WATER QUALITY ASSESSMENT NEAR VAMANJOOR SOLID WASTE DUMPING YARD

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ABSTRACT:

Mangalore has a total urban population of 6,23,800 (2011 census), if the population growth rate would continue to be same as in the year period 2001-2011(+1.47%/year), then the population in 2023 would be 7,50,000. The increased urban population is exerting pressure on the existing resources. The rivers and the wells are being polluted due to the dumpsites located close to the streams and ground water recharge areas this could be harmful to the end users. The main objective of the study was to check pollutant level in the ground and stream water with respect to guidelines provided by Indian Bureau of standards for drinking water. Considering the effect of seasonal variations of pollutants. A correlation between levels of pollutants in ground and surface water with distances from the dumping site was also examined.

Keywords: Urban population, pH, Electrical conductivity, Iron, Total dissolved solids

1 Introduction

The current study reviews the municipal solid waste composition and its effect on quality of both ground and surface waters. As per the latest assessment, the countries annual replenishable ground water resource is estimated to be 433 billion cubic meter (bcm), out of which 399 bcm is available for various purposes. About 92% of its annual withdrawal is for lone irrigation sector. The countries ground water development is highly uneven and also varies from place to place making it extremely complex to manage the valuable resource. As ground water is unevenly distributed and its utilization makes it near to impossible to have a single management strategy for the entire country. Aquifers and overlying land surface are connected hydraulically by the interwoven pores. The ground aquifer water quality depends on the quantity of contaminants that reach the aquifer, its travel time, and the geological system contaminant-attenuation capacity. Whereas the degree of attenuation in turn depends on the soil and rock type, contaminant type and its associated activities.

Calvo et al., 2005 presented formulated a series of environmental indices related to potential environmental issues due to landfills its impact on different environmental elements, pertaining to different location, design and operation. This study would facilitate the policy makers to prepare action plans and remediation or closure of the landfill sites. To prevent loss of metals due to container adsorption and possible chemical interactions the leachates need to be collected into clean plastic bottles and could be preserved with concentrated HNO_3 as it is a non-complexing and mildly oxidizing acid (Abdus-Salam et al., 2011). The CWG International Workshop Kolkata report shows that municipal solid waste management from different outlets whose collection, treatment and disposal should be satisfactory at the same time improve the living and working conditions of the waste recyclers. Though SWM is not mentioned explicitly in the Goals, Targets or Indicators, the right approach to handle solid waste can produce significant progress in achieving several goals (Gonzenbach, B. & Coad, A., 2007). Nabegu 2008 tested solid wastes from three residential zones of Kano metropolis i.e., suburban area, city and GRA. The study showed the bacterial isolates from the dumps varied in the three regions. This variation has implication for the frequency of collection, storage, transport disposal, choice and suitability of equipment's, health of the inhabitants and economics. The most serious health risks are due to human fecal matter, the decomposition of solids into constituent chemicals contaminating both air and water systems. Burning of dumps release methane and also causes air pollution. J Weststrate 2023 concludes from his findings that government needs to invest in sanitation especially in dense low-income urban areas which face high health risks and also explore alternatives to onsite sanitation. Adhikari et al., 2013 observed that the fresh leachate has relatively higher amount of BOD5 and CODcr and they concluded that the leachate composition is greatly affected with age of waste composition and percentage of organic content. A. C. Oyelami et al., 2013, An active dumpsite in Oshogbo metropolis was investigated for the leachates and found all major ions within the permissible limits of both standards, except chloride and sodium in some of the wells, probably due disinfectant addition and weathering of feldspars that characterize the basement rocks. For most of the trace metals, the concentrations were below detectable limits, except for zinc, iron, and manganese. However, iron and zinc concentrations fall well within the acceptable limit of both WHO and NSDWQ standards, while manganese concentrations were above the limit in most of the surface and shallow groundwaters downslope of the dumpsite. Ugwoha & Emete, 2015 studied the effect of Alakahia dumpsite on groundwater quality was examined and compared with the WHO and Federal Ministry of Environment Standards for drinking water. The physico-chemical parameters and heavy metal concentrations for the dumpsite leachate were generally well above the Standards, indicating that the leachate could contaminate groundwater. Solid waste management handling and disposal also depends on the income group to which people belong as per the report of Peter Schübeler 1996 it was found that households of educated class particularly high and middle class stored their waste covered plastic waste bins whereas most of the household in the low-class areas used uncovered metal waste bins.

Asim & Nageswara Rao, 2021studied the surface waters of river Yamuna using heavy metal pollution index (HPI) approach. Metals such as iron (Fe), copper (Cu), cobalt (Co), zinc (Zn), lead (Pb), cyanide (CN), nickel (Ni), and chromium (Cr) in selected sites of Yamuna River water were determined by using atomic absorption Home Environmental Monitoring and Assessment Article Search Log in spectrophotometer. It was found that about 85% of the river was highly polluted and drinking it is not recommendable. The standards for different end uses should be reviewed based on a more realistic approach, gradual and strategic implementation of the standards should be ensured setting achievable targets. The policy makers should set some incentives to reduce pollution, change some policies such as the 'polluter pays' and tax credits for sustainable initiatives (Bichi and Bello, 2013).

The study at Hyderabad, India assessed the impact of MSW dumpsite on groundwater bodies for both pre- as well as post-monsoon. They examined poor water quality according to WQI, for about 75% of the tested water samples. As per BIS standards water was unfit for neither drinking nor domestic purposes. It was also examined by the Spatial patterns obtained by GIS using inverse distance weighted interpolation technique that certain parameter concentrations were high due to solid waste degradation due to rainfall, especially during the post-monsoon. The study suggests for leachate treatment before disposal onto land, and continuous monitoring of groundwater wells is required to minimize potential health hazards and pollution control (Kamble and Saxena 2016). Obeta & Ochege, 2014 study found that streams of Nigeria have obvious amounts of physical, chemical and biological pollutants however some parameters tested for returned mean values, found below the WHO limits for consumption. To meet the Millennium Development Goal of clean and quality water supply in Nigeria, the surface water pollution must be tackled. The study also recommends the government to educate the citizens about voluntary actions through which household wastes can be properly managed and bring in new policies to improve dumpsite conditions or recycle the wastes.

1.1 Water Quality Standards and Guidelines

The standards and guidelines for every country is set to regulate the permissible levels of contaminants into various water sources. However, the degradation of water quality has attracted the attention of WHO in efforts to promote a worldwide response to water quality deterioration. The WHO Guidelines for Drinking Water Quality (GDWQ) covers the Physical, chemical and microbiological aspects of water quality. With the reference to WHO guidelines, a statutory institution BIS was established under the Bureau of Indian Standards Act, 1986 to certification of goods and attending to connected matters in the country. This research used the IS 10500 standards in the analysis of the Physico-chemical and biological analysis.

1.2 Waste management in Mangalore City

The Health Department handles the Solid waste management which is one of the most pressing problem faced due to rapid urbanization & changing lifestyles so much so, over the past few years; just handling this Municipal Solid Waste (MSW) is a major proportion in organizational, financial and environmental challenges. Despite the fact that MSW management being a major task of the local government, the urban local bodies are unable to provide effective services. Crude open dumping in low lying areas done by the urban local bodies results in foul smell, breeding of flies and generation of leachates posing serious threats to the underground-water-reserves. The Mangalore City Corporation produces an average of 220 TPD of wastes, with a daily collection frequency of 200 TPD. The waste thus collected has a composition of organic (60%), inorganic (25%), combustible (5%) and recyclable wastes (10%).

2 Location of the study area

The study was conducted at the municipal solid waste dumping site at pachanady Vamanjoor, Mangalore during the year September 2019 to March/April 2020. The Mangalore city is located in the confluence of Nethravathi and Gurupura rivers located at 12°52′N latitude and 74°49′E longitude bounded by Western Ghats in the east and by the Arabian Sea in the west. Study period includes the monsoon season i.e., August/September 2019 until dry season April 2020. The regions annual rainfall varies from 3000 mm to 3500 mm 90% received in the monsoon period, while temperature varies from 17ºC to 37ºC. The dumpsite pachanadi Vamanjoor is an urban area administrated by Mangalore City Corporation.

