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## Physico-Chemical Analysis of Ground Water

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**ABSTRACT:** Ground water samples were collected from different locations (Toopran, Tellapur, Praganyapur, Lingampally, Kompally) of Telangana State. These water samples were analyzed for their physico-chemical characteristics. Laboratory analyses on samples were performed for pH, Colour, Odour, Hardness, Chloride, Alkalinity, Total Dissolved Solids (TDS) and others. On comparing the results against drinking water quality standards laid by Indian water quality index and World Health Organization (WHO), it was found that some of the samples were non-potable for human consumption due to high concentrations of some of the parameters determined. An attempt was made to find out whether the quality of ground water in the areas of study is suitable for human consumption or not. DBPs (Disinfection by products) analysis is required to corroborate the present study.

**KEYWORDS:** Ground Water, Physico-Chemical Characteristics, Water Quality Index.

### I. INTRODUCTION

Water is considered absolutely essential to sustain life. In India ground water has a major role to satisfy the needs of domestic and agriculture purposes. The ever growing demands for water resources coupled with the rate at which much of the earth's fresh water being adversely affected by human activities demonstrate a developing crisis and horrible future if environmental water resources are not appropriately managed. The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Ground water occurs in weathered portion, along the joints and fractures of the rocks. In fact, industrial waste and the municipal solid waste have emerged as one of the leading causes of pollution of surface and ground water.

The objective of present work is to study the pollution level of Ground water and collected water samples were analysed for physio-chemical parameters and evaluate the temporal and spatial variations of water quality at all collecting points and checking quality of water and its pollution extent on basis of Physical, Chemical and Biological parameters.

Groundwater is a finite, renewable yet vulnerable natural resource catering to needs of multiple stakeholders for a range of purposes such as domestic water supply. People who are not researchers are most likely to intersect environmental science in the context of protecting or restoring a place or species about which they are concerned, or in the context of pollution trying to understand the sources and effects of contaminants, or trying to prevent or remediate environmental contamination.

### II. LITERATURE REVIEW

Groundwater is an important source of water supply for municipalities, agriculture and industry. Therefore the capability to predict the behaviour of chemical contaminates in flowing groundwater is of vital importance for a) the reliable assessment of hazardous or risks arising from groundwater contamination problems, and b) the design of efficient and effective techniques to mitigate them. There are several studies reported in this filed. Reliable and quantitative prediction of contaminant movement can be made only if we understand the processes controlling the transport of contaminants. These include a) advection, b) hydrodynamic dispersion and c) physical, chemical and biological reactions that affect their soluble concentrations in groundwater.

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Water quality standards are needed to determine whether ground water of a certain quality is suitable for its intended use. Guidelines for Drinking Water Quality have been published by IS: 10500- 2012. For Drinking water, quality is commonly expressed by classes of relative Suitability, although most classification systems include units on specific conductance, sodium content and boron concentration. Substances that naturally occur in ground water and problems caused due to their presence are given in Table 1.

WQI (water quality index) is an important technique for demarcating groundwater quality and its suitability for drinking purpose. It is computed to reduce the large amount of water quality data to a mere numerical value that expresses the overall water quality at a certain location and time based on several water quality parameters. In this index a mathematical equation used to transform large number of water quality data into a single number which is simple and easy to understandable for decision makers about quality and possible uses of any water body. It serves as the understanding of water quality for the possible uses by integrating complex data and generating a score that describes water quality status.

Table 1: List of Substances Found Naturally in Some Ground Waters Which Cause Problems in Operating Wells

S. No.	Substance	Types of problems
1	Iron( $\text{Fe}^{+2}, \text{Fe}^{+3}$ )	Encrustation, staining of laundry and toilet fixtures
2	Manganese ( $\text{Mn}^{-2}$ )	Encrustation, staining of laundry and toilet fixtures
3	Silica ( $\text{SiO}_2$ )	Encrustation
4	Chloride ( $\text{Cl}^-$ )	Portability, Corrosiveness
5	Fluoride ( $\text{F}^-$ )	Fluorosis
6	Nitrate ( $\text{NO}_3^-$ )	Methemoglobinemia
7	Sulphate ( $\text{SO}_4^{-2}$ )	Portability
8	Dissolved Gases	Corrosiveness
9	Dissolved Oxygen	Corrosiveness
10	Hydrogen Sulphide ( $\text{H}_2\text{S}$ )	Corrosiveness
11	Carbon dioxide ( $\text{CO}_2$ )	Corrosiveness
12	Radio Nuclides Portability	Portability
13	Minor Constituents	Portability, Health aspects
14	Calcium and Magnesium ( $\text{Ca}^{2+}, \text{Mg}^{2+}$ )	Encrustation

### III. CASE STUDY

Due to increasing urbanization, surface water is getting over contaminated and more stringent treatments would be required to make surface water potable. Therefore, it is required to additional sources for fulfill the requirement of water. Because the ground water sources are safe and potable for drinking and other useful purposes of human being. Hence studies of physic-chemical characteristics of underground water to find out whether it is fit for drinking or some other beneficial uses.

