A DETAILED STUDY ON THE EXISTING FRESH WATER QUALITY FROM SOURCE TO USER END IN DISTRICT MUZAFFARABAD

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Water quality biological assesment -
water quality bioassay
water quality management
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Water resources management
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IN THE NAME OF ALLAH, THE MOST MERCIFUL AND BENEFICIENT

Dedicated To my loving

Parents, respected teachers

& dear friends

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ABSTRACT

Quality of water is vital for sustaining healthy life and associated activities. The calamity of the October 2005, earthquake tore apart the whole area of Kashmir including Muzaffarabad (MZD). In this situation, not only water sources but water distribution systems were also damaged badly. So, a comprehensive study was designed to investigate the current condition of freshwater; at sources (springs) and at user end.

In district MZD, a total of 218 water samples were collected from 26 Union councils (UCs). Water samples were analyzed for 27 different physico-chemical and microbiological parameters. Results revealed that; only 3 UCs (Rayalli, Talgran, Heer Kutli) out of 26, were having all phisco-chemical parameters within the permissible limits of WHO. All water samples showed presence of microbial contamination in the form of total coliform and *E. coli*. Turbidity proved to be the second most pollution indicator in water samples and it was higher than permissible limits in 27 water samples of 13 UCs. A total of 69 samples in 16 UCs showed high values of Electric conductivity. Calcium levels in 52 samples of 15 UCs and nitrate levels in 4 samples of 4 UCs, were exceeding permissible levels. Only 1 scheme in Lammnian and Kiamanja showed objectionable levels of hardness, sulfate and Fe, respectively. With few exceptions, no significant variation in water quality parameters was observed from source to user end in all UCs of the district. Considering the overall results of the present study, it can be concluded that water supply schemes of the district, were not responsible for any significant contamination in water from sources to user ends. However, water sources at their sites were having small input of contaminants from adjacent areas or due to humans' and animals' activities.

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Jawad Ali

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List of Abbreviations used in the thesis

AJ&K	Azad Jammu and Kashmir
As	Arsenic
COD	Chemical Oxygen Demand
^{o}C	centigrade
Ca	Calcium
conc	concentration
Cl^{-}	Chloride
Dist	District
E.C	Electric Conductivity
E.D.T.A	Ethylene diamine Tetraacetate
F	Fluoride
Fe	Iron
I	Iodine
K	Potassium
l	litre
Li	Lithium
Max	Maximum
Mg	Magnesium
mg	miligram
Min	Minimum
ml	milliliter

MZD	Muzaffarabad
N	Normality
Na	Sodium
NGV	No Guide Line
NO_3	Nitrate
NTU	Nephlometric Turbidity Unit
P	Phosphorus
PO_4	Phosphate
ppm	part per million
ppt	precipitate
P.S.Q.C.A	Pakistan Standard Quality Control Authority
S	Source End
SO_4	Sulfate
STD	Standard
TDS	Total Dissolved Solid
U	User End
U.C	Union Council
Un Obj	Un Objectionable
-ve	Negative
+ve	Positive
WHO	World Health Organization
µ/S	Micro siemen

Chapter 1

Introduction

"Have ye observed the water which ye drink?" "Is it ye who shed it from the rain cloud, or are we the shedder?" (Al-Waqia; 68,69).

"Say: Have ye thought: If (all) your water were to disappear into the earth, who then could bring you gushing water?"(Al-Mulk:30).

Water is distinctive and most abundant substance in the universe. About 70% of the earth is covered with water and 97.5% of that constitutes salty oceans. The remaining 2.5% is fresh water, out of which less than 1% of this fresh water is useable. Fresh water would be enough to support the world's population if used with care. Fresh water however, is not distributed evenly with respect to population. Although 60% of the world's populations live in Asia, the continent has only 36% of the world's water resources. In 2004, 1.1 billion people lack access to improved water sources and 2.6 billion people lack access to improved sanitation, which represents 17 percent and 42 percent of the world's population respectively (Kahlown et al., 2008).

Water is one of the basic and essential liquid to sustain life on earth. Developing countries have inadequate access to clean drinking ; people may, therefore consume unhygienic water, which is one of the major causes of illness among consumers (Javaid et al., 2008). Domestic, industrial and commercial wastes pollute the natural water supplies, mostly streams and rivers. A huge amount of used water is disposed off generally by returning it to a natural body of water in the surrounding area, making it hazardous as it carries pathogenic organisms and toxic chemicals

(White et al., 2003).

Next to the air we breathe, water is the second most important substance of human being. Human body contains two thirds of water by weight. The Human brain contains 95% water, where as blood and lungs contain 82% and 90% water respectively (Fine waters 2006). The water also acts as a medium for regulating the body temperature and also plays a key role in the prevention of disease(s) (Kahlown et al., 2008).

There was little understanding of the correlation between drinking water and disease at the mid-19th century. Dr. John Snow, a British physician, firstly connected an outbreak of cholera to drinking water drawn from contaminated sources in London. Later on in 19 century Pasteur's discovery of the germ theory, explain how water sometimes made people sick. Bacterial pathogens would remain the focus of concern during most of the 20^{th} century (Afzal et al., 2006).

Disease-causing organisms (pathogens) mostly of fecal origin transmitted through drinking water and therefore known as enteric pathogens (Hunter et al., 2002). Since the pioneering epidemiology in the 1850's, whereby the English physician John Snow established that cholera was waterborne (Paneth et al., 1998). It was observed that transmission of various pathogens, through drinking water, cause diarrhea and other diseases in humans (Hunter et al., 2002). In the feces of all warm-blooded animals and some reptiles, common fecal indicator bacterium *Escherichia coli (E. coli),* is responsible for cholera (*Vibrio cholerae*) and typhoid fevers (Salmonella typhi and S. paratyphi), are needed to removed from drinking water by treatment (traditionally by filtration and chlorination) (Enriquez et al., 2001).

The World Health Organization (WHO) estimates that approximately 1.1 billion people in the world drink unsafe water (Kindhauser, 2003) and the main cause of diarrhea disease in the world (88%) is due to drinking unsafe water, sanitation and unhygienic condition (WHO, 2003). Approximately 3.1% of annual deaths (1.7 million) and 3.7% (54.2 million) of the annual health burden globally are attributable to unsafe water, sanitation and unhygienic condition (Ashbolt, 2004).

It is estimated by the year 2025 about 52 nations will face a severe shortage of potable water, including half the world's population. In the next 25 years, about 3 billions peoples will face water shortage. Similarly, in this context the major issues of South Asia include unavailability of fresh, limited access to potable and fresh water, seasonal limitation of availability of natural resource, depletion of fresh water aquifers and organic pollution, limited access to potable water born disease, arsenic contamination of drinking water, seasonal limitation of availability of natural resource, depletion of fresh water aquifers and organic pollution (Kahlown et al., 2008).

Biological contamination is the most common health risk, associated with drinking water.(Bryan et al., 2002). Ideal, drinking water should not contain any pathogen (Prasai et al., 2007). Pathogens are transmitted and cause diseases via drinking water (Ashbolt, 2004), contaminated with organic wastes, which supply food for bacteria (White et al., 2003). Microbial contamination increases the threat of water born disease(s) like typhoid fever, shigellosis, diarrhea, cholera, and dysentery in humans (WHO, 2006). About 1.1 billion people globally drink unsafe water and the vast majority of diarrhea disease (88%) in the world are attributing to contaminated water. Approximately 2.2 million annual deaths are attributed due to unsafe water (Clasen and Bastable, 2003; Ashbolt, 2004).

In Azad Jammu and Kashmir (AJK),unplanned disposal of a large volume of solid waste including household, municipal, and industrial waste contaminate the sources of drinking water by pouring higher concentration of trace element and other pollutants, ultimately result in causing pollution (Javaid et al., 2008).

Arsenic is a poisonous heavy metal, cause lung, kidney, liver, colon, and prostate cancers. Research shows a positive relation arsenic ingestion and cardiac and cerebrovascular disease and diabetes mellitus (Kazmi and Khan, 2005). Arsenic exists in the environment as a natural ingredient/component of soil and rocks. It has also been reported that drinking arsenic contaminant water, causes lesions and cancer on skins (Fytianos and Christophoros, 2004).

Alkalinity is another problem of water and it is associated with CO_3^{2-}, $HCO3^-$, OH^-, H_2BO_3, $H_2PO_4^-$, and HS^- of natural water systems. By far, the most common constituents of alkalinity are bicarbonates (HCO_3^-), carbonates (CO_3^{2-}), and hydroxide (OH^-) (Gupta 2004).

Calcium occurs in great abundance in all natural waters. Its source has been in the rocks from which it gets leached (Gupta, 2004). Calcium ion along with magnesium also accounts for water hardness. The most common manifestation of water hardness is the cruddy precipitate formed by soap in hard water. The precipitate form as a result of hardness and soap adheres to surfaces of tubs, sinks, and dishwashers and may stain clothing, dishes and other items. Residues of the hardness soap precipitate may remain in the pores, so that skin may feel rough and uncomfortable. Boiler scale, the result of the carbonate hardness precipitate may cause considerable economic loss through fouling of heaters and hot water pipes.

Chloride contents above 250mg/l make the water salty in taste; thought its concentration even up to 1000 mg/l has been found safe for human consumption (Gupta, 2004). Inland natural water generally has low chloride concentration, often less then that of bicarbonate and sulfates. High concentration of chlorine in natural waters is due to organic waste of animals and industrial effluents which is regarded as indicator of pollution (Trivedi and Raj, 1992).

Dissolved minerals, gases, and organic constituents may produce aesthetically displeasing color, taste and odors. Some chemicals may be toxic, and some of the dissolved organic constituents have been shown to be carcinogenic (Peavy et al, 1985). Generally, presence of any type of dissolve or suspended solids in water reduced its light transmitting ability. Turbidity is mostly present in surface water due to the erosion of colloidal materials, such as clay, silt, rock fragments and metal oxide from soil (Greenberg et al., 1998). Turbidity is not only aesthetically unacceptable, causing taste and odor problem but it also hinders the purification abilities of disinfectants (Peavy et al, 1985). A rapid decrease in photosynthetic activity is observed as the water gets more turbid, thereby the organisms depend on vegetation also reduce in number. So turbidity causes an overall decline in the productivity of aquatic ecosystem.

Electric Conductivity is the ability of a solvent to conduct electricity as to how much dissolved solids are present in the ionic form. Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. Mostly the units, which were used, are *Micron Seimen per centimeter* = µs/cm. Measurement of conductivity and its relation to cations and anions and the total solid concentration has been extensively used for pollution detection and monitoring the quality of agricultural and surface waters and in chemical oceanography for salinity determination (Ahmad, 2004).

Magnesium occurs in all natural waters. The main source of magnesium lies in rocks, however, somewhat lower than calcium. Magnesium has been an essential constituent of chlorophyll without which no ecosystem could work. High concentration of magnesium lowers the utility of water for domestic use, whereas its concentration above 500 mg/l gives an unpleasant taste and makes water unfit for drinking. High concentration of magnesium has been found to be diuretic and laxative (Trivedi and Raj, 1992).

Magnesium hardness particularly associated with the sulfate ions has laxative effects on persons unaccustomed to it. Calcium hardness presents no public health problem. In fact, hard water is apparently beneficial to the human cardiovascular system (Peavy et al, 1985).

Sulfates occur in an appreciable quantity in all type of water including, natural, sewage and industrial. Besides biological oxidation of reducing sulfur species, may add to sulfate content into water. Sulfates salts have been mostly soluble in water and impart hardness. Water with 500 mg/l sulfates is having a bitter taste and those with 1000 mg/l or more sulfates may bring about intestinal disorder (Trivedi and Raj, 1992).

Sulfate is natural constituent of water however; concentration varies widely depending on the source of water. Concentration greater than 250 ppm in drinking water may causes diarrhea in some people (Bartram and Balance, 1996).

Sodium is also found in water; however, its amount is much less than that of calcium and magnesium. Its main source in water has been the weathering of rocks. Sodium salts has been highly soluble in water and causes softness (Gupta, 2004). If sodium contents, in the form of chloride and sulfates, are very high, it makes the water salty in taste and unfit for human consumption can cause cardiac and kidney problems. High level of Na is also corrosive to metal surfaces and in large concentration is toxic to plants (Trivedi and Raj, 1992).

Increasing phosphorus concentration from point and diffuse source can result eutrophication(Abnormal growth of algae /plants), potentially leading to an increase in biomass and primary productivity within aquatic communities. Major point sources are sewage and industrial discharge. Land use, particularly agriculture, is also a significant diffuse source, which also contributes to phosphorus accumulation (Hanrahan et al., 2003).

Phosphate is a constituent of soils and is used extensively in fertilizer to replace or to supplement natural quantities on agricultural land. Phosphate is also a constituent of animal waste and may become incorporated into the soil in grazing and feeding areas. Runoff from agricultural areas is a major contributor to phosphate in surface waters (Trivedi and Raj, 1992). Phosphates are not toxic and do not represent a direct health threat to human or other living organism. Increases in the available phosphate in water, results in rapid growth of aquatic plants with sever consequences. Moreover, phosphate can also interfere with water treatment processes (Peavy et al, 1985).

Methaemoglobinaemia, especially in bottle fed infants has always been associated with presence of Nitrate and Nitrite in water. Nitrate concentration may arise from the excessive application of fertilizers or from leaching of wastewater or other organic wastes into surface and groundwater (Fytianos and Christophoros, 2004). In rural area, where people get their drinking water from aquifers nitrates and nitrites cause a health risk. There is a positive association between nitrates in drinking water and colorectal cancer (Nas and Berktay, 2005).

