MICROBIAL ANALYSIS OF DRINKING WATER AND WATER DISTRIBUTION SYSTEM OF URBAN LAHORE

*Nazma Malik[1] Muhammad Nawaz Chaudhry[2]
[1]Department of Family and Consumer Sciences, University of Home Economics Lahore
[2]Department of Earth and Environmental Sciences, University of the Punjab, Lahore
*Correspondence, email: nazmamalik@live.com

ABSTRACT

Human health is the most important ingredient for a nation's progress, prosperity and well-been but unfortunately it has not been accorded its due priority. Therefore, when going to deal with the water of Lahore, it was considered essential to probe and find out the state of its quality. The main objective of this article is to highlight microbial contamination of drinking water in the selected localities of Lahore. Furthermore, this study will be helpful for researchers and administrative agencies to initiate relevant studies and develop new policies to protect further deterioration of water supply with pathogenic microbes and ensure clean and safe drinking water to the public in Pakistan. Five localities were selected from Lahore for the study, namely Lahore Cantonment Board (LCB) Walton Cantonment Board (WCB), Gulberg, Defense Housing Authority (DHA) and Model Town Society (MTS). These localities have their own tube wells for the supply of water to their residents. To measure the quality of tap water, samples were taken from 2 tube-wells in each locality at different intervals, tested in a water testing Lab for chemical and microbial contamination. The results were compared with the WHO standards and averaged out. MTS and LCB have too numerous to count total coli forms. WCB and Gulberg are higher, in Arsenic content. Gulberg is touching the maximum level of iron content, followed by DHA.

Keywords: microbial analysis, urban ground water, domestic use, Lahore

INTRODUCTION

Lack of resources and awareness are the major cause of water pollution specially in countries like Pakistan (Ahmed et al. 2010). A large number of serious diseases are caused by impure and unclean water. Cholera, diarrhea are spread by S contaminated water, and all types of hepatitis are also caused because of it (Jabeen et al, 2011). Contaminated water is very harmful, particularly for the children health. The mortality rate among the children in Pakistan is very high and is mainly due to unsafe drinking water (Azizullah et al, 2011). Efforts are on to control this menace at social and government level, but adequate measures have not been taken so far due to both lack of will and lack of finances. Microbial communities play an important role in the aquatic environmental conditions as they can cause different diseases as pathogenic bacteria (Janjua et al., 2009). Various chemical parameters including pH, Total dissolved solids (TDS), Chlorides (Cl), Fluorides(F), iron, calcium, magnesium, hardness and alkalinity were measured by standard methods. Everybody wants to drink a totally bacteria free water. Bacteria free water is clean, tasteless or odour less. It must be remembered that the raw water in its natural state would rarely have these qualities.

METHODS

To measure the quality of water through a laboratory test, 10 samples were taken, 2 from one tube-well in each locality at different intervals and the results were averaged out. Thus two tube wells were used from each selected locality to analyze and prepare a detailed average result sheet. 100 ml sterilized glass bottles according to standard methods (APHA, 2012). pH, and TDS were measured onsite by pH meter (Hanna pH meter sensION 1) and conductivity meter respectively. Total Alkalinity as mg of CaCO3 was determined by acid titration method. Chloride , Fluoride and hardness values were measured by volumetric analysis of water samples (APHA, 2005). Microbial analysis of the water samples was carried

out within 24 hours of sample collection. For identification of bacteria, various characteristics including colony morphology, Gram reaction, citrate utilization, catalase, and oxidase tests were performed. For heavy metals analysis, clean plastic bottles were used for storing samples which were later kept overnight after adding 5ml HNO_3. Arsenic analysis was done onsite using Arsenic kit (Hanna, 2100).