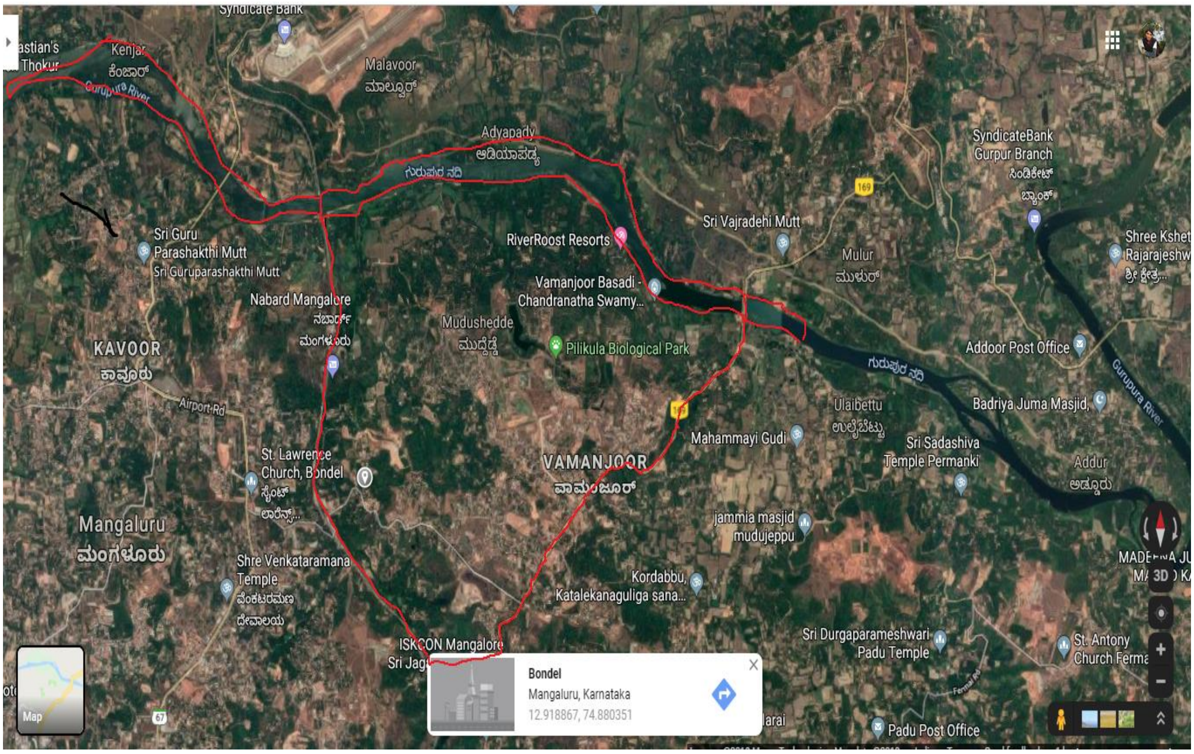

Fig. 1 Sampling point and the dumpsite

2.1 Climatic condition

Mangalore has a tropical monsoon climate receiving the southwest monsoon from the Arabian sea spanning from May to October, while remaining extremely dry from December to March. Mangalore receives an annual precipitation of 3649 millimeters with approximately 75% humidity on an average during May, June and July months. The humidity and heat are lowest from December to February and temperatures during the day stay below 30 °C (86 °F) and drop to about 19 °C (66 followed by a hot summer, from March to May, when temperature (100 °F).

Soils

The area is covered with lateritic soil characterized by higher iron content as well as aluminum content with red and yellow loamy colour. They are formed during Pleistocene period. The soil texture soil varies from fine to coarse in valleys and in intermediate slopes it is rich in loam whereas in upper slopes it is much coarse and gravelly in nature. These soils are derived by weathering from peninsular gneisses. They have good infiltration capacity with infiltration rate of 1 to 3 cm/hr. Th thickness of lateritic soils range from less than 2m to as high as 20m. The thickness of the soil cap is less in valley portions, while ridges have more thick soils.

2.2 Geology and hydrology

The area forming the part of hard rock terrain comprises of Archean peninsular gneisses with lateritic cap. These rocks are exposed in a valley located northeastern boundary of the study area. These rocks trend North East- south west and East - West and dips almost vertically. They are medium grained, grey in color, foliated and almost massive in nature with limited number of joints, fractures and quartz felspathic veins. Weathered zone of the rocks covered with laterites and lateritic soils are ranging in age from Pleistocene to recent.

Laterite occurs extensively and occupies a large part of the 50 km belt legging between the sea and the edge of Sahyadri Mountains. Laterite is one of the most widespread rocks in Coastal Karnataka. It is almost invariably surface formation like soil and is found covering. Gneissic rocks in the form of a sheet. Porous laterite can be defined as a product of intense rock weathering, generally reddish in colors, consisting mainly of Kaoline, gibbsite, goethite and quarz; having a vesicular and vermicular appearances. It is generally soft and can be cut into blocks of different sizes with a spade, but becomes very hard on exposure. The exposed surface is generally dark brown in colour. When broken, the rock is mottled with various shades of red, brown and yellow. It generally gives place to lithomarge clay and depth. On account of this property, it is widely used as an excellent building stone in coastal be in parts of Malnad. Compositionally, it is a mixture of hydrated oxide of iron admixture of clay. Meteorologically region falls in Costal Karnataka. There are many rain gauge stations in the area. Most stations were established in 1901, while the other gauges stations were thereafter. In view of the scantiness and variability in duration of these rain data only data of Mangalore station, which is incidentally the taluk head quarter station and located near the study region has been used for detailed analysis in the present study.

2.3 Total Waste Generation

The area coming under the jurisdiction of Mangalore City Corporation produces an average of 310 TPD of wastes, with a daily collection frequency of 320 TPD. The waste collected has a composition of 60% organic matter, with a per capita generation of about 512 g per day as on year 2018-19. The solid waste management project at the pachanady vamanjur dump yard on the city outskirts is run by Antony Waste Handling Ltd. Mangalore, it has multiple violations of environmental laws causing health hazards. For example, the foul smell emanating from the dumping yard has been taking a toll on the health of over 1 lakh residents of the nearby colonies. The stench is distinctly noticeable even in the residential areas about 7-8 km from the dumping yard. 90% waste are unprocessed and directly dumped to open land.

Sanitary landfill methods are not followed which leads the leachate to contaminate the ground and surface water.

2.4 Sampling methods and procedures

The collection of samples from 14 wells and the river was done during September 2019 and February 2020. The surface water samples were collected in 1.5-to-2.0-liter water bottles. The bottles were first cleaned with 10% Nitric acid, rinsed with distilled water, and then rinsed three times with the sampled water at the sites. Samples for the wells were filled in the 1.5 litres of sample bottles direct from the tap after sterilization of the sampling equipment transported to the Environmental Engineering laboratory of the department of civil engineering.

2.5 In-situ Measurements

The Physical parameters; Electrical conductivity, pH were determined in the field immediately after collection. The pH was measured using digital pH meter. Electrical Conductivity was determined using digital conductivity meter

3 Preparation of stock solutions and standard

3.1 Iron stock solution and standards

3.1.1 1.4N Dilute Hydrochloric acid:

Take about 500ml Distilled water in a beaker. Add 332 ml concentrated HCl slowly and mix it. Make it up to 1000ml.

3.1.2 Stock iron solution of ferrous ammonium sulphate, (0.2mg/l):

Slowly add 20ml Conc. Sulfuric acid to 50ml Distilled water and Dissolve 1.404g ferrous ammonium sulfate $Fe(NH_4)_2(SO_4)_26H_2O$. Add 0.1N Potassium permanganate, KMNO4 (0.3g/100ml – require approximately 35ml) drop wise until faint pink persists. Dilute to 1000ml (1ml = 2µg)

3.1.3 Standard Iron solution, (0.10 mg Fe/ml): Dilute the above (2) at 1:1 ratio 4. 5% Potassium Thiocyanate solution: Dissolve 5g of Potassium Thiocyanate in Distilled water and make it up to 1000ml

3.2 Atomic absorption (AA) spectrometer

The Atomic absorption (AA) spectrometer is used to analyze metals at very low concentrations, typically in the parts per million (ppm) or parts per billion (ppb) ranges. A liquid sample containing dissolved material whose concentration is to be measured is aspirated into a thin, wide AA flame, or is introduced into a small carbon furnace which is heated to a high temperature. In this project it is used for lead, Zinc, Iron

3.3 Basic Principle-AAS:

AAS is the measurement of absorption of radiation by free atoms. The total amount of absorption depends on the number of free atoms present and the degree to which the free atoms absorb the radiation. At the high temperature of the AA flame, which may be either oxy-acetylene as used here, or nitrous KSCST: Student Project Programme: 43rd series: 2019-2020 – Stream A 8 oxide/acetylene, the sample is broken down into atoms and it is the concentration of these atoms that is measured

3.4 Data analysis and presentation methods

Data on the levels of pollutants in the wells and stream water will analyse using descriptive statistics to obtain means. Correlation analysis will perform through cross tabulations to determine the relationship between the level of pollutants in the surface and Ground water as compared to the seasons and distances from dumping sites

3.5 Analytical Methodology

The initial reconnaissance survey within Vamanjoor city near Municipal dumping site, total of 14 wells and one river gurupura. The wells close to the dumping site will selected both upstream and downstream. The stream was equally sampled along the wells and close to the dumping site. The direction of flow and their proximity to the sampled wells and nearness to the surface leachate flow from the dumping site determined the choices of the sampling points. The collection of samples from wells and the surface water will collect from the rainy season of August, September and early October 2019 and the winter period of late October, November, December 2019, January, February 2020 and summer season of later March April 2020.

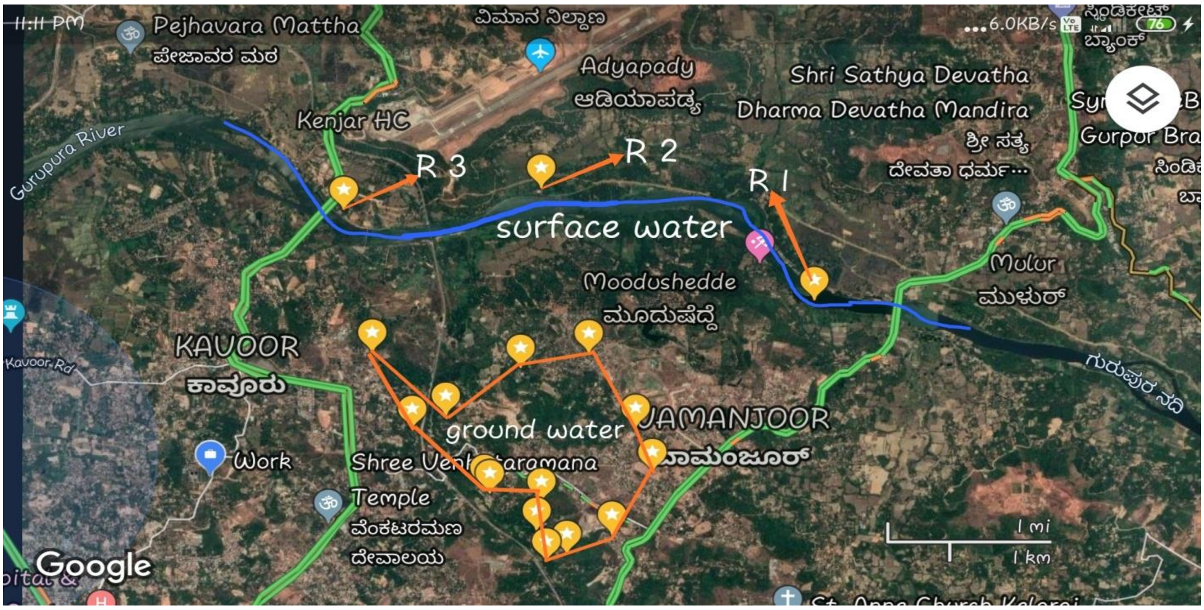

Fig. 2 selected locations for surface and ground water samples

The direction of flow and their proximity to the sampled wells and nearness to the surface leachate flow from the dumping site determined the choices of the sampling points. The collection of samples from wells and the surface water will collect from the rainy season of August, September and early October 2019 and the winter period of late October, November, December 2019, January, February 2020.

