EBT) indicator form a wine-red complex with metal ions, which turns blue when all ions are complexed by EDTA. Alkalinity: It is due to  $\text{OH}^-$ ,  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$  ions. It is determined by titration with standard acid using indicators to detect. All measurements were carried out at room temperature, and instruments were calibrated prior to use to ensure accuracy and reliability of results. Standards for Comparison The obtained values were compared with the permissible limits prescribed by the Bureau of Indian Standards (BIS) and the World Health Organisation (WHO).

Table no. 1 Drinking Water Quality Parameters

S.No.	Parameters	BIS/WHO Standard
1.	Ph	6.5 -8.5
2.	TDS	<500 mg/L
3.	EC	200-800 $\mu\text{S}/\text{cm}$ (as per WHO)
4.	Hardness	300
5.	Alkalinity	200

## IV. RESULTS AND DISCUSSION

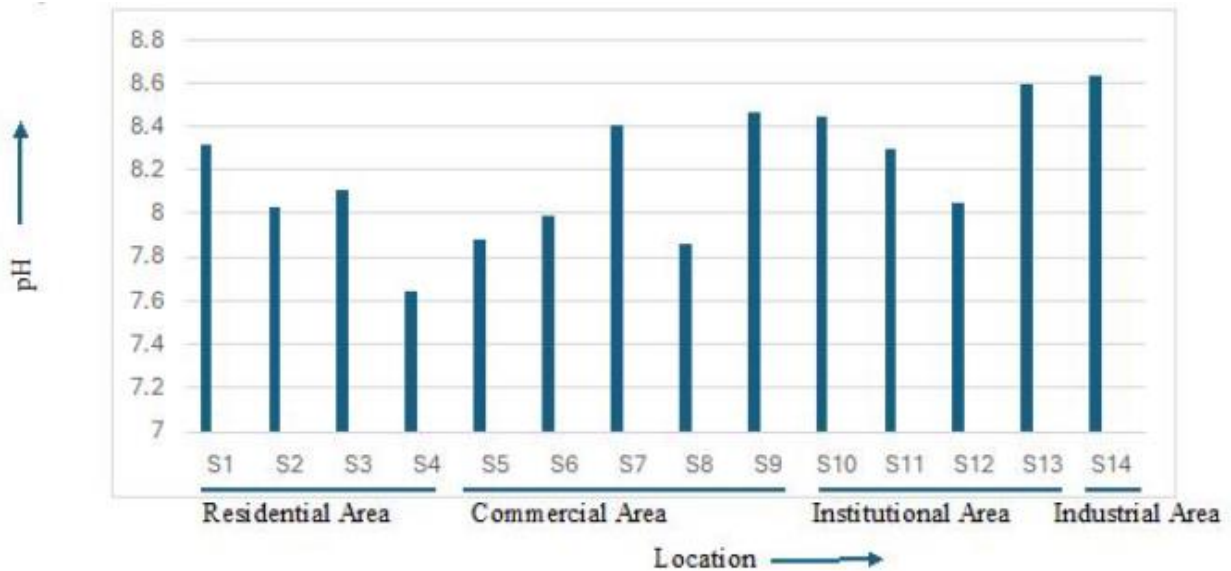
Table no. 2 Results

S.No.	Location	ph	TDS(in PPM)	EC ( in $\mu\text{S}/\text{cm}$ )	Hardness (mg/L)	Alkanity (mg/L)
1.	Nauka Vihar(S1)	8.32	353	688	249	181
2.	Taramandal(S2)	8.03	292	584	205	117
3.	Nausad(S3)	8.11	499	998	349	255
4.	Awas Vikas Colony(S4)	7.65	349	698	244	140
5.	Golghar(S5)	7.88	519	688	363	208
6.	Betiahata(S6)	7.99	483	584	332	193
7.	Rustampur(S7)	8.41	344	998	241	138
8.	Transportnagar(S8)	7.86	298	698	209	119
9.	Railway Station(S9)	8.47	312	688	218	125
10.	BRD Medical College(S10)	8.45	269	538	190	108
11.	Krishi Vidyalaya(S11)	8.3	185	376	130	95
12.	City Hospital(S12)	8.05	438	876	307	175
13.	Passport Office(S13)	8.6	218	444	153	89
14.	Gida(S14)	8.64	273	546	189	109

