Evaluation of Drinking water quality parameters in the areas of East - Lahore Pakistan : A case study

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Abstract

Water quality supplies for residents of East Lahore has been investigated and evaluated. For this purpose six sampling locations were selected which includes four sampling points from urban areas and two from the rural areas. Samples from the urban areas were collected from tube well which is connected to filter plant and also samples have been collected from three house connections of that area (tap water). For the assessment of water quality of the rural areas, samples were taken from three house connections (tube wells) of each sampling point. Physical characterizations (turbidity and pH), chemical characterizations (hardness, total dissolved solids, sulfates, chlorides) and biological parameters (total coliform and fecal coliform) were tested and compared with National Standards for Drinking Water Quality (NSDWQ). The results demonstrated that physical parameters provide almost satisfactory status. However, minor issue of hardness and turbidity were found. At consumer end, of the samples of location T1HC and T4HC were found, bacteriologically contaminated; hence compulsory chlorination is recommended. Currently in these areas, people are using bores having maximum depth of 150 feet which causes physiochemical contamination.

***Keywords*:** Water quality, East Lahore, urban areas, rural areas, Drinking water

1 Introduction

The Water supply and sanitation are the two basic needs of every individual. Clean water requires to be supplied at the door step to every consumer and the wastewater being generated needs to be safely disposed off [1]. Potable water contamination is one of the major issues in the under developed countries. Thousands of deaths have been reported due to the unavailability of clean and fresh drinking water [2]. It is estimated that in under developed countries 5 million children die each year because of inadequate water supply system [3]. Rapid population growth has resulted in problem of water quality

management [4]. Piped network and hand pumps are used for water supply purposes in Pakistan [5]. Poor water quality is the main cause of high disease and death ratio [6]. Diarrhea and gastroenteritis are the two notable diseases playing a leading role in causing death.

Through surveys, it is estimated that water quality is deteriorating due to excessive water pollution. Estimates show that by the year 2025, nation population will increase from 141 million to 221 million and per capita water availability will drop from 5,600m³ to 1,000m³ [7]. Quality of water is degrading because of the unconstrained disposal of domestic and industrial wastewater, without treatment to natural water bodies. Among the heavy metals Arsenic is one of the major contaminant found frequently in the different areas of Pakistan [8, 9]. The people are at high risk due to high-levels of arsenic in the drinking water [10, 11], which is causing cancer [12, 13], birth defects [13, 14], post-neonatal mortality and other diseases [15]. The geological phenomenon is believed to be one of the main reasons of its presence in the area.

Arsenic is difficult to detect while ingesting. It is tasteless, colourless and odourless. Additionally, the people can absorb significant quantity of arsenic without any immediate health impacts. Therefore, it is indeed important to investigate the presence of arsenic in our drinking water. In the present investigation along with the other physical, chemical and biological parameters an investigation of Arsenic conducted.

The aim of this study was to investigate the problem in the areas of East Lahore, Pakistan. To the best of our knowledge, no significant data on the quality of drinking water is available for this area. A portion of the area selected for this study include urban and portions come under rural population.

2 Experimental

2.1 Materials and reagents

All the chemicals were of analytical grade and were used without further purification. Ultrapure deionised water was used throughout the study.

2.2 Parameters tested

The water samples were analyzed for physical parameters (turbidity and pH), Chemical parameters (hardness, total dissolved solids, sulphates, chlorides) and Biological parameters (total coliform and faecal coliform) by using standard methods [16].

2.3 Analysis of arsenic

Aqueous arsenic concentrations were determined by atomic absorption spectroscopy (Perkin Elmer, AAnalyst800). All quality assurance steps were taken recommended in Standard Methods [16].

2.4 Sampling

Eastern Lahore was selected for the purpose of this study as a test case (Figure 1). This area consisted of both urban as well as rural areas. Eastern Lahore mainly consists of the areas of Mughalpura, Darogawal, Herbanspura, TajBagh, Askari IX, Pakistan Housing Authority and the areas near border including Sooter mill and Manawan.From the urban areas (Herbanspura, TajBagh, Askari IX, Pakistan Housing Authority) samples were taken from the filter plant in each of the area, tubewell and its respective three house connections, making a total of 20 sampling points from these four areas. Filter plants are installed by the Government as a measure to provide clean drinking water to the public. Water in urban areas is provided by Water and Sanitation Agency (WASA), Lahore through deep tube wells (depth upto 500 ft). In the rural areas (Sooter mill and Manawan), water is obtained by private shallow wells (150 ft depth) installed by the public. Samples were collected from the six house connections. This makes up a total of 26 sampling points. Results obtained were compared with National Standards for Drinking Water Quality (NSDWQ) as presented in table 1[17]. To ensure the statistical significance of the results the sampling was done three times from each sampling location. In this way total 78 samples were tested. Details of sampling locations are given in table 1.

