PERFORMANCE OF EXISTING WATER SUPPLY SYSTEM IN KHULNA CITY

Shams Jerin Khan *[1], Md. Saiful Islam [2] and Ripon Kumar Kundo[3]

[1]*Undergraduate Student, Dept. of Civil Engineering , Khulna University of Engineering and Technology, Bangladesh, e-mail: shamsjerinkhan@gmail.com*
[2] *Professor, Dept. of Civil Engineering , Khulna University of Engineering and Technology, Bangladesh, e-mail: saifulkuet92@gmail.com*
[3] *Undergraduate Student, Dept. of Civil Engineering , Khulna University of Engineering and Technology, Bangladesh, e-mail: Krishna.ripon@gmail.com*

ABSTRACT

Water supply & availability of safe drinking water has become an increasing concern of Khulna city. The existing water supply source in Khulna is depending only on Ground Water by KWASA's tube wells, hand pumps & private pumps. Due to huge extraction of ground water, the saline intrusion rate is increasing day by day. Also the water they supply through its distribution network is not satisfactory. In order to identify such water contamination problems, water samples from different locations of 21 & 29 No. Ward were analyzed in this study. Important ground water quality parameters like pH, chloride, iron, alkalinity, total dissolved solids, nitrate, turbidity, electrical conductivity, hardness, color, total coliform(TC), Escherichia coli(EC) were tested. Test results of water samples collected from the households of 21 & 29 No. Ward revealed that the water entering the distribution system was not meet the desired chemical and microbial quality except pH, chloride, hardness, TDS, nitrate, E.coli & arsenic.

Keywords: *KWASA, Water Quality, Water Demand, T.C & F.C.*

1. INTRODUCTION

Lack of safe water is more prominent in the third world countries. In Bangladesh, like many developing countries there is a great demand for safe water. Water is available in country apparently almost everywhere but availability of safe water is the prime question. Now, Khulna city faces the same problem. Khulna, the industrial and port city, is the third largest city of Bangladesh which is situated in the southwest region of Bangladesh and lies in the delta of the Ganges. The scarcity of water has been increased gradually owing to increasing resettlement from the surrounding districts, for rapid urbanization and industrialization but lack of parallel growth in necessary water supply infrastructure. Water crisis in Khulna city has turned for worse with the summer heat continuing to intensify for the last few days. Khulna Water Supply and Sewerage Authority (KWASA) supplies only 11crore 10 lakh liters of water per day against a demand for 24 crore for 15 lakh people, who lived in 31 wards under eight police stations. The rest 13 crore liters is being harvested by hand-driven tube wells and motorized water pumps owned by city dwellers. City dwellers have already fallen in grip of water crisis as groundwater level is gradually dropping. Besides, hand-driven tube wells are of no use if groundwater level drops below 26 feet and motor pumps do not function if the level drops below 30 feet, said Deputy Managing Director of KWASA Md Kamal Uddin.This study focuses on water inadequacy problem in Khulna city and supply coverage related problem which is taken by KWASA(Md. Rezaul Karim, Gazi Mohammad Mohsin).The aim of the study is to find out the amount of water regularly uses by households and demand by household and capability of KWASA to fulfill the demand. It also included quality of water and contamination of materials of water. Again with the seasonal variation the demand of water also changes for example in winter requires less amount of water but in summer requires a high amount of water and it also creates water scarcity of problem. The study was conducted to evaluate the existing status of water supply system of Khulna city & make a comparative analysis between them. Currently Khulna water supply system entirely depends on groundwater source. The population of Khulna City is increasing day by day and thus increasing water demand. To meet the future water demand in Khulna the provision of extension of groundwater development is very limited. Meanwhile salinity intrusion during several months of surface water surrounding rivers is the most significant issue for development of future drinking water resource for Khulna people. Therefore, to fulfill the future water demand it is very essential to use the groundwater and surface water in a combined manner.

2. SAMPLING POINT IN KHULNA WASA

Out of 31 wards of KCC, 21 & 29 No. wards were selected for the present study, which mainly cover the commercial and residential parts of the city. All sampling points are summarized in Table 4.1. Meaningful and reliable 10 sampling assures the validity of analytical findings. Therefore, utmost care was exercised to ensure that the analyses were representative of the actual composition of the water samples. The samples from different locations were collected in sterilized bottles and prior to filling the sample bottles were rinsed two to three times with the water to be collected. Collected samples were promptly carried to the Environmental Engineering laboratory of the Department of Civil Engineering of KUET and almost all the important water quality parameters were measured within four hours of collection. Khulna WASA have interconnected water supply network. So, collection of water in several households was done.

