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RESEARCH ARTICLE

STUDY OF GROUND WATER QUALITY OF BHOPAL CITY, MADHYA PRADESH, INDIA

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ABSTRACT

Ground water is one of the major alternative resources of the drinking water in Bhopal city, Madhya Pradesh, India. For present ground water study, Bhopal city is divided in to four corridors. North west, north east, south east, south west part of Bhopal city considered as corridor I, II, III and IV respectively. Nineteen monitoring locations were selected around at Bhopal city assessed for ground water quality for human consumption. Study of all physico -chemical parameters of ground water was carried out during different four quarters of year 2016 to 2018. All monitoring was done as per standard guidelines followed by Central Pollution Control Board and analyzed by standard methods. It is concluded that high contamination in ground waters observed in Corridor II as compare to three corridors of Bhopal city. Govindpura industrial area, transport, MSW dumping site, dense vehicle zone and anthropogenic activities are main reason of high contamination observed in corridor II of Bhopal city. All activities, which carried out on the ground level have direct or indirect impact on the groundwater whether associated with urban, agricultural activities large scale concentrated source of pollutants such as industrial discharge, chemicals and hazardous are source of ground water pollutants.

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INTRODUCTION

Ground water is an invaluable commodity available in very limited quantities to human being and other living beings. The usefulness of ground water to a great extent depends on its chemistry (Singh and Choudhary, 2011). The Composition of ground water is influenced mainly by geology, Climate, Hydrogeology and also human activities (Telebi *et al.,* 1994). The quality of ground water is generally considered superior than surface water, since the soil column purifies the contaminants in water through processes such as anaerobic decomposition, filtration, ion exchange etc. However, over exploitation of this vital resource may lead to decreasing the level of water and deteriorate the quality; hence it is very important to assess the ground water quality not only for present use but also potential sources of water for future consumption. Safe drinking water is prior need of every human being. Most of the person mainly depends upon the subsurface water resources, especially in our study area means in Bhopal city the newly developed colonies are fully depend on the ground water (Sharma *et al.,* 2014).

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The importance of ground water has been continuously increasing since last couple of decades because of uncertainties of the surface water resources, population growth and industrial development. Because of dependability of ground water resources, there has been indiscriminate use and mismanagement leading to its scarcity and deterioration of quality (Sahoo, 2003). It has excellent natural quality, usually free from pathogens, color and turbidity and can be consumed directly without treatment (Jain *et al.,* 2003). The problems of ground water quality in several parts of the country have become so acute in the areas that are densely populated and thickly Industrialized and have shallow ground water tube wells (Dutta *et al.,* 2011). There are many sources that contribute contaminants to the ground water, e.g. land disposal of solid wastes, disposal on land, agricultural activities, urban runoff and polluted surface water. The quality of water is of vital concern for man since it is directly related to the human health. The most common and widespread health risk associated with drinking water is microbial contamination which has the potential to cause large outbreaks of water born diseases like dysentery, cholera, typhoid, skin infections etc. The chemical contaminations do not cause immediate, acute health problems unless they are present in massive quantities through some accident and use of drinking water sources (Dwivedi *et al.,* 2016).

The dependence on the groundwater sources is increasing with the rapid expansion in the city limits. As the laying of pipelines is not able to keep pace with the rate of urbanization, the new developing areas of the city depend by and large on the groundwater sources for potable water. Groundwater is contained in the lower strata of ground and is therefore relatively away from direct human intervention. It is believed that pathogens also could not penetrate to the depths of the aquifer and therefore the groundwater is used for drinking purposes without any treatment. However, the results of previous investigation reveal that the groundwater sources of Bhopal city are contaminated both chemically and biologically (Jotwani *et al.,* 2014). Therefore this two years study is important for know the quality of ground water of Bhopal city.

METHODOLOGY

Study Area: Bhopal city is the capital of Madhya Pradesh which is very well connected to all the corners of the country situated in the central part of India. It lies between N-latitude 23°07' & 23°20' and E- longitude 77°19' & 77°31'. Bhopal is also known as the Lake Cityhttp://en.wikipedia.org/wiki/Bhopal#cite_note-2 for its various natural as well as artificial lakes and is one of the greenest cities in India. The population of Bhopal Municipal Corporation as per census 2011 is 23,71, 061. The climate is characterized by a hot summer and well distributed rainfall during the southwest monsoon season. There are three well defined seasons namely winter, summer and monsoon. The normal annual rainfall is 1260.2 mm. About 92% of the annual rainfall takes place during the southwest monsoon i.e. from July to September. The maximum rainfall (about 39%) occurs in July [wikipedia.org/wiki/Bhopal].

Geologically rocks of upper Vidhyan group comprising of quartzitic sandstone, shales and Deccan trap, occupy Bhopal (Jinwal and Dixit, 2008). The water supply of city mainly depends on surface water sources. The major requirement of drinking water supply in Bhopal city is met from surface water sources. Ground water is also used currently as a supplementary source and the supply is about 22.5 MLD from 42 dug wells, 614 tube wells and 1295 hand pumps. The unaccounted privately owned dug wells and bore wells also cater the requirement of individual households, industries, business complexes, private and government colonies developed in the out skirts of the Bhopal city (Bhopal district ground water information booklet, 2013).

Monitoring Points: Bhopal city is divided into four corridors for this study. North west part of Bhopal city considered as corridor I , north east of part of Bhopal city considered as corridor II, south east of part of Bhopal city considered as corridor III, south west part of Bhopal city considered as corridor IV. Total nineteen locations were selected for ground water monitoring. Details of all monitoring locations are depicted in table 1 and figure 1.

Monitoring and Analysis: All ground water monitoring was done as per standard guidelines followed by Central Pollution Control Board (Guidelines for the water monitoring, CPCB, 2007). Water samples were drawn from bore wells and hand pumps during this study. Samples were analyzed by as per standard methods (APHA, 2017] during this study. All results were compared with standard limits prescribed of drinking water (BIS 10500; 2012].

