*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. **1(2),** 1-7, September **(2012)** *I. Res. J. Environment Sci.*

Physico-Chemical, Bacteriological and Pesticide analysis of Tap Water in Millennium City Gurgoan, Haryana, India

Koul Nishtha[1], Lokhande R.S. [1] and Dhar J.K.[2],
[1]Dept. of Chemistry, Jaipur National University, Jagatpura, Jaipur Rajasthan, INDIA
[2]Indian Institute of Integrative Medicine, IIIM, Jammu, INDIA

Available online at: www.isca.in
Received 27th August 2012, revised 18th September 2012, accepted 20th September 2012

Abstract

Although water is a renewable source, but because of excessive exploitation and contamination, access to safe drinking water has become a major problem for humans. Sewage and industrial wastes are being directly poured into water bodies. These wastes may range from chemicals, organic wastes, nitrates, plastics, metals etc. Biodegradable components of these wastes can result in the spread of many dangerous water borne diseases. The objective of this study was to determine physico-chemical characteristics, bacterial contamination and pesticides in tap water samples collected from various selected sites of Gurgoan city. Tap water samples were assessed for physico-chemical parameters like : pH, Dissolved oxygen (DO), total dissolved solids (TDS), total hardness, fluoride (F), nitrate (NO_3^{-3}) and sulfate (SO_4^{-2}). The water samples were also analyzed for the presence of fecal bacteria namely: Escherichia coli (E.coli), Salmonella, Pseudomonas aeruginosa, Staphylococcus aureus and total coliform bacteria present in tap water. Pesticides namely : Chlorobenzilate, Hexachloro-benzene, Benzenether, pp-DDT, op-DDT, pp-DDE, pp-DDD, alpha-HCH, Beta-HCH, Lindane, Vinclozolin, Conumaphos, Malathion, Phosalone, Cyfluthrin, Cypermethrin, Deltamethrin, Permethrin, Fenvalerate, Fluvalinate, Cyhalothrin, Carbofurn, Propoxeur, Carbaryl, Cymiazol, Amitraz, Bromprophylate, Chinomethionate were also detected.

Keywords: Physico-chemical parameters, fecal bacteria, total coliform bacteria, pesticides, Gurgoan city etc.

Introduction

The availability of good quality drinking water is extremely important for prevention of diseases and for improving the quality of life for humans[1]. Pure water does not exist in nature. Water in its natural form contains living / non-living, soluble / insoluble, organic / inorganic components and its quality keeps on changing from time to time and place to place. The contamination of water is directly linked to the contamination of our environment[2]. Potable water is derived either from surface water (rivers, lakes, streams, ponds etc.) or ground water (aquifers, ranney wells etc.) However, water from either source is rarely fit for drinking[3].

Gurgoan is a heavily populated, industrialized and modern city of Haryana. It is a venue for many National and International activities. It becomes important to measure the toxicity of drinking water on regular basis to sufficiently support human health and to match BIS (Bureau of Indian Standards) as well as WHO (World Health Organization) standards.

Material and Methods

Experimental: A study was undertaken from October 2010 to October 2011 and seventy eight tap water samples were analyzed to obtain monthly variations in the quantity of physico-chemical parameters, bacterial contamination and pesticides at all study sites. The study sites were chosen to give representation of all areas.

Location of Study Sites with Map: Location of Study Sites with map is shown in figure-1.

Location 1 : Over Head Tank Kachnar Marg.
Location 2 : D.L.F Phase 1
Location 3 : Sushant Lok Colony
Location 4 : Palam Vihar Colony
Location 5 : Sec-56 Colony.
Location 6 : Sec-14 Colony.

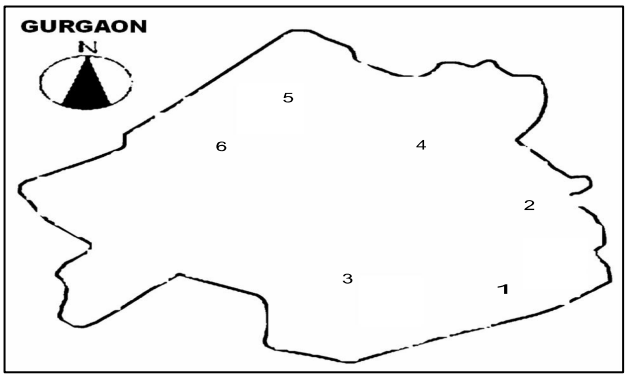

Figure-1
Location of Study Sites: Gurgoan, Haryana

Parameter	Units	Methods	Section No. APHA (1998) / Other Related Methodologies
pH		Electrometric Method	4500 – H+ B
Dissolved Oxygen (DO)	mg/L	Titrimetric Method	4500 – 0 B
Total Dissolved Solids (TDS)	mg/L	Gravimetric Method	2540 B
Total Hardness	mg/L	EDTA Titration Method	2340
Fluoride	mg/L	Ion-Selective Electrode Method	4500 – F – C
Nitrate (NO_3^{-3})	mg/L	Cadmium Reduction	4500 – NO3– - E
Sulfate (SO_4^{-2})	mg/L	Turbidimetric Method	4500 – SO4–2 E
Fecal Bacteria	MPN/ 100mL	E.coli Procedure	9221F
Total Coliform	MPN/ 100mL	Multiple-tube fermentation technique	9221-A
Pesticides	ppm	GCMS (Gas Chromatography Mass Spectrometer)	Thermo Finnegan