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Ground water sample were collected from five different areas (Toopran, Tellapur, Kompally, Praganayapur, Lingampally). Parameters to be analyzed: For the assessment of ground water quality of the bore well of the Indore city, Taking in view the following drinking water parameters are analyzed (1) pH (2) Turbidity (3) Total Dissolved Solids (4) Electrical Conductivity (5) Total hardness (6) Calcium (7) Magnesium, (8) Sulphate (9) Total alkalinity (10) Chloride (11) Fluoride (12) Dissolved Oxygen. The collected samples were tested and the readings were noted and compared with standard values given BIS and WHO.

The obtained values are tabulated in Table 2 and compared with the BIS standard values in Table 3. pH was measured with the help of pH meter (Model no. 101 E) of Electronic India, standardized with pH buffer 4,7 and 9.2. TDS was estimated by evaporation method at 180°C, Alkalinity, Hardness, D.O., Chloride, CO<sub>2</sub> and all parameters were analysed by standard procedure mentioned in APHA (1995).

Indications: S1-Tellapur, S2-Toopran, S3-Kompally, S4-Praganayapur, S5-lingampally.

Table 2: Readings of Water Quality Parameters of Collected Samples

S. No.	Parameter	S1	S2	S3	S4	S5
1	pH	7.55	6.97	7.97	7.2	7.5
2	Electrical Conductivity	2.1	1.4	1.5	1.3	1.7
3	Turbidity	2	3	2	3	2
4	Dissolved Oxygen	3.4	5.2	4	3.6	5
5	Total Dissolved Solids	811	571	628	537	682
6	Total Alkalinity	120	160	190	110	140
7	Calcium	84	98	104	96	120
8	Magnesium	45	34	38	49	54
9	Chloride	255	170	220	163	255
10	Fluoride	1.3	1	1.2	0.8	1.2
11	Total Hardness	423	391	423	313	427
12	Sulphate	350	280	250	350	325

Table 3: Physical and Chemical Properties of Ground Water as Per IS 10500-2012

S. No.	Parameter	Units	Acceptable limit	Permissible limit
1	PH	-	6.5-8.5	No relaxation
2	Electrical conductivity	Mg/l	-	
3	Turbidity	NTU	1	5
4	Dissolved oxygen	Mg/l	4-6	
5	Total Dissolved Solids	Mg/l	500	2000

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6	Total Alkalinity	Mg/l	200	600
7	Calcium	Mg/l	75	200
8	Magnesium	Mg/l	30	100
9	Chloride	Mg/l	250	1000
10	Fluoride	Mg/l	1	1.5
11	Total hardness	Mg/l	200	600
12	Sulphate	Mg/l	200	400

By comparing the results obtained for the collected samples and standard values the PH value for collected samples are under acceptable limit in the same way TDS, calcium, magnesium, sulphate, turbidity, total hardness are under acceptable limit to permissible limit. Whereas the dissolved oxygen for sample 1 i.e. in Tellapur and sample 3 i.e. in Kompally regions are less than the acceptable limits. Total alkalinity of all the collected samples are less than permissible limits. Chloride ratio is less in sample 2 i.e. Toopran and sample 4 i.e. Praganayapur regions than the acceptable limits. Fluoride ratio is less than acceptable limit in sample 4 region i.e. Praganayapur.

#### IV. EXPERIMENTS AND METHODOLOGY

The Table 4 shows different parameters and their experimental methods conducted in the present work.

Table 4: List of Parameters and their Experimental Method

Parameter	Experimental Method
pH	pH Meter
Electrical Conductivity	Conductivity Meter
Turbidity	Nephelo Turbid Meter
Dissolved Oxygen	D.O. Meter
Total Dissolved Solids	Gravimetric Method
Total Alkalinity	Titration
Calcium	Titration
Magnesium	Titration
Chloride	Argentometric Method
Fluoride	Titration
Total Hardness	EDTA Method
Sulphate	Gravimetric Method (By Barium Sulphate)

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**Water Quality Index:** Water quality index (WQI) provides a single number that expresses the overall water quality at a certain location and time based on several water quality parameters. The objective of WQI is to turn complex water quality data into information that is understandable and usable by the public. A number of indices have been developed to summarize water quality data in an easily expressible and easily understood format.

The WQI which was first developed by “**Horton** in the early 1970s” is basically a mathematical means of calculating a single value from multiple test results. The index result represents the level of water quality in a given water basin, such as lake, river or stream. After Horton, a number of workers all over the world developed WQI based on rating of different water quality parameters. Basically a WQI attempts to provide a mechanism for presenting a cumulatively derived, numerical expression defining a certain level of water quality. Ground water standard readings with their unit weights are given in Table 6.

