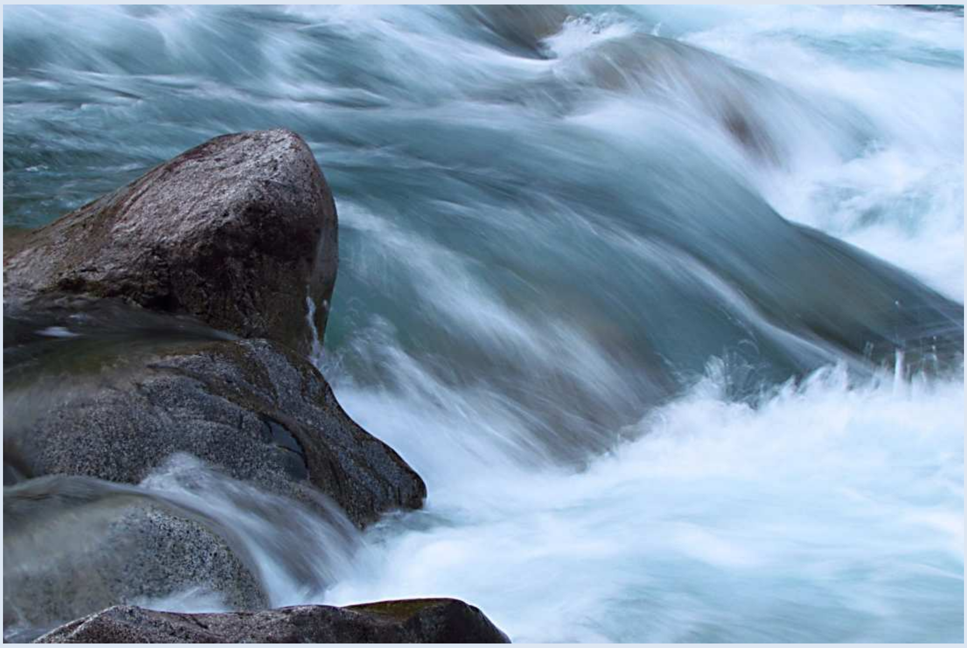
2012

Water and Wastewater Quality Survey in Gilgit Baltistan (GB)



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ACKNOWLEDGEMENTS

We are extremely grateful to the individuals without whose contribution the Report of Water and Wastewater Quality Survey in Gilgit-Baltistan would not have seen the light of the day.

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ACRONYMS & ABBREVIATIONS

ADP	Annual Development Plan
BHU	Basic Health Unit
Cr	Chromium
CMH	Combined Military Hospital
Cond	Conductivity
Cu	Copper
DHQ	District Headquarters
EPA	Environmental Protection Agency
Fe	Ferium (Iron)
LG&RD	Local Government and Rural Development
Mg	Milligram
NEQS	National Environmental Quality Standards
pH	Concentration of hydrogen ions
PHED	Public Health Engineering Department
SDO	Sub-Divisional Officer
SE	Superintendent Engineer
SEARO	South East Asia Regional Office (WHO)
TDS	Total Dissolved Solid
UNICEF	United Nation International Children Education Fund
WHO	World Health Organization
WASEP	Water and Sanitation Extension Programme
WSHHSP	Water Sanitation Hygiene and Health Studies Project
XEN	Executive Engineer

EXECUTIVE SUMMARY

1. A study was conducted to assess the quality of drinking water in seven urban settlements of Gilgit-Baltistan (GB). The water quality survey was conducted in seven district headquarters of Gilgit-Baltistan.

2. A four step methodology was adopted for the study: a literature search for secondary data collection on water quality issues, interviews with the relevant officials in the district headquarters and other institutions responsible for the provision of drinking water in urban areas, an intensive field survey of seven urban settlements and finally report writing.

3. The overall goal of the study is to promote and translate into practice the belief that: "Water Quality issues address society's concern on public health and environment". The study's main objective is to assess the existing drinking water and wastewater quality and suggest practical remedies for provision of safe drinking water in Gilgit Baltistan.

4. The present work may be helpful for various agencies involved in water supply systems to conduct detailed water and wastewater quality studies in urban centres of Gilgit-Baltistan. It may also provide useful information to professionals and other groups for designing and improving the quality of existing water supply systems in GB.

5. The present study is also of national significance to Pakistan considering that Gilgit-Baltistan is a major source of water for rest of the country as well as an important watershed (River Indus). It is therefore quite pertinent to study water quality in GB and to put in place a strategy and an action plan for ensuring quality on continuous basis.

6. A detailed survey was carried out to ascertain the existing drinking water quality and quantity issues in seven major GB towns– Astore, Aliabad, Chilas, Gilgit, Ghanche, Ghizer and Skardu. The survey included site visits, meetings with the people concerned and review of the relevant documents.

7. The survey revealed that very little information is available on drinking water and wastewater quality and quantity issues in GB. Therefore, the water management section relies heavily on the data provided by the relevant departments, literature search and visits to the different cities and their water delivery systems and sources. Discrepancies in the data are possible since no detailed and authentic data pool is available. This section will review the existing water management practices in the seven surveyed towns of GB. The review of each city covers the existing situation with respect to organizational structure, management of water delivery systems, issues and recommendations. The water quality analyses of each city reveal the

existing situation with respect to bacteriological, chemical and physical parameters of the water quality of drinking water sources.

8. For greater reliability and precision bacteriological testing was carried out on site. For this purpose portable Del-Agua water testing kits were used, which employ the membrane filtration method for bacteriological sampling. All the samples were processed in duplicates. At the end of each cycle a control sample of bottled mineral water was processed as means of quality control. The turbidity of the samples was measured in Turbidity Units by using the turbidity tube provided with the Del-Agua water testing kits. These turbidity tubes are graduated with a logarithmic scale and cover the range 5 to 2,000 TUs.

9. Chemical samples were collected in acid washed polyethylene bottles and acidified with concentrated nitric acid. Preserved water samples were then transported National Institute of Health-(NIH) Islamabad. Physical analysis was done at source.

10. At spring sources samples were taken from the spring eye. Representative water samples from delivery systems were taken from different locations.

11. Rivers, Springs and Streams are the main drinking water sources in the selected districts of GB.

12. The review of each city analyses the existing situation with respect to organizational structure, municipal waste, industrial waste, hospital waste, slaughterhouse waste and financial sustainability of the key institutions.

13. Gilgit is the state capital with three sub-divisions, and is the most populous urban centre in Gilgit-Baltistan. According to the 1998 census the existing population of Gilgit town is around 56,701, however due to rapid urbanization and being administrative and business hub the current population is far above then the projected population based on growth rate of 2.47 per year of 1998 census. The current population of Gilgit town is around 150000 living in 10000 numbers of households. However, this population size does not include the number of day comers and visitors visit Gilgit town daily.

14. Gilgit River, Kargah and Jutial Nallahs are the main source of drinking water for Gilgit urban areas. There are two water supply complexes and about nine-pumping stations to fulfil the need of drinking water in Gilgit town. Unfortunately, none of the drinking water supply system have water treatment facilities-water collected from main sources though pumps or water channels is directly distributed to water users without any treatment.

15. Gahkuch, is the headquarter of district Ghizer. According to the 1998 census the population of Gahkuch is about 11606 with an annual growth rate of 3.08 percent. Gahkuch urban areas is further divided into two main parts Gahkuch Bala and Gahkuch Paeen. River and spring are the main source of drinking water for both urban parts. Water from river is pumped to Gahkuch Bala in a storage tank, from where it is distributed to urban area without any proper treatment. Gilgit-Baltistan

Public Works Department (GBPWD), is the responsible agency to provide and maintain the drinking water supply systems for urban area of Gahkuch.

16. Aliabad is the headquarter of newly formed district Hunza/Niagar. According to 1998 census the population of Aliabad settlement is around 5370, with an average growth rate of 2.47 percent per annum. Being new district setup the government departments are in the process of establishment. Few departments such as GBPWD, Education, Health and District Management have been operational at the moment.

17. Husainabad and Ulter Nallah is the main source of water-from The water supply network in Aliabad town is connected to a spring situated in Hassanabad Nallah. Spring water is brought to storage reservoirs and distributed to consumers situated at top of the town. The stored water is distributed in Aliabad settlements intermittently.

18. Astor is the headquarter of district Astore. According to 1998 census the total population of Astor urban area is around 12000 persons with an annual growth rate of 3-13. There are two separate water supply systems for urban areas of Chongra and Edi Gha. Main source of water is spring for both water supply systems. The schemes have been constructed by LG&RD and now jointly managed by Gilgit-Baltistan Public Works Department (GBPWD) and LG&RD.

19. Chilas is the head quarter of District Diamer. According to 1998 census report the population of Chilas urban area is 17213 with an annual growth rate of 3.13. Chilas Nallah is the main source for drinking water for urban area of Chilas. The raw water is stored in a water storage tank situated at upper side of the Chilas and is distributed to consumers without any further treatment. Gilgit-Baltistan Public Works Department (GBPWD), is overall responsible for management of the drinking water supply system.

20. Skardu being the administrative head quarter, commercial and transportation hub of Baltistan Region is rapidly growing as one of the largest and most populated urban settlement of Baltistan Region. According to 1998 census report population of Skardu urban area is around 26023 persons. The main source of water for Skardu town is Sadpara Lake. Skardu town is the only urban settlement which has a complete and improved water supply system with primary, secondary and tertiary level treatment options. Water is supplied to town intermittently. Gilgit-Baltistan Public Works Department (GBPWD), is responsible for the drinking water supply system.

21. Khaplu is the headquarter of Gahnchae district with a population of 12883 individuals. Majority of the population is poor with income concentration into a few families. Both glacier and spring is the main source of drinking water for the population of Khaplu town. Drinking water is stored in a storage reservoir In summer season water is available for 24 hours, however in winter due to freezing people rely on man made water channels or springs situated near by settlements.

22. Bacteriological analysis indicates that 44 percent of the sampled drinking water sources have no contamination and are fit for human consumption. Whereas 56 percent sources are contaminated with faecal material and not fit for human consumption as per WHO and NEQ standards.

23. Chlorides levels in all sampled drinking water sources were found below the WHO and NEQ drinking water standards.

24. Chromium levels in Barmas and Konaodass drinking water sources were found higher than the recommended values set for drinking water by WHO and NEQs. All other sources have low levels of Chromium as per drinking water guideline values.

25. High concentration of Iron were observed in Gilgit River (drinking water source for Konodass), whereas drinking water sources of all other districts have Iron concentration below the recommended guideline values of WHO and NEQs,

26. High nitrate levels were observed in Jutial, Skardu and Chilas drinking water sources.

27. All water sources have pH values with in the range of WHO and NEQs recommendations.

28. Concentration of Sulphate was below the recommended WHO and NEQs values for drinking water.

29. Concentration of Total Dissolved Solids (TDS), were found lower than the recommended values for drinking water by WHO and NEQs.

30. Lack of coordination among various institutions working in the water sector is the main issue of concern. Other problems include lack of required capacity, lack of awareness on the importance of water quality and the absence of a water quality monitoring programme.

31. Survey findings revealed that there is a dire need of synergy between different departments working in the water sector. It is imperative to develop a purposeful and cost effective water quality monitoring programme. This can only be achieved by enhancing the coordination between different organizations working in the water sector. An inter-sectoral coordination committee should be formed to develop a water quality surveillance programme

32. Job-oriented training programmes in overall management of water delivery systems should be designed for operators and officials of PHED.

