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Groundwater Qualitative Analysis of REVA University Campus

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Abstract

The dependence on underground sources of water has increased with the increase in urbanization as well as time. Bore well water needs to be tested for safety before its use. Proper planning will help in finding out the quality of water that is needed in any particular area and will also give solutions for the water related problems in the future. This paper presents about the qualitative analysis of five different bore wells considered in REVA University, Bengaluru. For the quality analysis, the water from the five bore wells is tested for twelve different parameters. The quality of water was tested for the months of February and March. The qualitative analysis of water helps in finding out the characteristics of water which will help in finding out if the water is good for consumption. The test results showed the pH and turbidity values were found to be normal during both the months. The electrical conductivity, calcium hardness, magnesium hardness and alkalinity values were found to be higher for one of the bore wells which is closely located to a sewage treatment plant within the college. The water from the same bore well showed a lower chloride content compared to the other bore wells. The water quality of all the water from all the bore wells after testing were found to be within the permissible limit as per IS standards.

Keywords: *quality analysis, bore wells, physical, chemical, water quality standards.*

Introduction

Water is one of the most essential natural resources for eco-sustainability and is likely to become critical scarce in the coming decades due to increasing demand, rapid growth of urban populations, development of agriculture and industrial activities. Variations in availability of water in time, quantity and quality can cause significant fluctuations in the economy of a country [1,10]. Water is one of the most intrinsic and most valuable natural resources on the earth. The decrease in the availability of surface sources has led to the increase in the use of groundwater through bore wells. Groundwater is one of the most important sources of water for human activity which includes drinking water, agricultural and industrial sector use, and other domestic purposes. Groundwater and soil moisture collectively account for over 98% of global freshwater resources, with more than two billion people dependent on groundwater for their daily supply (Hiscock, 2005) [2]. The sustainability of groundwater sources are jeopardized due to various reasons, concerns about ground water resource includes questions about depletion of ground water levels, reductions in resources and changes in ground water quality etc. [3]. Groundwater is a major source of water for agriculture and to meet basic human needs in developing countries. All over the world bore well water represents the largest and most important source of fresh usable water. Bore well water is the enormous source of drinking water in both urban and rural areas. Due to increasing demand of water, most people in rural areas resort to bore-well water sources such as boreholes as an alternative water source. Thus, humans can abstract bore-well water through a borehole, which is drilled into the

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aquifer for industrial, agricultural and domestic use. However, bore well water resources are commonly not secure to pollution, which leads to the degradation of their quality. The rapid growth of urban area has two basic effects on groundwater resources such as: effects on natural recharge of aquifers due to sealing of ground with concrete and pollution of groundwater due to leakage from drainage and industrial wastage and effluents (Putra and Baier, 2009; Baier et al., 2013) [4].

Generally, bore well water quality changes from place to place according to the location of the bore well, nature of soils, surface and into soils, or through injection of wastes directly into bore well water. Due to rocks and surfaces through which it moves down Presence of solid waste on the surface enters the soil and reaches the groundwater table the process of leachate disturbs the quality of ground water[9] In addition, human activities can change the natural composition of bore-well water through the disposal of chemicals and microbial matter on the land [5]. The quality of ground water is of great importance in determining the suitability of particular ground water for a certain use (public water supply, irrigation, industrial applications, power generation etc.). This depends on a large number of individual hydrological, physical, chemical and biological factors that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged. Generally, higher proportions of dissolved constituents are found in ground water than in surface water because of greater interaction of ground water with various materials in geologic strata [6].

The qualitative analysis of water helps in finding out the characteristics of water which will help in finding out if the water is good for consumption.

The aim of the work presented in this paper is to brief about the basic general information about the bore well water quality analysis and research findings concerning testing of bore well water, to point out essential elements for a systematic approach and to discuss some of the significant issues.

The aim for this project also includes measures to provide clean, hygienic water for the people in REVA University by testing the water quality parameters according to the Indian Standards. This project is carried out using several research and data.

Study Area

REVA University was chosen as the study area as it had five bore wells within the campus. The water from these five bore wells were collected and analyzed parameter wise.

Bore well water quality tests are performed in February and March 2020.