Pure water is colorless. Many substances with which water comes into contact in nature or during human use may impart perceptible taste and odor. These include; metals, minerals, and salts from the soil, end product of biological reaction and other constituents of waste water. In potable water analysis, the common practice is to measure only the true color produced by organic acid resulting from decaying vegetation in the water. However, iron oxides cause reddish brown color, the manganese oxide cause brown or blackish water. Alkaline water imparts a bitter taste while metallic salts may give salty taste to water and reducing product of sulfur may produce a rotten egg taste and odor. The inorganic substances produce taste unaccompanied with odor, while organic material may impart both taste and odor. Colored water is aesthetically displeasing and unfit for drinking. Moreover, highly colored water is unsuitable for laundry, dyeing, beverages, dairy products, manufacturing and other food processing, textile and plastic production (Peavy et al, 1985).

Ground and surface water can be contaminated by natural i.e. leaching of soil, and by human activities i.e. discharge from sewage treatment plant and industrial effluent, uncontrolled discharge from land fill sites and from chemical accidents and disaster, refuse dumping sites, transport accident, infiltration of polluted rain water , excess use of fertilizers etc. Moreover unsanitary disposal of refuse dump and garbage, increase use of agricultural pesticides and fertilizers, industrial operation, use of pit latrines and problem with septic tank system constitute major anthropogenic activities causing ground water pollution (London et al., 2000).

1.1 Introduction to study area:

Kashmir, located in South Asia, is divided between India and Pakistan. The area of Kashmir under the administrative control of Pakistan is called AJ&K while the rest is occupied by India and is called Indian Occupied Kashmir. There is no municipal supplied drinking water in the valley. Streams are main sources of drinking water for locales for long being (javaid et al., 2008).

In hilly areas of Pakistan i.e. Northern belt and in AJ&K, most of the water supplies are natural streams. Due to October 2005, Earthquake, some of these streams were also affected, some streams became damaged while some new ones were formed. The main sources of water supply schemes in AJ&K and in dist Muzaffarabad are unfortunately not protected. As there is no proper Industrial zones in these areas, so there is less problem of COD. However, women wash their clothes at the source or nullah, animals' fetch their thirst and kids take bath. Moreover, these water sources are places of disposal of sewages from associated population. Consequently, all these contamination from different sources goes directly to the consumer end through pipelines and waterways resulting in different types of diseases like dysentery, diahorrea, cholera, hepatitis, high blood pressure, kidney stones in locals (Own experience).

1.2 Aims and Objectives

To estimated the overall quality (physico-chemical) of different waster sources in order to understand the pollution load.

1 To investigate the water quality with reference to physico-chemical and micro biological parameters in order to find out;

- Quality of water at sources
- Change in water quality from source to user end
- Possible impacts of different parameters on sources of fresh water quality sources

CHAPTER 2

MATERIAL AND METHODS

2.1 Study Areas

Muzaffarabad district of Azad Kashmir is located on the banks of the Neelum and the Jehlum river. The dist is bounded to Pakistan in the West and to Kupwara and Baramulla districts of Indian Occupied Kashmir in the East and Neelum dist fall on the Northeast of the dist.

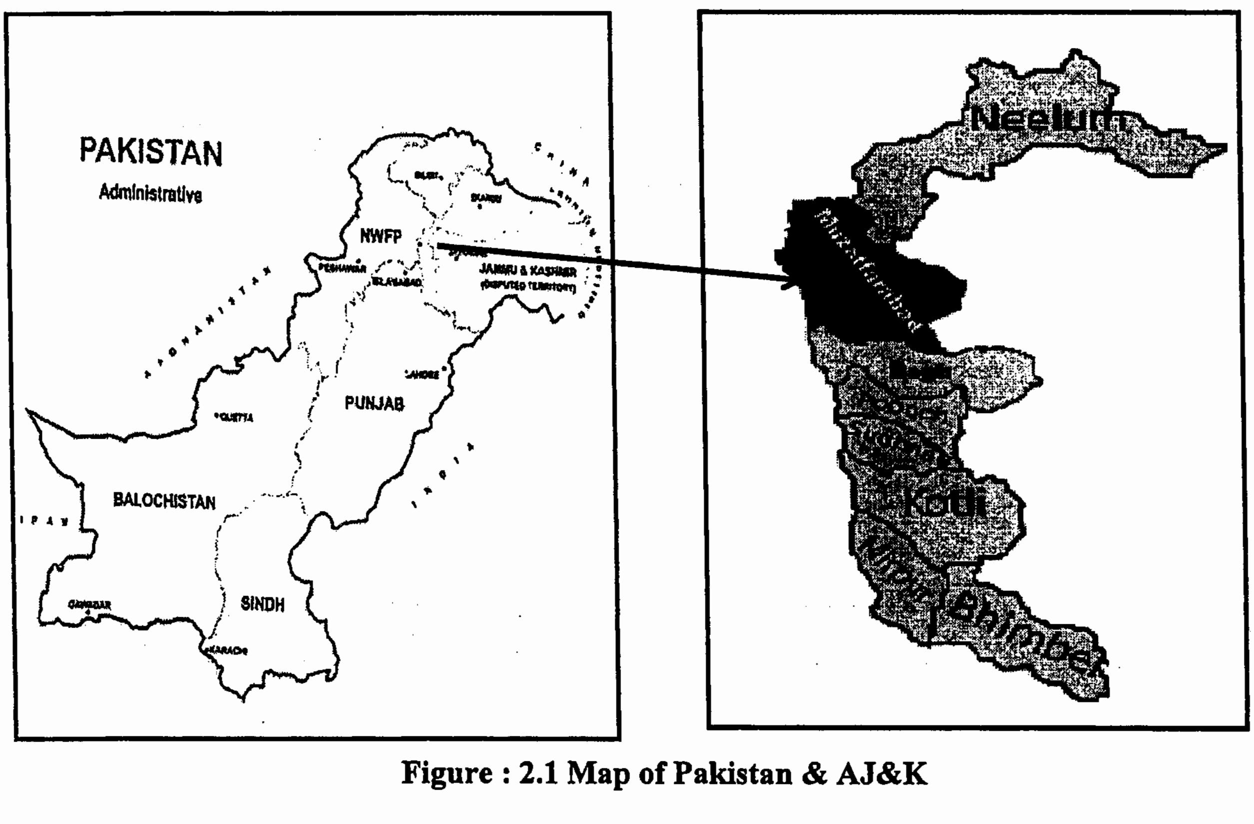

Figure : 2.1 Map of Pakistan & AJ&K

Total area of the district is 2496 sq.km. The total population of the district according to the 1998 census was 0.770 m. The district is administratively subdivided into two tehsils and fifty one Union Councils. Muzaffarabad city is the district, serves as capital of Azad Jammu and Kashmir.

2.2 Field Visits

Visits were made to various sites at remote area in dist AJ&K to get water samples and information related to study area. Meetings were arranged with local peoples. The water sampling in the field was started as per planned schedule. Sampling task was completed in 30 days started from 28th August to 27th September 2008.

Table 2.1 Description of total sampling of water supply schemes from each Union Council in Dist Muzaffarabad

S.no	Activity	Dist	Union council (U.C)	No of WSS
1	Sampling	Muzafarabad	Janddgran	02
2	Sampling	Muzafarabad	Kiamanja	12
3	Sampling	Muzafarabad	Langerpura	10
4	Sampling	Muzafarabad	Chattar Domail	03
5	Sampling	Muzafarabad	Hattian	05
6	Sampling	Muzafarabad	Danna	10
7	Sampling	Muzafarabad	Tarian	10
8	Sampling	Muzafarabad	MZD	08
9	Sampling	Muzafarabad	Lamnian	07
10	Sampling	Muzafarabad	Langla	05
11	Sampling	Muzafarabad	Panjgran	02
12	Sampling	Muzafarabad	Kathali	02
13	Sampling	Muzafarabad	Chattar klass	01
14	Sampling	Muzafarabad	Charak Pura	02
15	Sampling	Muzafarabad	Serli Sucha	02
16	Sampling	Muzafarabad	Sehotar	03
17	Sampling	Muzafarabad	Heer Kuttli	02
18	Sampling	Muzafarabad	Gojar Bandi	02
19	Sampling	Muzafarabad	Kot Kair	01
20	Sampling	Muzafarabad	Chakhama	02
21	Sampling	Muzafarabad	Komikot	07
22	Sampling	Muzafarabad	Gojara	04
23	Sampling	Muzafarabad	Saidpur	02
24	Sampling	Muzafarabad	Rayalli	03
25	Sampling	Muzafarabad	Talgran	02
26	Sampling	Muzafarabad	Panjkot	01

Total 218 water samples were collected from 110 water supplies schemes from 26 U.Cs in dist MZD. Generally, the water supply schemes in Kashmir including MZD have been chiefly crafted from natural springs and lakes. Two water samples were collected from each water supply scheme. One sample was taken from water source and the other from consumer end. Separate water sample was also collected for bacteriological analysis.

2.3 On Site Analysis

Physical parameters i.e. color, odor and taste were observed in the field, and bacteriological analysis was also carried out in the field by using field testing kits (Water Check, Redycult, and MERCK). Standard protocol was adopted for analysis of bacteriological samples in the field. Necessary equipments i.e. incubators, faces masks, gloves, spirit lamps, sterilized cotton, lighter, spirit, permanent marker and kits were provided for on-site analysis of bacterial samples.

2.4 Laboratory Analysis

Water samples collected for detailed chemical analysis in bottle were taken to "The Water Clinic" laboratory, Rahim Yar Khan for analysis. Water quality parameters including; Conductivity (micro-S/cm), TDS (mg/l), Turbidity (NTU), Arsenic (ppb), Alkalinity (mg/l), Bicarbonate (mg/l), Calcium (mg/l), Carbonate (mg/l), Chloride (mg/l), Iodine (mg/l), Hardness (mg/l), Magnesium (mg/l), Potassium (mg/l), Sodium (mg/l), Sulfate (mg/l), Iron (mg/l), Nitrate-NO_3 (mg/l), Fluoride (mg/l) and Phosphate (phosphorous), were analyzed in the laboratory by using standard methods as listed below:

2.5 Methods used for Physical/Chemical Parameters

2.5.1 Color

Color of samples was observed by naked eye. It was done during the sampling of water on the spot.

2.5.2 Taste and odor

Taste and odor are the prime consideration for the potable water. The sensation of taste and smell are closely related and often confused. Taste and Odor of the samples were performed by sensory test. Taste, and odor, testing were also done during the sampling on the spot.

2.5.3 pH

The pH of water samples was determined in laboratory by using "pH Meter, Hanna Instrument, Model 8519, Italy". Before conducting measurement of pH of water samples, the instrument was calibrated with distilled water.

2.5.4 Turbidity

Turbidity was measured by Jackson Turbidity meter. First of all, Jackson turbidity meter was calibrated with standard turbidity suspensions i.e. 10, 100 and 1000 NTU. The sample was taken in sample tube. Shake the sample thoroughly and allow the air bubbles subside. Put the sample tube in Jackson turbidity meter and note the reading.

2.5.5 Electric Conductivity

The Conductivity of water samples was determined in Laboratory with the help of "E.C meter, Hanna, Standard method 2520-B (2004)". First of all the water quality checker was washed with distilled water. Then water sample was taken into it. After power on, the water quality checker, the conductivity mode was selected by select button and reading was recorded. Bulb was washed with distilled water before putting in each water sample.

2.5.6 Total Dissolved Solid

The TDS in water samples was determined in Laboratory with the help of "2540C, Standard method (2004)". First of all the water quality checker was washed with distilled water. Then water sample was taken into it. After power on, the water quality checker, the TDS mode was selected by select button and reading was recorded. Bulb was washed with distilled water before putting in each water sample.

2.5.7 Arsenic

Analysis of Arsenic in water samples was determined in Laboratory with the help of "High sensitive, Arsenic test kit, MERCK, Germany".

2.5.8 Fluoride

Analysis of Fluoride in water samples was determined in Laboratory with the help of "4500-F-D SPADNS Method, Standard method (2004).

2.5.9 Iodine

The presence of Iodine in water samples was determined in Laboratory with the help of "4500-DOD Method, Standard method (2004).

2.5.10 Iron

The contamination of Iron in water samples was determined in Laboratory with the help of "3500-Fe-D Phenanthroline Method, Standard method (2004).

2.5.11 Alkalinity

Alkalinity in the analyzed samples was determined by titration method i.e. 2320, Standard method (2004). Alkalinity is a measure of the ability of water to neutralize acids. The most common constituents of alkalinity are bicarbonates, carbonates, and hydroxides.

Reagents

- Standard Sulfuric acid (H_2SO_4) solution (0.02N)
- Methyl orange indicator (0.5%)
- Phenolphthalein indicator (0.5)
- Standard Sodium carbonate (Na_2CO_3) solution (1N)

Standard H_2SO_4 solution (0.02N)

Take 27ml of concentrated H_2SO_4 and dilute it to 1 liter with distilled water in volumetric flask. Now take 20ml from this 1N solution and again dilute it with distilled water up to 1 liter in volumetric flask.

Methyl Orange Indicator (0.5%)

Dissolve 0.5 grams of methyl orange powder in 100 ml of 95% alcohol (Methanol).

Phenolphthalein indicator (0.5%)

Dissolve 0.5 gram Phenolphthalein powder in 100 ml of 60% alcohol (Ethanol).

Standard Na_2CO_3 solution (1N)

Take 53gram of Na_2CO_3 and dissolve it in few ml of distilled water and make 1 liter solution from it.

Procedure

Carbonate alkalinity (CO_3)

First of all take 20 ml of water sample and add few drops of Phenolphthalein indicator. If pink color does not appear so carbonate (CO_3) alkalinity is not present.