All the samples were collected, transported and preserved in accordance with WHO Guidelines, 2008. Clear, clean and dry polyethylene bottles were used for the collection. They were properly washed with the sampling water before filling, appropriately tagged and marked for the identification of sampling points and then finally stored in the refrigerator before analysis of different parameters. Sampling for bacteriological analysis was done with special care in order to avoid any external contamination. Sterilized glass bottles of 0.5 litre capacity were used. A final rinse was given to bottles with distilled water and sterilized at 121 °C for 15 minutes, in compliance with Standard Methods [16].

3 Results and discussion

3.1 Turbidity

The mean values of turbidity at all the points including filters, tube wells, house connections and private shallow wells are plotted in figure 2. The results indicate that the values of turbidity at all the private shallow wells are much high as compare to NSDWQ. The problem of turbidity is also significant

in T1 and its adjacent house connections T1HC1 and T1HC2. The high values of turbidity both at source and at houses indicate that there may be some problem with the groundwater or the depth from which the water is being pumped should be deeper in order to get better quality water. Sampling points where WASA tubes well are supplying water have lower turbidity level clearly supporting the above reason.

3.2 pH

The mean values of pH at all the sampling locations are plotted in figure 3. The permissible limit for pH is from 6.5 to 8.5. The values of pH at all the points are between 7.0 and 8.34. The figure 3 illustrates that the test results for pH of all the sampling points lie within NSDWQ.

3.3 Hardness

The mean values of hardness at all the sampling locations including tube wells, house bores, house connections and filters have been plotted in figure 4. The figure illustrates that at tube well T2 and its adjacent connections T2HC1, T2HC2, T2HC3 the values of total hardness are exceeding the acceptable limit provided in NSDWQ. The value of hardness at house bores A1H1 and A1H2 are also higher than the permissible limits. This could possibly due to the geology of Lahore.

3.4 Sulphates

The mean values of sulfates for all the samples from tube wells, filters, house bores and house connections are plotted in figure 5. The figure signifies that the rural areas A1 and A2 have high values of sulfates but still they are within guidelines values proposed by NSDWQ.

3.5 Chlorides

The figure 6 shows the mean values of chlorides at all the sampling points showing that the values of chlorides lie within NSDWQ. The maximum values of chlorides were found in the house connections adjacent to the tube wells T1 and T2 but these values are also within NSDWQ.

3.6 Total dissolved solids

Plotted in figure 7 are the mean values of the test results of total dissolved solids at all the sampling locations. Total dissolved solids varied from 288.63 mg/L to 782.7 mg/L at the sampling points. The comparison provides that the results of all the points lie meet NSDWQ.

3.7 Total coliform

The mean values of total coliform at all the sampling locations are plotted in figure 8 clearly indicating that the total coliform for all the tube wells as well as filters have a value of 0 MPN/100 mL. Therefore, bacteriologically the water at the source as well as at filters is suitable for drinking.

The problem of total coliform is however very intense at house connections T1HC1, T1HC2, T1HC3, T4HC1, T4HC2 and T4HC3. At some points the values are even 30 MPN/100ml. The presence of high values of coliform could be due to the unhygienic condition of the pipelines which are transmitting the water to the user end from the contaminated tap water, as the coliform bacteria have not been identified in the representative tubwell samples.

3.8 Fecal coliform (FC)

The values of fecal coliform at all the sampling locations have been plotted in figure 9. The results indicate that all the samples from tube wells, filters and house bores are free from FC. However, FC was found in the house connections next to tube well T3 and T1. The presence of fecal coliform clearly shows that somewhere sewage is being mixed with the water during the supply through pipe network. Possible causes of mixing may be cross connection between sewer and water lines and leakages in pipes. Since the water supply in the area was intermittent, therefore, seepage of sewage could occur during no supply hours.

This type of contamination is high because both the sewer lines and water supply lines are laid near each other in the soil. Sewer lines remain chocked most of the times because of garbage thrown in the sewage water. This scenario results in the leakage and overflow of sewage from manholes and this water becomes stagnant and leads to unhygienic conditions. The stagnant water seeps down and contaminates the water in the water supply system. The previous studies in the areas of southern Lahore indicates that the results obtained at the source were satisfactory however, in the bacteriological contamination were frequently found in the samples obtained from distribution system [18]. Similarly, this study also indicates that distribution systems in some areas are to be reassessed.

The concentrations of arsenic obtained from house hold connections as well as from respective tube wells have been presented in table 2. The overall results indicate that arsenic levels are satisfactory in the areas of East Lahore with respect to the NSDWQ (50 ppb).

