"Characterization Of Water Sample – Shimla to Solan"

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

Dr. Rajiv Ganguly (Associate Professor)

By

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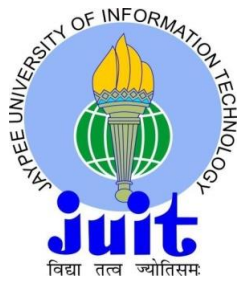
to



JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT, SOLAN – 173234

HIMACHAL PRADESH, INDIA

May 2017

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Characterization of Water Samples- Shimla to Solan"** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by ***Neeraj Bhatt (131627) & Pratishtha Mishra (131672)*** during a period from July 2016 to May 2017 under the supervision of **Dr. Rajiv Ganguly** Associate Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: - ……

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Acknowledgement

We are highly indebted to all the faculties of **Civil Engineering Department** of JUIT Waknaghat for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

We would like to express our gratitude towards **Dr. Rajiv Ganguly** Associate Professor for his kind co-operation and encouragement which help us in completion of this project and for giving us such attention and time.

Our thanks and appreciations also go to my friends in developing the project and people who have willingly helped me out with their abilities.

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Chapter 1

Introduction

1.1 General Introduction

Water quality analysis is the crucial part of environmental engineering. Water plays the most important role in all the fields. Domestic purposes and industrial purposes are the normal stream uses of water but as it comes to societal uses it stands with an important impact on the living beings and aquatic lives. Water is the prime source of the energy and should be examined thoroughly before being used. Analysis of water is a wide range of practices. Physical, chemical, microbiological and biological parameters are needed to be determined for the well-being of the breathing people around. Our project constitutes of 17 water samples- surface water, ground water and spring water. These water samples have been arranged in a manner that represents the downstream flow of water. It starts from Tattapani and ends at Solan. This project manages to withhold the fact that water used for drinking purposes are not fit or in other words apt for consumption and these parameters should not be overlooked.

This project constitutes of various experiments done on the collected samples. The various parameters which are tested by performing experiments are:

- Acidity
- Alkalinity
- Chlorides
- Conductivity
- Dissolved oxygen
- Hardness
- pH
- Total solids
- Turbidity

These parameters contribute towards the calculation of **WQI.** Therefore Water Quality Index helps in determining that water is consumable or not and specifies the quality in general grounds.

Steps involved in the project are:

1. Determine the objectives of the program scheduled.

2. Select and analyze chemical and physical indicators which are relevant to the objectives of the monitoring program.

3. Map out the site to determine the number and type of samples needed.

5. Obtain samples.

6. Accurately record site observations and measurements.

7. Label, preserve, store and transport sample appropriately for analysis.

8. Report results accurately and completely.

9. Provide informed interpretation.

1.2 Objective & Scope

There are narrative and numerical objectives of the project. Narrative objectives define general descriptions of water quality controlled through pollutant control measures. Also they are the basis for the development of detailed numerical objectives. Numerical objectives were developed to limit the adverse effect of pollutants in the water column. Numerical objectives describe pollutant concentrations, physical and chemical conditions of the water itself and the toxic nature of the water to aquatic organisms. These objectives are designed to represent the maximum amount of pollutants that contaminates water column without causing any adverse effect on living beings, organisms using the aquatic system as home, people consuming those organisms or water, and other current and potential beneficial uses.

Our main objective is to perform tests on samples, analyze water and compare it with the recommended limits1.3 Importance

This project lets us define a baseline for the analysis of different sources of water downstream which lets us know the seasonal and geographical variation in the quality.
It gives us a layout and maps all the places and shows us the critical points which might harm the beings in the surrounding areas.

1.3 Water Characteristics and Parameters

Water quality of water is affected by three factors and those are physical, chemical and biological. Physical properties of water include temperature and turbidity. Chemical properties include parameters such as pH and dissolved oxygen. Biological parameters include algae and phytoplankton. These parameters are relevant for surface, ground and industrial water.

These properties depend on the climatic, geomorphological and pollution conditions. Organic matter, in the form of phytoplankton and macrophytes is more in lakes and reservoirs than in rivers. Chemical quality of water bodies is measured by analytical method whereas biological quality needs both qualitative and quantitative characterization.

Chapter 2

Literature Review

I. **Basavaraja Simpi, S.M. Hiremath, KNS Murthy, K.N.Chandrashekarappa, Anil N Patel, E.T.Puttiah. "Analysis of Water Quality Using Physico-Chemical Parameters Hosahalli Tank in Shimoga District", Karnataka, India.**

Tank situated in shimoga district, Karnataka is analyzed on the basis of chemical and physical properties such as alkalinity, acidity, pH, dissolved oxygen, phosphate on monthly basis for a year and it was found to be pollution free. Resulting in use for domestic and irrigation purposes.

II. **O. A. Ojo*, S. B. Bakare and A. O. Babatunde. "Microbial and chemical analysis of potable water in public – water supply within lagos university, Department of Microbiology, Lagos University, Badagry Expressway, P. M. B. 1087 APAPA, Lagos – Nigeria.**

Water samples were collected from Lagos State University, Ojo Campus and was checked on the basis of chemical and microbiological parameters and it was found that level of iron, calcium and magnesium was very less than the values recommended by WHO. The main problem that was found of Coliform level in water which led to the health issues like dysentery, diarrhea and typhoid. These issues were taken into account and remedial measures were provided.

III. **Asheesh Shrivastava*, Shalini A Tandon, Rakesh Kumar "Water Quality Management Plan for Patalganga River for Drinking Purpose and Human Health Safety" National Environmental Engineering Research Institute, 89-B, Dr. A.B. Road, Worli, Mumbai.**

Deteriorating of water quality is one of the major problems in India. In this paper river named Patalganga situated 60km from Mumbai was checked on the physic- chemical parameters such as pH, acidity, alkalinity, hardness, NO3-N, NH3-N and metals like As, cu, Fe, P, SO3 and many more. This river is the major sources of water supply to Panvel, alibaug and rasayani. The water was collected from 14 different stations and many of them was found to be unsuitable for domestic purpose.

IV. Md. Khalid Hasan1*, Md. Razoanul Islam Khan2, Mst. Karimon Nesha1,Masuma Akter Happy2, "Analysis of Water Quality Using Chemical Parameters and Metal Status of Balu River" Dhaka, Bangladesh

In 2008, Balu river at Dhaka city was checked on the basis of physical and chemical properties. River was polluted due to constant flow of industrial effluents, untreated sewage waste and municipal waste. Water samples was collected from 10 different locations and total of 20 samples was collected in two seasons i;e Rainy and winter. It was found that concentration of chemicals was less in rainy season as compared to winter. The water was unsuitable for domestic and irrigation purpose in an account of chromium and bicarbonate levels.

V. S.P. BHALME, Dr. P.B.NAGARNAIK, "Analysis of Drinking Water of Different Places" G. H. Raisoni College of Engineering & Technology, NAGPUR, (India) – 440016

this is the analysis done on water quality by Educational institute , Hingna MIDC area, Nagpur.In this paper different papers were studied and collective information for treatment of water quality was given.

VI. Marisol Vega, Rafael Pardo, Enrique Barrado, Luis Debán, "Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis" Department of Analytical Chemistry, Faculty of Sciences, University of Valladolid, 47005 Valladolid, Spain.

Water sample was collected from three sampling locations located along in the river destroyed by man-made activities. This river had a section of 25 kms. 22 physico chemical variables were analyzed and the samples were collected in every three months for two and a half year from 3 sampling points on the river. Analysis of data was carried out by ANOVA, box plots, display methods (principal component analysis) and unsupervised pattern recognition (cluster analysis) to discriminate sources of variation of water quality in different parts of river. An ANOVA showed that (a) mineral contents depend on season and climate changes (b) pollution is caused by organic matter and nutrients created from anthropogenic sources, mainly generated from municipal wastewater.

VII. Y. Ouyang, P. Nkedi-Kizza, Q.T. Wu, D. Shinde, C.H. Huang, "Assessment of seasonal variations in surface water quality" Department of Water Resources, St. Johns River Water Management District, P.O. Box 1429, Palatka, FL 32178 1429, USA

Calculating seasonal changes in surface water quality is an important aspect for evaluating temperature variations of water pollution tanks. Surface water quality knowledge for physical and chemical parameters collected from 22 stations during a watercourse from years 1998 to 2001 were analyzed. Parameters affecting the water quality in one season might be different from the parameters affecting the other seasons except for DOC and electrical conductance, which are the most important parameters which contributed to variation in quality of water for every seasons.

VIII. H.S. Xua,b, Z.X. Xua*, W. Wua, F.F. Tanga "Assessment and Spatiotemporal Variation Analysis of Water Quality in the Zhangweinan River Basin" China.

For water resources protection and sustainable utilization spatiotemporal variation assessment of water quality and identification of sources of pollution in river basins is important. In this study, two statistical methods are included for analysis. They are- seasonal Kendall test method and - cluster analysis which were used to evaluate the variation of water quality due to spatiotemporal change in the Zhangweinan River basin Zhangweinan River was classified into two regions according to pollution levels assessed due to test results. First one is the Zhang River basin in northwest of the Zhangweinan River basin where quality of water is good. Second one includes the Wei River and eastern plain of the Zhangweinan River basin, this region is seriously polluted. The results through the two tests indicated that the sampling periods may be classified into three periods during the time period 2002-2009 according to quality of water.

IX. N. Subba Rao, "Seasonal variation of groundwater quality in a part of Guntur District, Andhra Pradesh" , India"

The area in Guntur district, Andhra Pradesh, India, is selected to discuss the impact of variation of quality of groundwater on irrigation and human health due to seasonal changes. As groundwater serves agriculture, rural folks and is the main supply for irrigation and drinking purposes it should be checked keenly. A comparison of the groundwater quality in relation WQS proves that the many samples are not appropriate for drinking, particularly in post-monsoon period. This is because of action of salts in infiltrating recharge waters. A management plan is recommended for property development of the realm**.**

X. M. Shamsudduha, R. E. Chandler, R. G. Taylor, and K. M. Ahmed, "Recent trends in groundwater levels in a highly seasonal hydrological system: the Ganges-Brahmaputra-Meghna.

Groundwater levels in shallow aquifers that are underlying in Asian mega-deltas square measured and characterized by sturdy seasonal variations that are related to monsoon precipitation. Statistic seasonal-trend decomposition procedure (STL) is applied to resolve trend and seasonal parts in weekly groundwater levels within the Ganges-Brahmaputra-Meghna (GBM) Delta, .

Chapter 3

Methodology

3.1 Site Locations

Objective is to assess the quality of the water supplied by the supply agency and of that at the point of use, so that samples of both should be taken. Any significant difference between the two has important implications for remedial strategies.

In selecting sampling points, each locality should be considered individually; therefore following criterion is followed for the same:

• Sampling points should represent the different sources from which water is obtained by the public or enters the system.

• These points should include those samples that represent points of possible contamination.

• Sampling points should be distributed throughout a piped distribution system, keeping in account the mass population; sampling points should be proportional to the number of branches.

• The points chosen should represent the system as a whole and its components i.e. each source.

• Sampling points should be viable from the storage.

• Each source should be prioritized on the basis of inhabitants served.