Bicarbonate alkalinity (HCO_3)

Take 0.02 N sulfuric acid in burette and 20 ml water sample in titration flask and few drops of methyl orange was added as indicator. Titrate it against 0.02 N sulfuric acid solutions till the color changes from orange yellow to orange red. The volume of Titrant used was recorded. Alkalinity was calculated by using the following formula.

Alkalinity as $CaCO_3$

$$= \frac{\text{volume of } H_2SO_4 \text{ used x normality of } H_2SO_4 \text{ x equivalent weight of } CaCO_3}{\text{100 ml of water sample used}}$$

2.5.12 Total Hardness

Hardness in the analyzed samples was determined by titration method i, e Standard Method (2004). Hardness is classified as carbonate hardness, and non carbonate hardness. It may be represented by the sum of calcium and magnesium ions.

Reagents

- Ammonia buffer solution.
- EDTA 0.01M.
- Erichrome Black T (EBT).

Ammonia buffer solution

Dissolve 16.9gm NH_4Cl in 143ml concentrated NH_4OH and dilute it to 250ml with distilled water.

EDTA 0.01M

Take 3.723gm of EDTA and dissolve in a few ml of distilled water now dilute this solution up to 1 liter.

EBT indicator

Dissolve 0.5gm EBT in 100gm Ethylene Glycol.

Procedure

Take 0.01M EDTA solution in Burette and 20ml water sample in Titration Flask. Add 1ml of Ammonia buffer solution and a few drops of EBT indicator to this sample and titrate it against EDTA till the color changes from light purple to light blue. Now record the volume of titrant used. Hardness is calculated using following formula.

$$\textbf{Total Hardness} = \frac{\text{ml of EDTA used x 1000}}{\text{ml of water sample use}}$$

2.5.13 Nitrates

Nitrate concentration in the analyzed sample was determined by "Cadmium Reduction Method, Standard Method (2004)".

2.5.14 Phosphates

Phosphate contents in water samples were analyzed by 4500-P-C, Amino Acid Method, Standard Method (2004). Phosphates are algal nutrients which cause Eutrophication in water bodies.

Reagents

- Sulfuric Acid (H_2SO_4) 5N.
- Potassium antimony tartarate solution.
- Ammonium Molybdate.
- Ascorbic acid.
- Combined reagent.
- Standard phosphate solution.

Sulfuric Acid 5N

Take 70ml concentrated sulfuric acid and dilute up to 500 ml with distilled water.

Stock phosphate solution

Take 1.436 gm of KH_2PO_4 and make 1 liter solution with distilled water

Standard phosphate solutions

10 ppm: take 1 ml of stock solution and dilute up to 100 ml with distilled water.

20 ppm: take 2 ml of stock solution and dilute up to 100 ml with distilled water.

30 ppm: take 3 ml of stock solution and dilute up to 100 ml with distilled water.

Procedure

Add few ml of combined reagent to standards and blue color will appear. Calibrate Spectrophotometer with these standards at visible wavelength of 880nm. Take 20ml of sample and add few ml of combined reagents till blue color appeared. Put distilled water as blank in 1st cell, standard phosphate solution in 2nd cell and water samples in 3rd and 4th cell respectively. Then record the reading at visible wavelength of 880nm.

2.5.15 Sulfates

Sulfates concentration in analyzed sample was determined by Turbidimetric Method, Standard Method (2004). Sulfates bring hardness in water.

Reagents

- Buffer solution
- $BaCl_2$ crystals
- Standard Sulfate solution

Buffer solution

Dissolve 30gm $MgCl_2.6H_2O$, 5gm Sodium acetate ($CH_3COONa.3H_2O$), 1gm KNO_3 and 20ml acetic acid (CH_3COOH – 99%) in 500ml distilled water and dilute up to 1 liter.

$BaCl_2$

20-30 mesh in crystal form.

Standard sulfate solution (100ppm)

Dissolve 0.148gm anhydrous Na_2SO_4 in distilled water and dilute up to 1 liter. Now make different standards from it by following method.

10ppm: take 10ml of 100ppm SO_4^{-2} solution and make 100ml solution with distilled water.

20ppm: take 20ml of 100ppm SO_4^{-2} solution and make 100ml solution with distilled water.

30ppm: take 30ml of 100ppm SO_4^{-2} solution and make 100ml solution with distilled water.

Procedure

Take 100ml from each standard and add 20ml buffer solution. While stirring, add a spoonful of $BaCl_2$ crystals. Put distilled water as blank in 1st cell, standard SO_4^{-2} solution in 2nd and calibrate the spectrophotometer. Now take 100ml sample of water and put 20ml buffer solution in it and after this pour 1 spoonful of $BaCl_2$ crystals. Put the water samples in 3rd and 4th cell of spectrophotometer and note the reading at visible wavelength of 740 nm.

2.5.16 Chlorides

Chloride concentration in analyzed water sample was determined by titration method, (Silver Nitrate), Standard Method (2004).

Reagents

- $AgNO_3$ solution 0.014N
- K_2CrO_4 indicator
- H_2O_2 30%

$AgNO_3$ solution 0.014N

Take 2.395gm of $AgNO_3$ and make 1 liter solution with distilled water.

K_2CrO_4 indicator

Dissolve 50gm K_2CrO_4 in little distilled water. Add $AgNO_3$ solution until a definite red ppt is formed. Let stand for 12 hours, filter and dilute to 1 liter with distilled water.

H_2O_2 30%

Take 30ml H_2O_2 and dissolve in 70 ml of distilled water. Or use already prepared 30% solution.

Procedure

Take $AgNO_3$ in burette and 30ml water sample in Titration flask. Add 1 ml K_2CrO_4 indicator and 1ml H_2O_2 to the water sample. Titrate it against the $AgNO_3$ in burette till the color changes from pale yellow to brick red.

2.5.17 Calcium

Calcium concentration in the analyzed sample was determined by titration method 3500-Ca-D, Standard Method (2004)

Reagents

- NaOH 1N
- Murexide (Ammonium purparate) indicator
- EDTA 0.01M

NaOH 1N

Dissolve 40gm of NaOH in distilled water and make 1 liter solution.

Murexide indicator

Dissolve 150gm dye in 100gm absolute Ethylene Glycol. Mix 200gm murexide with 100 gm solid NaCl.

EDTA 0.01M

Dissolve 3.723gm of disodium salt EDTA in distilled water to prepare 1 liter solution.

Procedure

Take 20ml of sample in titration flask. To this, add 2ml of NaOH and a few drops of Murexide indicator. Titrate this solution against EDTA solution in burette till the pink color changes to purple.

Calcium is calculated by using following formula.

$$(\textbf{Ca mg/l}) = X \times \frac{400.5 \times 1.05}{V}$$

X = volume of titrant (ml)

V = volume of water sample (ml).

Calculating Calcium Hardness

To determine calcium hardness, use the following formula.

$$\textbf{Calcium Hardness } (\mathbf{CaCO_3}\textbf{ mg/l}) = X \times \frac{1000 \times 1.05}{V}$$

X = volume of titrant (ml),

V = volume of water sample (ml)

Calculating Magnesium Hardness

Magnesium hardness can be calculated by subtracting calcium hardness from total hardness because total hardness is the sum of Calcium hardness and Magnesium hardness.

Magnesium hardness (mg/l) = X – C

X = total hardness (mg/l as $CaCO_3$)

C = Calcium hardness (mg/l as $CaCO_3$)

Calculating Magnesium

Magnesium can be calculated from magnesium hardness using following formula.

Magnesium (mg/l) = (X – C) x 0.244

X = total hardness (mg/l as $CaCO_3$)

C = Calcium hardness (mg/l as $CaCO_3$).

2.5.18 Sodium

Sodium concentration in the water sample was determined by 3500-K-D, Flame photometer, Standard Method (2004).

Reagents

- Stock sodium solution (NaCl) (1000 ppm)
- Standard sodium solutions (10, 20, 30ppm)

Stock sodium solution

Dissolve 2.5419gm dried NaCl in distilled water to make 1 liter solution.

Standard sodium solution

Make standard solutions from stock solution

10ppm: take 1ml from stock sodium solution and dilute it up to 100ml with distilled water.

20ppm: take 2ml from stock sodium solution and dilute it up to 100ml with distilled water.

30ppm: take 3ml from stock sodium solution and dilute it up to 100ml with distilled water.

Procedure

Set the filter for readings at sodium. After starting the compressor, light and burner of flame photometer, adjust the gas feeder so as to have a blue sharp flame. Put the standard sodium solution of the highest value in the range and adjust the flame photometer to read full value of emission on the scale. Adjust the zero value of the meter by putting distilled water. Now put different standards sodium solutions i.e. 10, 20, 30ppm one by one and note down the mission value for each standard. Now put water sample in flam photometer and note the readings.

2.5.19 Potassium

Potassium in the water sample was determined by 3500-D, Flame photometer, Standard Method (2004).

Reagents

- Stock potassium solution (1000ppm)
- Standard potassium solutions (10,20,30ppm)

Stock potassium solution

Dissolve 1.9064gm of dried KCl in distilled water to make 1 liter solution. It is 1000ppm potassium solution.

Standard potassium solutions

Make standard solutions from stock potassium solution.

10ppm: take 1ml from stock potassium solution and dilute up to 100ml with distilled water.

20ppm: take 2ml from stock potassium solution and dilute up to 100ml with distilled water.

30ppm: take 3ml from stock potassium solution and dilute up to 100ml with distilled water.

Procedure

Set the filter for readings at Potassium. After starting the compressor, light and burner of flame photometer, adjust the gas feeder so as to have a blue sharp flame. Put the standard potassium solution of the highest value in the range and adjust the flame photometer to read full value of emission on the scale. Adjust the zero value of the meter by putting distilled water. Now put different standards potassium solutions i.e. 10, 20, 30ppm one by one and note down the mission value for each standard. Now put water samples in flam photometer and note the readings.

2.5.20 Phosphorus

The Phosphorus in water samples was determined in Laboratory with the help of "3500-K-D, Flame photometer, Standard Method (2004).

Chapter 3

Results

3.1 General

In district Muzaffarabad, capital of AJ&K, 26 union council (UC) were selected for the analysis of water quality and in them a total of 218 water samples (from source and user end) were collected from 110 water supply schemes (28th Aug to 27th Sep 2008). The number of water supply schemes checked in each UC varied from 1-12. Sample collected were examined for 27 different parameters related to safe drinking water quality, besides they were also compared with WHO and local standards (PSQCA).

Out of 26 Union Councils, only 3 Union Councils, including; Rayyali, Talgran, and Heer Kutli showed all water quality parameters falling within the permissible limits of WHO STD. Most of the samples in U.Cs like Dana, Kiamanja, Komikot, and Tarrian showed high Ca values, turbidity, bad smell and color (Muddy). U.Cs like Lammnian, Jandgran, Heryolla, Charak Pura, Kot Kair, Kathali, were having only one sample each, showing high Ca levels than prescribed limits. A total of 13 U.Cs, showed high turbidity, and 4 U.Cs were having high nitrate level, than prescribed level of WHO. Water samples of all the U.Cs were having bacteriologically contaminated by Coli form and E-coli that are always taken as an important fresh water pollution indicator.

3.1.1 Color, Odor and Taste

Water samples in scheme no(s); 2 (S), 4 (S) and 4 (U) in Danna, 10 (S) in Tarrian, and 7 (S) in Komikot were having muddy color. Scheme no(s): 9 (U) in Kiamanja, 3 (U) in Danna, and 1 (S) and 2 (S) in Heer Kutli, were having odor and objectionable taste in water samples.

3.1.2 Turbidity

The Prescribed limit of turbidity of fresh water is 5 NTU in WHO and 5-25 NTU in PSQCA, STD. In all the water samples collected, the minimum turbidity value was 0.22 and the maximum value was 122, and their average value was 3.77 NTU. The results showed that turbidity of 27 samples were higher than WHO STD. Turbidity of most of the samples i,e 205 was falling between 0-10 (NTU). Water supply scheme no(s) 5 and 9 in Kiamanja, 2, 3 and 4 in Danna, 6 (U), 8 (S) and 10 (S) in Tarrian, 2 (S) and 5 in Langla, 7 (U) in MZD, 1 (U) in Chattar Klass, 1 (U) in Hattia, 2 (S) in Chakhamma, 1 and 4 (U) in Gojra, 1 (U) in Serli Sucha, 2 in Gojar Bandi, and 2 in Komikot were having turbidy values exceeding from WHO.

In U.C, Kiamanja, turbidity increased from 9.00 to 20.4 in scheme no(s) 5, however, it decreased from 8.1 to 3.5, in scheme 9. In U.C Danna, turbidity decreased from 35 to 16.8 in scheme 02, from 9.1 to 8.0 in scheme 03, while it increases from 57 to 122 in scheme 4..In U.C Tarrian, turbidity increased from 0.4 to 5.9 in scheme 6, however, it decreased from 6.7 to 2.9, 63 to 0.4 in schemes 8 and 10 respectively.

3.1.3 Calcium

The prescribed limit of Calcium in fresh water is 75 mg/l in WHO STD. The average value (mg/l) of Ca in water samples of 26 U.Cs was 60.87; however, it varied from 12 to 152 mg/l. Most of the samples were having Ca level falling between 20 to 80 mg/l. Ca values in schemes no(s); 1, 6, 7, 8 (U), 9 (U), 10, and 12 in Danna, 6 in Lammnian, 1 in Jandgran, 1 in Heryolla, 1, and 2 in CharkPura, 1 (S) in Kotkair, 1 in Panjgran, 1 in Panjkot, 3 in Chattar Domail, 2 (S), 4, 5, 6 and 8 (U) in Tarrian, 2 (S) in Kachalli, 1 and 2 in Said pur, 2 and 3 in Gojra, 2 in Serli Sucha, and 3 ,4 (S) and 7 in KomiKot were above the prescribed limits of WHO.

