“Parametric Evaluation of Water Characteristics from 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)

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To

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **“Parametric Evaluation on Water Characteristics – 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 *Palden Phuntshok (141618), Karma Jamtsho (141634) and Jamyang Khandu (141635)* during a period from January 2018 to May 2018 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.

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Chapter 1

Introduction

1.1 General Introduction.

Water superiority examination is the rudimentary piece of the natural building. Water expect the simplest part in every single one of the fields. private purposes and current day clarifications behind existing are the consistent stream organizations of water however as it comes to societal utilizations it remains with a fundamental influence on the living creatures and sea lives. Examination of water is a wide multiplicity of practices. Physical substance and normal parameters should have remained complete due with the accomplishment of the breathing people around. There are description and numerical focal points of the endeavor. Description targets portray general delineations of water quality which are controlled over toxic substance control measure. Numerical objectives typically describe pollutant concentrations, physical/chemical conditions of the water itself, and the toxicity of the water to aquatic organisms.

Our project consists of eight different samples of underground water and surface water from water sources available between Shimla to Solan. These water samples are collected twice a week and various experiments are performed on them and their results are tabulated in an excel sheet, evaluated, analyzed and plotted on graphs on a monthly basis, seasonal basis and even annual basis. We performed experiments as follows:

1. PH
2. Dissolved Oxygen
3. Turbidity
4. Electrical Conductivity
5. Total Hardness
6. Chloride Content
7. Acidity
8. Alkalinity

These are some of the physical and chemical parameters of the water characteristics which enable us to determine the water quality index and whether the particular water is consumable or not. We can also determine its suitability in domestic and industrial purposes.

The steps we implemented to continue with this project are as follows:

1. Determine the objectives and scope of the project scheduled.
2. Map out the location and site to determine the number and type of samples needed.
3. Collect the samples and accurately analyze and select the specific chemical and physical indicators which are relevant to the objectives of this project.
4. Label, preserve, store and transport sample appropriately for the analysis.
5. After the laboratory analysis, report the results and tabulate accurately.
6. From the results, locate the unusual variations and analyze them.

1.2 Objective and Scope.

There are description and numerical targets of the task. Description destinations designate the general depictions of water quality which are controlled through the toxin rheostat measures. They are additionally the reason for the enhancement of definite numerical destinations. Numerical targets were created to constrain the unfriendly impacts of the toxins in the water segment.

- The different water quality parameters generally experience a variation while flowing from upstream to downstream with most parameters showing a decrease as the water travels downstream. In this context, the water quality characteristics are monitored wherein water flows from Shimla to Solan.
- To analyze and determine the variation of the water quality characteristics seasonally and annually for both surface and subsurface sources.
- To determine the water quality index for varying water samples.
- Suggest suitable remedial measures if certain parameters exceed the prescribed limits.

1.3 Water Characteristics and Parameters

Water attributes are represented by parameters, for example, physical, chemical, and organic variables. Physical parameters incorporate temperature and turbidity. Chemical parameters incorporate parameters, for example, pH and broke up oxygen. Natural elements incorporate green growth and phytoplankton. These parameters are useful for both ground water and surface water sources. The physical and chemical properties of a water body rely upon the climatic, geochemical, geomorphological and contamination conditions winning in the seepage bowl and the basic aquifer. Compound nature of water bodies can be estimated by reasonable investigative technique yet organic quality is a blend of both subjective and quantitative portrayal.

Water quality is controlled by physical, chemical and microbiological properties of water. This water quality attributes all through the world are described with wide fluctuation. Thusly the nature of normal water sources utilized for various purposes ought to be set up as far as the particular water-quality parameters that most influence the conceivable utilization of water. Physical qualities of water (temperature, shading, taste, scent and so on.) are dictated by faculties of touch, sight, smell, and taste. For instance, temperature by touch, shading, gliding trash, turbidity and suspended solids by sight, and taste and scent by smell. The compound attributes of characteristic water are an impression of the dirts and rocks with which the water has been in contact. Also, farming and urban spillover and civil and mechanical treated wastewater affect the water quality. Microbial and concoction changes likewise influence the substance qualities of water.

Chapter 2

Literature Review

S. P. Bhalme and Dr. P. B. Nagarnaik: "Analysis of Drinking Water of Different Places" Vol. 2, Issue 3, May-Jun 2012, pp.3155-3158.

The examination relies upon the examination of drinking water parameters in an Educational foundation masterminded in Hingna MIDC locale, Nagpur. In this paper, unmistakable makers' papers inclinations of Arubabh Mishra and Vasishta Bhat are compressed on water examination and their treatment shapes in different region, which is valuable to know the assorted treatment strategies and parameters used as a piece of the examination.

S. B. Bakare and A. O. Babatunde: "Microbial and Chemical Analysis of Potable Water in Public Place – Water Supply within Lagos University".

Water illustrations were gathered especially into sterile bottles at four specific focuses Inside of Lagos State-claimed University, Ojo . The water cases were straight risked to both substance and microbiological examination so as to appraise the nature of consumable water in Dinner inside the college grounds and order its wellsprings of contamination. Levels of iron, calcium and magnesium quantifiable in the circling drinking water were far underneath the WHO said limits. Be that as it may, all the more hypothetically tricky experience was the level of Coliform polluting influence which far surpasses the WHO esteems. There is the requirement for tolerable changes to be made at focuses where water circulation. Frameworks veracity appeared collaborated. The college group is encouraged to bubble water before admission so as to avoid drinking of unpalatable organic specialists in the water supply frameworks.

P.N Patil, D.V Sawant and R.N Deshmukh: "Physico-chemical parameters for testing of water''- International Journal of Environmental Sciences Vol. 3, Issue 3, 2012.

People around the globe are under immense threat as a result of undesired changes in the physical, blend and normal properties of air, water and soil. Due to extended human masses, industrialization, use of fertilizers and man-impacted activity to water is uncommonly dirtied with different terrible contaminants. It is essential that the idea of drinking water should be checked at a reliable time interval. The openness of good quality water is a basic component for keeping away from sicknesses and improving individual fulfillment. It is critical to know experiences about different physic-creation parameters, for instance, shading, temperature, causticity, hardness, pH, sulfate, chloride, DO, BOD, COD, alkalinity used for testing of water quality. Some water examination reports with physic-compound parameters have been given for the researching parameter think about.

Sabrina Sorlini, Daniela Palazzini, J. M. Sieliechi and M. B. Ngassoum: "Assessment of Physical-Chemical Drinking Water Quality in the Logon Valley"

Risky drinking water is one of the principle worries in creating nations. Keeping in mind the end goal to manage this issue, a participation venture was set up by the ACRA Foundation in the Logone valley (Chad-Cameroon). Water supplies were examined all through the towns of this region for the most part from boreholes, open wells, waterways and lakes and also some funneled waters. Aftereffects of the evaluation affirmed that in the considered territory there are a few parameters of wellbeing and stylish concern. Raised lead levels were identified both in aquifers and in surface waters. Also, numerous groundwater sources are contrarily affected by parameters of stylish concern, for example, turbidity, iron and manganese. Despite the fact that they don't influence human wellbeing, lifted levels of these parameters make buyers forsake enhanced water supplies, regularly for surface water sources that are microbiologically sullied.

