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Appraisal Of Physico-Chemical Parameters In Groundwater Quality For Drinking Purposes In Sandur Taluk Bellary District (India)

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Abstract

The present study was conducted to determine the factors which are required and as per regulating groundwater quality in Sandur taluk, Bellary district, Karnataka state, India with drinking purposes as main use. Under this study fifty groundwater samples have been collected in selected ground water samples in Sandur taluke. Groundwater samples were analyzed for 10 physico-chemical factors in order to understand the different geochemical practices affecting the groundwater quality. The analytical results shows higher concentration of chloride (2%), electrical conductivity (40%) and magnesium (6%) and total dissolved solids (20%), potassium (2%), total hardness (90%), calcium (98%) and magnesium (6%) during the study period from March 2015 to April 2016, the study indicates signs of deterioration as per WHO and BIS standards. On the other hand, 94% groundwater sample is unsuitable for drinking purposes when seen from total hardness and calcium levels and also based on EC and TDS parameters is 30%. The study revealed that due to mining activity and Assessment of groundwater samples from various parameters indicates that groundwater in most part of the study area is chemically unsuitable for drinking purpose. The data structures show that mining activity and geological structure contributing the higher concentration of ions in aquifer of Sandur taluka, Bellary District.

Keywords: physico-chemical, ground water, drinking water quality, total hardness and calcium.

1. Introduction

Ground water is the main sources for all human activities and which occurs beneath the earth surface is considered free from pollutants, hence usable but human activity as well as natural factors are affecting the quality as well as quantity of naturally available resource due to unplanned urbanization and industrialization for the past 2-3 decades in few parts of the country are facing ground water pollution problems (Annapoorna and Janardhana, 2015).

Many researchers across the globe worked on chemical composition (Babiker et al., 2007; Vennila et al., 2008) of ground water, possible sources of pollution in ground water (Shomar et al., 2010 and Magesh et al., 2013). Day by day due to anthropogenic activity urbanization and industrialization throughout the world and fresh water availability is becoming scarce. Currently lack of surface water communities are depending and exploiting to meet the demand of various purposes. Distribution and quality of ground water is deteriorating because of the local geologic set-up and anthropogenic factors, including that for human consumption. An appraisal of ground water quality for drinking purposes involves the estimation of chemical composition of ground water and control measures for restoring of the quality of groundwater. Present work contains on the chemical composition of the selected ground water and investigate the possible sources of pollution in ground water. The results are compare with the WHO and BIS standards for drinking purposes.

The study was carried out at Sandur area of Bellary district, Karnataka which is geographically bounded by 15° 10' and 15°50' north latitude and 76° 55' and 76° 61' east longitude covering an area of above 565 meters (Figure 1). Sandur and its surrounding village's places of natural beauty with lush green mountains, valleys, deep gorges and most of the villages are depending upon the ground water for their daily needs. Geomorphological of the area indicates an undulating plain with linear operational hills and composed with iron ore sequences. The Sandur town located to the south of Hosapete. As per 2011 census the population of the study area is 37,431. It located on the southern edge of the original Vijayanagara metropolitan area. Sanduru Taluka has deposits

of manganese ore and hematite (iron ore), and is home to several mines and steel plants in and around the taluka. Study area receives 750mm of elevation but has seen more than 1000mm of rainfall. The average annual temperature varies from 45°C to 26°C. Drainage of the study area is of ephermal type and small patches of water in the study region.

2. Materials and Methods

A total number of 50 groundwater samples were collected in 5 L colored polythene cans from different bore wells and hand pumps from the selected location in Sandur taluk for the period of one year from March 2015 to April 2016. Before collecting the water samples, the ground water was pumped out from bore wells for about 15 minutes to remove stagnant groundwater. 0.45 Millipore membrane was used to filter the samples during sampling. The physical parameters measured and recorded in the field are colour, taste, odour, temperature (Thermometer), EC (using conductivity meter) and pH (using pH meter). Groundwater samples collected were colorless, odorless but were very spiteful to taste. As far as water temperature is concerned there was not much difference between the groundwater and that of air temperature in a limited samples wherein the temperature varied between 10C and 2^0C. The physicochemical parameters have been analyzed by volumetric like total hardness, calcium and chloride (APHA, 2005). Sulphate were measured using spectrophotometer and sodium and potassium was measured using flame photometer.