33. No systematic sanitary inspection procedure is in place for sanitary risk assessment of drinking water supply systems in Gilgit-Baltistan. It is imperative to design and implement sanitary inspection to reduce likelihood of contamination in catchment areas of water supply works and system components.

1 INTRODUCTION

1.1 WATER AND HEALTH

Safe and adequate water for all is perhaps the most basic requirement for human survival. It is also one of the most pressing challenges on today's sustainable development agenda. Although the focus on water is nothing new, and the water sector has long formed the cornerstone of government and donor investment strategies, there has recently been a strong reiteration of the need to develop and fund water infrastructure. For example, one of the eight Millennium Development Goals aims to improve access to safe water supplies. The Johannesburg Plan of Action restates this target, and also flags the need to increase access to sanitation and to develop integrated water resources management and efficiency plans.

Water pollution and wasteful use of freshwater threaten development projects and make water treatment essential in order to produce safe drinking water. It has been unequivocally demonstrated that water of good quality is crucial to sustainable socio-economic development. The main factors responsible for water degradation include lack of sanitation facilities, absence of environmental legislations and competitive authority especially in the developing world.

The World Health Organization (WHO), has estimated that up to 80 percent of all sickness and diseases, and 30 percent of deaths in the developing world are caused by inadequate sanitation, polluted water, unavailability of water and poor hygiene. A survey carried out in developing countries shows that 1.2 billion people suffer from diseases caused by unsafe drinking water or poor sanitation, more than four million children die from water borne diseases and fifteen percent of children will die before reaching the age of five due to diarrhoea that might be avoided with reasonable water and sanitation services (Juha I Uitoo et al, 1999).

The main cause of water related diseases is the presence of pathogenic organism in drinking water. Water born infections such as diarrhoea, Cholera, Typhoid, and Hepatitis are endemic in Gilgit-Baltistan. Various epidemiological studies and hospital records indicates high prevalence of water born infections in the populations, among which children are the most affected group.

1.2 GILGIT BALTISTAN AT A GLANCE

Gilgit-Baltistan is located in the extreme of north Pakistan, bordering with Wakhan corridor of Afghanistan to the northwest, China's Uygur Autonomous Region of Xinjiang to the northeast, the Indian-controlled state of Jammu and Kashmir to the south and southeast, the Pakistani-controlled state of Azad Jammu and Kashmir to the south, and Pakistan's Khayber Phaktunkhwa to the west comprising an area of 72,496 k m^2(27,990 sq. miles). The region is home to some of the world's highest mountain ranges—the main ranges are the Karakoram and the western Himalayas. The Pamir mountains are to the north, and the Hindu Kush lies to the west. Amongst the highest mountains are K2 (Mount Godwin-Austen) and Nanga Parbat, the latter being one of the most feared mountains in the world. Three of the world's longest glaciers outside the Polar Regions are found in Gilgit-Baltistan — the Biafo Glacier, the Baltoro Glacier, and the Batura Glacier. Indus River is the main river of the area and life line of Pakistan, originates from western Tibet flowing laddakh, Baltistan and enters into KPK. Its important tributaries include Gilgit, Hunza, Ishkuman, Yasin, Shigar, and Shyok rivers which are nourished by numerous snow fields and glaciers of the area.

Climatic conditions vary widely in Gilgit Baltistan region ranging from the monsoon influenced moist temperate zone in western Himalayas, to the arid and semi arid cold deserts in northern Karakuram and Hindukush. This area is characterized by low overall precipitation, a great range of mean monthly temperature values, low winter temperature and severe frost during portions of winter season. Below 3,000 meters precipitation is minimal rarely exceeding 200mm annually and at 6,000 meters, the equivalent of 2,000mm per year as snow. Most of the precipitation is not derived from the monsoon, but from depressions moving in from the west during the spring and summer. Monsoon disturbances do occasionally succeed in extending sufficiently far north to enter this area, and when they do, precipitation levels can be substantially increased. (Rao 1981) Temperatures in the valley bottoms can vary from extremes of 40ºC in summer to less than -10ºC in winter .

The population of Gilgit Baltistan is more than double since the first Population Census in 1951. It was 650,000 in 1981 compared to 416,000 in 1972, at an annual growth rate of 3.8 percent during 1971-81.According to the Population Census Organization (1998), the total population of Gilgit Baltistan was 870,347; of this total, 122,324 (14 percent) were classified as urban, and 748023 (86 percent) were classified as rural. Average population density is 12 persons/km^2 whilst household size is 13.35persons/km^2.

On 29 August 2009, the Gilgit-Baltistan Empowerment and Self-Governance Order 2009, passed by the federal government, granted self-rule to the people of Gilgit- Baltistan. The political and administrative reforms were started in 1975 through Northern Areas Legal Framework Order, 1975 and further improvement in 1994 by Federal government. In new political scenario Gilgit Baltistan Legislative Assembly (GBLA) is headed by Chief Minister, where Governor Gilgit Baltistan represents the federal government.

The economy of the region is made up of agriculture, tourism, and government employment.

1.3 STATE OF GILGIT BALTISTAN'S URBAN ENVIRONMENT

The environmental problems in the urban centres of Gilgit-Baltistan, are increasing at an alarming rate due to the mushroom urban growth and inadequacy of the present urban planning and existing setup.

According to 1998 censes around 5 district headquarters were declared as urban settlements in Gilgit Baltistan based on population size. Overall environmental situation of these urban settlements is becoming worst with the passage of time due to rapid population growth, changing in life style, influx of rural population towards big towns and cities due to provision of better job opportunities, main centre for trading (national and international level), administrative head offices, and provision of better health facilities are the vital factors for migration of rural population towards urban centres. In addition to this every year national and international visitors visit Gilgit-Baltistan for recreational and business purposes. All these factors ultimately effects urban environment of big towns and main centres of the Gilgit Baltistan.

1.4 SOURCES OF DRINKING WATER AND DEVELIVERY SYSTEMS:

Glaciers and snow deposits are the principal sources of all water in the Gilgit-Baltistan The melted water enters streams, which subsequently feed man-made channels – Kuhls – that bring water into the settlements for agriculture, livestock and domestic requirements.

The water supply sector in Pakistan is characterized by extremely low level of coverage particularly in the rural areas. Presently, only 80% of the urban population has access to the piped water supply, whereas 11% of rural population is benefiting from this facility (GWP 2000). The situation is not better in the Gilgit Baltistan as the coverage of piped water supply claimed is only 40% but in reality it might be less than half. However, these systems are becoming more common in the Gilgit Baltistan as most settlements are established on slopes and thus the piped water supply systems can be operated by gravity. The observations indicated that many of the systems are either completely out of order or need some sort of rehabilitation (WSHHSP 1996).

The water supply systems in the urban centres of the Gilgit Baltistan are based primarily on the utilization of surface waters. Groundwater use for domestic water supply is not common except in the low lying settlements in Gilgit town and a few riverside villages in Skardu, where people draw water from shallow wells. Most of the urban centres depending on surface supplies face moderate to acute shortage of water during the winter months when the snow- and glacier-melt is reduced.

Lack of proper sewerage, and drainage systems in urban centres highly affected the quality of surface waters bodies which are the primary source for almost all drinking water supply networks of urban settlements of Gilgit-Baltistan.

Similarly, a lack of proper drinking water treatment and improper supply networks have resulted in considerable environmental health problems related to water contamination in Gilgit Baltistan. Almost all drinking water systems are contaminated with organic and inorganic pollutants. Water borne infections are endemic in the rural and urban settlements. A case-control study conducted in Oshikandas Village, in 1996-97, revealed a significant association of drinking water contaminated with Cyptospridium parvum and outbreaks of diarrhoeal disease (Raza 1997). The health data of DHQ laboratory and CMH Gilgit showed high prevalence rate of water born diseases in Gilgit Baltistan. (IUCN, 2003)

1.5 NEQS /WHO-INTERNATIONAL GUIDELINES

To intervene the spread of these infectious diseases via water, WHO published International Guideline values for drinking water in 1983. These guideline values have been revised several times. According to WHO guidelines the faecal contamination levels of drinking water must be 0 E.coli / 100 ml for safe drinking water. However, for developing countries WHO has recommended 0-10 E.coli /100 ml in drinking water as acceptable limits. According to WHO/SEARO (recommendations of WHO/SEARO member states conference held in Khatmandu, September 1996) the water can be divided into four groups with reference to the contamination levels (see **Table 1**)

Table 1: Classification of Fecal Contamination Levels as per WHO Guidelines

Grade	Faecal coliform / 100 ml	Health Risk
A	0	No risk
B	1-10	Low risk
C	11-100	High risk
D	101-1000	Very high risk

1.6 BACKGROUND OF THE SURVEY

Like other parts of the country water quality is a major concern in Gilgit Baltistan. A number of studies conducted by various organizations revealed water quality and water borne diseases as a major concern here. The Gilgit Baltistan Environmental Protection Agency (GBEPA) soon after its establishment in 2007, realized that drinking water quality is an important issue and is the main contributor to water borne illness in Gilgit Baltistan region. In order to reduce the risk of water borne disease burden the population of Gilgit Baltistan, GB-EPA focused its attention on water quality issues and measures to mitigate point and non-point sources of water quality deterioration. In this connection, in the past few years a water quality monitoring laboratory has been established in GBEPA at Gilgit. In order to judge the quantum of water quality issues and associated factors with it, GBEPA sourced out water and waste water quality analysis to Karakuram Scientific Traders. Keeping in view the significant role of water quality in human health and economical conditions, the GBEPA planned to initiate a comprehensive study to analyze drinking water quality and to identify potential sources of water pollution in Gilgit Baltistan.

1.7 SCOPE OF STUDY

Like other parts of the country, little attention has been given to water quality and associated health risks in Gilgit-Baltistan. The main reasons of this negligence include funding constraints, lack of required skill and more importantly lack of responsiveness by the authorities. However, today the authorities involved in supplying drinking water have become more conscious about water quality rather than quantity as compared to the past. This awareness can be attributed to the high prevalence of water borne diseases as well as the pressure of donor agencies. The present survey may be helpful for various agencies involved in water supply systems, to develop water quality monitoring programmes and select cost-effective criteria for point and non-point sources of water pollution in Gilgit-Baltistan. It would also provide useful information to professionals and other groups for designing and making improvement in the quality of existing drinking water through application of state-off-that art water treatment technologies.

The current survey is of national significance to Pakistan considering that Gilgit Baltistan is an important source of water for the country as well as a major watershed (River Indus and its tributaries). It is therefore quite pertinent to study water quality and to put in place a strategy and action plan for ensuring quality on continuous basis.

1.8 OBJECTIVES

The overall objective of the present work is to assess the bacteriological and chemical quality of drinking water in seven urban centres of Gilgit-Baltistan. The specific task carried out during the study include;

Inventory of drinking water supply in seven urban centres of Gilgit-Baltistan, with complete information regarding type of source, storage capacity, type of existing treatment and physio-chemical and bacteriological analysis of drinking water. Following are the main tasks of the study.

1. Assess quality of wastewater from point and non-point sources at entering points of fresh waste bodies as per NEQS parameters.
2. Identify potential source of wastewater generation and quantification of effluents
3. Provide action plan for water and waste water treatment for urban centres areas of Gilgit-Baltistan
4. Provide copies of all reports in hard and soft form.

1.9 METHODOLOGY

Following approach was adopted to conduct the drinking water and waste water quality surveys in selected towns of Gilgit-Baltistan.

Literature search has been carried out to collect secondary level data (including library and internet searches).

Meetings were undertaken with the relevant people in the GBEPA in Gilgit and PHE departments to get their point of view on the issue of water quality in Gilgit-Baltistan.