Sampling: Sampling for bacteriological analysis was done aseptically with care, ensuring that there was no external contamination of samples. For analysis, sterilized plastic poly ethylene (PET) bottles were used which were cleaned and rinsed carefully; given a final rinse with distilled water, and sterilized in boiling water for 15 minutes. Effectiveness of sterilization was checked with each run by using sterilization strips (commercially available) inside sampling bottles and glassware used. Sodium thiosulfate ($Na_2S_2O_3$) solution (75 mg Na_2SO_3 per liter) was added to these sampling bottles before sterilization, to dechlorinate the sample. Sometimes, this reagent was not added to the sampling bottles then after checking for chlorine, it was added to positive samples after filter.

During sample collection, ample air space was left in the bottle (at least 2.5 cm) to facilitate mixing by shaking, before examination. Samples were collected that were representative of the water being tested flushed or disinfected the sample ports and used aseptic techniques to avoid contamination. Sample bottles were kept closed until filled (without rinsing) and caps were replaced immediately. For tap water samples, tap is open fully and water is allowed to run for 2-3 minutes and then reduce water flow to permit filling of water samples.

Results and Discussion

The monthly variations in the physico-chemical parameters of tap water samples observed at all sites are presented in tables 1 to 7 from October 2010 to October 2011.

Physico-Chemical Analysis: pH reveals if a solution is acidic or alkaline. pH of water beyond permissible range can affect mucous membrane of cells and cause corrosiveness in water supply system[4]. pH value determined for all the water samples collected from selected sites was found in the range of 6.80 to 7.80. All water samples were found to have pH within the limits of BIS / WHO i.e. 6.5 to 8.5.

Dissolved Oxygen (DO) is an important for many chemical and biological processes taking place in water. DO in water can decrease due to microbial activity, respiratory and organic decay. Dissolved Oxygen value is an indicative of pollution in water and depicts an inverse relationship with water temperature. The permissible limit for DO as per BIS / WHO is 6 mg/L. Drinking water samples collected from various sites of Gurgoan were found to contain DO levels ranging from 1.96 mg/L to 5.58 mg/L. All drinking water samples had DO within BIS/WHO permissible limit.

Total Dissolved Solids (TDS) of water refers to the inorganic salts and organic matter present in water which may be due to the presence of sodium, potassium, calcium, magnesium, carbonates, hydrogen carbonate and ions of chloride, sulfate and nitrate[5]. Total Dissolved Solids content of the drinking water samples collected from various sites of Gurgoan showed a range between 92 mg/L to 160 mg/L. However; all the water samples showed TDS value within BIS/WHO guidelines i.e. 500 mg/L.

Total Hardness: The major sources of hardness in water are dissolved calcium and magnesium ions from sedimentary rocks whereas minor contribution to the hardness of water is made by ions of aluminium, barium, manganese, iron, zinc etc[6]. The range of total hardness in all the drinking water samples was between 23 mg/L to 29 mg/L. However, all the water samples showed the range of hardness within permissible WHO/BIS (300 mg/L) limits.

Nitrates: Toxicity in infants causes methaemoglobiaemia. In adults it is less effective due to nitrate metabolizing triglycerides present at higher concentration[7]. Nitrate was present in all drinking water samples and the level ranged from 0.02 mg/L to 0.08 mg/L. All water samples had nitrate content within permitted BIS (45 mg/L), WHO (10 mg/L) permissible limit.

Sulfates: Which are a form of sulfur get into the water supply when sulfite ores are oxidized. Sulfur containing minerals are found in most of the rocks and soils around the world. As ground water seeps through the earth, some of these compound is sulfur are dissolved by the water. Rain water that leaches into the ground is also a source of sulfur. The biggest problem of sulfur in drinking water is that its stinks. Drinking water which has high level of sulfate can cause diarrhea, especially in infants[8]. Sulfate content in the drinking water samples ranged from 2.0 mg/L to 4.2 mg/L. All water samples contained sulfate content within the permissible limit as suggested by BIS / WHO i.e. 200 mg/L.

Fluoride: Exposure to excess consumption of fluoride over some period may lead to increased chances of bone fractures, pain in bones and tenderness in adults. Young children exposed to excess amounts of fluoride have a chance of developing pits in tooth enamel[9]. Fluoride levels ranging from 0.02 mg/L to 0.06 mg/L were detected in the drinking water samples. All dinking water samples had fluoride content within the range as suggested by WHO is 1.0 mg/L and as per BIS is 1.5 mg/L.