U.Cs which specifically showed high Ca value than prescribed limit was including Danna, Tarrian, and Komikot. There was observed an increase in Ca from source to user end in schemes no (s); 6 (90-94), 8 (70-84), 9 (64-94), and 12 (108-110) in Danna, 4 (90-95), 5 (116-136), 8 (70-82), 3 (108-112) in Komikot. Contrarily scheme no(s); 2 (76-70), and 6 (104-102), in Tarrian and 4 (92-64) and 7 (88-84) in Komikot showed decrease in Ca from source to user end. In scheme no(s); 1 (76), 7 (88), and 12 (102) in Danna, Ca level though were observed higher than prescribed limit but remained constant from source to user end.

3.1.4 Nitrates

WHO limit for nitrate in fresh water is 10 mg/l in WHO STD. Average nitrate concentration in water samples was 2.54 and it varied from 0-19 mg/l. There were only 4 schemes that showed high nitrate level than permissible limit of WHO. Maximum number of water samples i.e. 171 samples in schemes of different U.Cs were having NO_3 concentration between 00 to 04 ppm.

Scheme no(s); 1 (S) in Panjgran, and Panjkot, 2 (U) in Chattar Domail, and Said Pur showed nitrate level higher than WHO limit. Moreover, there was observed an increased in nitrate concentration from 3.1 to 19 and 10 to 11 mg/l in Chattar Domail and Said Pur respectively while in U.C Panjgran Ca value decreased from 13.6 to 2.8 and in Panjkot it decreased from 15.7 to 8.9 mg/l.

3.1.5 Hardness

The prescribed limit for hardness in fresh water in WHO STD is 500 mg/l. Average hardness in all water supply schemes was 207.37; however, minimum value of hardness in water samples was 40 while maximum value was 520 mg/l. Hardness value of most of the samples i, e 179 samples, in different U.Cs were falling in the range of 100-300 mg/l. Hardness value increased only in scheme no 6 (S and U) in Lammnian i, e 515 to 520.

3.1.6 Sulfate

WHO limit for Sulfate concentration in fresh water is 250 mg/l in WHO STD. Average value of Sulfate in all water supply schemes was 14.39, however, sulfate value varied between 0-360 mg/l in all water samples, however sulfate concentration of most of the samples i,e 155 samples, in different U.Cs were falling in the range of 0-40 mg/l. Sulfate concentration increased only in U.C Lammnian in scheme no 6 (S and U) i, e 360 at source and user end.

3.1.7 pH

The prescribed limit of pH in fresh water is 6.5-8.5 in WHO STD. The average pH value in all water samples of different schemes was 7.59. The analyzed samples of drinking water were within permissible limit for pH. The range of pH value in the analyzed water sample was 6.8 to 8.42, however most of the samples i, e 191 samples were falling between 7-8 range of pH. pH of none of the water supply scheme, exceed from WHO limit.

3.1.8 Electric Conductivity

There is (NGV) no guide line value of Electric Conductivity in fresh water in WHO STD but the water having E.C above than 500 µs/cm is not good quality water. Average electrical conductivity of all the water samples of 110 water supply schemes was 438.21, though it varied between 90µs/cm to 1000µs/cm. There are 69 water samples in 16 U.Cs including scheme no(s); 3, 4, and 7 (S) in Komikot, 2 in Serlisucha, 1, 2, 3 in Gojra, 1, and 2 in Said Pur, 2 in kathalli, 5 in Hattian, 2, 3, 4, 5, 6, 7, 8, and 10, in Tarrian, 3 in Chattar Domail, 1 in Panjkot, 1 in Panjgran, 1 and 2 in CharakPura, 1 in Heryolla, 1 in Jandgran, 6 in Lammnian, 3, 5, 6, 7, 8, 9, 10, and 12 in Danna, and 4 in Langer Pura. E.C of most of the sample i.e 54 samples were falling in the rage between 400 to 500.

U.Cs which specifically showed high E.C value than prescribed limit was including Danna, Tarrian, Komikot and Lammnian There was observed an increase in E.C from source to user end in schemes no (s); 3 (600-610), and 4 (550-570) in Komikot, 3 (510-520), and 4 (640-660), in Tarrian and 6 (560-570), 7 (620-630), 8 (530-550) and 12 (860-875) in Danna, while decreased was also observed in these U.Cs in scheme no(s) 2 (580-560), 6 (630-619), and 7 (570-540) in Tarrian and 3 (580-560) in Danna, however scheme no(s) 5, 8, and 10 in Tarrian, 9, and 10 in Danna and 6 in Lammnian as E.C was observed higher but remain constant from source to user end. Scheme no 7 (510) in Komikot and 5 (560) in Danna have no user end.

3.1.9 Alkalinity

There is (NGV) no guide line value for Alkalinity in fresh water in WHO STD. Average value of Alkalinity of all water supplies was 183.76 mg/l, minimum value of alkalinity was 35 mg/l while maximum value was 320 mg/l in all water samples. Most of the samples i, e 128 samples were falling in the range of 100 ppm to 200 mg/l.

3.1.10 Chloride

The prescribed limit for Chloride concentration in fresh water is 250 mg/l in WHO STD. Average Chloride concentration in water supplies was 6.40, however, chloride concentration in water samples varied from 2 mg/l to 53mg/l. Most of the samples i, e 171 samples were falling in between the range of 0-8, and 39 samples in between 8-16. None of the water sample was above the WHO prescribed limit.

3.1.11 Sodium

The prescribed limits for Sodium in fresh water is 200 mg/l in WHO STD. Average Sodium concentration in water supplies was 6.29 mg/l, however, sodium concentration in water samples varied between 0-36 mg/l. Most of the samples i, e 94 samples were falling in the range between 0-5, and 44 samples in the range of 5-10. None of the water sample exceed from WHO limit.

3.1.12 Potassium

The prescribed limits for Potassium is 75mg/l in fresh water in WHO STD. Average Potassium concentration in water supplies was 1.21 mg/l, however, potassium concentration in all water samples, varied between 0 to 5 mg/l. Most of the samples i, e 158 samples were falling in the range of 0 to 2 mg/l. None of the water sample exceed from the prescribed limits of WHO.

3.1.13 Magnesium

WHO limit for magnesium in fresh water is 150 mg/l. Average magnesium concentration in water samples was 13.34; however, minimum concentration of magnesium in all water samples was 2 while maximum concentration was 49 mg/l. Most of the sample i, e 139 samples were falling in the range of 0 to 8 mg/l. None of water sample exceed from WHO limit.

3.1.14 Phosphates

There is (NGV) no guide line value for Phosphate concentration in fresh water in WHO STD. Average value of Phosphate conc in water samples was 0.095 mg/l, and Phosphate concentration in overall water sample varied between 0 to 1.9. Most of the samples i, e 79 samples were falling in between the rage of 1 to 1.5 mg/l.

3.1.15 Total Dissolve Solids

The prescribed limit for TDS in fresh water in WHO STD is 1000 mg/l. Average TDS concentration in water samples was 243.72, however, TDS concentration in all water samples, varied from 47 to 665 mg/l. Most of the sample i, e 65 samples were falling in between the range of 210 to 280 mg/l. None of water sample exceed from WHO limit.

3.1.16 Bi carbonates

There is (NGV) no guide line value for Bicarbonate concentration in fresh water in WHO STD. Average bicarbonate concentration in water samples was 224.28 mg/l, however, bicarbonate value varied in between 43 to 390 mg/l. Most of the samples i, e 54 samples were falling in between the range of 200 to 240 mg/l.

3.1.17 Carbonates

There is (NGV) no guide line value for Carbonate concentration in fresh water in WHO STD. Carbonate value in overall water samples was in between 0 to 10 mg/l, however, average value of Carbonate concentration in water supplies was 0.20 mg/l. Most of the water samples i, e 212 water samples have 00 carbonate value.

3.1.18 Lithium

There is (NGV) no guideline value for Lithium concentration in fresh water in WHO STD. Lithium value found to be 00 in all the water samples analyzed in the lab.

3.1.19 Phosphorus

There is (NGV) no guide line value for Phosphorus concentration in fresh water in WHO STD. Average phosphorus concentration in overall water samples was 0.30 mg/l, while its value varied between 0 to 0.8 mg/l. Most of the water samples i, e 90 water samples were falling in between the range of 0.2 to 0.4 mg/l.

3.1.20 Fluoride

The prescribed value for fluoride concentration in fresh water in WHO STD is 1.5 mg/l. Average fluoride concentration in water samples was 0.092 mg/l; however, its concentration varied between 00 to 0.5 mg/l. Most of the sample i, e 90 samples have 00 fluoride concentration and 94 samples were having fluoride conc in the range between 00-0.2 mg/l.

3.1.21 Iodine

There is (NGV) no guide line value for Iodine concentration for fresh water in WHO STD. Average Iodine concentration in water samples was 0.28 mg/l, however, its concentration varied between 00 to 0.6 mg/l. Most of the samples i, e 142 water samples were falling in between the range of 0.2- 0.4 mg/l.

3.1.22 Arsenic

The prescribed limit for arsenic in fresh water is 10 ppb in WHO STD. Average arsenic concentration in water samples was 1.55 ppb, however, its varied between 00 to 10 ppb. As concentration was falling between 0-5 ppb in most of the water samples i, e 216. Only 3 samples 1 (S and U) in Talgran and 2 (U) in Kiamanja have As conc 10 ppb.

3.1.23 Iron

The prescribed limit for Iron concentration in WHO STD is 0.30 mg/l. Average iron concentration in overall water samples were 0.011 mg/l, however, its value ranged from 0 to 0.36mg/l in water samples. There was only one scheme in Kiamanja (09) that showed high value of Fe (0.36 mg/l at source and 0.31 at user end.) compared to WHO standard. Most of the water samples i, e 184 showed zero Fe concentration. However, 29 samples showed Fe values between 00-0.1 mg/l.

Table 3.1: Physico-chemical characterization of water samples of U.C Komikot

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	420	7.6	234	0.6	180	220	0	205	62	12	9	6	5	1	0	0	4.6	0.04	1.9	0.6	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	430	7.4	237	1.2	185	226	0	210	66	11	9	5	4	1	0	0	3.7	0.1	1.9	0.6	0.4	0	-ve	-ve	Un Obj	+ve	+ve
2-S	480	7.4	264	15.3	190	232	0	230	68	15	8	6	3	1	0	0	5.2	0.0	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-U	470	7.4	258.5	9.4	185	228	0	225	68	16	8	5	3	1	0	0	5.2	0.0	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-S	600	7.8	341	0.0	270	329	0	310	108	10	9	5	4	0	0	0	4.4	0.1	1.5	0.5	0.2	0	-ve	-ve	Un Obj	+ve	+ve
3-U	610	7.8	344	0.0	270	329	0	315	112	9	10	5	4	0	0	0	3.7	0.0	1.1	.36	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-S	550	7.5	313.5	4.5	270	329	0	280	92	12	5	5	4	1	0	0	1.5	0.05	1.8	0.6	0.4	0	-ve	-ve	Un Obj	+ve	+ve
4-U	570	7.6	324.9	0.4	270	329	0	245	64	21	6	5	5	2	0	0	1.3	0.1	0.2	0.1	0.1	0	-ve	-ve	Un Obj	+ve	+ve
5-S	430	7.4	236	1.4	195	238	0	205	50	19	4	3	9	2	0	0	4.3	0.1	1.6	0.5	0.3	5	-ve	-ve	Un Obj	+ve	+ve
5-U	430	7.5	231	1.4	195	238	0	195	50	17	4	0	9	2	0	0	4.2	0.2	1.2	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
6-S	400	7.6	229	0.3	190	232	0	200	60	12	3	5	5	1	0	0	2.0	0.1	0.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-U	400	7.8	229	0.2	190	232	0	205	64	11	3	3	3	1	0	0	2.3	0.2	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
7-S	510	7.5	284	2.3	220	268	0	260	88	10	11	4	4	0	0	2	3.7	0.2	1.1	0.4	0.3	0	Slightly Yellow	-ve	Un Obj	+ve	+ve
7-U	490	7.7	274	0.4	215	262	0	245	84	9	10	4	4	0	0	0	3.6	0.2	1.3	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; At U.C komikot sample no 2(S) are turbid (2.676429) ,and 3, 4(S), and 7(S) , have high Ca value (74) and slightly muddy in color respectively.

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.2: Physico-chemical characterization of water samples of U.C Gojar Bandi

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	500	7.5	282	4.4	230	281	0	230	68	15	3	6	15	2	0	0	1.5	0	0.6	0.2	0.3	5	-ve	-ve	Un Obj	+ve	+ve
1-U	500	7.7	282	5.0	230	281	0	230	68	15	3	6	15	2	0	0	1.5	0	0.6	0.2	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-S	420	7.6	232	8.6	185	226	0	190	54	13	3	7	14	2	0	0	1.3	0	1.3	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-U	440	7.8	255	6.2	190	232	0	200	55	15	4	9	16	3	0	0	0.9	.03	1.4	0.5	0.3	5	-ve	-ve	Un Obj	+ve	+ve

Note; At Gojar Bandi sample no 2 have high turbidity (6.05).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.3: Physico-chemical characterization of water samples of U.C Heer Kutli

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un Obj	Nill in 100ml	Nill in 100ml
1- S	44 0	7.8	25 5	0.4	190	232	0	230	48	27	2	37	0	0	0	0	0.0	0.0	1.3	0.4	0.4	0	-ve	+ve	Objectionable	+ve	+ve
1- U	45 0	7.7	25 6	0.5	190	232	0	230	48	27	2	38	0	0	0	0	0.0	0.0	1.2	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve
2- S	45 0	7.8	25 .4	0.1	185	226	0	230	48	27.0	2	39	0	0	0	0	0.0	0.0	1.4	0.4	0.3	0	-ve	+ve	Objectionable	+ve	+ve
2- U	45 0	7.7	25 2	0.2	185	226	0	230	48	27.0	2	36	0	0	0	0	1.4	0.0	0.6	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Note; At Heer Kutli sample 01 and 02 are both odored and objectionable in taste.