Visits were made to the seven district headquarters in Gilgit-Baltistan to meet officials of the PHED/GBPWD in order to gain first hand information on existing water delivery systems and future plans.

Field visits were made to various drinking water sources and water delivery systems in the seven urban areas of Gilgit-Baltistan districts.

The report has been compiled based on the observations and data collected during the visit.

For greater reliability and precision bacteriological testing was undertaken on site. Portable Del-Agua water testing kits were used, which employ the membrane filtration method for bacteriological sampling. All the samples were processed in duplicates. At the end of each cycle a control sample of bottled mineral water was processed as means of quality control.

The turbidity of the samples was measured in Turbidity Units by using the turbidity tube provided with the Del-Agua water testing kits. These turbidity tubes are graduated with a logarithmic scale and cover the range 5 to 2,000 TUs.

In the membrane filtration technique a known volume of water is sucked through the membrane (fitted in the sterile membrane filtration unit) with the help of vacuum pump. The membrane is then placed on the absorbent pad saturated with membrane lauryl sulphate broth in a sterile aluminum petri-dish. The plates are then incubated for 18 hours at 42 - 44oC. After completion of the incubation period all yellow colonies on the membrane are counted and reported in per 100 ml of water. In case of a dilution the following formula is used for calculating the result:

$$\frac{\text{Total number of colony count}}{\text{Volume filtered}} * 100$$

In order to assess the selected parameters of wastewater, samples were collected from selected points and analyzed in Gilgit. Chemical samples were collected in acid washed polyethylene bottles and acidified with concentrated nitric acid. Preserved water samples were then transported to National Institute of Health (NIH) Islamabad for further analysis. In-situ physical analysis of water was done at the water sampling point. Information was collected from the people present at the sampling source. For wastewater analysis water samples were collected from selected points of urban settlements and transported to the laboratory in glass bottles washed with acid and demonized water.

2 DEMOGRAPHY OF URBAN CENTERS & EXISTING DRINKING WATER SUPPLY SYSTEMS

2.1 GILGIT

Gilgit is the administrative hub of district Gilgit and provincial capital of Gilgit-Baltistan. It is the most populous metropolitan of Gilgit-Baltistan, having a population of 56,000 individuals with a growing rate of 2.47% per annum (1998 census). Based on this growth rate the current population of Gilgit urban area is around 76903 persons. There is constant emigration from the surrounding areas due to push and pull factors and emigration is negligible. The population is broad based with children below 15 constituting bulk of the population. Wide spread income inequality prevails with majority of the population eking out subsistence living. The urban settlement covers an area of 4,046 square kilometers comprising 22 municipal wards and 7426 households. There are three main hospitals, 22 hotels and more than 20 big and small restaurants that consume drinking water and hence generate ample amount of sewage water in Gilgit city.

Gilgit River, Kargah and Jutial Nallahs are main sources of drinking water supply networks in Gilgit town. Kargah Nallah is the main source of water for 70 percent of the Gilgit town, from where water is brought to Burmas Complex and is distributed to different parts of the towns. Jutial Nallah is the main source of water for Jutial and Khomar area. Source water from kargah and Jutial Nallah is brought to Jutial and Barmas water complexes through un-fenced man made water channel. Urban population settled in Konodass area and Zulfiqarabad mostly rely on Gilgit River for drinking & irrigation purposes. River water is being lifted through pumps to water storage reservoirs situated at both ends of the river- and is distributed to households through gravity. ,

In addition to the PHE water supply networks-two community owned water pumps are also operational in Jutial. These water pumps full fill the requirements of new settlements in Jutial and Zulfiqarabad area. Despite of PHE and community owned water supply systems- the communities of Gilgit town face severe shortage of water in spring and summer seasons. In order to fulfill the gap in supply and demand people have to purchase water tankers.

Gilgit urban settlement is lacking liquid and solid waste disposal systems, hence surface and ground water bodies are under threat of fecal and chemical pollution due to household and agricultural runoff. Currently all types of surface run offs and waste effluents from households and commercial areas is directly enters into the nearby water collecting bodies and enters in the main Gilgit river.

2.2 GHAKUCH

Ghakuch is the headquarter of district Ghizer. According to the 1998 census the total population of Ghakuch urban area is around 11606 persons. The urban settlement is consisted of two main parts Gahkuch Bala and Gahkuch Paeen.

Ghakuch river and spring situated in Gahkuch bala are the main source of drinking water for the town settlements. Water Department of GBPWD, is the responsible agency to maintain the water supply systems in Ghakuch town.

Water from river is lifted through 75 horsepower pump to Ghakuch Bala and stored in storage tank having a capacity of 0.45 million litters of water. The water from spring is collected through a man made channel, in a storage reservoir of 0.56 million litters. Water from these storage reservoirs is distributed to about 5000 water consumers daily for 24 hours. There is no any water treatment option is in place for both water storage reservoirs.

A team of 45 numbers of staff headed by an Executive Engineer is responsible to maintain the drinking water supply system in functional condition. Lake of technical skills, shortage of funding, and continuity in electric supply are the main issues of the department.

Similar to Gilgit town, Ghakuch town has not proposer liquid and solid waste collection and disposal systems. On site sewage systems (soak pits) are the only means of disposal of liquid waste. Hence surface water bodies are under threat to get polluted.

2.3 ALIABAD-HUNZA/NIGAR

Aliabad is the headquarter of newly formed district Hunza/Nagar. According to 1998 census the population of Aliabad settlement is around 5370, with an average growth rate of 2.47 percent per annum. Being new district setup the government departments are in the process of establishment. Few departments such as GBPWD, Education, Health and District Management have been operational at the moment.

Aliabad town is lacking proper water supply and sanitation systems like other towns of Gilgit-Baltistan. There is no municipal committee to deal with solid waste-as other towns of Gilgit-Baltistan. Husainabad and Ulter Nallah is the main source of water-from where water is brought to Aliabad town for agricultural purposes. Some parts of the Aliabad town use this water for drinking purposes as well. The water supply network in Aliabad town is connected to a spring situated in Hassanabad Nallah. Spring water is brought to storage reservoirs situated at top of the town. The stored water is distributed in Aliabad settlements intermittently.

2.4 ASTORE

District Astore is newly formed district headquarter and has poor infrastructure. Although new development schemes are underway, however very litter attention has been given to the water supply and wastewater disposal and treatment.

According to 1998 census report the population of Astore urban area is around 10,000 persons and 2000 households. The main water source for drinking purpose is spring. Water from spring is stored in storage reservoirs through 2” and 3” dia pipes. At the moment three storage reservoirs has been operational for different localities of the Astore urban area such as Colony, Eidgah and Chungra. Water is stored in these storage reservoirs and supplied to consumers without any proper treatment.

2.5 CHILAS

Chilas is the Headquarter, as well as transportation and commercial nerve centre for the entire district of Diamer. People from the surroundings areas flock to the town during winter. Situated on the Karakuram High Way it is the main junction and stopping point between Islamabad and Gilgit-Baltistan. Hence there is a large traffic flow to and from Islamabad. According to 1998 census, the population of Chilas urban area is 16575 persons and household of 1848 with a household size of 9 persons and @ 3.13 persons per annum which is highest rate in the Gilgit-Baltistan.

Chilas Nallah is the main source of water for Chilas town. The raw water is stored in a water storage tank having a size of 76x46x12 situated at upper side of the urban settlement. The raw water is stored in the storage reservoir and is distributed to consumers without any further treatment.

2.6 SKARDU

Skardu being the administrative head quarter, commercial and transportation hub of Baltistan Region is rapidly growing as one of the largest and most populated urban settlement of Baltistan Region. The Skardu urban settlements are situated at an elevation of about 7700 feet above sea level. The river Indus which is passing north of the town flows from east to west. The population within the urban jurisdiction is 26023 persons which is growing @4.85% per annum (1998 census). Based on this growth rate the population of Skardu urban area is projected to 41787 persons in the next 10 years. There is constant immigration from the surrounding areas due to push and pull factors and emigration is negligible. Majority of the population is poor with income concentration into a few families.

2.7 KHAPLU

Khaplu is the headquarter of Ghanche district with a population of 12883 persons which is approximately growing @ 1.11% per annum (1998 census). Based on this growth rate the population of Khaplu Municipality is projected to be 14387 persons in the next 10 years. The total number of household in the municipality is 1840 having a household size of 7 persons. Majority of the population is poor with income concentration into a few families. Basic service utilities are very poor in Khaplu urban settlement. Main source of water for drinking water supply system is Khaplu Nallah. Water is stored in a reservoir and supplied to urban population without any treatment. In summer season water is available for 24 hours, however in winter due to freezing people rely on manmade water channels or nearby springs.

A detailed water survey was carried out to ascertain the existing drinking water quality and quantity issues in seven major Gilgit-Baltistan's urban settlements – Gilgit, Skardu, Chilas, Astore, Ghanche and Gahkuch. The survey included site visits, meetings with the people concerned and review of relevant documents. The survey revealed that data is not available on drinking water quality and quantity issues in Gilgit-Baltistan. No detailed survey has ever been carried out to ascertain the water quality of the Gilgit-Baltistan water delivery systems and sources. Therefore, the water management section relies heavily on the data provided by relevant departments, literature search and visits to different cities and their water delivery systems and sources. Discrepancies in the data are possible since no detailed and authentic data pool is available. This section will review the existing water management practices in the seven surveyed towns of Gilgit-Baltistan. The review of each city covers the existing situation with respect to organizational structure, management of water delivery systems, future plans, issues and recommendations.

3 WATER MANAGEMENT

Since most of the urban settlements are established on slopes, therefore piped systems operate by gravity. Generally, the water supply systems are being fed by main channels and are consisted of a storage reservoir and distribution networks. Although, in bigger urban settlements like Gilgit and Skardu substantial improvements have been made in existing drinking water supply systems, in the last two decades, nonetheless, maintaining the drinking water quality remains an issue in almost all urban areas, due to lake of proper design and treatment facilities.

In order to assess the bacteriological contamination of drinking water supply systems, about 89 samples were collected from selected points of the systems including source.

3.1 GILGIT

As mentioned in section-1 of this report, Khargah Nallah, Jutial Nallah and Gilgit River are the main water sources for drinking purposes in Gilgit town. Drinking water from Kargah Nallah is fetched to Burma water supply complex-This water supply network serves urban population settled in Khomar, Amphery, Kashrote and some parts of Konodaas area. The main water source for remaining town settlements in Jutial, Zulfiqarabad and some parts of Yasin Colony is Jutial Nallah. For urban area in Konodaas raw water from Gilgit river is sucked through 9 suction pumps to storage reservoirs and supplied for drinking purposes on timings.

Generally, raw water collected from aforementioned water sources is supplied to target population without any proper treatment. However, in Konodass areas, PHED has constructed dug wells at suction points of the pumps to reduce turbidity levels of river water in summer season. However, bacteriological quality of drinking water remains as an issue due to improper supply networks and un hygienic conditions near by water storage reservoirs.

According to PHE the total demand of drinking water for Gilgit urban settlement is about 22.77 cubic feet per second. The Supervisor Barmas Complex informed that initially the Plant had been designed to treat 3,375 gallons/minute (15,188 l/min). However due to the increased demand, they now have to treat 4,400 gallons/minute (19,800 l/min). He maintained that they are meeting the demand of 50,000 registered consumers; however, almost a same number of unregistered consumers are also being supplied water from this treatment plant.

At present there is no any treatment either at primary or secondary level in practice. The raw water collected from Kargah, Jutial and Gilgit river is directly distributed to households in Gilgit town. There is no proper set-up of water testing facility in the PHE department.