4 Results and discussions

The study investigated the effects of solid waste dumping on water quality in Mangalore Municipality. The chapter contains three sections. The first section describes the levels of pollutants in the wells and surface water and compares them to the recommended standards by IS 10500.

4.1 Levels of pollutants in the wells and stream water as compared to guidelines provided by IS-10500 for portable water

4.1.1 pH

The pH of surface and groundwater were measured (Fig 3, 4 and table 4.1, 4.2). The results in Table 1 & 2 shows that the pH in ground & stream water ranged from 6.0 to 7.80. Table 1 & 2 indicates that the mean pH in wells and stream during September 2020 – February 2020. The average pH during the study was within the guidelines and in acceptable range. The pH value indicates a neutral to alkaline leachate, which suggests a methanogenic stage.

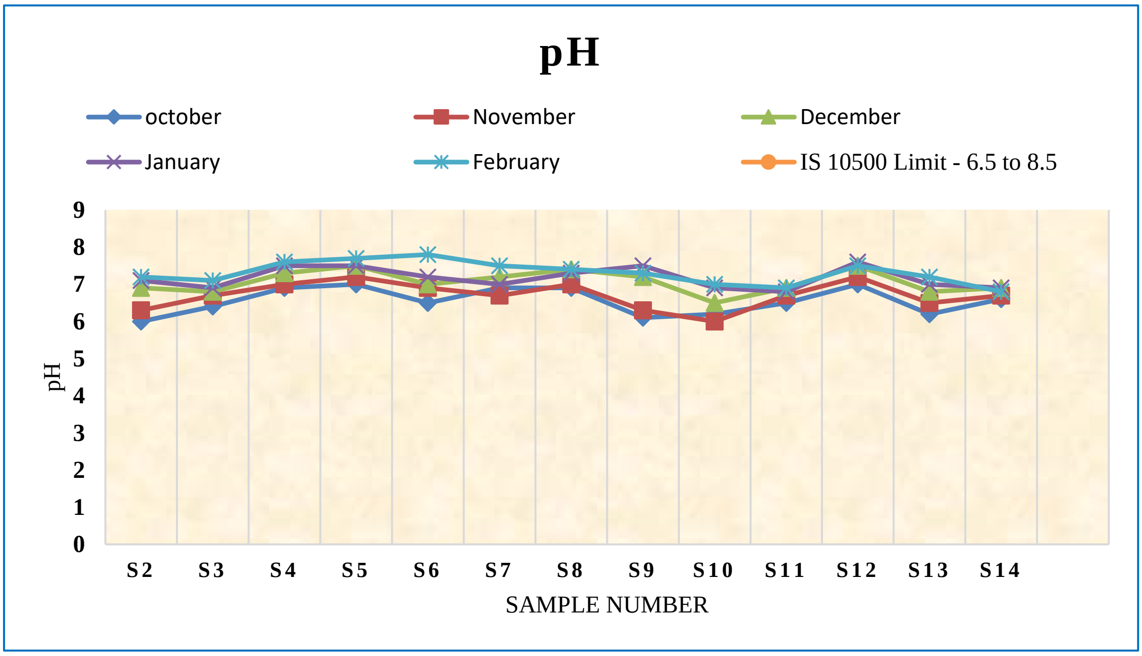

Fig. 3 pH Values for the Fourteen Sampling Points

Sample Numbers	September	October	November	December	January	February	Mean
S1	6.3	6.1	6.1	6.5	7	7	6.5
S2	6.2	6	6.3	6.9	7.1	7.2	6.6
S3	6.5	6.4	6.7	6.8	6.9	7.1	6.7
S4	7.4	6.9	7	7.3	7.5	7.6	7.3
S5	7.6	7	7.2	7.5	7.5	7.7	7.4
S6	6.7	6.5	6.9	7	7.2	7.8	7.0
S7	6.5	6.9	6.7	7.2	7	7.5	7.0
S8	7.2	6.9	7	7.4	7.3	7.4	7.2
S9	6.1	6.1	6.3	7.2	7.5	7.3	6.8
S10	6	6.2	6	6.5	6.9	7	6.4
S11	6.4	6.5	6.7	6.9	6.8	6.9	6.7
S12	6.9	7	7.2	7.5	7.6	7.5	7.3
S13	6	6.2	6.5	6.8	7	7.2	6.6
S14	6.8	6.6	6.7	6.9	6.9	6.8	6.8

Table 1 pH Values for the Fourteen Sampling Points

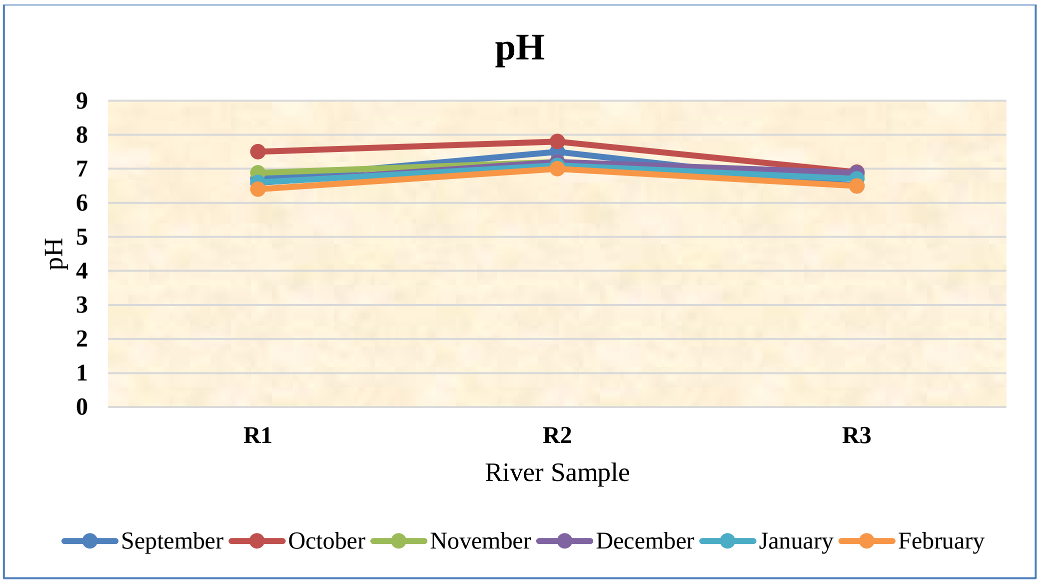

Fig. 4 pH Values for the Stream Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	6.7	7.5	6.88	6.59	6.6	6.4	6.8
R2	7.5	7.8	7.2	7.2	7.1	7	7.3
R3	6.5	6.9	6.8	6.88	6.7	6.5	6.7

Table 2 pH Values for the Stream Sampling Points

4.1.2 Electrical Conductivity of Water

The electrical conductivity (EC) for wet and dry seasons as compared to IS 10500 guideline is presented in Fig. 5 and table 3. The location of the wells/ bore wells (S1 to S14) and sampling points (S1 to S14) respectively from the dumpsite. The results in Fig.6 and table 4 indicates that Electrical Conductivity (EC) of the well water was high in range from 600 and 1774µS/cm across different period with an average concentration of 653µS/cm. The highest desirable level of EC at 250 C is 750µS/cm A high value of EC indicates high concentration of anions and cations. The water samples near dumping site (S1 to S4)) had high concentration of EC and exceeded the highest desirable level. It is a clear indication of the effect of dumping site on the groundwater quality.

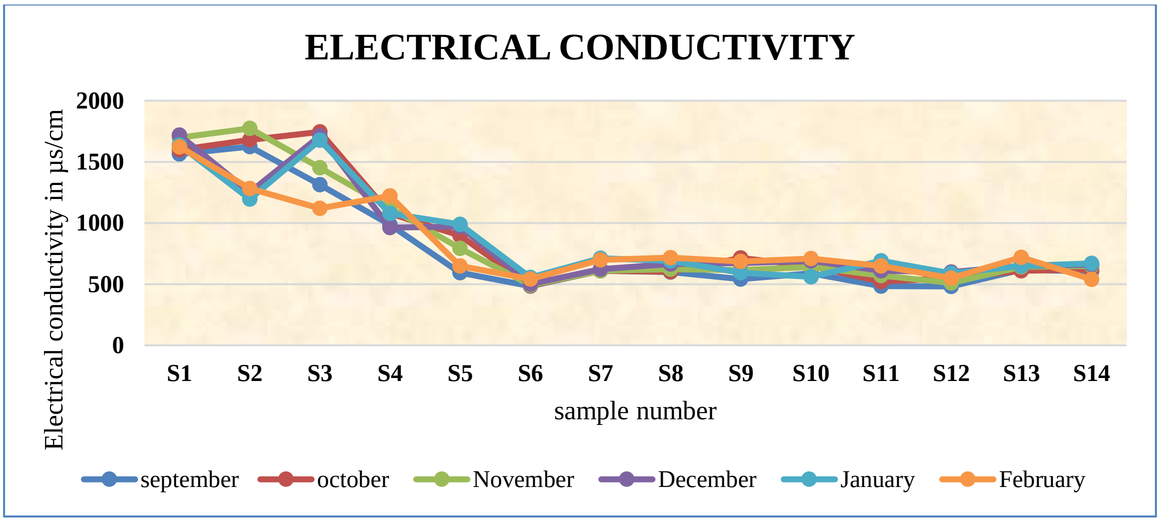

Fig. 5 EC Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	1564	1598	1697	1718	1637	1623	1640
S2	1625	1679	1774	1252	1195	1281	1468
S3	1314	1745	1452	1712	1678	1121	1504
S4	987	1079	1125	963	1079	1223	1076
S5	593	898	793	971	989	650	816
S6	484	488	493	501	555	543	511
S7	609	609	611	622	712	698	644
S8	599	601	623	665	691	718	650
S9	542	715	614	673	593	685	637
S10	588	650	640	690	560	710	640
S11	483	520	570	610	690	650	587
S12	482	550	510	600	590	550	547
S13	617	610	640	650	650	690	643
S14	605	620	650	660	670	540	624