Table1: Sample no. and sampling location

Sample No.	Location
1(21)	Railway Guar Colony
2(21)	Railway Colony (Jessore Road)
3(21)	Jailkhana Road
4(21)	Bara Bazar Road
5(21)	Hospital Road
1(29)	Babu Khan Road
2(29)	Tank Road
3(29)	Babu Khan Road (Pump)
4(29)	T.B Cross Road
5(29)	South Central Road

3. MATERIALS AND METHODS

The collected GW samples are analysed for pH, Colour, Turbidity, Iron, Chloride, Arsenic, Hardness, Nitrate, Alkalinity, Electrical Conductivity,BOD5, TDS, TC and EC. All physical, chemical and bacteriological analyses are performed according to the standard methods for the examination of water and wastewater. TDS and pH were determined by TDS meter and pH meter respectively. Iron, Nitrate and colour are determined by Spectrophotometer and turbidity is measured by Hellige turbid meter. Chloride, alkalinity &hardness are determined by titration method. For chloride test, 0.0141N AgNO3 with K2Cr2O7 indicator is used, H2SO4 with methyl orange as a indicator is used for alkalinity test and standard soap solution is used for hardness test. The water quality parameters are assessed by comparing the test results with both Bangladesh Drinking Water Standard (BDS) and WHO guidelines for drinking water quality. (Kanij Fahmida, Md. Hasibur Rahman Lemon, Md. Saiful Islam, Md. Abdul Kader)

4. RESULTS AND DISCUSSION

4.1 pH

The pH value is an important index of water and controlled value of pH is desired in water supplies, sewage treatment and chemical process plants. The pH values of all samples of two Ward were found in permissible range of 6.5-8.5 according to WHO (2006) and ECR (1997) recommended values with a varying range 7.70 to 7.91. The variations of pH in collected samples are presented in Fig. 1(a) & 1(b).

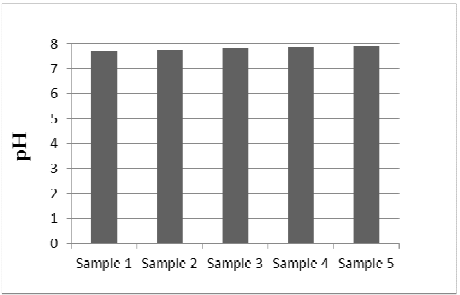

Figure1 (a):pH at different locations of 21 No. Ward

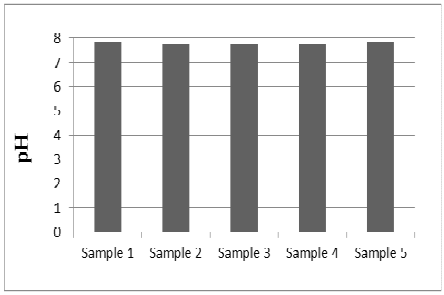

Figure 1(b):pH at different locations of 29 No. Ward

4.2 Color

Colored water does not cause so many health problems but it is aesthetically unacceptable. The color of 21 & 29 No. Ward was measured and the values were within the range of o to 28 TCU. It is observed that the value of color has exceeded the permissible limit. The variations of color in collected samples are presented in Fig. 2(a) & 2(b).

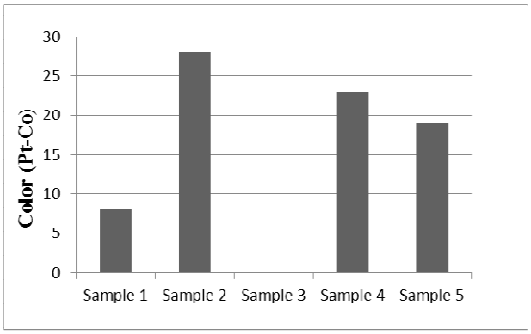

Figure 2(a): Color at different locations of 21 No. Ward

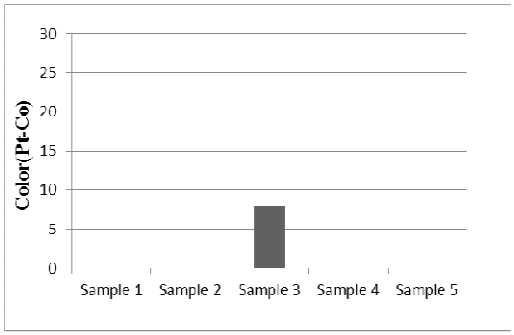

Figure 2(b): Color at different locations of 29 No. Ward

4.3 Turbidity

Turbid water is aesthetically unacceptable to the consumers of public water supplies. The turbidity of 21 & 29 No. Ward was measured and the values are within the range of 1.24 NTU to 4.62 NTU that satisfies the standard value. The variations of turbidity in collected samples are presented in Fig. 3(a) & 3(b).