3.2 GHAKUCH

In Ghakuch town, PWD is responsible for drinking water management. Like Gilgit a separate Public Health Department has not been established so far in Ghakuch. There are 45 staff members responsible for the management of drinking water supply in Ghakuch urban area.. The staff is headed by an Executive Engineer, whilst other staff includes Assistant Executive Engineer, Sub-Divisional Officer, a sub-engineer, supervisor, plumbers, pump operators, caretakers and electricians.

Main issues in water management include understaffing, shortage of appropriate funding, shortage of power to run pumps, and lake of spare parts to repair the pumps and machines.

Cleaning of water tanks is being done twice a year with the help of local labor. In summer season bleaching powder is used based on availability of funds.

3.3 ALIABAD

Aliabad, very recently formed district headquarter has very poor drinking water supply system. Like other districts of Gilgit-Baltistan, except Gilgit district, in Aliabad there is not a responsible agency like PHE in Gilgit for drinking water management. However, water management comes under the XEN, who with support staff looks after the drinking water issues.

3.4 ASTORE

The water supply Astore is the headquarter of . NAPWD is the main responsible agency to provide drinking water facility to Astore town.

3.5 CHILAS

Like other districts of GB, GB-NAPWD is taking care of water supply system in Chilas town with their meager resources. No water treatment facility is available in Chilas town water collected from Chilas nallah is distributed to water consumers without any proper treatment. Lack of financial and technical persons are the main issues in water management in Chilas town.

3.6 SKARDU

GB-PWD is the main responsible agency for provision of drinking water to urban area of Skardu. Drinking water is supplied to urban areas intermittently. Leakages in mains and networks are main operational issues similar to other water supply systems in other districts of GB. The water supply system is well designed according to international standards and has all water treatment components in place. However, capacity of the staff is an issue. On need basis chlorination of drinking water is being done.

3.7 GHANCHE

In Khaplu urban area, the water supply system is initially constructed by LG&RD and some components have been constructed by GBPWD. The systems operation is still lies with LG&RD. No proper water treatment facility exists in the water work.

3.8 ORGANIZATIONAL STRUCTURE

Generally Gilgit-Baltistan Public Works Department (GBPWD), is responsible for the supply of drinking water and wastewater management in Gilgit-Baltistan. At provincial level Secretary Works Heads the drinking water supply component in GBPWD, whilst at district level Superintendent Engineer is responsible for drinking water supply component. In district Gilgit-Director Public Health Engineering Department is responsible for the management of drinking water supply for urban settlement.

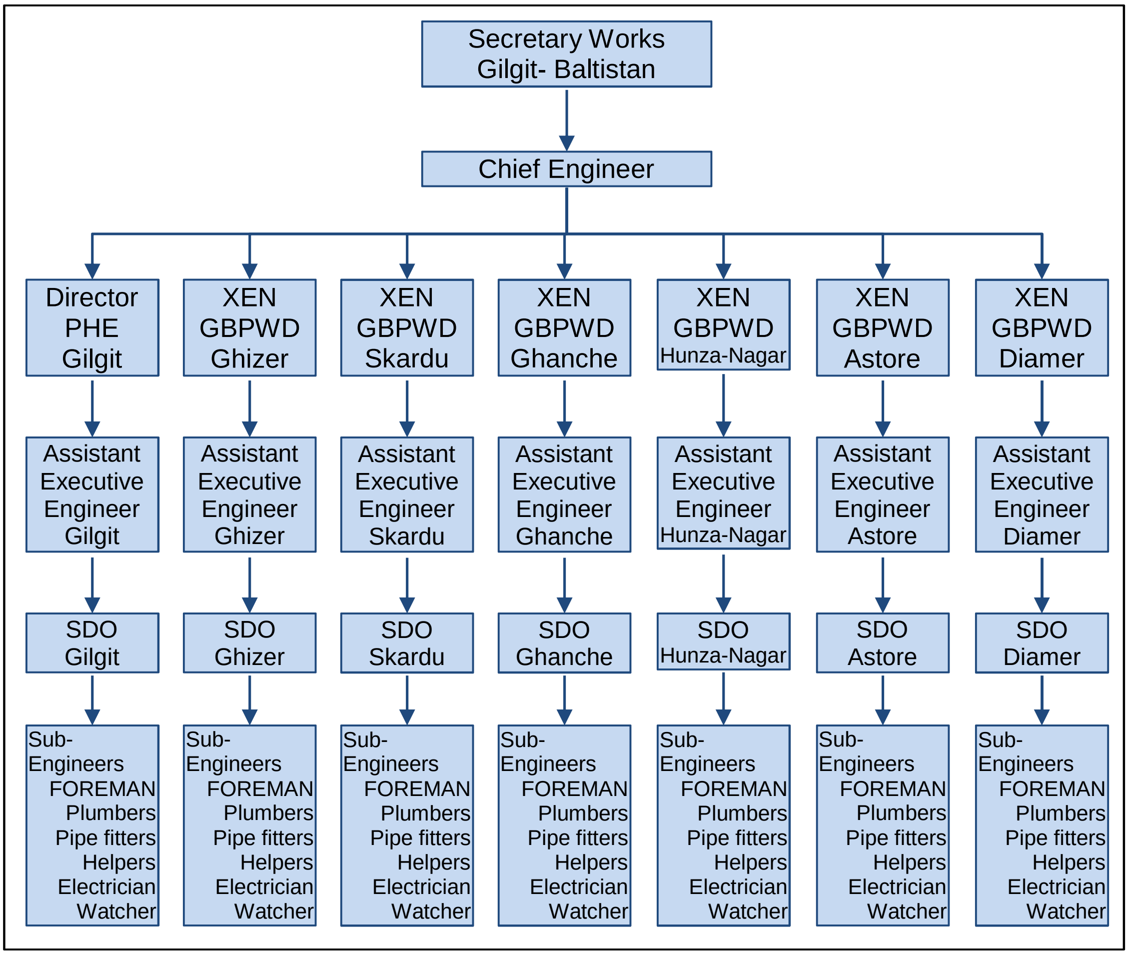

Figure 1: Organizational Structure of Public Health Engineering Department (PHED)

4 ISSUES IN WATER MANAGEMENT

4.1 LACK OF COORDINATION

There is very little coordination between the relevant institutions that are concerned with supply of drinking water and its quality assurance in urban settlements of GB. LG&RD and Water and Sanitation Extension Programme (WASEP), a project of Aga Khan Planning and Building Services for Pakistan (AKPBSP), though have state-of-the-art facilities for chemical and bacteriological testing of dinking water quality, but only focus rural areas and lacks preemptive strategies either to control pollution or maintain the source water quality in the networks. GBEPA has good facilities to check important environmental pollutants including water-but due to lack of resource couldn't run a comprehensive water quality surveillance programme in GB.

4.2 LACK OF EXPERTISE

Expertise on environmental issues in general, and ensuring the provision of safe drinking water in particular, is very limited in GB. By and large, those who are not aware of the technicalities of water treatment are calling the shots, which results in adverse effects (such as taste problems) on the water from water treatment plant. Consequently the majority of the population use polluted water for drinking purposes. Lack of technical expertise in PHED is the main hindrance to adopting modern water filtration techniques and to designing water delivery systems as per local needs. At the moment no educational institution in GB offers any courses in water related issues and hence there is an acute shortage of qualified professionals. Although such expertise is available in Pakistan, the lack of resources makes it difficult to induct such professionals.

4.3 LACK OF AWARENESS

The level of awareness on water quality issues in PHED and LG&RD is quite low. Very few professionals know the technicalities of water treatment. None of the institutions in GB have initiated any awareness raising campaigns for pollution control nearby feeding channels of drinking water supply systems and overall water management. As a result, the general public is not care to using tap water which results demand and supply issues in major town of GB.

5 WATER QUALITY RESULTS

5.1 CONSOLIDATED BACTERIOLOGICAL RESULTS

Altogether 88 water samples were collected from various drinking water sources and different points of the delivery system in seven urban centers of Gilgit-Baltistan districts. Bacteriological water quality results revealed that 22 percent of the total water samples were in category A, and are safe for drinking. 37 and 32 percent of the total samples were in Category B (low risk), and C (high risk) respectively. Only 8 percent of the total samples were in category D (very high risk), with contamination levels greater that 101 E.coli/100 ml as per WHO recommendations (see **Figure 2**). It is worth mentioning that fecal contamination levels may be significantly higher in the summer seasons.

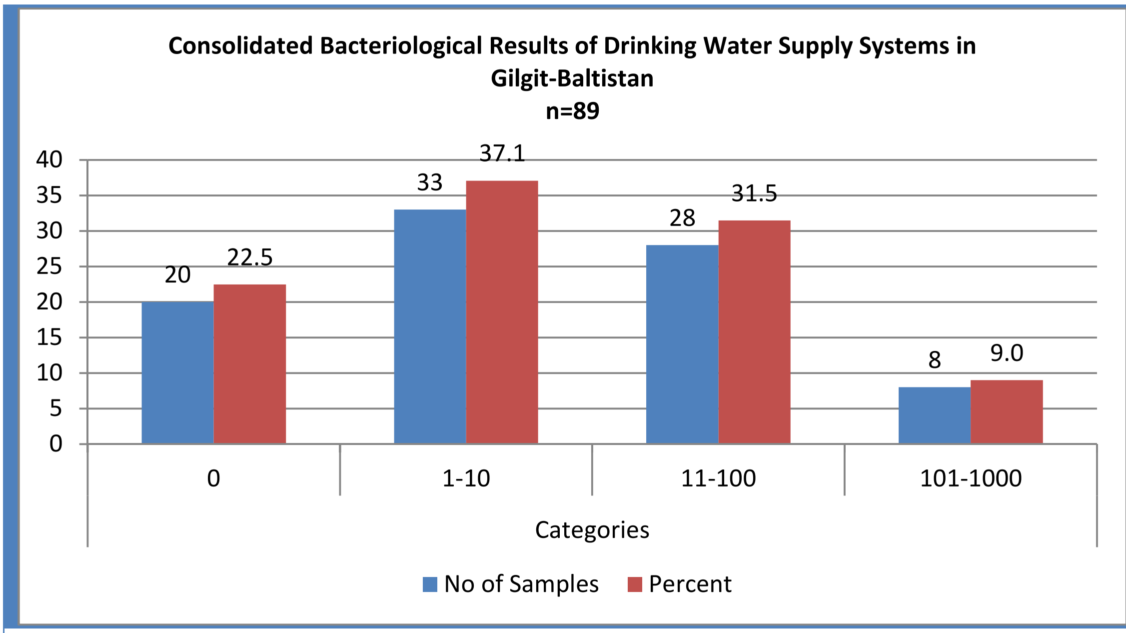

Figure 2: Consolidated Bacteriological Results of Drinking Water Supply Systems in GB

5.1.1 SOURCE WATER

Water samples from nine water sources were analyzed for bacteriological contamination as per categories set by WHO for drinking purposes. Out of nine water samples 44 percent of the total samples have contamination levels as 0. Ecoli/ml and fit for human consumption. Remaining 56% fall in category B and C which indicates low to high risk for drinking purposes. (See **Figure 3**)