RESULTS AND DISCUSSION

The physicochemical characteristics of groundwater determine its usefulness for various purposes. Chemical analysis of groundwater includes the determination of the concentrations of inorganic constituent. The study of ground water quality of all selected monitoring locations is depicted in Table 2. The ground water was observed in range of neutral during this two years study is showing in Figure 2. Total solids were observed in the range of 342-752 and 370- 800.5 mg/l during this two years study is showing in Figure 3.

Table 1: Selected sampling locations for ground water monitoring

S.N.	Code	Monitoring Locations	Source of sample
Corridor I (North West of Bhopal)			
1	GW 1	Bairagharh	Hand pump
2	GW 2	Navi Bhag	Hand pump
3	GW 3	Chhola Road	Bore well
4	GW 4	Sultania Road	Bore well
Corridor II (North East of Bhopal)			
5	GW 5	Karod	Bore well
6	GW 6	BHEL Area	Hand pump
7	GW 7	Govindpura	Bore well
8	GW 8	Anand Nagar	Bore well
Corridor III (South East of Bhopal)			
9	GW 9	Arera Colony	Hand pump
10	GW 10	Saket Nagar	Hand pump
11	GW 11	Katara Hills	Hand pump
12	GW 12	Vidhya Nagar	Hand pump
13	GW 13	Babdiya Kalan	Hand pump
14	GW 14	Misrod	Bore well
Corridor IV (South West of Bhopal)			
15	GW 15	Gehun Kheda Kolar	Bore well
16	GW 16	Balmi, Kolar	Bore well
17	GW 17	Kotra	Bore well
18	GW 18	T. T Nagar	Hand pump
19	GW 19	Van Vihar Colony	Hand pump

Chloride in ground water was observed in range of 44.8-134.67 and 27.66-181.7 mg/l during this two years study is showing in Figure 4. Ammonical nitrogen in ground water was observed in range of 0.0-0.1 mg/l during this two years study is showing in Figure 5. Nitrate in ground water were observed in range of 1.16-71.18 and 1.07- 42.3 mg/l during two years study is showing in Figure 6. Total alkalinity in ground water was observed in range of 218-529 and 167.4- 564 mg/l during this two years study is showing in Figure 7. Total hardness as calcium carbonate in ground water was observed in range of 218-529 and 167.4- 564 mg/l during this two years study is showing in Figure 8. Sulphate concentration was observed in range of 19.76 - 72.5mg/l and 12.3 to 72 mg/l during this two years study is showing in figure 9.Fluoride concentration was observed in range of 0.69- 1.47 mg/l and 0.35 to 1.37 mg/l during this two years study is showing in figure 10.Manganese concentration was observed in range of 0.0002- 0.366 mg/l and 0.0 to 0.484 mg/l during this two years study is showing in figure 11. Copper concentration observed in range of 0.003-0.058 mg/l and 0.0-0.001 mg/l during this two year study is showing in figure 12. Zinc concentration observed in range of 0.015-0.59 mg/l and 0.0 to 0.002 mg/l during this two years study is showing in figure 13.Iron concentration observed in range of 0.07- 1.212 mg/l and 0.0 to 1.52 mg/l during this two years study is showing in Figure 14.

Table 2. Ground water quality status of Bhopal city

S.N.	Analytes	Unit	BIS 10500 (2012)		Corridor I							
			Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source	Bairagharh		Navi Bhag		Chhola Road		Sultania Road	
					1^{st} Y	2^{nd} Y	1^{st} Y	2^{nd} Y	1^{st} Y	2^{nd} Y	1^{st} Y	2^{nd} Y
1	pH	pH unit	6.5-8.5	Not Relaxation	7.2	7.6	7.4	7.6	7.2	7.5	7.5	7.0
2	Total Dissolved Solids	mg/L	500	2000	690	542	666	709	510	616	408	418
3	Chloride	mg/L	250	1000	67	66	121	118	65	76	67	58
4	Ammonical Nitrogen	mg/L	0.5	Not Relaxation	0.01	BDL	BDL	BDL	0.01	BDL	0.1	BDL
5	Nitrate	mg/L	45	Not Relaxation	13.7	19.6	30.9	42.3	17.6	17.5	11.4	16.4
6	Total Alkalinity	mg/L	200	600	391	368	415	366	378	300	263	208
7	Total Hardness	mg/L	200	600	405	465	484	405	444	352	300	221
8	Sulphate	mg/L	200	400	46	72	61	39	50	53	27	21
9	Fluoride	mg/L	1	1.5	0.84	0.78	0.98	0.87	0.69	0.95	0.88	0.79
10	Mn	mg/L	0.3	0.1	0.168	0.039	0.172	0.00	0.366	0.043	0.015	0.00
11	Cu	mg/L	0.05	1.5	0.008	ND	0.022	ND	0.003	ND	0.003	ND
12	Zn	mg/L	5	15	0.227	ND	0.492	ND	0.277	ND	0.051	ND
13	Fe	mg/L	0.3	Not Relaxation	0.417	0.101	0.385	0.056	0.475	0.231	0.067	0.086
Remark: 1^{st} Y -2016-17, 2^{nd} Y-2018-19												

Table 2: Continue.

S.N.	Analytes	Unit	BIS 10500 (2012)		Corridor II							
			Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source	Karod		BHEL Area		Govindpura		Anand Nagar	
					1^{st} Y	2^{nd} Y	1^{st} Y	2^{nd} Y	1^{st} Y	2^{nd} Y	1^{st} Y	2^{nd} Y
1	pH	pH unit	6.5-8.5	Not Relaxation	7.6	7.6	7.2	7.4	7.3	7.5	7.2	7.4
2	Total Dissolved Solids	mg/L	500	2000	737	800	668	550	752	797	727	635
3	Chloride	mg/L	250	1000	134	171	52	53	134	181	100	104
4	Ammonical Nitrogen	mg/L	0.5	Not Relaxation	0.01	BDL	0.08	BDL	BDL	BDL	BDL	BDL
5	Nitrate	mg/L	45	Not Relaxation	12.3	23.8	18.3	22.3	13.5	39.8	10.8	33.2
6	Total Alkalinity	mg/L	200	600	347	383	529	243	481	445	426	380
7	Total Hardness	mg/L	200	600	345	421	525	390	467	564	438	442
8	Sulphate	mg/L	200	400	20	40	34	46	38	56	37	47
9	Fluoride	mg/L	1	1.5	1.33	0.87	1.1	0.42	1.2	0.44	1.21	0.41
10	Mn	mg/L	0.3	0.1	0.013	0.020	0.04	0.011	0.012	0.053	0.006	0.012
11	Cu	mg/L	0.05	1.5	0.012	ND	0.008	ND	0.053	ND	0.012	ND
12	Zn	mg/L	5	15	0.19	ND	0.507	ND	0.59	ND	0.145	ND
13	Fe	mg/L	0.3	Not Relaxation	0.092	0.027	0.159	0.051	0.067	0.41	0.07	0.33
Remark: 1^{st} Y -2016-17, 2^{nd} Y-2018-19												

Table 2: Continue.

