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Quality Assesment of Municipal Water Supply In Dhaka City –A Case Study In Saidabad Area

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Abstract– ***The specific objectives of the study were to assess the overall quality of drinking water from source (both surface water and ground water) to user end, to find out the variation of water quality at different locations of the study area, to identify the water quality problems, to study the water use characteristic of the people and to make some recommendations so that safe and adequate quantity of water is available at the user end. In Dhaka city municipal water is supplied by Dhaka Water and Sewerage Authority (DWASA) through 599 deep tube wells (DTWs). As the ground water is not sufficient to satisfy the demand completely, at present water is also extracted from surface water bodies. Surface water is sent into treatment plant before sending into the pipes. It is very important that the water entering the pipes is of good quality. Five different locations were carefully selected around SWTP and samples have been collected from three chosen points - the Main line, service line and underground reservoir of each location.***

The samples were then tested for a wide range of water quality parameters included pH, color, turbidity, TDS, alkalinity, hardness, chloride, manganese, TC and FC.

The value of pH varied from 6.20 to 7.22 with an average of 6.73. 22.22% of samples showed deviation from the ECR'97 standard. Minimum value observed was 4.61% lower than the recommended lower limit. Color varied from 0 to 10 mg/L units with an average of 4.23 mg/L units. 0% of the samples showed deviation from the ECR'97 standard. .Turbidity varied from 0.39 to 5 NTU with an average of 1.28 NTU. TDS varied from 103 to 469 mg/L with an average of 379 mg/L. Chloride varied from 27 to 250 mg/L with an average of 91.55 mg/L. No samples showed deviation from the ECR '97 standard for turbidity, TDS, and chloride. Alkalinity varied from 197 to 249 mg/ as CaCo3 with an average of 199.11 mg/L as CaCO3. Hardness varied from 190 to 248 mg/ as CaCO3 with an average of 209.49 mg/ as CaCO3. 27.70% of the samples showed lower value the recommended lower limit according to ECR '97. Manganese varied from 0

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to 0.111 with an average of 0.063 mg/L. 12.5% of the samples has deviation from ECR '97. TC varied from 0/100 mL. 50% of the samples were unacceptable according to ECR 97. FC varied from 0/100 mL. 50% of the samples were unacceptable according to ECR 97. Based on the assessment drawn above the necessary recommendations were made for the continuation of present work in future .

Keywords: *DWASA, TDS, Hardness, Alkalinity, SWTP, Groundwater Reservoir.*

1. Introduction

In Dhaka city, Dhaka Water and Sewerage Authority (DWASA) supplies water to users' end through a network of underground pipelines. Here main source of water is ground water, which is extracted from ground through deep tube wells, and then sent into the pipe network. As the ground water is not sufficient to satisfy the demand completely, at present water is also extracted from surface water bodies. Surface water is sent into treatment plant before sending into the pipes. It is very important that the water entering the pipe is of good quality. In Dhaka, the pipe system is very old and most of the pipes are in poor condition. There are leakage and breakage through which contaminants from outside the pipe may inter and get mixed with the supplied water. Due to lack of adequate quantity of water these pipes are often empty and out pressure. There is also an illegal practice of drawing water from pipes by suction. Both of these phenomena make it easier for the contaminants to get in. Again, due to improper layout of water supply lines and sewer lines, there might be crossings between them. This can cause fecal contamination. Thus it is very much possible that, even if the water, while entering the pipe, satisfies the specifications of drinking water quality, it is no longer potable and palatable at the users' end. As the water quality at the users' end is of main concern, it is very important to test quality there. Water quality at the end should satisfy the Environmental Conservation Rules (ECR'97) and preferably the World Health Organization (WHO) guidelines.