Bacteriological Analysis: The most common and widespread health risks associated with drinking water are of biological origins. Ten major water borne diseases are responsible for over twenty eight billion episodes of disease annually in developing countries[10]. According to World Health Organization (WHO) and Bureau of India Standard (BIS) characteristics for drinking water (IS 10500: 1991), drinking water should contain "0" total coliform bacteria per 100 mL of water. The maximum permissible limit for fecal coliform is "0" per 100 mL of water. (MPN 0/100 mL). Bacteriological analysis of potable water sample of Gurgoan did not have any fecal bacteria namely: Escherichia coli (E.coli), Salmonella, Pseudomonas aeruginosa and Staphylococcus aureus. Results of MPN for drinking water samples collected from this area showed total coliform bacteria ranging from 2–20/100 mL. However, contamination of total coliform bacteria was found in 30.7 percent tap water samples.

Pesticides: The term pesticide is a composite term used to refer chemical substances which are used to kill and control pests. In agriculture, this includes herbicides (weeds), insecticides (insects), fungicides (fungi), nematicides (nematodes), and rodenticides (vertebrate poisons)[11]. Drinking water samples collected from various areas of Gurgoan did not contain any pesticides. However, the standard for individual pesticides has been described at 0.001 mg/L and for total pesticides at 0.0005 mg/L as per BIS (IS 10500:1991) guidelines. WHO has proposed guidelines for some pesticides, however there are no guidelines for majority of pesticides.

Conclusion

Tap water samples collected from various areas of Gurgoan city did not have any physico-chemical parameters and pesticides above BIS/WHO permissible limits. However, there was contamination of total coliform in tap water samples and 30.7 percent samples of water were found unfit for drinking purposes.

Acknowledgement

At the outset, I express my deep sense of gratitude to my supervisor Dr. Rama S. Lokhande, my co-supervisor Dr. J.K. Dhar, Dr. Surrinder Koul and my family for initiating me to research and providing constant inspiration, guidance and encouragement. The kind cooperation, technical support and help of the laboratory staff of IIIM. My due thanks to Mr. Shashi for typing out script.

References

1. Adewoya B.L., and Oludura A.O., Efficiency of Morigna Oleifera Seeds Extract on Microflora of Surface and Ground Water, *Journal of Plant Sciences*, **6,** 453-438 **(2007)**

2. Skeat W.O., Manual of British Water Engineering practice; Water Quality and Treatment, The Institution of Water Engineers, London, England **(1969)**

3. Asaulo S.S., Adeyinowa C.E., Ipinmoriti K.O. and Olaofe O., Assessment of Physico-chemical Status of Water Samples from Major Dams in Ekiti Status, Nigeria, *Pak. J. Nutri.,* **6(6),** 657-659 **(2007)**

4. Course Manual for Chemists and Bacteriologist of PHED Laboratories under National Drinking Water Quality Monitoring and Surveillance Programme, Public Health Department, West Bengal **(2010)**

5. WHO (World Health Organization). Guidelines for Drinking Water Quality, Vol. 2 Recommendations, 2 Edn. Geneva **(1996)**

6. WHO (World Health Organization). Hardness in Drinking Water : Background document for Development of WHO Guidelines for Drinking Water Quality, WHO/HSE/WSH/10.01/10/Rev. 1 **(2011)**

7. EPA, Environmental Protection Agency and the Centers for Disease Control and Prevention : Health Effects from Exposure to High Levels of Sulfate in Drinking Water Study **(2010)**

8. Basic Information in Nitrates in Drinking Water : Basic information about Regulated Drinking Water Contaminants, US-EPA-Environment Protection Agency **(2012)**

9. US-EPA, Basic Information about Fluoride in Drinking Water, United States Environmental Protection Agency **(2010)**

10. Walsh J.A., Estimating the Burden of Illness in the Tropics, In: Warrner, K.S., Mahoud, A.A.F., (Editors), Tropical and Geographical Medicines, 2nd Edn. New York, Mc-Graw Hill **(1990)**

11. The International Code of Conduct on the Distribution and use of Pesticides Formulated and Implemented by FAO, Control of Water Pollution from Agriculture **(1990)**

Table-1
Monthly Variations in pH Levels of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	7.79	7.76	7.79	**7.78**	**0.02**	7.79	7.81	7.80	**7.80**	**0.01**	7.79	7.76	7.80	**7.78**	**0.02**	7.79	7.80	7.76	**7.78**	**0.02**	7.78
Site 2	6.86	6.84	6.85	**6.85**	**0.01**	6.86	6.84	6.85	**6.85**	**0.01**	6.86	6.85	6.86	**6.86**	**0.01**	6.87	6.83	6.87	**6.86**	**0.02**	6.83
Site 3	7.48	7.47	7.43	**7.46**	**0.03**	7.48	7.48	7.46	**7.47**	**0.01**	7.43	7.48	7.45	**7.45**	**0.03**	7.46	7.46	7.48	**7.47**	**0.01**	7.51
Site 4	7.37	7.35	7.35	**7.36**	**0.01**	7.37	7.35	7.35	**7.36**	**0.01**	7.37	7.37	7.39	**7.38**	**0.01**	7.41	7.39	7.36	**7.39**	**0.03**	7.35
Site 5	7.31	7.30	7.31	**7.31**	**0.01**	7.31	7.30	7.30	**7.30**	**0.01**	7.31	7.30	7.31	**7.31**	**0.01**	7.31	7.40	7.39	**7.37**	**0.05**	7.39
Site 6	6.82	6.80	6.80	**6.81**	**0.01**	6.82	6.81	6.82	**6.82**	**0.01**	6.81	6.82	6.84	**6.82**	**0.02**	6.84	6.87	6.84	**6.85**	**0.02**	6.85