S. P. Gorde and M. V. Jadhav: "Assessment of Water Quality Parameters"- Vol. 3, Issue 6, Nov-Dec 2013, pp.2029-2035.

It depends on the investigation of water quality file (WQI) that has been ascertained for various surface water assets particularly lakes (Pravara River Water, Lonar Lake, Hebbal pool of Mysore) for the session January to December 2008, including three seasons, summer, winter and stormy season. The regular estimations of WQI demonstrate that amid summer season, lake water is more influenced than amid winter. This could be because of the way that the microbial movement gets diminished because of low temperature, subsequently keeping DO level at an exceptionally tasteful range amid whole winter season. Consequence of water quality evaluation obviously demonstrated that a large portion of the water quality parameters marginally higher in the wet season than in the dry season. The proposed measures to enhance the lake water quality incorporates add up to prohibition on the exercises that causes contamination.

Arvind Prasad Dwived: "Assessment of Physico-Chemical Studies on Groundwater in and Around Banda City, Uttar Pradesh" Vol. 1 Issue 6, August – 2017, pp. 1-9

The present examination was explored different physic-compound parameters like Temperature, pH, DO, COD, TDS, TSS, Alkalinity, Total Hardness, Nitrate, Chloride and Sulfate and so on. The consequences of the above work demonstrate that a large portion of the physico-synthetic Parameters are well inside as far as possible. DO was accounted for at all the inspecting station are more than as far as possible. Fifteen percent tests of BOD are higher than as far as possible recommended by WHO. COD was found at inspecting station are surpassing the farthest point. Mn and Cr were identified at all the examples were beneath the admissible furthest reaches of WHO.

K. P. Ranjith, N. N. Raman, P. Pranav, D. Pamanna, Adnan Amin and S. S. Sumanjali: "**The physico-chemical characteristics of Vembanad backwaters at Eramalloor region, Alappuzha district, Kerala"- International Journal of Fisheries and Aquatic Studies 2017; Vol.5 Issue 5, pp. 258-262.**

The present examination was done on Vembanad Lake in the Eramalloor locale of Ernakulam region, Alappuzha, Kerala. The examination was completed for a time of 11 months from September 2015 to July 2016. Amid the investigation, the normal temperature was 29.0ºC, the least disintegrated oxygen was seen amid the long stretch of March 3.8 mg/l, pH was watched most extreme in the period of May (8.1) and least (6.2) in the long stretch of October. The normal alkalinity was 90.98 mg/l.The show examination about the Physio-Chemical Characteristics, demonstrates all the water quality parameters are inside the cutoff points. Typically Monsoon season is an awesome effect on hydrobiologiacal parameters at consider locale.

Chadetrik Rout and Arabinda Sharma: "Assessment of drinking water quality: A case study of Ambala cantonment area, Haryana, India"-Vol. 2, Issue 2, 2011.

Water is a key asset for human survival. In the present examination, the physico-concoction attributes of groundwater of Ambala Cantonment zone were evaluated for its appropriateness for drinking purposes. An aggregate of 26 water tests were gathered from profound aquifer based tube wells from various parts of Ambala Cantonment zone. With a specific end goal to evaluate the ground water quality, the water tests were broke down for various physico-compound properties. All the physio-synthetic parameters were observed to be in the endorsed allowable point of confinement .From the pH esteems plainly the ground water of the examination region is soluble in nature and the aggregate hardness differs in the middle of 116.6mg/l - 129.4 mg/l, which shows that water in the profound aquifer is respectably hard. Consequently it is proposed to the cantonment areas to relax the tube well water before utilization. It can be inferred that groundwater is ok to drink purposes from the perspective of levels of pH, EC, TDS, TA, and Cl^-.

R. P. Chopra and Krishan: "Assessment of Ground Water Quality in Punjab, India", Volume 5, Issue 10.

In the present investigation, groundwater quality in regard of local groundwater has been resolved in the whole State of Punjab amid the establishment of perception wells under World Bank supported Hydrology Project Phase II attempted amid 2009-2014 by Water Resources and Environment Directorate, Punjab. The consequences of examining done amid establishment of perception wells demonstrate that the groundwater quality in the profundity scope of 45-60 m based on Electrical Conductivity and Residual Sodium Carbonate is sorted as: fit in 53% and minimal in 22% and unfit in 25%. The spatial dissemination of the groundwater quality demonstrates that the vast majority of the parts of Upper Bari Doab Canal Tract (UBDC) and Bist Doab Tract (BD) are fall in fit class while a large portion of the south-western part falls in minor to unfit classification showing high saltiness water, which can't be utilized for water system purposes. In such conditions, the dirt must be penetrable, seepage must be sufficient, water system water must be connected in overabundance to give significant draining and salt-tolerant harvests/plants ought to be chosen.

P. J. Puri, M. K. N. Yenkie, S.P. Sangal , N.V. Gandhare , G. B. Sarote and D. B. Dhanorkar (2011)- "Surface Water (lakes) quality assessment in Nagpur city (India) based on water quality index"

This paper is planned to be an examination worried with surface water (lakes) quality in Nagpur city (India) in view of water quality record (WQI). In exhibit contemplate, water quality record (WQI) has been figured for various surface water assets particularly lakes, in Nagpur city, Maharashtra, (India), for the session January to December 2008; including three seasons, summer, winter and stormy season. Examining focuses were chosen based on their significance. Water quality record was ascertained utilizing water quality list adding machine given by National Sanitation Foundation (NSF) data framework. The ascertained (WQI) for different contemplated lakes demonstrated reasonable water quality in rainstorm season which at that point changed to medium in winter and poor for summer season. Gorewada Lake indicated medium water quality rating in all season with the exception of storm season. Futala, Ambazari and Gandhisagar Lake has additionally declined in stylish quality over past decade following attack of amphibian weeds, for example, hydrilla and water primrose, so the motivations to import water quality change and measures to be taken up as far as surface water (lakes) quality administration are required.

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 fundamental Asian uber deltas square measure portrayed by tough regular varieties identified with storm precipitation. To determine pattern and regular parts in week by week groundwater levels inside the Ganges-Brahmaputra-Meghna (GBM) Delta, we have a tendency to apply a measurement occasional pattern disintegration method (STL) to perceptions aggregated from 1985– 2005 in Asian country. Regularity overwhelms determined change in groundwater levels however declining groundwater levels (>1 m/yr) square measure distinguished in urban and peri-urban regions around Dhaka also as in north-focal, northwestern, and southwestern parts of the nation (0.1– 0.5 m/yr) wherever serious reflection of groundwater is led for dry-season rice development. Rising groundwater levels (0.5– 2.5 cm/yr) square measure saw inside the waterway and southern beach front areas. This novel utilization of the STL system uncovers, for the essential time, the unsustainability of water system gave by shallow aquifers in a few territories (e.g. High Barind Tract) of the GBM Delta and furthermore the hydrological effect of potential water interruption of seaside aquifers identified with swamp rise. Our discoveries give essential understanding into the hydrological effects of groundwater-nourished water system and swamp ascend in various Asian uber deltas wherever recognition data square measure restricted. Primrose, so the motivations to import water quality change and measures to be taken up regarding surface water (lakes) quality administration are required.

