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Drinking water Quality analysis of Water supply network at Ghanish valley Hunza-Nagar Gilgit-Baltistan, Pakistan

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Abstract

The drinking water quality of water supply network of Ghanish valley Hunza-Nagar has been studied. Water quality testing along with sanitary inspection of the entire distribution network was carried out during the last week of July, 2011. The various constituents monitored include the physio-chemical characters like pH, turbidity, temperature, color, odor and taste, electrical conductivity, total dissolved solids; chemical parameters include nitrate and nitrite; and microbiological parameters like E. coli count. Waqtech water testing kit was used for microbiological analysis which employs the membrane filtration technique. Chemical parameters were analyzed by using Photometer. Results obtained from assessment of different physio-chemical parameters were as follows. Temperature value fluctuate between 16-25 °C, turbidity levels were 200-500 NTU, pH ranged from 7-8.3, Electrical Conductivity ranged from 200-400 µS/cm, TDS values were 208-580 ppm , and E. coli (colonies) were 6-17 at different sampling locations. Nitrate concentration was 20.3-49.0 and nitrite was 1.0-2.9 respectively. Results showed that all the samples taken from water distribution network were bacteriologically contaminated with E. coli (colonies) an indicator organism of water borne diseases, falls in high risk category according to WHO guidelines and not fit for human consumption. During the sanitary inspection it was found that the sewage collection system, the main sewer of Karimabad is very close (4 to 5 feet), and on the upstream drinking water supply channel of Union Council Ghanish. Due to choking of manholes of sewers of Karimabad, the sewage enter into the water supply channel of Ghanish making it contaminated bacteriologically and thus become source of water borne disease. It was found that design of Karimabad sewage system is faulty, improper operation and maintenance and lack of technical expertise make it a health hazard for the people of Ghanish valley. During summer due to tourist influx, the main sewer use to choke twice in a month and majority of tourists belong to western countries that may spread new strains of microorganisms and subsequently new episodes of outbreaks in the respective village.

Keywords: Drinking Water Quality, E. coli, turbidity, World Health Organization, Environmental Protection Agency.

Introduction

High-quality and enough water supply services are most important requirement for community health and well being[1]. Many water resources in developing countries are unhealthy because they contain harmful physical, chemical and biological agents[2]. Microbiological water quality is weakening day by day due to unplanned industrialization, urban sprawl, reckless development, and faulty water distribution systems[3]. Such kind of microbiological contamination has been reported worldwide[4-6]. Drinking water protection is a worldwide worry. Drinking water usually has a physically powerful impact on the public health because water play major role in the spread of disease causing microorganisms which are liable to cause diseases in people[7]. Water is considered to be safe if it has no significant health risk over lifetime consumption[8]. Unfortunately, many people in the world are deprived of this basic need. The condition in developed countries is not severe as 95 % of the inhabitants has access to clean drinking water and 90 % of the inhabitants has sufficient disposal facilities[9].

The impact of safe drinking water supply and sanitation facilities can help in avoiding water and sanitation related diseases[10,11]. Drinking water being distributed by municipality to the community is frequently infected with communicable microorganisms or harmful chemicals[12]. The United Nations has anticipated that at least 2.5 billion people in developing countries have no suitable hygienic system and over 780 million have no right to use harmless drinking water[13]. As a result, about 2.3 billion people across the world are experiencing from water related diseases[14]. Outbreaks of E. coli have been evident from many countries owing to contamination of drinking water and food[15].

Resembling to other developing countries drinking water quality is main issue in Pakistan and it stands at 80th position among 120 nations[16]. Bacteriological contamination has been considered as most important drinking water difficulty in Pakistan[17]. In Pakistan water related disease (diarrhea) is commonest illness which is come across more or less by every person at least once a year[18, 19] and 30-50% of hospital entrance

are due to diarrhea[20,21]. Unequal water delivery is widespread in urban areas and outbreaks of gastroenteritis and other water born diseases has become an ordinary characteristic [22]. According to Pakistan Millennium Development Goals Report, 2006[23], in Pakistan water delivery coverage through piped network and hand pumps is around 66%. Global Water Partnership Report, 2000[24] anticipated that, in Pakistan, 30% of all diseases and 40% of all deaths are due to deprived water quality.