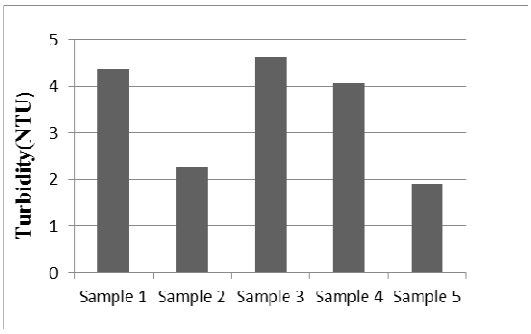

Figure 3(a): Turbidity at different locations of 21 No. Ward

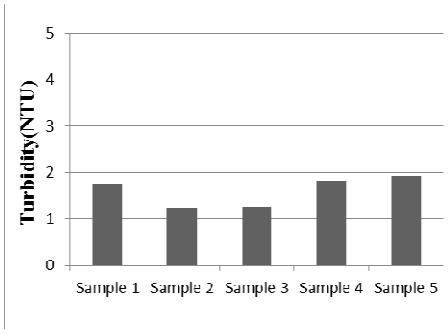

Figure 3(b): Turbidity at different locations of 29No. Ward

4.4 Chloride

High chloride content in inland water distribution system usually indicates sewage pollution. The maximum and minimum chloride concentrations were found about 330 mg/L at T.B cross road of 29 No. Ward and 140 mg/L Hospital Road of 21 No. Ward. High chloride concentration are quite may be due to the saline water intrusion problem, which is quite frequent in KCC area. No sample exceeds 600 mg/L. The variations of chloride in collected samples are presented in Fig. 4(a) & 4(b).

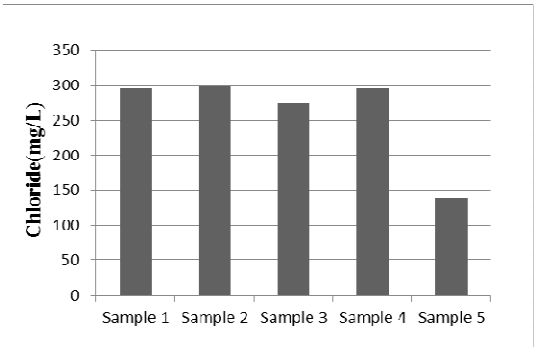

Figure 4(a): Chloride at different locations of 21 No. Ward

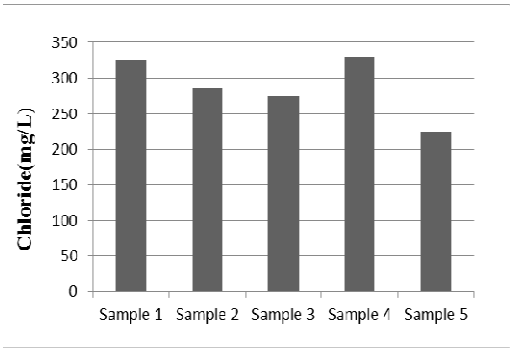

Figure 4(b): Chloride at different locations of 29 No. Ward

4.5 Iron

Iron defects lead to anemia, causing tiredness, headaches and loss of concentration. Minimum value of iron (0.03 mg/L) was found in the sample of T.B Cross Road of 29 No. Ward and maximum value (0.35 mg/L) was found in the sample of Jailkhana Road. Among all samples, no samples exceeds ECR (1997) recommended value and 20% samples exceeds WHO (2006) permissible value (0.3 mg/L) for drinking water. The variations of iron in collected samples are presented in Fig. 5(a) & 5(b).

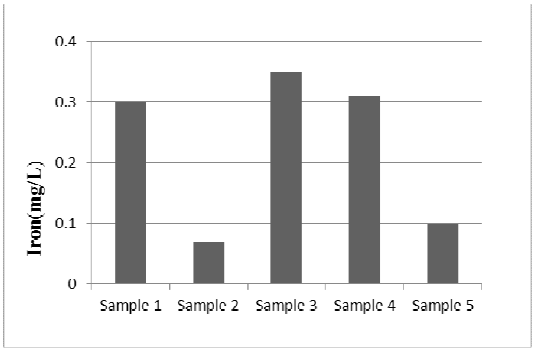

Figure 5(a): Iron at different locations of 21 No. Ward

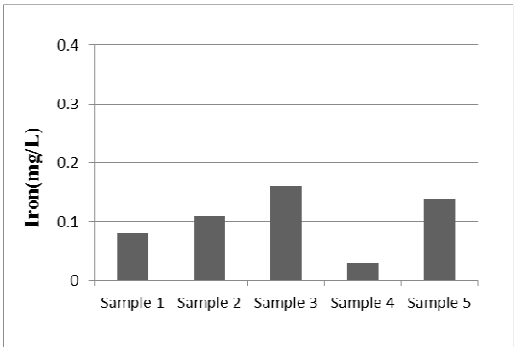

Figure 5(b): Iron at different locations of 29 No. Ward

4.6 Hardness

The maximum value of hardness was found 666.72 mg/L in the sample of Railway Colony (Jessore Road) of 21 No. Ward and the minimum value was found 203.72 mg/L in the sample of Jailkhana Road of 21 No. Ward .All the results were within the Bangladesh Water Quality Standards recommend hardness between 200-5000 mg/L based on taste and household use considerations. The variations of hardness in collected samples are presented in Fig. 6(a) & 6(b).