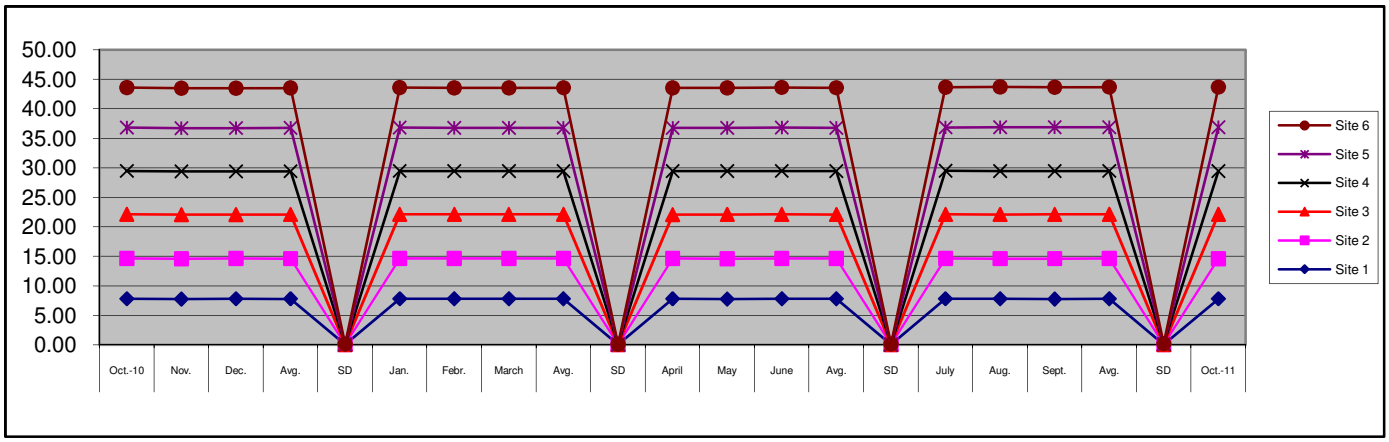

Figure-2
Monthly Variations in pH Levels of Water from October 2010 to October 2011

Table-2
Monthly Variations in Dissolved Oxygen (Mg/L) Levels of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	1.87	4.05	5.58	**3.83**	**1.86**	3.53	5.43	3.05	**4.00**	**1.26**	2.26	5.26	3.53	**3.68**	**1.51**	4.43	4.09	5.58	**4.70**	**0.78**	3.53
Site 2	4.65	3.65	2.00	**3.43**	**1.34**	5.45	4.43	2.40	**4.09**	**1.55**	2.72	5.42	5.45	**4.53**	**1.57**	3.05	4.65	5.26	**4.32**	**1.14**	5.45
Site 3	5.90	3.53	5.42	**4.95**	**1.25**	1.80	4.70	5.04	**3.85**	**1.78**	2.90	4.05	5.20	**4.05**	**1.15**	1.93	5.90	5.42	**4.42**	**2.17**	5.20
Site 4	3.07	5.45	4.05	**4.19**	**1.20**	1.96	2.72	5.58	**3.42**	**1.91**	4.40	3.65	4.43	**4.16**	**0.44**	4.40	3.07	4.05	**3.84**	**0.69**	4.43
Site 5	4.70	5.20	3.65	**4.52**	**0.79**	3.05	3.07	4.26	**3.46**	**0.69**	5.43	3.53	3.05	**4.00**	**1.26**	4.43	4.70	3.65	**4.26**	**0.55**	3.05
Site 6	2.72	4.43	3.53	**3.56**	**0.86**	5.58	2.01	5.42	**4.34**	**2.02**	4.43	5.45	2.05	**3.98**	**1.74**	3.58	2.72	3.53	**3.28**	**0.48**	5.58