3. Results and Discussion

In the present study, the parameters are classified is a main chemical element that is (total hardness, Ca, Mg, Na, K, SO4, Cl) and physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS) (Table 1). From these data can be analyzed descriptively about the feasibility and usefulness of groundwater for consumption and the suitability of groundwater for drinking purposes. Physico-chemical parameters and chemical composition of major ions analysis were performed to compare the composition of water samples in the field with the standards which has been specified by the (WHO, 2004 and ISI, 1993). Present work and analytical results will determine percentage of water suitable for drinking purposes. Descriptive analysis of each parameter will be discussed below.

pH is measure of intensity of acidity or alkalinity of water. pH indicates the chemical and biological reaction on water ecosystem and also provides the vital information about the geological equilibrium and solubility (Hem JD, 1985). The limit of pH value for drinking water is specified as 6.5–8.5 (WHO, 2004) and 6.5 to 9.5 (ISI, 1993). In the present study in selected ground water samples shown the pH value varies from 6.69 to 7.49. Most of pH condition in the study sites proved that the water is safe for drinking purposes as per the WHO and ISI, The optimum pH condition for drinking is given in Table 2. The results showed that the groundwater from selected locations were moderately alkaline (pH 7.2 and 7.6) thus, it is usable for drinking purposes.

Electrical conductivity is a measure the transportation of electric current in water. Desirable limit as per the WHO, 2004 for EC in drinking water is 1.500 µmhos/cm. In the present area. The EC of the groundwater is varying from 761.04 µmhos/cm to 4916.59 µmhos/cm, with an average value of 2305.05 µmhos/cm and standard deviation is ±2300.18. Some of the selected ground water samples are showing maximum EC values, this may be due to high salt composition contained in groundwater. Based on the analysis and previous studies EC can be classified into low salt content (value of EC <1.500 µmhos/cm), medium salt content (value of EC 1.500 and 3.000 µmhos/cm) and maximum salt content (value of EC > 3.000 µmhos/cm). From the present investigation designates, only 14% of the ground water showing above 3000 µmhos/cm of EC, 40% of the ground water samples are comes under medium salt content. About 46% of the ground water samples are 46% classified as the first category with a low salt content. This may be due to the study area are mining zone. Present study also indicates 46% of the ground water samples can be used for drinking purposes. According to WHO specification TDS, the maximum permissible limit for drinking water is 1500 mg/L and lowest up to 500 mg/L. In the present study, the TDS has value varies between 109.89 mg/L and 3599.69 mg/L. According to table 2 and 4 indicates that selected groundwater samples in the study area is in (500 mg/L to 1500 mg/L) permissible level for drinking purposes which is about 82%. The maximum permitted levels of analysis sample approximately 18%.

During the study period (March 2015 to April 2016), the total hardness, values range from 89.13 mg/L to 2919.91 mg/L. As per the classification total hardness, (WHO, 1984) total hardness can be classified into soft water (<75 mg/L), moderately hard (75 mg/L to 150 mg/L), hard (150 mg/L to 300 mg/L) and very hard (>300 mg/L). The analysis results shows that selected all ground water samples are above the 300 mg/L and fall in the very hard water category. Maximum allowable limit of TH for drinking and the most desirable as per the WHO ((Table 2) standard. Based on this classification it indicates that all of the groundwater samples are exceed the maximum allowable limits. Hence the present work concludes before used for drinking purposes, the water should be processed through filters like Reverse osmosis and other water treatment units. In the entire study only five ground water samples (S39, S36, S28, S23 and S22) were shown below 500 mg/L. These ground water may be used for drinking purpose without any treatment.

Calcium and magnesium are the most abundant elements in the natural surface and groundwater. It exist mainly as bicarbonates and a lesser degree in the form of sulfate and chloride. In the present study, calcium varying from 49.52 mg/L to 1622.17 mg/L. The maximum allowable limit of calcium concentration for drinking water is specified as 200 mg/L (ISI, 1993). The same trend observed as in total hardness. Present study reveals the calcium content in most of the ground water samples are above the allowable level (Table 2).The higher Calcium content can cause abdominal ailments and is undesirable for domestic usage as it cause encrustation and scaling (S. Srinivasa Gowd, 2005). Magnesium content is varying from 5.98–195.91mg/L. The maximum permissible limit of Mg concentration of drinking water is specified as 150 mg/L WHO, 2005.