The Gilgit-Baltistan of Pakistan is mountainous, and its public face health exposures because of deprived sanitation practices, i.e. lacking sewage treatment or use of latrines, lack of cleanliness education, and use of extremely dirty water. Parasitic and bacterial gastrointestinal illnesses are frequent, and sometimes eruptions occur[25]. Thus the present study was carried out to check the drinking water quality status of water supply networks of Ghanish valley Hunza.

Materials and Methods

For microbiological analysis of water samples Waqtech Water Testing Kit was used which employ the membrane filtration technique and membrane Lauryl suplhate broth as medium. With the help of Vacuum Pump a 100ml volume of water was sucked through the membrane (fitted in the sterile membrane unit). In sterile Aluminum Petri Dish the membrane was then placed on the absorbent pad saturated with Membrane Lauryl Sulphate Broth. The plates were than incubate for 18 hours at 40-44 C. All yellow colonies on the membrane were counted and reported after incubation period in per 100 ml of water. Electrical conductivity and Total dissolved solids was measured with TDS meter. pH was measured by pH meter and turbidity was measured with turbidity tubes provided with the Waqtech Water Testing Kit. These tubes are graduated with logarithmic scale and cover the range 5 to 2000 NTUs.

Table-1
Showing detailed results of different sampling locations at the study area

Sampling Location	Parameters Tested and Permissible limits set by WHO										
	Temp °C	**pH 6.5-8.5**	**Turbidity <5NTUs**	**E. coli 0col/100ml**	**EC 400µS/cm**	**TDS 1000ppm**	**Color**	**Odor**	**Taste**	**Nitrate ≤ 50**	**Nitrite ≤ 3**
Tank inlet	23	7.8	400	11	300	400	No obj	No obj	No obj	22.5	2.3
Outlet	21	7.5	450	9	250	290	No obj	No obj	No obj	20.3	2.7
Hotel tape	18	7.3	300	7	200	580	No obj	No obj	No obj	34.9	2.1
House tape L 1	18	7.7	200	7	210	408	No obj	No obj	No obj	45.0	2.9
House Tape L 2	16	7.2	270	6	350	380	No obj	No obj	No obj	35.5	1.8
House Tape L 3	20	7.0	250	8	400	295	No obj	No obj	No obj	48.1	1.2
House Tape L 4	16	7.1	280	7	300	406	No obj	No obj	No obj	32.7	1.0
House Tape L 5	16	7.8	200	7	200	208	No obj	No obj	No obj	47.6	2.0
Water tank	25	7.6	500	17	250	370	No obj	No obj	No obj	21.8	2.7
House Tape L 6	22	8.1	200	12	210	402	No obj	No obj	No obj	22.0	1.9
House Tape L 7	15	8.3	490	10	400	429	No obj	No obj	No obj	49.0	2.7
Ghanish proper House Tape	16	7.8	400	6	300	356	No obj	No obj	No obj	42.7	1.7

Results and Discussion

Results: Comparative results are given in Table-1.

Discussion: Temperature: The range of water temperature during the present study was in between 16-25°C (Figure-1). The temperature of drinking water is often not a most important concern to consumers especially in terms of drinking water quality. There are no set guidelines for drinking water temperature therefore quality of water with respect to temperature are generally left to the individual taste and preference[26].

Turbidity: According to USEPA, 2003[27]turbidity may specify the existence of disease causing organisms. These organisms consist of bacteria, viruses, parasites that can cause nausea, cramps, diarrhea and related headaches. Turbidity values recorded in the present study ranged from 200-500 NTUs (Figure-2) thus exceeding the WHO limits of <5NTUs and showing clear chances of disease causing organisms that have been shown in analyzed water samples which are contaminated with E. coli (colonies).