Following are the sampling points:

1. Kandaghat- Hand pump
2. Kandaghat- Drinking Water
3. Solan- Mohan Mc. Spring
4. Waknaghat- Spring
5. Tattapani
6. Solan- Kotlanala Spring
7. Panog- Baawdi
8. Lakkar Bazaar- Drinking
9. Shogi- Supply Water
10. Shogi- Hand Pump
11. Solan- Hand Pump
12. Solan- Drinking Water
13. Lakkar Bazaar Baawdi
14. Shimla- Drinking Water
15. Lakkar Bazaar- Hand pump
16. Waknaghat-Sewage Treatment Plant Inlet JUIT
17. Waknaghat-Sewage Treatment Plant Outlet JUIT

Ground Water

S1	**Tattapani**
S2	**Lakkar Bazar Handpump**
S3	**Lakkar Bazar Bawdi**
S4	**Shogi Handpump**
S5	**Panog Bawdi**
S6	**Kanda Handpump**
S7	**Solan Handpump**

Table-1

Spring Water

S1	**Wakna Spring**
S2	**Mohan Meakin Spring**
S3	**Kotlanala Spring**

Table-2

Surface Water

S1	**Lakkar Bazar Drinking**
S2	**Shimla Drinking**
S3	**Shogi Supply Water**
S4	**Kandaghat Drinking**
S5	**Solan Drinking**

Table-3

Wastewater

S1	**STP waknaghat- inlet**
S2	**STP-wakna outlet**

Table-4

3.2 Map of Sampling points

Figure 1: Sampling Location – Shimla to Solan

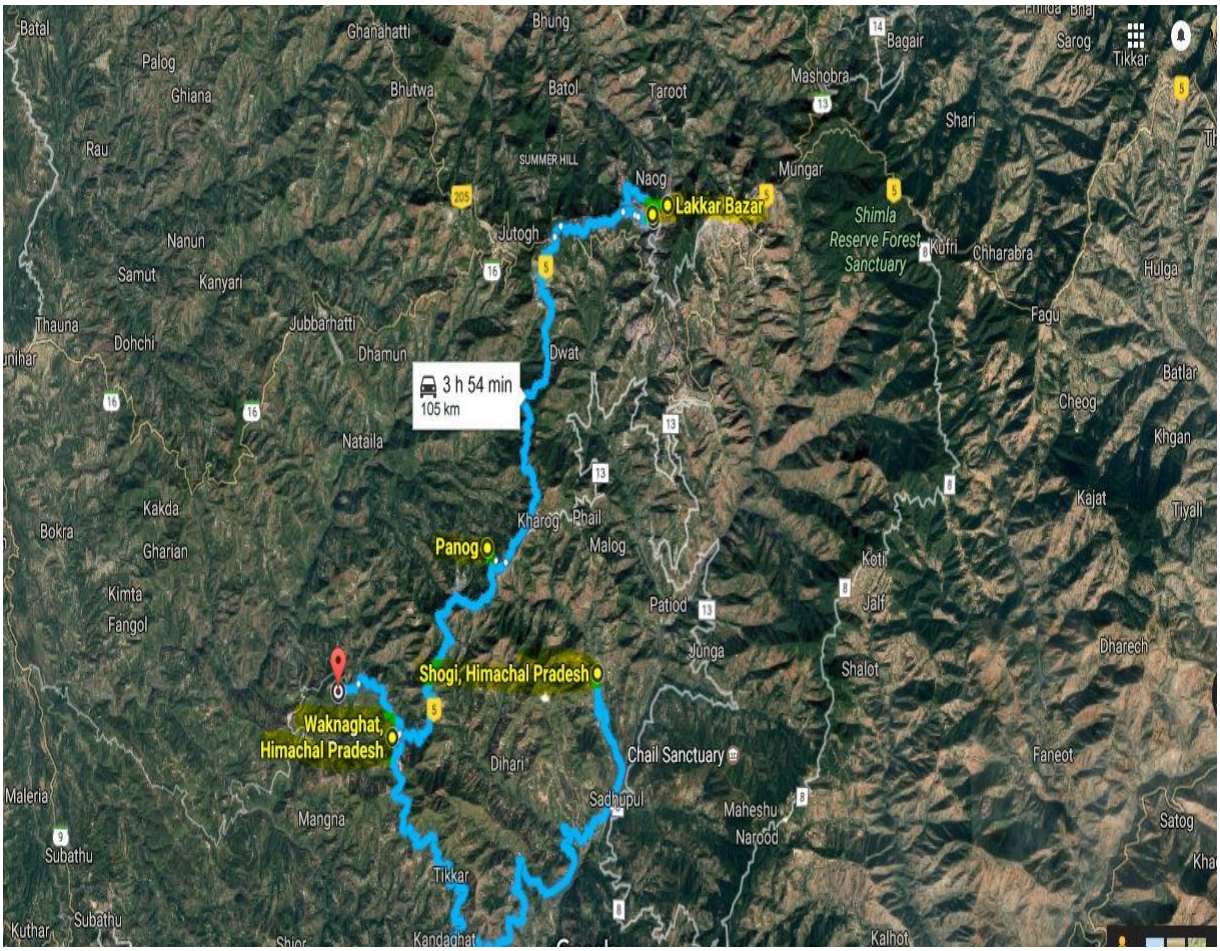


Figure 2: Shimla to Waknaghat

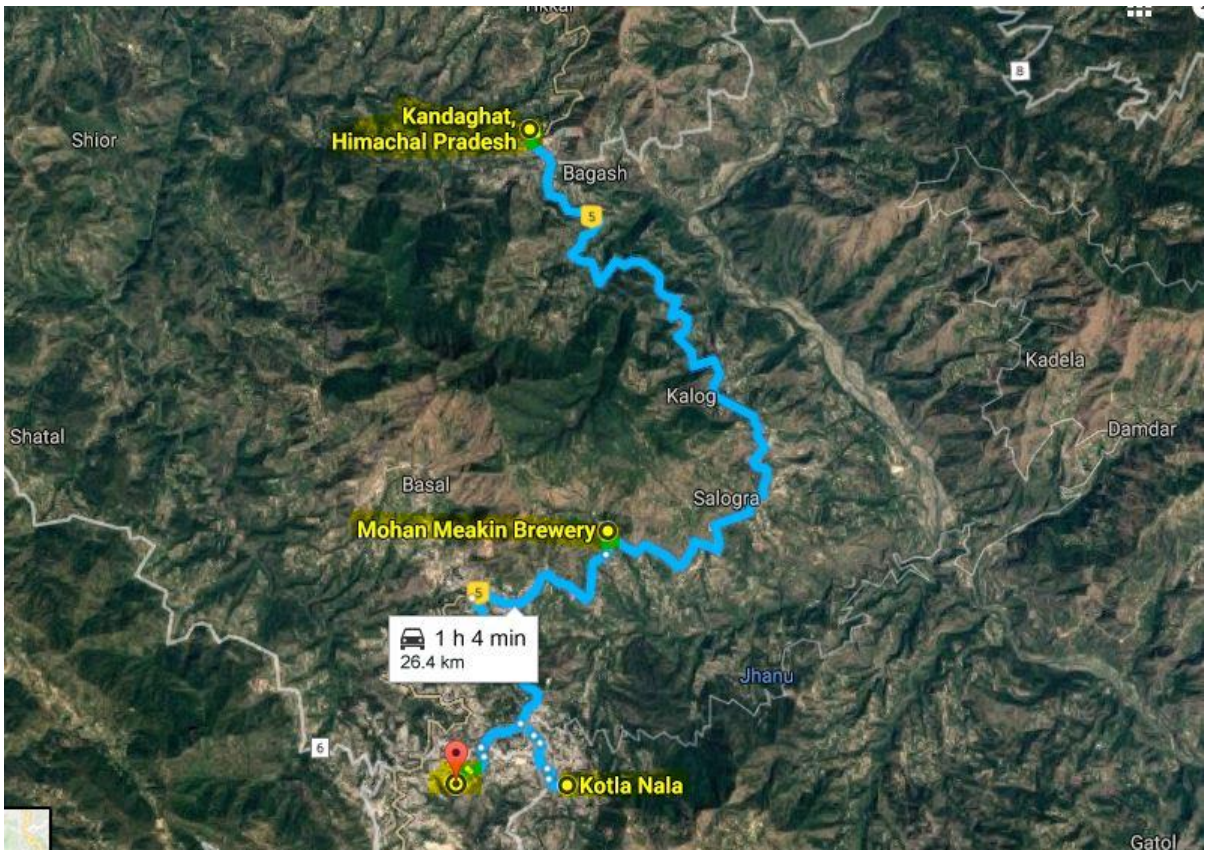


Figure 3: Kandaghat to Solan

3.3 Parameters

There are certain parameters which are physical, chemical, biological etc that categorizes water into different streams and water is analyzed accordingly:

Chemical parameters:

Biological Oxygen Demand (BOD)

Calcium Hardness

Chemical Oxygen Demand (COD)

Chlorides

Dissolved Oxygen (D.O)

Electrical Conductivity (E.C)

Fluorides

Free Carbon-di-oxide

Magnesium Hardness

Nitrates

pH

Phosphates

Potassium

Sodium

Sulphates

Total Dissolved Solids (TDS)

Total Hardness

Total Solids (TS) and

Total Suspended Solids (TSS)

Physical parameters:

Colour

Odour

Temperature

Transparency and

Turbidity

Heavy metals:

Cadmium

Chromium

Copper

Iron

Lead

Nickel

Zinc

Biological parameters: The qualitative analyses of planktons (zooplankton and phytoplankton).

Field measurement: It includes pH, conductivity, dissolved oxygen, temperature and transparency.

3.3.1 Parameters tested

We have certain parameters for which we have performed tests and calculated results accordingly:

Procedure is as follows:

First of all there is collection of adequate amount of water samples to perform all the tests and accordingly perform the following tests:

1. Hardness:

Water with bicarbonates, chlorides and sulphates of calcium and magnesium is considered as hard water. Also this water has the high mineral content.
When it is treated with soap it gets precipitated as salts of calcium and magnesium which are insoluble. There are two types of hardness
1. Temporary hardness
2. Permanent hardness
Temporary hardness is caused due to the presence of bicarbonates of calcium and magnesium and can be easily removed by boiling.
Permanent hardness is caused due to the presence of chlorides and sulphates of calcium and magnesium and it cannot be removed by temporary methods like boiling.

2. Chloride content

Chlorides are present as salts of calcium, sodium and potassium in water and wastewater. The salty taste produced in potable water by chloride concentration is variable and dependent on the chemical composition of water. The major taste producing salts are sodium chloride and calcium chloride. Chloride anions and associated cations in water produce salty taste. Water which is having only 250mg/L of chloride may have a detectable salty taste if the salt is sodium chloride. On the other hand even if the water is having very high chloride concentration, a typical salty taste may be absent. For example: 100mg/L, this is because the predominant cation present in the water is not sodium but either calcium or magnesium may be present.

3. Alkalinity

Alkalinity is a way of measuring the acid neutralizing capacity of water in other words its ability to maintain a relatively constant pH.
To maintain constant pH, hydroxyl, carbonate and bicarbonate ions must be present in water. Calcium and carbonate presence in water lets it act as a buffer in a part.
Carbonate and Calcium ions can be obtained from limestone or calcium carbonate which increases the amount of hardness and alkalinity.

4. Acidity

Acidity of water is the capacity to neutralize bases. Acidity is a collection of all titrable acid present in the water sample. Strong mineral acid and weak acids contributes to acidity of water. Dissolved CO_2 contributes a lot to the acidity of unpolluted water.
The volume of standard alkali required to titrate a specific volume of a sample to pH 8.3 is called phenolphthalein acidity (total acidity).
The volume of standard alkali required to titrate a specific volume of the water sample to pH 3.7 is called methyl orange acidity (mineral acidity).

5. Turbidity

Turbidity is the characteristic of water that obstructs the transmission of light. Also it is a qualitative property. It refers to the cloudiness of a solution. Turbidity is caused due to the presence of dispersed and suspended solids like clay, silt, organic matter, algae and other microorganisms.

6. Conductivity

Electric current is the result of flow of charged particles in the field produced by applied voltage. Flow of charged particles produce conductance. A current arise from the flow of electrons in most solid materials, which is called electronic conduction. Electrical conductivity depends on the number of electrons available to participate to the conduction process.
Pure water is a bad conductor of electricity. Ordinary distilled water in equilibrium has a conductivity of about 10×10^{-6} $W^{-1}*m^{-1}$ (20 dS/m). Conductivity increases as the concentration of ions increases.