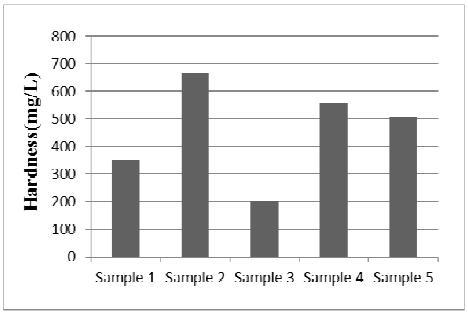

Figure 6(a): Hardness at different locations of 21 No. Ward

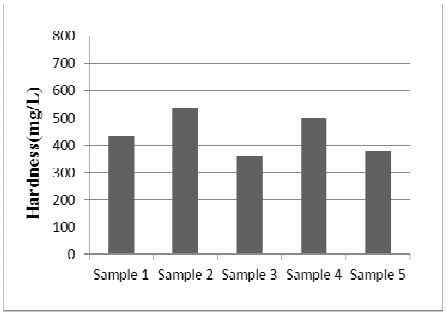

Figure 6(b): Hardness at different locations of 29 No. Ward

4.7 Total Dissolved Solid (TDS)

Total dissolved solids comprise inorganic salts and small amounts of organic matter. The maximum value of hardness was found 850 mg/L in T.B Cross Road of 29 No. Ward& the minimum value was found 500 mg/L in Hospital Roadof 21 No. Ward. It is observed that almost all the samples are fair (600-900 mg/L) and only one sample is good (300-600 mg/L). So, the water is not desirable for drinking or other purposes. The variations of TDS in collected samples are presented in Fig. 7(a) & 7(b).

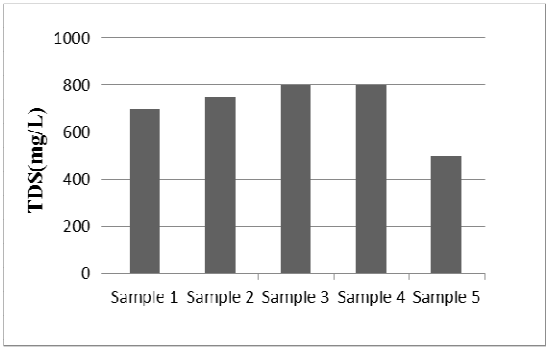

Figure 7(a): TDS at different locations of 21 No. Ward

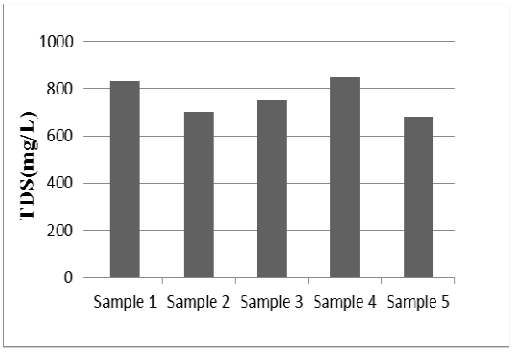

Figure 7(b): TDS at different locations of 29 No. Ward

4.8 BOD_5

All the collected water samples(10) from different location of 21 & 29 No. Ward had BOD5 concentration greater than the permissible value of 0.20 mg/L of BDS samples. The maximum BOD5 concentration was found 1.31 mg/L in Railway Guar Colony of 21 No. Ward and the minimum was 0.52 mg/L was found in the Railway Colony (Jessore Road) of 21 No. Ward.In 29 No.Ward, the maximum value was found 1.21 mg/L in South Central Road and the minimum value was found 0.56 mg/L in BabuKhan Road (pump). Therefore, high BOD5 concentration in the distribution system might be due to cross-contamination through leaking pipes,unauthorized connection, improper domestic storage facilities etc. The variations of BOD_5 in collected samples are presented in Fig. 8(a) & 8(b).