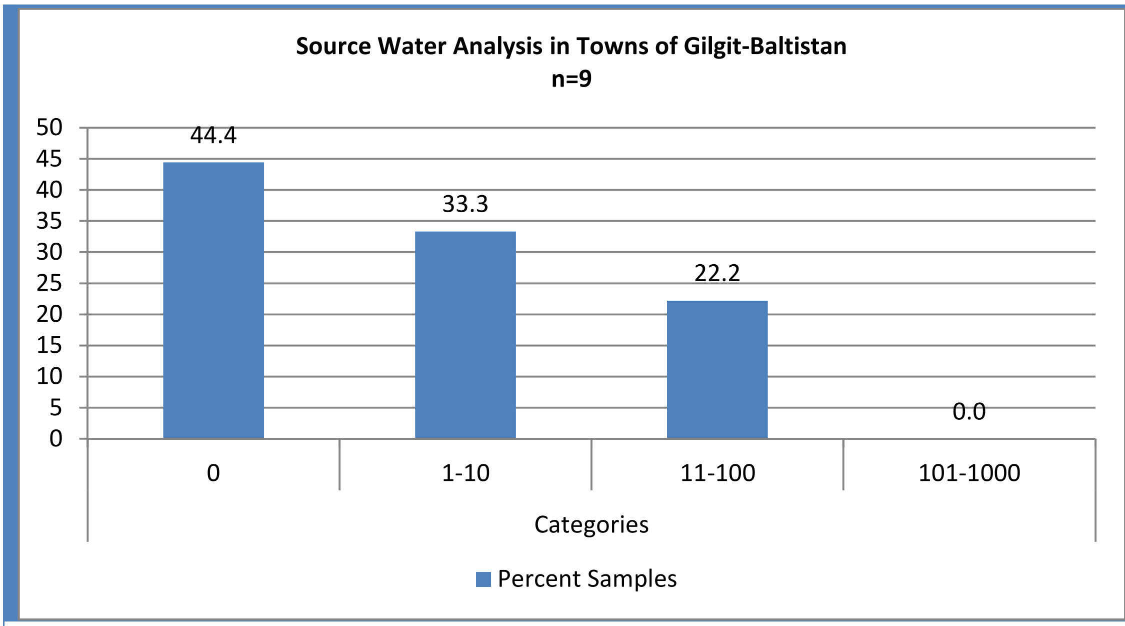

Figure 3: Bacteriological Results of Drinking Water Sources in GB

5.1.2 STORAGE RESERVOIRS

Water samples collected from nine storage reservoirs of seven urban water supply systems in GB, indicates that none of the storage reservoirs fall in category 0/E.coli/100 ml recommended as fit for human consumption. Although none of the storage reservoir found to be grossly contaminated with fecal material according to categories but, all systems are in medium to high risk category (See **Figure 4**).

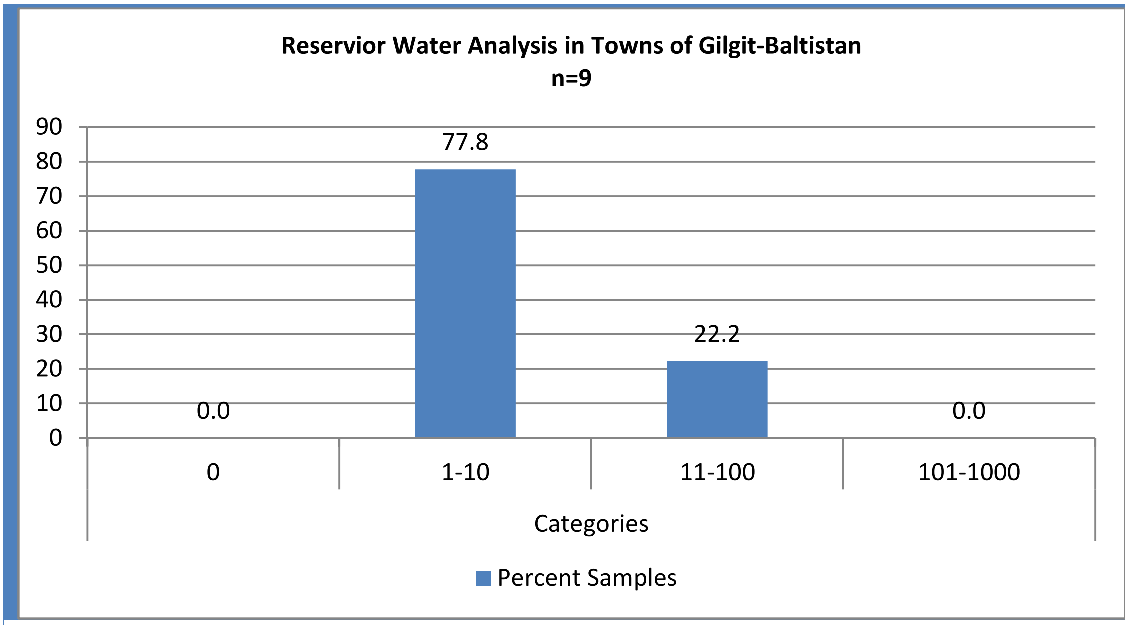

Figure 4: Bacteriological Results of Drinking Water Reservoirs in GB

5.1.3 TAP WATER QUALITY

About 72 water samples from urban water supply distribution system have been analyzed for fecal contamination. Out of 72 water samples only 15 percent of the total samples found to be fit human consumption as per WHO guidelines and NEQ standards set for drinking water quality. 11 percent of the total samples were found to be grossly contaminated and very high risk category. Remaining 36 and 38 percent samples falls in category of medium to high risk (See **Figure 5**).

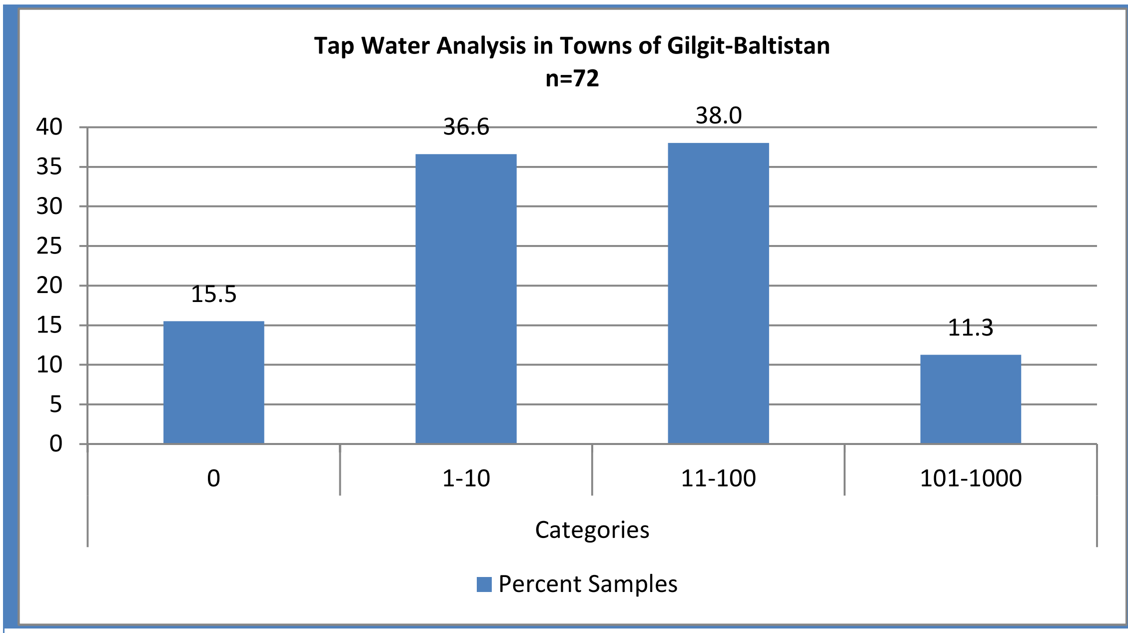

Figure 5: Bacteriological Results of Drinking Tap Water in GB

5.2 DISTRICT WISE BACTERIOLOGICAL RESULTS:

5.2.1 GILGIT URBAN AREA

Overall, 30 water samples were collected from different water supply networks in Gilgit town. The water samples were collected from different locations of the supply networks in of Barmas Complex, Jutial water supply, and Konodass areas. However, due to the unavailability of water in the distribution networks, water sampling could not be undertaken in some areas see **Table 2, 3 and 4** in Annexure.

The bacteriological water quality results of Gilgit town shows that almost all water supply networks have fecal contamination and is not fit for human consumption as per NEQS and WHO guidelines.

5.2.2 SKARDU URBAN AREA

Out of 10 water samples, 2 were collected from the intake and outlet of the water supply system. Remaining 8 samples were collected from the network at different locations of the Skardu town. The results reveal that there is not contamination at source (intake of the system) however meager contamination levels were observed in some water samples collected from public hydrants sees **Table 5** in Annexure

5.2.3 CHILAS URBAN AREA

In Chilas town water is rarely used for drinking purposes due to the limited number of spring sources in town. Overall, 10 water samples were collected from different points including source and outlet of the water-work.

Low level of fecal contamination levels were observed at inlet and outlet of the system. The contamination level in water samples collected from distribution lines was in the range of 3-10 fecal colifroms per 100 mL, which is not according to the drinking water standards set by NEQS or WHO guidelines for drinking water see **Table 6** in Annexure.

5.2.4 GAHKUCH URBAN AREA

The main sources of drinking water for Gahkuch town are river and spring. Water samples were collected from river and spring separately to judge the water quality of both sources. Eight samples were collected from different points of the distribution network. The results indicate that both water sources and distribution network are fecal contaminated and not fit for human consumption as per NEQS standard for drinking purposes see **Table 7** in Annexure.

5.2.5 KHAPLU URBAN AREA

About 10 water samples representing different points of the system including source and waterworks have been analyzed for fecal contamination. The results indicate that quality of water at source and intake of the system, comply with the drinking water standards set by NEQS and fit for human consumption. However high level of contamination was recorded in water samples collected from various points of the distribution network in Khaplu town see **Table 8** in Annexure.

5.2.6 ASTORE URBAN AREA

Main source of water for Astore town is spring-10 water samples were collected from source, water works and selected points of the distribution system. Chongra water supply tank and network has been selected for study purpose. The water samples indicate that water at source and at distribution system is fit for human consumption as per NEQS standards. Very low contamination level has been observed at few points in distribution network see **Table 9** in Annexure.

5.2.7 ALIABAD URBAN AREA

Drinking water for Aliabad is tapped from Hassanabad Nallah. About 10 water samples representing intake of water supply system, outlet and selected points of the distribution system have been analyzed for fecal contamination. Almost all samples fall in category C i.e. high rick for human consumption as per WHO guidelines. None of the samples comply with drinking water standards of NEQS. The contamination levels recorded in the range of 71-300 fecal coliforms per 100 ml see **Table 10** in Annexure.

6 PHYSIO-CHEMICAL RESULTS

Since in almost all districts have piped water supply systems, there for samples chemical analysis have been taken only from source i.e. intake of the water supply systems. For Physical parameters water samples were analyzed for Total Dissolved Solids (TDS), Turbidity and pH. For Chemical analysis water samples were checked for Total Hardness, Sulfate, Nitrate, Chromium and Chloride. The results of the analysis have been given below in alphabetical order.

6.1 CHLORIDES

Chloride is widely distributed in nature, generally in the form of sodium (NaCl), potassium (KCl) and Calcium (CaCl2) salts. The presence of chloride in natural water is attributed to dissolution of salt deposits, leacheates from refuse, sewerage effluents and irrigation discharges. Conventional water treatment processes do not remove the chloride ion from water. WHO and NEQ standards recommend 250 mg/L of chloride in drinking water. Almost all samples taken from drinking water sources of town water supply systems has Chloride levels below the recommended guideline for drinking purposes see **Figure 6**.