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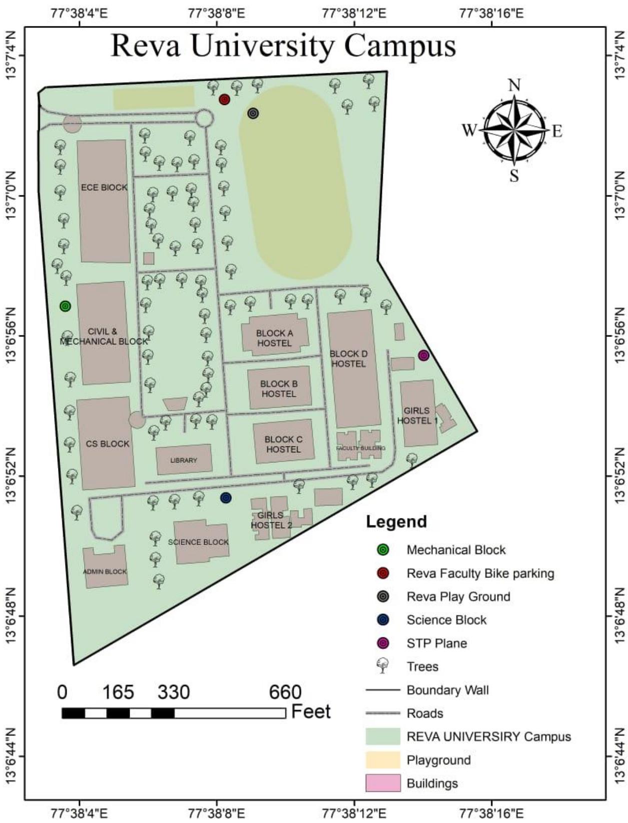

Fig. 1. Bore well water samples location map

The five bore wells that were chosen are given in Table 1.

Table 1: Location of the bore wells

Bore well. No	**Location of Bore well**
1	Behind Mechanical Block
2	Science Block
3	Girls Hostel
4	Parking Lot
5	REVA Playground

Methodology

The study area map was prepared using GIS software. Geographic information system (GIS) is used to represent the spatial distribution of the parameters and raster maps were created [7].
The water were tested for the following parameters as mentioned in Figure 2.

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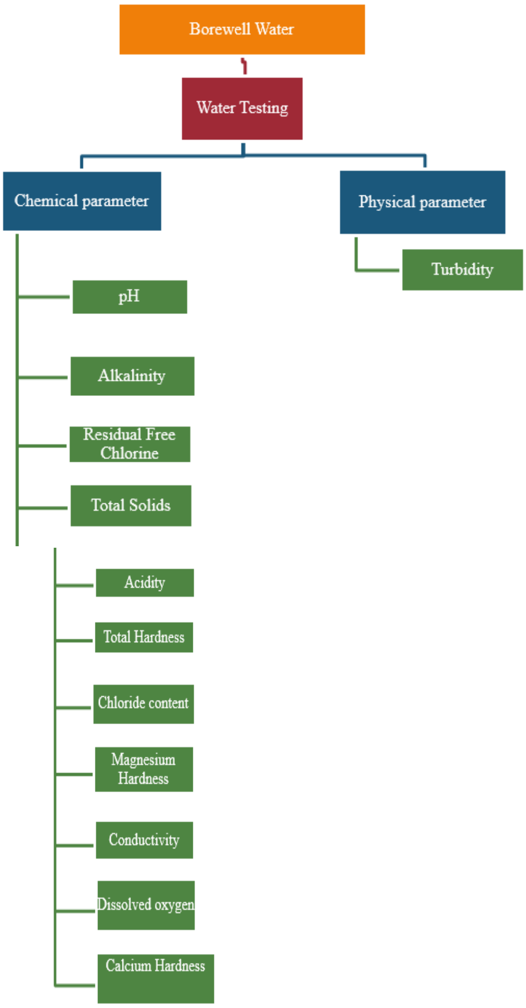

Fig. 2. The parameters considered for quality testing

Sampling area was finalized and the water from the bore well was tested for 12 parameters. Twelve physico-chemical parameters were considered in the analysis.
The 5 samples collected were tested in the month of February and March. All the collected samples were laboratory tested.
The Indian standards of water quality BIS 10500 (2012) was used for comparing and analyzing the results obtained [8].

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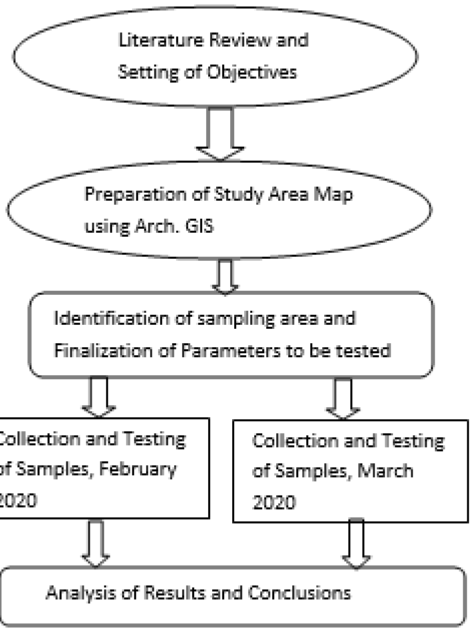

Fig. 3. Methodology Flowchart

The sample results obtained after testing for the 12 parameters are then compared with the Bureau of Indian Standards values shown in Table 2.