Table 3 EC Values for the Fourteen Sampling Points

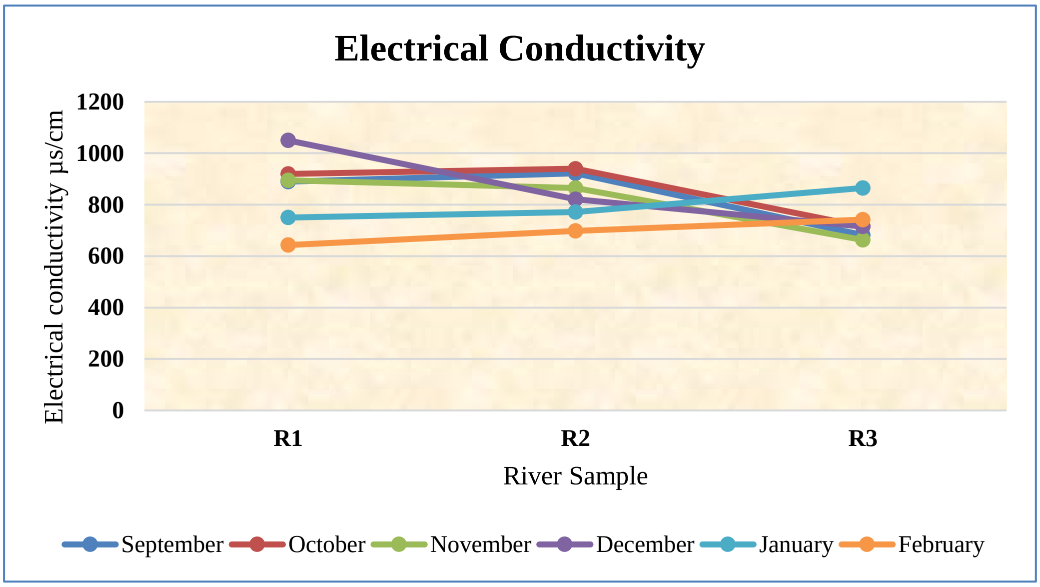

Fig. 6 EC Values for the Stream Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	890	920	895	1050	750	643	858
R2	922	940	865	821	771	698	836
R3	682	715	663	715	865	742	730

Table 4 EC Values for the stream Sampling Points

4.1.3 Turbidity

The mean values for this parameter ranged from 0.2 to 31.5 NTU for well sample and 17.5 to 3.5 NTU for stream sample as shown in (Fig. 7 & 8 and Table 5 & 6). Some of the sampling points values recorded were higher than the IS 10500 value of 5 NTU. The high turbidity value could be due to the siting of the landfills/dumpsites close to the water bodies. It could also be due to indiscriminate disposal of waste into the water bodies

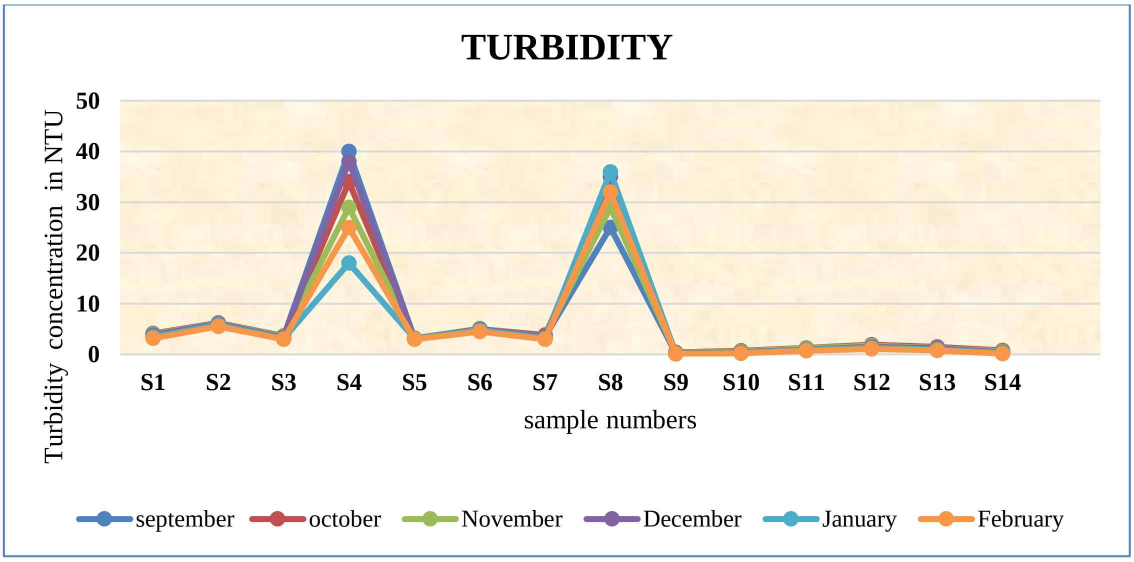

Fig. 7 Turbidity Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	4	4.1	4	3.8	3.5	3.2	3.8
S2	6	6.2	6.1	6	5.8	5.5	5.9
S3	3.5	3.6	3.5	3.3	3.1	3	3.3
S4	40	34	29	38	18	25	30.7
S5	3.1	3.2	3.2	3.1	3.1	3	3.1
S6	5	5	5.1	5	4.8	4.5	4.9
S7	3.5	3.8	3.5	3.4	3.2	3	3.4
S8	25	32	29	35	36	32	31.5
S9	0.2	0.4	0.3	0.2	0.15	0.1	0.2
S10	0.6	0.7	0.6	0.4	0.3	0.2	0.5
S11	1.2	1.3	1.2	1	0.9	0.7	1.1
S12	1.8	1.9	1.7	1.5	1.3	1.1	1.6
S13	1.3	1.5	1.3	1.2	1	0.8	1.2
S14	0.5	0.8	0.6	0.4	0.25	0.15	0.5

Table 5 Turbidity Values for the Fourteen Sampling Points

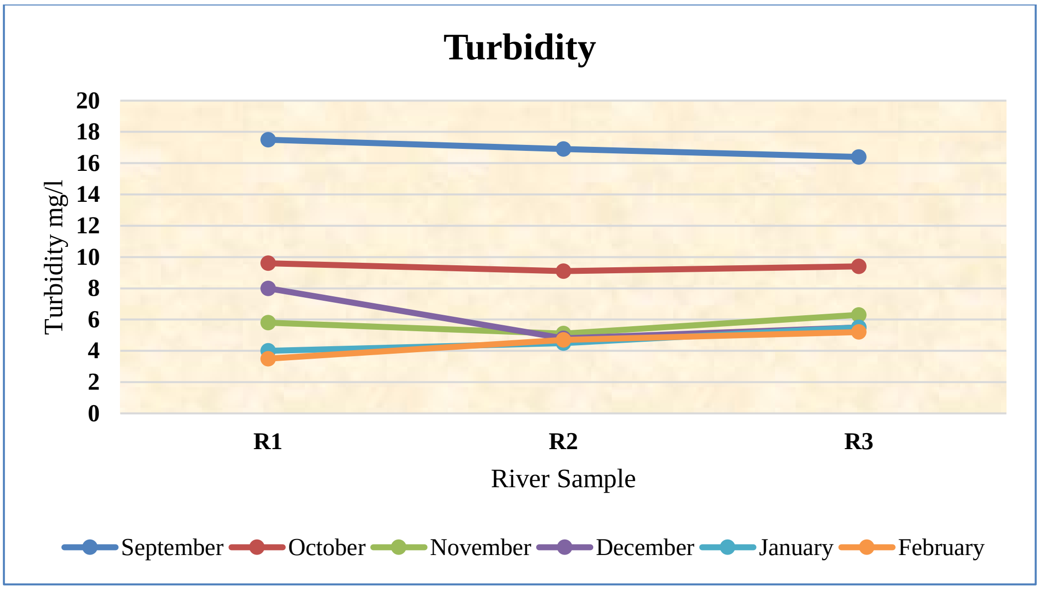

Fig. 8 Turbidity Values for the Stream Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	17.5	9.6	5.8	8	4	3.5	8.1
R2	16.9	9.1	5.1	4.8	4.5	4.7	7.5
R3	16.4	9.4	6.3	5.5	5.5	5.2	8.1

Table 6 turbidity Values for the stream Sampling Points

4.1.4 Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) were high in the range of 81 and 872 mg/L across different period of study in the study area (Table 7 & 8). The highest values of TDS were recorded at S1, S2, S3 and S4 which are very closer to the dump-site and exceeded the maximum allowable limit of 500mg/L for drinking water (IS 10500- 2012) depicted in Fig. 9, 10. The concentration of EC and TDS were high during the months of January and February irrespective of well location. The presence of high amounts of inorganic materials might have attributed for highest values of TDS in the well water sampled near to the dumping site. The groundwater pollution from the vicinity of the dumping sites is detectable through the increased TDS concentration in water.