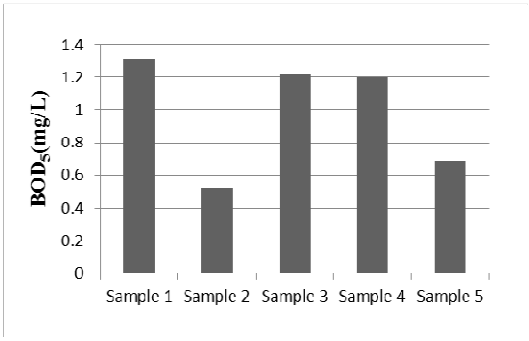

Figure 8(a):BOD_5 at different locations of 21 No. Ward

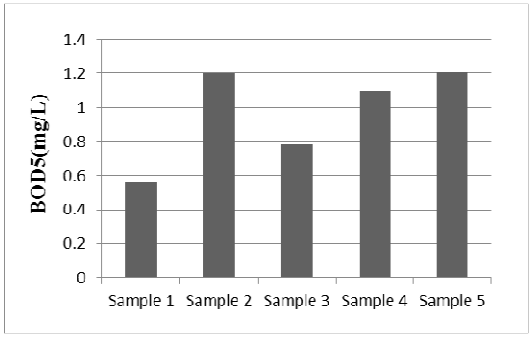

Figure 8(b):BOD_5 at different locations of 29 No. Ward

4.9 Nitrate

Nitrate is toxic when present in excessive amounts in water. No diseases have definitely been proven to be caused by water containing less than 10 mg/L nitrate-N.All the samples of 21 & 29 No.Ward are within the allowable limit. The maximum value was found 3.5 mg/L in T.B Cross Road of 29 No. Ward. The variations of nitrate in collected samples are presented in Fig. 9(a) & 9(b).

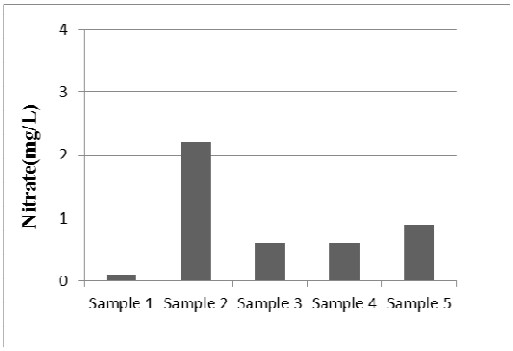

Figure 9(a): Nitrate at different locations of 21 No. Ward

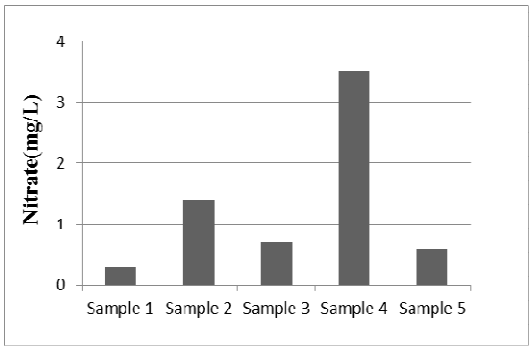

Figure 9(b): Nitrate at different locations of 21 No. Ward

4.10 Alkalinity

The alkalinity of water is a measure of its capacity to neutralize acids. Excessive or insufficient alkalinity interferes with water treatment (coagulation).The maximum alkalinity was found 450 mg/L in the sample of Railway Guar Colony of 21 No. Ward and the minimum value was found 310 mg/L in the sample of Tank Road of 29 No. Ward. The variations of alkalinity in collected samples are presented in Fig. 10(a) & 10(b).

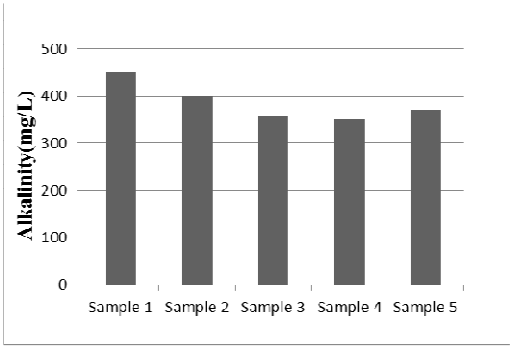

Figure 10(a): Alkalinity at different locations of 21 No.Ward

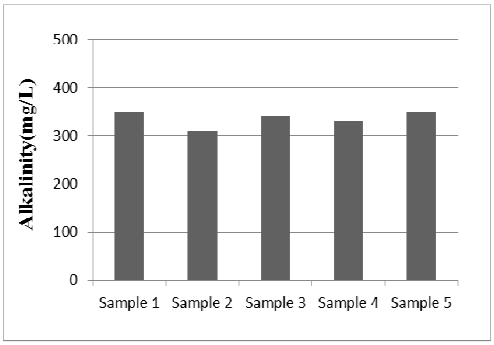

Figure 10 (b): Alkalinity at different locations of 29 No. Ward.

4.11 Electrical Conductivity

All the collected water samples from different location of 21 & 29 No. Ward had electrical conductivity within the allowable limit of 1200 Mmhos/cm(according to B.S). The maximum electrical conductivity was found 958 Mmhos/cm in T.B Cross Road of 29 No. Ward and the minimum was found726 Mmhos/cm in Hospital Road of 21 No. Ward. . The variations of electrical conductivity in collected samples are presented in Fig. 11(a) & 11(b).