Table 2: Acceptable limits according to BIS

Test Parameter	Acceptable limit according to BIS
pH	6.5 – 8.5
Turbidity	1 NTU
Electrical Conductivity	800
Total solids	500
Total hardness	200
Calcium hardness	75
Magnesium hardness	30
Chloride	250
Alkalinity	200
Acidity	8.5
Dissolved oxygen	5
Residual Free Chlorine	0.2

Results

The samples obtained from the bore wells are named as they are mentioned in Table 3.

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Table 3: Naming of the samples

Sample No.	Bore well pumping water to
1	CS Block
2	Admin Block
3	Girls Hostel
4	EC Block
5	Civil Block

The test results obtained from conducting the quality analysis in the month of February and March are as given in Table 4 and Table 5 respectively.

Table 4: Quality test results for the month of February

Sl. No	Parameters	S1	S2	S3	S4	S5
1	pH value	6.61	6.65	7.12	6.7	6.56
2	Turbidity	<1	<1	<1	<1	<1
3	Electrical Conductivity	558	496	624	544	543
4	Total solids	349	311	389	342	342
5	Total Hardness	72	56	136	68	72
6	Calcium Hardness	48	36	88	40	48
7	Magnesium Hardness	24	20	48	28	24
8	Chloride	115	95	85	110	110
9	Alkalinity	76	64	152	72	72
10	Acidity	5	7	10	5	5
11	Dissolved Oxygen	6	5.8	5.8	5.9	5.9
12	Residual Free Chlorine	<0.1	<0.1	<0.1	<0.1	<0.1

Table 5: Quality test results for the month of March

Sl. N	Parameter	S1	S2	S3	S4	S5

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1	pH value	5.86	6.72	6.78	6.08	6.54
2	Turbidity	<1	<1	<1	<1	<1
3	Electrical Conductivity	760.5	400.2	501.9	518.4	462.8
4	Total solids	427.8	218.8	264.8	274.8	245
5	Total Hardness	68	79	139	89	82
6	Calcium Hardness	48	36	88	40	48
7	Magnesium Hardness	24	20	48	28	24
8	Chloride	111	87	95	121	123
9	Alkalinity	108	86	196	110	86
10	Acidity	4	8	10	6	4
11	Dissolved Oxygen	10.14	6.06	7.9	7.86	5.9
12	Residual Free Chlorine	<0.1	<0.1	<0.1	<0.1	<0.1

Discussion

pH - pH value of samples in the study area varied from 6.56 to 7.12 in the month of February. According to the BIS the value needs to range from 6.5 to 8.5. Thereby, all the samples are well within the acceptable limits in the month of February.

In March, pH varied from 5.86 to 6.78. Sample 1 and 4 showed an acidic nature. pH below 6.5 causes corrosion in pipe.

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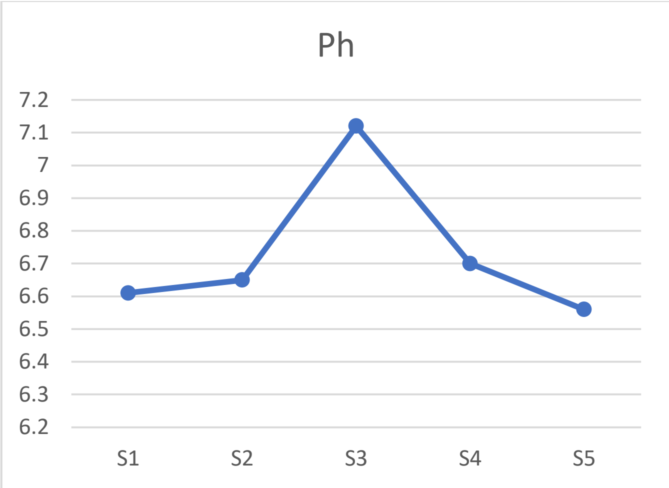

Fig. 4. pH versus sample collected in February

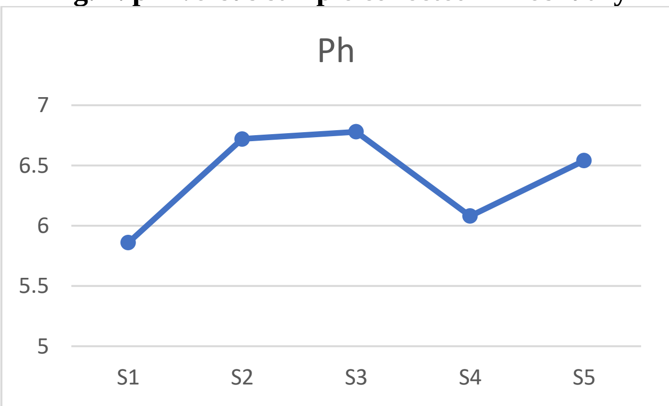

Fig. 5. pH versus sample collected in March

Turbidity – Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates.
All the samples showed turbidity values less than 1NTU for both the months which indicates that the values are well within the acceptable and safe limits.