Results

The Table below depicts the average of the results obtained through this process along with WHO guideline where available:

Table 1: Microbial Analysis of Drinking Water of Selected Localities of Lahore

S.N	Parameters	Units	WHO Guideline	Gulberg	DHA	Model Town	LCB	WCB
1	pH	……	6.5-8.5	8.01	7.6	7.4	7.64	7.38
2	Total Dissolved Solids	mg/l	1000.0	369.0	675	524	458	378
3	Iron Total	mg/l	0.3	0.3	0.18	0.01	0.03	0.05
4	Calcium Hardness	mg/l	…..	117.0	110	61	78	70
5	Magnesium Hardness	mg/l	…..	149.0	138	85	104	94
6	Total Hardness	mg/l	…..	266.0	248	146	182	164
7	Sodium	mg/l	200	73.0	152.3	192.3	96.7	78.4
8	Potassium	mg/l	….	2.5	3.4	3.5	3.2	2.8
9	Arsenic	mg/l	0.01	0.1	0	0.005	0.014	0.029
10	Chloride	mg/l	250	114.0	188	18	25	36
11	Fluoride	mg/l	1.5	0.61	0.54	0.58	0.48	0.46
12	Sulphate	mg/l	250	114.0	178	96	104	80
13	Total Colony Count**	cfu/ ml	500	+++*	+++*	+++*	+++*	+++*
14	Total Coliforms**	cfu/100 ml	0	0	0	+++*	+++*	0
15	Fecal E. Coli**	cfu/100 ml	0	0	0	0	0	0

***too numerous to count**

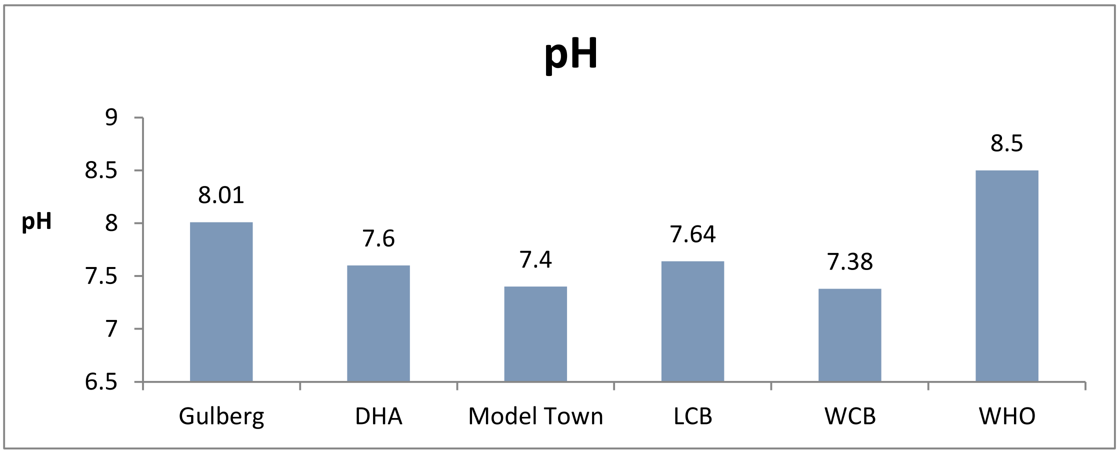

Figure 1: Level of pH

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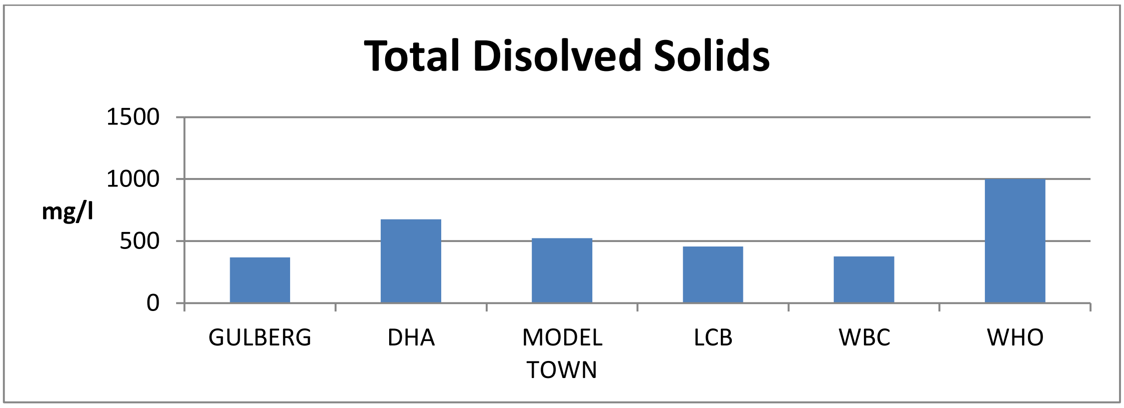