2. LITERATURE REVIEW

2.1. PRESENT CONDITION:

Dhaka water Supply and Sewerage Authority (DWASA) used both surface water source and ground water sources to supply water to people of Dhaka

city. According to Management Information Report of DWASA for the month of December 2011, 86.22% of total production of water was from ground water sources and the rest 13.11% was from the surface water sources. There are 599 deep tube wells (DTW) in operation for extraction of ground water, 4 water treatment plants for the treatment of surface water. There are also 38 Overhead tanks in operation. (Management Information Report, 2005)

Dhaka is divided into 7 zones by DWASA. The study area of Dhaka City is situated of deep tube wells and surface water. Total number of DTW's in zone I is 72 of which, 70 DTW's are in operation. The total capacity of these DTW's is 698.40 MLD. (The DTW's located at Maniknogor, Motijheel and Moghda are nearest the study area and it can be conveniently assumed that only these three deep tube wells contribute to the water that flows through the water pipes inside the area in question.

2.2. Water Quality Parameters:

Commonly used parameters to ensure the quality of supplied water are-pH, turbidity, solids, CO_2, alkalinity, hardness, color, chloride, iron, manganese, arsenic, nitrate, fluoride, total & fecal coliform, etc. Besides COD value and also be checked. All these parameters have certain environmental impacts and some of them can be hazardous to health if present in water beyond the tolerable limits.

3. DATA COLLECTION AND ANALYSIS

For determination of supplied water quality of a municipal area, samples need to be collected from different zones and sampling should also contain reasonable number of points which are not only well distributed over the entire area but also of different types . To do this assessment for Dhaka city, in this thesis, the study area is chosen to be Saidabad and five locations around it which are Maniknagar, Bashaboo, Tongi diversion road, North-south road and Chankher pool area near DMC.

4. METHODOLOGY:

The water supply network of Dhaka City contains three main pipelines. The left and the right ones have branch lines under the lanes to distribute water to occupancies on the left and right side of the road respectively.

Case Study On Effluent Treatment Plant Of Acs Textiles (Bangladesh) Limited

4.1 The sampling collected points are listed below in Table 1 & Table 2.

Table 1: Location of Selected Sampling Points (*Saidabad Water Treatment Plant Map, 2011)*

Type	Name of Location		Identify of Map
1	Saidabad water treatment plant 1S	Raw Water	1R
		Clarifier	2C
		Treated Water	3T
2	Maniknogor 2M	Main line W1	4 W1
		Service Line	5 S
		Underground reservoir	6 U
3	Middle Bashabo 3 M	Mainline W 2	7 W2
		S Service line	8 S
		U.G.R	9 U
4	Tongi diversion Road 4 T	Main line W 3	10 W3
		S. L	11 S
		UGR	12U
5	North South Road 5 N	Main line W4	13 W4
		S.L	14 S
		U.G.R	15 U
6	Chnakhar pool	Main line W 5	16 W5
		S. L	17 U

	6 C		
		UGR	18 U

Table 2: Location of Selected DTW's *(Saidabad Water Treatment Plant Map, 2011)*

Map Designation	Location	Name
1	Maniknogor Pump	1-M
2	Motijheel Pump	2-M
3	Moghda Pump	3-M

4.2 The samples were then tested for a wide range of water quality parameters included pH, color, turbidity, TDS, alkalinity, hardness, chloride, manganese, TC and FC.

5. DATA ANALYSIS

5.1 Overall Water Quality at Different Location.

The entire test result is shown in bar chart from parameter wise in Figure 1, 2, 3, 4, 5, 6, 7, 8, 9.and 10