7. Dissolved oxygen

Dissolved oxygen is the level of free, non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality as it has great influence on the organisms living within a body of water. In limnology (the study of lakes), dissolved oxygen is an essential factor. DO level too high or too low can harm aquatic life and affect water quality.

8. Total solids

Collection of suspended and dissolved solids in the water is known as total solids. These include all sorts of metals, anions, cations, minerals, salts and some amount of organic solid etc. it is easy to remove the suspended solids by filtration but dissolved solids are measured by heating at high temperature.

9. pH

pH is a measure of basicity or acidity of water. The range goes from 0 – 14, with 7 being neutral. pH less than 7 indicates acidity of water, whereas a pH greater than 7 indicates a base. pH is a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydroxyl ions is basic, whereas water that has more free hydrogen ions is acidic. pH can be affected by chemicals in the water, it is an important indicator of water that changes chemically. pH is reported in "logarithmic units".

10. Chemical Oxygen Demand

The chemical oxygen demand (COD) test is used to indirectly measure the amount of organic compounds in water. Most applications of COD are to determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution.

11. Biochemical Oxygen Demand

Biochemical oxygen demand (BOD, also called biological oxygen demand) is the amount of dissolved oxygen needed (i.e., demanded) to break down organic material present in a given water sample by aerobic biological organisms at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C.

3.3.2 Procedure

Alkalinity

The reagents that are used to calculate alkalinity in water samples are Sulphuric acid, phenolphthalein, methyl orange and distilled water. In this Experiment take 50ml of water sample and add phenolphthalein indicator in it. Now add sulphuric acid to the burette and titrate the sample till it changes it color to colorless. Now add two drops of methyl orange in the sample and again titrate it with acid until it changes to wine red.

Acidity

The reagents used in this experiment are sodium hydroxide, sulphuric acid methyl orange, phenolphthalein indicator and distilled water. First add ml of water sample to the flask and fill the burette with sodium hydroxide and ad few drops of methyl orange and if it changes to yellow then take 50 milliliter of new sample and add phenolphthalein indicator and titrate is with sodium hydroxide till the color changes to red.

Chlorides

The reagents used for calculating chloride content in given water sample are Silver Nitrate, phenolphthalein indicator, sodium chloride and potassium chromate. Procedure involved is as follows, first add 20ml of water sample in flask and add few drops of potassium chromate and titrate it with silver Nitrate which is filled in burette til the color changes to brick red.

Hardness

The reagents used in this experiment are ammonium chloride, ammonium hydroxide, EDTA, Erichrome Black-T and magnesium sulphate. Procedure to conduct this experiment is, first take 50mll of water sample and add few drops of ammonia buffer and Erichrome black-T to it. Now titrate it with .EDTA till it changes to steel blue. Now boil the 100ml sample and repeat the procedure.

Total Dissolved Solids

Measure the weight of crucible and filter paper inside the analytical balance. Now fill the crucible with 100ml of water sample and keep it inside the oven at 103-105º C for 24 hours. After that measure the weight of crucible once again. Now filter the new 100ml water sample and keep those filter paper inside the oven for 24 hours and hen weigh it.

Conductivity

Start the conductivity meter 30 minutes prior conducting the experiment. Now prepare the 0.1N potassium chloride solution and calibrate the meter to 14.12mhos using the standard solution of 0.1 KCl by adjusting calibration knob. Read the meter by inserting the sample.

pH

Take different water samples in small dishes and put pH paper inside it and compare it with standard colors to get pH.

Dissolved Oxygen

Take BOD bottle and fill it completely with water sample and spill out the excess water. Now take dissolved oxygen meter and calculate the DO of the sample.

Turbidity

Start the turbidity meter 30 minutes prior conducting the experiment. Prepare 400 NTU solution and calibrate the meter with it similarly with distilled water for 0 NTU. Now read the turbidity meter by inserting the samples.

Biological Oxygen Demand

Take 2 300ml BOD bottles and add 10ml of water samples to one of them and fill the remaining with dilution water. And fill complete dilution water to the other for blank. There should not be any air bubbles inside it keeping this in mind put the stopper. Mark the samples and keep that incubator at 20ºC for 5 days. Analyze remaining one blank for dissolved oxygen. Analyze the bottles for DO after 5 days.

Chemical Oxygen Demand

Take 2.5ml of water samples in the tube and 2.5ml of distilled water in other. Add 1.5ml of Potassium dichromate and 3.5ml of sulphuric acid to both the tubes. Tightly close the tubes kept in COD digestor at 150ºC for 2 hours. After cooling to the room temperature transfer the content to conical flask and titrate it against ferrous ammonium sulphate. Add few drops of ferroin indicator. Stop titration when colour changes to reddish brown.

Chapter 4

Results & Discussion

4.1 Winter

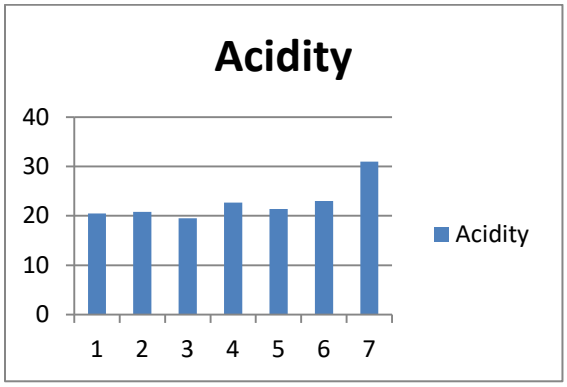
4.1.1 Ground Water

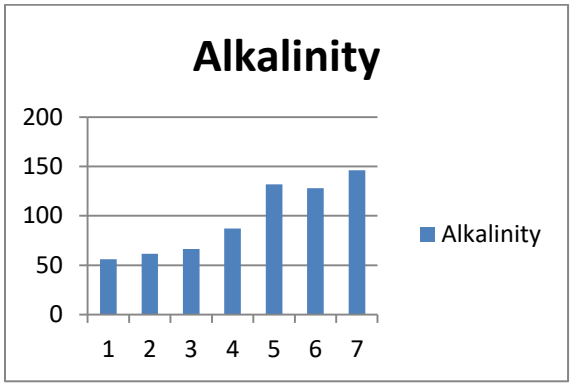
Parameters	Sites							BIS Standard(IS: 10500: 1991)	
	s1	s2	s3	s4	s5	s6	s7	Permissible	Desirable
Acidity (mg/L)	23.33	32.5	40	25	22.5	21.67	21.31		
Alkalinity (mg/L)	23.83	155	145	165	60	11.83	20.64	600mg/L	200mg/L
Chlorides (mg/L)	538.33	13.33	33.33	16.67	60	5	40	1000mg/L	250mg/L
pH	8	7.5	6.5	6.5	6	7	6	6.5-8.5	
Conductivity (mmho/cm)	1.95	0.4	0.395	0.208	0.48	0.42	0.41	1.8mmho/cm	1.14mmho/cm
Turbidity (NTU)	0	5	0	3	1	3	4	10NTU	5NTU
Hardness (mg/L)	462	284	234	200	218	492	256	600mg/L	300mg/L
Total dissolved solids (mg/L)	1409	620	710	253	206	408.8	350.87	2000mg/L	500mg/L
Dissolved oxygen	6.77	6.12	7.33	4.93	6.92	6.92	5.48	6.5-8.5	
WQI	234.95	70.99	78.57	39.66	41.08	58.732	48.74		

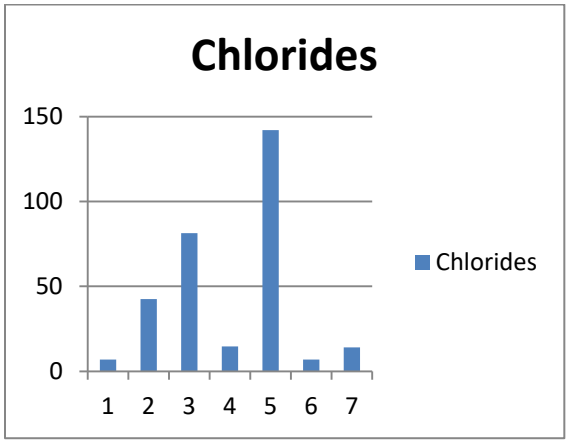
Table- 5

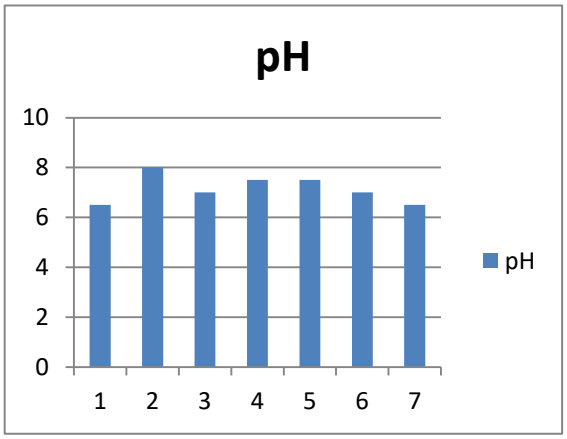
- Kandaghat hand pump and solan hand pump have hardness more than the permissible limit and DO level is low in Tattapani, lakkar bazar,baawdi and solan Hand pump.

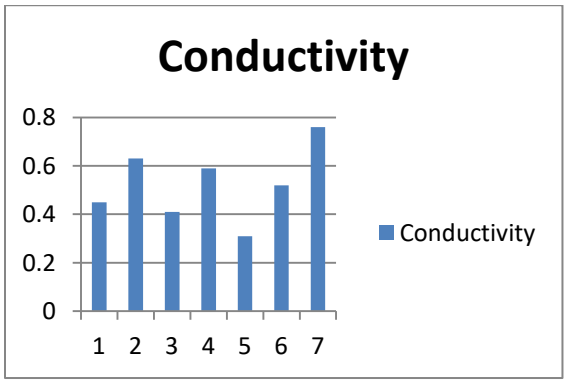
i) Graphs- Ground water

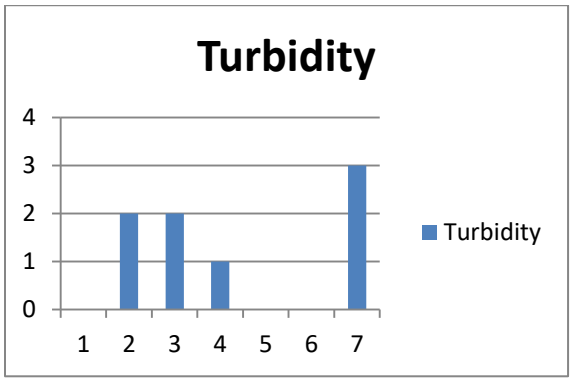


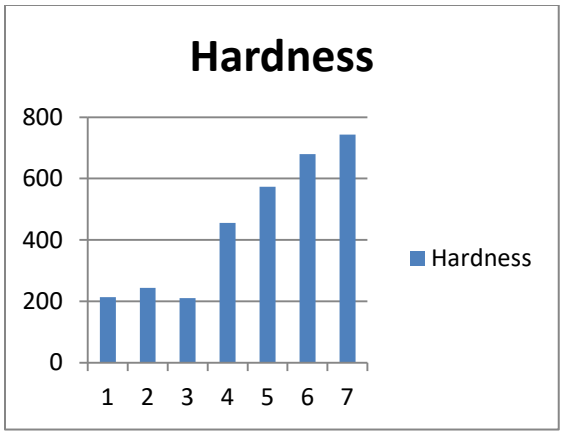


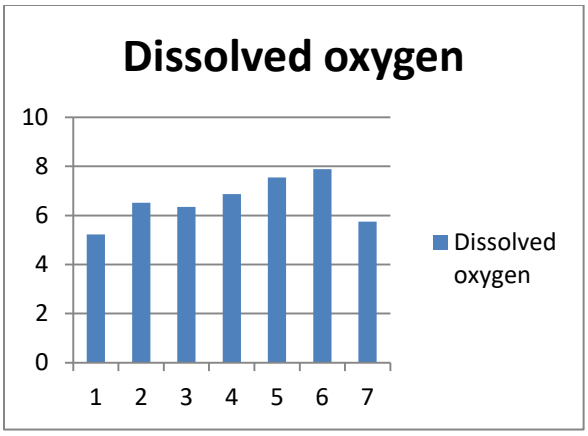


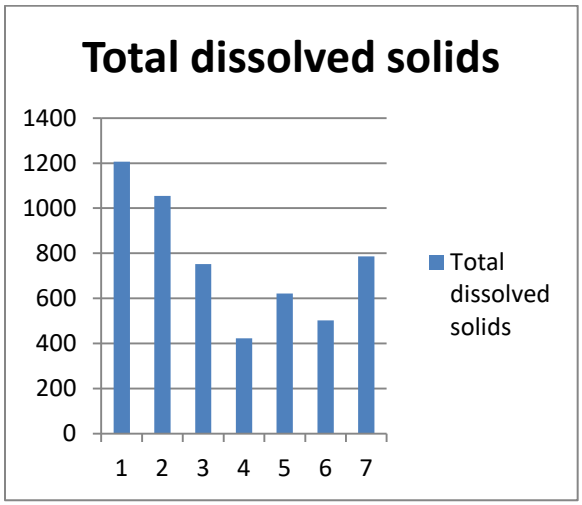












Acidity of the water is increasing down the stream as down the lane the temperature rises due to low altitude therefore leading to production of more H^+ ions leading to more acidity.