Electrical Conductivity – Electrical conductivity is a measure of water's capacity to conduct the electric current. The electrical conductivity of the water samples ranged between 496µmho/cm to 624µmho/cm at all the sampling sites in the month of February. The values in the month of March ranged from 400.2µmho/cm to 760.5µmho/cm. Sample 1 showed the highest value out of all the bore wells but is safe within the acceptable limit of 800µmho/cm.

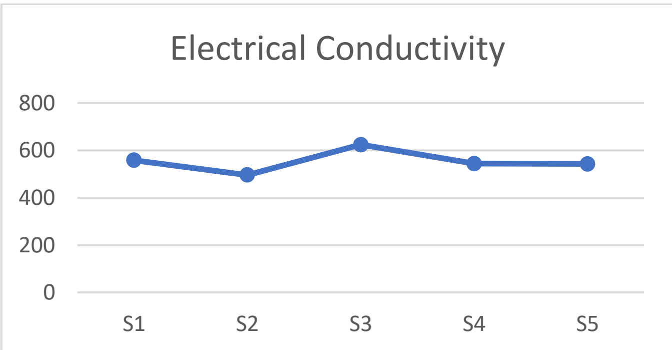

Fig. 6. Electrical conductivity versus sample collected in February

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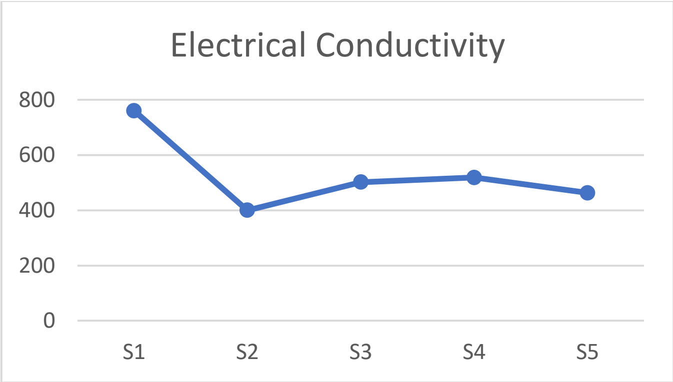

Fig. 7. Electrical conductivity versus sample collected in March

Total Solids – Hardness is caused by the compounds of calcium and magnesium, and by a variety of other metals. The total solids of water sample in the month of February ranges from 311ppm to 389ppm. In the month of March the value ranged from 218.8ppm to 427.8ppm. The BIS limit of total solids is 500ppm. All total solids of water samples are in safe level. It elevates the overall density of water and reduces solubility.