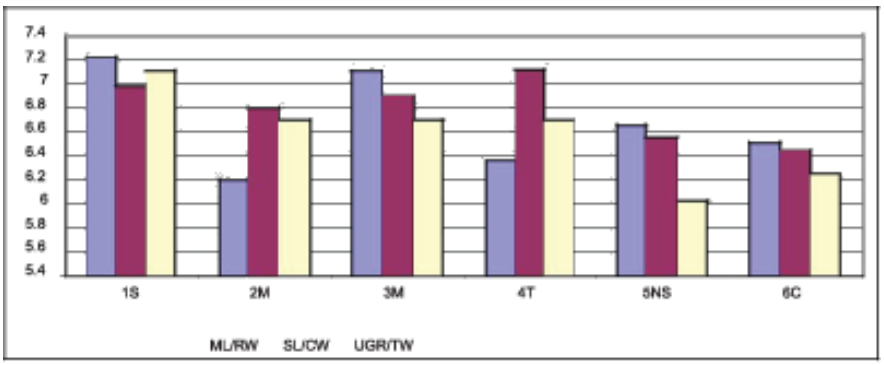

Figure 1: pH Values of Samples Collected from Different location

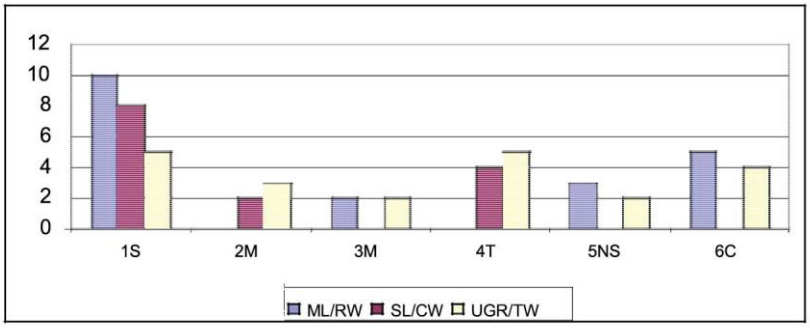

Figure 2: Color Values (mg/L units) of Samples Collected from Different location

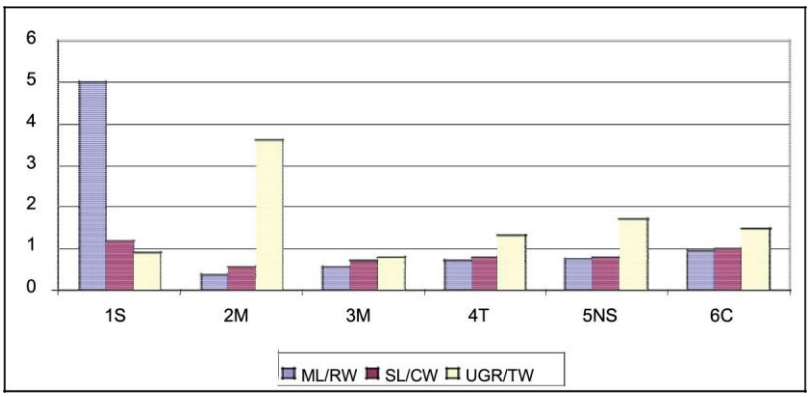

Figure 3: Turbidity Values (NTU) of samples Collected from Different location

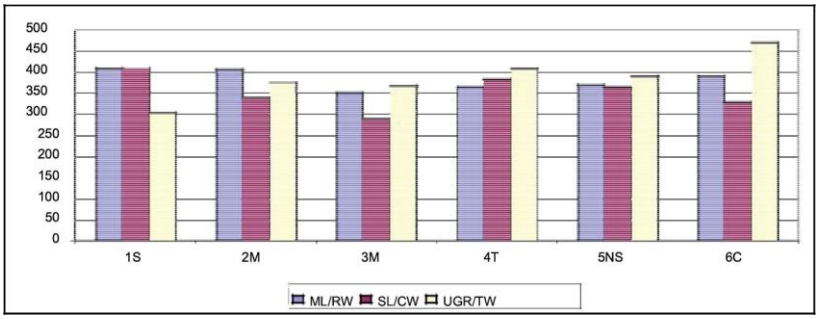

Figure 4: TDS Values (mg/L) of Samples Collected from Different location