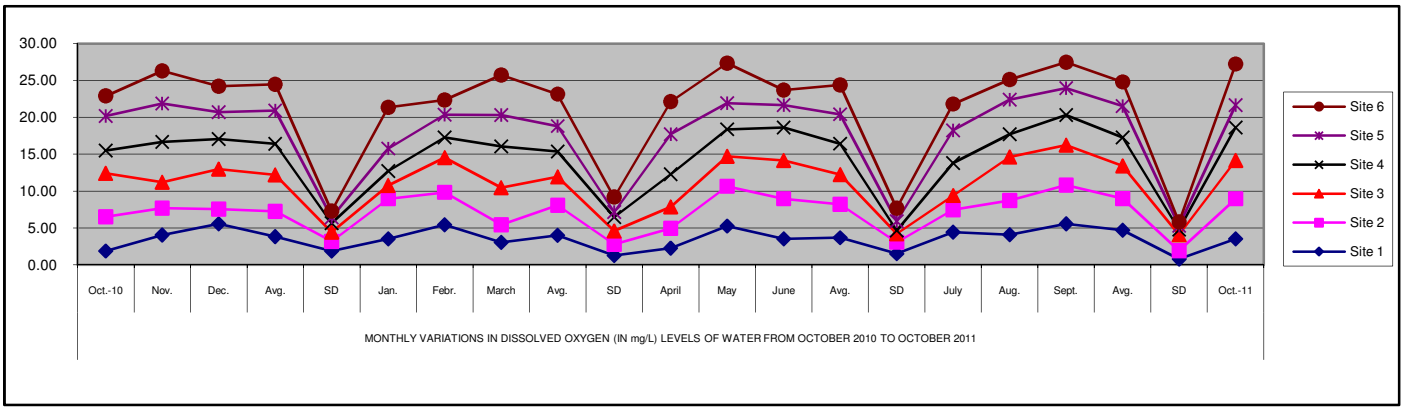

Figure-3
Monthly Variations in Dissolved Oxygen (Mg/L) Levels of Water from October 2010 to October 2011

Table-3
Monthly Variations in TDS Levels (Mg/L) Levels of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	176	173	173	**174**	**1.73**	170	168	168	**169**	**1.15**	169	171	168	**169**	**1.53**	171	168	172	**170**	**2.08**	174
Site 2	134	134	133	**134**	**0.58**	132	132	132	**132**	**0.00**	132	132	134	**133**	**1.15**	134	134	133	**134**	**0.58**	133
Site 3	123	122	122	**122**	**0.58**	123	123	124	**123**	**0.58**	124	124	124	**124**	**0.00**	124	124	125	**124**	**0.58**	125
Site 4	126	125	125	**125**	**0.58**	126	126	126	**126**	**0.00**	128	128	128	**128**	**0.00**	130	130	128	**129**	**1.15**	128
Site 5	131	130	130	**130**	**0.58**	129	129	129	**129**	**0.00**	129	128	128	**128**	**0.58**	128	128	128	**128**	**0.00**	129
Site 6	93	93	92	**93**	**0.58**	92	92	93	**92**	**0.58**	93	93	90	**92**	**1.73**	90	90	89	**90**	**0.58**	89

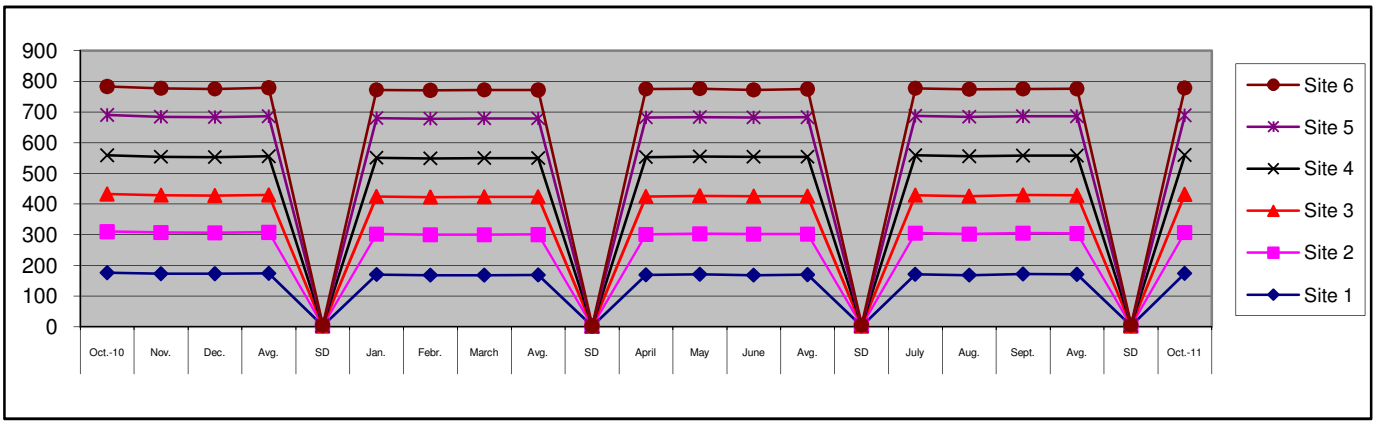

Figure-4
Monthly Variations in TDS Levels (Mg/L) Levels of Water from October 2010 to October 2011

Table-4
Monthly Variations in Total Hardness (mg/l) of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	25	25	25	**25.0**	**0.0**	24	25	25	**24.7**	**0.6**	24	25	25	**24.7**	**0.6**	24	24	25	**24.3**	**0.6**	25
Site 2	29	28	28	**28.3**	**0.6**	29	28	29	**28.7**	**0.6**	29	29	28	**28.7**	**0.6**	29	28	28	**28.3**	**0.6**	28
Site 3	16	15	16	**15.7**	**0.6**	16	15	16	**15.7**	**0.6**	16	15	15	**15.3**	**0.6**	16	16	16	**16.0**	**0.0**	17
Site 4	31	32	31	**31.3**	**0.6**	32	31	31	**31.3**	**0.6**	30	31	30	**30.3**	**0.6**	30	31	31	**30.7**	**0.6**	30
Site 5	27	26	27	**26.7**	**0.6**	26	26	26	**26.0**	**0.0**	27	27	26	**26.7**	**0.6**	26	27	27	**26.7**	**0.6**	26
Site 6	25	25	26	**25.3**	**0.6**	25	25	26	**25.3**	**0.6**	25	24	24	**24.3**	**0.6**	24	24	23	**23.7**	**0.6**	23