There is a rise in alkalinity too and as the alkaline nature is due to OH^-, CO_3^-, HCO_3^- , there is a possibility of a limestone bed beneath from where the water passes.

pH stands in the permissible limits as in winters there is no increase in ions due to dissociation.

Lakkar bazar handpump, lakkar bazar bawdi and panog bawdi have high concentration oh chloride and the reason might be high amount of salt not of sodium but of potassium and calcium as it wasn't salty.

Conductivity is high in solan's handpump water; there might be a possibility that it contains more of regular salts that dissociated to form ions due to some reasons.

Turbidity is high in solan's water the reason might be that water coming from below the surface is either not filtered properly or has some impurities.

There is increase in hardness downstream which shows that downstream the salts of calcium and magnesium are increasing.

Lakkar bazar and Solan handpump have low DO, the reason might be the bacterial growth or fertilizers runoff.

From the bar chart TDS is decreasing down the lane which specifies that dissolved solids are more in the water as turbidity.

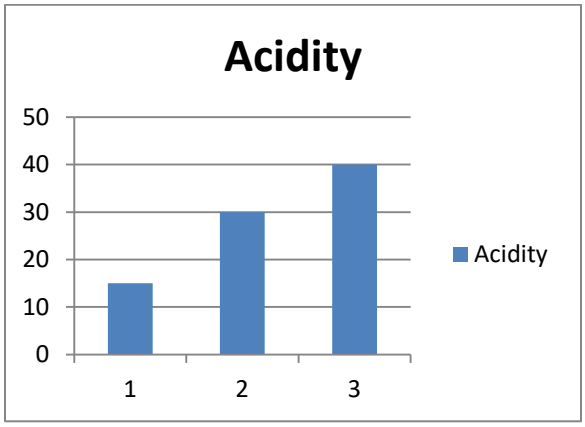
4.1.2 Spring Water

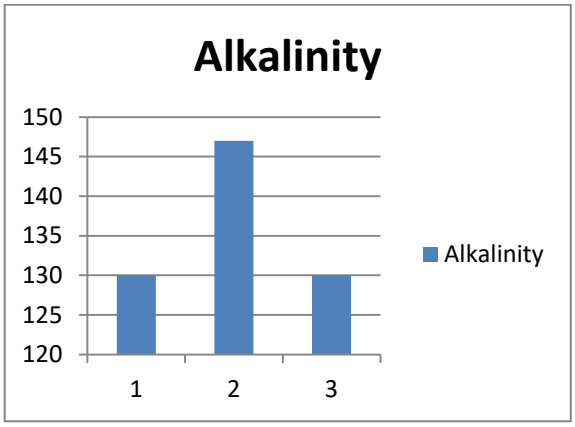
Parameters	sites			BIS(IS: 10500: 1991)	
	s1	s2	s3	Permissible	Desirable
Acidity (mg/L)	10	43.3	45		
Alkalinity (mg/L)	11.8	15.2	28.8	600mg/L	200mg/L
Chlorides (mg/L)	3.34	8.33	41.6	1000mg/L	250mg/L
pH	7	6.5	8	6.5-8.5	
Conductivity (mmho/cm)	0.12	1.08	0.65	1.8mmho/cm	1.14mmho/cm
Turbidity (NTU)	0	3	2	10NTU	5NTU
Hardness (mg/L)	204	1770	726	600mg/L	300mg/L
Total dissolved solids (mg/L)	40	1292	6500	2000mg/L	500mg/L
Dissolved oxygen	6.26	6.79	6.71	6.5-8.5	
WQI	15.02	194.78	541.776		

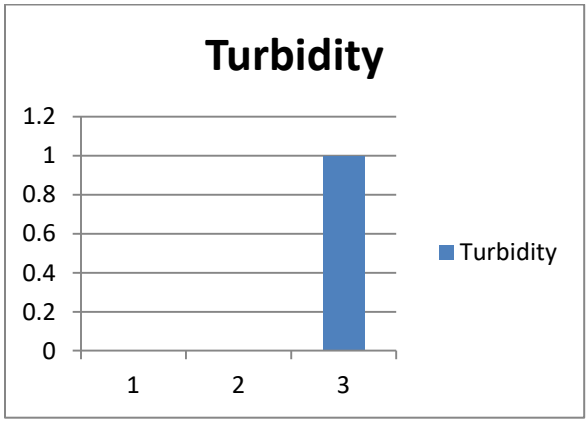
Table-6

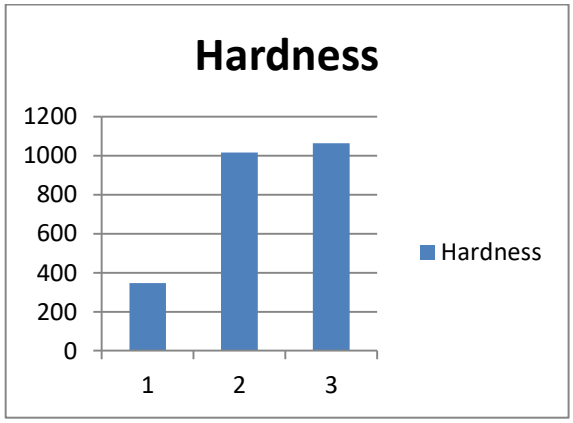
- Conductivity is high in Waknaghat spring.
- Hardness is above the permissible limits in Mohan Meakin spring and kotlanala spring.
- Total dissolved solid is high in kotlanala spring water.
- DO level is high in Waknaghat spring water and low in kotlanala spring water.

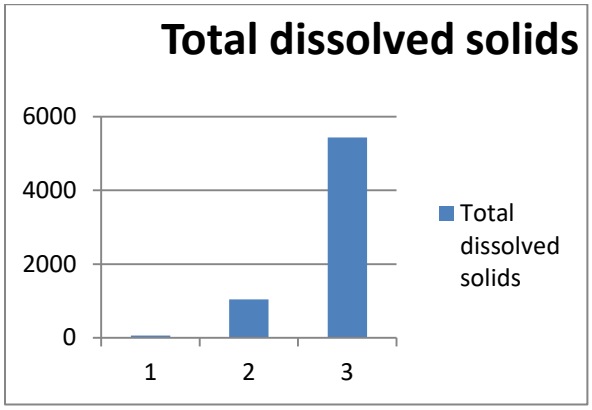
ii) Graphs- Spring Water

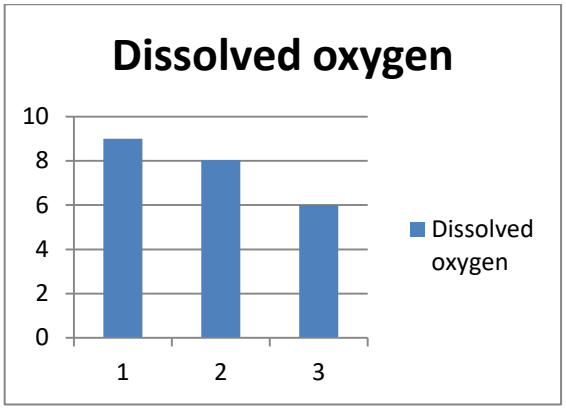


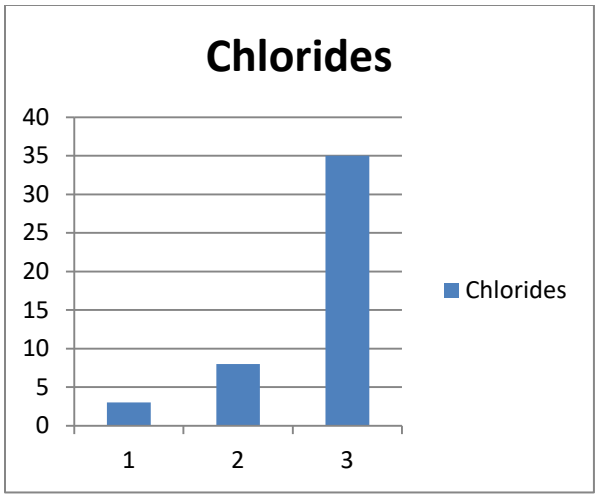


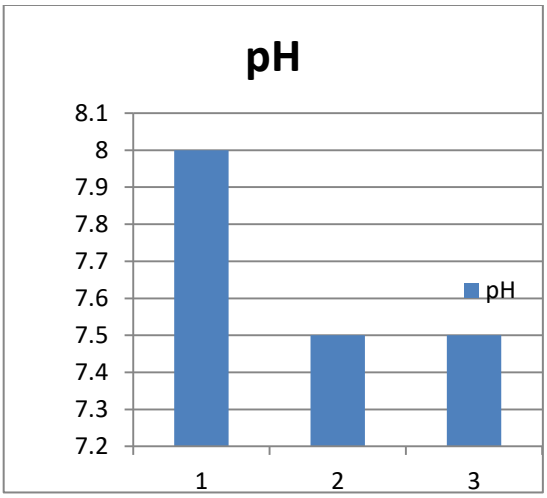


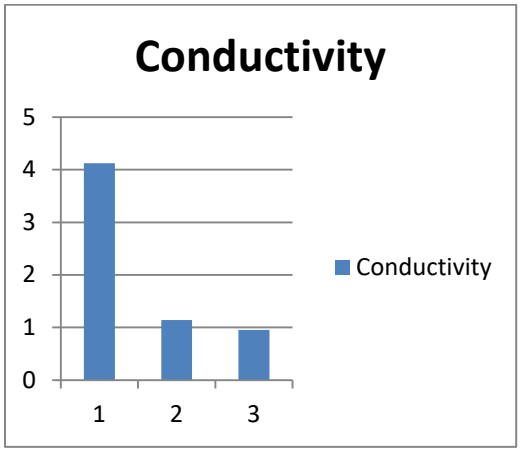












There is an increase in acidity down the stream; the reason behind might be the increase of H^+ ions due to low altitude and increase in temperature.

There is a decrease in alkalinity as there would be less of hydroxyl, carbonates and bicarbonates down the stream.

As acidity is increasing and alkalinity is decreasing a bit the pH is decreasing due to more production of H^+ ions.

Kotlanala spring water has more of turbidity in fact high turbidity and TDS as well which shows the possibility of more of suspended solids that hamper the passage of light in water. Reason behind would be the presence of more of salts or dissolved solids beneath.