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

The region in Guntur region, Andhra Pradesh, India, is talked about the effect of occasional variety of groundwater quality on water system and human wellbeing, wherever the horticulture is that the principle keep of country people and the groundwater is that the fundamental supply for water system and drinking. Stone gneisses identified with schist's and charnockites of the Precambrian Eastern Ghats underlie the domain. Groundwater tests gathered regularly, pre-and post-rainstorm, amid 3 years from forty wells in the space were broke down for pH scale, EC, TDS, TA, TH, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, $CO_3\ ^{2}$, HCO_3^{1-}, Cl^{1-}, SO_4^{2-}, NO_3 and F. The compound connections in Piper's graph, Chebotarev's hereditary characterization and Gibbs' outline direct that the ground waters basically have a place with noncarbonated soluble base sort and Cl^{-} group, and zone unit controlled by dissipation strength, individually, because of the impact of semiarid atmosphere, delicate slant, drowsy discharging conditions, more prominent water– shake communication, and anthropogenic exercises. A correlation of the groundwater quality in connection to water quality norms demonstrates that most of the water tests don't appear to be fitting for drinking, especially in post-rainstorm period. Joined States of America Salinity Laboratory's and Wilcox's charts, and $\%Na^{+}$ utilized for assessing the water quality for water system direct that most of the groundwater tests are not sensible for water system in post storm thought about thereto in pre rainstorm.

Chapter 3

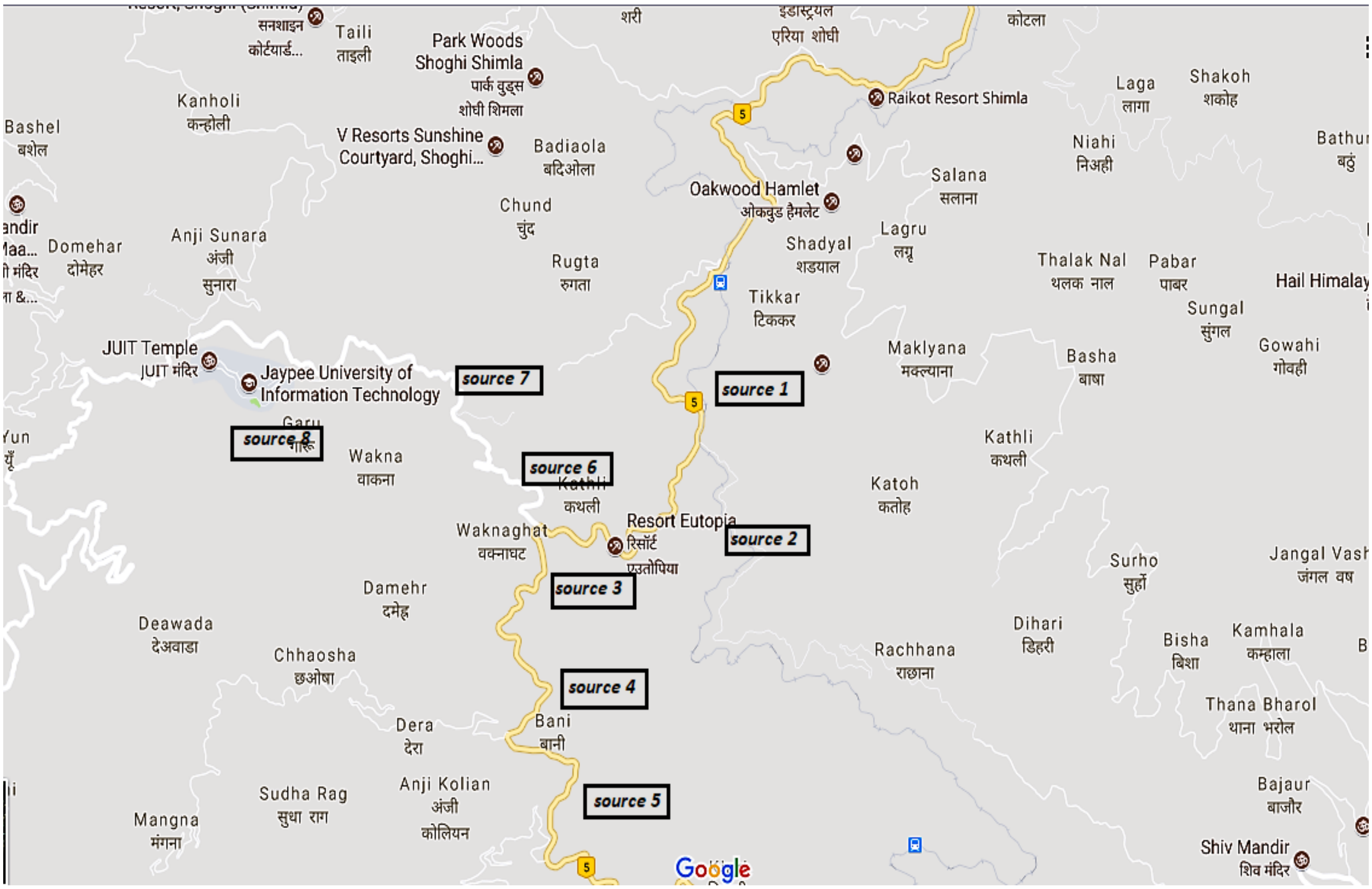
Methodology

3.1 Site Locations

Our main objective is to assess the quality of the water at the sites from where the samples are collected. In the locating and the selecting part of the site, the following general criteria are usually applicable: (Environmental Engineering (Volume 1) - S.K. Garg)

1. Sampling points should be selected such that the samples taken are representative of the different sources from which water is obtained by the public or enters the system.
2. These points should include those sites that have a sample representing the conditions at the most unfavorable sources or places in the supply system, particularly the points of possible contamination such as unprotected sources, loops, reservoirs etc.
3. The points chosen should generally yield samples that are representative of the system as a whole and of its main components.
4. Sampling points should be located in such a way that water can be sampled from reserve tanks and reservoirs, etc.
5. In systems with more than one water source, the locations of the sampling points should take account of the number of inhabitants served by each source.

3.2 Map of the Sites



Between Solan and Shimla, we located 8 water sources which include both surface and ground water and performed tests on water samples twice a week. We performed tests on the various water samples given in the table 2.

The following table represents the type of water of the site we have selected to perform experiments.

Table 1: Types of Water samples

Water types	Sample No.
Surface water	S1, S3, S4, S8
Sub- Surface water	S2, S5, S6, S7

3.3 Analytical methods

We have two kind of water samples collected from eight different sources namely surface water sources and sub-surface water sources. For these two type of water sources, there are different fundamental parameters considered based on the type of water sources. Since it is the water supply that we are more concerned about and since the water has been already assumed to be treated, we are not concerned about the water going to a treatment plant. Thus we have not considered the fundamental parameters such as chemical oxygen demand, biological oxygen demand etc... So therefore, we have considered only those fundamental parameters which are given in the table below.

Table 2: Methodological details

Sl.no	Parameters	Apparatus	Method
1	pH	pH papers	Instrumental
2	Conductivity	Conductivity meter	Titrimetric
3	Acidity	Titration with Std.NaOH solution	Titrimetric
4	Alkalinity	Titration with Std.H_2SO_4	Titrimetric
5	Turbidity	Turbidity meter	Instrumental
6	Chloride content	Titration Std. $AgNO_3$, Std.NaCl	Titrimetric
7	Total hardness	Titration with Buffer solution and Std. EDTA solution	Titrimetric
8	Dissolved oxygen	HQD portable meter	Instrumental/Titrimetric
9	Total Dissolved Solids	Oven	Oven dried Method

3.4 Parameters Tested and Procedures

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

1. pH.

pH is a measure of how basic or acidic the water is. pH is a measure of the relative amount of free hydrogen and hydroxyl ions in the water. It ranges from 0 - 14, with 7 being neutral. pH less than 7 specifies acidity, whereas a pH greater than 7 specifies a base. 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". pH is most important in determining the corrosive nature of water. Lower the pH value higher is the destructive nature of water. pH was positively correlated with electrical conductance and total alkalinity.