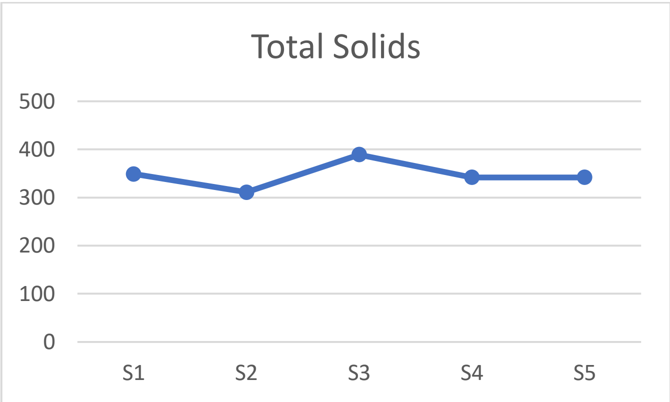

Fig. 8. Total solids versus sample collected in February

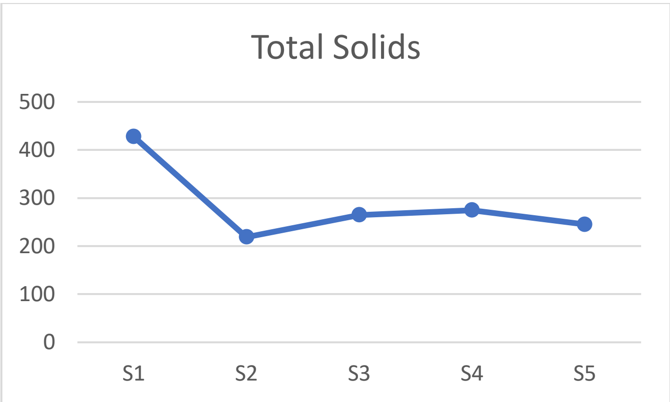

Fig. 9. Total solids versus sample collected in March

Total Hardness – It ranged between 56ppm to 136ppm in February. In March in ranged from 68ppm to 139ppm. The BIS limits of total hardness is 200ppm. Hardness in water is caused by certain salts held in solution Total hardness of water is caused by the presence of calcium and magnesium salts.

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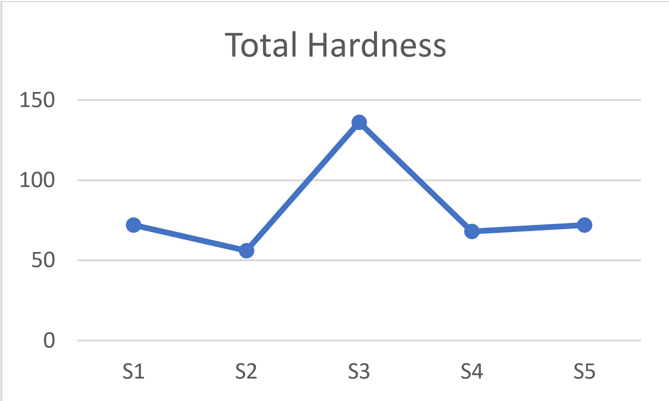

Fig. 10. Total hardness versus sample collected in February

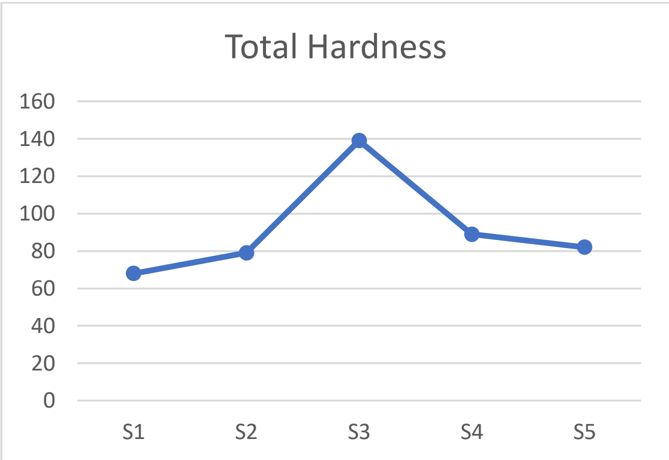

Fig. 11. Total hardness versus sample collected in March

Calcium hardness- Calcium hardness is the amount of dissolved calcium in water. The value ranged from 36ppm to 88ppm in the month of February. Sample 3 has calcium hardness value higher than the acceptable limit of 75ppm. The following month also showed a similar trend with sample 3 having higher value of calcium hardness.

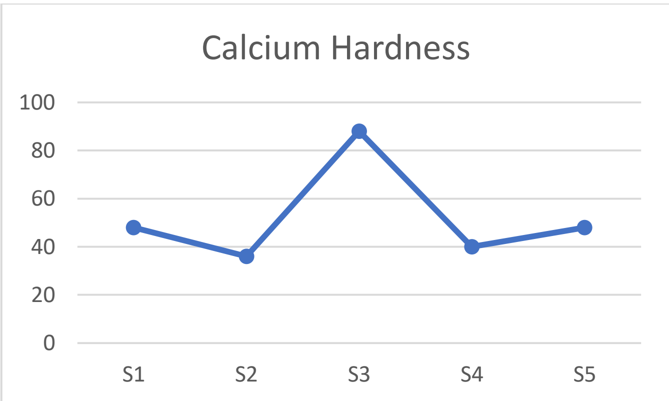

Fig. 12. Calcium hardness versus sample collected in February

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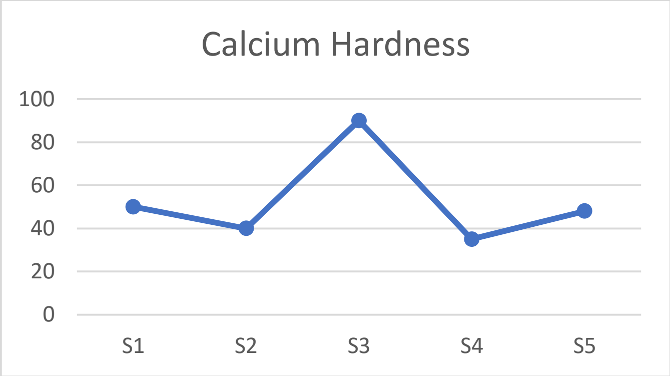

Fig. 13. Calcium hardness versus sample collected in March

Magnesium Hardness – This value ranged from 20ppm to 48ppm in the month of February. In the month of March, the value ranged in a similar manner. Hence sample 3 is not within the acceptable limits. The BIS limit for magnesium hardness is 30ppm.