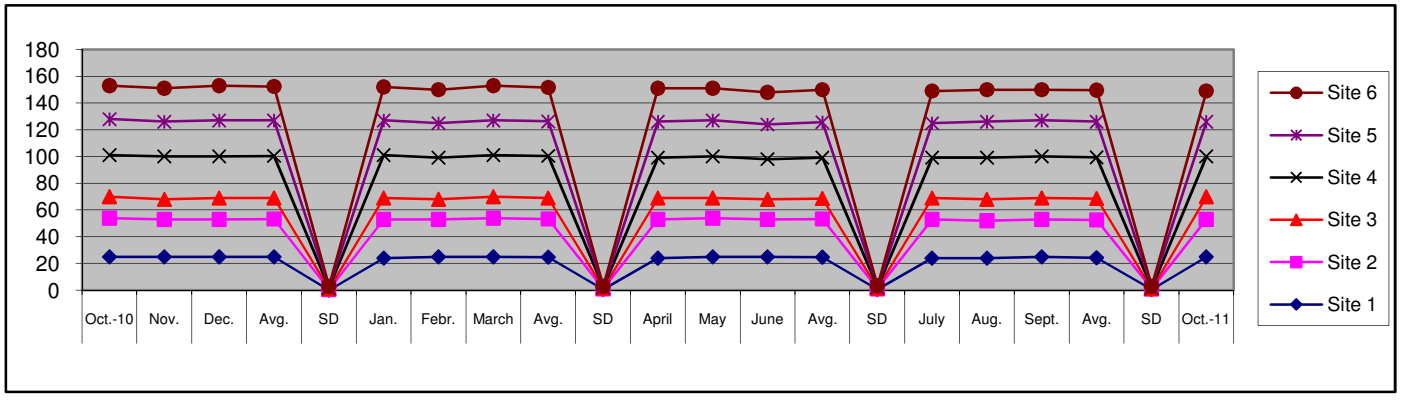

Figure-5
Monthly Variations in Total Hardness (mg/l) of Water from October 2010 to October 2011

Table-5
Monthly Variations in Fluoride (Mg/L) Levels of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	0.02	0.02	0.02	**0.02**	**0.00**	0.02	0.02	0.03	**0.02**	**0.01**	0.03	0.03	0.03	**0.03**	**0.00**	0.02	0.02	0.02	**0.02**	**0.00**	0.03
Site 2	0.04	0.04	0.04	**0.04**	**0.00**	0.03	0.03	0.03	**0.03**	**0.00**	0.02	0.02	0.03	**0.02**	**0.01**	0.03	0.03	0.04	**0.03**	**0.01**	0.04
Site 3	0.03	0.02	0.02	**0.02**	**0.01**	0.02	0.03	0.03	**0.03**	**0.01**	0.03	0.04	0.04	**0.04**	**0.01**	0.04	0.03	0.04	**0.04**	**0.01**	0.04
Site 4	0.04	0.04	0.04	**0.04**	**0.00**	0.03	0.03	0.03	**0.03**	**0.00**	0.04	0.04	0.04	**0.04**	**0.00**	0.03	0.03	0.02	**0.03**	**0.01**	0.03
Site 5	0.06	0.06	0.06	**0.06**	**0.00**	0.05	0.05	0.05	**0.05**	**0.00**	0.04	0.04	0.04	**0.04**	**0.00**	0.04	0.03	0.03	**0.03**	**0.01**	0.04
Site 6	0.02	0.03	0.03	**0.03**	**0.01**	0.02	0.02	0.02	**0.02**	**0.00**	0.02	0.02	0.03	**0.02**	**0.01**	0.03	0.03	0.03	**0.03**	**0.00**	0.03