Figure 2 : Level of TDS

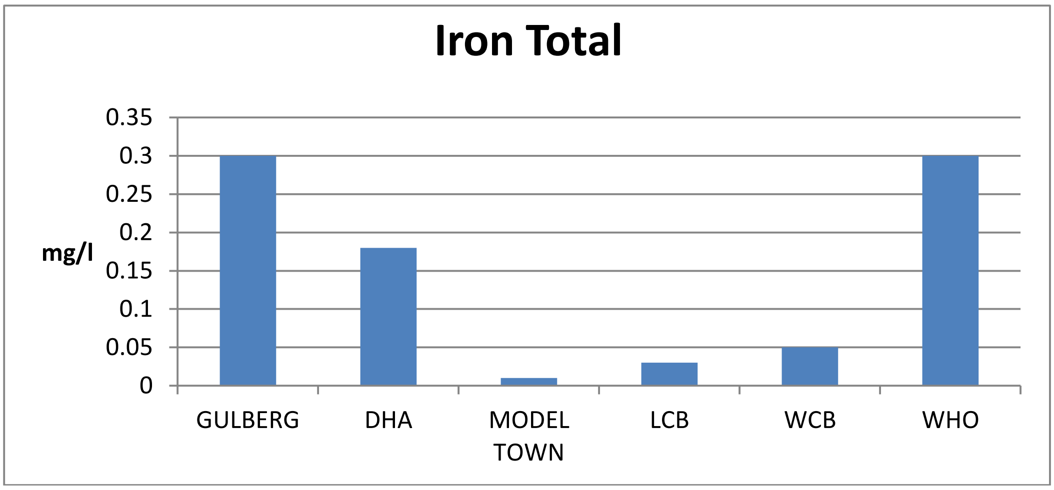

Figure 3 : Level of Iron

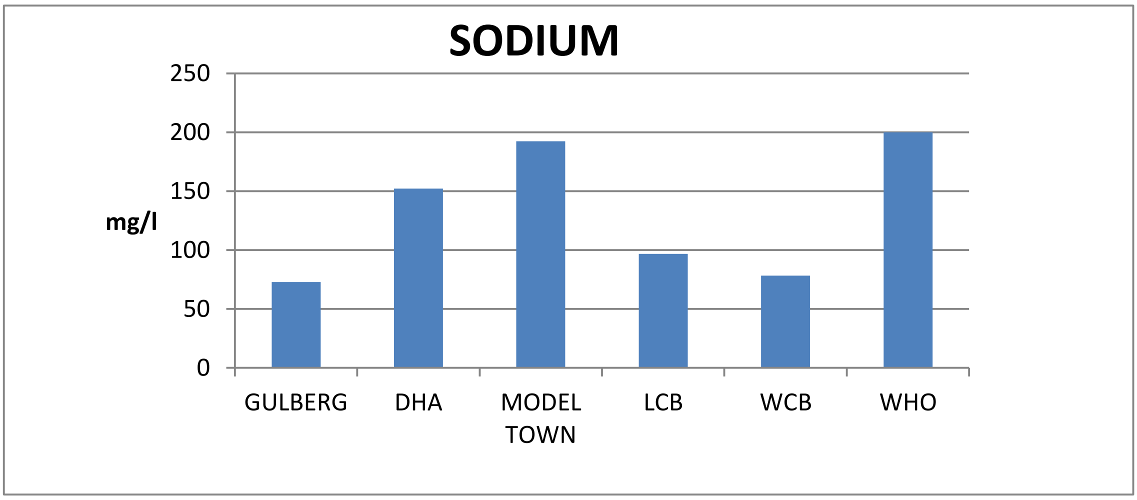

Figure 4: : Level of Sodium

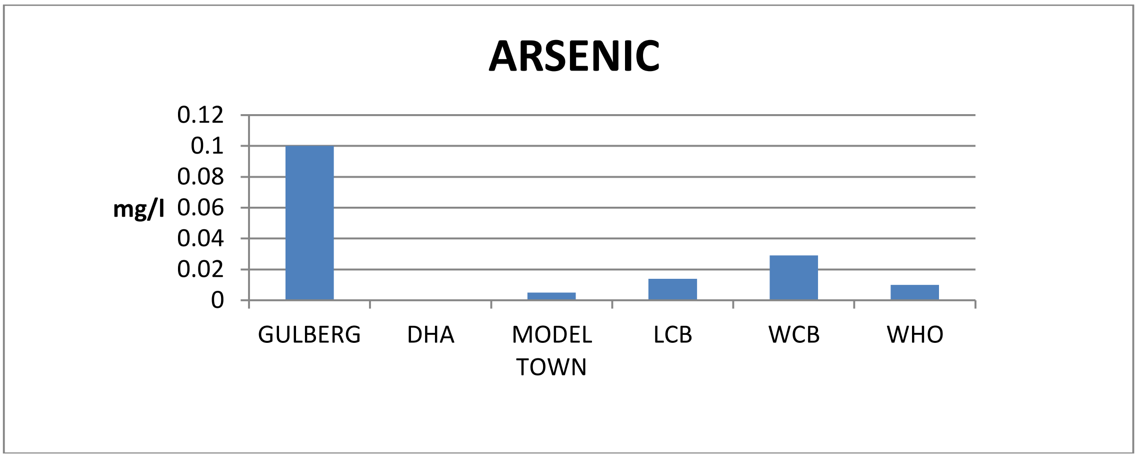

Figure 5: : Level of Arsenic

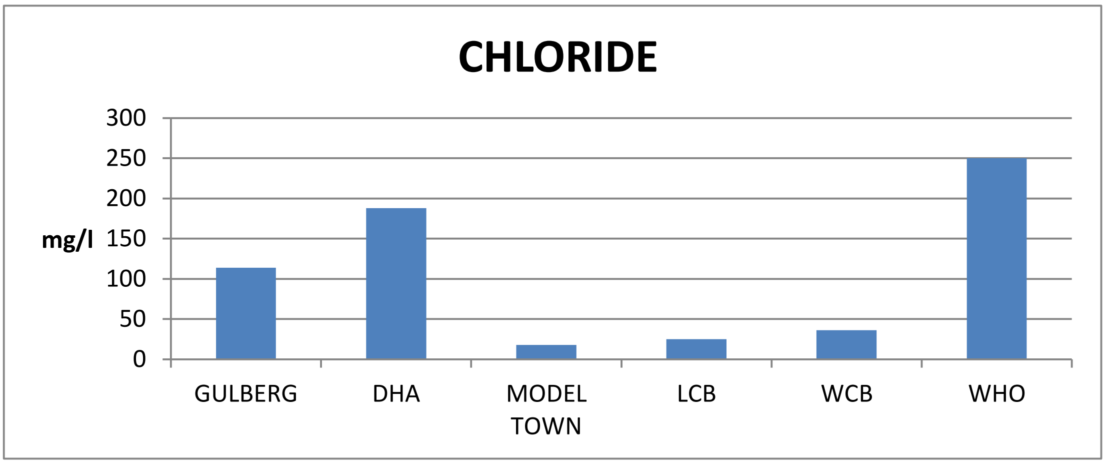

Figure 6 : Level of Chloride

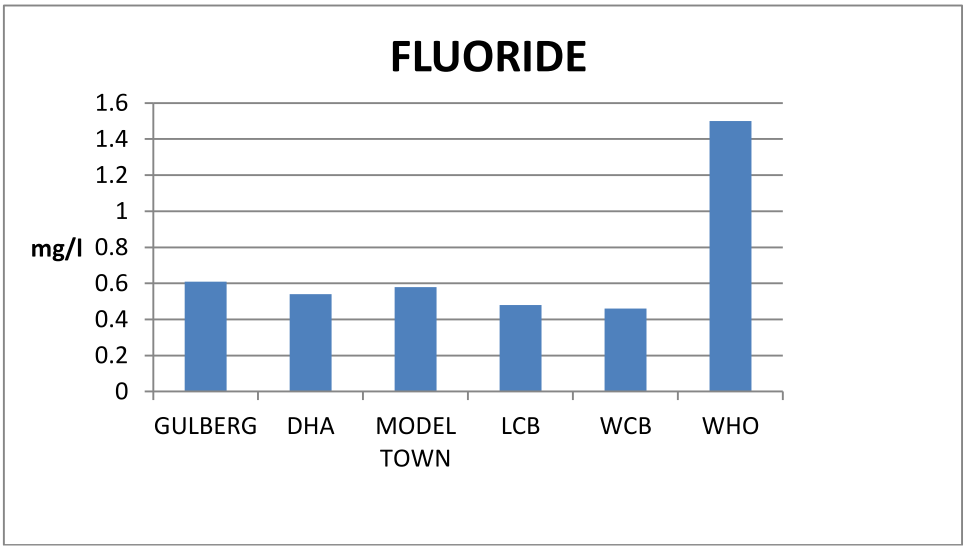

Figure 7 : Level of Flouride

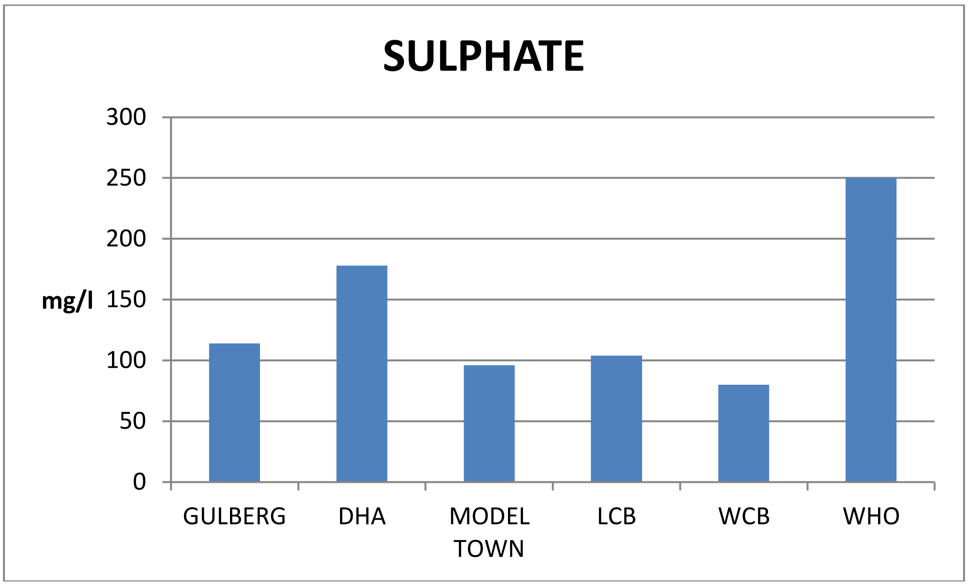

Figure 8: : Level of Sulphate

DISCUSSION

The pH scale of all five localities remain within prescribed limits of WHO, which is from 6.5-8.5. An outcome above 7 falls in the category of soft water. Gulberg is slightly ahead of the rest while MTS is much closer to the neutral state. Apparently there is no problem with pH scale of water. The state of total dissolved solids (TDS), according to the United States Environmental Agency (EPA) is classified as a secondary contaminant. It is measured in mg per unit value of water (mg/l). For drinking water the maximum concentration level set by EPA is 500mg/l. The panel of experts while examining the palatability of drinking water and its relationship with the TDS level has rated, "Excellent, less than 300 mg/l; good, between 300 - 600mg/l ; fair, between 600-900 mg/l; poor, between 900-1200mg/l; unacceptable, greater than 1200 mg/l". Water having less than 300 mg/l level of TDS would have totally flat taste and would not be palatable (WHO 