Hardness of mohan meakin's and solan's spring is high which states the presence and increase of calcium and magnesium salt down the lane.

DO is decreasing down the stream; the reason might be given as rise in temperature due to low altitude and more bacterial growth which increases BOD demand.

Chloride is high in solans water without salty taste which suggests that water would have been composed of chlorides of calcium and potassium.

pH is high in Waknaghat which shows that down the stream water turns more of acidic with increase in H^+ ions.

Conductivity is high in Waknaghat which suggests that there would be more ions in the water.

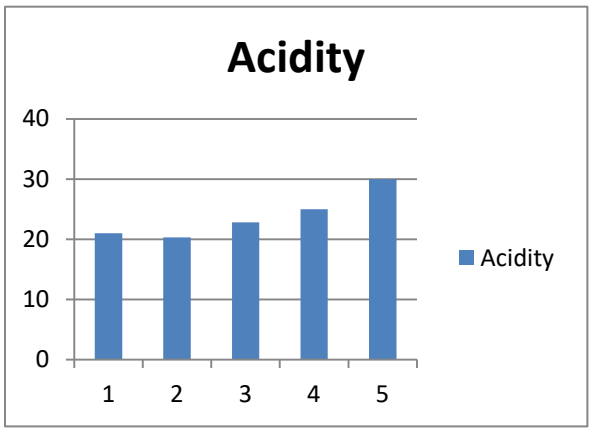
4.1.3 Surface Water

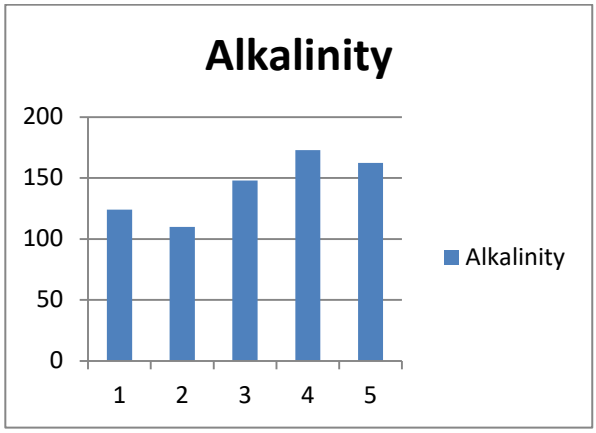
Parameters	Sites					BIS Standard(IS: 10500: 1991)	
	S1	S2	S3	S4	S5	permissible	Desirable
Acidity (mg/L)	25	22.5	25	11.83	18.56		
Alkalinity (mg/L)	135	130	95	96.7	95.14	600mg/L	200mg/L
Chlorides (mg/L)	10	6.66	6.66	11.66	8.6	1000mg/L	250mg/L
pH	6.5	6.5	6.5	8	7.5	6.5-8.5	
Conductivity (mmho/cm)	0.28	0.25	0.825	0.62	0.6	1.8mmho/cm	1.14mmho/cm
Turbidity (NTU)	0	2	2	0	2	10NTU	5NTU
Hardness (mg/L)	206	222	524	806	804	600mg/L	300mg/L
Total dissolved solids (mg/L)	203	123	1563	627	432	2000mg/L	500mg/L
Dissolved oxygen	8.01	7.23	6.3	6.99	5.68	6.5-8.5	
WQI	33.71	27.65	151.8	96.72	81.15		

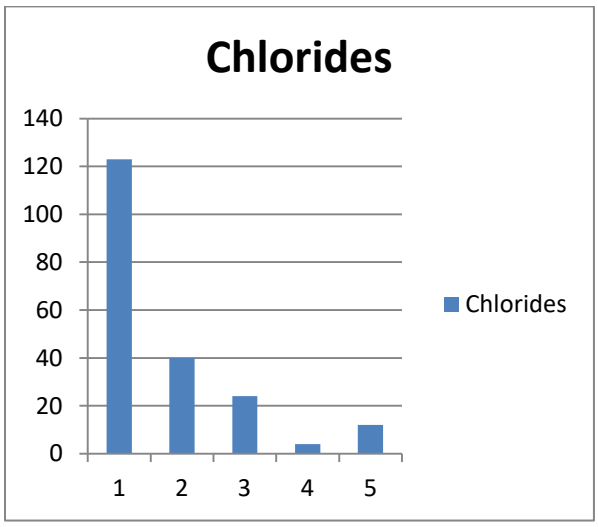
Table-7

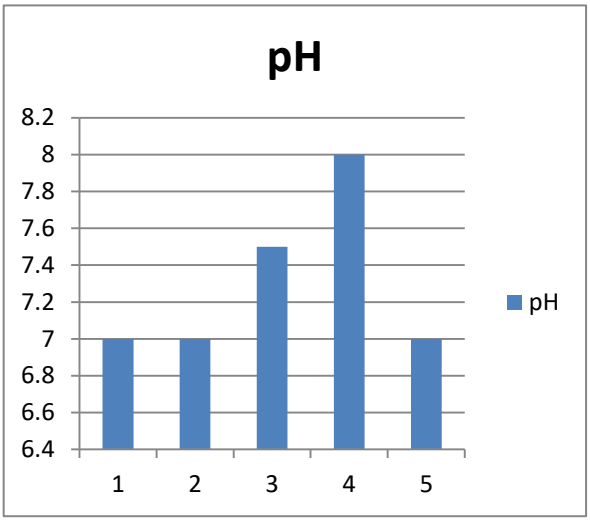
- Hardness is high in kandaghat drinking water.
- DO is high in lakkar bazaar drinking water.

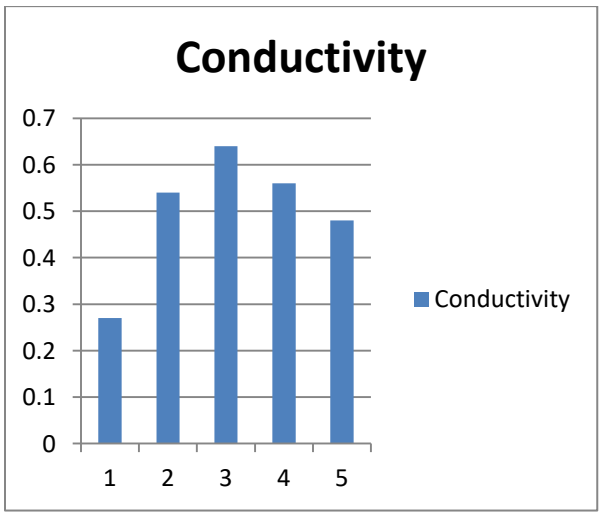
iii) Graphs- Surface Water

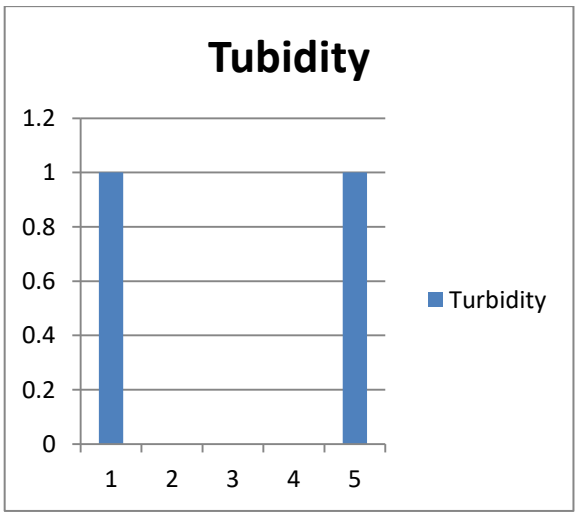


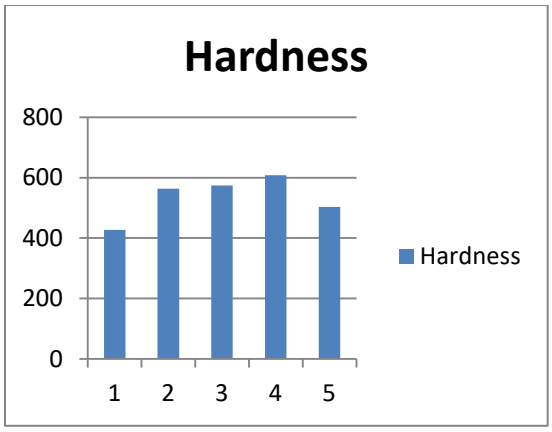


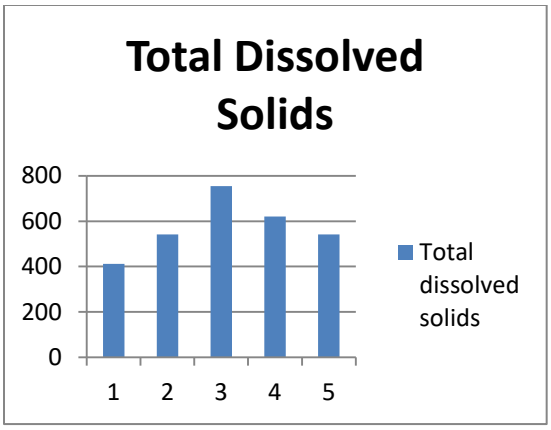


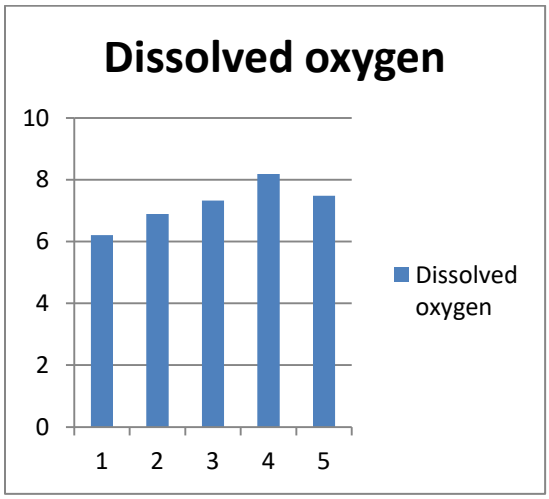












Increase in acidity is due to dissociation of water molecules due to decreasing altitude and increasing temp which does not support the hydrogen bonding.

Shogi, Kandaghat and Solan supply water have high alkalinity which shows presence of carbonates, bicarbonates and hydroxyl group.

Both the alkalinity and acidity aptly show the variation in pH as most alkaline water has highest pH i.e. Kandaghat drinking water.

Chloride content is high in Lakkar bazar drinking water which shows the presence of chlorides and its alarmingly decreasing down the lane showing the decrease in salts of potassium nd calcium and bit of sodium.

Also hardness is under recommended limits and is almost the same showing almost equal amount of salts of calcium and magnesium down the stream.

Conductivity has increased and then decreased from shogi. There is a slight change but conductivity is high in all the sources showing rapid movement of ions.

Lakkar bazar and Solan supply water are turbid to presence of solids that does not let light penetrate i.e. suspended solids. This also shows high value of TDS which in map is almost same for all. The reason behind would be more of dissolved solids rather than suspended ones in non-turbid water.

DO is permissible in all the sources this shows that surface water has maintained DO as it is in contact with the atmosphere.