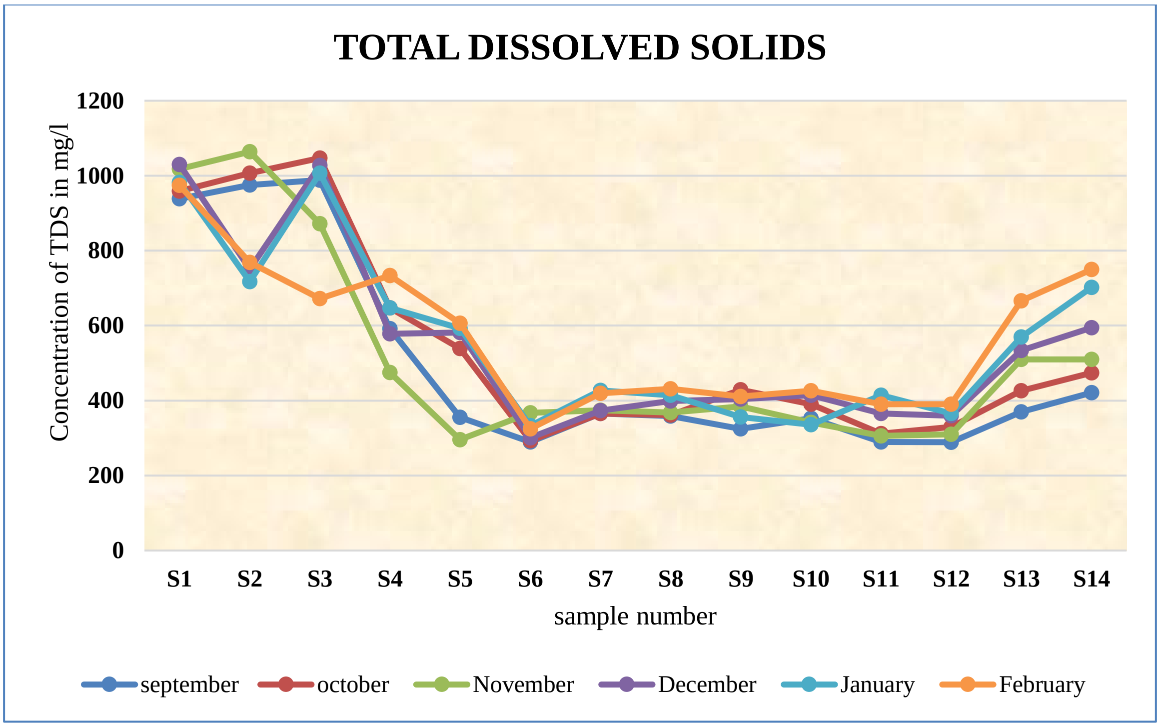

Fig. 9 TDS Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	938	959	1018	1030	982	974	983.5
S2	975	1007	1064	751	717	769	880.5
S3	988	1047	872	1027	1007	672	935.5
S4	592	647	475	578	647.4	734	612.2
S5	355	539	296	582	593	606	495.2
S6	290	293	367	301	333	325	318.2
S7	366	366	374	373	427	419	387.5
S8	359	361	368	399	414.6	431	388.8
S9	325	429	384	404	356	411	384.8
S10	353	390	342	414	336	426	376.8
S11	290	312	306	366	414	390	346.3
S12	289	330	310	360	366	390	340.8
S13	370	426	510	534	570	666	512.7
S14	421	474	510	594	702	750	575.2

Table 7 TDS Values for the Fourteen Sampling Points

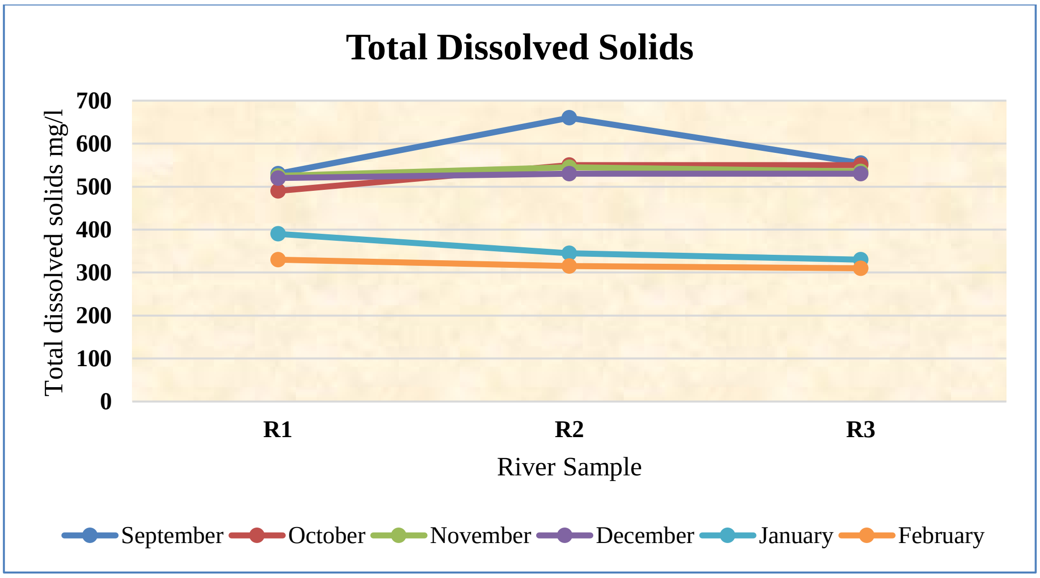

Fig. 10 TDS Values for the Stream Sampling Points

Sample Number	September	October	November	December	January	February
R1	530	490	525	520	390	330
R2	660	550	545	530	345	315
R3	555	550	535	530	330	310

Table 8 TDS Values for the stream Sampling Points

4.1.5 Chloride

Chloride were Normal in the range of 118 and 334 mg/L across different period of study in the study area (Table 9 & 10) both stream and well sample. The highest values of Chloride were recorded at S8, S9 and S13. Chloride is not harmful to human at low concentration but could alter the taste of water at concentration above 250 mg/l (Fig.11&12).

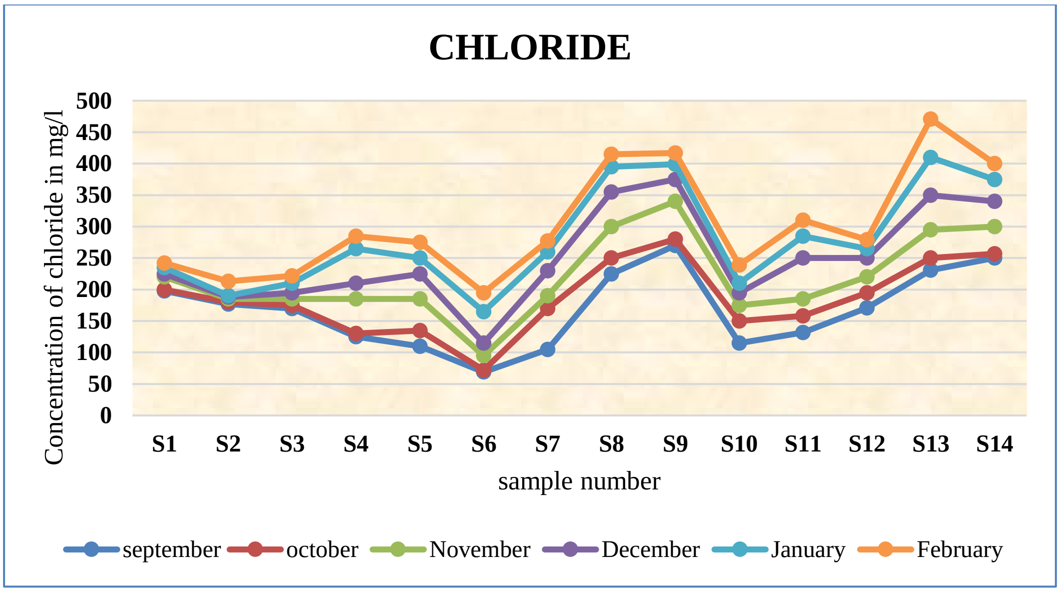

Fig. 11 Chloride Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	198	200	220	225	235	242	220.0
S2	177	180	185	188	190	213	188.8
S3	170	175	185	195	210	222	192.8
S4	125	130	185	210	265	285	200.0
S5	110	135	185	225	250	275	196.7
S6	69	72	95	115	165	195	118.5
S7	105	170	190	230	260	277	205.3
S8	225	250	300	355	395	415	323.3
S9	270	280	340	375	399	417	346.8
S10	115	150	175	195	210	239	180.7
S11	132	158	185	250	285	310	220.0
S12	171	195	220	250	265	279	230.0
S13	231	250	295	350	410	471	334.5
S14	250	257	300	340	375	400	320.3

Table 9 Chloride Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	155	154	152	152	151	418	197.0
R2	167	166	165	163	160	158	163.2
R3	175	178	172	171	170	170	172.7

Table 10 Chloride Values for the stream Sampling Points

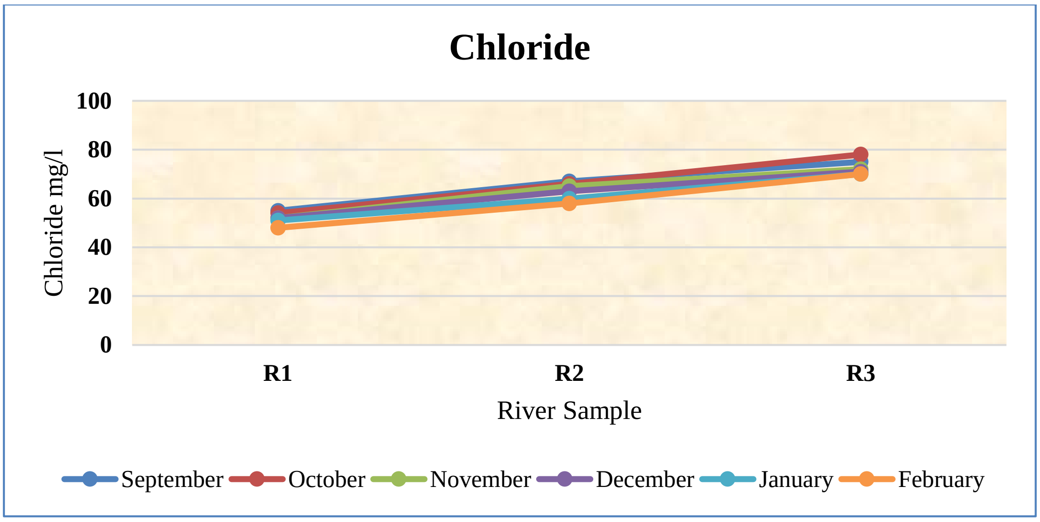

Fig. 12 Chloride Values for the Stream Sampling Points

4.1.6 Total Hardness

Hardness is one of the important properties of ground water from utility point of view particularly for domestic purposes. The Total Hardness (TH) was found in range of 140 to 300 mg/L in well and 45 to 47.5 mg/l in stream sample Fig. 13, all the analyzed water samples fall within the maximum allowable limit of 600mg/L (IS 10500 -2012).