The results indicate that across all the locations the pH value ranges from 7.66 to 8.64, which exist between the BIS range but at some location like Passport office, GIDA, and Railway station slightly exceed the permissible limit which is in alkaline in nature. TDS varies from 185 to 519 mg/L which is under desirable limit except some location like Golghar (519 mg/L) and Nausad (499 mg/L) indicate high dissolved solid but it still in permissible because the maximum permissible limit for TDS are 2000 mg/L. Electrical Conductivity ranges between 376 to 998  $\mu\text{S}/\text{cm}$ . High EC is at Nausad and Rustampur which indicates high ionic concentration. Total Hardness ranges from 130

to 363 mg/L but for the desirable limit is 200 mg/L, many location exceed it but remain within permissible limit which is 600 mg/L like Golghar, Betiahata, Nausad, and City Hospital show relatively hard water. The Alkalinity lies in between 89 to 255 mg/L, many samples are within the desirable limit which is 200 mg/L though Nausad and Golghar exceed minely which show higher bicarbonate presence. Overall assessment is that water quality is generally acceptable for drinking after basic treatment but Hardness and Alkalinity are moderately high at several location, few location show minimal high pH which indicate the need for softening before use.

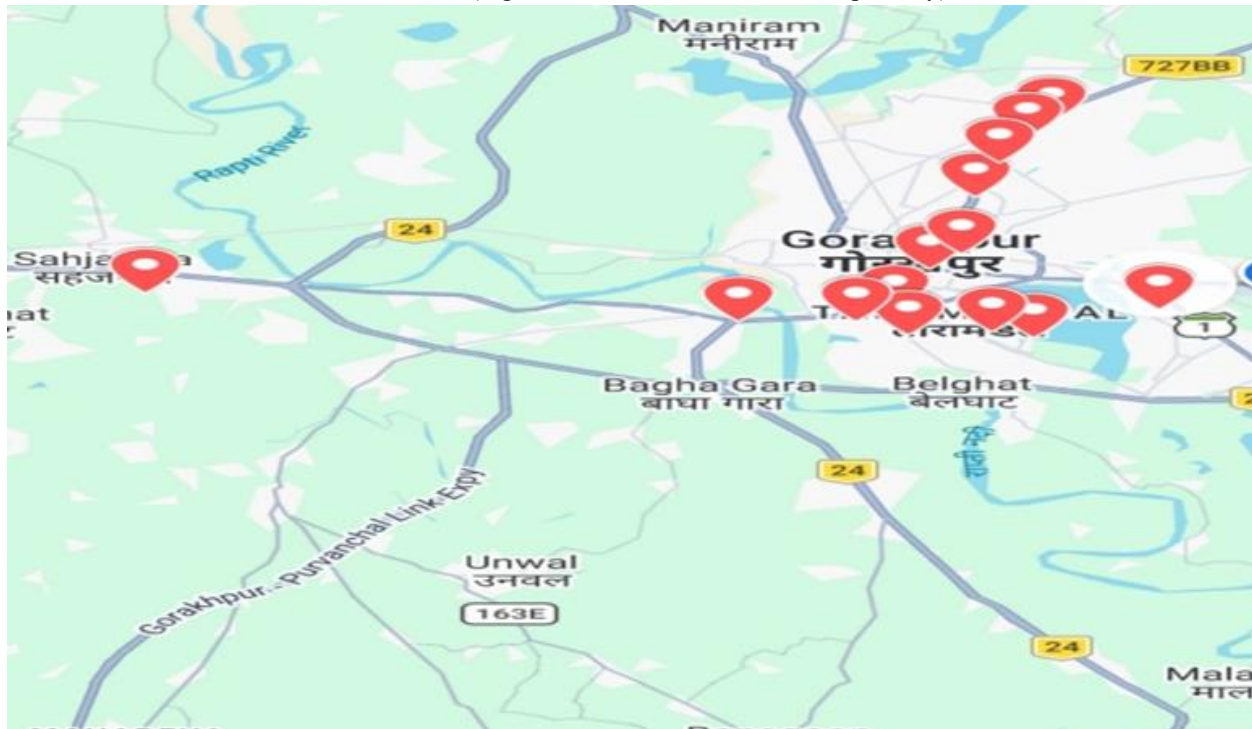
Graph 1. Ph vs Location



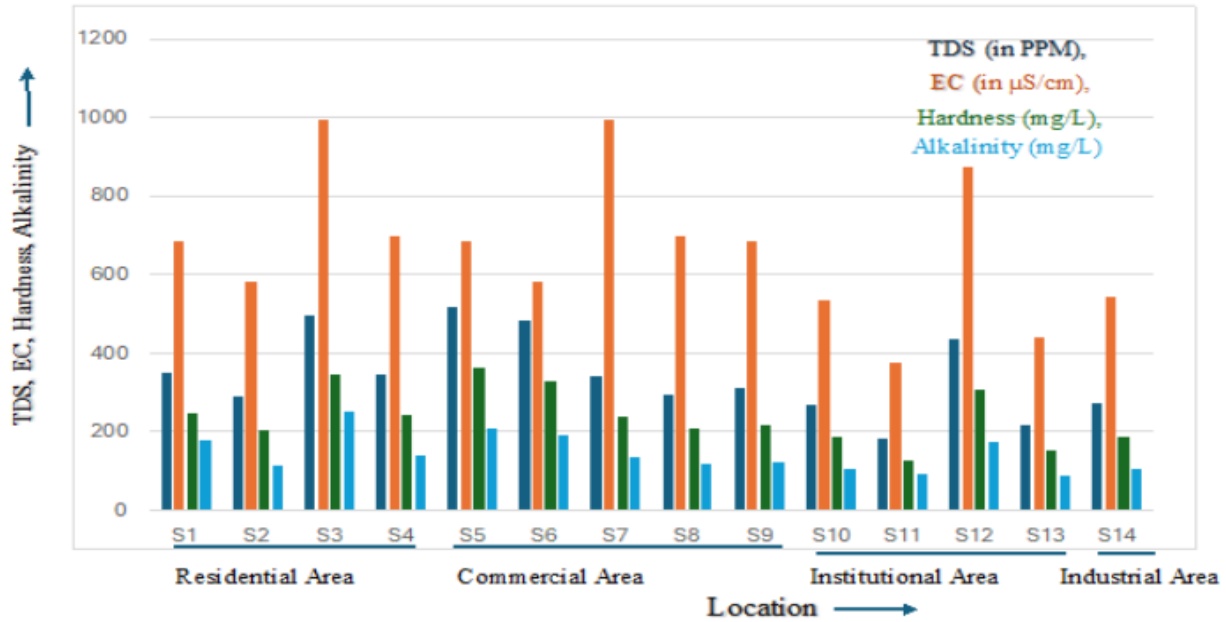
The Graph 1. Gives the relationship between the pH and various area-wise location like Residential, Commercial, Institutional, and Industrial area. Industrial area like Gida have highest pH due to urban runoff, domestic wastewater infiltration and possible alkaline industrial influence. S4 (Awas Vikas Colony) have less pH from all the locations which is 7.65, Most

of the location have acceptable value except few places like Gida which is slightly more. Residential location generally shows low pH value compared to Industrial areas. Water quality with respect to acidity/alkalinity, showing alkaline nature and no significant risk.

MAP STUDY (Figure of research location Gorakhpur City)

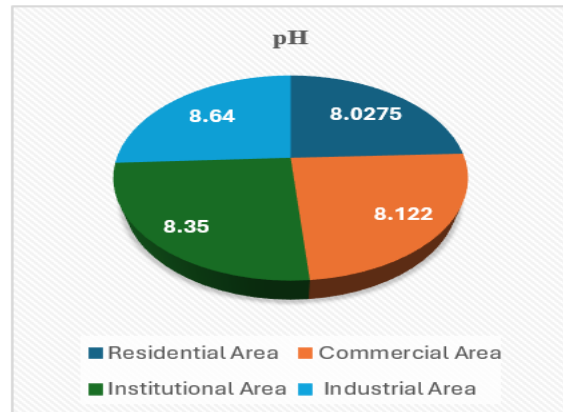


Graph 2. TDS (in PPM), EC (in  $\mu\text{S}/\text{cm}$ ), Hardness (mg/L) and Alkalinity (mg/L) vs Location