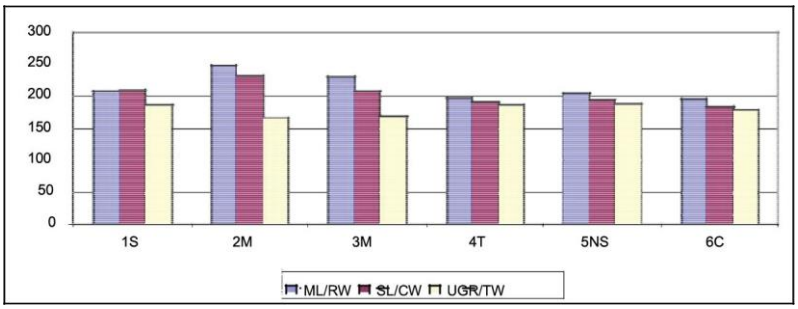

Figure 5: Alkalinity Values (mg/L as CaCO3) of Samples Collected from Different location

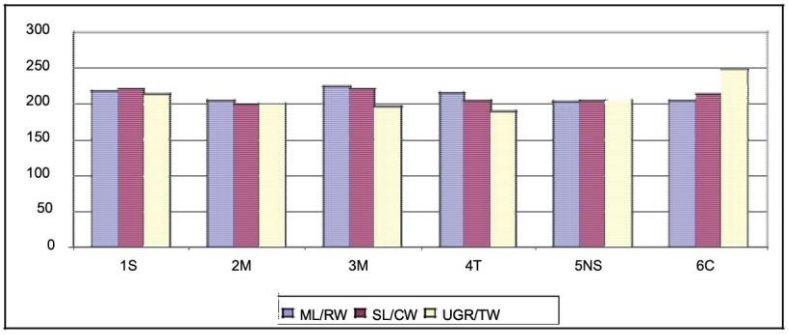

Figure 6: Hardness Values (mg/L as CaCO3) of Samples Collected from Different location

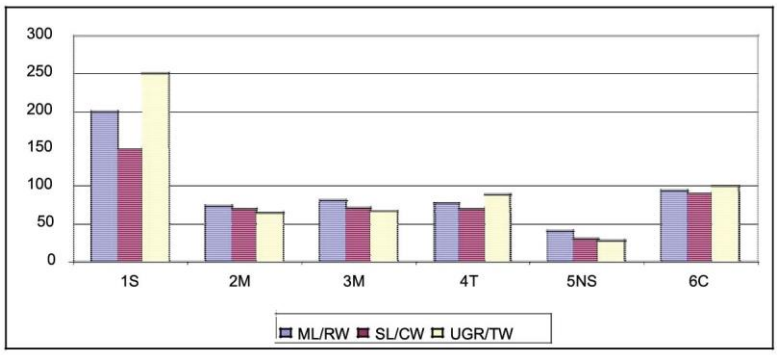

Figure 7: Chloride Values (mg/L) of Samples Collected from Different location

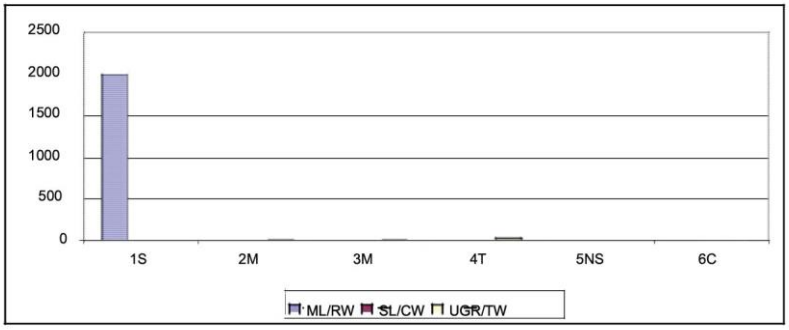

Figure 8: Total coliform Values (mg/L) of Samples Collected from Different location