Sixth most abundant element in the Earth crush is sodium, it produces from the rocks and soils. Marine water contains more sodium compared to rivers and lakes. Concentrations however are much lower depending on geological conditions and wastewater contamination (S. M. Shah and N. J. Mistry, 2013). The Sodium content in selected ground water samples has shown variations from 11.95 mg/L to 145.41 mg/L (Table 2 and 4). In the entire study, sodium content observed 100% samples are below the maximum allowable prescribed by ISI and WHO. Accordingly, 100% of the samples had levels of sodium are allowed to drink.

Potassium levels lower than in comparison with sodium, the low concentration of potassium is due to the high resistance of potash feldspars to chemical weathering in the study area (Shomar, et al., 2010).The concentration of potassium is observed between 1.03 mg/L and 12.32 mg/L. The maximum permissible limit of potassium in the drinking water is 12 mg/L. from the study reveals, almost all of ground water samples tend to be safe to drink when seen from potassium levels, but there is one sample which S48 (Antapura, Havinamadagu road) ground water samples that have high levels is 12.32 mg/L.

Sulphate is one of the major anion contained in the groundwater. The value of sulphate is observed from 39.0 mg/L to 134.56 mg/L. The concentration standard that permissible for drinking water is 200 mg/L. Based on this, the entire sample has a good sulphate and the concentration to be used as drinking water.

Chloride form in ground water may be due to formation of weathering, leaching of sedimentary rocks and soils, intrusion of saltwater, windblown salt in precipitation, domestic and industrial waste discharges, municipal effluents, etc (Karanth, 1987). In the study area, the concentration of chloride is between 30.38 mg/L and 759.49 mg/L. The desirable limit of chloride for drinking water is specified as 250 mg/L. It shows that the sample of ground water surround the study area has a high concentration of chloride which caused mining activity and other human activity within the study area and has a low level of resistance to weathering making it possible to drink.

4. Conclusion

The study carried out in the Sandur taluk on ground water samples conform that the pH level of ground water was within limit. In 20 samples were having Electrical Conductivity more than Maximum Permissible Limit. It is said that these water cannot be used for drinking purpose. The value of T.D.S. were more than maximum permissible limit in 10 samples. The analytical results indicates higher concentration of total dissolved solids (20%), electrical conductivity (40%), Chloride (2%), total hardness (90%), calcium (98%, sodium (0), pH (0) and magnesium (6%), which indicates signs of deterioration as per WHO and BIS standards. The groundwater of the Sandur taluk is aquifer exhibit conductivities from 761.04 to 4916.59 µmhos/cm. A few wells of the study area record extraordinary values of conductivity due to the usage of fertilizer for agricultural activity in the study area. Groundwater sample is unsuitable for drinking purposes according to total hardness and calcium. The data structures show that mining activity and geological structure contributing the higher concentration of ions in aquifer of Sandur taluka, Bellary District.

Table 1: physico-chemical parameters of bore well (BW) and hand pump (HP) of Sandur taluk, Bellary district