4.2 Summer

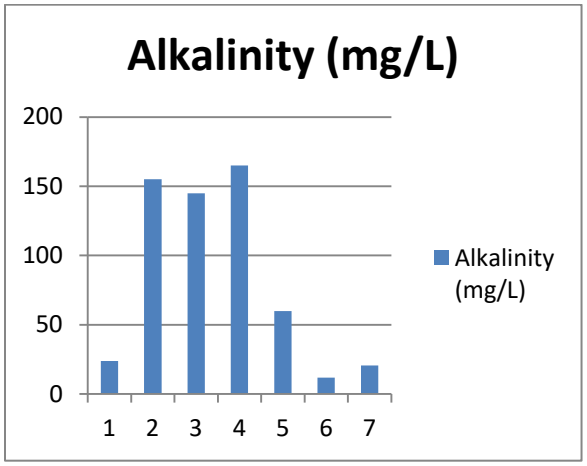
4.2.1 Ground Water

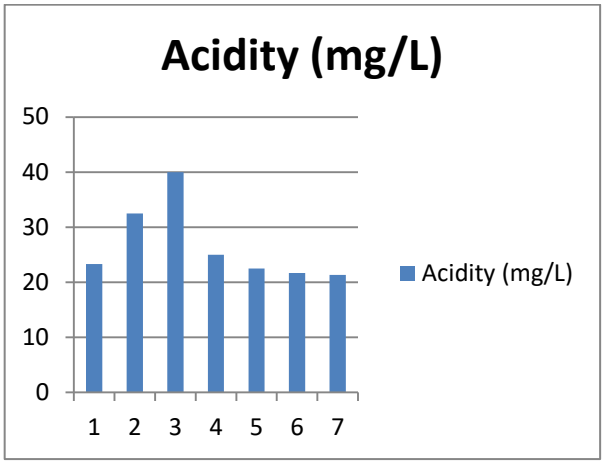
Parameters	Sites							BIS Standard(IS: 10500: 1991)	
	s1	s2	s3	s4	s5	s6	s7	Permissible	Desirable
Acidity (mg/L)	23.33	32.5	40	25	22.5	21.67	21.31		
Alkalinity (mg/L)	23.83	155	145	165	60	11.83	20.64	600mg/L	200mg/L
Chlorides (mg/L)	538.33	13.33	33.33	16.67	60	5	40	1000mg/L	250mg/L
pH	8	7.5	6.5	6.5	6	7	6	6.5-8.5	
Conductivity (mmho/cm)	1.95	0.4	0.395	0.208	0.48	0.42	0.41	1.8mmho/cm	1.14mmho/cm
Turbidity (NTU)	0	5	0	3	1	3	4	10NTU	5NTU
Hardness (mg/L)	462	284	234	200	218	492	256	600mg/L	300mg/L
Total dissolved solids (mg/L)	1409	620	710	253	206	408.8	350.87	2000mg/L	500mg/L
Dissolved oxygen	6.77	6.12	7.33	4.93	6.92	6.92	5.48	6.5-8.5	
WQI	234.95	70.99	78.57	39.66	41.08	58.732	48.74		

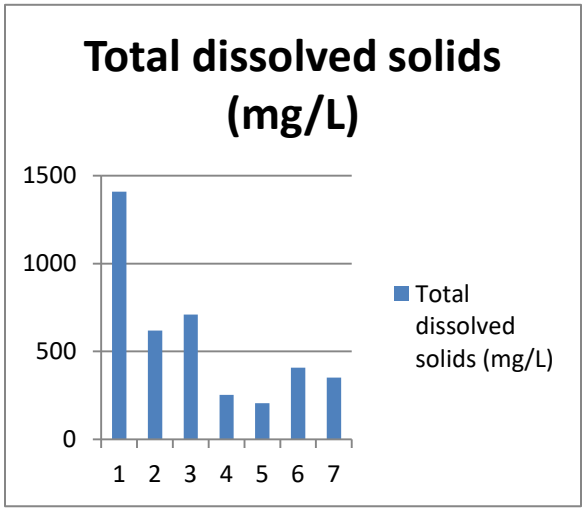
Table-8

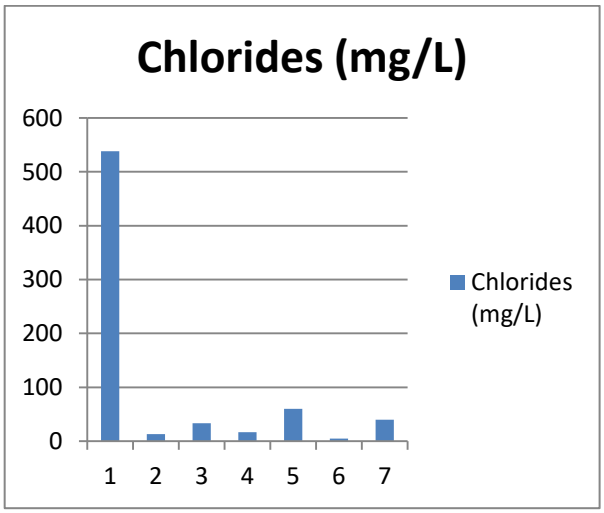
- Chloride content is high in Tattapani.
- Panog bawdi water and solan handpump water have low pH.
- Conductivity of Tattapani is high.
- Hardness of Tattapani and kandaghat handpump is higher than desirable limit.
- All the samples have high total dissolved solids.
- Lakkar bazar bawdi, shogi handpump and solan handpump have low DO.

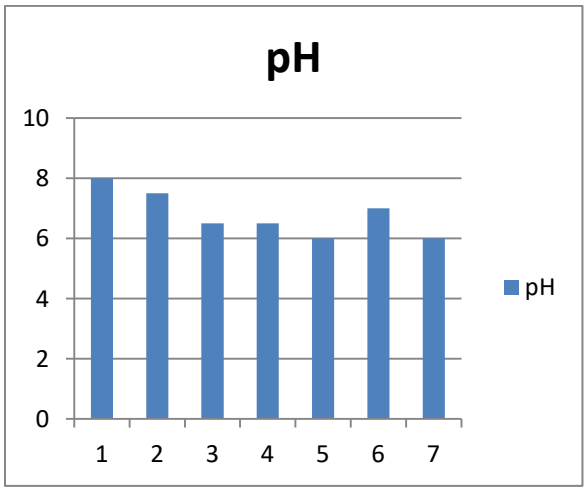
iv) Graphs- Ground Water

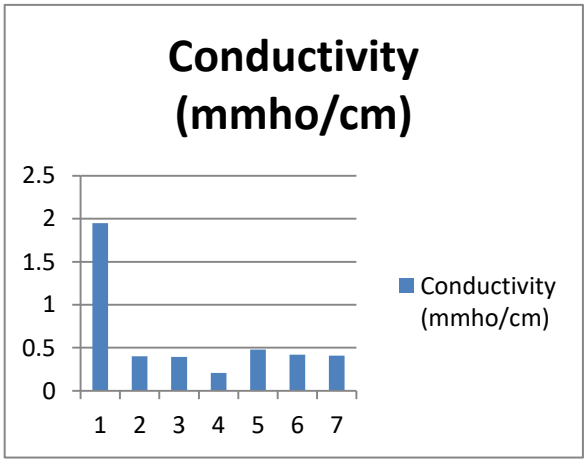


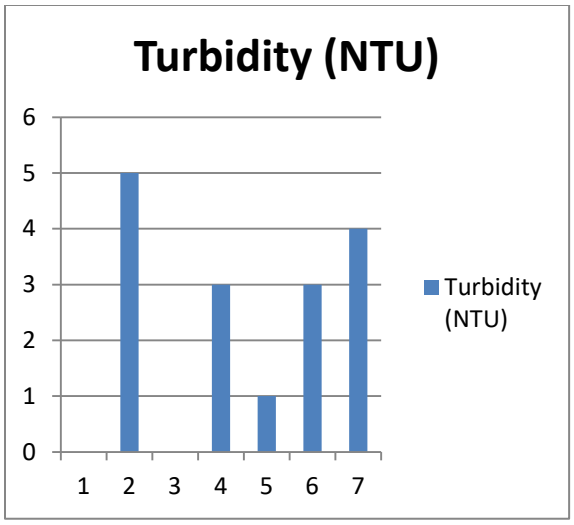


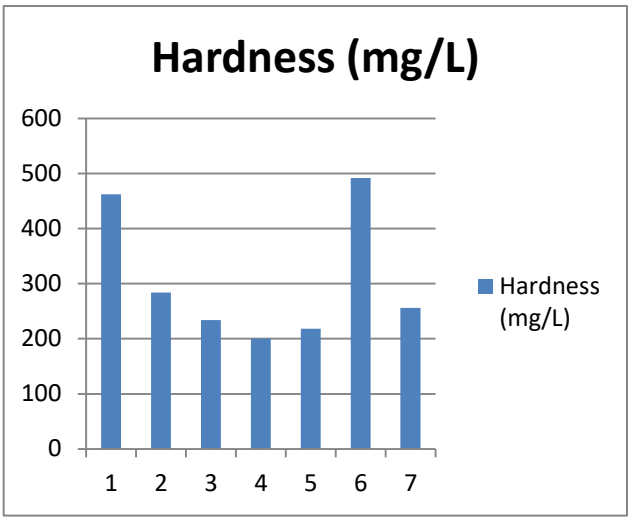


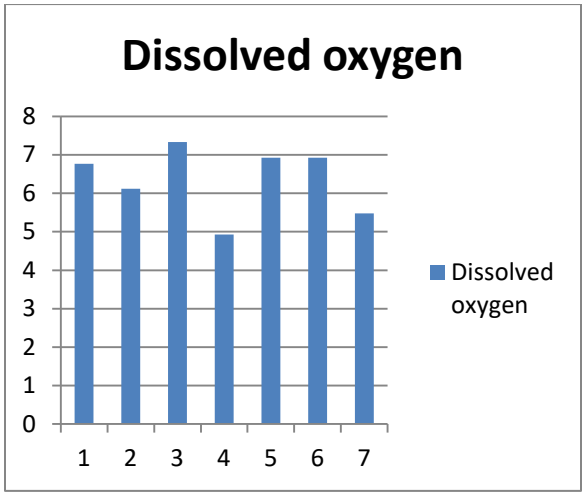







Turbidity (NTU)
6
5
4
3
2
1
0
1 2 3 4 5 6 7
Turbidity (NTU)


Hardness (mg/L)
600
500
400
300
200
100
0
1 2 3 4 5 6 7
Hardness (mg/L)


Dissolved oxygen
8
7
6
5
4
3
2
1
0
1 2 3 4 5 6 7
Dissolved oxygen

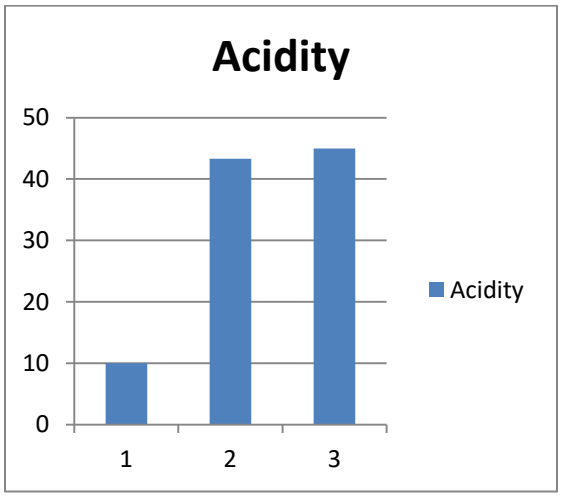
4.2.2 Spring Water

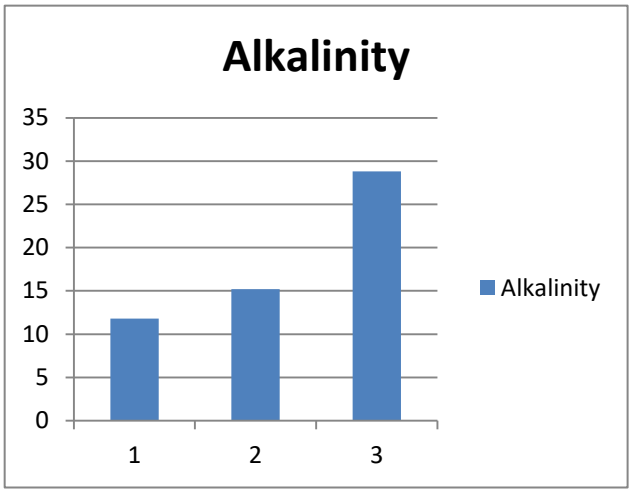
Parameters	sites			BIS(IS: 10500: 1991)	
	s1	s2	s3	Permissible	Desirable
Acidity (mg/L)	10	43.3	45		
Alkalinity (mg/L)	11.8	15.2	28.8	600mg/L	200mg/L
Chlorides (mg/L)	3.34	8.33	41.6	1000mg/L	250mg/L
pH	7	6.5	8	6.5-8.5	
Conductivity (mmho/cm)	0.12	1.08	0.65	1.8mmho/cm	1.14mmho/cm
Turbidity (NTU)	0	3	2	10NTU	5NTU
Hardness (mg/L)	204	1770	726	600mg/L	300mg/L
Total dissolved solids (mg/L)	40	1292	6500	2000mg/L	500mg/L
Dissolved oxygen	6.26	6.79	6.71	6.5-8.5	
WQI	15.02	194.78	541.776		