1996). WHO has allowed the permissible level up to 100mg/l. All our samples produce water of good quality of water with DHA slightly shooting beyond this level. DHA is a new area and with a passage of time an extraction of more water it is likely to stabilize. Iron concentration in water is seldom found greater than 10mg/l. The permissible level as indicated by WHO is 0.3 mg/l. Gulberg is touching the maximum level followed by DHA. MTS is at the lowest ebb. Reason for higher contents of iron in Gulberg needs investigation. Even the corroded iron pipes of tube wells can cause this escalation. Sodium ions are ubiquitous in water. In some countries, levels can exceed 250mg/l. It could be due to saline intrusions, mineral deposits or sewage effluents (WHO 1996). All our samples are well within the limits with MTS leading on the higher side. Least iron contents and best sodium contents in MTS water should have some cogent explanation. Arsenic is a poison if found in drinking water can cause severe skin diseases including lung, kidney and bladder cancers, hypertension and even diabetes (C.Hopenhyn, 2006) . Arsenic is among the 10 chemicals of major public health concern according to WHO. EPA has set an arsenic maximum contaminant level (MCL) for public supplies at 0.010mg/l or 10 micrograms/l or 10 parts / billion. arsenic concentration according to an article, " Arsenic Contamination of Ground Water by Shankar et al", published on 14 Oct 2014, is contamination of ground water due to natural and/ or anthropogenic sources. DHA and MTS are safe and so is LCB but the results of WCB and Gulberg are higher than the limits.

Chloride is essential for human health but its concentration in excess of about 250 mg/l can change the taste of water. All samples have produced satisfactory results with DHA leading and MTS lagging at the tail. Chloride in MTS water can be increased if need be by its treatment with chloride and chlorine. WHO allows concentration of fluoride in drinking water up to 1.5 mg/l. Any number above that is considered unhealthy because the excessive use and long exposure to fluoride causes brain damage and resistance to insulin. All the samples from our study area were found to be within limits. Fluoride pollution generated

by industries can also contaminate water beyond the desired level. Drinking water has contents of sulphate is the dissolved form. To control the algae in the raw water as well the supplies meant for public consumption, a treatment by copper sulphate is required (McGuire MJ et al, 1984). Fresh water sulphate concentration varies from 0-630 mg/l and only 3% of the total water sampled contained sulphate level beyond 250 mg/l (EPA, 1999a). Daily human intake of sulphate is average 500mg. It is derived from drinking water, food and air, food being the major source. Results achieved in our study fell within the permissible limits.

CONCLUSION

Almost all the parameters (besides Arsenic and microbiology) were found to be within the prescribed limit of WHO which is an encouraging sign. Arsenic is a toxic metal and causes severe poisoning, if taken on regular basis as it bio-accumulates in the body. The source of arsenic in the ground water may be natural and also anthropogenic, as the ground water gets recharged through rivers which are being polluted by the industrial waste. The presence of bacteria in all the samples is alarming as it indicates very poor quality of water and calls for immediate measures to be taken to resolve this critical issue. The bacteria (total colony count) are beyond limits in all the samples, indicating organic contamination that may be occurring due to numerous sources. The presence of coli-forms in two samples is much too alarming that indicates sewerage contamination of the ground water. It indicates the absence inadequacy of appropriate sewerage channels. The two localities where the coli-forms are present beyond count are MTS and LCB. Both these localities have soakage pits systems. The soakage pits system allows downward percolation of water to the aquifer, thus causing ground water contamination. Only recently some waste water channels have been added. MTS and LCB happen to be the oldest localities among the selected five localities.