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.4: Physico-chemical characterization of water samples of U.C Serli sucha

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	440	7.7	229	4.2	175	213	0	195	44	21	11	5	11	4	0	0	3.4	0.0	1.6	0.5	0.4	5	-ve	-ve	Un Obj	+ve	+ve
1-U	460	7.7	257	9.3	210	256	0	195	48	18	4	5	22	1	0	0	3.1	0.1	0.7	0.2	0.4	5	-ve	-ve	Un Obj	+ve	+ve
2-S	580	7.2	335	4.0	275	336	0	295	92	16	10	3	7	1	0	0	0.7	0.0	0.9	0.3	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-U	580	7.4	334	3.5	275	336	0	295	90	17	10	3	7	1	0	0	1.0	0.0	1.4	0.5	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Note; At Serli Sucha sample no 01 have high turbudity (5.265), and sample 02 have high Ca value(68.5).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.5: Physico-chemical characterization of water samples of U.C Talgran

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	160	7.8	88	0.5	75	92	0	75	20	6	2	0	4	0	0	0	0.0	0.0	1.4	0.5	0.2	10	-ve	-ve	Un Obj	+ve	+ve
1-U	160	7.6	88	0.5	75	92	0	75	20	6	2	0	4	0	0	0	0.2	0.0	1.3	0.4	0.3	10	-ve	-ve	Un Obj	+ve	+ve
2-S	160	7.6	87	2.3	75	92	0	75	20	6	2	0	3	0	0	0.02	0.0	0.0	1.3	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-U	160	7.7	87	0.6	75	92	0	75	20	6	2	0	3	0	0	0	0.0	0.0	1.4	0.4	0.2	5	-ve	-ve	Un Obj	+ve	+ve

Note; In Talgran all the samples were in range.

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.6: Physico-chemical characterization of water samples of U.C Rayali

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	280	7.7	148	0.7	110	134	0	135	40	8	3	5	4	0	0	0	6.5	0.0	0.9	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
1-U	270	7.5	139	0.6	105	128	0	125	36	8	3	5	4	0	0	0	5.1	0.03	0.8	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-S	250	7.7	134	3.6	105	128	0	120	34	8	2	7	3	0	0	0	1.6	0.0	1.3	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-U	270	7.7	146	2.5	115	140	0	135	36	11	2	7	3	0	0	0	1.7	0.0	1.4	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
3-S	370	7.6	194	0.4	135	165	0	175	52	11	13	7	6	0	0	0	4.0	0.0	1.6	0.5	0.3	5	-ve	-ve	Un Obj	+ve	+ve
3-U	410	7.5	211	1.9	150	183	0	195	62	10	11	7	4	0	0	0	5.1	0.0	1.7	0.5	0.4	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Rayali all the samples were in the range.

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.7: Physico-chemical characterization of water samples of U.C Gojra

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	610	8.3	352	10.6	215	262	10	310	54	42	2	83	8	1	0	0	2.5	0.16	0.8	0.3	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	610	8.4	353	22.4	215	262	10	310	56	41	2	83	7	1	0	0	3.7	0.1	0.6	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-S	730	7.3	422	0.2	280	342	0	390	76	49	2	81	1	1	0	0	3.1	0.5	1.3	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve
2-U	730	7.3	422	0.2	280	342	0	390	78	47	3	79	1	2	0	0	3.8	0.48	1.5	0.5	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-S	730	7.5	416	0.2	280	342	0	380	76	46	2	78	1	2	0	0	2.8	0.5	1.6	0.5	0.2	0	-ve	-ve	Un Obj	+ve	+ve
3-U	730	7.4	421	0.3	280	342	0	390	76	49	2	78	1	2	0	0.01	4.0	0.5	1.7	0.5	0.1	0	-ve	-ve	Un Obj	+ve	+ve
4-S	90	7.0	47	2.1	35	43	0	40	12	2	2	0	3	0	0	0.04	2.2	0.0	1.8	0.5	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	100	7.1	54	18.4	40	49	0	45	14	2	2	0	4	0	0	0.05	2.2	0.1	0.9	0.3	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Gojra sample 01 and sample 04 have high turbidity value (6.79) and sample 02 and 03 have high Ca value(55.25).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.8: Physico-chemical characterization of water samples of U.C Chakhamma

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	430	7.3	245.1	2.3	200	244	0	220	66	13	5	0	7	1	0	0	2.7	0.0	1.3	0.4	0.2	5	-ve	-ve	Un Obj	+ve	+ve
1-U	360	7.5	195	0.8	155	195	0	160	48	10	3	3	10	1	0	0.12	0.7	0.0	1.3	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-S	410	7.3	233	31.2	185	226	0	205	72	6	7	3	4	2	0	0.01	1.7	0.0	1.4	0.5	0.4	0	-ve	-ve	Un Obj	+ve	+ve
2-U	440	7.4	230	5.5	185	226	0	215	60	16	7	0	5	1	0	0.02	3.3	0.0	1.4	0.5	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Chakhamma only sample 02 have high turbidity value(9.94).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.9: Physico-chemical characterization of water samples of U.C Said Pur

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	560	7.4	319.2	0.5	230	281	0	280	96	10	13	4	5	1	0	0	4.1	0.0	1.5	0.5	0.4	0	-ve	-ve	Un Obj	+ve	+ve
1-U	570	7.7	324.9	0.8	230	281	0	290	98	11	13	4	6	1	0	0	4.5	0.1	1.5	0.8	0.6	0	-ve	-ve	Un Obj	+ve	+ve
2-S	860	7.4	469	0.5	285	348	0	425	132	23	46	30	14	1	0	0	10.0	0.0	1.7	0.5	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-U	880	7.4	469	1.0	285	348	0	430	136	22	46	30	12	1	0	0.04	11.0	0.0	1.8	0.6	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Said Pur sample 01 and 02 have high Ca value (115.5)and sample 02 have high NO_3 value(7.4).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.10: Physico-chemical characterization of water samples of U.C Kathalli

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	440	7.5	236	0.5	195	238	0	185	58	10	7	5	9	1	0	0	1.2	0.1	0.3	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
1-U	440	7.6	236	0.4	195	238	0	190	58	11	7	5	9	1	0	0	1.1	0.0	0.5	0.2	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-S	530	7.5	305	0.0	230	281	0	260	96	5	9	3	3	0	0	0	2.2	0.0	0.2	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-U	530	7.8	305	0.2	240	293	0	235	52	25	7	21	17	3	0	0	1.0	0.1	1.3	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Kachalli only sample no 02 have high Ca value(66).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.11: Physico-chemical characterization of water samples of U.C Chattar Klass

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	330	8	175	4.9	140	171	0	145	42	10	6	4	7	1	0	0	0.4	0.0	0.8	0.3	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	330	8.0	173	11.7	140	171	0	145	42	10	6	3	7	1	0	0	0.2	0.0	0.4	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Chattar Klass sample 01 have high turbidity value(8.25).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable .

Table 3.12: Physico-chemical characterization of water samples of U.C Muzaffarabad

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	210	7.7	109	0.6	85	104	0	100	26	8.5	2	3	2	1	0	0	3.1	0.0	0.2	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	190	7.3	102	0.4	75	91	0	90	22	8	3	12	2	0	0	0	0.0	0.0	1.9	0.6	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-S	230	7.7	123	1.0	100	122	0	105	28	8.5	2	4	4	1	0	0	1.0	0.0	0.5	0.2	0.4	5	-ve	-ve	Un Obj	+ve	+ve
2-U	210	7.5	111	0.9	85	104	0	95	28	6	2	10	2	0	0	0.03	0.0	0.15	1.3	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
3-S	380	7.5	212	0.5	175	213	0	190	72	2	3	1	2	0	0	0	2.1	0.0	0.3	0.1	0.4	0	-ve	-ve	Un Obj	+ve	+ve
3-U	390	7.4	212	0.3	165	201	0	200	75	4	3	3	4	2	0	0	0.3	0.0	0.9	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
4-S	260	7.9	136	0.6	110	134	0	125	36	8.5	3	2	2	1	0	0	1.8	0.0	0.3	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	270	7.5	145	2.6	120	146	0	135	32	13	2	3	5	1	0	0	5.8	0.0	0.8	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
5-S	230	7.5	121	0.7	100	122	0	105	32	6	3	0	2	1	0	0	0.9	0.0	0.2	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
5-U	250	7.6	135	1.5	115	140	0	120	34	8	2	0	4	1	0	0.01	0.2	0.0	0.9	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
6-S	260	7.8	143	0.9	115	140	0	115	32	8.5	2	2	5	1	0	0	0.4	0.0	0.5	0.2	0.1	5	-ve	-ve	Un Obj	+ve	+ve
6-U	260	7.7	143	1.3	120	146	0	120	32	10	2	3	5	1	0	0.1	0.1	0.2	1.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
7-S	270	7.5	145	3.3	120	146	0	135	32	13	2	3	6	1	0	0	2.5	0.0	0.3	0.1	0.2	5	-ve	-ve	Un Obj	+ve	+ve
7-U	270	7.5	145	14.2	120	146	0	135	32	13	2	3	6	1	0	0	2.5	0.05	1.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
8-S	260	7.3	143	1.3	120	146	0	120	32	10	2	3	5	1	0	0	0.6	0.0	0.6	0.2	0.2	5	-ve	-ve	Un Obj	+ve	+ve
8-U	250	7.5	136	1.3	120	146	0	115	30	10	2	0	6	0	0	0	0.5	0.0	1.4	0.5	0.3	5	-ve	-ve	Un Obj	+ve	+ve

Note; In MZD only sample no 07 have high turbidity value(1.96).
Abbreviation : E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.13: Physico-chemical characterization of water samples of U.C Langla

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	390	7.4	212	0.3	165	201	0	165	50	10	3	9	13	2	0	0	2.8	0.03	0.9	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
1-U	390	7.7	216	0.4	170	207	0	165	52	9	3	9	14	2	0	0	1.2	0.1	1.2	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-S	360	7.8	202	8.3	160	195	5	155	48	9	4	6	12	1	0	0	3.4	0.01	1.1	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
2-U	400	8.04	213	1.9	165	201	0	160	50	9	4	9	13	2	0	0	3.2	0.02	1.5	0.49	0.3	5	-ve	--ve	Un Obj	+ve	+ve
3-S	350	7.2	199	2.7	165	201	0	175	61	5	2	5	2	1	0	0	0.0	0.0	1.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-U	350	7.1	199	2.1	165	201	0	175	62	5	2	4	2	1	0	0	0.0	0.0	1.5	0.5	0.2	0	-ve	-ve	Un Obj	+ve	+ve
4-S	340	7.5	197	0.9	165	201	0	175	66	2	2	3	1	0	0	0	0.0	0.0	1.7	0.5	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	340	7.7	197	1.4	165	201	0	175	66	2	2	3	1	0	0	0	0.5	0.0	1.6	0.5	0.1	0	-ve	-ve	Un Obj	+ve	+ve
5-S	340	7.0	196	8.8	165	201	0	175	66	2	2	0	1	0	0	0.02	2.5	0.0	1.4	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
5-U	340	7.0	196	8.7	165	201	0	175	66	2	2	0	1	0	0	0	2.3	0.0	1.1	0.3	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Langla sample 02 and 05 have high turbidity value(3.52).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.14: Physico-chemical characterization of water samples of U.C Hattian

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	410	7.2	224	0.4	175	213	0	170	46	13	3	13	15	2	0	0	1.9	0.08	0.4	0.13	0.3	5	-ve	-ve	Un Obj	+ve	+ve
1-U	410	7.1	225	19.9	175	214	0	175	48	13	6	9	17	1	0	0.06	0.4	0.04	1.9	0.6	0.4	5	-ve	-ve	Un Obj	+ve	+ve
2-S	290	8.0	157	4.3	130	159	0	140	36	12	3	4	3	1	0	0	0.8	0.0	0.3	0.1	0.5	0	-ve	-ve	Un Obj	+ve	+ve
2-U	320	8.3	176	0.7	145	177	5	155	40	13	4	0	4	1	0	0	1.0	0.0	1.4	0.4	0.2	5	-ve	-ve	Un Obj	+ve	+ve
3-S	440	7.5	270	0.9	150	183	0	175	46	15	2	71	23	1	0	0	0.6	0.1	0.5	0.2	0.4	5	-ve	-ve	Un Obj	+ve	+ve
3-U	460	7.3	263	1.1	155	189	0	180	48	14	3	56	26	1	0	0.01	0.0	0.1	1.6	0.5	0.2	5	-ve	-ve	Un Obj	+ve	+ve
4-S	290	8.0	159.5	3.4	130	159	0	135	36	11	2	2	3	1	0	0	1.0	0.0	0.6	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	310	7.9	170.5	3.5	150	183	0	140	32	14	2	4	12	3	0	0.1	0.9	0.2	0.3	0.3	0.4	0	-ve	-ve	Un Obj	+ve	+ve
5-S	670	7.9	384	0.9	185	226	0	260	72	19	6	110	35	3	0	0.02	0.9	0.3	1.1	0.3	0.4	5	-ve	-ve	Un Obj	+ve	+ve
5-U	610	7.4	363	0.2	200	244	0	250	64	22	6	97	19	3	0	0	1.6	0.1	0.7	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Hattia Dupata sample 01 have high turbidity(3.52).