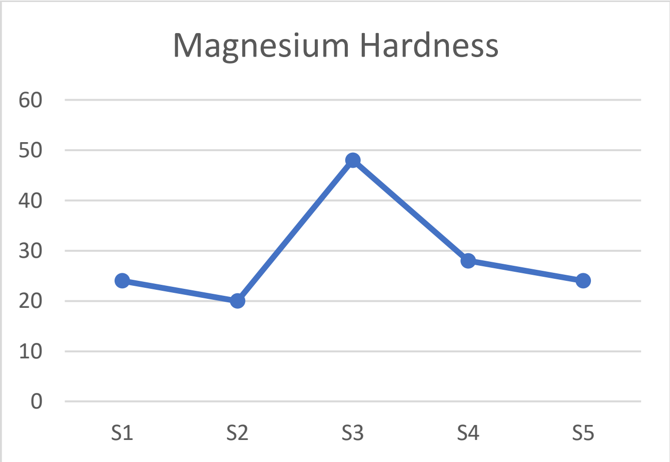

Fig. 14. Magnesium hardness versus sample collected in February

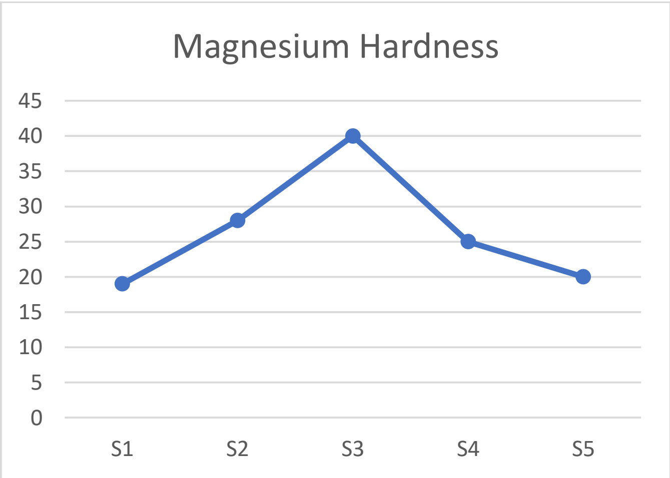

Fig. 15. Magnesium hardness versus sample collected in March

Chloride – Chlorides associated with sodium exert salty taste, when its concentration is more than 250mg/l which is the acceptable limit of chloride in water. In February, the value ranged from 85mg/l to 115mg/l and in March it ranged from 87mg/l to 123mg/l. All the samples are safe and well within the acceptable limit.

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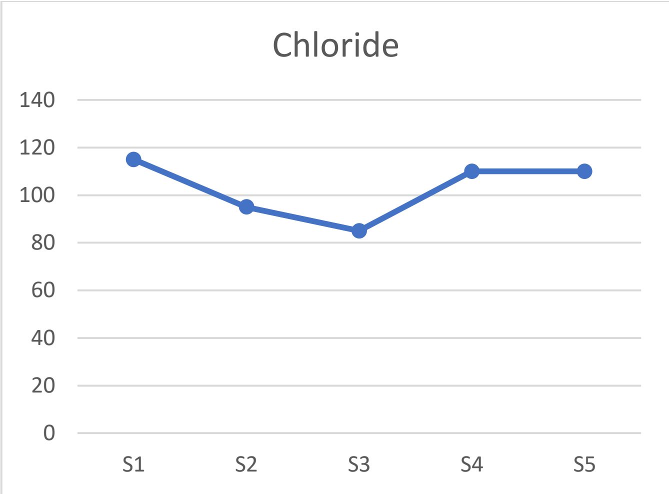