sample no	Village	location	Water	pH	EC	TDS	Na	K	TH	Ca	Mg	Cl	SO_4
S1	Laxmipura	Outside village	B.W	7.23	3140.21	1899.89	44.21	1.82	1541.02	856.12	103.40	273.42	62.64
S2	Nandihalli	near school	B.W	7.09	1201.23	714.89	19.17	3.32	579.85	322.14	38.91	60.76	128.52
S3	Tumati	Down the village	**H.P**	7.13	1223.21	637.29	23.63	2.76	516.91	287.17	34.68	60.76	68.14
S4	Bujanganagara	Near bus station	B.W	7.39	1401.87	824.89	20.32	1.34	669.08	371.71	44.89	91.14	57.81
S5	Narasingapura	bus stop circle	**H.P**	7.19	2423.89	1429.89	38.40	1.97	1159.80	644.33	77.82	273.42	49.00
S6	RanaJIthpura	near school	**H.P**	7.09	1407.62	824.89	27.39	1.50	669.08	371.71	44.89	91.14	56.12
S7	Susheelanagara	Hospet road side	**H.P**	7.11	1779.78	1044.89	23.43	3.00	847.52	470.84	56.87	151.90	54.68
S8	Siddapura	near devi temple	**H.P**	6.94	1693.80	699.89	20.43	2.05	567.69	315.38	38.09	60.76	72.87
S9	Jaisingpura	outside	B.W	6.81	2508.11	1699.89	23.02	1.11	1378.80	766.00	92.51	243.04	58.68
S10	Venkatagiri	near Anjaiani temple	B.W	6.98	2320.00	1374.89	63.24	2.53	1115.19	619.55	74.82	212.66	49.50
S11	Dowlatpura	near masjid	B.W	7.19	2048.50	1209.89	29.18	3.40	981.35	545.20	65.84	151.90	71.12
S12	D.Thimmalapura	Outside village	**H.P**	7.04	1961.97	1099.89	70.64	1.90	892.13	495.63	59.86	121.52	66.18
S13	Taranagara	near halla	**H.P**	7.13	1687.43	860.59	22.22	1.18	698.03	387.80	46.84	151.90	72.37
S14	Muraripura	Near Doni	H.P	7.03	2517.71	1484.89	45.56	2.53	1204.41	669.12	80.81	212.66	65.41
S15	V-Nagalpura	Behind the Govt. school	B.W	7.14	3064.40	1814.89	92.66	2.84	1472.08	817.82	98.77	334.18	64.82
S16	Taluru	Govt schcool	B.W	7.23	1596.29	934.89	29.42	1.97	758.30	421.28	50.88	121.52	70.71
S17	Chikkantapura	road side irrigation land	B.W	7.04	2600.67	2099.89	28.30	4.03	1703.24	946.25	114.28	182.28	69.68
S18	S-Basapura	near bus stand	**H.P**	6.87	4455.31	3599.89	145.41	3.40	2919.91	1622.17	195.91	698.73	114.54
S19	Kurekuppa	Road side	B.W	7.47	1503.20	879.89	124.89	2.69	713.69	396.49	47.89	121.52	60.39
S20	Dharmapura	Ashryaya colony	B.W	6.87	2599.16	1539.89	44.27	1.90	1249.02	693.90	83.80	273.42	57.21
S21	Yashavantanagara	kudligi road side	B.W	6.98	2423.79	1339.89	51.55	1.42	1086.80	603.78	72.92	243.04	55.12
S22	Nidagurthi	beside the pond	B.W	7.19	1121.81	549.89	66.09	2.76	446.02	247.79	29.93	30.38	68.03
S23	72-Mallapura	near Govt. school	B.W	7.49	853.83	494.89	24.93	1.82	401.41	223.00	26.93	30.38	74.57
S24	Katinakamba	near bus stand	B.W	6.96	2045.09	1209.89	23.05	1.11	981.35	545.20	65.84	198.60	59.01
S25	Bandri	inside vasavi temple	**H.P**	7.09	4074.75	2933.82	60.27	1.34	2379.65	1322.03	159.67	455.69	65.02
S26	Ankamnal	mallapur road	B.W	7.29	1777.19	1044.89	140.98	1.82	847.52	470.84	56.87	91.14	49.00
S27	D-Mallapura	Near tank	B.W	7.09	1497.38	879.89	25.07	1.66	713.69	396.49	47.89	91.14	49.50
S28	Hiralu	near pakkira devru temple	B.W	7.29	1035.56	604.89	28.27	2.84	490.63	272.57	32.92	30.38	39.00
S29	Thippanamaradi	Near angannavadi	B.W	7.13	1121.08	659.89	27.45	1.03	535.24	297.36	35.91	60.76	44.50
S30	Tyagadalu	village entrance	B.W	6.69	4916.59	2999.89	88.11	2.05	2433.24	1351.80	163.26	759.49	41.00
S31	Kalingeri	Choranur Roadside	B.W	7.00	2230.70	1319.89	29.01	3.55	1070.58	594.76	71.83	243.04	50.12
S32	Sovenahalli	near gramapanchyati	B.W	7.23	1315.46	769.89	27.19	2.76	624.46	346.92	41.90	91.14	62.12
S33	Agrahara	near water tank	B.W	7.21	1222.75	714.89	28.27	2.05	579.85	322.14	38.91	30.38	65.71
S34	Sulthanpura	Road side water tank	B.W	7.03	1312.79	769.89	22.14	1.34	624.46	346.92	41.90	91.14	58.16
S35	Mallarahalli	road side	B.W	6.89	2322.03	1374.89	73.60	1.42	1115.19	619.55	74.82	151.90	70.18
S36	S.Lakkalahalli	Roadside arriculture land	B.W	7.24	761.04	439.89	22.20	1.03	356.80	198.22	23.94	30.38	54.12
S37	Genethikatte	chornur road side	B.W	7.31	1220.25	714.89	48.59	2.92	579.85	322.14	38.91	30.38	63.67
S38	Nallabande	near minwater tank	B.W	7.23	1318.23	769.89	25.92	1.97	624.46	346.92	41.90	60.76	53.14
S39	Hosavaddanakatte	road side	B.W	7.33	1962.72	109.89	29.18	1.03	89.13	49.52	5.98	121.52	65.62
S40	Choranuru	near water tank	B.W	7.14	1682.00	989.89	60.42	2.45	802.91	446.06	53.87	151.90	60.60
S41	Bommagatta	near hulikunteshwara temple	B.W	7.09	838.88	494.89	29.45	1.42	401.41	223.00	26.93	30.38	52.66
S42	Bannihatti	near anganavadi	B.W	7.19	1038.06	604.89	11.95	1.97	490.63	272.57	32.92	30.38	68.56
S43	Lingadahalli	ubbalgundi road side	**H.P**	6.90	2320.09	899.89	19.82	2.05	729.91	405.50	48.97	121.52	52.54
S44	Ubbalagundi	outside village	**H.P**	7.07	1407.90	824.89	19.55	1.34	669.08	371.71	44.89	60.76	50.52