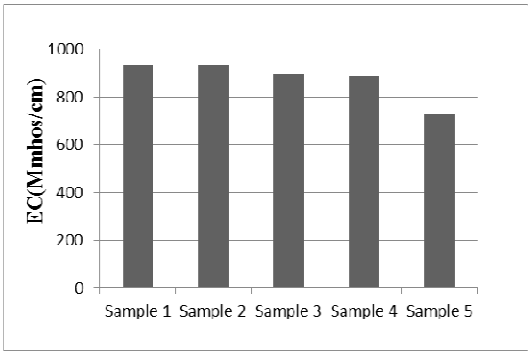

Figure 11(a): Electrical Conductivity at different locations of 21 No. Ward

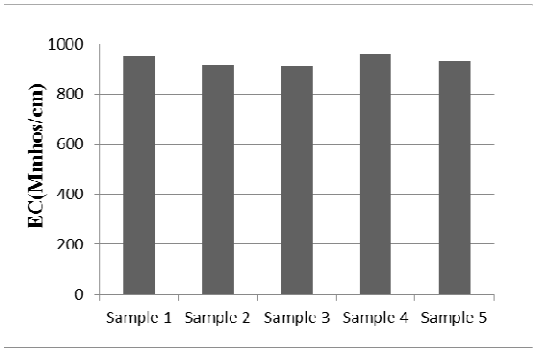

Figure 11(b): Electrical Conductivity at different locations of 29 No. Ward

4.12 Total Coliform &Faecal Coliform

Test results for TC and E. coli are given in the following Table-2. Maximum TC was found 59 NOS. in water sample collected from Babu Khan Road (pump). However, maximum E. coli was found 13 NOS.in sample no 5 which is collected from house hold also at South Central Road. Therefore, water supply in those areas may not be safe considering the microbiological water quality standard. The water passing through the distribution network in this area carries TC and E. coli which indicates that microbial contamination in the distribution system might happen due to cross contamination by leaking pipes, unauthorized connections, improper domestic storage etc. All the values of TC and 70% of the FC values of the samples are exceeding the standard values of WHO guideline and BDS (Table 2).(Kanij Fahmida, Md. Hasibur Rahman Lemon, Md. Saiful Islam, Md. Abdul Kader).

Table 2: Coliform counts in water samples of Khulna WASA in different location of 21 & 29 No. Ward

Sample No.	TC(NOS/100 ML)	E. coli(Nos/100 mL)
1(21)	6	1
2(21)	5	1
3(21)	6	0
4(21)	29	0
5(21)	31	0
1(29)	17	9
2(29)	10	6
3(29)	59	11
4(29)	10	5
5(29)	21	13

4.13 Arsenic

Arsenic enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices. To protect consumers served by public water systems from the effects of long-term, it is limited to 0.05 mg/L and WHO standard is 0.01 mg/L. All the collected samples are totally free from arsenic.

5. FIELD INVESTIGATION

A survey was made in the 21 & 29 No. Ward. From the survey it was found that the water that WASA supply is not sufficient for the people & also the water they supply contain sand, waste, insects etc.; that water is not suitable for drinking. In ward no. 21, total 8.16 % of household use tap water, 89.74% use tube well water and 2.0 % use water from other sources (pond, river, canal) for drinking & in Ward no. 29, total 4.3 % of household use tap water, 95.7 % use tube well water and 0.0% use water from other sources (pond, river, canal) for drinking.

5.1 Supply Coverage

Though the area is located within the coverage area of KWASA, only 13% of houses has piped water connection on 21 No. ward& 52% of houses has piped water connection in 29 No. ward of KWASA. Supply water of WASA is not adequate and so most of the houses cannot rely on it.

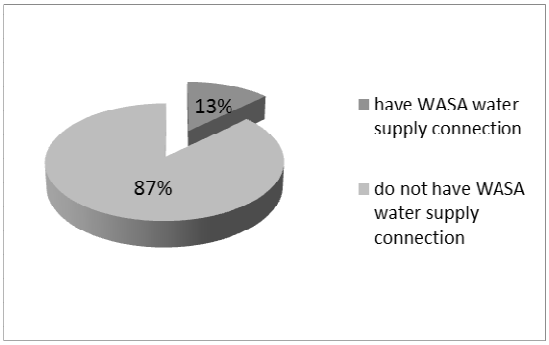

Figure 12 (a): WASA water supply coverage in Ward No. 21

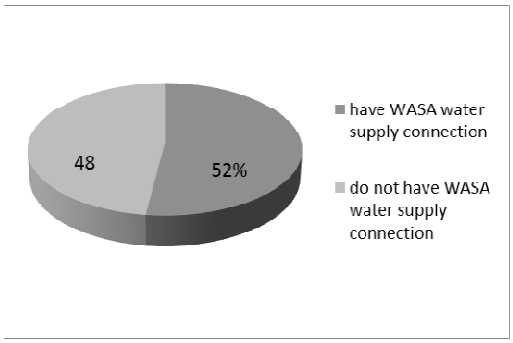

Figure 12 (b): WASA water supply coverage in Ward No. 29

5.2 Water Continuity

The ward No. 21 & 29 has the highest Water source continuity among the study area. Most of the people of the area have a continuous supply of water. 64% household of 21 No. ward& 85% household of 29 No. ward respondents have accessibility to the use of the water sources for more than 12 hours a day.