Fig. 16. Chloride versus sample collected in February

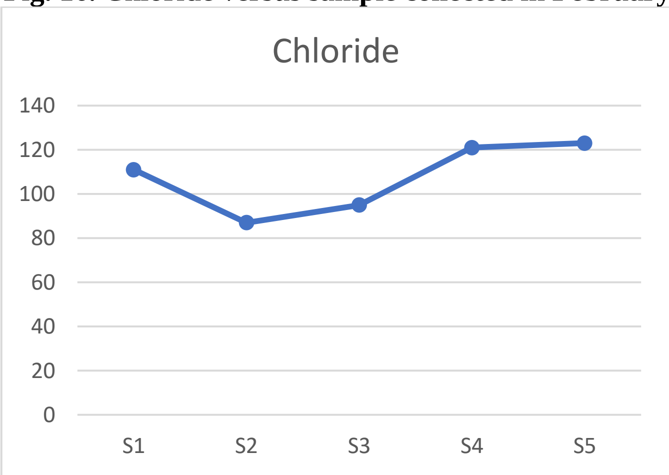

Fig. 17. Chloride versus sample collected in March

Alkalinity – The value of alkalinity in water provides an idea of the natural salts present in water. The cause of alkalinity is the minerals which dissolves in water from the soil. The alkalinity of the water sample ranged between 64ppm to 152ppm at all the sampling sites as shown in Fig 18. In March, the value ranged from 86ppm to 196ppm. The BIS limit of alkalinity is 200ppm.

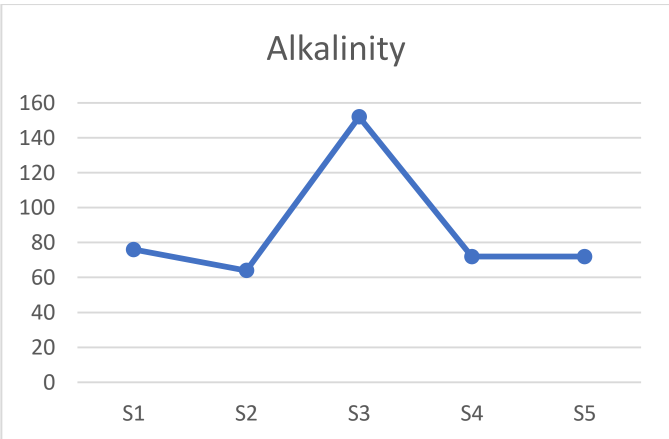

Fig. 18. Alkalinity versus sample collected in February

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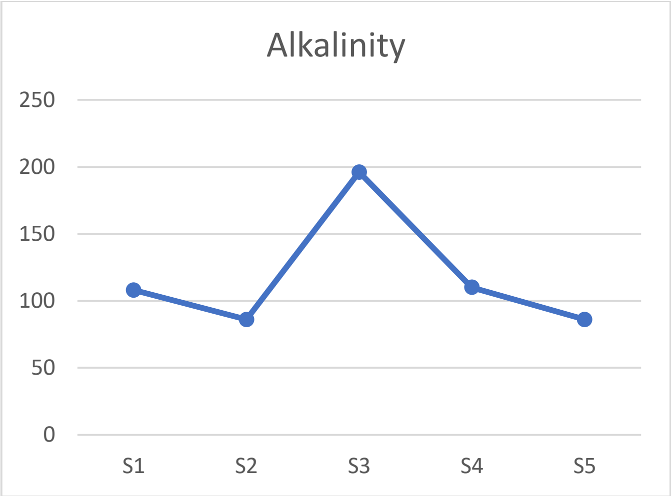

Fig. 19. Alkalinity versus sample collected in March

Acidity – Acidity is the quantitative capacity of a water or solution to neutralize an alkali. The BIS limit for acidity is 8.5. All the values other than sample 3 showed values within this limit. But, sample 3 showed a value of 10 for both the months which is not within the safe values.