4 Discussion

The results discussed above indicate that the physical parameters such as hardness, total dissolved solids, sulphates, chlorides, turbidity and pH provides satisfactory results. Few minor issues of hardness and turbidity have been reported. Therefore, proper treatment is required to remove hardness and turbidity of water. It is important to mention here that at consumer end, the most samples of the location T1HC and T4HC were found bacteriologic ally contaminated. The people in these areas may be at risk and may suffer from various water borne diseases. The above mentioned locations may have other parameters such as hardness slightly higher than other locations. Therefore, the water supply pipelines should be analysed in these areas. Additionally, chlorination is recommended in these areas. Apart from above mentioned parameters concentration of arsenic was also assessed. The results were found to be satisfactory; the arsenic levels were well within the NSDWQ (Table1).

5 . Conclusions and recommendations

From the study results it can be concluded that physico-chemical quality of water in the study area of Lahore was satisfactory and meets NSDWQ with the exception of rural area where turbidity and hardness was high and did not meet NSDWQ. Possible reason appears to be shallow depth bores to obtain water.

The results of bacteriological parameters show contamination at consumers' end for T1, T2 and T4. The probable causes of this problem may be poor maintenance of water supply system, un-repaired leakages and intermittent water supply. It was also learned that, in the affected area, water and sewer lines are laid in the same trench, which further increase the chances of contamination. Arsenic levels have been obtained less than that prescribed in NSDWQ (50 ppb).

1. Following recommendations are made in the light of above study. In order to improve the bacteriological quality of water, effective chlorination must be done at source.
2. Efficient wastewater collection system must be adopted in order to avoid the unwanted pounding of the wastewater in the streets.
3. Water supply and sewer lines should be laid on the opposite sides of the street in order to maintain safe distance between them in future water supply and sanitation projects undertaken by WASA.

Acknowledgments

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Sampling Point	GPS Coordinates
Manawan	31° 35' 38.457", 74° 27' 38.6886"
Harbanspura	31° 34' 27.8256",74° 25' 23.2212"
Askari X	31° 32' 7.4862", 74° 25' 1.902"
Taj Bagh	31° 33' 50.7054",74° 24' 52.0122"
Sooter Mills	31° 35' 43.2198",74° 24' 7.9452"
PHA	31° 34' 36.6276",74° 20' 51.7338"

Figure 1 Location plan of localities in East Lahore [19]