S45	Rajapura	near chappardahalli	**H.P**	7.10	1682.29	989.89	29.18	2.05	802.91	446.06	53.87	91.14	49.00
S46	Metriki	near bus stand	**H.P**	6.97	3439.04	2034.89	94.01	2.76	1650.52	916.96	110.74	334.18	58.01
S47	Vittalapura	beside govt. school	**H.P**	7.09	2227.84	999.89	58.83	2.69	811.02	450.57	54.42	121.52	134.56
S48	Anthapura	Havinamadagu road	B.W	6.89	4270.15	2299.89	132.23	12.32	1865.46	1036.37	125.17	455.69	70.58
S49	Sandur	Shanbogar street	**H.P**	7.00	1950.89	1154.89	58.78	6.56	936.74	520.41	62.85	121.52	68.12
S50	Kodalu	outside village	**H.P**	7.07	1589.82	934.89	26.01	2.21	758.30	421.28	50.88	90.59	61.12

Note: All the parameters are expressed in mg/L except pH, and EC

Table 2: Ground water samples of the selected locations exceeding permissible limits for drinking purposes

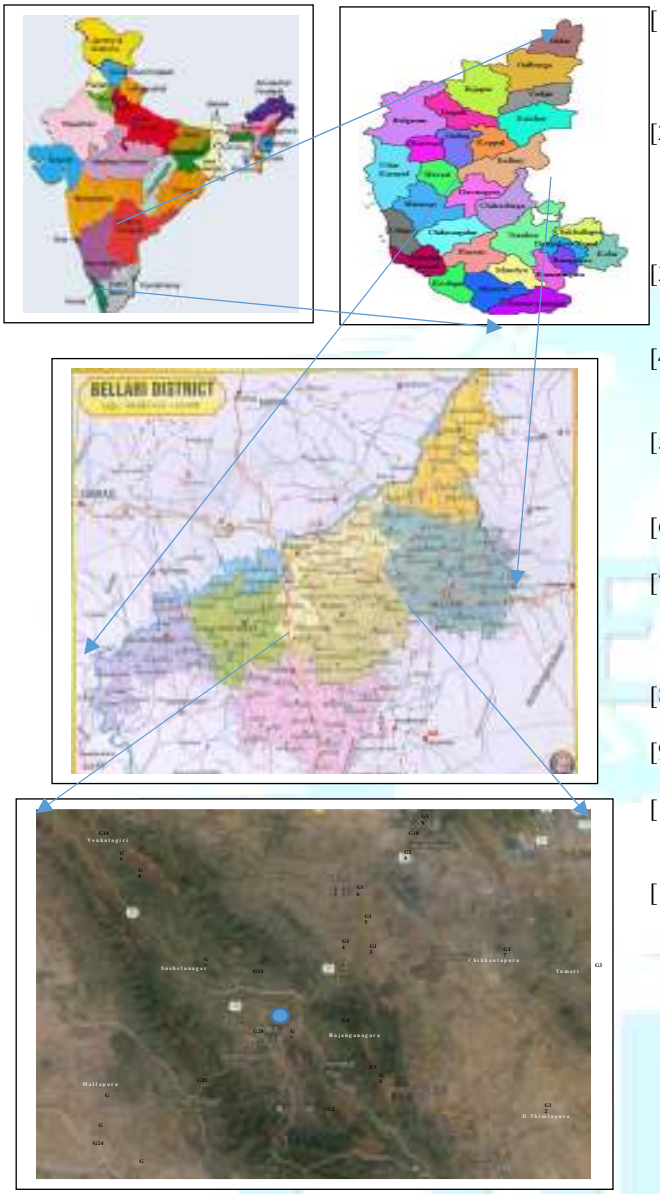
Water quality Parameters	WHO		ISI		Data Samples	
	Min	Max	Highest	Max	Min	Max
pH	6.5	8.5	6.5 – 8.5	6.5 – 9.5	6.69	7.49
EC	1400	-	-	-	761.04	4916.59
TDS	500	1500	500	2000	109.89	3599.69
TH	100	500	300	600	89.13	2919.91
Calcium	75	200	75	200	49.52	1622.17
Magnesium	50	150	30	100	5.98	195.91
Sodium	-	200	-	200	11.95	145.41
Potassium	-	12	-	-	1.03	12.32
Sulphate	200	400	200	400	39.00	134.56
Chloride	200	600	250	1000	30.38	759.49