Abbreviation;

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.15: Physico-chemical characterization of water samples of U.C Tarrian

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	290	8.0	159.5	0.4	140	171	0	130	40	7	2	0	5	1	0	0	1.4	0.0	0.8	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
1-U	300	7.8	165	2.2	130	159	0	140	38	9	2	0	5	1	0	0	1.0	0.3	0.5	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-S	580	6.9	325	2.1	275	336	0	270	76	19	7	7	9	1	0	0	0.8	0.3	0.2	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-U	560	7.8	309	1.5	265	323	0	245	70	17	6	8	9	1	0	0	1.0	0.3	0.5	0.2	0.4	0	-ve	-ve	Un Obj	+ve	+ve
3-S	510	7.9	284	0.8	240	293	0	235	72	13	4	5	10	1	0	0	0.4	0.2	0.8	0.3	0.2	0	-ve	-ve	Un Obj	+ve	+ve
3-U	520	7.6	293	1.4	245	299	0	240	72	14	4	7	12	1	0	0	0.5	0.3	0.5	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-S	640	7.4	343	1.1	280	342	0	285	90	15	14	5	6	1	0	0	3.0	0.2	0.9	0.3	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	660	7.5	378	0.5	290	354	0	300	95	18	16	6	5	1	0	0	1.9	0.2	0.6	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
5-S	810	7.5	414	0.8	310	378	0	360	116	17	26	8	7	2	0	0	7.2	0.2	1.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
5-U	810	7.2	430	1.4	320	390	0	365	136	6	26	7	7	2	0	0	7.8	0.3	0.5	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-S	630	7.3	341	0.4	290	354	0	305	104	11	6	0	4	0	0	0	0.3	0.3	0.2	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-U	610	7.3	338	5.9	285	348	0	300	102	11	6	0	5	1	0	0	0.8	0.2	0.9	0.3	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Table 3.15: Physico-chemical characterization of water samples of U.C Tarrian (Continued previous Table)

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
7-S	570	7.7	324.9	0.8	230	281	0	245	70	17	13	4	6	1	0	0	3.3	0.2	0.2	0.1	0.4	0	-ve	-ve	Un Obj	+ve	+ve
7-U	540	7.6	307.8	0.7	220	268	0	235	64	18	12	3	6	1	0	0	2.5	0.3	0.4	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
8-S	540	7.6	307.8	6.7	250	305	0	250	70	18	7	10	4	1	0	0.01	2.0	0.2	0.1	0.0	0.5	0	-ve	-ve	Un Obj	+ve	+ve
8-U	540	8.0	307.8	2.9	245	299	0	250	82	11	7	9	4	1	0	0	2.2	0.2	0.7	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
9-S	480	7.8	248	1.9	200	244	0	225	64	16	9	4	3	1	0	0	1.9	0.3	0.1	0.0	0.3	0	-ve	-ve	Un Obj	+ve	+ve
9-U	480	7.8	247	1.0	200	244	0	225	62	17	9	4	3	1	0	0	2.3	0.2	0.6	0.2	0.4	0	-ve	-ve	Un Obj	+ve	+ve
10-S	540	7.7	281	63.0	230	281	0	245	68	18	9	8	4	1	0	0.21	2.1	0.0	0	0.0	0.2	0	Muddy	-ve	Un Obj	+ve	+ve
10-U	540	7.2	289	0.4	240	293	0	245	70	17	8	8	4	1	0	0	2.1	0.0	0.6	0.2	0.4	0	-ve	-ve	Un Obj	+ve	+ve

Note; Tarrian 02, 04, 05,06, 08 have high Ca level , 06 have both high level of Ca and turbidity, 08 was turbid, and have high Ca while 10 was both Turbid and Muddy. Total Calcium mean was (78.05) while turbidity mean was (4.79).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.16: Physico-chemical characterization of water samples of U.C Chattar Domail

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	410	7.6	233	3.9	200	244	0	205	56	16	3	3	4	1	0	0	1.7	0.2	0.2	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
1-U	480	7.1	282	0.4	235	287	0	245	72	16	6	6	5	1	0	0	1.5	0.0	1.8	0.6	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-S	420	7.6	235.2	1.6	195	238	0	210	64	12	7	5	4	1	0	0	3.1	0.2	0.7	0.2	0.4	0	-ve	-ve	Un Obj	+ve	+ve
2-U	420	7.3	235.2	2.0	195	238	0	195	60	11	6	5	6	1	0	0	19.0	0.02	1.9	0.6	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-S	570	8.1	315	2.5	235	287	0	280	92	12	14	7	8	0	0	0	5.6	0.2	1	0.3	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-U	560	7.3	304	1.5	255	311	0	245	76	13	9	7	6	1	0	0.1	0.3	0.0	0.9	0.3	0.6	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Chattar Domail sample 02 have high NO_3 (5.2)while sample 03 were having high Ca value (70).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.17: Physico-chemical characterization of water samples of U.C Panjkot

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	860	7.6	490.2	0.3	250	305	0	365	120	16	45	35	14	1	0	0	15.7	0.2	1.6	0.5	0.3	0	-ve	-ve	Un Obj	+ve	+ve
1-U	870	7.4	495.9	0.1	255	310	0	370	122	17	45	36	15	1	0	0.01	8.9	0.07	1.4	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Panjkot Only sample were having both high Ca(121) and high NO_3 value(12.3).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.18: Physico-chemical characterization of water samples of U.C Panjgran

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	720	7.6	410.4	0.3	200	244	0	335	110	15	53	29	13	1	0	0	13.6	0.3	0.8	0.3	0.3	5	-ve	-ve	Un Obj	+ve	+ve
1-U	730	7.5	416.1	0.5	280	342	0	380	76	46	2	78	1	2	0	0	2.8	0.5	1.6	0.5	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-S	420	7.7	231	5.3	180	220	0	185	50	15	4	8	12	2	0	0	6.2	0.02	1.6	0.5	0.4	5	-ve	-ve	Un Obj	+ve	+ve
2-U	420	7.6	233	2.8	180	220	0	185	50	15	4	9	12	2	0	0	6.4	0.0	1.9	0.6	0.3	5	-ve	-ve	Un Obj	+ve	+ve

Note; In Panjgran sample 01 have both high Ca(71.5) and high NO_3 value(7.25).

Abbreviation :
E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.19: Physico-chemical characterization of water samples of U.C Kotkair

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	440	7.6	261	0.9	215	262	0	230	82	6	3	7	1	1	0	0	1.1	0.0	1.1	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
1-U	440	7.2	259	1.4	215	262	0	230	72	12	3	5	3	1	0	0	2.8	0.0	1.1	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Kotkair only sample have only high Ca value (77).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.20: Physico-chemical characterization of water samples of U.C Charakpura

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	610	7.1	347.7	3.0	310	378	0	320	118	6	6	0	3	0	0	0	1.3	0.1	0.8	0.3	0.4	0	-ve	-ve	Un Obj	+ve	+ve
2-S	660	7.5	378	0.5	290	354	0	345	122	10	11	5	4	1	0	0	9.6	0.05	0.7	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-U	665	7.7	380	0.3	290	354	0	350	124	10	13	4	4	1	0	0	7.9	0.04	1.1	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Charak Pura both sample have high Ca value (120).

Abbreviation :
E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.21: Physico-chemical characterization of water samples of U.C Heryola

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	530	7.5	283	0.5	220	268	0	260	86	11	9	5	4	1	0	0	3.3	0.2	0.6	0.2	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	530	7.5	282	0.5	220	268	0	260	86	11	9	4	4	1	0	0	3.5	0.2	0.5	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Heryola only sample have only high value of Ca (86).

Abbreviation ;

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.22: Physico-chemical characterization of water samples of U.C Jandgran

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	560	7.2	296	0.1	245	299	0	245	80	11	9	4	5	2	0	0	2.5	0.2	0.3	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
1-U	560	7.3	304	1.5	255	311	0	245	76	13	9	7	6	1	0	0.02	2.4	0.2	0.4	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-S	370	7.3	208	1.4	165	201	0	185	56	11	3	5	5	1	0	0	4.1	0.0	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-U	370	7.5	209	1.0	165	201	0	180	58	9	3	4	6	2	0	0	4.3	0.0	1.1	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Jandgran sample 01 have only high value of Ca (67.5).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.23: Physico-chemical characterization of water samples of U.C Lammnian

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	310	7.3	173	1.2	140	171	0	155	40	13	3	5	5	1	0	0	1.8	0.0	0.9	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	310	7.4	172	3.5	140	171	0	150	44	10	3	4	5	1	0	0	1.2	0.0	1.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-S	440	7.2	249	0.1	205	250	0	220	68	10	4	3	8	1	0	0	2.4	0.0	0.9	0.3	0.5	0	-ve	-ve	Un Obj	+ve	+ve
2-U	460	7.4	240	1.8	180	220	0	215	70	10	9	5	2	5	0	0	4.4	0.0	0.5	0.16	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-S	310	7.4	181	1.1	150	183	0	160	50	9	2	4	3	0	0	0	1.8	0.0	1.5	0.5	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-U	320	7.9	186	1.9	155	189	0	165	56	6	4	0	2	1	0	0	1.4	0.0	0.9	0.3	0.2	0	-ve	-ve	Un Obj	+ve	+ve
4-S	370	7.6	215	0.0	130	159	0	170	52	10	2	46	4	1	0	0	2.7	0.0	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	380	7.6	224	0.0	135	165	0	180	54	11	2	46	4	1	0	0	4.0	0.0	1.2	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve
5-S	170	7.7	105	1.1	35	43	0	120	26	2	2	43	3	2	0	0	1.2	0.2	1.3	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
5-U	180	7.5	113	1.1	40	49	0	120	28	2	2	45	3	2	0	0	1.0	0.1	1.5	0.2	0.4	0	-ve	-ve	Un Obj	+ve	+ve
6-S	1000	7.5	664	1.0	140	171	0	515	152	33	3	360	4	5	0	0	2.3	0.4	1.4	0.6	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-U	1000	7.5	665	0.0	140	171	0	520	152	34	3	360	4	5	0	0	3.0	0.4	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
7-S	420	7.4	242	0.5	200	244	0	215	64	13	3	6	5	1	0	0	0.9	0.0	1.4	0.6	0.3	5	-ve	-ve	Un Obj	+ve	+ve
7-U	420	7.5	221	1.0	190	232	0	185	46	17	4	0	8	2	0	0	2.6	0.1	1.2	0.39	0.1	5	-ve	-ve	Un Obj	+ve	+ve

Note; In Lammnian sample 06 have high value of Hardness (220.71), Ca (64.42) and Sulfate (66.21) and comparatively high E.C as there is no guide line value for E.C(435).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.24: Physico-chemical characterization of water samples of U.C Danna

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	490	7.8	266	0.1	210	256	0	225	76	9	9	6	7	1	0	0	2.1	0.2	1.2	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	490	8.1	267	0.1	210	256	0	230	76	10	9	5	7	1	0	0	2.6	0.2	0.9	0.3	0.1	0	-ve	-ve	Un Obj	+ve	+ve
2-S	360	8.1	185	35.0	155	189	0	155	46	11	6	0	3	1	0	0	2.6	0.2	0.5	0.2	0.2	0	Muddy	-ve	Un Obj	+ve	+ve
2-U	330	7.9	173	16.8	145	177	0	150	44	10	6	0	3	1	0	0	0.8	0.2	1.1	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve
3-S	580	7.9	324.8	9.1	255	311	0	250	70	18	8	7	6	4	0	0	1.4	0.1	0.6	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
3-U	560	7.6	313.6	8.0	230	281	0	230	64	17	7	6	6	4	0	0	2.6	0.1	0.2	0.1	0.2	0	-ve	Bad Smell	Objectionable	+ve	+ve
4-S	380	7.8	216	57.0	185	226	0	195	56	13	4	0	4	1	0	0.03	0.1	0.1	1.1	0.4	0.2	0	Muddy	-ve	Un Obj	+ve	+ve
4-U	380	7.8	216	122.0	185	226	0	195	54	15	4	0	4	1	0	0.04	0.0	0.1	0.3	0.1	0	0	Muddy	-ve	Un Obj	+ve	+ve
5-S	560	7.9	318	1.2	250	305	0	200	48	20	5	20	36	2	0	0	1.1	0.3	0.7	0.2	0.2	0	-ve	-ve	Un Obj	+ve	+ve
6-S	560	7.4	306	1.4	245	299	0	280	90	13	13	0	4	1	0	0	3.0	0.2	1.1	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve
6-U	570	7.7	312	0.2	250	305	0	280	94	11	13	0	4	1	0	0	3.0	0.2	0.4	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
7-S	620	7.6	344	1.4	300	366	0	280	88	15	6	5	5	1	0	0	0.6	0.1	0.9	0.3	0.1	0	-ve	-ve	Un Obj	+ve	+ve
7-U	630	7.6	365	0.5	280	342	0	280	88	15	6	4	4	1	0	0	0.0	0.1	0.6	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Table 3.24: Physico-chemical characterization of water samples of U.C Danna(Continued previous table)

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
8-S	530	7.7	268	0.9	210	256	0	230	70	13	13	6	5	1	0	0	3.1	0.1	0.4	0.1	0	0	-ve	-ve	Un Obj	+ve	+ve
8-U	550	7.9	292	0.6	230	281	0	250	84	10	13	5	5	1	0	0	2.6	0.1	0.4	0.1	0	0	-ve	-ve	Un Obj	+ve	+ve
9-S	570	7.6	305	0.4	270	329	0	245	64	21	6	5	5	2	0	0	1.3	0.1	0.2	0.1	0.1	0	-ve	-ve	Un Obj	+ve	+ve
9-U	570	7.7	312	0.2	250	305	0	280	94	11	13	0	4	1	0	0	3.0	0.2	0.4	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
10-S	570	7.4	328	0.3	280	342	0	300	102	11	3	0	2	0	0	0	1.3	0.02	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
10-U	570	7.2	328	2.0	280	342	0	300	102	11	3	0	2	0	0	0	1.3	0.02	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
11-S	160	7.2	93	3.1	45	55	0	75	24	4	2	27	1	1	0	0.3	0.4	0.0	1.5	0.5	0.4	0	-ve	-ve	Un Obj	+ve	+ve
11-U	160	7.2	93	2.0	45	55	0	75	24	4	2	27	1	1	0	0.03	0.9	0.0	0.9	0.3	0.1	0	-ve	-ve	Un Obj	+ve	+ve
12-S	860	7.5	430	0.2	300	366	0	365	108	23	38	12	16	1	0	0.01	8.9	0.07	1.4	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve
12-U	875	7.4	437	0.1	305	370	0	370	110	25	38	12	16	1	0	0.01	8.9	0.07	1.4	0.4	0.4	0	-ve	-ve	Un Obj	+ve	+ve

Note; At Danna 01, 06, 07, 08, 09, 10, 12 have high Ca,02, and 04 were Turbid and Muddy, 33AU, 34AS were Turbid, and 03 were Turbid ,bad smell and objectionable in Taste total calcium mean was (72.86) and turbidity mean was (11.40).