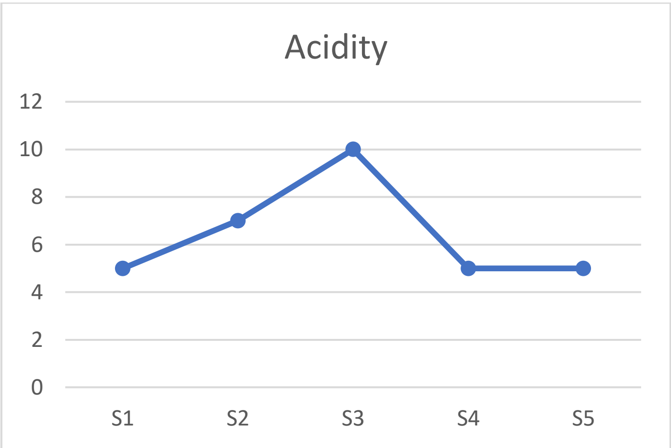

Fig. 20. Acidity versus sample collected in February

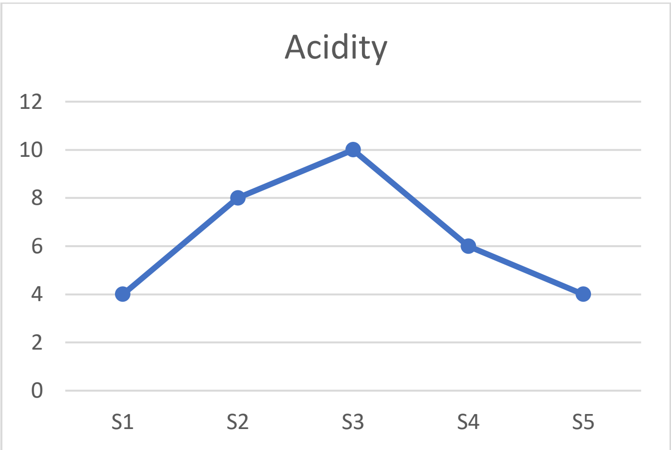

Fig. 21. Acidity versus sample collected in March

Dissolved oxygen - The dissolved oxygen values indicate the degree of pollution in the water bodies. The dissolved oxygen content of water samples ranged between 5.8mg/lit to 7.6mg/lit.

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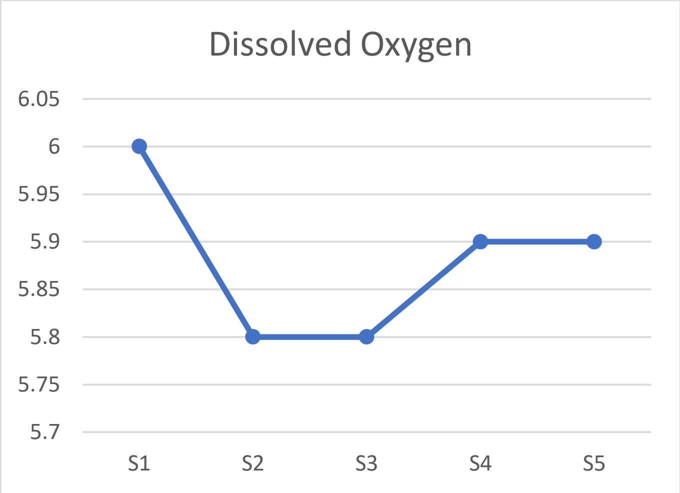

Fig. 22. Dissolved oxygen versus sample collected in February

The dissolved oxygen value of sample 1 in the month of March is above the standard limit. The IS limit of dissolved oxygen is 8mg/lit.

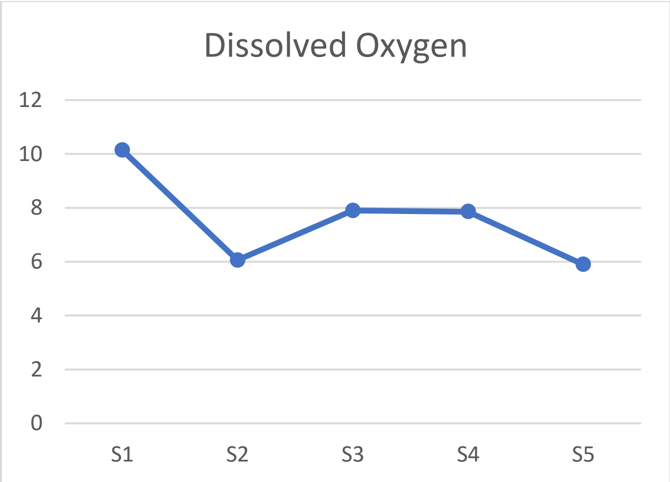

Fig. 23. Dissolved oxygen versus sample collected in March

Residual Free Chlorine – The acceptable limit for residual free chlorine content according to BIS is 0.2mg/l. All the samples in both the months of February and March showed values less than 0.1mg/l. Therefore all samples are safe within the acceptable limits.

Conclusion

For the qualitative analysis in the month of February and March the test results for bore well 3 showed higher values of calcium hardness, magnesium hardness and acidity. This is due to its location as it is closely situated near a sewage treatment plant and also could be because of its depth. The contaminants may percolate down through the upper layers of the ground surface to the aquifer and around the outside of the casing.

In the month of March, the quality test values for the bore well 1 showed slightly lesser pH and higher value of dissolved oxygen.

The pH showed slightly acidic trend and this is due to the geology of catchment area and the buffer capacity of water. It can also be due to the contamination by seepage at a point in aquifer.

The water from bore well 2, 4 and 5 are safe for drinking and well within the acceptable limits. The water from bore well 1 and 3 needs to undergo further tests to ensure if it's safe for drinking. If not, it can be used only for other purposes.

The sewage water must be pre-treated and then disposed of into the environment to minimize the contamination for avoiding health hazards.

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