Table 3: Descriptive statistics of Physico-Chemical parameters

Descriptive stats	pH	Cond	TDS	TH	CaH
Mean	7.10	2305.05	1172.13	950.73	528.18
Standard Error	0.02	325.29	97.56	79.13	43.96
Median	7.09	1778.49	962.39	780.61	433.67
Mode	7.09	1521.24	714.89	579.85	322.14
SD	0.16	2300.18	689.84	559.53	310.85
Sample Variance	0.03	5290815.87	475876.07	313079.35	96629.81
Kurtosis	0.32	33.50	3.11	3.11	3.11
Skewness	0.07	5.36	1.66	1.66	1.66
Range	0.80	16059.25	3490.00	2830.78	1572.65
Minimum	6.69	761.04	109.89	89.13	49.52
Maximum	7.49	49160.29	3599.89	2919.91	1622.17
Sum	355.15	115252.36	58606.53	47536.32	26409.05
Count	50.00	50.00	50.00	50.00	50.00
Descriptive stats	**MgH**	**Cl**	**SO_4**	**Na**	**K**
Mean	63.79	166.80	63.69	46.36	2.42
Standard Error	5.31	22.06	2.57	4.76	0.24
Median	52.38	121.52	60.86	29.18	2.05
Mode	38.91	30.38	49.00	29.18	2.05
SD	37.54	155.96	18.18	33.63	1.73
Sample Variance	1409.42	24323.82	330.60	1131.09	2.99
Kurtosis	3.11	5.51	7.52	2.05	22.52
Skewness	1.66	2.18	2.49	1.64	4.22
Range	189.93	729.11	95.56	133.46	11.29
Minimum	5.98	30.38	39.00	11.95	1.03
Maximum	195.91	759.49	134.56	145.41	12.32
Sum	3189.50	8339.85	3184.25	2317.89	120.98
Count	50.00	50.00	50.00	50.00	50.00
Mean	63.79	166.80	63.69	46.36	2.42

Table 4: Water Quality Parameters Exciding the Permissible WHO and ISI Standards

Water quality Parameters	WHO maximum allowable limit	No. Of Sample Within Permissible Limit	Percentage Of Sample Exceeding Permissible Limit	No. Of Sample Exceed Permissible Limit	Percentage Of Sample Exceeding Permissible Limit
pH	8.5	50	100	0	0
EC	2000	30	60	20	40
TDS	1500	40	80	10	20
TH	500	5	10	45	90
Calcium	200	1	2	49	98
Magnesium	150	47	94	3	6
Sodium	200	50	100	0	0
Potassium	12	49	98	1	2
Sulphate	400	50	100	0	0
Chloride	600	49	98	1	2



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