Highest values were recorded during rainy season. Total hardness is normally expressed as the total concentration of Ca2+ and Mg2+ in mg/L, equivalent $CaCO_3$. The Fig. 14 shows that total hardness is high in the vicinity of the landfill. However, concentration was also high at W17, this may be due to dissolution of polyvalent metallic ions from sedimentary rocks, seepage, and runoff from the adjacent site (Table 11 & 12).

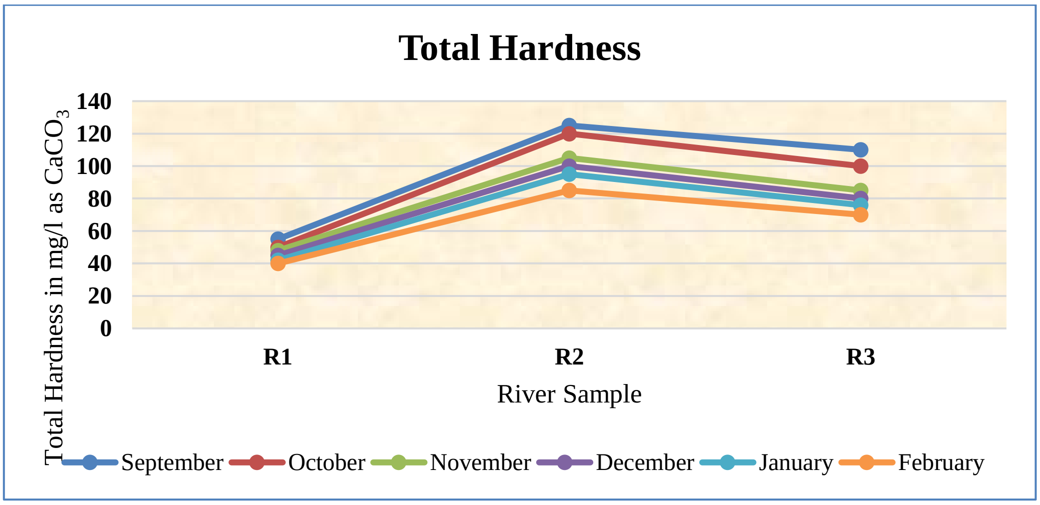

Fig. 13 Total Hardness Values for the Stream Sampling Points

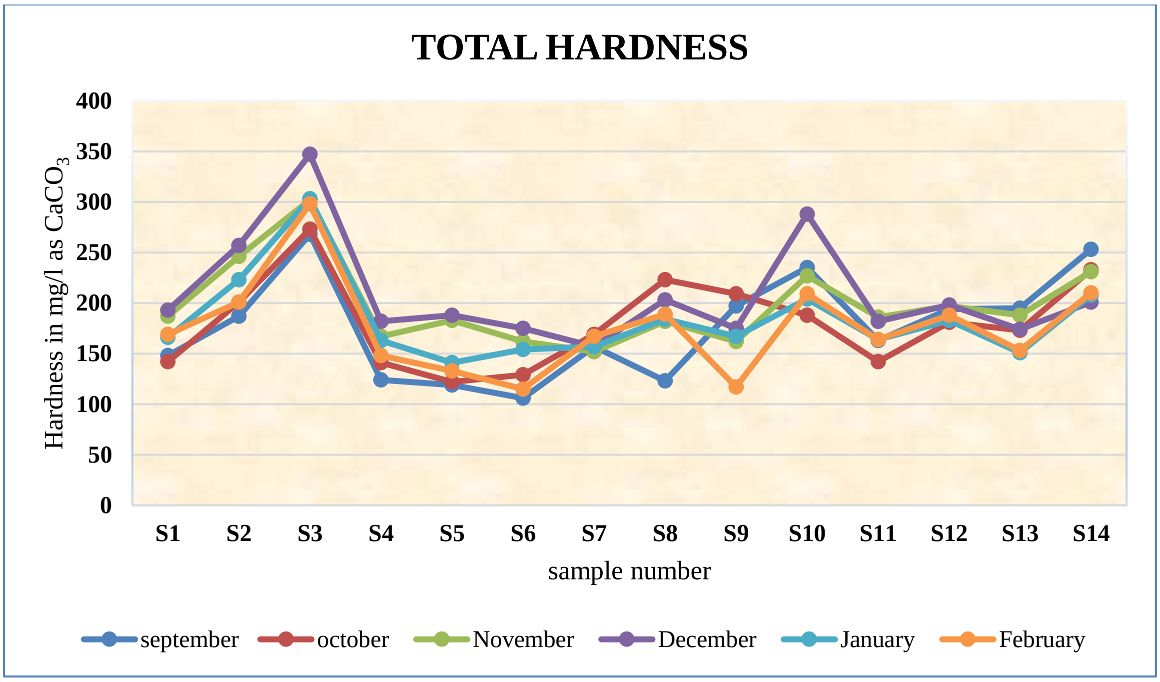

Fig. 14 Total Hardness Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	148	142	187	193	166	169	167.5
S2	187	201	246	257	223	201	219.2
S3	268	273	302	347	303	298	298.5
S4	124	141	167	182	163	148	154.2
S5	119	122	183	188	141	133	147.7
S6	106	129	162	175	154	115	140.2
S7	157	169	152	157	157	167	159.8
S8	123	223	182	203	184	189	184.0
S9	197	209	162	175	167	117	171.2
S10	235	188	227	288	204	209	225.2
S11	163	142	186	182	164	164	166.8
S12	194	181	197	198	183	188	190.2
S13	195	173	188	174	151	153	172.3
S14	253	233	231	201	208	210	222.7

Table 11 Total Hardness Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	55	50	48	45	42	40	46.7
R2	45	60	45	50	35	35	45.0
R3	40	50	52	48	56	39	47.5

Table 12 Total Hardness Values for the stream Sampling Points

4.1.7 Total Alkalinity

The total alkalinity in the well water and stream water is as shown in Table 11 & 12. The results from both Fig. 15 & 16 shows that the total alkalinity levels within the prescribed limits. The total alkalinity was found to be in the range of 166 to 300 mg/l in ground water samples and 88.3 to 93.4 mg/l as $CaCO_3$.

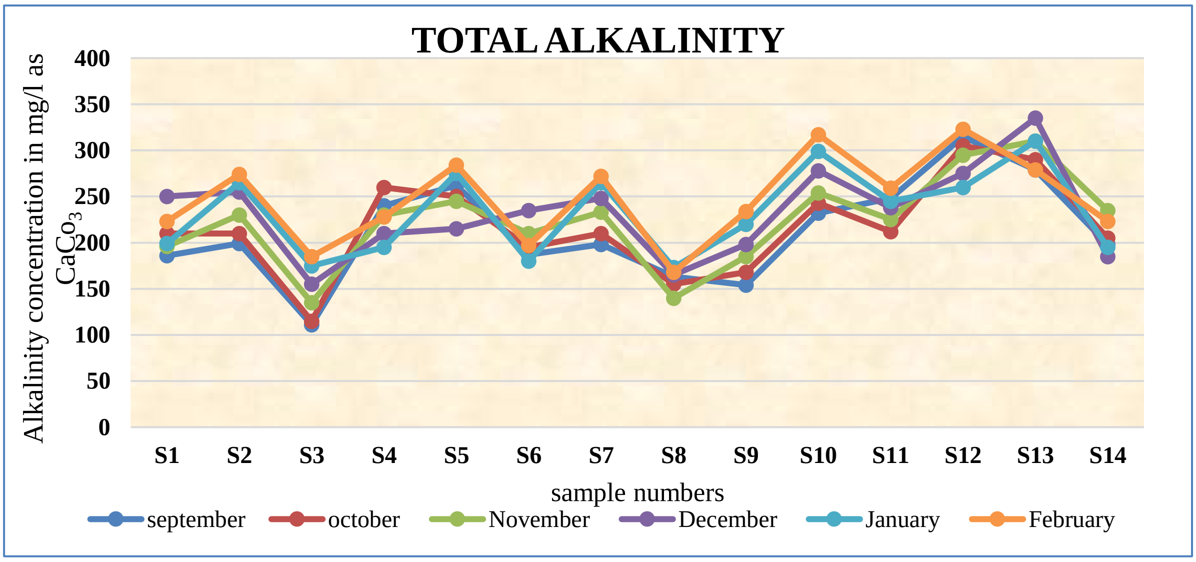

Fig. 15 Total Alkalinity Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	186	210	196	250	199	223	210.7
S2	199	210	230	255	265	274	238.8
S3	111	115	135	155	175	185	146.0
S4	240	260	230	210	195	228	227.2
S5	262	250	245	215	275	284	255.2
S6	187	195	210	235	180	197	200.7
S7	198	210	233	248	265	272	237.7
S8	163	155	140	165	173	168	160.7
S9	154	168	185	198	220	234	193.2
S10	232	243	254	278	299	317	270.5
S11	248	212	225	238	245	259	237.8
S12	315	305	295	275	260	323	295.5
S13	279	290	310	335	310	279	300.5
S14	198	205	235	185	195	223	206.8