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.25: Physico-chemical characterization of water samples of U.C Langerpura

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	240	7.8	124	1.8	100	122	0	110	30	9	2	5	1	1	0	0	1.2	0.12	0.1	0	0.2	0	-ve	-ve	Un Obj	+ve	+ve
1-U	240	7.6	124	1.3	100	122	0	110	30	9	2	5	1	1	0	0	1.2	0.12	0.1	0	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-S	300	7.8	157	2.2	130	159	0	140	36	12	2	4	3	1	0	0.01	1.7	0.1	0.4	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
2-U	290	7.7	157	3.3	130	159	0	140	48	5	2	0	3	1	0	0	1.2	0.1	0.2	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
3-S	440	7.4	227	1.4	190	232	0	190	48	17	6	0	9	2	0	0	3.1	0.2	0.8	0.3	0.4	5	-ve	-ve	Un Obj	+ve	+ve
3-U	430	7.4	225	2.8	190	232	0	185	48	16	6	0	9	2	0	0	2.4	0.1	0.5	0.2	0.3	5	-ve	-ve	Un Obj	+ve	+ve
4-S	510	7.5	303	0.3	205	250	0	230	70	13	4	50	11	2	0	0	1.2	0.3	0.2	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
4-U	520	7.5	320	1.3	210	256	0	255	72	18	5	56	11	1	0	0	1.0	0.02	1.1	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
5-S	350	7.6	201	0.5	160	195	0	170	56	7	5	5	5	2	0	0.01	1.8	0.2	0.6	0.2	0.1	0	-ve	-ve	Un Obj	+ve	+ve
5-U	370	7.6	215	0.0	130	159	0	170	52	10	2	46	4	1	0	0	2.7	0.0	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-S	420	7.3	231	7.0	195	238	0	195	60	11	6	5	6	1	0	0.01	0.2	0.1	0.3	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-U	420	7.9	231	1.6	195	238	0	210	64	12	7	5	4	1	0	0	3.1	0.2	0.7	0.2	0.4	0	-ve	-ve	Un Obj	+ve	+ve
7-S	400	7.5	226	1.3	175	214	0	170	42	16	4	13	18	1	0	0.01	1.6	0.0	1.6	0.5	0.5	5	-ve	-ve	Un Obj	+ve	+ve
7-U	450	7.5	245	0.2	190	232	0	205	66	10	7	8	7	3	0	0	2.8	0.0	1.1	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve

Table 3.25: Physico-chemical characterization of water samples of U.C Langerpura(Continued previous table)

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
8-S	380	6.8	210	0.3	180	220	0	160	40	14	3	0	17	1	0	0	0.4	0.04	1.7	0.5	0.3	5	-ve	-ve	Un Obj	+ve	+ve
8-U	370	6.8	209	0.3	180	220	0	160	40	14	2	0	17	1	0	0	0.4	0.04	1.3	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
9-S	290	7.6	165	0.4	125	152	0	140	40	10	2	16	3	1	0	0	0.6	0.0	0.5	0.2	0.3	0	-ve	-ve	Un Obj	+ve	+ve
9-U	270	7.9	151	3.9	125	152	0	130	34	11	3	5	4	1	0	0	0.4	0.0	0.9	0.3	0.4	0	-ve	-ve	Un Obj	+ve	+ve
10-S	300	7.6	169	0.4	125	152	0	140	40	10	3	17	4	1	0	0	0.8	0.0	0.6	0.2	0.3	5	-ve	-ve	Un Obj	+ve	+ve
10-U	340	7.1	192	0.9	135	165	0	145	39	11	2	22	15	1	0	0	1.0	0.05	1.9	0.6	0.3	5	-ve	-ve	Un Obj	+ve	+ve

Note; In Langer Pura all the samples were in Permissible range of WHO.

Abbreviation :

E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Table 3.26: Physico-chemical characterization of water samples of U.C Kiamanja

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
1-S	460	8.1	240	1.8	180	220	0	215	70	10	9	5	2	5	0	0	4.4	0.0	0.5	0.16	0.3	0	-ve	-ve	Un Obj	+ve	+ve
1-U	480	7.8	259	1.5	200	244	0	245	72	16	6	5	2	4	0	0	5.3	0.0	0.8	0.26	0.3	0	-ve	-ve	Un Obj	+ve	+ve
2-S	420	7.5	221	1.6	190	232	0	185	46	17	4	0	8	2	0	0	2.6	0.1	1.2	0.39	0.1	5	-ve	-ve	Un Obj	+ve	+ve
2-U	440	7.3	244	1.2	200	244	0	215	50	21	9	0	9	2	0	0	3.8	0.00	0.9	0.4	0.3	10	-ve	-ve	Un Obj	+ve	+ve
3-S	270	8.4	138	1.7	110	134	5	125	28	13	2	5	4	1	0	0	3.0	0.17	0	0.0	0.2	0	-ve	-ve	Un Obj	+ve	+ve
3-U	270	8.4	136	1.4	110	134	5	115	30	10	2	4	4	1	0	0	2.9	0.2	0.8	0.26	0.1	0	-ve	-ve	Un Obj	+ve	+ve
4-S	280	8.2	151	1.1	120	147	0	140	30	16	3	4	4	1	0	0	3.1	0.02	1.1	0.4	0.3	5	-ve	-ve	Un Obj	+ve	+ve
4-U	280	8.1	150	1.5	120	147	0	140	30	16	3	5	3	1	0	0	2.8	0.00	1.5	0	0.4	5	-ve	-ve	Un Obj	+ve	+ve
5-S	280	7.9	154	9.0	125	153	0	140	30	16	3	4	4	1	0	0	3.1	0.02	1.5	0.5	0.2	5	-ve	-ve	Un Obj	+ve	+ve
5-U	300	7.2	170	20.4	145	177	0	150	48	7	2	0	2	1	0	0	1.8	0.0	1.2	0.4	0.3	0	-ve	-ve	Un Obj	+ve	+ve
6-S	470	8.2	246	2.9	190	232	0	215	72	9	6	6	2	5	0	0	4.5	0.0	0.6	0.2	0.2	0	-ve	-ve	Un Obj	+ve	+ve
6-U	480	7.9	261	1.0	200	244	0	240	74	13	7	5	3	5	0	0	5.3	0.0	0.9	0.4	0.2	0	-ve	-ve	Un Obj	+ve	+ve
7-S	270	8.4	148.5	2.2	105	128	5	125	30	12	5	6	4	1	0	0	2.8	0.2	0.5	0.2	0.2	0	-ve	-ve	Un Obj	+ve	+ve
7-U	280	8.1	150	1.5	120	147	0	140	30	16	3	5	3	1	0	0	2.8	0.00	1.5	0	0.4	5	-ve	-ve	Un Obj	+ve	+ve

Table 3.26: Physico-chemical characterization of water samples of U.C Kiamanja(Continued previous table)

Sample No	E.C	pH	TDS	Turbidity	Alkalanity	HCO_3	CO_3	Hardness	Ca	Mg	Cl	SO_4	Na	K	LI	Fe	NO_3	F	PO_4	P	I	As	Colour	Odour	Taste	Coli form	E-Coli
W.H.O STD	NGV	6.5-8.5	1000 mg/l	5 NTU	NGV	NGV	NGV	500 mg/l	75 mg/l	150 mg/l	250 mg/l	250 mg/l	200 mg/l	75 mg/l	NGV	0.30 mg/l	10 mg/l	1.5 mg/l	NGV	NGV	NGV	10ppb	Colorless	Odorless	Un-Obj	Nill in 100ml	Nill in 100ml
8-S	280	8.2	146	2.8	115	140	0	130	42	6	3	4	2	1	0	0	3.1	0.2	0.4	0.1	0.1	0	-ve	-ve	Un Obj	+ve	+ve
8-U	290	7.7	157	3.3	130	159	0	140	48	5	2	0	3	1	0	0	1.2	0.1	0.2	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
9-S	300	8.1	165	8.1	140	171	0	130	30	13	2	5	12	2	0	0.36	2.5	0.3	0.4	0.1	0.2	5	-ve	-ve	Un Obj	+ve	+ve
9-U	310	7.9	170.5	3.5	150	183	0	140	32	14	2	4	14	3	0	0.31	1.7	0.1	1.6	0.5	0.4	5	-ve	Odorous	Objectionable	+ve	+ve
10-S	320	7.9	176	1.5	140	171	0	155	46	10	2	5	5	1	0	0	2.3	0.3	0.4	0.1	0.2	0	-ve	-ve	Un Obj	+ve	+ve
10-U	360	7.6	195	0.9	160	195	0	155	48	9	3	3	10	1	0	0	2.6	0.0	0.9	0.3	0	5	-ve	-ve	Un Obj	+ve	+ve
11-S	280	8.2	151	1.3	125	153	0	130	40	7	2	0	5	1	0	0	2.3	0.1	0.2	0.1	0.3	5	-ve	-ve	Un Obj	+ve	+ve
11-U	290	8.0	158	0.2	135	165	0	135	38	10	2	0	5	1	0	0	1.7	0.0	0.7	0.2	0.3	5	-ve	-ve	Un Obj	+ve	+ve
12-S	350	7.7	192	1.0	155	189	0	160	44	12	3	5	9	1	0	0	3.1	0.2	0.4	0.1	0.4	5	-ve	-ve	Un Obj	+ve	+ve
12-U	330	7.4	174	4.7	150	183	0	160	48	10	2	0	2	0	0	0.02	0.2	0.2	0.4	0.1	0.3	0	-ve	-ve	Un Obj	+ve	+ve

Note; In Kiamanja sample no 05 and 09 were turbid (3.16) and 09 was also having high Fe (0.028) and bad odor and objectionable in taste.

Abbreviation :
E.C=Electric Conductivity, pH=Power of Hydrogen, TDS=Total Dissolved Solid, Ca=Calcium, Mg=Magnesium, Cl=Chloride, SO_4=Sulfate, Na=Sodium, K =Potassium, Li=Lithium, Fe=Iron, NO_3=Nitrate, F =Fluoride, PO_4=Phosphate, P =Phosphorus, I =Iodine, As=Arsenic, STD = Standard, -ve=Negative, +ve=Positive, Un Obj=Un Objectionable

Chapter 4

Discussion

Currently, the world is facing a serious problem of climatic change. This change is largely due to rise in human race and its associated activities. For the satisfaction of need, human population has not only put a great stress on the natural resources but also deteriorated the overall environment and his owns life. Modern science and technology play a vital role in fulfilling the demands of human, yet has failed to control the impact caused by human beings on natural resources like water, soil and air.

Pakistan being a developing nation, has threatened by serious environmental problem due to continuous rise in population and poor management of natural resources like land, water, and air. Northern areas of Pakistan are rich in natural resources. However, global trend in climatic change and local exploitation of the natural resources of these areas are really threatening aquatic and terrestrial environment. A major catastrophe occurred in these areas specifically by Earthquake in AJ&K, in October 2005 that has brought a big change in the landscape and associated freshwater resources of these areas. Besides, it has inflicted a great loss of life in the form of humans, animals and plants. So, present study was planned in this perspective to evaluate the quality of freshwater resource of district MZD, capital of Azad Jammu and Kashmir, Pakistan.

Water is an important indicator to predict the health of an area. So, finding the water profile of an area tells the story of prevailing natural and artificial condition and inhabitants of the area. A detailed physico-chemical characterization of water from 110 water schemes (from source to user end) in 26 UCs of district MZD showed varying conditions. Results showed that most of the water supplies were not facing any serious threats in form of chemical agents. Nevertheless, certain water schemes of different U.Cs were specifically indicated pollution load of single to multiple water quality parameters (E.C, turbidity and Ca) exceeding the desire limits of WHO.