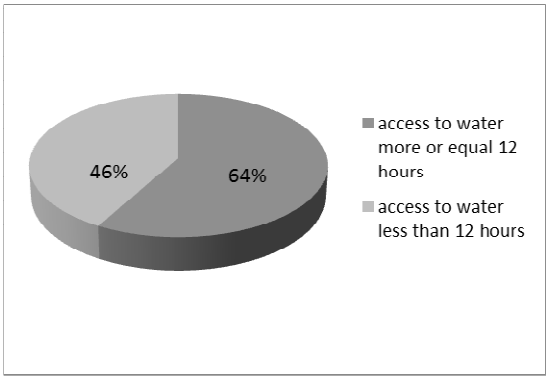

Figure 13(a):Water Continuity in Ward No. 21

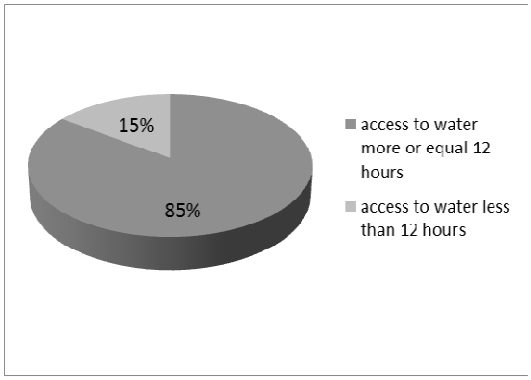

Figure 13(b):Water Continuity in Ward No. 29

5.3 Water Demand

Water that supply KWASA cannot fulfill the demand of the population .The domestic demand of water is 90% and non-domestic demand of water is only 10%.It is assumed on an average in 21 & 29 No. ward.

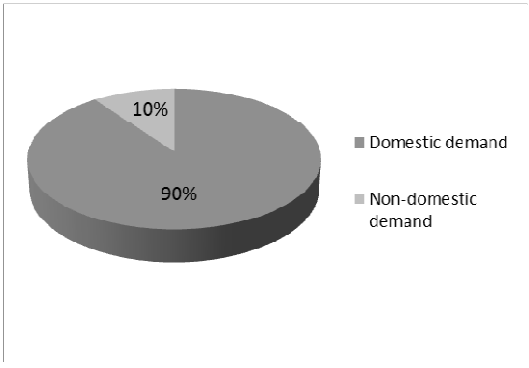

Figure 14: Percentage of domestic demand & non-domestic demand of water

5.4 Water Quality

Water that supply to the huge population of 21 & 29 No. ward is not safe to drink, because 82% people get unwanted things like insects, sand, dust, waste from water and also bad smell in water. They use light clothes to avoid these unwanted things. This contamination problem may happen due to the pipe leakage, structure failure. Sometimes the people repair the pipe, tank or fix the other problems by their own. But WASA does not pay any heed to the problems and the problems are increasing day by day. People from WASA should come forward to solve this problem.