The most worrisome issue seems to be the presence of Colony Count and Coli forms in abundance. Colony counts are too numerous to count in all the five localities. MTS and LCB have too numerous to count total coli forms as well. It indicates the extent of fecal and organic matter present in water. According to the laid down quality standard of water it should be completely free from any pathogens. Bathing and swimming pool water can have 200 colonies and the recreational water about 1000 colonies/100 ml (WHO, 2006). The main source of pathogens in drinking water is from human and animal waste. Sewage discharges, improper septic treatment, animal manures, water runoffs and wild life beside the poor well construction can increase the risk of ground water contamination. Maximum acceptable concentration for drinking water is none detectable/ 100ml. Presence of fecal material may cause diseases related with bacteria, viruses and parasite including nausea, vomiting and diarrhea. It may affect lungs, skin, eyes, nervous system, kidney and liver. It requires proper planning and regular maintenance system of the water supplies. Water must be boiled at least for 1 minute and should be treated by adding chlorine.

The problem of receding water table and deteriorating water quality makes it too critically adverse for living conditions to be sustainable. It is an immediate need that a through survey is carried out (not part of this study) to continuously monitor the ground water quality of Lahore in order to ensure the provision of safe drinking water to its population. The changes in climate and other environmental factors makes it mandatory for the municipal authorities and governmental agencies to maintain an up to date record of varying states of underground water. Safe water is essential for human health, progress and prosperity and it must be accorded its due importance.

REFERENCES

Ahmad, M. K., Islam, S., Rahman, S., Haque, M. R., Islam, M. M. (2010). Heavy metals in water, sediment and some fishes of Buriganga river, Bangladesh. International Journal of Environmental Research, 4, 321-332.

APHA (2005) Standard Methods for the Examination of Water and Wastewater. 21st Edition, American Public Health Association/American Water Works Association/Water Environment Federation, Washington DC.

APHA (American Public Health Association) (2012). Standard methods for the examination of water and wastewater, 21st edition, Washington, DC, USA

Azizullah, A., Khattak, M. N. K., Richter, P., & Häder, D. P. (2011). Water pollution in Pakistan and its impact on public health—a review. Environment International, 37(2), 479-497.

Drinking Water Advisory. (2003): Consumer Acceptability Advice and Health Effects Analysis on Sulphate. U.S Environmental Protection Agency.
Hopenhayn, C. (2006). Arsenic in drinking water: impact on human health. Elements, 2(2), 103-107.
Jabeen, S., Mahmood, Q., Tariq, S., Nawab, B., & Elahi, N. (2011). Health impact caused by poor water and sanitation in district Abbottabad. Journal of Ayub Medical College Abbottabad, 23(1), 47-50.
Janjua, M.Y., Ahmad, T., Akhtar, N. (2009). Limnology and trophic status of Shahpur dam reservoir, Pakistan.The Journal of Animal & Plant Sciences,19, 224-273.
Jiménez-Cisneros, B. (1996). Water availability index based on quality and quantity: its application in Mexico. Water Science and Technology, 34(12), 165-172
McGuire, M. J., Jones, R. M., Means, E. G., Izaguirre, G., & Preston, A. E. (1984). Controlling attached blue-green algae with copper sulfate. Journal (American Water Works Association), 60-65.
Shankar, S., & Shanker, U. (2014). Arsenic contamination of groundwater: a review of sources, prevalence, health risks, and strategies for mitigation. The scientific world journal, 2014.
US EPA (1999a) Health effects from exposure to high levels of sulfate in drinking water study. Washington, DC, US Environmental Protection Agency, Office of Water (EPA 815-R-99-001).
Water, S., & World Health Organization. (2006). Guidelines for safe recreational water environments. Volume 2, Swimming pools and similar environments.
World Health Organization, Geneva, 1996. **Guidelines for drinking-water quality**, 2nd ed. Vol. 2. Health criteria and other supporting information.
World Health Organization. (2017). Guidelines for Drinking Water Quality: Fourth edition incorporating the First Addendum