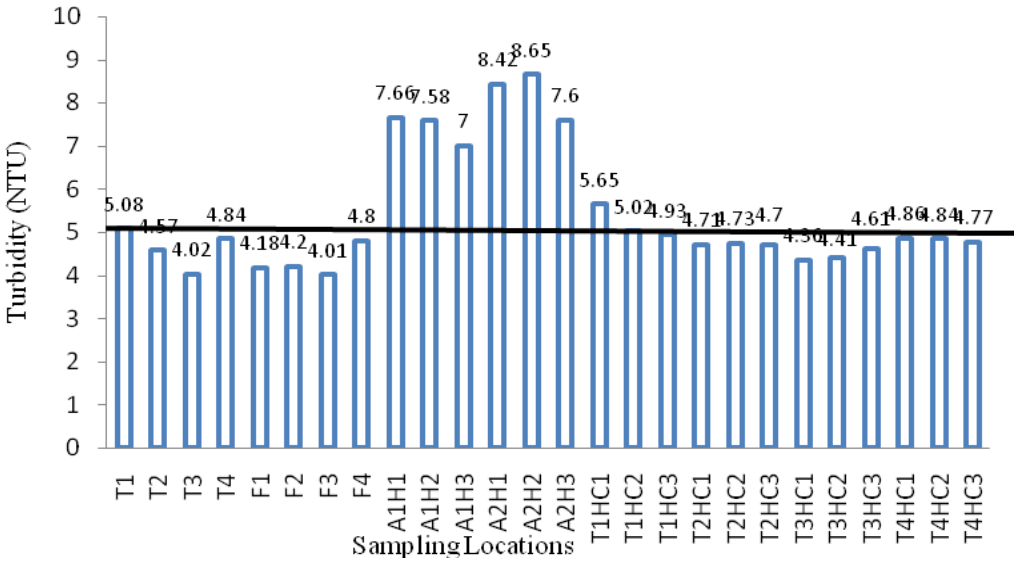

Figure 2 Comparison of mean values of Turbidity

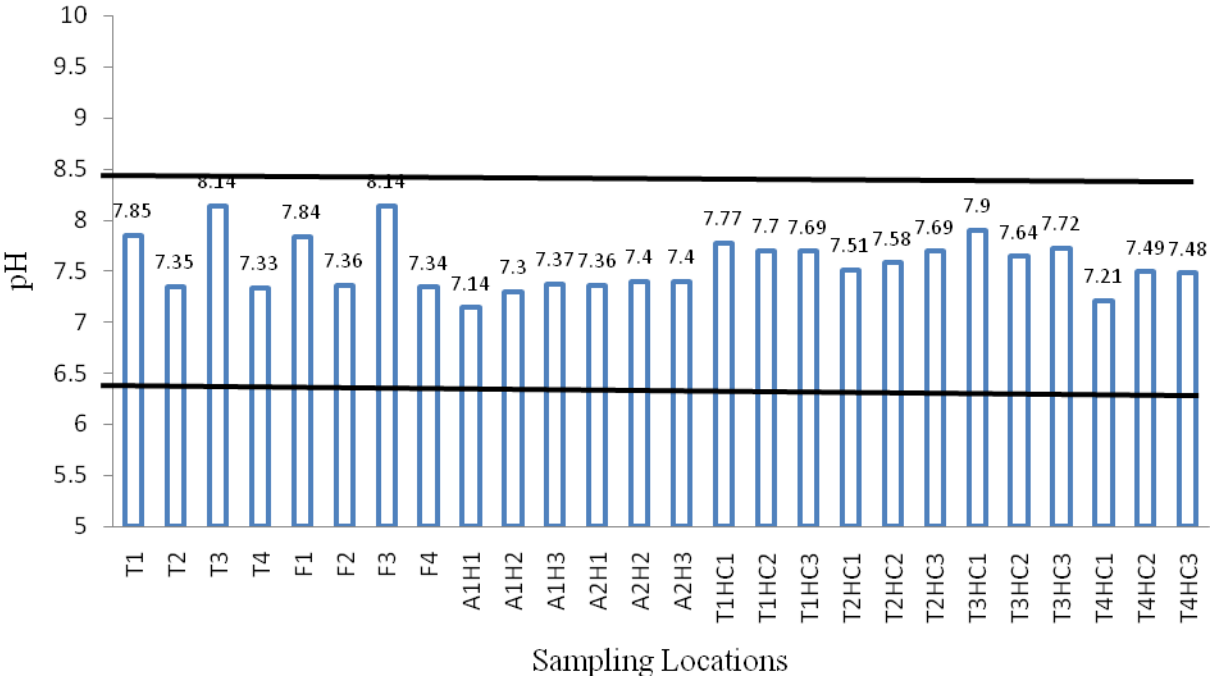

Figure 3 Comparison of mean values of pH

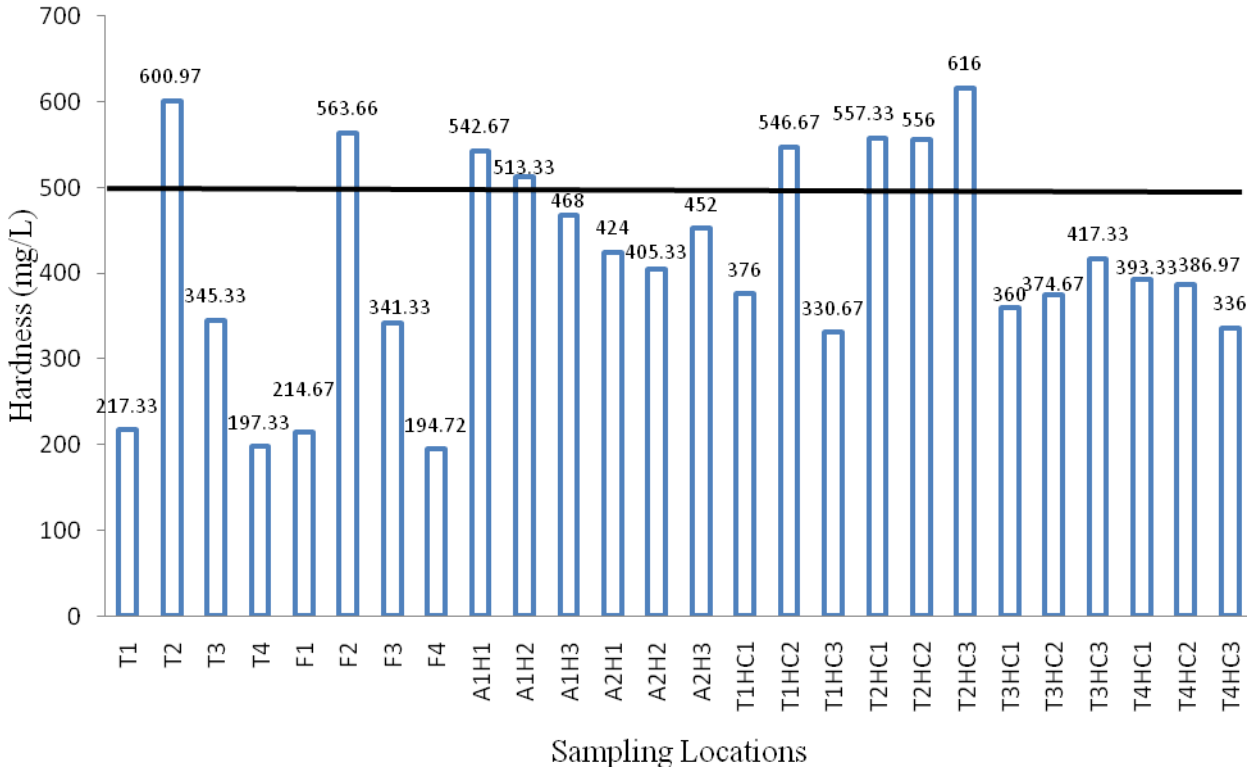

Figure 4 Comparison of mean values of Hardness

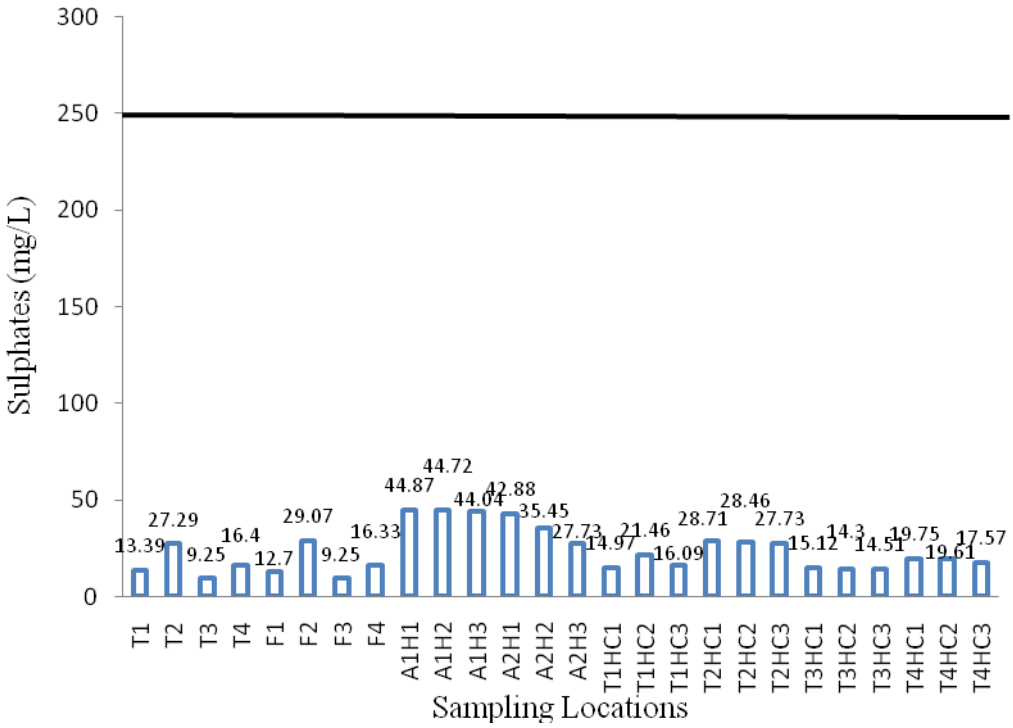

Figure 5 Comparison of mean values of Sulphates

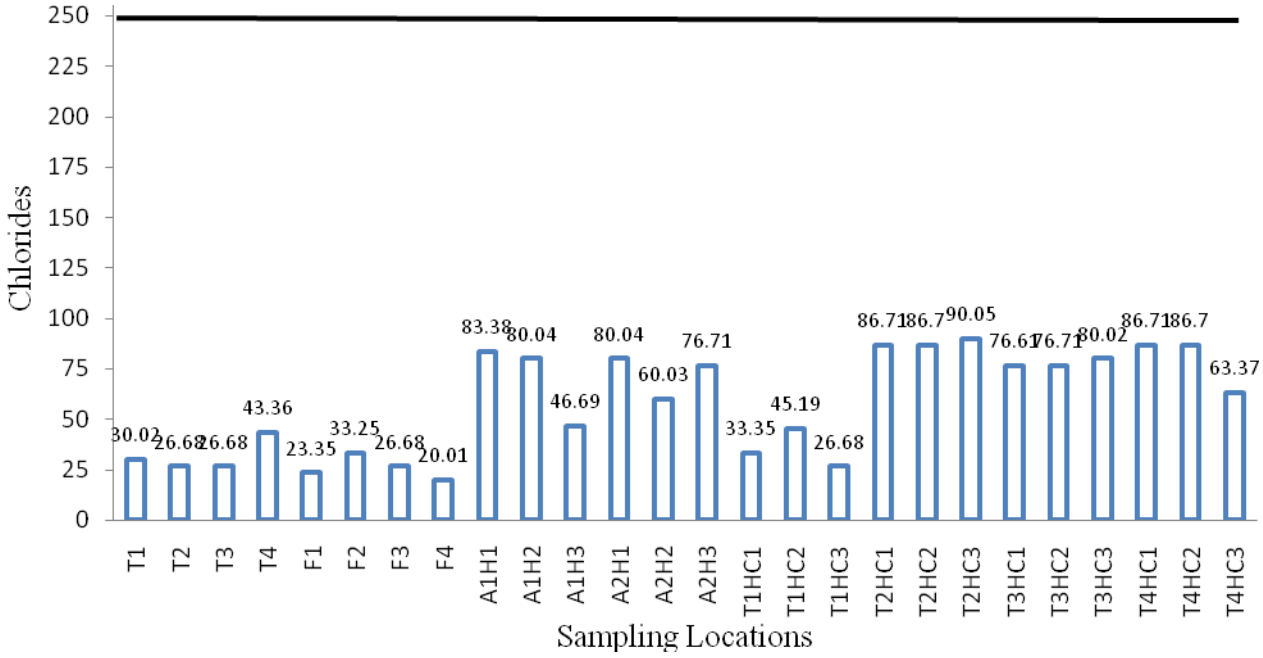

Figure 6 Comparison of mean values of Chlorides

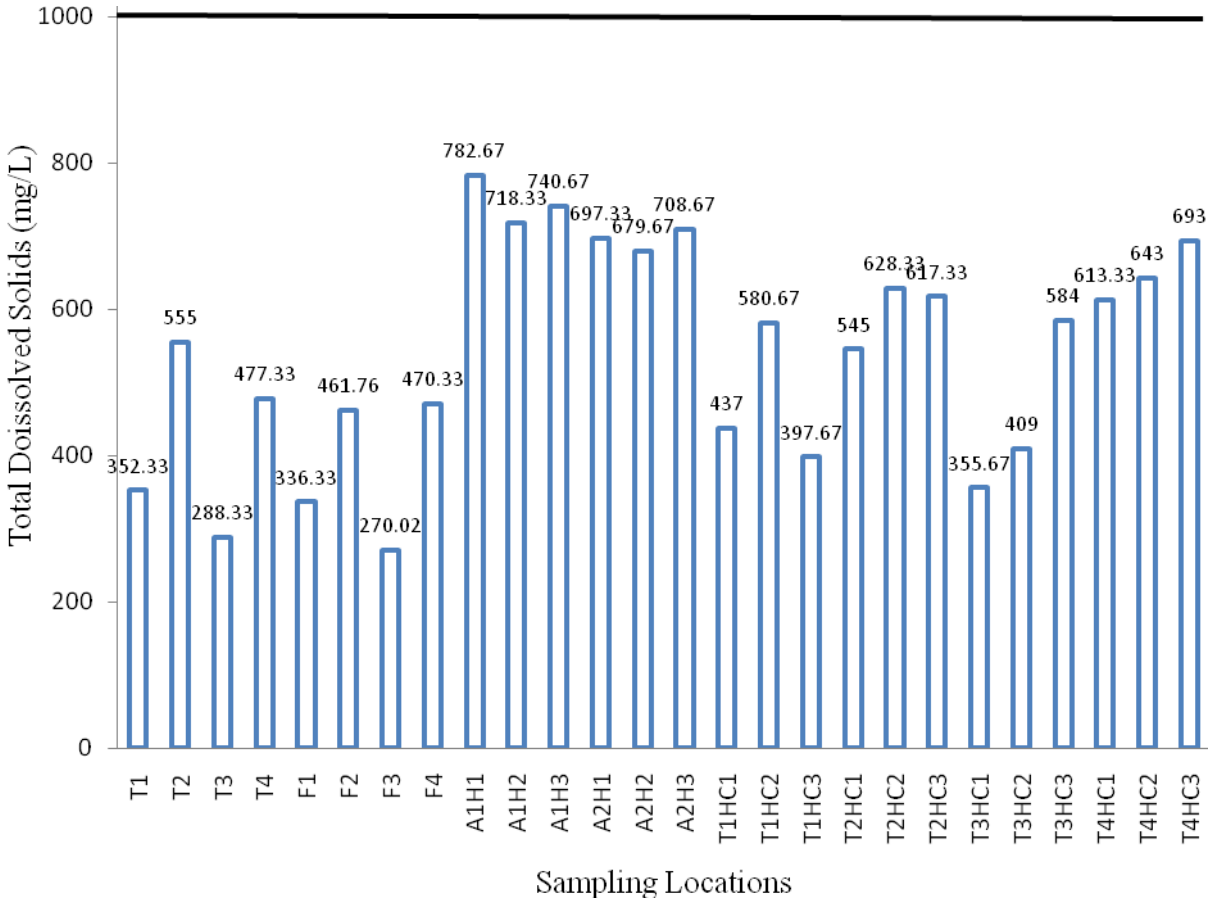

Figure 7 Comparison of mean values of Total Dissolved Solids