Table 13 Total alkalinity Values for the Fourteen Sampling Points

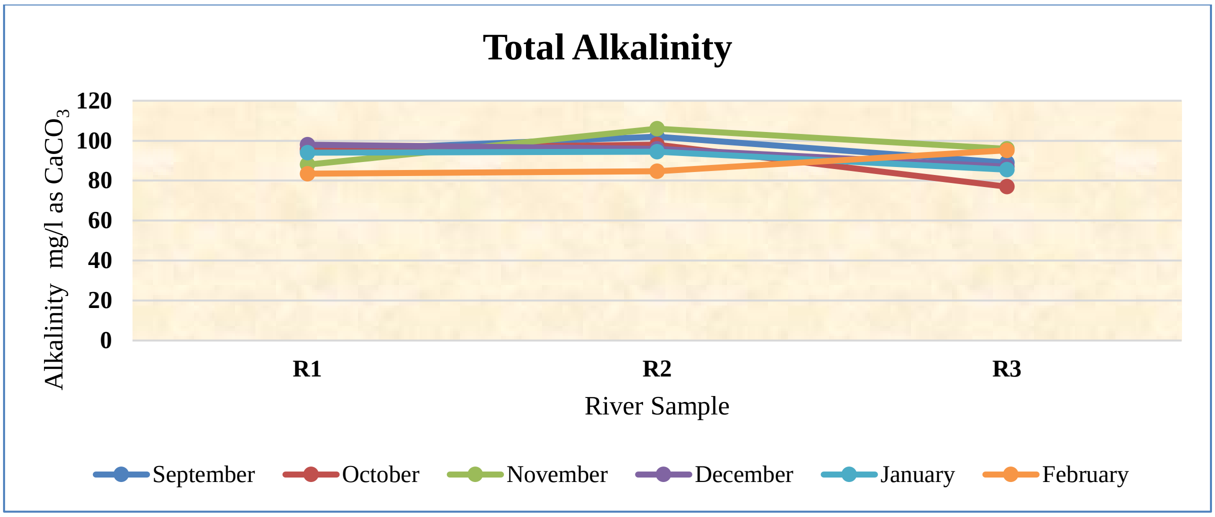

Fig. 16 Total alkalinity Values for the Stream Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	95	96	88	98	94	83.5	92.4
R2	102	98	106	96	94.5	84.7	96.9
R3	89	77	96	87	85.5	95.2	88.3

Table 14 Total alkalinity Values for the stream Sampling Points

4.1.8 Iron

Iron in rural ground supplies is a common problem. It is a concentration levels ranges 50 mg/l, while WHO recommended level is < 0.3 mg/l. The concentration of iron is of in the Ground water and distance of the well from the dumpsite in dry and wet reasons measured respectively. The results from ground water Fig.17 & 18 shows that the iron levels extremely increased as one moved from the wells downstream to the wells upstream. Iron concentration high in the range of 0.2 and 14.6 mg/L across different period of study in the study area (Table 15 & 16). The highest values of Iron were recorded at S2, S4, S8 and S11 which are vicinity to the dump-site and exceeded the maximum allowable limit of 0.3 mg/L for drinking water (IS 10500- 2012) and stream water concentration are within permissible limit.

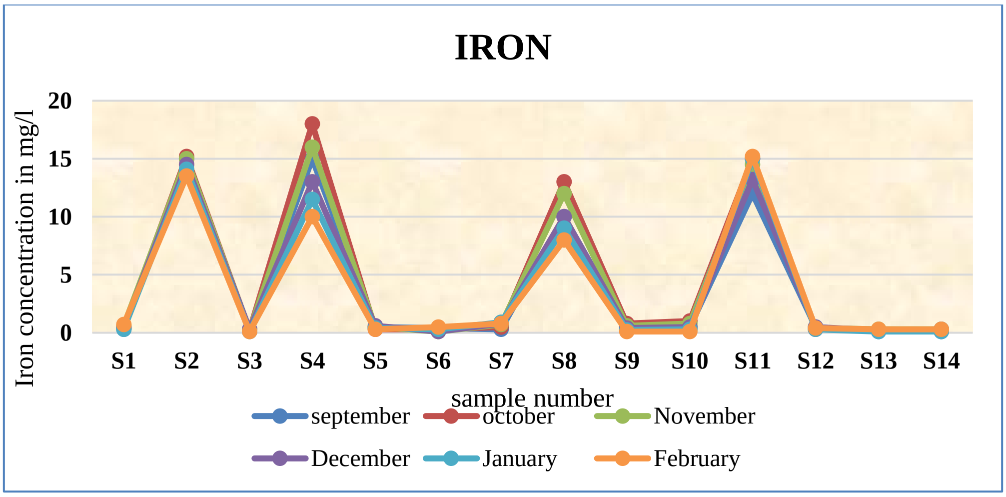

Fig. 17 Iron Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
S1	0.3	0.4	0.6	0.5	0.3	0.7	0.5
S2	15	15.2	15	14.5	14.1	13.5	14.6
S3	0.2	0.2	0.2	0.3	0.1	0.1	0.2
S4	15	18	16	13	11.5	10	13.9
S5	0.5	0.3	0.5	0.6	0.4	0.3	0.4
S6	0.4	0.3	0.1	0.1	0.3	0.5	0.3
S7	0.3	0.5	0.7	0.8	0.9	0.8	0.7
S8	10	13	12	10	9	8	10.3
S9	0.5	0.8	0.6	0.4	0.25	0.1	0.4
S10	0.5	1	0.8	0.5	0.3	0.1	0.5
S11	12	15	14.5	13.2	15	15.2	14.2
S12	0.5	0.3	0.4	0.5	0.3	0.4	0.4
S13	0.1	0.2	0.3	0.2	0.1	0.3	0.2
S14	0.1	0.2	0.3	0.3	0.1	0.3	0.2

Table 15 Iron Values for the Fourteen Sampling Points

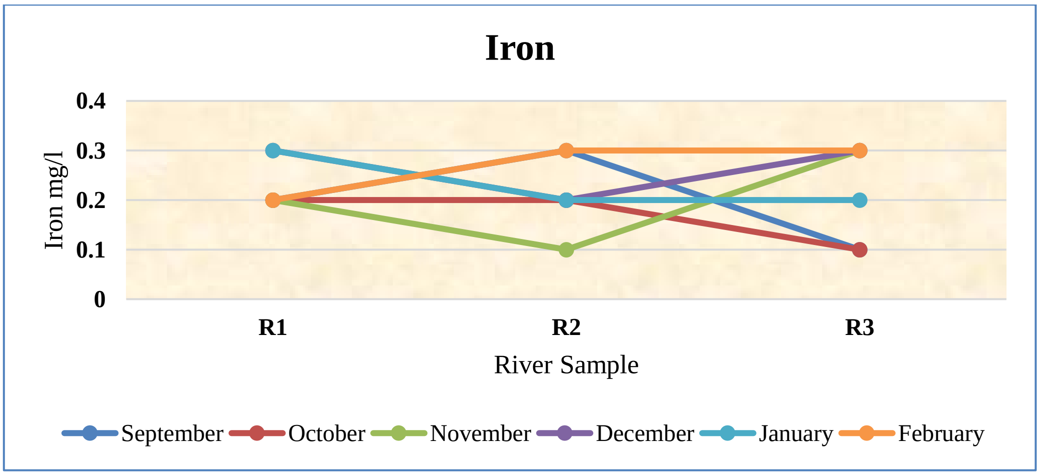

Fig. 18 Iron Values for the Stream Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	0.2	0.2	0.2	0.3	0.3	0.2	0.2
R2	0.3	0.2	0.1	0.2	0.2	0.3	0.2
R3	0.1	0.1	0.3	0.3	0.2	0.3	0.2

Table 16 Iron Values for the stream Sampling Points

4.1.9 Dissolved Oxygen

The correlations between levels Dissolved oxygen in the surface well water and distance of the well from the dumpsite in dry and wet reasons conducted respectively. The results from both Fig. shows that the Dissolved oxygen levels within the prescribed limits. DO of ground water samples were found in the range of 3.5 to 5.0 mg/l in groud water and 6.5 to 6.8 mg/l in stream, due to the capacity of water to hold oxygen (Fig. 19 & 20) (Table 17 & 18).