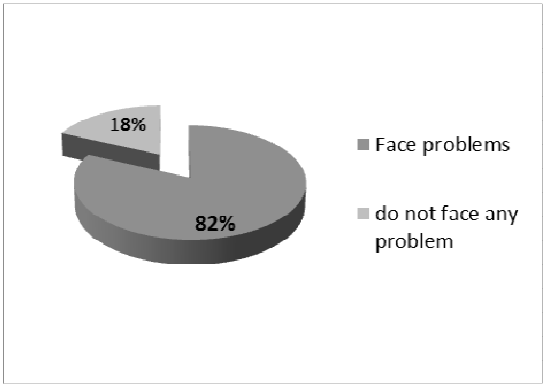

Figure 15: Users acceptance about the existing water supply system

6. OVERALL ASSESSMENT OF THE KWASA SUPPLY WATER AND RECOMMENDATION

Test results of water samples collected from the household of 21 & 29 No. ward revealed that the water entering the distribution system was not meet the desired chemical and microbial quality except pH, chloride, hardness, TDS, nitrate, EC & arsenic. However, this quality drinking water can suffer more serious contamination in distribution system because of breaches in the integrity of the pipe work. So, contamination occurs in the network. Therefore, it can be concluded from random tests of biological water quality that the people of Khulna city are at high risk due to contamination of drinking water. They also face some technical problems about supplying water from WASA. No people come from WASA to observe their source & sometimes the failure of structure like pump, pipe, and tank create water pollution but they don't pay any heed to them. One of the major tasks to ensure improved water quality is to find out possible point of sources of microbial contamination i.e., cross contamination by leaking pipes, unauthorized connection to the main at road sides, lack of maintenance of domestic storage and distribution system etc and to take necessary preventing measures. Current practice in many countries is to use disinfectant residuals to control the growth of microorganisms in distribution systems. In fact, proper system efficiency depends on quality monitoring which could be achieved by a program of frequent monitoring at service connection throughout the system. Besides, low cost treatment plants can be installed in the inlet of distribution network to provide standard quality water in the distribution network. (Kanij Fahmida, Md. Hasibur Rahman Lemon, Md. Saiful Islam, Md. Abdul Kader).

In future, Khulna WASA will supply treated surface water to the city dwellers. In rainy season, there are sufficient quantities of water in river but in dry season, the water level becomes low. So, the authority of Khulna WASA keeps alternative sources of ground water by providing some production tube wells. It is a matter of doubt that the production tube wells may not fulfill the required demand.

The water distribution network of Khulna city is interconnected and the water supplied by the network gets contaminated by leaking pipes, lack of maintenance etc. If newly constructed distribution pipes connect with the old supply network, the supplied water will be contaminated.(S.K. Adhikary, M.M.A. Elahi, and A.M.I. Hossain,)

7. CONCLUSIONS

- KWASA's plan for increasing water coverage and adoption of new water sources are expected to be effective in providing better services for the city people, implementing challenges is manifold.
- Consideration of demographic attributes along with existing qualitative and quantitative assessment of water supply services illustrates that the surface and ground water resources are vulnerable.

- Furthermore, organizational coordination and perspicacious responses were prerequisite for successful implementation of the projects.
- Concerned authorities should also put emphasis on demand management side to have a strong grip on water consumption.
- An effective water supply system would be achievable only when properly mechanized demands management approaches are in action. Inclusion of civil society, consumer and other stakeholder in water section planning and implementation is very crucial.
- The authority should conduct regular monitoring program to prevent possible contamination of water along its distribution.
- Public consciousness can also play an important role to help prevent such problems.
- To supply safe and adequate water in future, the alternative production tube wells are provided for the dry season, when surface water quantity becomes insufficient.
- Further study should be adopted to know the numbers of production tube wells are sufficient or not.
- The new distribution pipe line should keep separate from the old network for preventing the contamination problems. If the connection is necessary, then the old distribution network should be repaired or replaced or reconstructed.(M.M.A. Elahi, and A.M.I. Hossain)

ACKNOWLEDGEMENTS

The authors wish to express their acknowledgement to the Department of Civil Engineering, Khulna University of Engineering & Technology (KUET), Bangladesh and KWASA, Khulna, Bangladesh for extending all sorts of Supports to use the laboratory facilities for this study and collecting secondary data respectively.

REFERENCES

ECR (1997). Environmental Conservation Rules, Ministry of Environment and Forest, Government of Bangladesh, 1997.

Fahmida, K., Lemon, M.H.R., Islam, M.S., Kader, M.A. (2013). Assessment of Supplied Water Quality of Khulna WASA of Bangladesh, International Conference on Mechanical, Industrial and Materials Engineering 1-3 November, 2013, RUET, Rajshahi, Bangladesh.

Ahmed, M.F. and Rahman, M.M. (2000). Water supply & sanitation, International Training Network (ITN), Bangladesh University of Engineering and Technology (BUET), Bangladesh, 2000.

Zuthi, M.F.R., Biswas, M. and Bahar, M.N. (2009). Assessment of Supply Water Quality in the Chittagong City, ARPN Journal of Engineering and Applied Sciences, vol No.3, pp.73-80, 2009.

Elahi, M.M.A. and Hossain, A.M.I. (20011) Assessment of spatial and temporal variations of Water quality in the coastal areas of Bangladesh‖, B.Sc. Eng. Thesis, Department of Civil Engineering, Khulna University of Engineering & Technology Bangladesh, 2011.

Karim, M.R. and Mohsin, G.M. (2009). Assessment of Urban Water Supply Situation: A Case Study in Khulna City Corporation Area. 2nd International Conference on Water & Flood Management (ICWFM-2009).

Adhikary, S.K. Elahi, M.M.A. and Hossain, A.M.I. (20012). Assessment of shallow Groundwater quality from six wards of Khulna City Corporation, Bangladesh, Int. Journal of Applied Science and Engineering Research, quality from six wards of Khulna City Corporation, vol.1, No.3, pp. 488-498, 2012.