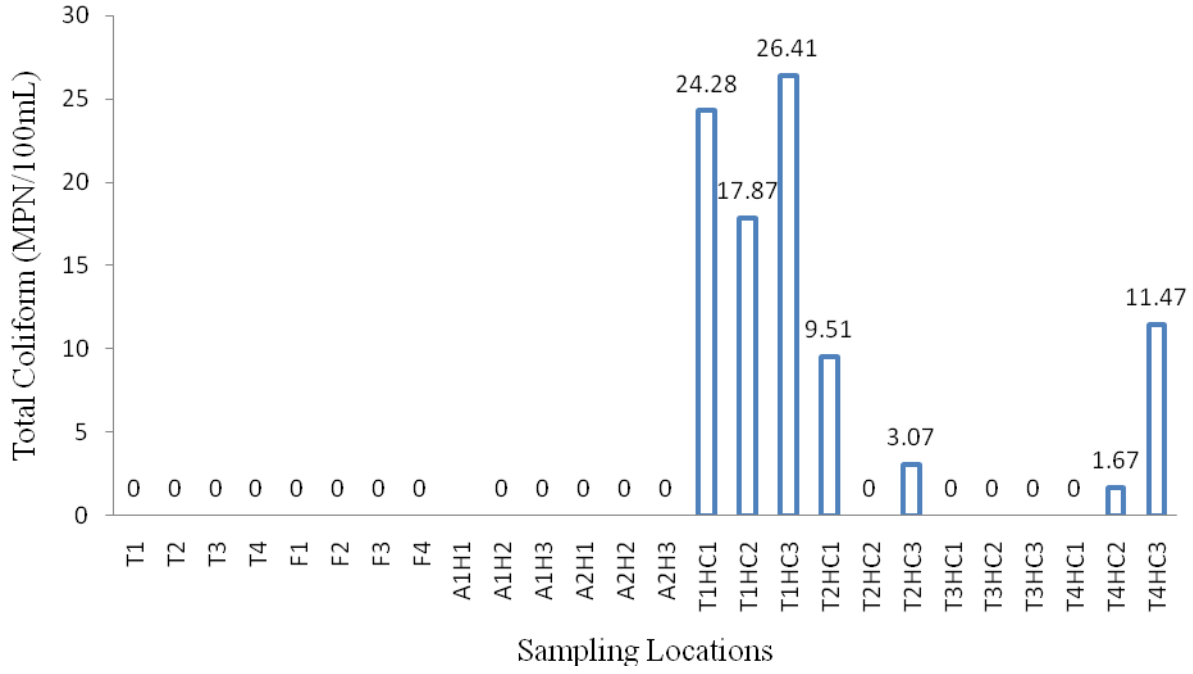

Figure 8 Comparison of mean values of Total Coliforms

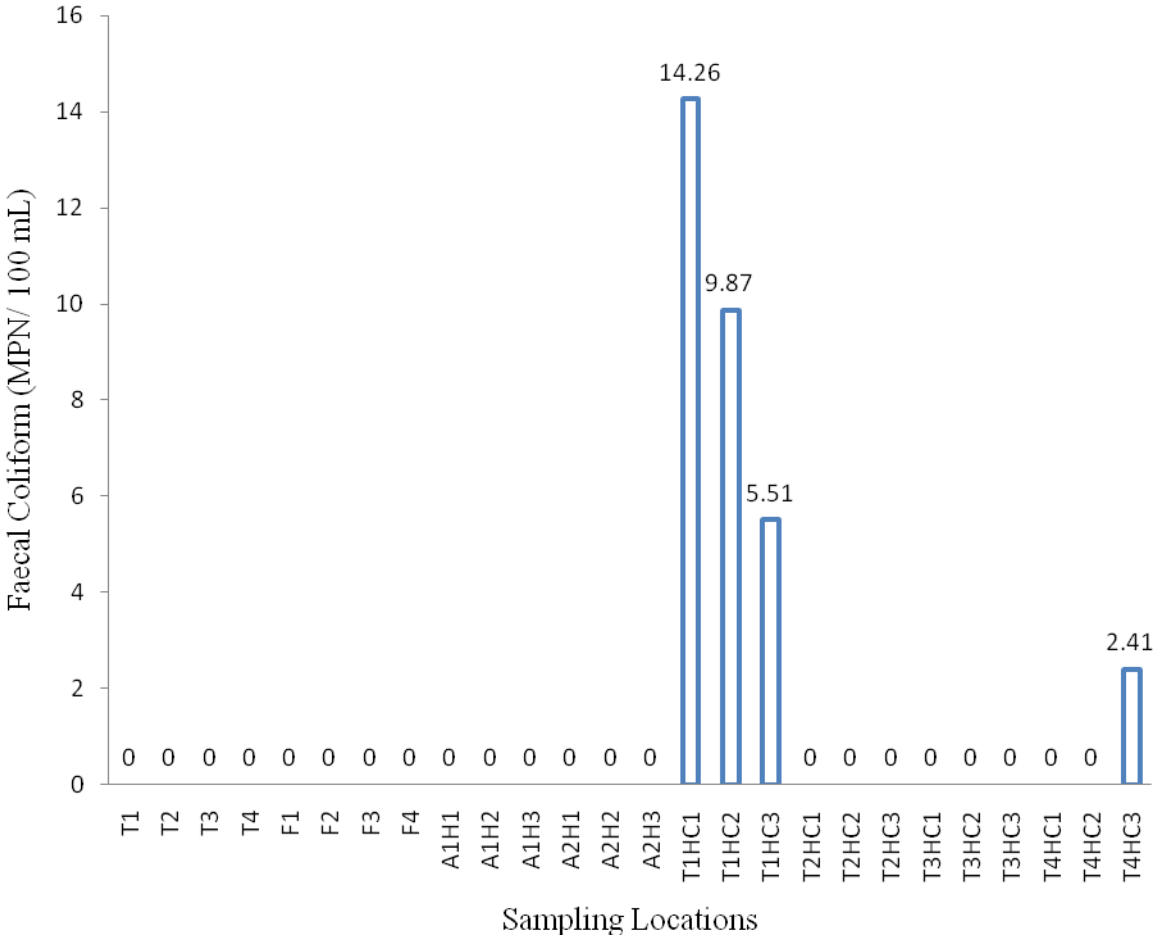

Figure 9 Comparison of mean values of Fecal Coliform

Table 1: National Standards for Drinking Water Quality and WHO guideline values of studied parameters [17]

Parameters	NSDWQ	WHO Guidelines
All water intended for drinking (E.Coli or Thermotolerant)	Must be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample
Turbidity	< 5 NTU	< 5 NTU
Total Hardness as $CaCO_3$	< 500mg/L	—