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

2. EC (electrical conductivity).

Electrical conductivity is a result from the motion of electrically charged particles in reaction to forces that act on them from an applied electric field. Conductivity displays significant correlation with ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, and chloride and iron concentration of water. A current ascend from the flow of electrons in most solid materials, which is called electronic conduction. Electronic conduction exists in all conductors, semiconductors, and many insulated materials and the electrical conductivity is dependent on the number of electrons available to participate to the conduction process. Pure water is not a good conductor of electricity.

Procedure:

1. Switch on the conductivity meter fir 15 minutes prior to the experiment.

2. Take out the conductivity cell dipped in distilled water, wash it with distilled water and wipe it dry with tissue paper.

3. Calibrate the cell with standard 0.1N KCl solution of conductivity 14.12 mmhos at 30 C.

4. Take out the conductivity cell, wash it thoroughly with distilled water and wipe it dry.

5. Dip the cell in to sample solution, swirl the solution and wait up to 1 minute for steady reading.

6. Note down the instrument reading and also temperature by thermometer.

3. Turbidity

When light is passed through a sample having suspended particles some of the light is scattered by the particles. The scattering of the light is generally proportional to the turbidity. The turbidity of the sample is thus measured from amount of light scattered by the sample taking a reference with standard turbidity suspension.

Procedure:

1. Switch on the nephelometeric turbidity meter and wait for few minutes till it warms up.

2. Set the instrument at 100 on the scale with 40 NTU standard suspension. In this case every division on the scale will be equal to 0.4 NTU turbidity.

3. Shake the sample thoroughly and keep it for some time to eliminate the air bubbles.

4. Take the sample inn Nephelometer sample tube and put the sample in the sample chamber and find out the value on the scale.

5. Dilute the sample with turbidity free water and again read the turbidity.

4. Chloride concentration:

The Mohr method for determination of the chlorides in water is based upon the fact that in solution containing chloride and chromate, silver reacts with all the chloride and precipitates before reaction with chromate begins. The appearance of the brick-red color of the silver chromate precipitates is the end-point of the titration.

Reagents used:

1. Cl_2 free distilled water

2. K_2CrO_4 color indicator.

3. Standard $AgNO_3$ solution (0.0141N).

4. Standard KCl solution (0.0141N)

Procedure:

1. Take 100 ml of water sample in conical flask.

2. Adjust the pH between 7.0 and 8.0 either with sulphuric acid or sodium hydroxide solution.

3. Add 1 ml of potassium chromate indicator to get light yellow color.

4. Titrate with standard silver nitrate solution till color changes to brick-red from yellow.

5. Note down the volume of silver nitrate added (A).

6. For higher precision, titrate 100 ml of distilled water in the same way after adding 1 ml of potassium chromate indicator to establish reagent blank.

7. Note down the volume of silver nitrate added for distilled water (B).

Model calculation:

Chloride content in (mg\L) = $\frac{(A-B)*/normality\ of\ AgNO3*35.46*1000)}{\text{volume of sample taken.}}$

Where, A= ml of $AgNO_3$ required for the sample.

B= ml of $AgNO_3$ required for the blank.

5. 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. The ability of natural water to act as a buffer in part is controlled by the amount of calcium and carbonate ions in solution. Carbonate and Calcium ions come from limestone or calcium carbonate which elevates hardness and alkalinity.

In this Experiment take 50ml of water sample and add phenolphthalein indicator in it and sample turns pink. After that add sulphuric acid to the burette and titrate the sample till it changes it color to colorless. Note down the volume of sulphuric acid added (V_1).

Now add two drops of methyl orange indicator in the sample. The sample turns to yellow in color. Again titrate it with sulphuric acid until it changes its color to wine red and note down volume of H_2SO_4 used(V_2).The reagents that are used to calculate alkalinity in water samples are sulphuric acid, phenolphthalein, methyl orange and distilled water.

Model calculations:

1. Phenolphthalein alkalinity (P) mg/L) as $CaCO_3 = \frac{V1 * normality\ of\ H2SO4*1000*50}{volume\ of\ sample\ taken}$

2. Total alkalinity (T) (mg/L) as $CaCO_3 = \frac{(V2*1000)/}{volume\ of\ sample\ taken}$

3. Total acidity (as $CaCO_3$) = mineral acidity + CO_2 acidity

6. Acidity

Acidity is the capacity of water to nullify bases. Acidity is a collection of all titratable acid present in the water sample. Strong mineral acid and weak acids such as acetic acid, carbonic acid etc. present in the water sample subsidizes to acidity of water. Usually dissolved CO_2 is the major acidic component present in the unpolluted surface waters. The reagents used in this experiment are sodium hydroxide, sulphuric acid, methyl orange, phenolphthalein indicator and carbon dioxide free distilled water.

First add 50ml of water sample in the conical flask and add two drops of methyl orange indicator. The sample turn pink. After that titrate against 0.02N standard sodium hydroxide solution until the pink changes to yellow. Note down the volume of NaOH added (V_1).then take another 50ml of new sample and add phenolphthalein indicator and titrate is with sodium hydroxide till the color changes to red. Note down the total volume of NaOH added (V_2).

Model calculation:

i). Mineral acidity due to minerals acids (as $CaCO_3$) (mg\L) = $\frac{V1*1000}{volume\ of\ sample\ taken}$

ii). CO_2 acidity due to CO_2 (as $CaCO_3$) (mg\L) = $\frac{(V2*1000)/}{volume\ of\ sample\ taken}$

iii).Total acidity (as $CaCO_3$) = mineral acidity + CO_2 acidity

7. Hardness.

Water hardness is the amount of dissolved calcium and magnesium in the water. Hard water is high in dissolved minerals, both calcium and magnesium. There are two types of hardness namely

a) Temporary hardness: Temporary hardness is caused by dissolved calcium hydrogen carbonate which is removed by boiling.

b) Permanent hardness: Permanent hardness is caused by dissolved calcium sulfate which is not removed by boiling.

The reagents used in this experiment are ammonium chloride, ammonium hydroxide, EDTA, Erichrome Black-T and magnesium sulphate. Method to conduct this experiment is first take 50ml of water sample and add few drops of ammonia buffer and few drops of Erichrome black-T to it. After that titrate it with EDTA solution till its color changes to steel blue and note down the volume of EDTA solution used. After that to calculate the amount of permanent hardness take a known quantity of sample and boil it for sufficiently long period, cool and filter and repeat the above procedures.

Model calculations:

A) Total Hardness (mg\L) ($CaCO_3$ scale) = $\frac{ml\ of\ EDTA\ used\ (unboiled\ sample\ )*1000}{ml\ of\ sample\ used.}$

B) Permanent Hardness (mg\L) ($CaCO_3$ scale) = $\frac{ml\ of\ EDTA\ used(boiled\ sample)*1000}{ml\ of\ sample\ taken.}$

C) Temporary Hardness (mg\L) ($CaCO_3$ scale) = Total Hardness – Permanent Hardness

8. Dissolved oxygen.

DO is one amongst the foremost essential parameter of the water quality. DO is that the level of free, non-compound chemical element gift in water or different liquids. It’s a crucial parameter in evaluating water quality because it has nice impact on the creatures living at intervals a frame of water. Its association with water body provides direct and indirect facts e.g. microorganism activity, chemical change, convenience of nutrients, stratification etc. within the progress of summer, dissolved chemical element shriveled thanks to upsurge in temperature and conjointly thanks to inflated microbial activity. The high neutralize summer is thanks to increase in temperature and period of bright daylight has influence on the proportion of soluble gases (O^2 & CO^2).