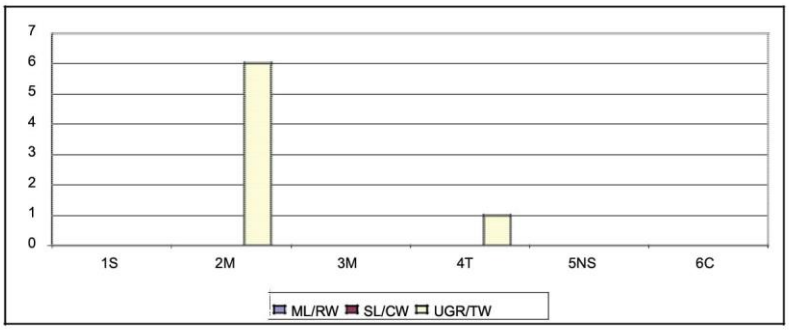

Figure 9: Fecal coliform Value (mg/L) of Samples Collected from Different location

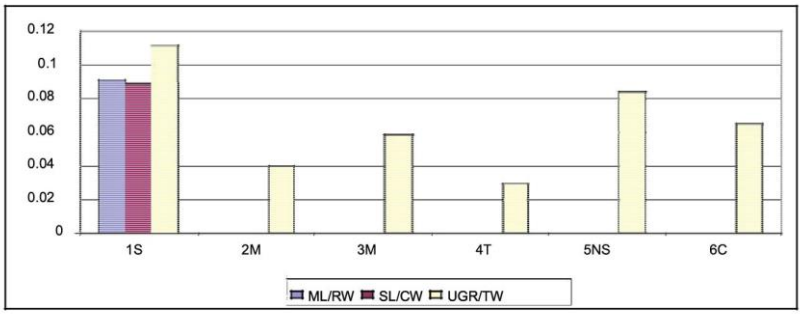

Figure 10: Manganese Value (mg/L) of Samples Collected from Different location

6. RESULTS AND DISCUSSIONS

OVERALL WATER QUALITY:

6.1 pH:

The pH of water of SWTP has shown a variation from 7.22 to 6.98 and the pH of water of DWASA tube wells and treated surface water has shown a variation from 6.50 to 6.6, whereas that of different occupancies varied from 6.20 to 7.22 with a weighted average of 6.73. The pH of a nearby DTW not belonging to DWASA was found to be 7.5.

The ECR'97 recommends a range of 6.5-8.5. No sample has crossed the upper limit but 4 out of total 18 samples, at some point, have not satisfied the lower limit, i.e., pH of DWASA supply water is mostly in the acidic range. This might be because of its being groundwater as groundwater is usually rich in dissolved carbon dioxide and hence has low pH value.(Saha,G.C ,2011)

6.2 COLOR:

The color of water SWTP has shown a variation from 5 to10 and the color of water of DWASA tube wells has shown a variation from 1 to 4 Mg/L units, whereas that of different occupancies varied from 0 to as high as 10 mg/L units with a weighted average of 4.23 mg/L units. The color of water of a nearby DTW not belonging to DWASA was found to be 3 mg/L units.

It is observed that the color of water extracted at SWTP and pumps is reasonably low the different location is not has exceeded the recommended limit (ECR'97) of 15 Mg/L units. So it can be concluded that, Water seems to become more colored while flowing through the underground pipe network. It indicates the possibility of leaks in the pipes, through which colored contaminants can enter and impart color to the water.

6.3 TURBIDITY:

The turbidity of the water of SWTP has shown .89 to5 and the Turbidity of the water of DWASA DTW treated and surface water was found to very

from 0.39 to 1.04 NTU, and that of different occupancies showed a range of 0.39 to 5.0 NTU with a weighted average of 1.28 NTU. The same from a DTW not belonging to DWASA had a value of 1.15 NTU.The turbidity of water of a near by DTW not belonging to DWASA was found 1.15

NTU.

The turbidity of water reaching the occupancies is much higher that extracted at the pump locations though turbidity everywhere is well below the recommended limit (ECR ’97) of 10 NTU. The increase in turbidity also indicates towards the possible presence of leaks in the pipe network. But it can be concluded that water quality of the study area in terms of turbidity is good.