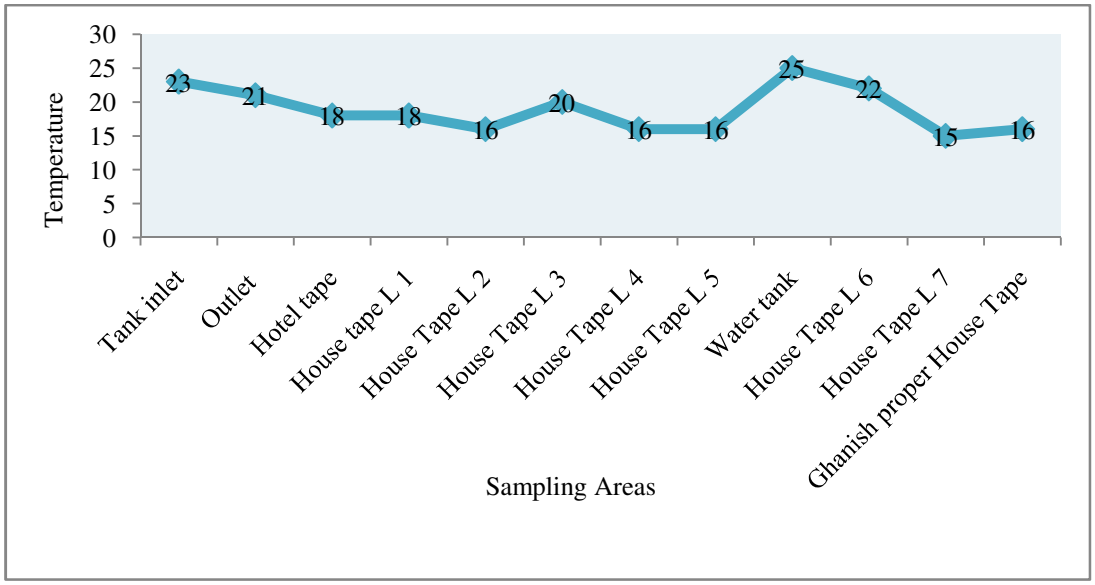

Figure-1
Showing temperature values at different sampling Locations of the study area

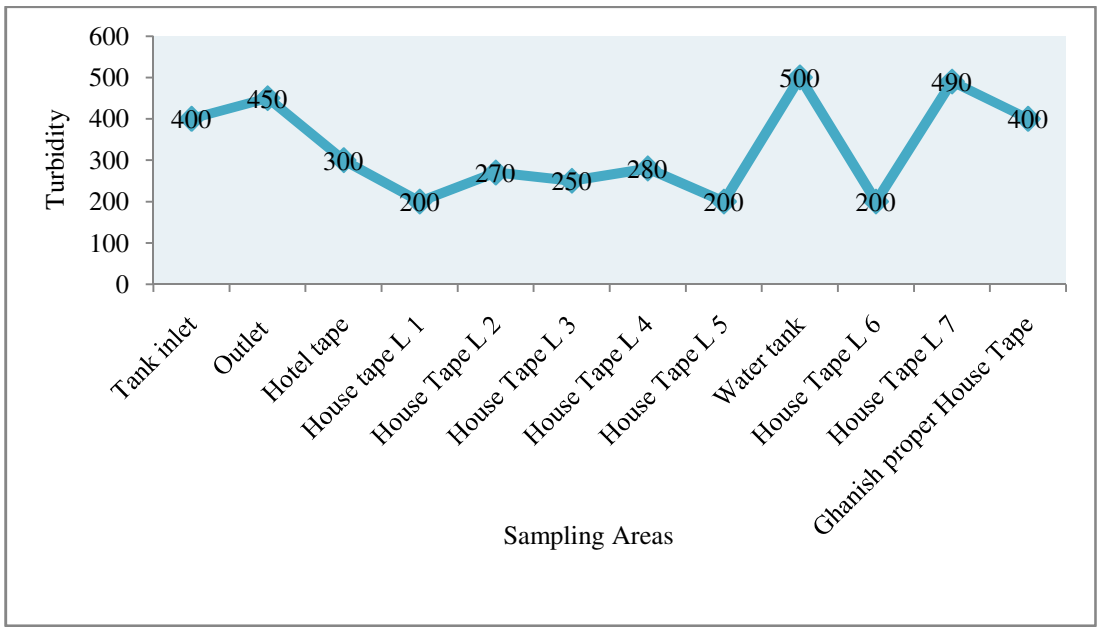

Figure-2
Showing turbidity values at different sampling locations of the study area