Take the shape bottle and fill it fully with water sample and stream the surplus water. Currently take dissolved chemical element meter and calibrate the DO of the sample.

8. Turbidity

Turbidity is a qualitative characteristic divulged by solid particles obstructing the transmittance of light through a water sample. It is a technical term referring to the opacity of a solution. Turbidity indicates the presence of dispersed and suspended solids like clay, silt, organic matter, algae and other microorganisms.

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.

Chapter 4

Results and Discussions.

4.1 Results for Sub-Surface Water - Autumn season.

The tables underneath demonstrates the assessed aftereffect of the sub-surface water and surface water amid the long stretch of August 2017 to May 2018. Amid the timeframe, we performed following tests twice every week for better outcomes. The examining focuses are situated between Shimla and Solan.

Parameters	Sites				BIS standard IS:10500:1991	
	S2	S5	S6	S7	Permissible	Desirable
pH	7.4	7.3	7.4	7.3	6.5-8.5	
Dissolved oxygen (mg/L)	4.9	5.3	7.1	5.6	4	
Conductivity(µmhos/cm)	125.1	190.3	137.4	192.9		
Turbidity(NTU)	8.3	2.76	0	0	10NTU	5NTU
Chloride Content(mg/L)	15.2	16.4	16.1	13.7	1000(mg/L)	250(mg/L)
Total Hardness(mg/L)	88.2	115.1	120.6	106.4	600(mg/L)	300(mg/L)
Acidity(mg/L)	21.4	31.9	22.9	22.2		
Alkalinity (mg/L)	76.3	85.3	93.1	108.3	600(mg/L)	200(mg/L)
Water quality index(WQI)	60.5	64.1	44.3	54.1		

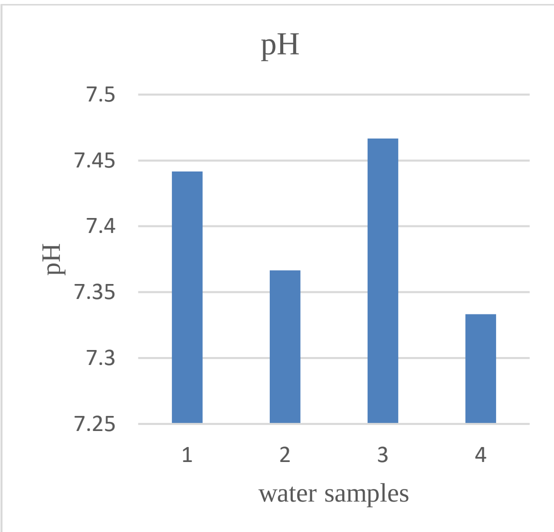
Table 3: Results for Sub-Surface Water - Autumn season.

- pH remains in as far as possible as in winters there is no expansion in particles because of separation.
- Conductivity is high in inspecting point four (hand pump), there may be a probability that it contains a greater amount of consistent salts that separated to shape particles because of a few reasons.
- Turbidity is high in inspecting point two. The reason may be that water originating from beneath the surface is either not separated appropriately or has a few contaminations.
- The chloride substances of all testing focuses are inside admissible points of confinement. There is increment in hardness downstream which demonstrates that downstream the salts of calcium and magnesium are expanding.

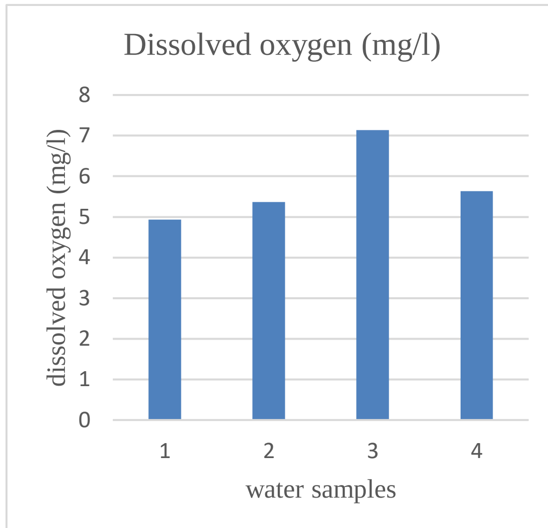
- The testing point six have high broken down oxygen, the reason may be because of bacterial development and low use of the hotspot for drinking purposes.

4.1.1 Figures of Sub surface water – Autumn season.

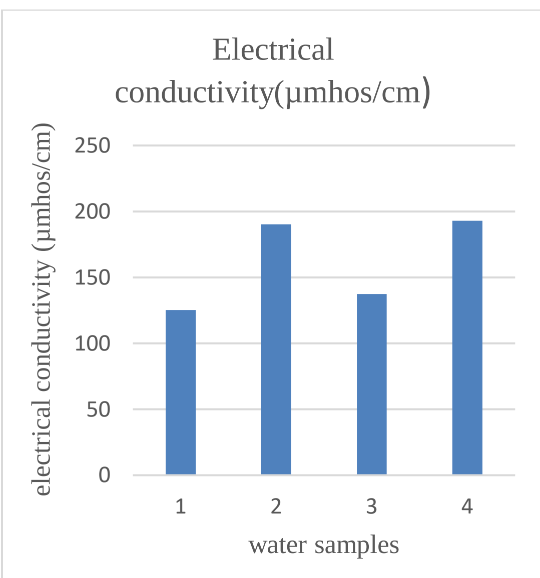
Figure 1

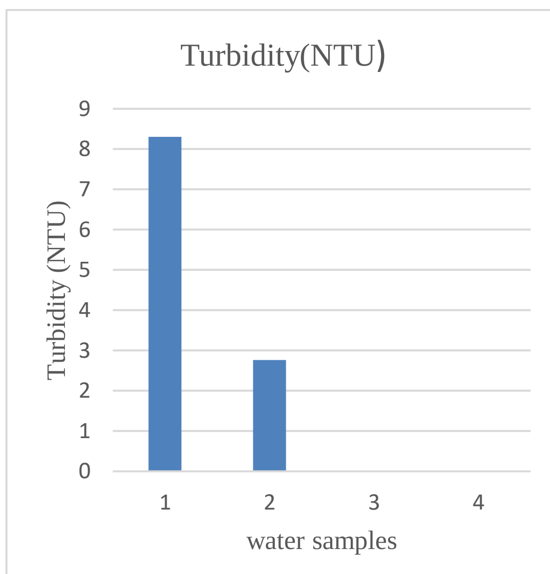


(Fig.1.a)

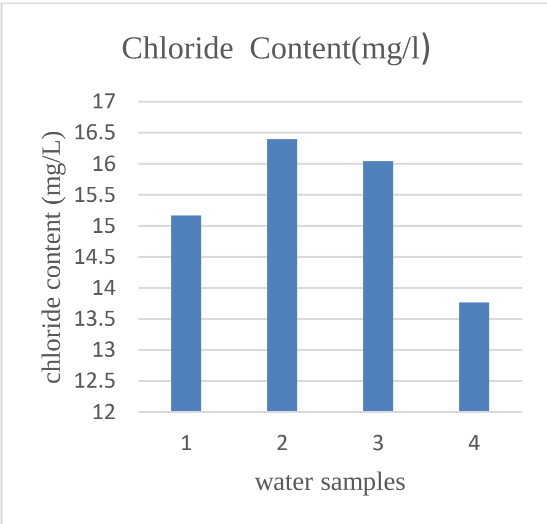


(Fig.1.b)