S.N.	Analytes	Unit	BIS 10500 (2012)		Corridor III											
			Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source	Arera Colony		Saket Nagar		Katara Hills		Vidhya Nagar		Babdiya Kalan		Misrod	
					1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y
1	pH	pH unit	6.5-8.5	Not Relaxation	7.2	7.3	7.2	7.6	7	7.4	7.3	7.2	7.4	7.4	7.3	7.2
2	Total Dissolved Solids	mg/L	500	2000	389	370	391	415	428	777	552	348	672	812	577	777
3	Chloride	mg/L	250	1000	44	28	54	64	59	126	70	41	98	117	109	158
4	Ammonical Nitrogen	mg/L	0.5	Not Relaxation	0.02	BDL	0.06	BDL	BDL	BDL	0.01	BDL	0.01	BDL	0.01	BDL
5	Nitrate	mg/L	45	Not Relaxation	1.1	1.0	4.2	1.4	18.2	22.4	71.1	4.5	36.4	22.3	20.3	10.8
6	Total Alkalinity	mg/L	200	600	369	217	278	293	218	501	449	167	438	407	433	360
7	Total Hardness	mg/L	200	600	347	250	259	328	226	565	462	229	449	599	471	436
8	Sulphate	mg/L	200	400	47	28	42	28	19	47	72	29	39	49	55	32
9	Fluoride	mg/L	1	1.5	0.85	1.37	1.12	0.46	1.03	0.38	1.24	0.35	1.14	0.37	1.47	0.35
10	Mn	mg/L	0.3	0.1	0.082	0.144	0.092	0.033	0.052	0.484	0.007	0.00	0.02	0.00	0.01	0.00
11	Cu	mg/L	0.05	1.5	0.026	ND	0.028	0.00	0.005	ND	0.013	ND	0.029	ND	0.058	ND
12	Zn	mg/L	5	15	0.321	ND	0.305	0.00	0.412	ND	0.102	ND	0.239	ND	0.015	ND
13	Fe	mg/L	0.3	Not Relaxation	0.231	ND	1.212	0.63	1.10	1.52	0.18	0.00	0.782	0.00	0.087	ND
Remark: 1st Y -2016-17, 2nd Y-2018-19																

Table 2. Continue..

S.N.	Analytes	Unit	BIS 10500 (2012)		Corridor IV									
			Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source	Gehun Kheda Kolar		WALMI Kolar		Kotra		T T Nagar		VanVihar Colony	
					1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y	1st Y	2nd Y
1	pH	pH unit	6.5-8.5	Not Relaxation	7.4	7.4	7.3	7.3	7.3	7.3	7.5	7.2	7.2	7.5
2	Total Dissolved Solids	mg/L	500	2000	568	632	450	468	579	745	594	582	342	382
3	Chloride	mg/L	250	1000	52	70	50	27	67	71	48	68	53	47
4	Ammonical Nitrogen	mg/L	0.5	Not Relaxation	0.035	BDL	BDL	BDL	0.035	BDL	0.02	BDL	0.022	BDL
5	Nitrate	mg/L	45	Not Relaxation	16.2	21.8	6.30	12.0	18.8	29.7	22.6	14.0	2.9	5.8
6	Total Alkalinity	mg/L	200	600	0.21	0.65	0.09	0.46	0.19	0.02	0.18	0.09	0.22	0.04
7	Total Hardness	mg/L	200	600	431	353	381	299	362	454	451	378	267	211
8	Sulphate	mg/L	200	400	403	417	358	306	417	515	433	429	251	196
9	Fluoride	mg/L	1	1.5	50	51	40	23	48	49	65	42	21	12
10	Mn	mg/L	0.3	0.1	0.015	0.001	0.002	0.023	0.013	0.033	0.017	0.001	0.047	0.042
11	Cu	mg/L	0.05	1.5	0.005	0.001	0.013	ND	0.015	ND	0.01	ND	0.005	ND
12	Zn	mg/L	5	15	0.057	0.002	0.34	ND	0.377	ND	0.142	ND	0.08	ND
13	Fe	mg/L	0.3	Not Relaxation	0.08	0.041	0.057	0.41	0.27	0.45	0.237	0.00	0.65	0.65
Remark: 1st Y -2016-17, 2nd Y-2018-19														