pH: In determining the acidic nature of water pH is mainly essential [28]. pH values ranged between7-8.3 (Figure-3) thus within the prescribed limits set by WHO. These results are similar to the other studies[29-32].

E. coli: Being more restricted to feces of human and warm-blooded animals E. coli is considered to be a better indicator of fecal contamination[33]. E. coli is the major species in the fecal coliform group and are generally undamaging but some strains may cause severe illness (e.g., E. coli 0157:H7)[34]. E. coli must not be detectable in 0/100 ml of water according to WHO guidelines for drinking water quality but in the present study number of E. coli (colonies) ranged from 6-17 (Figure-4) at different sampling points thus exceeding the WHO guidelines and falls in high risk category and not fit for human consumption. The results for microbiological analysis were similar to that of related studies conducted by various reserchers[35-38].

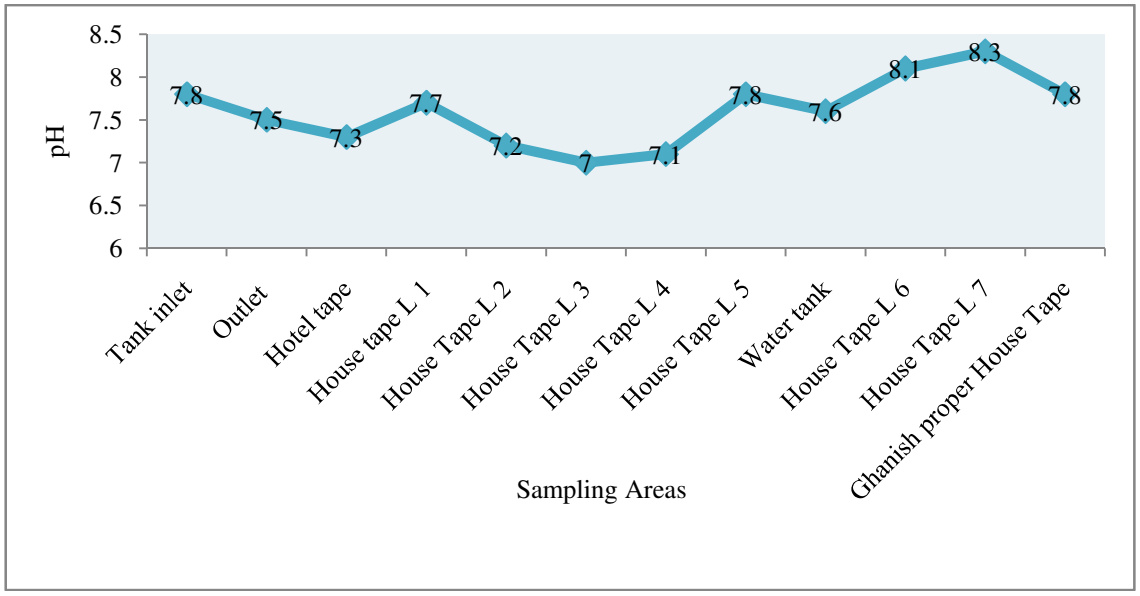

Figure-3
Showing pH values at different sampling Locations of study area

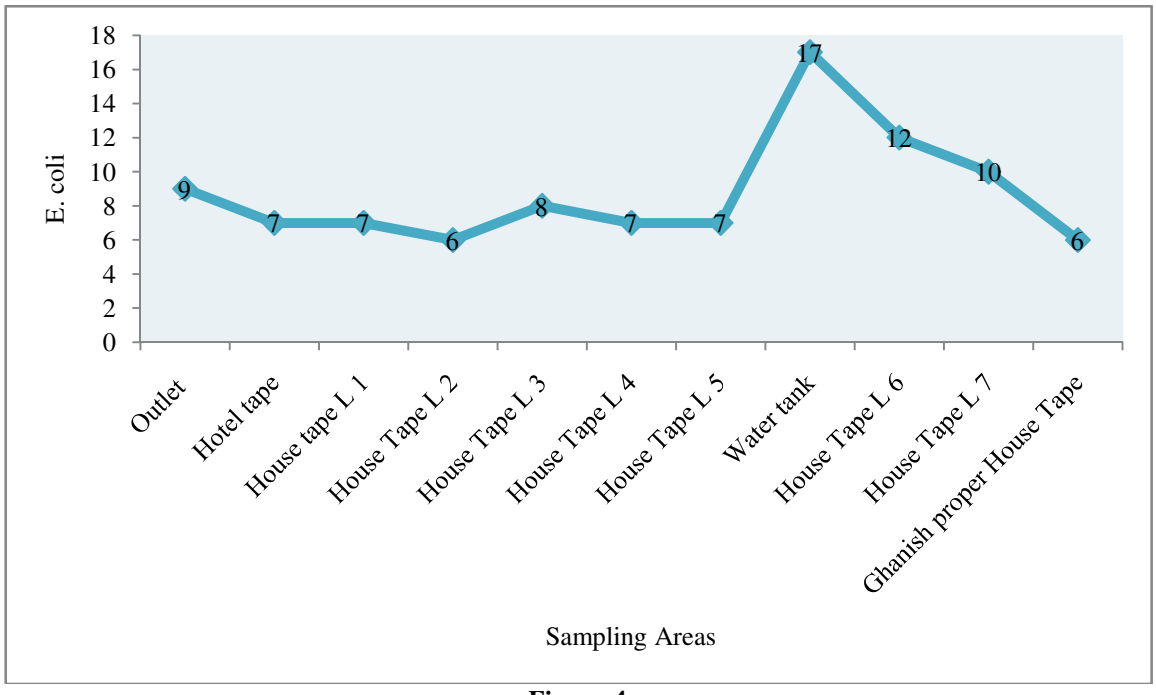

Figure-4
Showing number of E. coli (colonies) found at different sampling locations

Electrical Conductivity: A quick and easy mean of assessing the concentration of electrolytes in water is the determination of electrical conductivity. It would be stronger as greater will be the dissolved solids[39]. Electrical conductivity value recorded in the current study was 200-400 µS/cm (Figure-5). These values were not high compared with WHO guidelines values of 400 µS/cm. Many researchers[40-42] found similar electrical conductivity values which were within the permissible limits of WHO guidelines of 400 µS/cm.

Total Dissolved Solids: A general indicator of overall water quality is Total Dissolved Solids. It determines inorganic and organic materials dissolved in water. Higher TDS levels may tell about bad odor or taste to drinking water, but also cause scaling of pipes and rusting[43]. WHO permissible limits for TDS is 1000 ppm and in the present study TDS values ranged between 208-580 ppm (Figure-6) thus within the prescribed limits set by WHO. Total Dissolved Solids values were in agreement with the other studies carried[44-46].