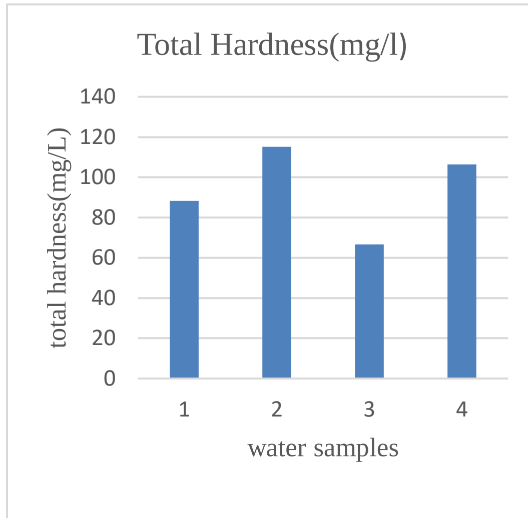




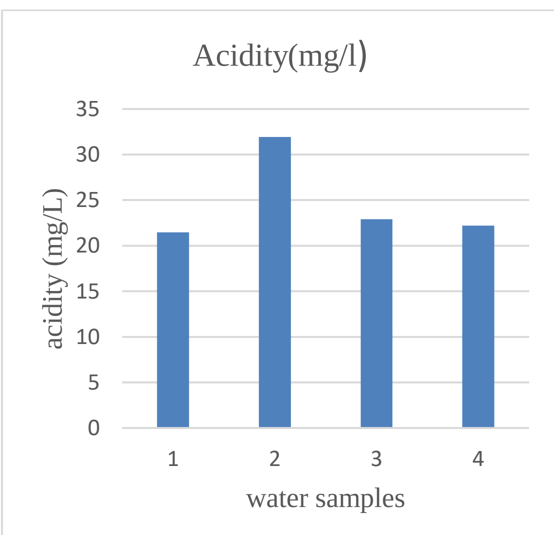
(Fig.1.c) (Fig.1.d)



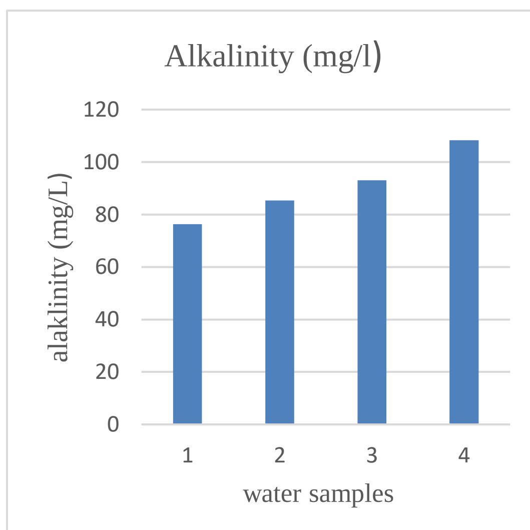
(Fig.1.e)



(Fig.1.f)



(Fig.1.g)



(Fig.1.h)

4.2 Results for Sub-Surface Water- Winter season.

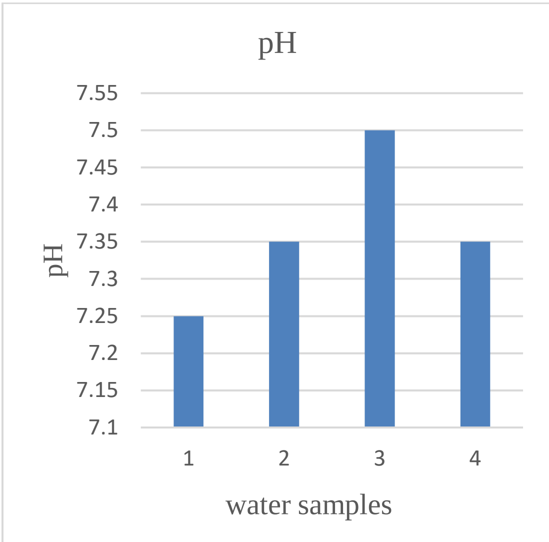
Parameters	Sites				BIS standard	IS:10500:1991
	S2	S5	S6	S7	Permissible	Desirable
pH	7.25	7.35	7.5	7.35	6.5-8.5	
Dissolved oxygen (mg/l)	5.5	5.65	5.2	4.55	4	
Conductivity(μmhos/cm)	122.3	61.75	99.6	205.3		
Turbidity(NTU)	16	8.5	2	7.15	10NTU	5NTU
Chloride Content(mg/l)	11.85	5.3	10.25	23	1000(mg/L)	250(mg/L)
Total Hardness(mg/l)	60.75	25	45.5	79.4	600(mg/L)	300(mg/L)
Acidity(mg/l)	19.75	12.75	16	38		
Alkalinity (mg/l)	77.75	34.75	50.5	97	600(mg/L)	200(mg/L)
Water quality index(WQI)	55.7	48.4	57.4	71.5		

Table 4: Results for Sub-Surface Water- Winter season.

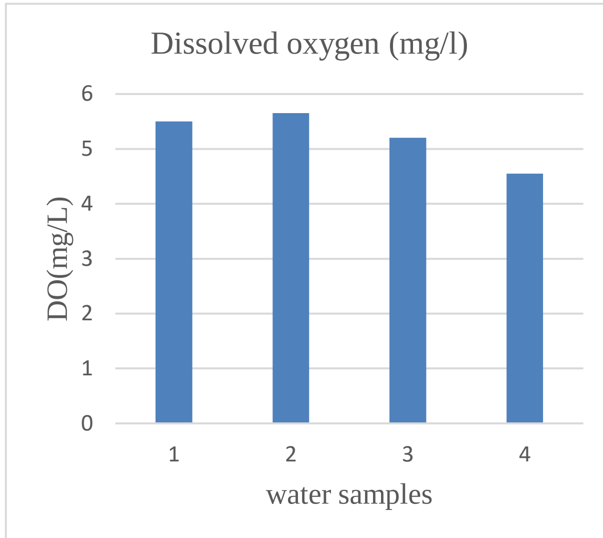
- pH remains in the permissible limit.
- Dissolved oxygen is above 4mg/l but it is slightly less than the permissible limit as it is dry season and there is less photosynthesis activities around the water sources thereby reducing the oxygen level.
- The conductivity is quite high. The reasons for the increase might be due to usage of chlorine for purify water. This Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, phosphate etc.
- Turbidity is caused by particles suspended or dissolved in water. The value of turbidity is high as our water sources lies along the highway and there is more pollution due to vehicles travelling along