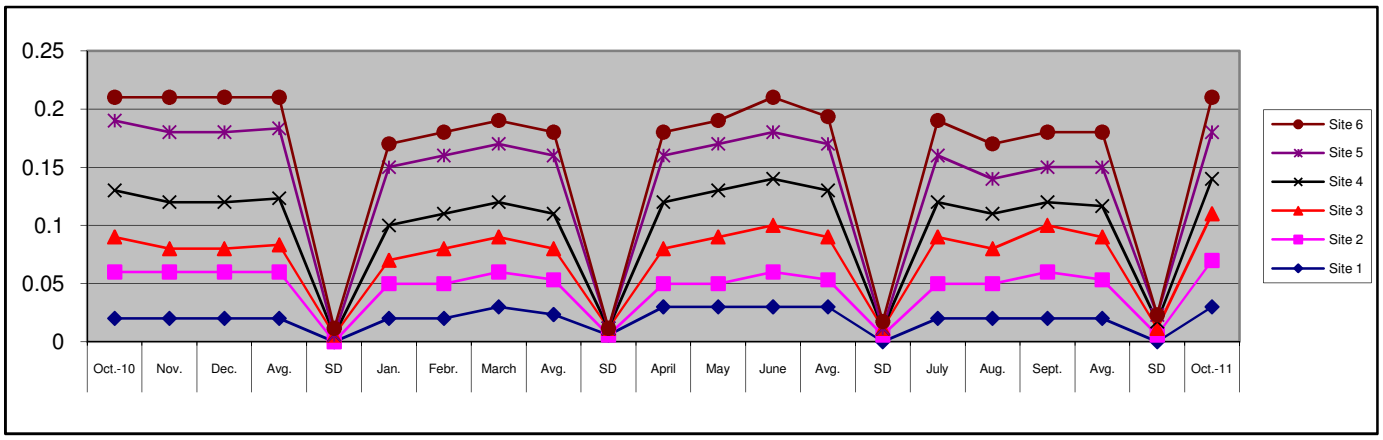

Figure-6
Monthly Variations in Fluoride (Mg/L) Levels of Water from October 2010 to October 2011

Table-6
Monthly Variations in Nitrate (Mg/L) Levels of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	0.04	0.03	0.03	**0.03**	**0.01**	0.03	0.02	0.02	**0.02**	**0.01**	0.03	0.03	0.03	**0.03**	**0.00**	0.04	0.04	0.03	**0.04**	**0.01**	0.03
Site 2	0.03	0.03	0.03	**0.03**	**0.00**	0.02	0.02	0.02	**0.02**	**0.00**	0.02	0.03	0.03	**0.03**	**0.01**	0.03	0.03	0.02	**0.03**	**0.01**	0.02
Site 3	0.05	0.05	0.05	**0.05**	**0.00**	0.05	0.06	0.06	**0.06**	**0.01**	0.05	0.05	0.06	**0.05**	**0.01**	0.06	0.05	0.04	**0.05**	**0.01**	0.04
Site 4	0.03	0.02	0.03	**0.03**	**0.01**	0.03	0.02	0.02	**0.02**	**0.01**	0.02	0.03	0.03	**0.03**	**0.01**	0.04	0.04	0.04	**0.04**	**0.00**	0.04
Site 5	0.06	0.05	0.05	**0.05**	**0.01**	0.05	0.06	0.06	**0.06**	**0.01**	0.05	0.05	0.05	**0.05**	**0.00**	0.04	0.04	0.04	**0.04**	**0.00**	0.04
Site 6	0.08	0.08	0.07	**0.08**	**0.01**	0.07	0.07	0.06	**0.07**	**0.01**	0.06	0.06	0.07	**0.06**	**0.01**	0.07	0.07	0.06	**0.07**	**0.01**	0.06

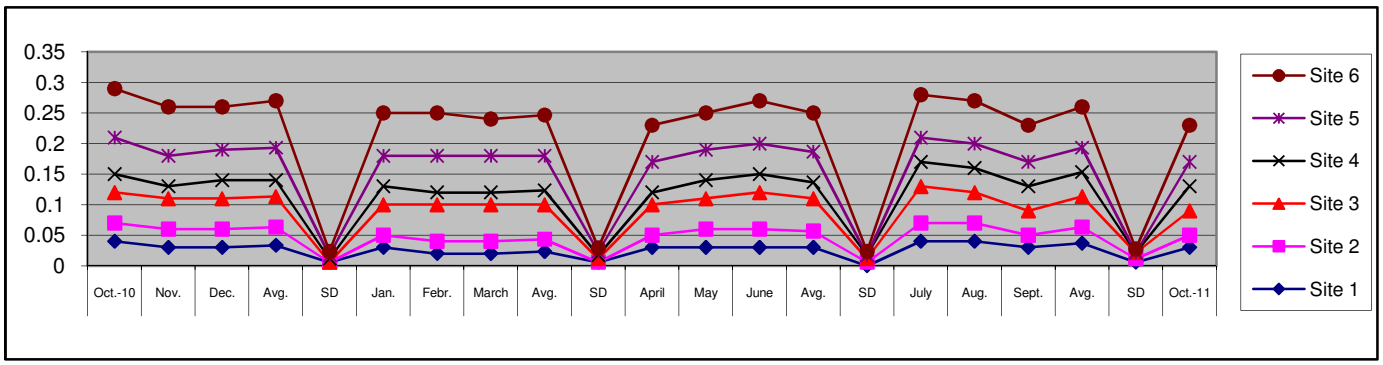

Figure-7
Monthly Variations in Nitrate (Mg/L) Levels of Water from October 2010 to October 2011

Table-7
Monthly Variations in Sulfate (Mg/L) Levels of Water from October 2010 to October 2011