Chlorides	250 mg/L	250 mg/L
TDS	<1000 mg/L	<1000 mg/L
pH	6.5-8.5	6.5-8.5
Arsenic (As)	≤ 0.05 (P)	0.01

Table 2 Detail of Sampling Locations

Sr.No.	Location	Detail
1	F1	Filter at Taj Bagh
2	T1	Tubewell at Taj Bagh
3	T1HC1	House connection no. 1 of T1
4	T1HC2	House connection no. 2 of T1
5	T1HC3	House connection no. 3 of T1
6	F2	Filter at Pakistan Housing Authority
7	T2	Tubewell at Pakistan Housing Authority
8	T2HC1	House connection no. 1 of T2
9	T2HC2	House connection no. 2 of T2
10	T2HC3	House connection no. 3 of T2
11	F3	Filter at Askari
12	T3	Tubewell at Askari
13	T3HC1	House connection no. 1 of T3
14	T3HC2	House connection no. 2 of T3
15	T3HC3	House connection no. 3 of T3
16	F4	Filter at Herbanspura
17	T4	Tubewell at Herbanspura
18	T4HC1	House connection no. 1 of T4
19	T4HC2	House connection no. 2 of T4
20	T4HC3	House connection no. 3 of T4

21	A1H1	House connection no 1 at Sooter mill
22	A1H2	House connection no 2 at Sooter mill
23	A1H3	House connection no 3 at Sooter mill
24	A2H1	House connection no 1 at Manawan
25	A2H2	House connection no 2 at Manawan
26	A2H3	House connection no 3 at Manawan

Table 3 Arsenic in the areas of East Lahore

S.No.	Location	Detail	Arsenic (ppb)
1	T1	Tubewell at Taj Bagh	2.8
2	T1HC2	House connection no. 2 of T1	10.92
3	T2	Tubewell at Pakistan Housing Authority	11.0
4	T2HC1	House connection no. 1 of T2	5.1
5	T3	Tubewell at Askari	6.1
6	T3HC3	House connection no. 3 of T3	5.8
7	T4	Tubewell at Herbanspura	0.18
8	T4HC1	House connection no. 1 of T4	5.9
9	A1H2	House connection no 2 at Sooter mill	4.8
10	A2H1	House connection no 1 at Manawan	5.5