### Calculation of Water Quality Index:

#### Arithmetic Mean Method

There are three steps for calculate WQI. In the first step each of the parameters has been assigned a weight ( $w_i$ ) according to its relative importance in the overall quality of water for drinking purpose, maximum weight of 5 has been assigned to nitrate due to its major importance in water quality assessment. In the second step, the relative weight is calculated from the following equation

$$W_i = w_i / \sum w_i n_i = 0$$

Where;  $W_i$  is the relative weight,  $w_i$  is the weight of each parameter and  $n$  is the number of parameters. Standard water quality index and quality of water are given in Table 5 and calculated  $W_i$  values of the parameter are given in Table 7 and same has been represented as bar chart Fig.1. The third step is a quality rating scale ( $q_i$ ) for each parameter is assigned by dividing its concentration of each water sample by its respective standard according to the guidelines laid down in the BIS and the result multiplied by 100.

$$q_i = (C_i - C_{io} / S_i - C_{io}) \times 100$$

Where;  $C_i$  is the concentration of each chemical parameter in each water sample in mg/L,  $C_{io}$  is the ideal value of the parameter in pure water and  $S_i$  is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the BIS. For pH,  $C_{io}$  is 7 and the remaining parameters the ideal value is 0.

$$\text{For pH: } q_i = (C_i - 7) / (S_i - 7) \times 100.$$

For calculating the WQI, the sub index ( $S_i$ ) is first determined for each parameter, which is used to determine the WQI as per the following equations.

$$S_i = w_i * q_i$$

$S_i$  is the sub index of the  $i^{\text{th}}$  parameter

$$WQI = \sum S_i$$

Table 5: Water Quality Index and Quality of Water

Water Quality Index	Water Quality Status
<50	EXCELLENT
50-100	GOOD
100-200	POOR
200-300	VERY POOR
>300	UNSUITABLE

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Table 6: Ground Water Standard Readings, Unit Weights and Recommended Agencies

Parameter	Standard Readings	Recommended Agencies	Unit Weight
pH	6.5-8.5	ICMR/BIS	0.2190
Electrical Conductivity	300	ICMR/BIS	0.371
Turbidity	1	ICMR/BIS	0.08
Dissolved Oxygen	5	ICMR/BIS	0.3723
Total Dissolved Solids	500	ICMR/BIS	0.0037
Total Alkalinity	200	ICMR/BIS	0.0155
Calcium	75	ICMR/BIS	0.025
Magnesium	30	ICMR/BIS	0.061
Chloride	250	ICMR/BIS	0.0074
Fluoride	1	ICMR/BIS	0.09756
Total Hardness	300	ICMR/BIS	0.0062
Sulphate	200	ICMR/BIS	0.01236

Table 7: Water Quality Index of the Collected Samples

Parameter	S1	S2	S3	S4	S5
pH	7.55	6.97	7.97	7.2	7.5
Electrical Conductivity	2.1	1.4	1.5	1.3	1.7
Turbidity	2	3	2	3	2
Dissolved Oxygen	3.4	5.2	4	3.6	5
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Calcium	84	98	104	96	120

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Magnesium	45	34	38	49	54
Chloride	255	170	220	163	255
Fluoride	1.3	1	1.2	0.8	1.2
Total Hardness	423	391	423	313	427
Sulphate	350	280	250	350	325
Water Quality Index(Wqi)=W*Q/Q	102.99	93.59	99.24	107.50	95.40
Water Quality Status	Poor	Good	Good	Poor	Good

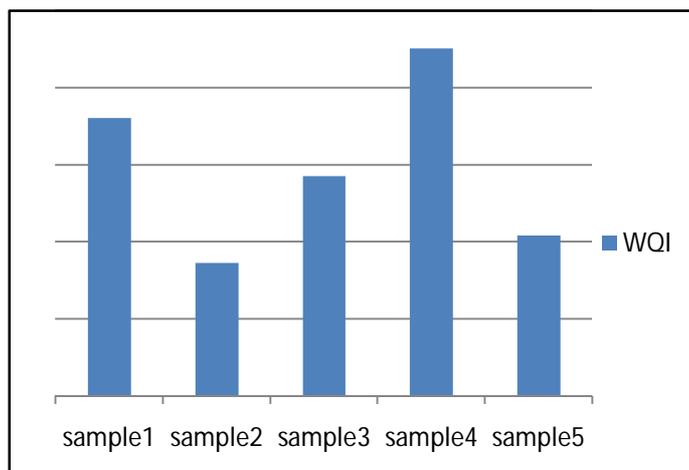


Fig. 1: Bar Chart Representing WQI of Collected Samples

### V. CONCLUSION

Water quality index of collected samples were calculated from important physical and chemical parameters of ground water. The values various parameters were represented in table 3, the water quality index of collected water samples were tabulated in table 7. The water quality in the Tellapur and Praganayapur areas was poor and not suitable for drinking purposes and water quality in Toopran, Kompally, Lingampally was good and can be used for drinking purposes corroborated with disinfection by products.

The above water quality is also supported by the following physicochemical parameters variations observed among different collected samples. Among all the physicochemical parameters selected for water quality index calculations, pH is an important parameter which determines suitability of water for various purposes. In present study pH ranged between 6.8 to 7.8. So the water quality index of collected water samples in different areas were calculated and the sample1 and sample 4 were not that much useful for the various purposes compared to other samples 2,3,5 which are suitable for domestic and drinking purpose by disinfection.

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