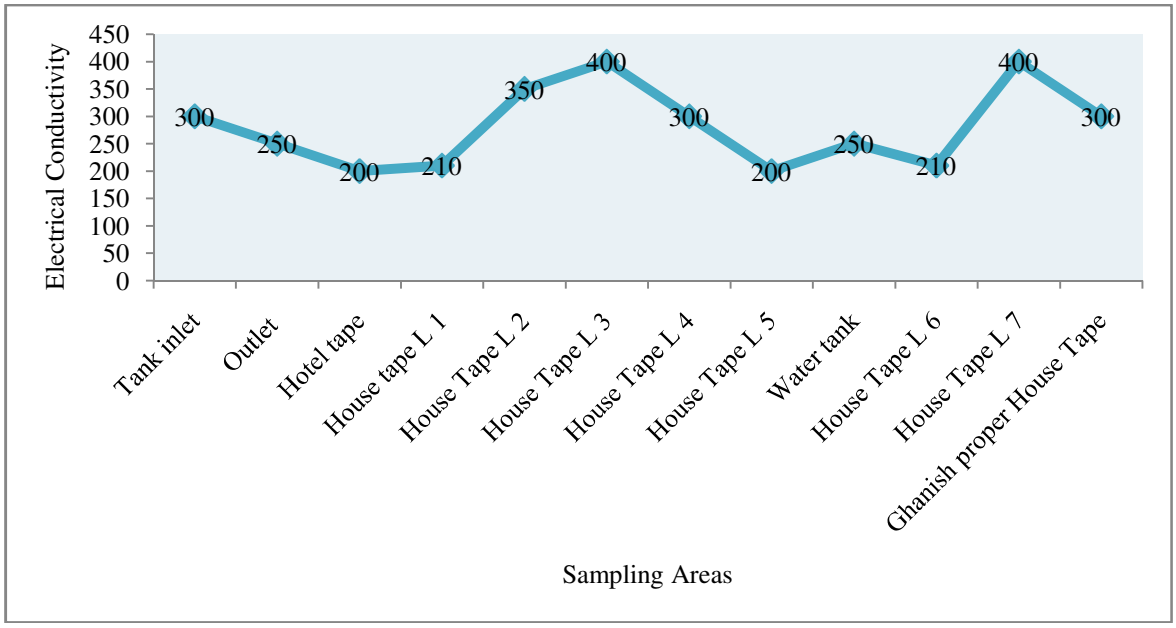

Figure-5
Showing EC values at different sampling locations of the study area

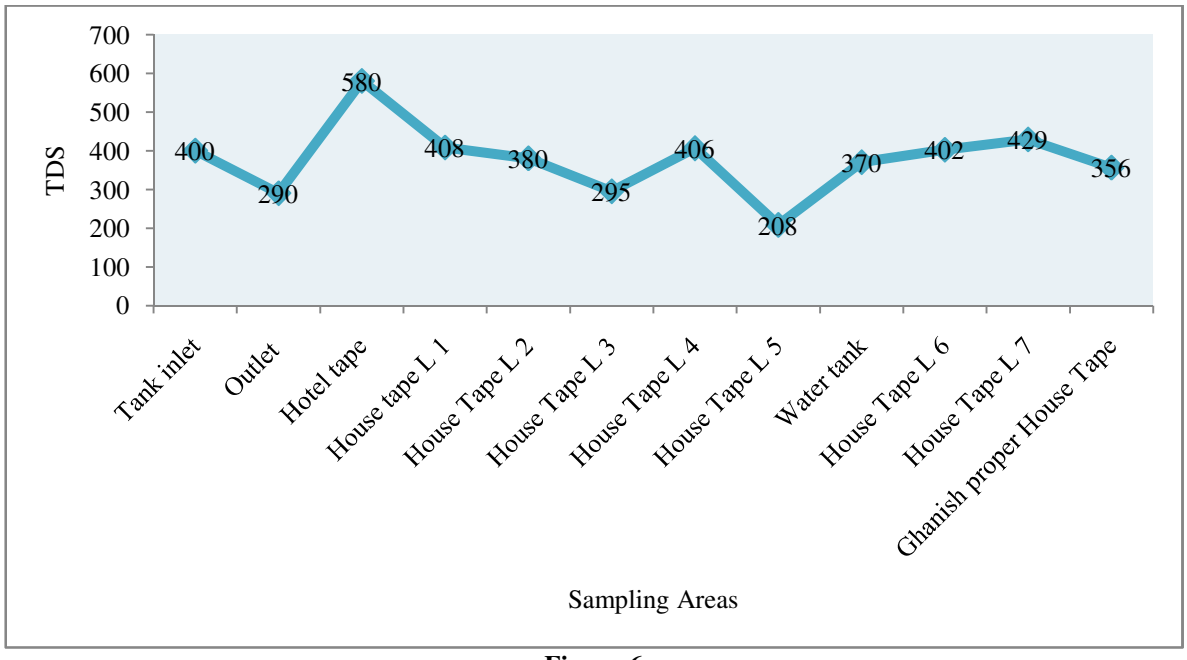

Figure-6
Showing TDS values at different sampling locations of study area

Nitrate: 15 - 75% of nitrate from drinking water accounts for person's contact to nitrate from environmental resources. A large number of diseases like dizziness, abdominal disorder, vomiting, and weaknesses, high rate of palpation, mental disorder and even stomach cancer etc. are caused by the use of nitrate rich water. Reddy[48-50]. Nitrate concentration in the current study ranged from 20.3-49.0 (Figure-7) and thus within the permissible limits of WHO guidelines for drinking water quality.