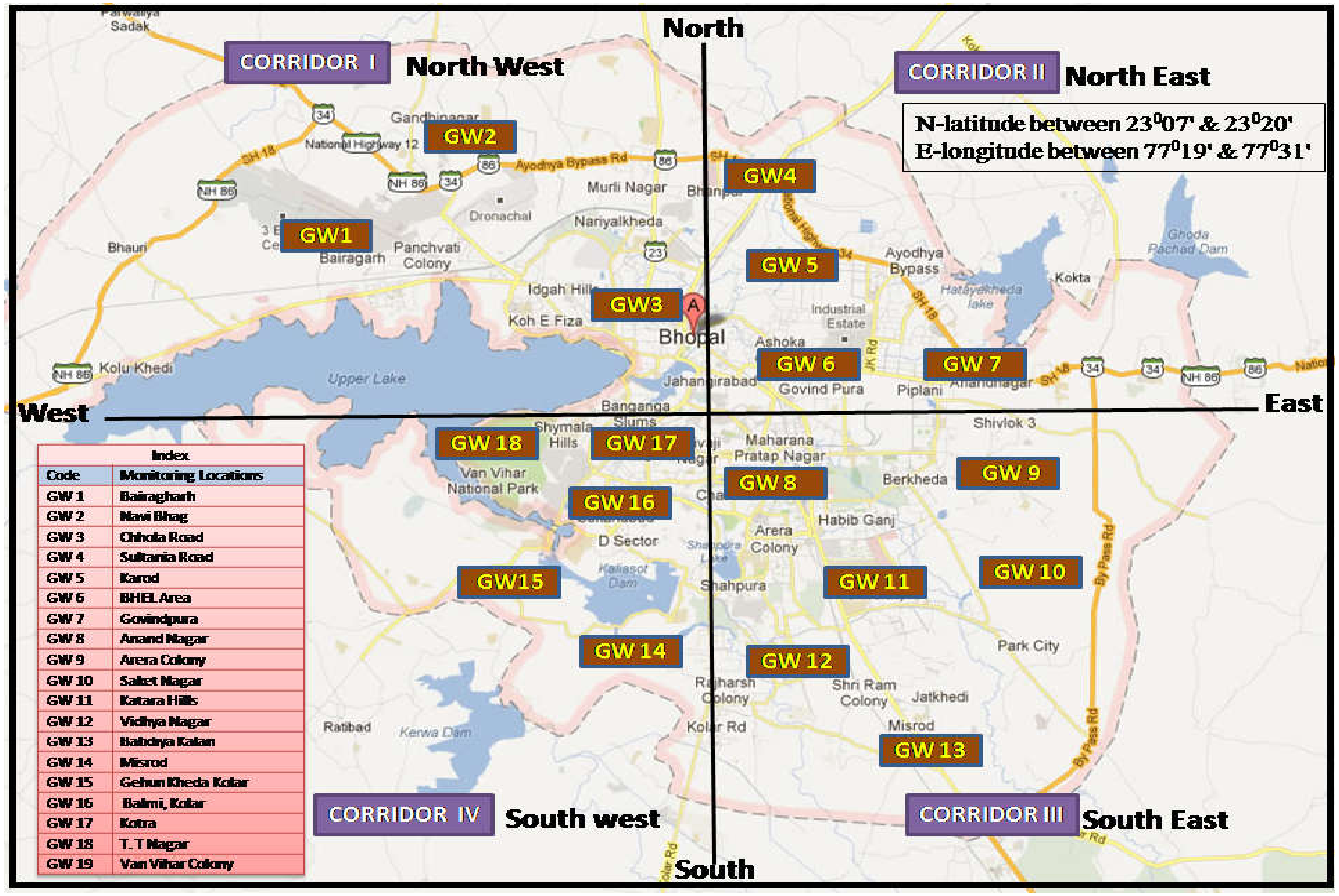

Figure 1. Monitoring locations

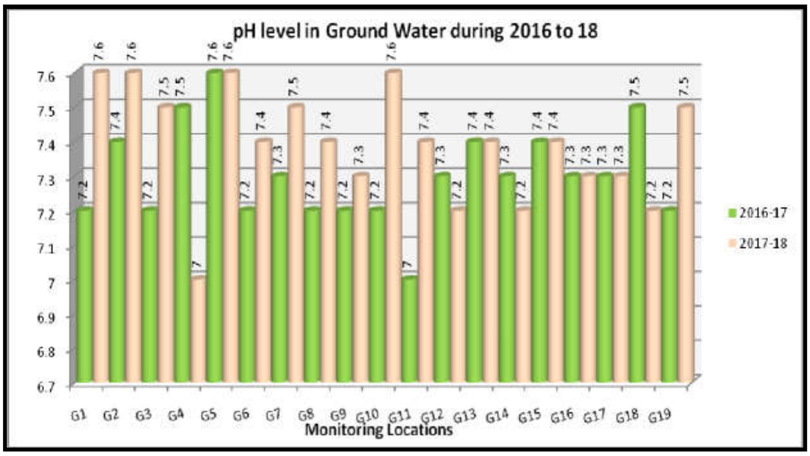

Figure 2: pH level in ground water

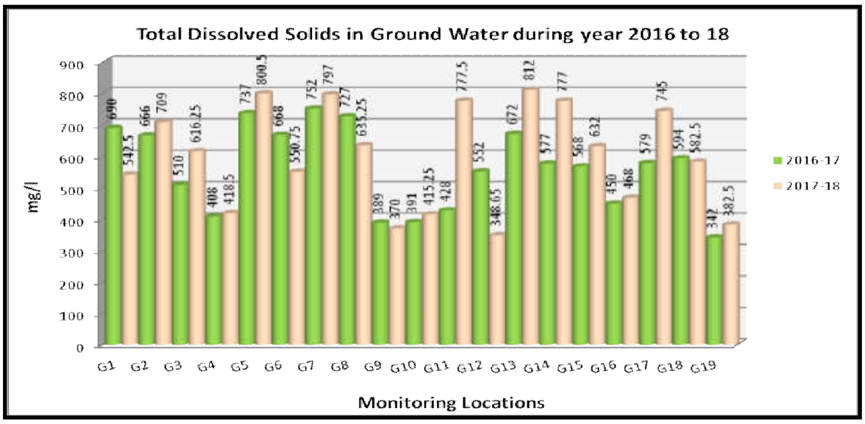

Figure 3. Total dissolved solids concentration in ground water

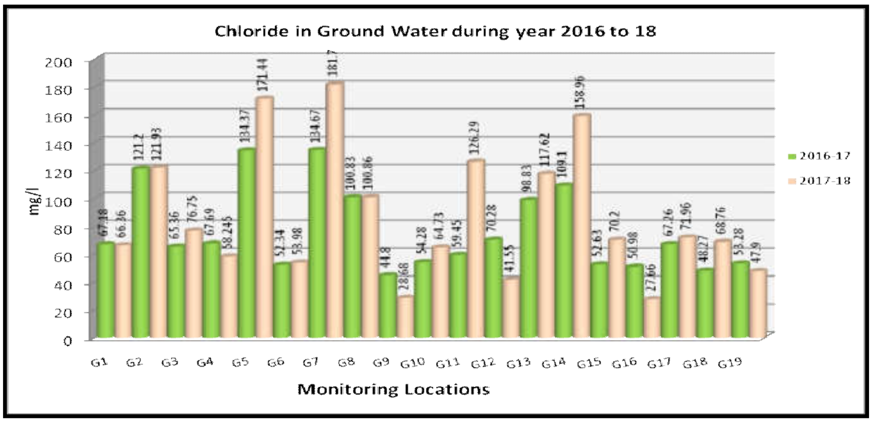

Figure 4. Chloride concentration in ground water

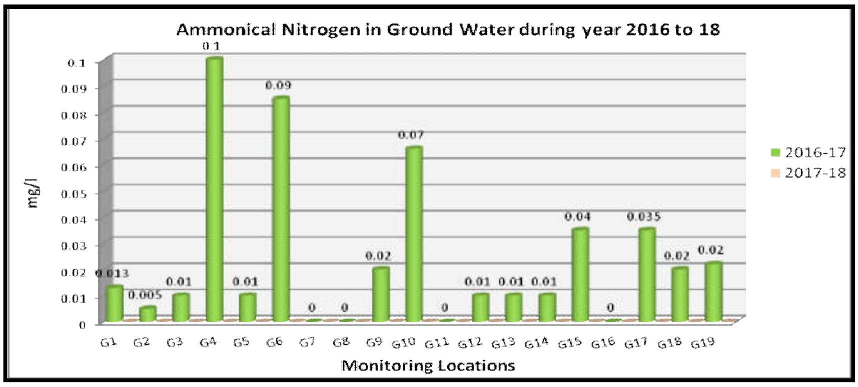

Figure 5: Ammonical nitrogen concentration in ground water

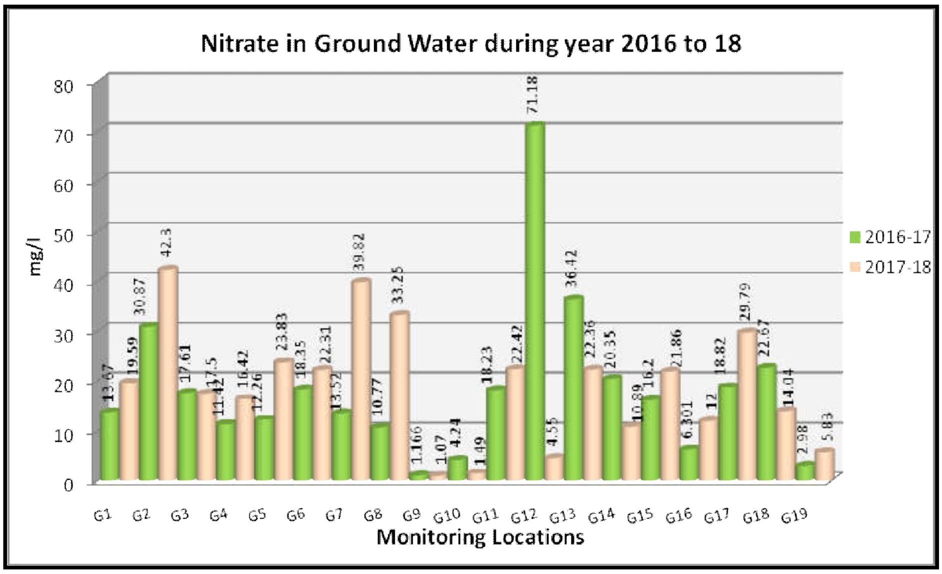

Figure 6. Nitrate concentration in ground water

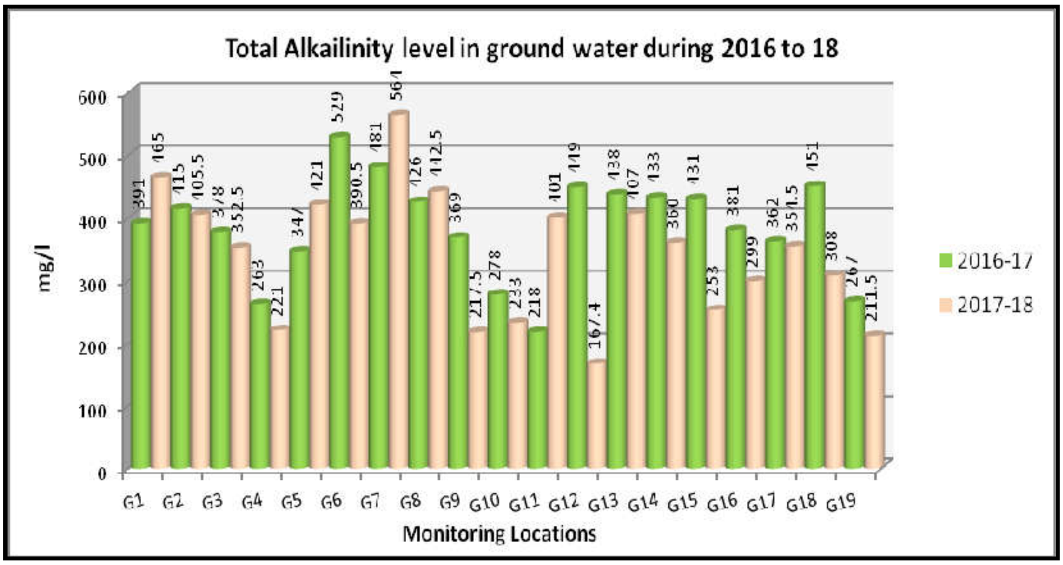

Figure 7. Total alkalinity concentration in ground water

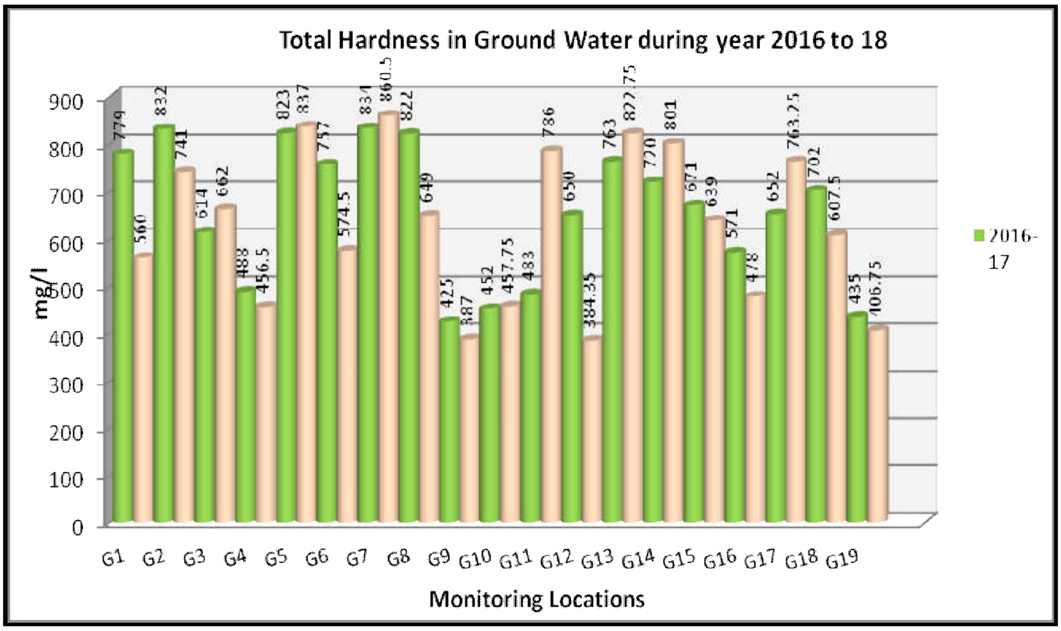

Figure 8. Total Hardness concentration in ground water

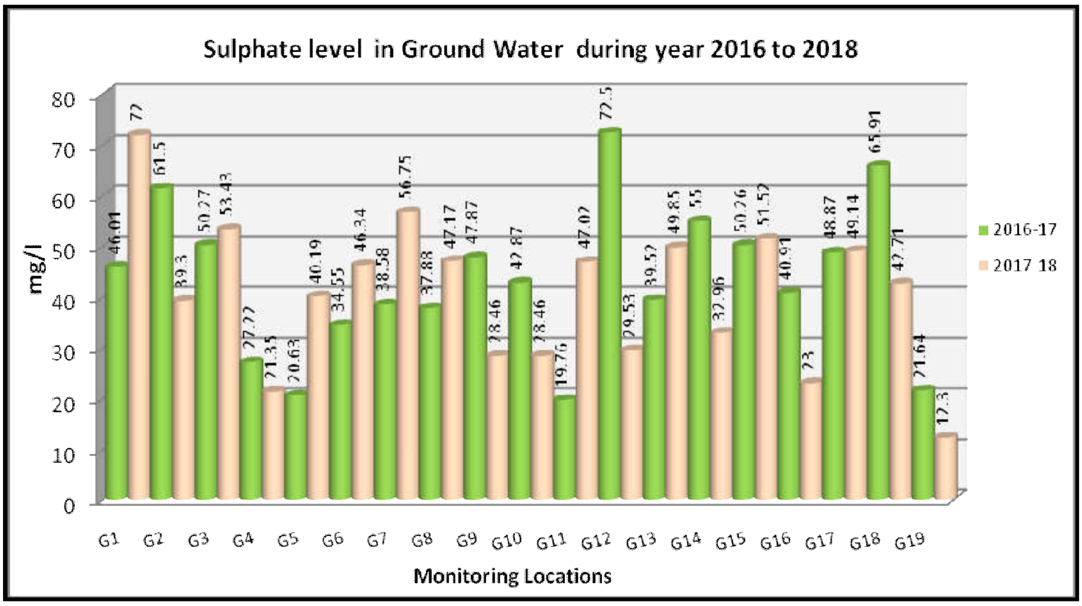

Figure 9. Sulphate concentration in ground water

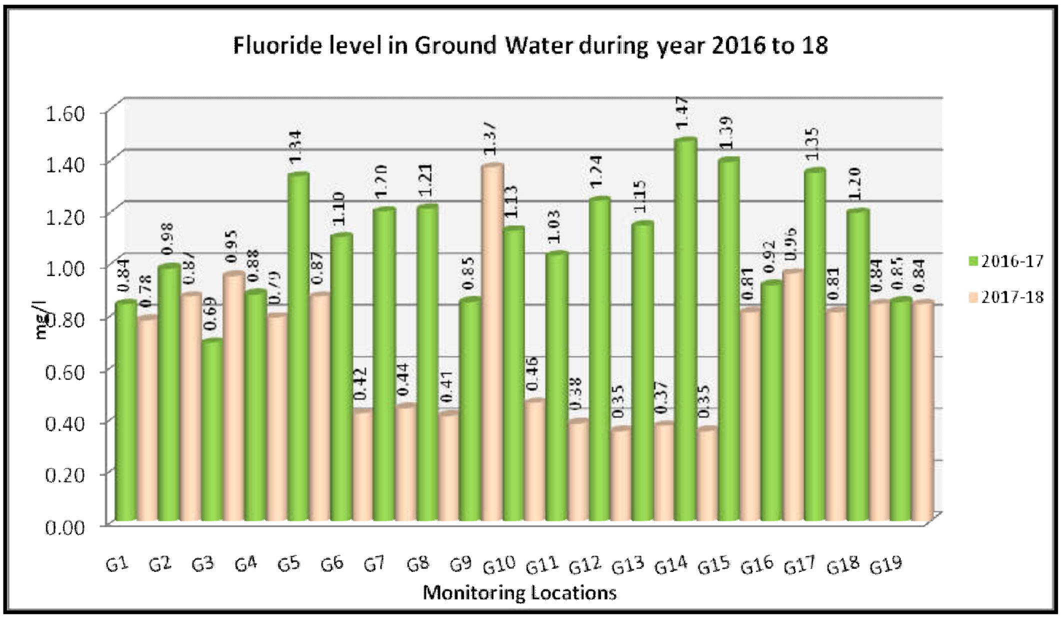

Figure 10. Fluoride concentration in ground water

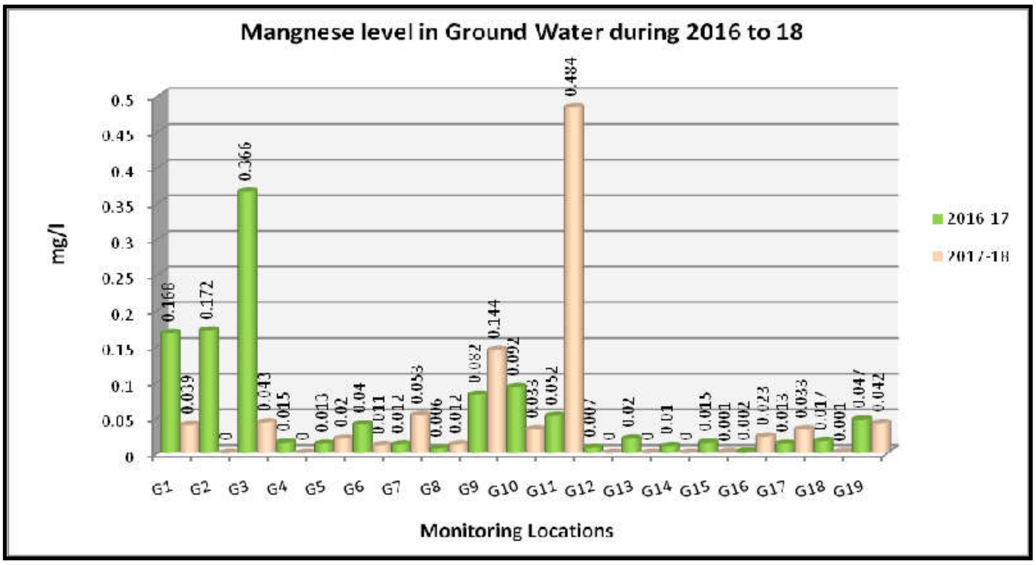

Figure 11: Manganese concentration in ground water

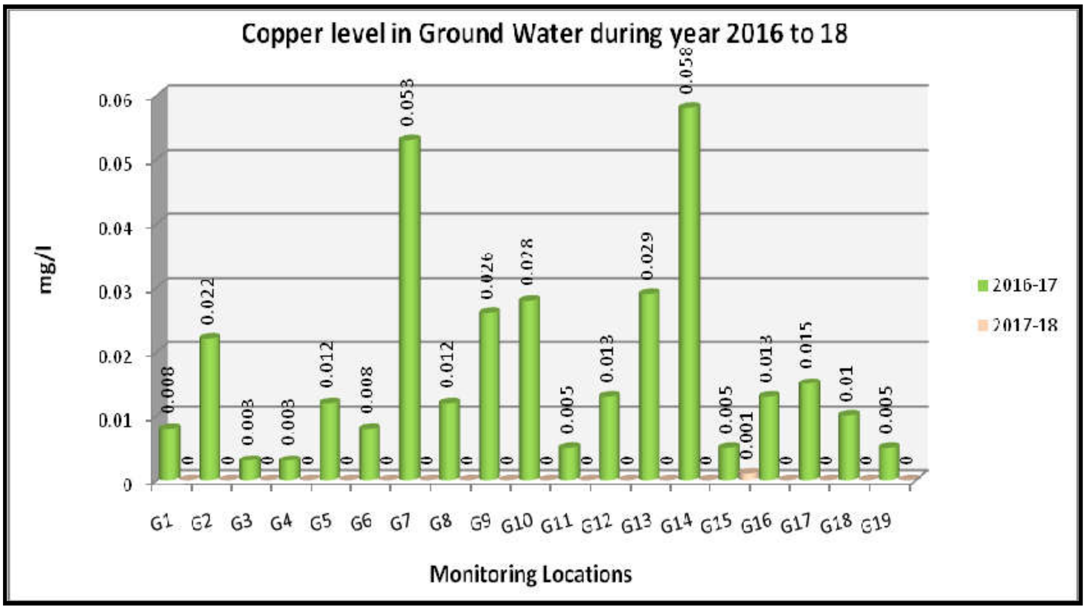