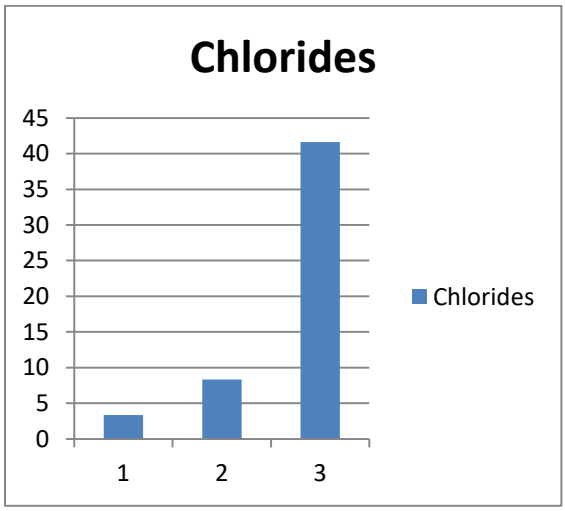
Table-9

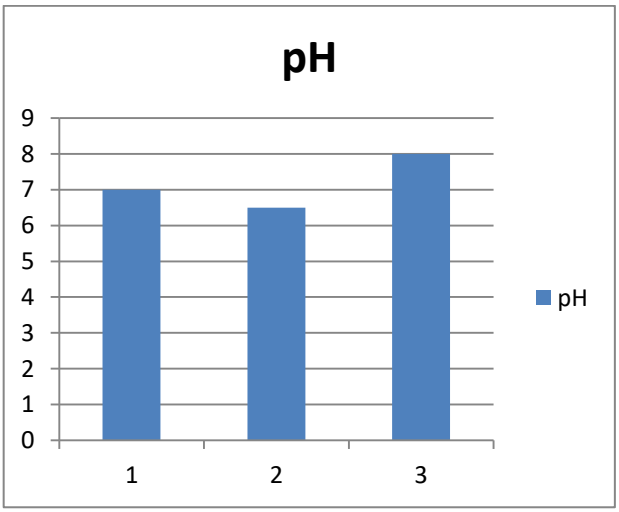
- Mohan meakin spring has most hardness whereas kotlanala spring has hardness not desirable but permissible.
- TDS is high in mohan meakin spring and kotlanala spring water.
- DO level is high in Waknaghat spring.

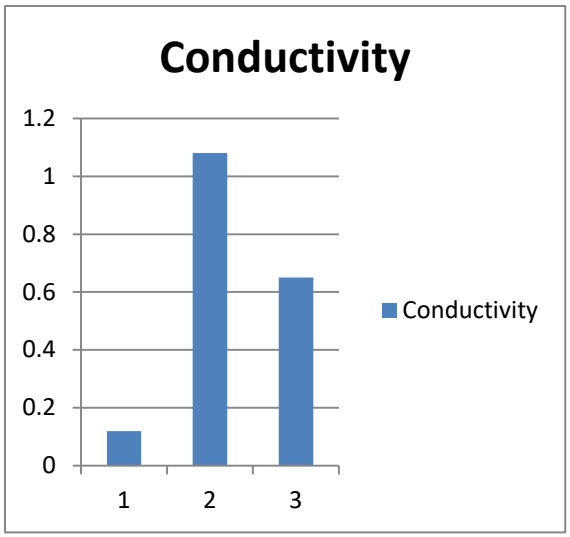
v) Graphs- Spring Water

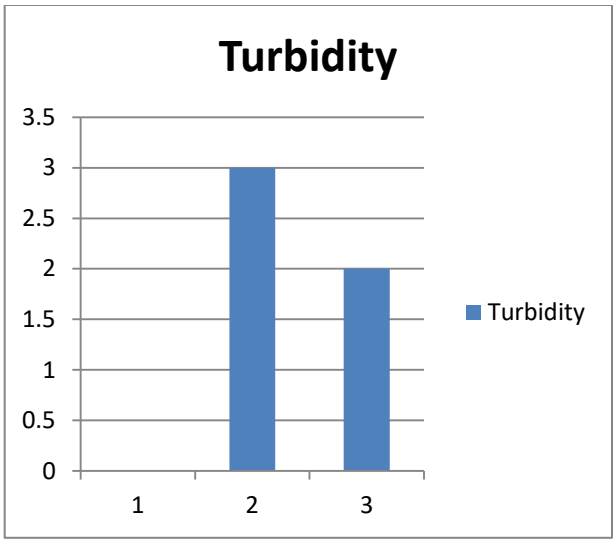


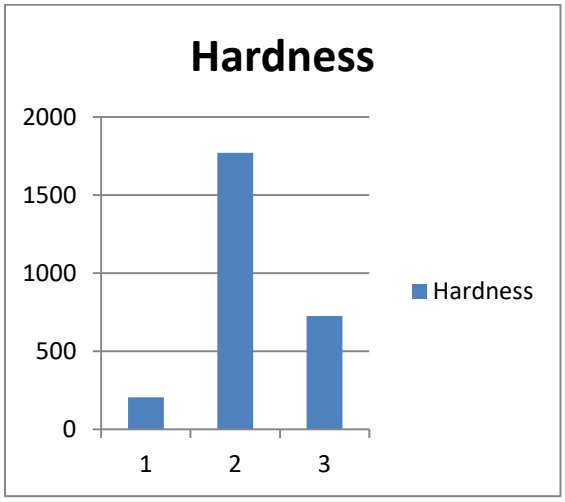


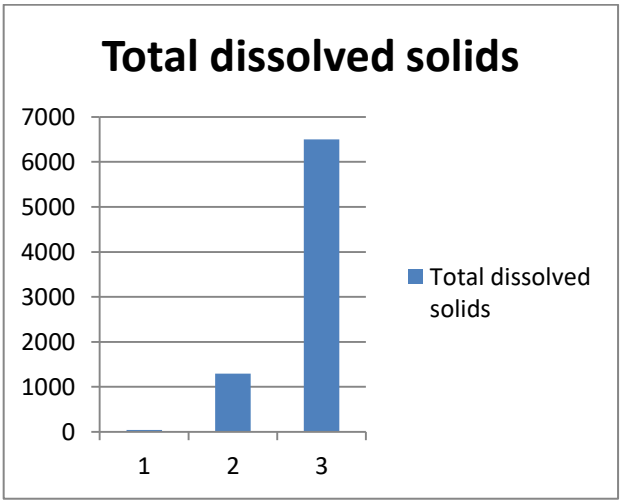


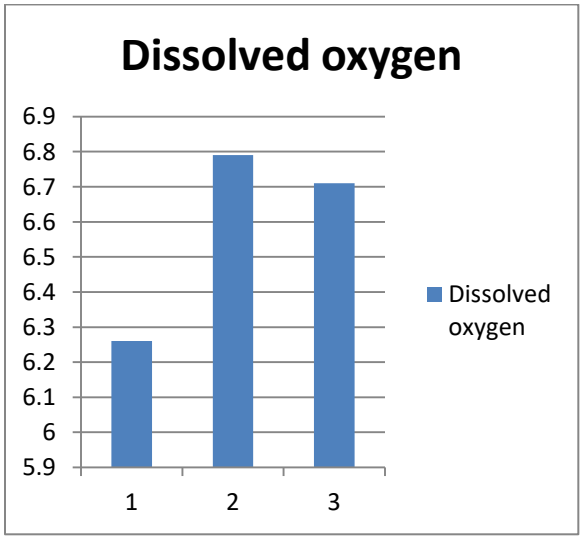



Conductivity
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
Conductivity


Turbidity
3.5
3
2.5
2
1.5
1
0.5
0
1
2
3
Turbidity


Hardness
2000
1500
1000
500
0
1
2
3
Hardness


Total dissolved solids
7000
6000
5000
4000
3000
2000
1000
0
1
2
3
Total dissolved solids


Dissolved oxygen
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6
5.9
1
2
3
Dissolved oxygen

Increase in acidity is due to change in temperature and that to an increment leading to high acidic nature of water, also alkalinity increases and the reason might be more of carbonate and bicarbonate ions. These two parameters are so arranged that pH lies in near neutral range.

Chloride is high in kotlanala spring and the reason behind is the presence of some rocks or source inside the earth which is made of KCl or $CaCl_2$.

Water of mohan mk. and kotlanala spring is turbid also water of kotlanala has high level of TDS that says there is more of dissolved solids in kotlanala water and more o suspended solid would be there in he mohan mk. Water.

Conductivity and hardness of mohan mk. is more suggesting that salts present of calcium and magnesium have dissociated into ions at high temperature leading to conductivity.

DO of is increased at mohan mk. and kotlanala. Reason might be the high temperature which lets the oxygen be used by the atmosphere and growing bacteria.

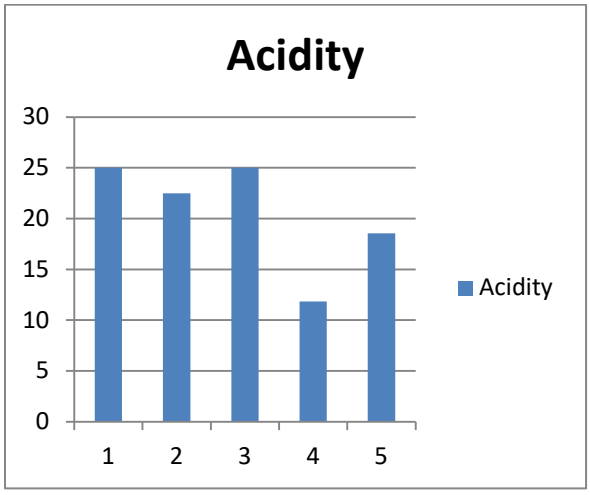
4.2.3 Surface water

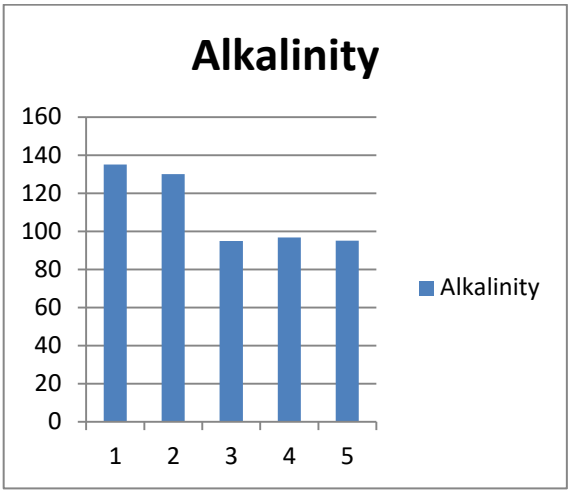
Parameters	Sites					BIS Standard(IS: 10500: 1991)	
	s1	s2	s3	s4	s5	permissible	Desirable
Acidity (mg/L)	25	22.5	25	11.83	18.56		
Alkalinity (mg/L)	135	130	95	96.7	95.14	600mg/L	200mg/L
Chlorides (mg/L)	10	6.66	6.66	11.66	8.6	1000mg/L	250mg/L
pH	6.5	6.5	6.5	8	7.5	6.5-8.5	
Conductivity (mmho/cm)	0.28	0.25	0.825	0.62	0.6	1.8mmho/cm	1.14mmho/cm
Turbidity (NTU)	0	2	2	0	2	10NTU	5NTU
Hardness (mg/L)	206	222	524	806	804	600mg/L	300mg/L
Total dissolved solids (mg/L)	203	123	1563	627	432	2000mg/L	500mg/L
Dissolved oxygen	8.01	7.23	6.3	6.99	5.68	6.5-8.5	
WQI	33.71	27.65	151.8	96.72	81.15		