Nitrite: Nitrite concentration in the present study was 1.0-2.9 mg/L (Figure-8) and thus within the range of WHO guidelines of ≤ 3 mg/L. Nitrite ions are formed from the nitrate or the ammonium ions by certain micro-organisms found in soil, water, sewage and digestive tract. In infants under three months of age the reaction of nitrite with hemoglobin can be risky. Absorption over 1 mg/L waters with nitrite nitrogen should not be used for infants' feedings. Similarly waters with considerable nitrite absorption generally would be deeply polluted most likely bacteriologically un-acceptable[51].

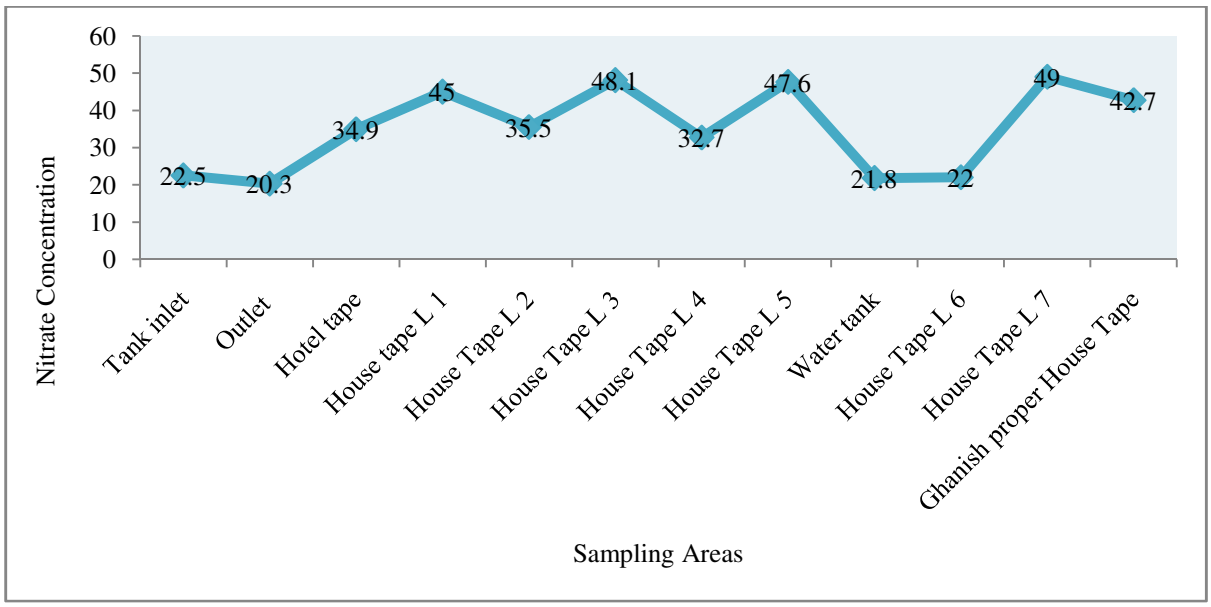

Figure-7
Showing nitrate concentration at different sampling locations of study area