Figure 12. Copper concentration in ground water

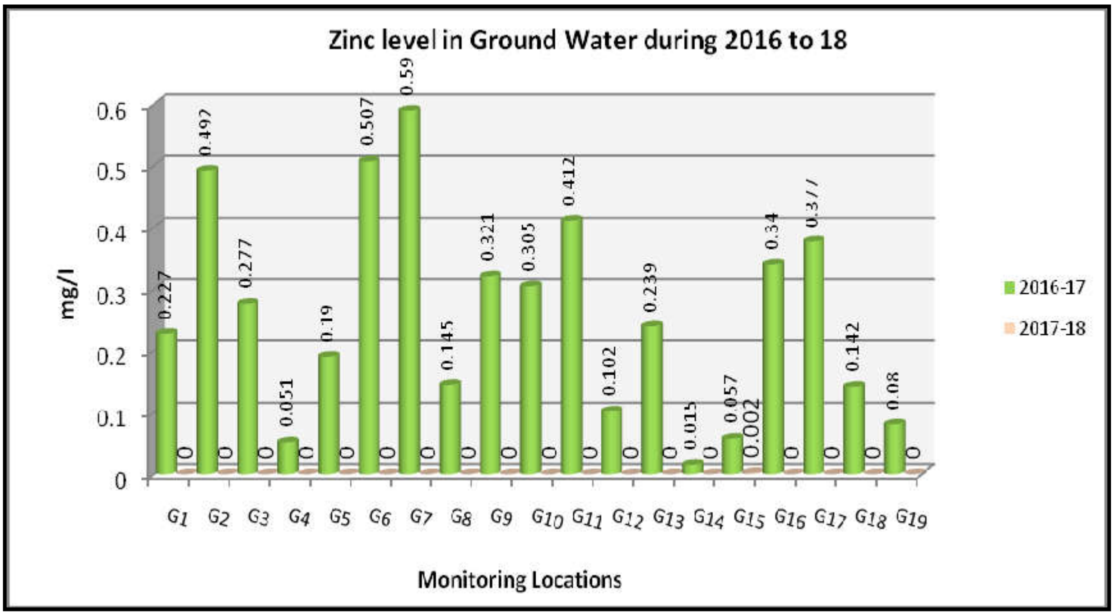

Figure 13: Zinc concentration in ground water

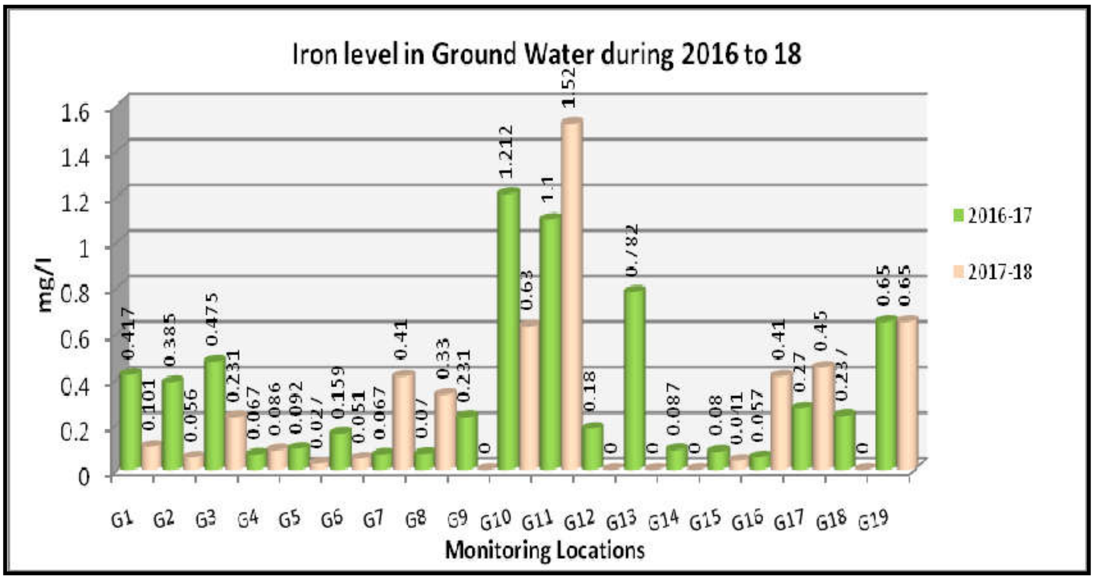

Figure 14. Iron concentration in ground water

The order of the analyzed metals are observed as Zn>Fe>Mn> Cu in ground water at all monitoring locations during this study.

Conclusion

Bhopal city, being the capital of Madhya Pradesh has witnessed rapid urban growth both in terms of population and industrialization. Bhopal is fast developing city since nineties of the 20th century. Numerous infrastructures in the city have paved the way for a stable economy. Thus, the demand for pollution free environment has increased enormously, resulting in a severe pressure on the environmental resources. The present study is an attempt to visualize the pollutant concentration present in ground water in different Corridor present in the Bhopal city. The groundwater is not always pure water in nature because usually contains dissolved minerals ions. The amount of concentration and their type can