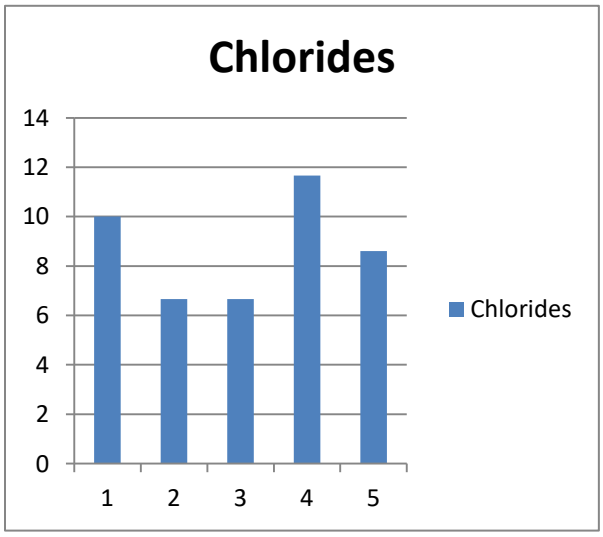
Table-10

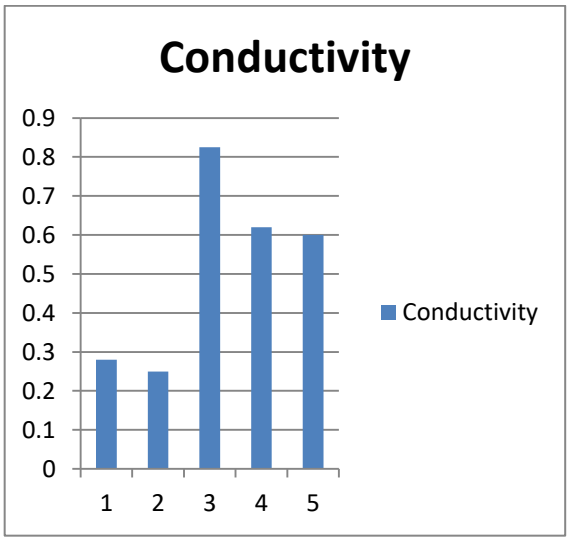
- Hardness level is high in shogi, kandaghat and solan supply waters.
- Content of TDS is high in shogi and kandaghat supply water and low in lakkar bazar drinking water, Shimla drinking water and solan drinking water.
- DO level is low in shogi and solan supply waters.

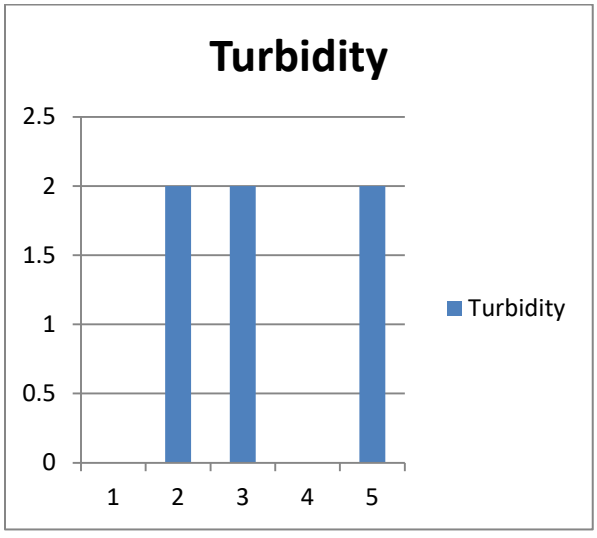
vi) Graphs- Surface Water

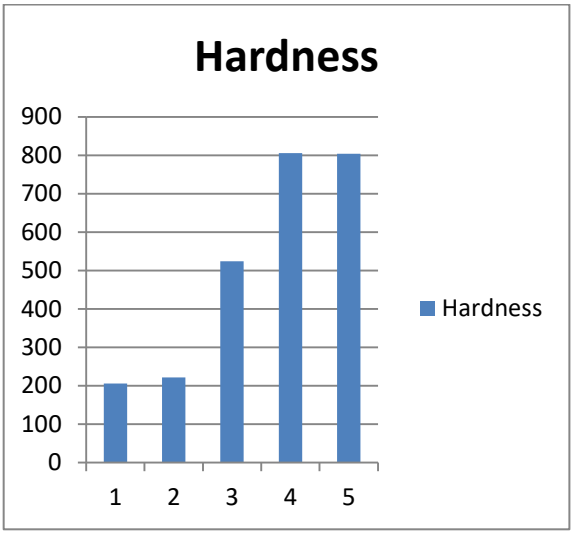


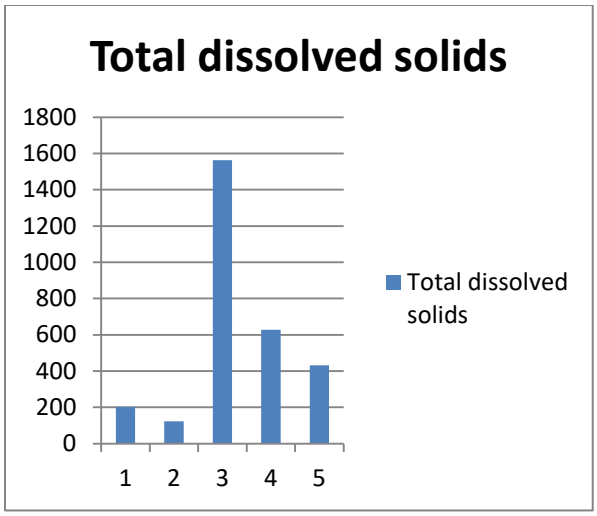


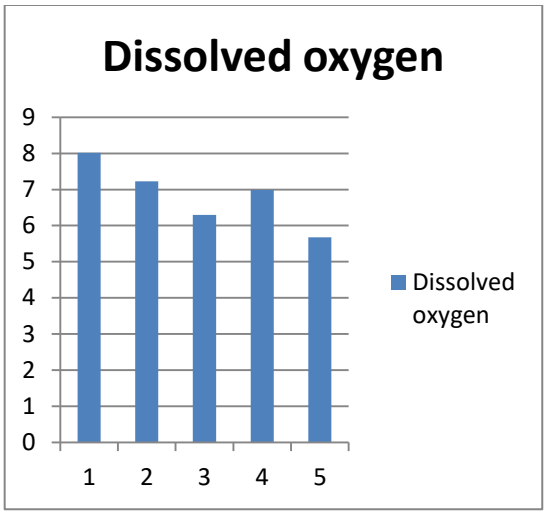


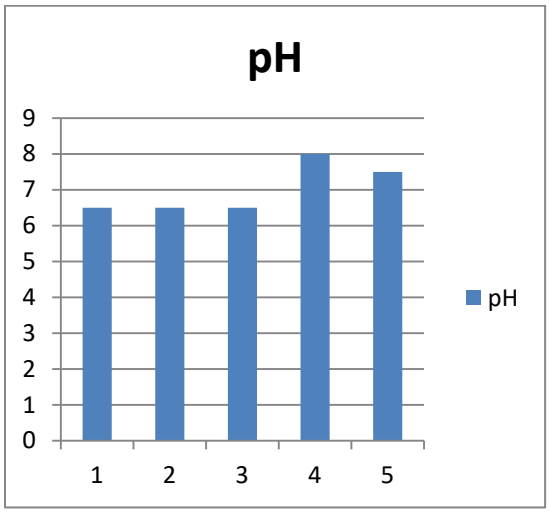












Acidity is decreasing down the lane and the reason behind might be the scorching heat conditions at altitude leading to dissociation of water into hydrogen and hydroxyl ions. More of hydrogen ions increase acidity. Down the lane acidity is less for their might be a drop in the temperature due to location of the sampling points.

Alkalinity is also decreasing down the lane suggesting an apt reason of presence of more carbonates and bicarbonates in the water which gets washed away depositing the salts riverside down the stream.

pH lies in the desirable range.

DO is decreasing down the lane because of the increasing temperature downstream which leads to the usage of oxygen by the atmosphere and also there might be a possibility of more BOD demand by the bacterial growth.

Turbidity is high in Shimla, shogi and solan drinking water as there would be more of suspended and dissolved solids in the these samples whereas TDS level of shogi water is high which shows that there is more of suspended solids in the samples making it turbid.

Conductivity is increasing down the lane but maximum is of shogi and the reason behind would be the presence of ions due to high temperature which leads to dissociation of salts and more of randomness.

Hardness increases down the lane which shows the increase in the level of calcium and magnesium salts which the surface water would have carried down the lane from some nearby sources

4.3 Quality Of water

As per the water quality index values, the water can be classified into five categories i.e., excellent water (<50); good water (50–100); poor water (100–200); very poor water (200– 300); and water unsuitable for drinking purposes (>300).

Sampling points	Quality in winters	Quality in summers
tattapani	Poor	Very poor
Lakkad bazar handpump	Poor	Good
Lakkar bazar bawdi	Good	Good
Shogi handpump	Good	Good
Panog bawdi	Poor	Very good
Kandaghat handpump	Good	Good
Solan handpump	Poor	Very good
Waknaghat spring	Excellent	Very good
Mohan meakin spring	Poor	Poor
Kotlanala spring	Unsuitable	Unsuitable
Lakkar bazar drinking water	Good	Very good
Shimla drinking water	Good	Very good
Shogi supply water	Good	Poor
Kandaghat drinking water	Good	Good
Solan drinking water	Good	Good

Table-11

Chapter 5

Conclusion

Conclusion drawn is that the parameters experience a change down the lane

1. There is a change of acidity due to temperature difference.
2. Alkalinity is changed due to salts of carbonates and bicarbonates which might strike the water in the form of stone, rocks or some other source.
3. Hardness is also observed to be increasing leading to more of calcium and magnesium salts in the water down the lane.
4. Turbidity and TDS have a correlation. There is a fair graphing which shows that where turbidity is high TDS level too goes high i.e. there is more of suspended solids but in case the turbidity is absent and TDS level is high there is more of of dissolved solids in the water.
5. Increasing conductivity is the reason of randomness of ions and dissociation of ions too.
6. pH is in the near neutral range as acidity and alkalinity counter each other by their own reason of existence.
7. DO in total is decreasing because of the bacterial growth, increase in temperature that leads to usage of oxygen by the atmosphere or aquatic life consuming more of DO.
8. Chlorides are randomly changing depending upon the availability of carbonates and bicarbonates.
9. Also there is a change in the summers and winters as in summers high temperature brings upon the changes down the lane because on the mountains, down the lane, temperature shows a drastic change.
10. Also the change in the surface water is considerable as compared to surface water because of the maintained temperature underground. But hardness, alkalinity, conductivity, TDS and turbidity has a change and high values somewhere due to presence of filtration beds that might add on to their characteristics. Salts are high because of presence of some or the other bed beneath composed of unwanted material.
11. BOD and COD increases with the change in temperature. As the rate of reaction and bacterial growth increases the consumption of oxygen, COD and BOD experiences a drastic change and they increase with temperature. Water has been analyzed and characterized accordingly. Change is observed and reasons are laid to compensate the degrading quality.

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