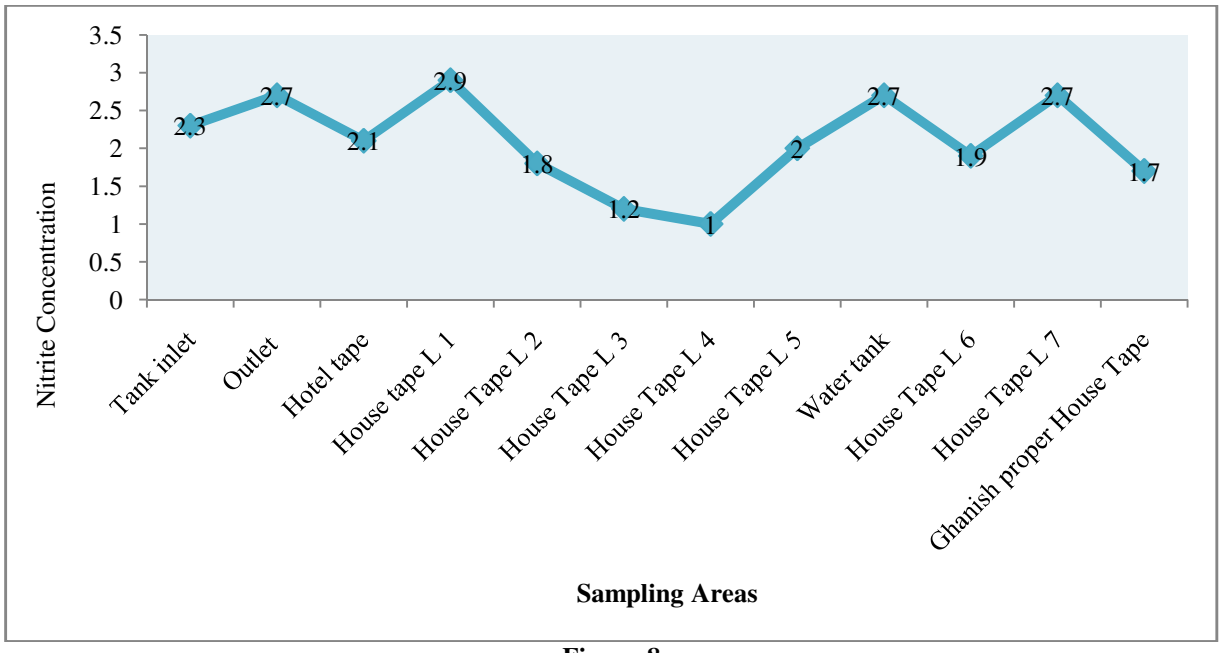

Figure-8
Showing nitrite concentration at different locations of study area

Conclusion

Sanitary inspection and microbiological analysis of the entire distribution network revealed that the sewage collection system, the main sewer of Karimabad is very close to (4 to 5 feet) and on upstream to the drinking water supply channel of union council Ghanish. Due to choking of manholes of sewers of Karimabad, the sewage enters into the water supply channel of Ghanish valley, making it bacteriologically contaminated and thus become the source of water borne diseases. It is also found that design of Karimabad sewage system is faulty, improper operation and maintenance and lack of technical expertise make it a health hazard for the people of Ghanish valley. During summer tourist influx may also spread new strains of microorganism and subsequently new episodes of outbreaks in the respective village.

Recommendations: Following recommendations are suggested: The sewage system that is close to the main supply water channel should properly be managed and operated by technical experts so that chances of contamination to water should be minimized. Protection of water supply system of village is needed on emergency basis with provision of pipelines form source to water storage tanks and re-alignment of sewage system below existing water channel. During peak season main water storage tanks should be de contaminated using chlorine twice a year. Sufficient amount of chlorine should be stored at community water supply systems in order to avoid future water borne epidemics.

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