6.4 TOTAL DISSOLVED SOLID:

TDS of the water of SWTP was found to very from 303 to 409 and TDS of the water of DWASA deep tube wells treated and surface water varied from 355 to 431 mg/L, whereas that of the different location varied from 103 to 469 mg/L with a weighted average of 379 mg/L. Another sample tested from a tube well not belonging to DWASA has shown a value of 290 mg/L.

The value of TDS dose not seem to be following any specific pattern as both lowest and highest value from the occupancies has exceeded the lowest and highest value of DTW. But it can be concluded that the water of the study area is fairly good in terms of TDS as all of them satisfied the limit set by ECR ’97 at 1000 mg/L

6.5 ALKALINITY:

Alkalinity of the water of SWTP was found to very from 186 to 211 mg/L and The minimum and maximum values of alkalinity found for DWASA tube well water and treated surface water were 188 and 199 mg/L as $CaCO_3$, while that for the location were 197 and 249 mg/L as $CaCO_3$ and with a weighted average of 199.11 mg/L as $CaCO_3$.

Though the minimum value is not less compared to the weighted average, the other values are much higher. A nearby tube well not

belonging to DWASA had water with alkalinity value of 170 mg/L as $CaCO_3$.

A through analysis of the values show that value of alkalinity more or less remains same for all sources. There is no limit set for alkalinity by ECR '97.

6.6 HARDNESS:

The hardness of water of SWTP has shown a variation from 214 to 220 mg/L and The minimum and maximum values of hardness found for DWASA tube well water and treated surface water were 163 and 200 mg/L as $CaCO_3$ respectively, while that for the occupancies were 190 and 248 mg/L as $CaCO_3$ and with a weighted average of 209.94 mg/L as $CaCO_3$. . Hardness of water of a nearby DTW not belonging to DWASA was found to be 165 mg/L as $CaCO_3$.

The ECR '97 recommends a range of hardness for potable water to be 200 to 500 mg/L as $CaCO_3$. No sample was found to have crossed the upper limit though 4 out of 18 has failed to satisfy the lower limit. And 2 out of 3 DWASA DTW samples have failed it. So it can be concluded that the hardness of the source water itself is low. Hardness was not found to change noticeably from DTW to occupancies. It is recommended that the hardness of the water should be increased by some means to satisfy the lower limit.

6.7 CHLORIDE:

The chloride of water of SWTP were found to 150 to 250 mg/L and Chloride value of water of DWASA tube wells and treated surface water were found to very from 91 to 100 mg/L, i.e., in a very small range. On the other hand chloride content of water from different location varied from 27 to 250 mg/L with a weighted average of 76 mg/L, i.e., over a quite large range. A through analysis of the values indicates that chloride content seems to from to the occupancies. The

Chloride of water sample of a nearby DTW not belonging to DWASA was found to be 50 mg/L.

ECR ’97 allows a range of 150 to 600 mg/L chloride in drinking water. None of the samples has crossed the limit. So it can be concluded that the chloride content of the study area is low as desired.

6.8 MANGANESE:

The minimum and maximum values of Manganese found of SWTP water were 0.089 to 0.111 and Manganese value of water of DWASA tube wells and treated surface water were found to vary from 0.063 to 0.182 mg/L and that of different occupancies were found to vary from 0.0 to 0.111 mg/L with a weighted average of 0.063 mg/L. The same for a DTW not belonging to DWASA was found to be 0.07. So the manganese concentration seems to vary over a large and does not follow any trend.

ECR’97 guidelines have set a maximum limit of 0.10 mg/L of manganese content for drinking water. Though some samples has shown very low manganese values, even zero, yet 1 out of 18 samples at some point has exceeded the specified limit. It is recommended that this should be checked.