Graph 2. Gives the relationship between TDS, EC, Hardness and Alkalinity with the location. S1 to S4 are in Residential area in which the TDS high in Naushad (S3), EC are higher in Naushad (S3), Hardness are also high in S3 and Alkalinity also high in S3. From S5 to S9 are in Commercial area in which the Golghar (S5) has high TDS that is 688, EC are high in Rustampur (S7), Hardness is high in Golghar(S5) and Alkalinity are also high in Golghar (S5). From S10 to S13 came under Institutional area in which the TDS are high in City Hospital (S12), EC are high in City Hospital(S12), Hardness are high in S12 and Alkalinity are high in S12. Gida (S14) have TDS, EC, Hardness, Alkalinity value 273, 546, 189, and 109 respectively. All the data have desirable limit except some places. That location which has TDS high mean they have high dissolved salts and mineral content, which have high EC indicates higher ionic concentration in groundwater, which have high Hardness mean it indicates presence of Calcium and Magnesium salts and those have high Alkalinity mean carbonate and bicarbonate dominance.

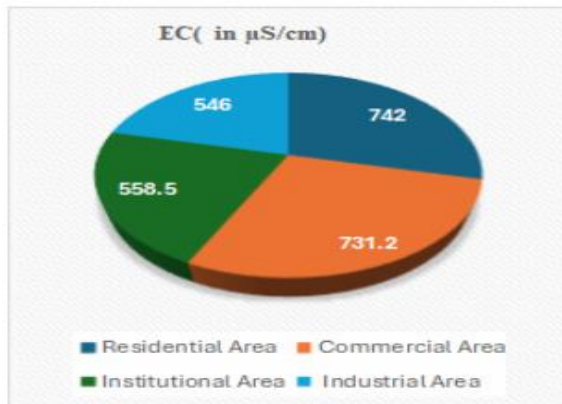
Pie Chart 1. pH



Pie Chart 2. TDS



Pie Chart 3. EC



The Pie Chart 2. Represent the average Total dissolved solid distribution over area wise categories, in these Commercial areas have highest TDS which is due to higher concentration of dissolved salts due to dense market waste, still it is desirable limit.

Commercial area > Residential area > Institutional area > Industrial area

The Pie Chart 3. Shows the average Electrical Conductivity distribution over area wise categories, in this Residential area have high EC due to high concentration of dissolved ions due to domestic wastewater seepage.

Residential area > Commercial area > Institutional area > Industrial area

The Pie Chart 4. Shows the average Total Hardness distribution over area wise category, in this Commercial area have highest Hardness which is due to strong presence of Calcium and Magnesium salts.

Commercial area > Residential area > Institutional area > Industrial area

The pie chart 5. Shows the average Alkalinity distribution over area wise category, in this Residential area have high alkalinity due to presence of bicarbonates and carbonates from domestic wastewater, detergents, and soil interaction.

Residential area > Commercial area > Institutional area > Industrial area

Pie Chart 4. Hardness



Pie Chart 5. Alkalinity



The Pie Chart 1. indicate average pH distribution over area wise categories, in this the Industrial area has highest ph due to industrial discharge and alkaline soil. All samples lie within acceptable limit except industrial area.

Industrial area > Institutional area > Commercial Area > Residential area

## V. CONCLUSION

The Drinking Water Quality assessment based on PH, TDS, EC, Hardness and Alkalinity across area wise shows clear spatial variation influenced by human activities. Groundwater in this study is slightly alkaline in nature. The industrial area shows high ph indicating possibility of alkaline effluents.

The analysis of TDS and EC reveals that commercial and residential area have high dissolved solids and ionic concentration due to urbanization, domestic waste water seepage and surface runoff.

The Hardness results indicate groundwater in residential and commercial falls in the hard water category, Alkalinity shows minimal high in residential and commercial area.

Most of the water samples fall under the drinking water standards except some area which shows minimal differences with the acceptable limit. This

study highlights the significant role of land use practices in controlling water quality and emphasize for regular monitoring and proper management.

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