4.2.1 Figures for Sub surface water – Winter season

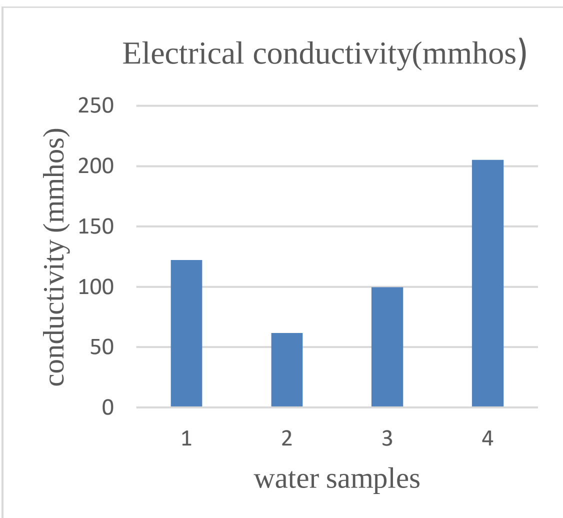
Figure 2



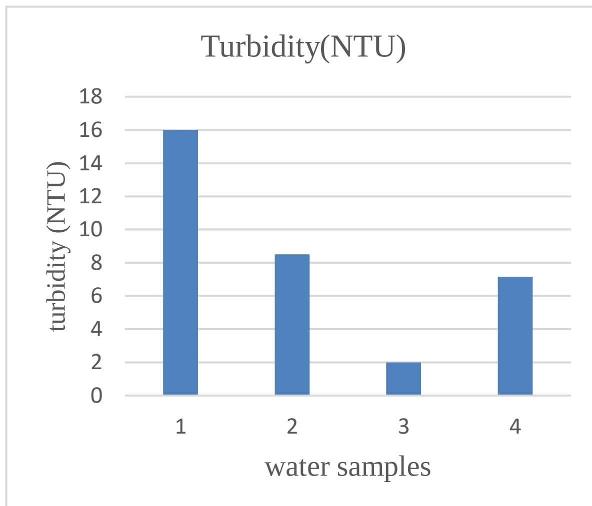
(Fig.2.a)



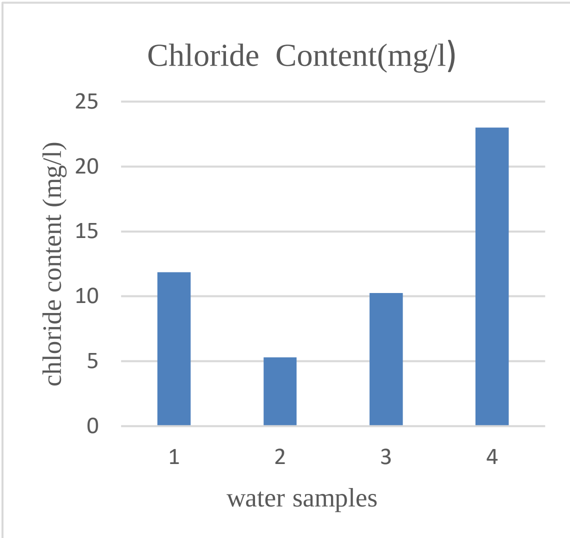
(Fig.2.b)



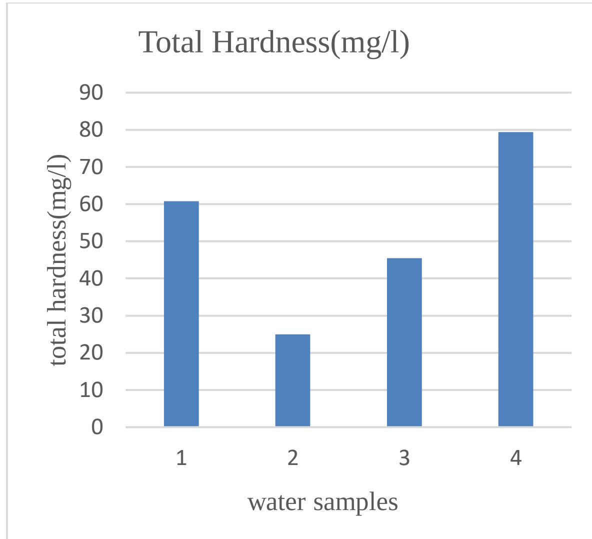
(Fig.2.c)



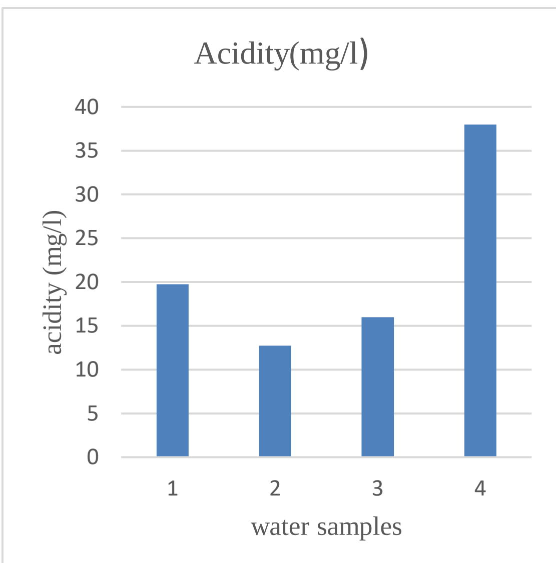
(Fig.2.d)



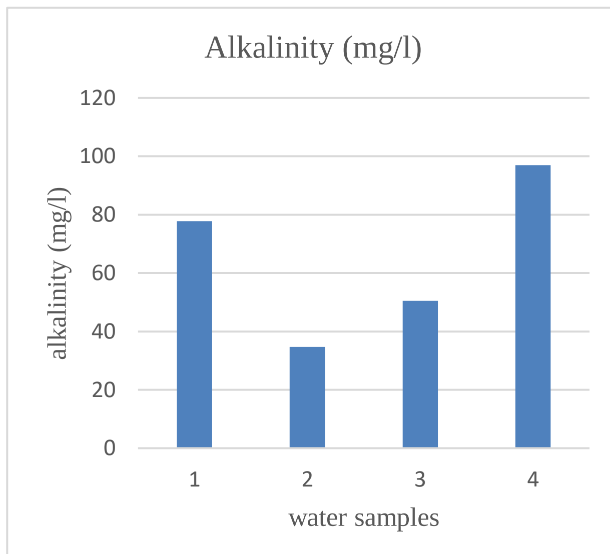
(Fig.2.e)



(Fig.2.f)



(Fig.2.g)



(Fig.2.h)

4.3 Results for Sub Surface Water – Spring season.

Parameters	Sites				BIS Standard IS:10500:1991	
	S2	**S5**	**S6**	**S7**	**Permissible**	**Desirable**
pH	7.2	7.45	7.55	7.5	6.5-8.5	
Dissolved oxygen (mg/l)	5	5.25	5.7	6.3	4	
Conductivity(µmhos/cm)	136.7	200.85	219.7	240.55		
Turbidity(NTU)	22.4	11.5	0	5.9	10NTU	5NTU
Chloride Content(mg/l)	16.4	25	15.45	11.45	1000(mg/L)	250(mg/L)
Total Hardness(mg/l)	36.05	69.15	67.75	63.4	600(mg/L)	300(mg/L)
Acidity(mg/l)	25.9	46.25	33.625	41		
Alkalinity (mg/l)	58.4	50.75	70.375	88.25	600(mg/L)	200(mg/L)
Water quality index(WQI)	58.4	69.1	71.4	71.1		

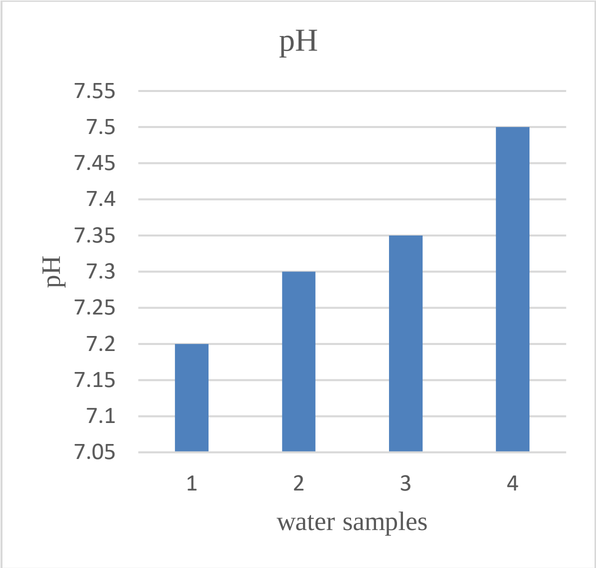
Table 5: Results for Sub Surface Water – Spring season.