6.9 Total Coliform (TC) and Faecal Coliform (FC):

The Total coliform of RAW water of SWTP was found 2000 per 100/mg.after treated the water no coliform has found .Do not any faecal coliform found at SWTP water after treated the water .ECR ’97 guidelines do not allow any existence of TC or FC in drinking water. Three DWASA tube wells were tested for coliforms, and one has passed the test, but the other was found with 10TC and 2 FC per 100 mL. As it is ground water it can be assumed that, the water got contaminated from some outside source like contaminated hand, etc. The same for a DTW not belonging to DWASA was found to be 1 TC and 0 FC/100 mL. As the number is very small it too probably just got contaminated from the outside. In case of the occupancies, only nine out of 18 samples tested were found with zero TC, while two were found with 0 FC. Four samples were found with presence of TC less than 10/100mL, and the number is fifteen for FC. The rest of the samples were found with large TC, FC values and samples. And the samples with values less than 10/100 mL, can be expected to be contaminated from outside through improper handling. But the other samples are grossly polluted. These can either be due to improper

maintenance of underground reservoir and/or overhead tank or due to the supplied water itself being contaminated. This can occur when the pipe line carrying the water has leaks with nearby sewer lines or cross-connections with them. The process is enhanced when water is pulled from the pipe by suction, which is a common practice in Dhaka.

7. CHANGE IN WATER QUALITY FROM DTW TO UGR (Sanyal et. al,2010)

7.1 pH:

The weighted average value of pH of water from DWASA deep tube wells was 6.45 whereas that from underground reservoirs was found to be 6.58. This indicates that pH of water increases and water quality improves in terms of pH flowing from DTW to UGR.

7.2 COLOR:

The weighted average of color of water from DWASA deep tube wells was 2.7 Pt-Co units whereas that from underground reservoirs was found to be 7.11 Pt-Co units.

3 TURBIDITY:

The weighted average of turbidity of water from DWASA deep tube wells was 0.72 NTU whereas that from underground was found to be 2 NTU.

7. 4 TDS:

The weighted average of TDS of water from DWASA deep tube wells was 404 mg/L whereas that from underground reservoirs was found to be 328.2 mg/L.

7.5 ALKALINITY:

The weighted average of alkalinity of water from DWASA deep tube wells was 192 mg/L as $CaCO_3$ whereas that from underground reservoirs was found to be 168 mg/L as $CaCO_3$. Alkalinity deceased by 12.5% from DTW to UGR.

7.6 HARDNESS:

The weighted average of hardness of water from DWASA deep tube wells was 185 mg/L as $CaCO_3$ whereas that from underground reservoirs was 173.3 mg/L as $CaCO_3$.

7.7 CHLORIDE:

The weighted average of chloride content of water changed from 96 mg/L to 58.4 mg/L while flowing from DTW to UGR.

7.8 MANGANESE:

The weighted average value of manganese of water from DWASA deep tube wells was 0.107 mg/L whereas that from underground reservoirs was found to be 0.074 mg/L.

8. CHANGE IN WATER QUALITY FROM SWTP MAIN LINE (ML) TO SERVICE LINE (SL) :

8.1 pH:

The weighted average value of pH of water from SWTP ML was 6.56 whereas that from service line was found to be 6.76. This indicates the pH of water in creases and water quality improves in terms of pH flowing from M.L to S.L. (Mixed water).

8.2 COLOR:

The weighted average of color of water SWTP ML was 2.60 mg/L units whereas that from S.L was found to be 1.20 mg/L units.

8.3. Turbidity:

The weighted average of turbidity of water from SWTP ML was 0.664 NTU whereas that from S.L was found 0.77 NTU.

8.4 TDS:

The weighted average of TDS of water from SWTP ML was 356 mg/L whereas that from S.L was found to be 362 mg/L.

8.5 ALKALINITY:

The weighted average of alkalinity of water from S.L was 215.60 mg/L as $CaCo_3$ whereas that from S.L was found to be 202.40 mg/L as $CaCo_3$.