	Oct.-10	Nov.	Dec.	Avg.	SD	Jan.	Febr.	March	Avg.	SD	April	May	June	Avg.	SD	July	Aug.	Sept.	Avg.	SD	Oct.-11
Site 1	4.0	4.1	4.1	**4.1**	**0.1**	4.1	4.0	4.0	**4.0**	**0.1**	4.0	4.1	4.1	**4.1**	**0.1**	4.2	4.2	4.1	**4.2**	**0.1**	4.1
Site 2	2.2	2.1	2.3	**2.2**	**0.1**	2.1	2.3	2.1	**2.2**	**0.1**	2.2	2.3	2.1	**2.2**	**0.1**	2.1	2.0	2.0	**2.0**	**0.1**	2.0
Site 3	3.2	3.3	3.3	**3.3**	**0.1**	3.3	3.2	3.2	**3.2**	**0.1**	3.2	3.3	3.3	**3.3**	**0.1**	3.3	3.2	3.2	**3.2**	**0.1**	3.3
Site 4	2.2	2.2	2.2	**2.2**	**0.0**	2.1	2.1	2.1	**2.1**	**0.0**	2.0	2.0	2.0	**2.0**	**0.0**	2.1	2.1	2.0	**2.1**	**0.1**	2.1
Site 5	4.2	4.1	4.1	**4.1**	**0.1**	4.1	4.2	4.2	**4.2**	**0.1**	4.1	4.1	4.1	**4.1**	**0.0**	4.0	4.0	4.1	**4.0**	**0.1**	4.0
Site 6	4.0	4.0	4.0	**4.0**	**0.0**	4.0	4.1	4.2	**4.1**	**0.1**	4.1	4.2	4.2	**4.2**	**0.1**	4.2	4.2	4.1	**4.2**	**0.1**	4.1

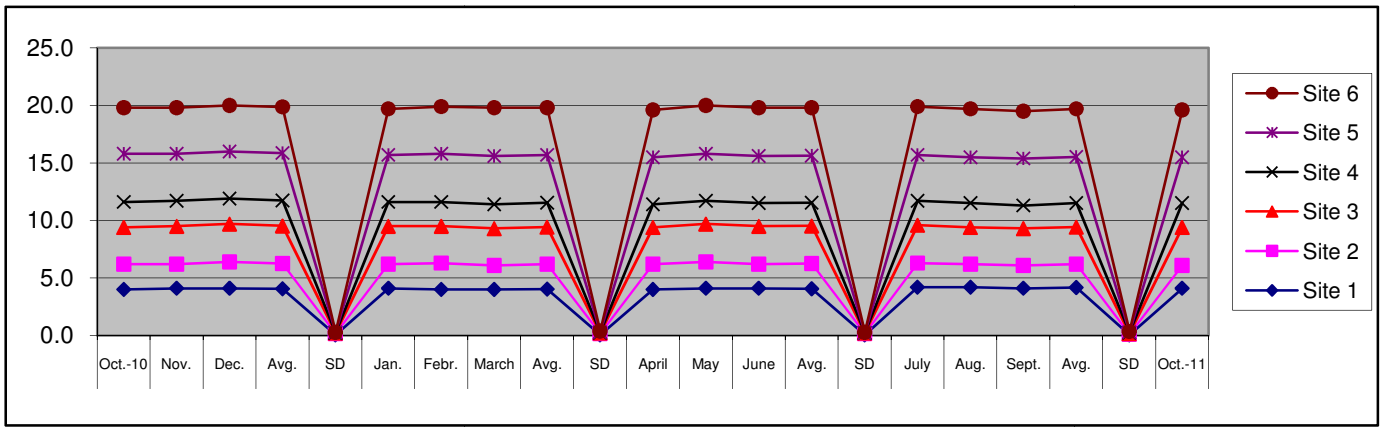

Figure-8
Monthly Variations in Sulfate (Mg/L) Levels of Water from October 2010 to October 2011

Table-8
Monthly Variations in Total Coliform Bacterial Load from October 2010 to October 2011

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
October-10	20	0	6	0	4	0
November	9	0	0	0	0	0
December	0	11	0	0	9	0
January	5	8	11	13	5	0
February	0	4	0	2	0	4
March	0	0	0	6	5	2
April	0	0	0	2	0	0
May	0	0	0	4	0	0
June	0	0	0	0	0	14
July	3	0	12	0	5	0
August	0	0	0	0	0	0
September	0	0	0	0	0	6
October-11	4	2	0	0	0	0

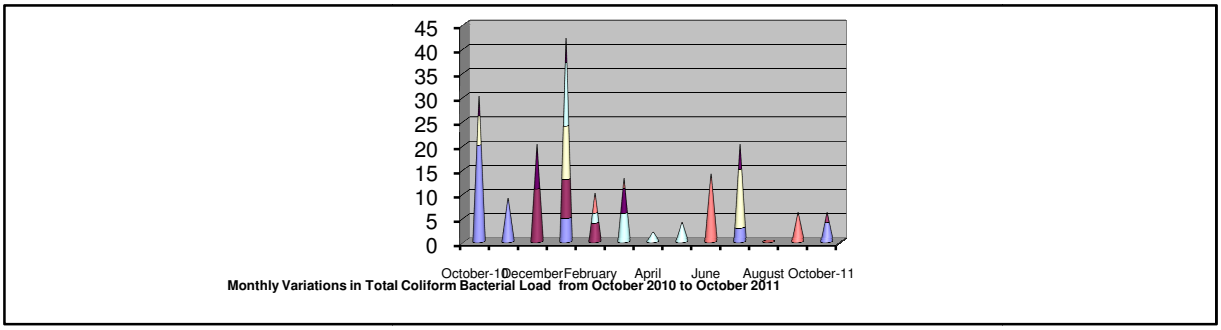

Figure-9
Monthly Variations in Total Coliform Bacterial Load from October 2010 to October 2011