Ground and surface water can be contaminated naturally or because of numerous types of human activities including residential, commercial, industrial, and agricultural (U.S. E.P.A, 1986). Presence of biological agents such as fecal coliform bacteria, members of the family *Enterobacteriacae*, include *Escherichia coli, Citrobacter, Enterobacter* and *Klebsiella* and other species are consider very unhygienic, specially, when water containing such organisms is used for drinking purposes. Coliforms are relatively easy to identify, and are usually present in larger numbers than more dangerous pathogens. *E. coli* as being the member of coliform bacteria is always taken as indicator of fecal pollution in water. When a stream is polluted by fecal material, pathogenic bacteria, viruses, and parasites may be introduced, posing a health hazard to those who come in contact with the water, in the form of diseases like typhoid fever, hepatitis, gastroenteritis, dysentery, and ear infections in human beings. Municipal and rural water supplies can transmit human diseases such as cholera (*Vibrio cholerae*), typhoid fever (*Salmonella typhi*), shigellosis (*Shigella*), salmonellosis (*Salmonella)*, and gastroenteritis (*Campylobacter jejuni, Escherichia coli, Giardia lamblia*). The threat of such disease transmission becomes more plausible as the population density of human increases, resulting contamination of public water supplies, through sewage. (http://www.freedrinkingwater.com/water_quality/quality1/1-how-coliform-bacteria-affect-water-quality.htm).

Results of present study positively indicated the presence of fecal coli form especially in the form of *E. coli* in water samples of all the supplies schemes (from source to user end). However, bacterial count was not found in each sample along with identification of other pathogenic species and these are the two major drawbacks in current work and that needs to be assessed in future. Bacterial dose in water can really tell us that which scheme is good or bad and at what spot (source, in-line, storage tank or at user end) the water in a scheme is being polluted through time and what could be associated reasons. Presence of bacterial pollutions as coliform clearly suggests that all the water sources whether ponds, lakes or streams were affected by human or animal's feces.

Groundwater is the source of drinking water for lots of people around the world, especially in rural areas. In AJ&K, water is often carried out from source to consumers end through communal water source, such as storage tanks and water connection pipes. The storage of water for hours or even days allows the possibility of fecal contamination inside the household. (Jenson et al., 2002). However, at some places where still pipes were not installed, women often have to walk for hours to get the daily water ration for a family, from sources, in their utensils. While in some places water is provided only at certain time intervals during the day. Although connected to a supply system, the user has to store water to have a sufficient amount of water available during the non-supply periods. Water storage is therefore a necessity both for those who are connected to a non-continuous water supply system and those who depend on drinking water sources located outside the household perimeter.

The key reasons of pollution in dist MZD is un-fortification of sources as it was also observed in the study area that none of the source was protected in the whole dist. Generally, washing (clothes), and bathing activities take place at sources. Rain water leaches the feces of animals and humans to sources and mix up their, resulting in accumulation of certain bacteria including pathogenic infections. Moreover, the handlings of water collection, from storage to consumer end, can contribute significant contaminants in water. Considering all factors, fecal incorporation in water from animals sources are the major reason of water microbiology (Mintz et al.,1995). Children are another cause of contamination when they put their fecaly contaminated hands or utensils into the household water container. This domestic pathway of pathogen contamination of the household drinking water is independent of pollution at the source (Cairncross et al., 1996).

Kashmir is basically located in the northern side of Pakistan having low to high rise mountains. This region is further categorized into mountainous ranges having different mineral in the form of limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. As a result of geological variation and water rock interactions, varying concentrations of different chemicals may become part of flowing water source. Generally, the water supply schemes in Kashmir including MZD have been chiefly crafted from natural springs and lakes. So considering the variation in water chemistry through time and space, water supplies schemes of different UCs, were examined for parameters viz E.C, pH, TDS, turbidity, alklanity, HCO_3, CO_3, hardness, Ca, Mg, Cl^-, SO_4, Na, K, Li, Fe, PO_4, P, I, and As. The results of most of the parameters including pH, TDS, alklanity, HCO_3, CO_3, Mg, Cl, Na, K, Li, F, PO_4, P, I, and As were falling within permissible limits of water, although some variation or high value of some parameters were found at some instances.

U.Cs including; Rayali, Talgran, and Heer Kutli showed all water quality parameters falling within the permissible limits set by WHO. However, these U.Cs did show increase in values of certain parameters like E.C, TDS, turbidity, Ca, nitrate, hardness, bicarbonate, phosphate, sulfate, and phosphorus from source to user end. Most of the samples in U.Cs like Danna (10) samples, Kiamanja (3), Komikot (4), and in Tarrian (8), showed high Ca, turbidity, besides, they were giving off bad smell and are muddy in color. Calcium is largely responsible for water hardness, and may negatively influence toxicity of other compounds. Moreover it also functions as a pH stabilizer, due to its buffering abilities. Large intake of calcium can have negative influence on human health. Metallic calcium corrodes the skin when it comes in contact with skin, eyes and mucous membranes. Turbidity influences the cloudiness of the water, caused by different particles.

Suspended particles in water absorb heat from the sunlight and make it warmer. Turbidity also results in reducing the concentration of oxygen in the water. Suspended particles in water scatter the sun light, thus decreasing the photosynthetic activity, inhibiting growth of submerged aquatic plants and associated animals. Urbanization and associated construction activities contribute a large amount of turbidity and sedimentation in water bodies specifically during rain and storm water runoff. Contaminants like viruses or bacteria may be attached to the suspended solids, and they become safe from disinfectants like chlorine and ultraviolet (UV) radiations. So, high turbidity levels in water, in other words, can indirectly support the spread of infectious diseases to human and other vertebrates (http://www.lenntech.com/turbidity.htm).

Out of 26 U.Cs, 27 samples were having high turbidity levels than permissible limits of WHO. Scheme no(s); 5 (9.0-20.4) and 9 (8.1-3.5) in Kiamanja, 6 (0.4-5.9), 8 (6.7-2.9), and 10 (63-0.4) in Tarrian, 2 (8.3-1.9), and 5 (8.8-8.7) in Langla, 7 (3.3-14.2) in MZD, 1 (4.3-11.7) in Chattar Klass, 1 (0.4-19.9) in Hattian, 2 (31.2-5.5) in Chakhamma, 1 (10.6-22.4) and 5 (2.1-18.4) in Gojra, 1 (4.2-9.3) in Serlisucha, 2 (8.6-6.2) in Gojar Bandi, and 2 (15.3-9.4) in Komikot, showed high turbidity level at source and user ends. High turbidity and nitrate levels in water are normally linked to: run off and seepage of chemical from fertilized used land, farming practices, disposal of municipal waste water, solid waste disposal practice and erosion (Nebbache et al., 2001). All these factors exaggerate during rainy season and was also noticed in current study, as sampling was carried out during the month of August/September. Similarly nitrate level also elevated in petty wells, burrowed on farmed area, and in springs (Gelberg et al., 1999; Knobeloch et al., 2000; Gatseva et al., 2000).

Normally high nitrate in water may lead to some problems related to human beings; nevertheless, high nitrate is always useful to biotic productivity of fresh water sources. Scheme no(s); 1 (13.6-2.8) in Panjgran, 1 (15.7-8.9) in Panjkot, 2 (3.1-19) in Chattar Domail, and 2 (10-11) in Said Pur showed high values of nitrates. Nitrate does not normally cause health problems unless it reduced to nitrite (NO_2) by a chemical process called reduction. (http://pmep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.html). Nitrate is one of the most common groundwater contaminants in rural areas. It is regulated in drinking water primarily because its excess levels can cause methemoglobinemia, or "blue baby" disease. Although, nitrate levels that affect infants, do not pose a direct threat to older children and adults. Nitrates can be reduced to toxic nitrites in the human intestine, and many babies have been seriously poisoned by well water containing high levels of nitrate (Knepp and Arkin, 1973). Groundwater contamination by nitrates is a worldwide problem mainly related to the excessive use of fertilizers in intensive agriculture (Nas and Berktay, 2005). Highly levels of nitrates stimulate the growth of plankton and weeds that provide food for fish, there by increases the fish population. However increase of algae in water bodies may deplete the oxygen levels which can cause death of the fishes.

Ca is the fifth element and the third most abundant metal in the earth's crust. The calcium compounds account for 3.64% of the earth's crust. (Chemical properties, Health and Environmental effects" -http://www.lenntech.com/Periodic-chart-elements/ca-en.htm#ixzz0Fm9o6zaj&A). Calcium is naturally present in water. It may dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. Calcium is another determinant of water hardness (Ca^{2+}ions). Permissible limit of Ca in drinking water samples is 75 mg/l set by WHO. Calcium is present in various construction materials, such as cement, brick lime and concrete. Calcium often positively affects soil quality and its various compounds are applied as a fertilizer. For example, $CaCl_2^{-}$ or Ca

$(NO)_3$ solutions are applied in horticulture (http://www.lenntech.com/elements-and-water/calcium-and water.htm#ixzz0FmAnlNTd&A).

Calcium is an important determinant of water hardness, and it also functions as a pH stabilizer, because of its buffering qualities. Calcium also gives water a better taste (www.lenntech.com/elements-and-water/calcium-and-water.htm-14*k*). Scheme no(s); 1(76-76), 6 (90-90.4), 7 (88-88), 8 (70-84), 9 (64-94), and 12 (108-110) in Danna, 6 (152-152) in Lammnian, 1 (80-76) in Jandgran, 1 (86-86) in Heryolla, 1 (118), and 2 (122-124) in Charak Pura, 1 (82-72) in Kotkair, 1 (110-76) in Panjgran, 1(120-122) in Panjkot, 3 (92-76) in Chattar Domail, 2 (76-70), 4 (90-95), 5 (116-136), 6 (104-102), and 8 (70-82) in Tarraian, 2(96-52) in Kachalli, 1 (96-98), and 2 (132-136) in Said Pur, 2 (76-78), and 3 (76-76) in Gojra, 2 (92-90) in Serlisucha, and 3 (108-112), 4 (92-64), and 7 (88-84) in Komikot have high calcium value from WHO STD. The main source of high calcium in these UCs was mostly linked with chemical weathering of atmospheric deposition of dissolve rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite, gypsiferous shale and apatite respectively (Kahlown et al., 2008).

Kent et al., 2006. investigated the effects of temperature and calcium concentrations, on growth, survival and moulting of freshwater crayfish (*Paranephrops zealandicus*). He observed that growth rates increased with rise in water temperature (maximum specific growth rate = 0.57) but remain ineffective with increase of calcium water concentration. Variability in growth rates decreased with increased water calcium concentrations Survival decreased as water temperatures exceeded 16 °C, however, it increased when calcium concentrations increased above 10 mg/l.

Electrical conductivity (EC) estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. High E.C value in water is the result of dissolution of carbonate minerals, waste water from sewage treatment plant, wastewater from septic systems and drain field on-site of wastewater treatment and disposal systems, urban runoff, agricultural runoff of water. Evaporation of water from the surface of lakes concentrates the dissolved solids in the remaining water which increases the value of E.C. (Michaud, 1991). E.C determines the flow rate of an electric current in water. Temperature and CO_2 affect E.C by about 2% /1°C, dissolved CO_2 increases conductivity without increasing mineral salt content respectively (Kahlown et al., 2008).

E.C is the most important factor for drinking fresh water quality. Water having E.C in between 5-500 μs/cm represent good water, however, water having E.C value beyond 500 μs/cm is always consider bad for health. There are total 69 water sample in 16 U.Cs that showed high E.C values beyond 500 μs/cm. It means they contain high levels of dissolved inorganics. High dissolve solids always lead to high COD levels in water.

There was only one scheme (S and U) in U.C Lammnian having high sulfate (360), and hardness (515-520) mg/l, values from WHO drinking water standards. Sulfate is abundant in the earth's crust and its minute concentrations may be present in water due to leaching of gypsum, sodium-sulfate and shale. High concentrations of sulfate may be present due to oxidation of pyrite and mine drainage. Sulfate also comes from sulfur containing organic compounds and industrial wastes discharge. While Hardness is defined as the sum of calcium and magnesium concentration, both expressed as calcium carbonate, in milligram per liter. As calcium level of the aforementioned sample was also above from WHO limit so the main cause of this hardness is the high Calcium value respectively (Kahlown et al., 2008).

Only scheme no(s); 2 (0.36-0.31) in Kiamanja shows high value of Iron than WHO permissible limits. The main cause of Fe in water is due to its abundance in earth's crust but exist generally in minor concentration in natural water system. The formation of hydrated ferric oxide makes iron-laden water objectionable. This ferric precipitate imparts an orange stain to any setting surface including laundry articles, cooking and eating utensils and plumbing fixtures respectively (Kahlown et al., 2008). which were mostly practiced in district.

Mostly high conc. of As in water, are related to the occurrence of sulfide minerals such as *arsenopyrite* and *pyrite,* and they may causes skin cancer. The most problematic area are India and Bangladesh where As concentration is higher than WHO permissible limits (50 µg/l) whereas in Kashmir, maximum value was 10 ppb which is falling within permissible limits and may cause no serious health threat.

Values of other parameters like pH, TDS, alkalinity, HCO_3, CO_3, Mg, Cl, Na, K, Li, PO_4, P, I, and As were falling within permissible limits of WHO. However, there was observed a minor variation in them from source to user end, which could cause no serious threats to human health.

Chapter 5

Conclusion and Suggestion

- Most of the water sources (springs) in AJ&K are at good health.
- High levels of E.C, turbidity, Ca, hardness, sulfate, nitrate, and iron in water samples of a number of UCs can lead to some serious problem to fresh water ecology and associated human population.
- Bacteriological contamination is evident in all water sources and user end. There is need of disinfection practices if water of such sources has to be used for drinking.
- Turbidity of most of the samples suggested poor water quality that can be detrimental to fresh water ecosystem of sources. Moreover, high turbidity levels can be problematic when water of such sources has to be disinfected with U.V radiation and by chlorine.
- With few exceptions, no significant variation in water quality parameters was observed from source to user end. It suggested that most of the water supply schemes were at good condition and no significant input of chemical contaminants was observed in water ways from source to user end.
- It is recommended to adapt disinfection measures such as boiling, chlorination, and use of direct sun light at domestic level for the water contaminated only with bacteria.
- It is recommended to use Alum for that water where turbidity is high.

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