8.6 HARDNESS:

The Weighted average of hardness of from SWTP mainline was 210.40 mg/L as $CaCo_3$ whereas that from service line was 208.20 mg/L as $CaCo_3$.

8.7 CHLORIDE:

The weighted average of chloride content of water changes from 74 to 66 mg/L while water flowing from SWTP main line to S.L.

8.8 MANGANESE:

The weighted average value of manganess of water from SWTP main line was mg/L whereas that from S.L was found to be 0 mg/L. This indicates of water quality no change from ML to Service line.

9. CONCLUSIONS

Major conclusions derived from the analysis of these results are summarized below:

Water quality of different occupancies getting water from same supply main varies due to both the different levels of maintenance and conditions of water pipes. The overall quality of supplied water is as follows:

- pH varied from 6.20 to 7.22 . Minimum value observed was 4% lower than the lower limit of pH recommended by EC'97
- Color varied from 0 to 10 mg/L units with a weighted average of 4.23 mg/L units of the samples showed deviation from the standard (ECR '97).
- Turbidity varied from 0.39 to 5 NTU with a weighted average of 1.28
- NTU of the samples showed deviation from the standard.
- TDS varied from 103 to 469 mg/L with a weighted average of 379 mg/L. of the samples showed deviation from the standard. There is no standard set for alkalinity by ECR '97.
- Hardness varied from 190 to 248 mg/L as CaCO3 with a weighted average of 209.94 mg/L as CaCO3 of the samples have shown lower value than the lower limit recommended by ECR '97 for drinking water a maximum deviation of 74%.
- Chloride varied from 27 to 250 mg/L with a weighted average of 76 mg/L. of the samples showed deviation from the standard set by ECR '97 for drinking water.
- Manganese varied from 0 to 0.111 with a weighted average of 0.063 mg/L. 8.7% of the samples showed deviation from ECR '97 standard for drinking water with a maximum deviation of 16%.
- 89.5% of the TC samples were unacceptable according to ECR '97.

- 42.1% of the FC samples were unacceptable according to ECR ’97.

Water quality changes as it flows from deep tube wells to underground reservoirs. The pattern of variation from DTW to UGR is as follows:

- PH increased by 1.8% which improved the water quality according to ECR ’97.
- Turbidity highly increased by 143.05% which deteriorated the water quality according to ECR ’97.
- Color increase by 18.51% which means decrease the water quality according to ECR-97
- TDS, Chloride and manganese decreased by .39%, 28.16.% and 48.60% respectively which improved the water quality according to ECR ’97.
- Alkalinity slightly decreased by 7.5%
- Hardness decreased by only 12.6% which can be considered insignificants.

Water quality change as it flows from SWTP Main line to service line (Mixed water, SWTP main line water and Deep tube well water)

The pattern of variation from SWTP ML to SL

- pH increased by 2% which improved the water quality according to ECR’97.
- Color highly increased by 53.84% from SWTP ML to S.L. This indicates that water quality deteriorated the water quality according ECR’97
- Turbidity increased by 16.67% from SWTP ML to S.L. This indicates that water quality deteriorates from SWTP ML to SL according to ECR’97.
- TDS Slightly increase by 1.68%
- Alkalinity increase by 1.05% from SWTP ML to S.L
- Hardness decreased by 1.05% from SWTP ML to SL which can be considered in significant.
- Chloride decreased by 10.27% from SWTP ML to SL which improved the water quality according to ECR’97.
- Manganese value does not change from SWTP ML to SL.

10. Recommendations

Major limitation of this was the shortage of time for which some aspects could not be covered.

The recommendations for continuation of the present work in future are summarized below.

- The study should include different types of area and each study area should include more sampling points.
- Samples from each collection points should be collected more than three time, which could not be done in this study.
- Water quality needs to be monitored over a larger period of time to assess the pattern of change in water quality with time.
- Variation of water quality with temperature and seasonal variation needs to be studied.
- Impact of flood on water quality needs to be studied.
- Result of such study can lead to possible leak detection in underground pipe network.

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