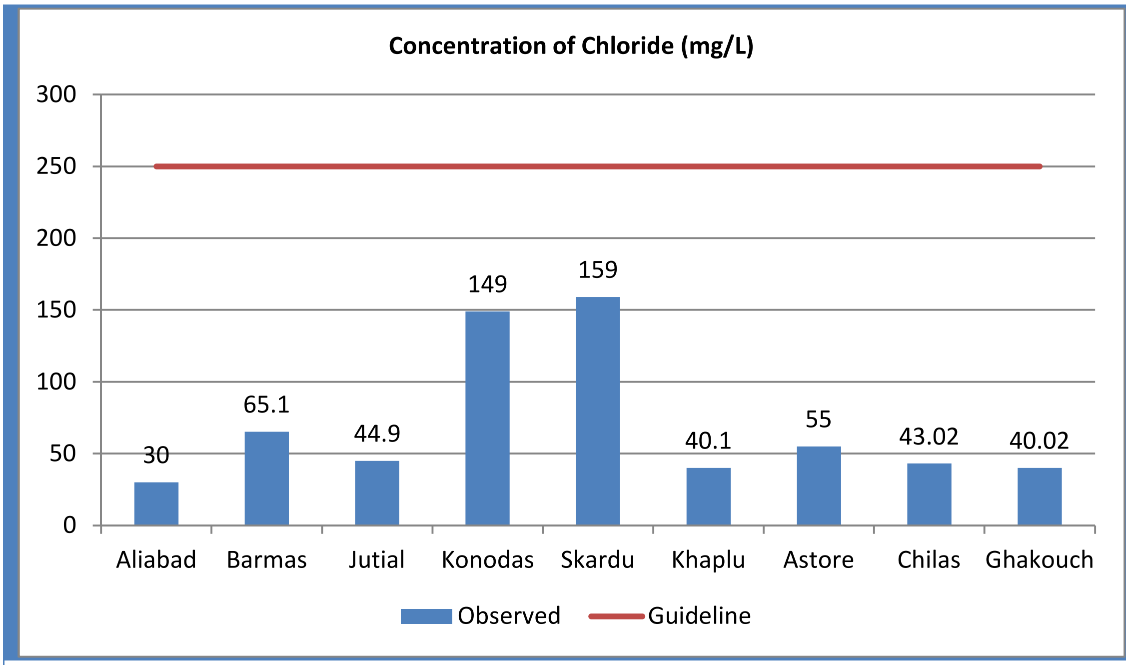

Figure 6: Chloride levels in drinking water sources in GB Towns

6.2 CHROMIUM

Chromium is found in most of the rocks and soil in small amounts. However, in water the main source of Chromium contamination is discharge of effluent containing chromium compounds. Over all nine samples collected from intake of the drinking water supply systems in seven urban headquarters were analyzed for Chromium concentration. The results indicates that except water samples collected from Barmas and Konodass (Gilgit River), the level of Chromium was below the WHO guideline values and NEQS set for drinking water. High levels of Chromium were observed in Barmas and Konodass as 0.09 mg/L and 0.17 mg/L respectively. (See **Figure 7**)

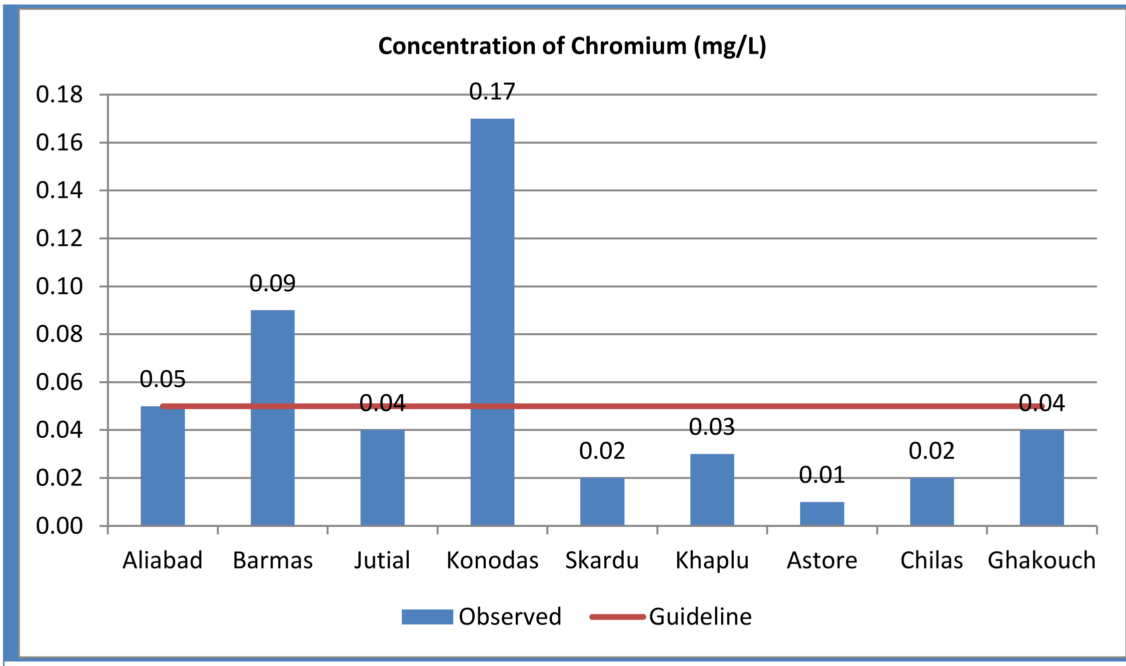

Figure 7: Chromium levels in drinking water sources in GB Towns

6.3 IRON

Iron is the fourth most abundant element by weight in the earth's crust. The presence of iron in surface water can be attributed to the dissolution of rocks and minerals, landfill leachates or sewage. Out of nine water samples analyzed for Iron concentration, only Konodass water source showed higher concentration (0.3 mg/L) of Iron as per WHO guidelines and NAEQS set for drinking water. All other sources of drinking water in town water supply systems of GB have low concentration of Iron as per standards see **Figure 8**.

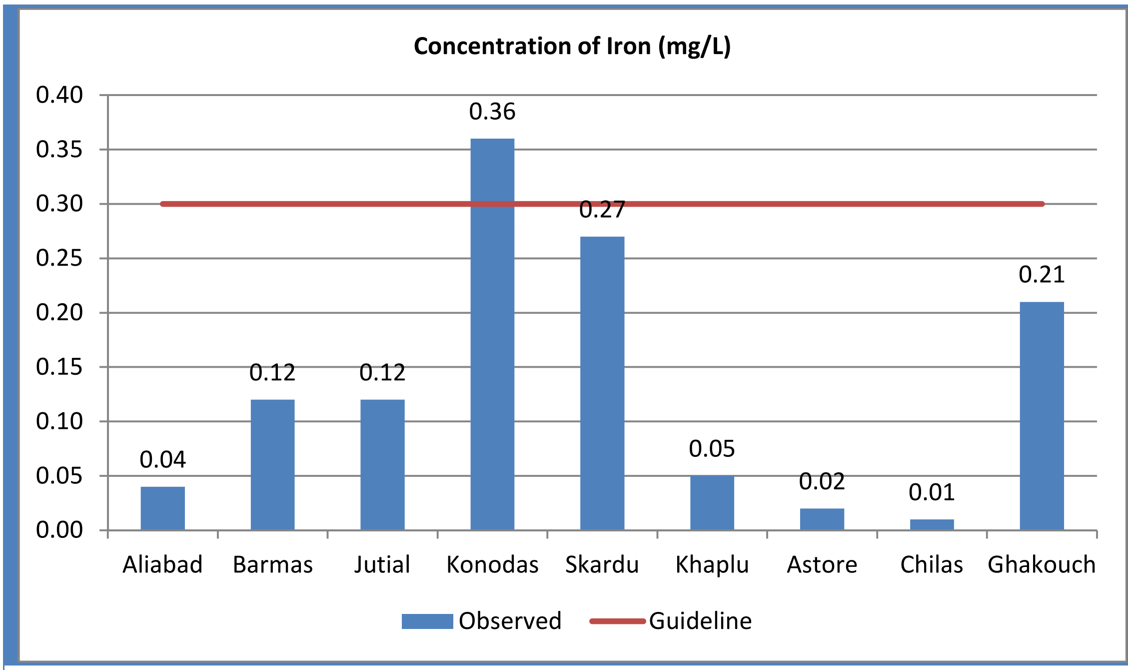

Figure 8: Iron levels in drinking water sources in GB Towns

6.4 NITRATE

Nitrates are widely present in substantial quantities in soil, in most waters and in plants including vegetables. Fertilizer use, decayed vegetable and animal matters, domestic waste effluents, and leachate from refuse dumps all contribute to these ions in water sources. None of the conventional water treatment and disinfection practices modify the levels of Nitrates to any appreciable extent, and hence nitrate concentration is not changed markedly in water distribution system. In GB no water treatment option is in practice therefore water samples from the intake of all town drinking water supply systems were analyzed for concentration of Nitrate. Out of nine water sources, Nitrate concentration was recorded on higher side in three water sources See Figure-8. Rest of the water sources of GB town areas used for drinking water have lower concentration of Nitrate in mg/L as per guidelines and standards fix by WHO and NEQS see **Figure 9**.

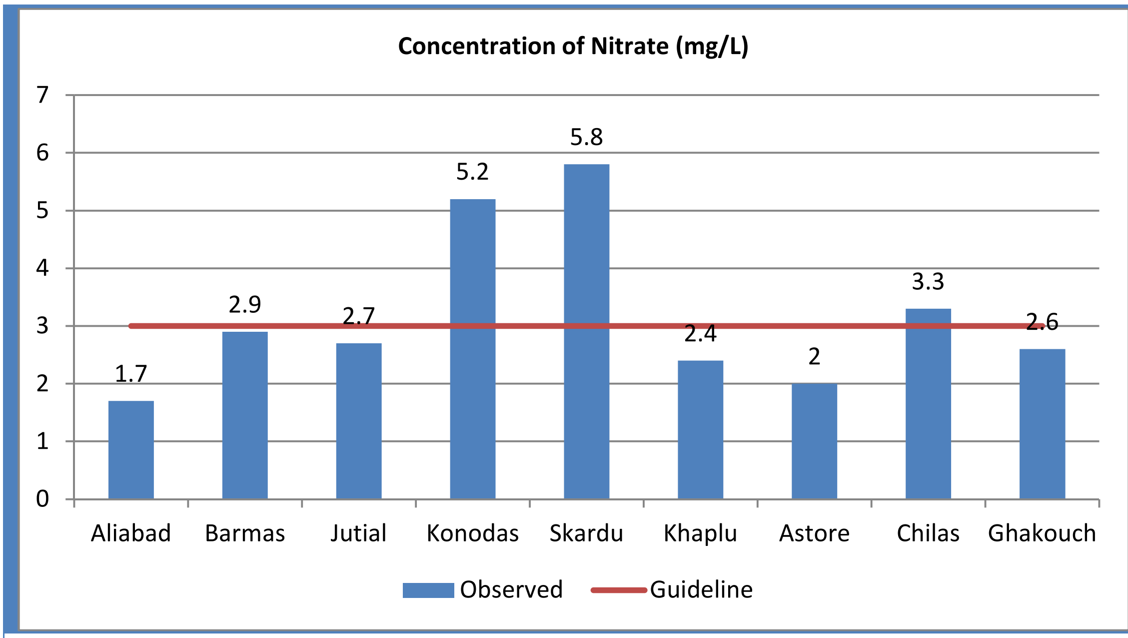

Figure 9: Nitrate levels in drinking water sources in GB Towns

6.5 PH

The pH is a measure of the acid-base equilibrium in waters. The pH of most raw water sources lies within the range 6.5-8.5. No scientific link to health issues has been established yet with pH values, however, corrosion in water mains and maintaining of specific chemical water treatment requires adjustment in pH values accordingly. In GB pH values of water sources of drinking water supply systems in town areas has been given in **Figure 10**.