affects the usefulness of ground water for different purpose such as domestic, agriculture and industrial use. Ground water quality is affected by both point and non-point sources of pollution. It is evident from the data that water samples can be classified as moderate hard for household use. It is concluded that high contamination in ground waters observed in Corridor II as compare to other three corridors of Bhopal city. Govindpura Industrial area, transport, MSW dumping site, dense vehicle zone and anthropogenic activities are main reason of high contamination observed in ground waters of corridor II in Bhopal city, Madhya Pradesh, India.

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REFERENCES

Bhopal district ground water information booklet, Ministry of Water Resources Central Ground Water Board, North Central Region Bhopal. 2013.

Dwivedi A.P. & Tripathi I.P. 2016. Quality assessment of ground water and surface water samples collected from two different zone of central India. *International Journal of Science Engineering & Technology,* 5 (4): 199-204.

Dutta J., Chetia M. & Mishra, A.K. 2011. Drinking water quality in six small tea garden of Sonitpur district of Assam , India, with special reference to heavy metals. *J Environmental Engineering Science,* 53 (4):443-450.

Guidelines for the water monitoring, Central Pollution Control Board, New Delhi. 2007.

https://en.wikipedia.org/wiki/bhopal

Indian standard, drinking water-specification (second revision), Bureau of Indian standards, New Delhi, India. 2012: IS 10500.

Jain C.K., Kumarand C.P. & Sharma M.K. 2003. Ground water quality of Ghataprabha command area, Karnataka. Indian Journal of Environment & Ecoplanning, 7: 251-262.

Jinwal A. & Dixit S. 2008. Pre- and post-monsoon variation in physico- chemical characteristics in groundwater quality of Bhopal "The City of Lakes" India. *Asian Journal of Experimental Sciences,* 22 (3): 311-316.

Jotwani J., Jain B. & Malik S. 2014. Assessment of potability of different water sources at Bhopal city. International *Journal of Environmental Science and Technology*, 4 (5): 890-899.

Sharma S., Kadam D.S. & Chaurse, V.K. 2014. Assessment of ground water quality at different areas in the City of Lakes Bhopal, Madhya Pradesh to find out the class of water. *Indian Journal of Fundamental and Applied Life Science*, 9:1-9.

Singh A. & Choudhary S.K. 2011. Chemical analysis of ground water Nathnagar block under Bhagalpur district, Bihar (India). *Journal of Environmental Science & Engineering*, 53 (4): 469-474.

Sahoo H.K. 2003. Hydrogeochemistry of groundwater of the area around pallahara, Angul district, Orissa. Journal of Science and Technology, XIV & XV: 36-42.

Standard Methods for the Examination of Water and Wastewater. 23rd edition, American Public Health Association, American Water Works Association and Water Pollution Control Federation, Washington DC, 2017.

Telebi A., Chandrashekhara M.J.G., Fazlli M.S., Khosra F.V. & Bhole, A.G. 1994. Hydrogeo Chemistry and Quality of Ground Water in yenne Hole watershed. *Journal of Indian Association for Environmental Management*, 21: 8-16.

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