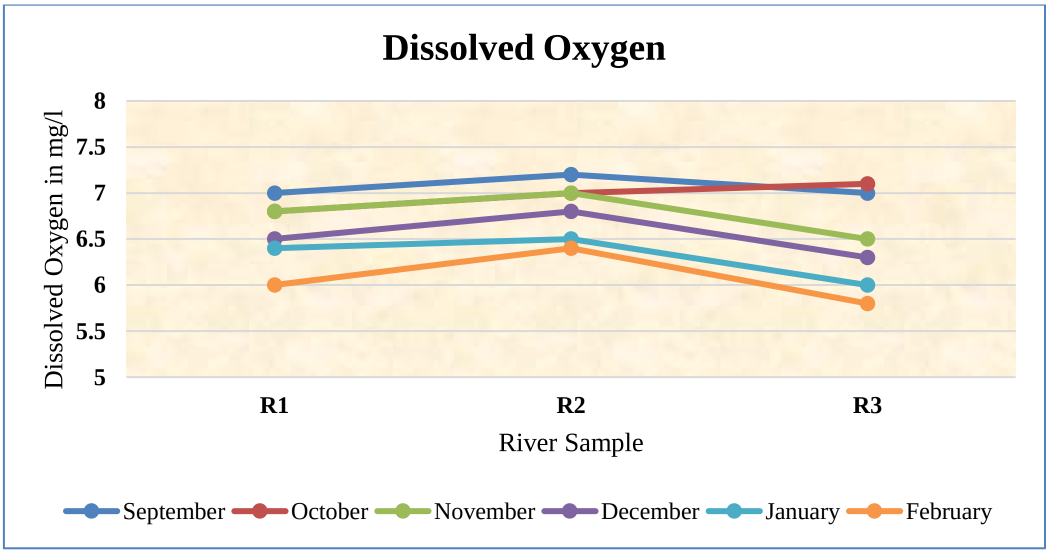

Fig. 19 D.O Values for the Stream Sampling Points

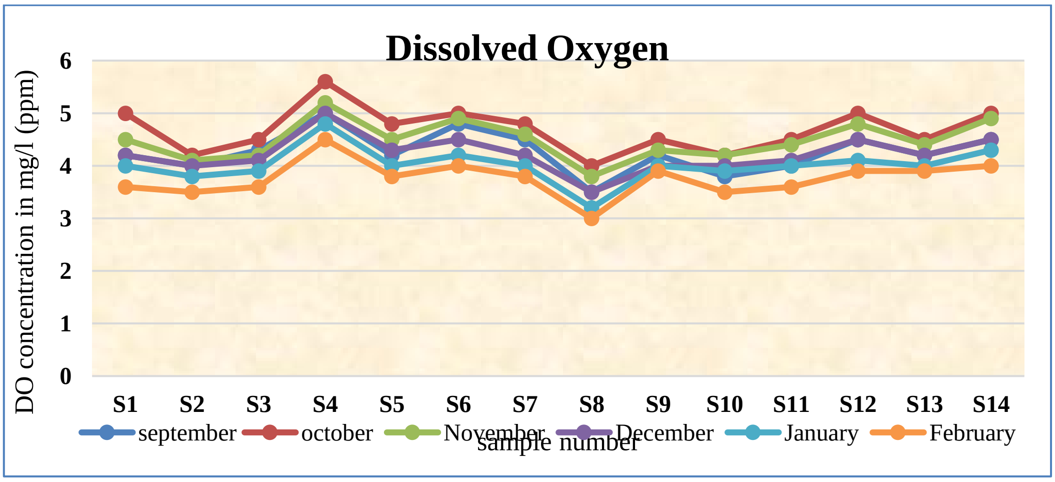

Fig. 20 DO Values for the Fourteen Sampling Points

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Sample Number	September	October	November	December	January	February	Mean
S1	4.2	5	4.5	4.2	4	3.6	4.3
S2	4	4.2	4.1	4	3.8	3.5	3.9
S3	4.3	4.5	4.2	4.1	3.9	3.6	4.1
S4	5	5.6	5.2	5	4.8	4.5	5.0
S5	4.2	4.8	4.5	4.3	4	3.8	4.3
S6	4.8	5	4.9	4.5	4.2	4	4.6
S7	4.5	4.8	4.6	4.2	4	3.8	4.3
S8	3.5	4	3.8	3.5	3.2	3	3.5
S9	4.2	4.5	4.3	4	4	3.9	4.2
S10	3.8	4.2	4.2	4	3.9	3.5	3.9
S11	4	4.5	4.4	4.1	4	3.6	4.1
S12	4.5	5	4.8	4.5	4.1	3.9	4.5
S13	4.2	4.5	4.4	4.2	4	3.9	4.2
S14	4.5	5	4.9	4.5	4.3	4	4.5

Table 17 DO Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	7	6.8	6.8	6.5	6.4	6	6.6
R2	7.2	7	7	6.8	6.5	6.4	6.8
R3	7	7.1	6.5	6.3	6	5.8	6.5

Table 18 D.O Values for the stream Sampling Points

4.1.10 Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) is used to determine the quantity of oxygen demanding waste in water. Based on this study, BOD at all well sample location ranges from 2.0 – 72.1 mg/L and stream water ranges from 6.3 – 6.5mg/l. Presence of high concentration of organic matter in the groundwater may be the reason for high BOD. On the other hand, high BOD values (5 – 10 mg/L) indicate the presence of water with high amounts of organic contaminants or water of low quality (Fig. 21 & 22). BOD Values for the Fourteen Sampling Points and three stream Sampling Points are as shown in (Table 19 & 20).

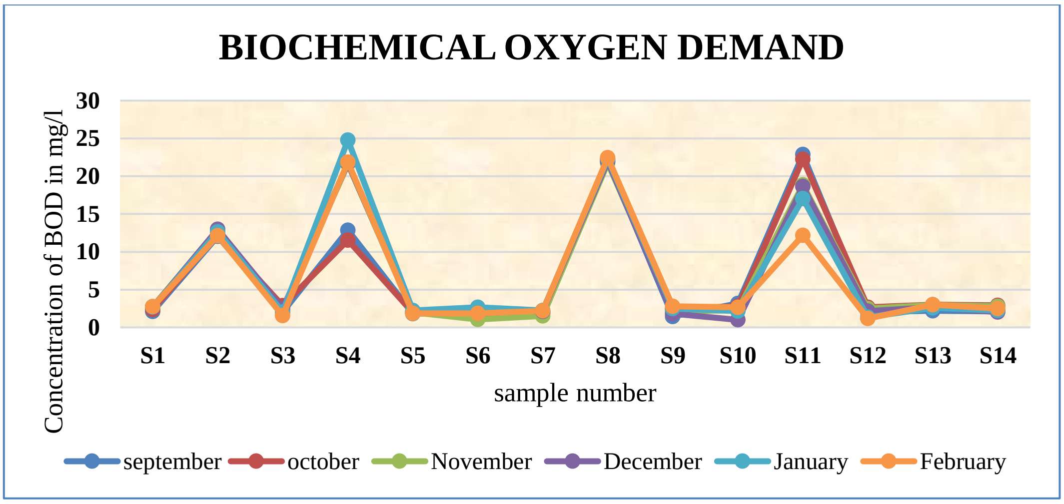

Fig. 21 BOD Values for the Fourteen Sampling Points

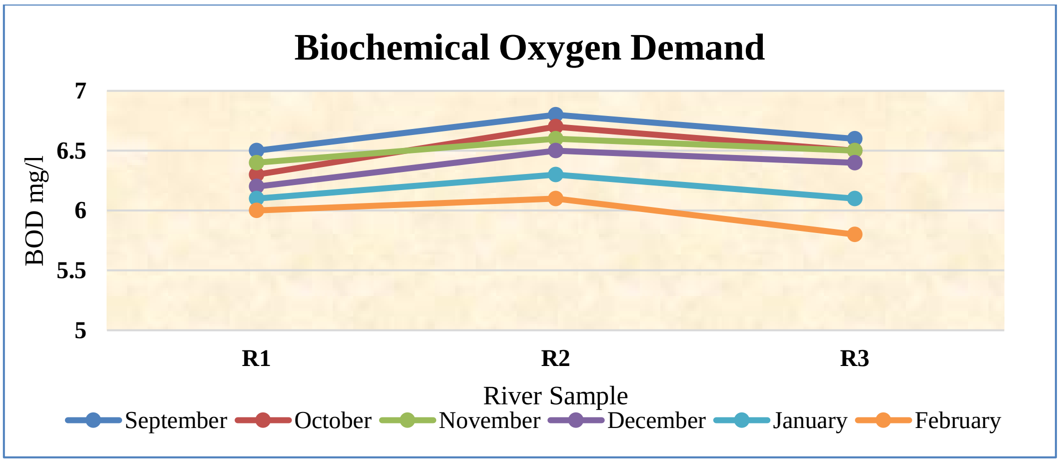

Fig. 22 BOD Values for the Stream Sampling Point

Sample Number	September	October	November	December	January	February	Mean
S1	2.1	2.36	2.76	2.65	2.7	2.77	2.6
S2	12.06	12.27	12.92	13	12.65	12.13	12.5
S3	2.01	2.89	2.34	2.45	2.02	1.57	2.2
S4	12.86	11.53	21.6	21.7	24.78	21.85	19.1
S5	1.82	1.93	1.98	2.05	2.25	1.87	2.0
S6	1.97	1.87	1.05	2.5	2.65	1.87	2.0
S7	1.87	1.93	1.53	2.1	2.25	2.18	2.0
S8	22.18	21.9	21.75	21.98	22.3	22.46	22.1
S9	1.46	2.45	2.1	1.8	2.5	2.78	2.2
S10	3.16	2.78	2.3	1	2.15	2.67	2.3
S11	22.86	22.26	18.85	18.65	17.05	12.19	18.6
S12	2.05	2.67	2.5	2.15	1.35	1.17	2.0
S13	2.19	3	2.95	2.68	2.56	3.02	2.7
S14	2.1	2.9	2.78	2.03	2.23	2.5	2.4

Table 19 BOD Values for the Fourteen Sampling Points

Sample Number	September	October	November	December	January	February	Mean
R1	6.5	6.3	6.4	6.2	6.1	6	6.3
R2	6.8	6.7	6.6	6.5	6.3	6.1	6.5
R3	6.6	6.5	6.5	6.4	6.1	5.8	6.3

Table 20 BOD Values for the stream Sampling Points

IS 10500 – 2012 Drinking Water specification

Sl no	Parameters	IS 10500- 2012
1	pH	6.5 -8.5
2	Electrical Conductivity	750µS/cm
3	Turbidity	1 - 5 NTU
4	Total Dissolved Solids	500 – 200m mg/l
5	Chloride	250 – 1000 mg/l
6	Total Hardness	200 – 600 mg/l
7	Total Alkalinity	200 – 600mg/l
8	Iron	0.3 mg/l
9	Dissolved oxygen	4 – 5 mh/l
10	Biochemical Oxygen Demand	0 -10 mg/l

Table 21 IS 10500 -2012 Drinking water standards

5. CONCLUSIONS

The Physical parameters measured show that pH, Electrical conductivity, Iron, Total dissolved solids concentration values exceeded the IS10500 guidelines for drinking water. The presence of high load of bacteria in both surface and ground water samples mean that leachate is altering the water quality of water in the vicinity of the dumpsite. Bacteriological concentration of water from all sampling sites exceeded the IS10500 standards. Hence, the water in the vicinity of the dumpsite presents significant threat to public health. Any use of this water especially for domestic purposes should be disallowed, as its use will lead to waterborne diseases such as cholera and typhoid.

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