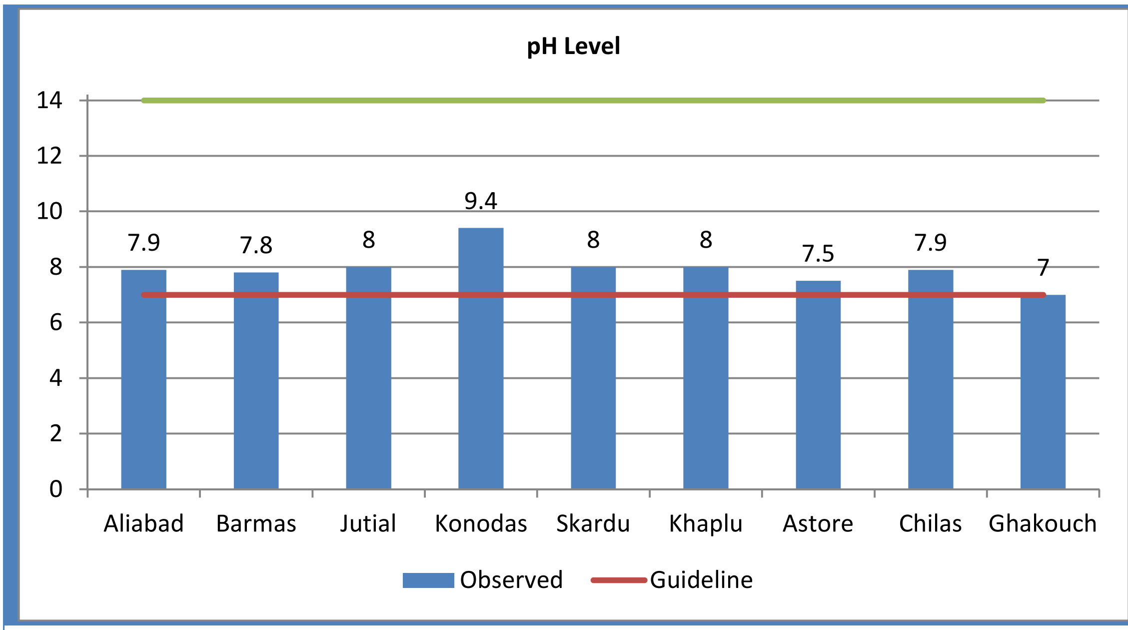

Figure 10: Sulfate levels in drinking water sources in GB Towns

6.6 SULFATE

Majority of the sulfates are soluble in water and its concentration in most fresh waters is very low. Sulfates cannot be removed by conventional water treatment systems. No significant health impact of sulfate has been established so far, however high concentration of Sulfates in drinking water systems may cause taste and corrosion problems. In GB nine water samples were analyzed for concentration Sulfate in drinking water sources of seven town water supply systems. The results indicate that all sources have Sulfate concentrations below the recommended guideline value of WHO and NEQ standards for drinking water see **Figure 11**.

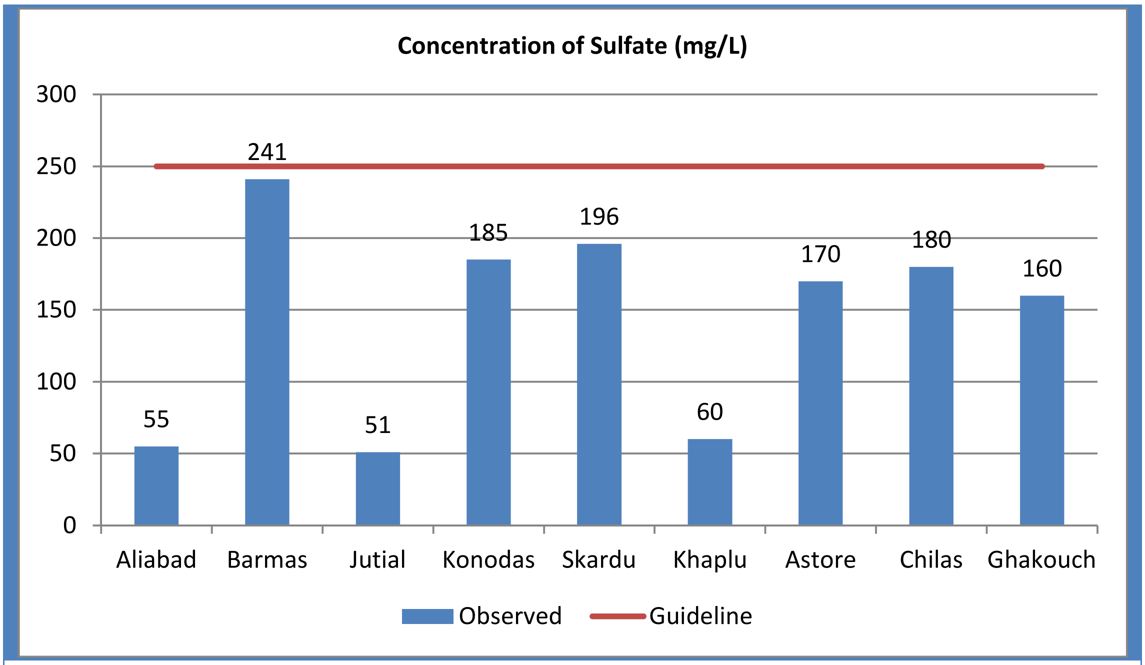

Figure 11: Sulfate levels in drinking water sources in GB Towns

6.7 TURBIDITY

Turbidity in water is caused by the presence of suspended matter, such as clay, silt, colloidal organic particles, plankton and other microscopic organisms. Turbidity is an expression of certain light-scattering and light-observing properties of water samples. Five methods are being used for turbidity measurements, however nephelometry and turbidimetry from the present standards methods. For this survey the first method was used to judge the turbidity level at drinking water sources. Out of nine water samples only three samples has recommended turbidity levels, whereas six samples have 2 to 4 times high turbidity level as per standards and guidelines set by NEQS and WHO for drinking water see **Figure 12**. No significant health impacts have been established with excess turbidity levels, except the higher concentration may reduced the water treatment process and aesthetic values.

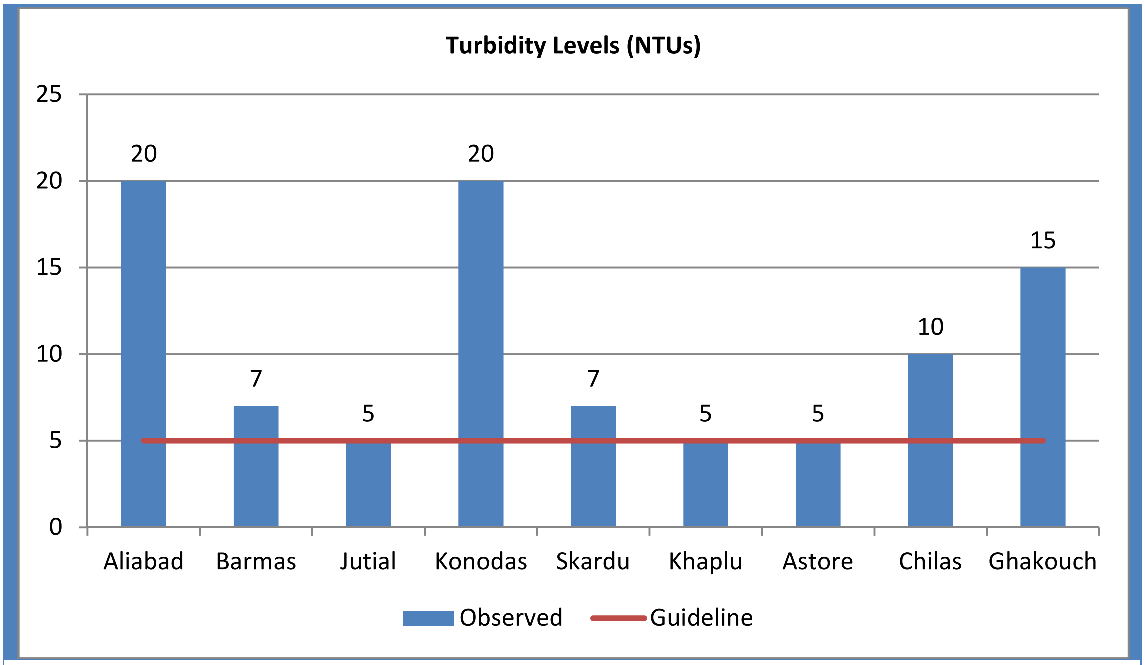

Figure 12: Turbidity levels in drinking water sources in GB Towns

6.8 TOTAL DISSOLVED SOLIDS

The Total Dissolved Solids (TDS) in water comprise inorganic salts and small amounts of organic matter. The principal ions contributing to TDS are carbonate, bicarbonate, Chloride, Sulfate, nitrate, sodium etc. There is no health evidence of deleterious physiological reactions occurring in persons consuming high TDS levels drinking water. However, TDS influence other qualities of drinking water, such as taste, hardness, corrosion and tendency to incrustation. TDS are not generally removed by conventional water treatment plants. Almost all water sources used for drinking water supply systems in towns of GB TDS values below the WHO guidelines and NEQS set for drinking purposes.

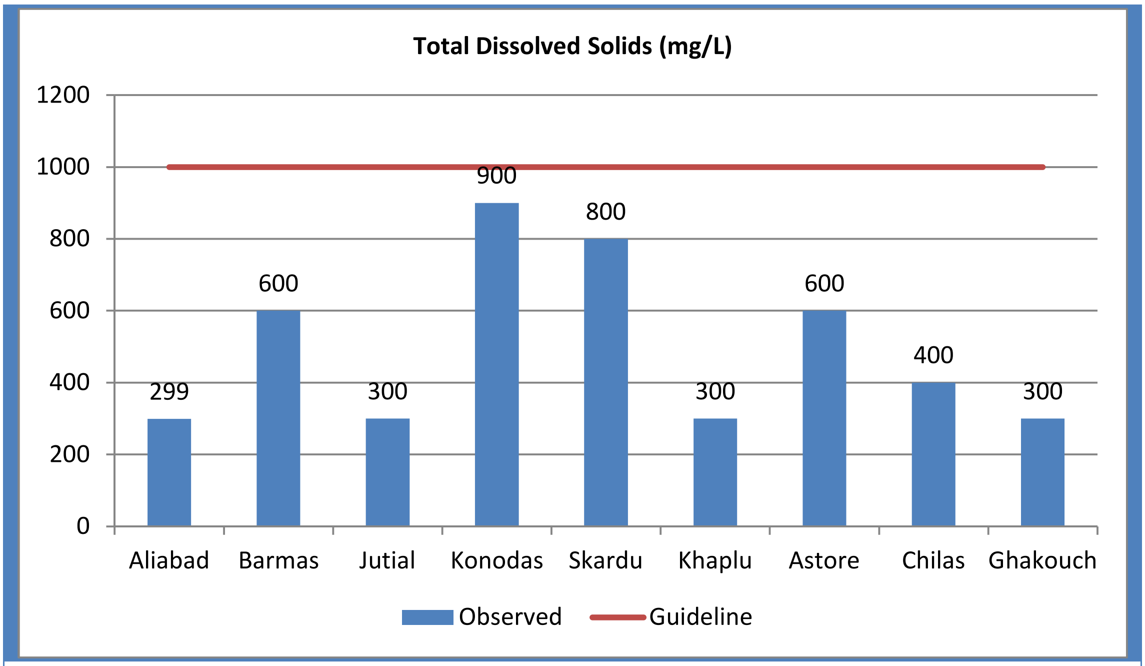

Figure 13: TDS levels in drinking water sources in GB Towns

7 RECOMMENDATIONS

7.1 WATER QUALITY

Only 22 percent of the total water samples comply with the WHO standards for drinking water. The remaining 78 percent falls in the categories of low to very high risk. It is worth mentioning that contamination levels may be doubled in the summer seasons due to high animate activities in the catchment area. The following steps are necessary to improve the existing water quality of different water sources and delivery systems;

1. All drinking water sources should be protected and tapped as per international standards.
2. Water delivery systems should be chlorinated as per WHO recommendations, especially in summer seasons.
3. Leakages in old water networks should be repaired immediately.
4. In order to improve the existing water quality water treatment facilities should be incorporated in urban drinking water works.

7.2 INTER-SECTORAL COORDINATION

The findings of the water quality survey indicate that there is a dire need of synergy between different departments working in the water sector and that it is imperative to develop a purposeful and cost effective water quality monitoring programme. This can only be achieved by enhancing the coordination between different organizations working in the water sector. The GBEPA has modest and user-friendly equipment for bacteriological, physical and chemical water quality testing. This equipment could be used for water quality monitoring under the supervision of GBEPA. However, GBEPA should develop a water quality monitoring programme for whole GB, keeping in view the existing resources of LG&RD, PHED and WASEP. The role of GBEPA should be as surveillance and monitoring agency. The Department of Health must also be involved in the water quality monitoring programme since it can play a vital role in awareness raising campaigns on water handling practices and to control mismanagement of tap water. The following steps need to be taken:

a. An inter-sectoral coordination committee should be formed to develop water quality surveillance programme. The main responsibilities of this committee should be:

b. To formulate and revise technical standards for the control of drinking water quality;

c. To promote the development of water quality control at the health area level;

d. To promote and advise on the implementation of water quality control and water surveillance laboratories; and

e. To recommend and support the training of quality control and surveillance staff.

f. Strong linkages should be developed with environment section LG to monitor the rural water supply systems.

g. GBEPA should be given the full responsibility for water quality monitoring in GB towns.

h. GB-EPA should take the lead role in water quality surveillance of whole AJK rather then direct involvement in water quality monitoring.

7.3 CAPACITY BUILDING AND INFRASTRUCTURE:

In discussions with PHED/GBPWD and LG&RD staff during the water quality survey, it was felt that job oriented capacity building programmes are necessary to improve the existing management. Hence the following should be undertaken:

Job-oriented training programmes targeted at the over all management of water delivery systems should be designed for operators and officials of PHED.

PHED laboratories should be established at district levels for bacteriological and physical testing of drinking water. In this connection user friendly and low-cost water testing kits should be used.

A three-tier infrastructure approach should be adopted to establish laboratories in the region:

7.3.1 CENTRAL LABORATORY

At the highest level a central or regional reference laboratory should be established at GBEPA. This laboratory should be well staffed and equipped with conventional and advanced equipment. It should eventually be capable of analyzing all WHO guideline parameters.

7.3.2 REGIONAL LEVEL

These laboratories should be located in district headquarters and staffed and equipped to analyze up to 35 parameters. Existing PHE/LG&RD offices could be used for regional set-up.

7.3.3 BASIC LABORATORIES

Basic laboratories may be established at the tehsil level and equipped to analyze 5-10 parameters. However, initially they may be equipped to analyze faecal Coliform counts, turbidity and residual Chlorine. For this purpose water testing kits could be used.

7.4 SANITARY INSPECTION AND RISK ASSESSMENT

No systematic sanitary inspection procedure was applied by the technical staff of water delivery systems, and hence no quantitative risk assessment data was available. It is imperative to design sanitary survey forms for each of the main types of water resources in the area. This would reduce the likelihood of contamination to a greater extent. The report form should intend to serve the following purposes:

1. identify all the potential sources of contamination of the water sources and supply system;
2. quantify the level of risk of each drinking water facility; and
3. Provide clear guidance for PHED or other relevant institutions for remedial actions.

ANNEXURES

ANNEXURE 1: WATER QUALITY ANALYSIS – BACTERIOLOGICAL, CHEMICAL AND PHYSICAL PARAMETERS

Table 2: Bacteriological Water Quality Analysis – Gilgit Town (Barmas Complex)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	Intake of Barmas Complex	10	0 E.coli/100 ml	Not fit for drinking
2	Water works	Storage Reservoir	10	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Public tap Raja Bazar	20	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Punyial Road	30	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Pubic Tap Jamat Khana Bazar	15	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Airport Road	25	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap Dumyial Link road	10	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap Amphery near filling station	28	0 E.coli/100 ml	Not-fit for drinking
9	Distribution network	Public Tape Domiyal Near AKRSP office	22	0 E.coli/100 ml	Not-fit for drinking
10	Distribution network	Public Tap Nagral Road	8	0 E.coli/100 ml	Not-fit for drinking
	Control		**0**		

Table 3: Bacteriological Water Quality Analysis – Gilgit Town (Konodas - Near Chief Court)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	River near pumping station	8	0 E.coli/100 ml	Not fit for drinking
2	Water works	Storage Reservoir	10	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Household tap	12	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Household tap	25	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Street Hydrant	16	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Mosque Konodass colony	11	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Street Hydrant	18	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap Near Court	20	0 E.coli/100 ml	Not fit for drinking
9	Distribution network	School Hydrant	13	0 E.coli/100 ml	Not fit for drinking
10	Distribution network	House tap	8	0 E.coli/100 ml	Not fit for drinking
	Control		**0**		

Table 4: Bacteriological Water Quality Analysis – Gilgit Town (Jutial Complex)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	Intake of Jutial Complex	0	0 E.coli/100 ml	Fit for drinking
2	Water works	Storage Reservoir	5	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Public Tap-Khomar Chowk	8	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Near APS	10	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Public Tap Mosque Riaz Road	6	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Jutial Chowk	4	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap Sereena Chowk	3	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap Near Radio Pakistan	10	0 E.coli/100 ml	Not fit for drinking
9	Distribution network	Public Tap near Panorama Hotel	14	0 E.coli/100 ml	Not fit for drinking
10	Distribution network	Public Tap Near Komar Market	11	0 E.coli/100 ml	Not fit for drinking
	Control		**0**		

Table 5: Bacteriological Water Quality Analysis – Skardu Town (Skardu Complex)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	Intake of Skardu Complex	0	0 E.coli/100 ml	Fit for drinking
2	Water works	Storage Reservoir	2	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Public Tap-Preshan Chowk	5	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Alamdar Chowk	0	0 E.coli/100 ml	Fit for drinking
5	Distribution network	Public Tap Main Bazar Near Qatal Gha	1	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Main Bazar Near Alabbas Medical Store	1	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap Near PTDC	6	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap Near Hospital	0	0 E.coli/100 ml	Fit for drinking
9	Distribution network	Public Tap Near MC office	0	0 E.coli/100 ml	Fit for drinking
10	Distribution network	Public Tap Near K2 Buss terminal	0	0 E.coli/100 ml	Fit for drinking
	Control		**0**		

Table 6: Bacteriological Water Quality Analysis – Chilas Town (Chilas Water Supply Complex)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	Intake of water work	2	0 E.coli/100 ml	Not fit for drinking
2	Water works	Storage Reservoir	1	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Public Tap-Near Police Station	8	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Near Hospital	6	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Public Tap Near Filling station	4	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Main GT road	3	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap NADP office	10	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap Chilas Inn	5	0 E.coli/100 ml	Not fit for drinking
9	Distribution network	Public Tap NATCO Bus Stop	6	0 E.coli/100 ml	Not fit for drinking
10	Distribution network	Public Tap Main GT Road	10	0 E.coli/100 ml	Not fit for drinking
	Control		**0**		

Table 7: Bacteriological Water Quality Analysis – Chakuch Town (Ghakuch Water Supply Complex)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source (River)	Near pumping station	20	0 E.coli/100 ml	Not fit for drinking
2	Source (Spring)	Intake	10	0 E.coli/100 ml	Not fit for drinking
3	Water-work	Distribution reservoir	30	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Near Rest House	60	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Public Tap Near Filling station	40	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Near Green Hotel	38	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap Main Road	70	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap Near PWD office	58	0 E.coli/100 ml	Not fit for drinking
9	Distribution network	Public Tap NATCO Bus Stop	60	0 E.coli/100 ml	Not fit for drinking
10	Distribution network	Public Tap Main Road	40	0 E.coli/100 ml	Not fit for drinking
	Control		**0**		

Table 8: Bacteriological Water Quality Analysis – Khaplu Town (Khaplu water supply network)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source (Spring)	Intake of water supply	0	0 E.coli/100 ml	Fit for drinking
2	Water works	Storage Reservoir	0	0 E.coli/100 ml	Fit for drinking
3	Distribution network	Public Tap-Main Bazar	0	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Main Bazar	2	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Public Tap Near PTDC	15	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Near MC office	25	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap AKCSP Office	10	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap near Mosque	28	0 E.coli/100 ml	Not fit for drinking
9	Distribution network	Public Tap Near Chaqcham	22	0 E.coli/100 ml	Not fit for drinking
10	Distribution network	Public Tap Near DC office	8	0 E.coli/100 ml	Not fit for drinking
	Control		**0**		

Table 9: Bacteriological Water Quality Analysis – Astore (Chongra water supply network)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	Spring	0	0 E.coli/100 ml	Fit for drinking
2	Water works	Storage Reservoir	2	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Public Tap-	1	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap	0	0 E.coli/100 ml	Fit for drinking
5	Distribution network	Public Tap	2	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap	1	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap	0	0 E.coli/100 ml	Fit for drinking
8	Distribution network	Pubic Tap	0	0 E.coli/100 ml	Fit for drinking
9	Distribution network	Public Tap	0	0 E.coli/100 ml	Fit for drinking
10	Distribution network	Public Tap	0	0 E.coli/100 ml	Fit for drinking
	Control		**0**		

Table 10: Bacteriological Water Quality Analysis – Aliabad (Aliabad water supply network)

S.No.	Sampling point	Location	E.Coli/100 ml	NEQS/WHO Guidelines	Remarks
1	Source	Intake of water supply system	71	0 E.coli/100 ml	Not fit for drinking
2	Water works	Storage Reservoir	100	0 E.coli/100 ml	Not fit for drinking
3	Distribution network	Public Tap-Near Jamat Khana	288	0 E.coli/100 ml	Not fit for drinking
4	Distribution network	Public Tap Near Maternity home	300	0 E.coli/100 ml	Not fit for drinking
5	Distribution network	Public Tap Near Main Markeet	250	0 E.coli/100 ml	Not fit for drinking
6	Distribution network	Public Tap Near leaders School	275	0 E.coli/100 ml	Not fit for drinking
7	Distribution network	Public Tap-Main Markeet	300	0 E.coli/100 ml	Not fit for drinking
8	Distribution network	Pubic Tap	280	0 E.coli/100 ml	Not fit for drinking
9	Distribution network	Public Tap	200	0 E.coli/100 ml	Not fit for drinking
10	Distribution network	Public Tap	185	0 E.coli/100 ml	Not fit for drinking
	Control		**0**		

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