- pH is within the permissible limit. The change in temperature, carbon concentration, rainfall etc. may cause the pH of water to change.
- The dissolved oxygen level is slightly less than permissible limit. The water we used consists both surface and sub-surface water. It is slightly less because the mineral content is more in subsurface source and other reason may be due algae growth on surface water source, which reduces the DO level.
- The conductivity is quite high. The reasons for the increase might be due to usage of chlorine for purify water. This Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, phosphate etc.

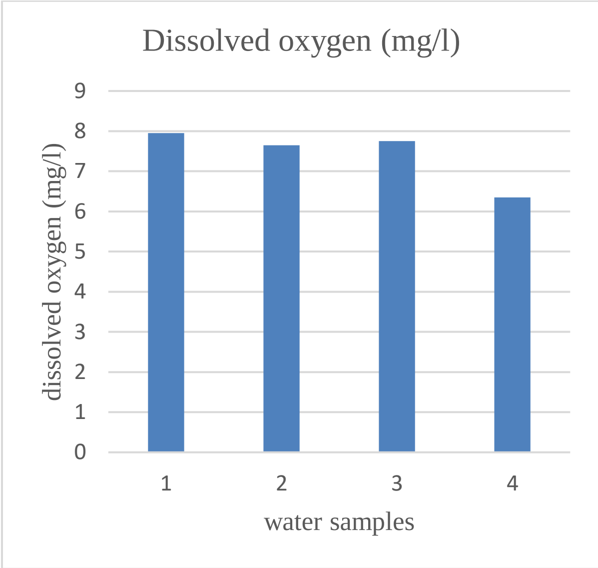
- Turbidity is caused by particles suspended or dissolved in water. The value of turbidity is high as our water sources lies along the highway and there is more pollution due to vehicles travelling along.
- Total hardness and alkalinity is low due to less content of magnesium and calcium content.

4.3.1 Figures for sub Surface water – spring season

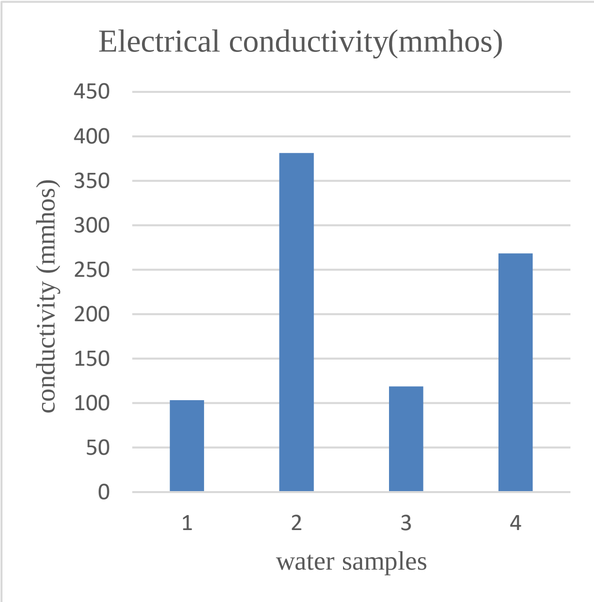
Figure 3



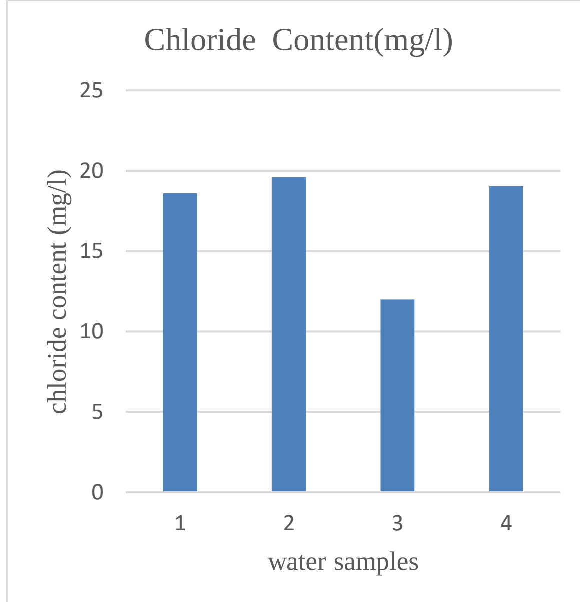
(Fig.3.a)



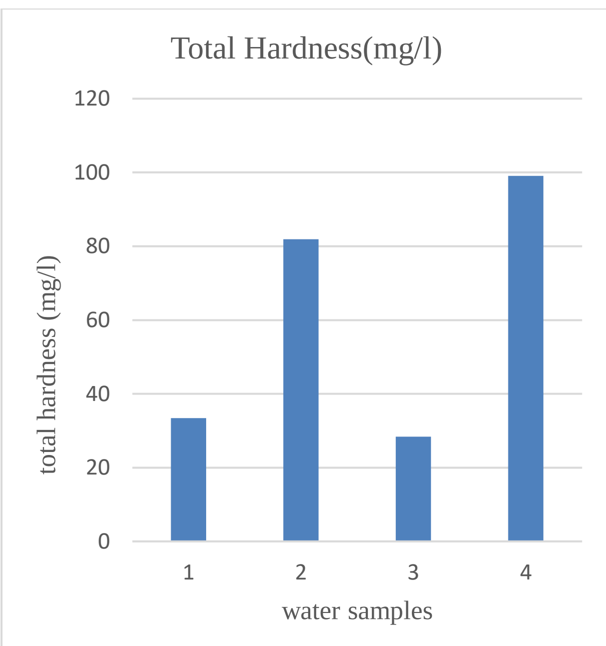
(Fig.3.b)



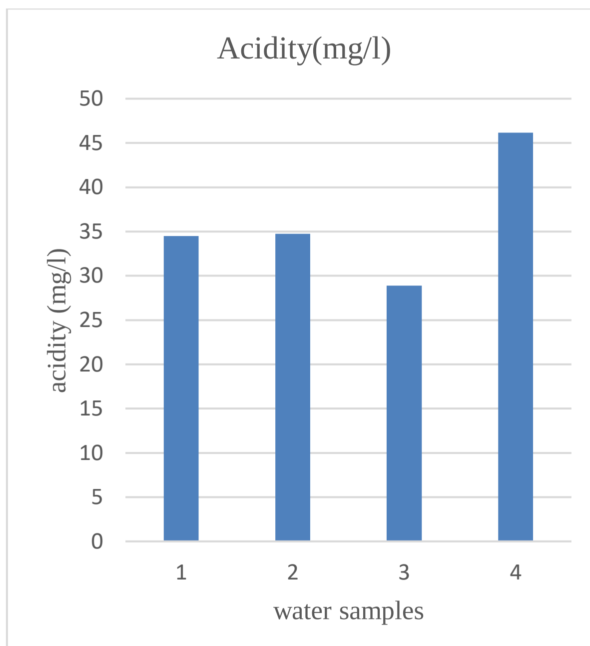
(Fig.3.c)



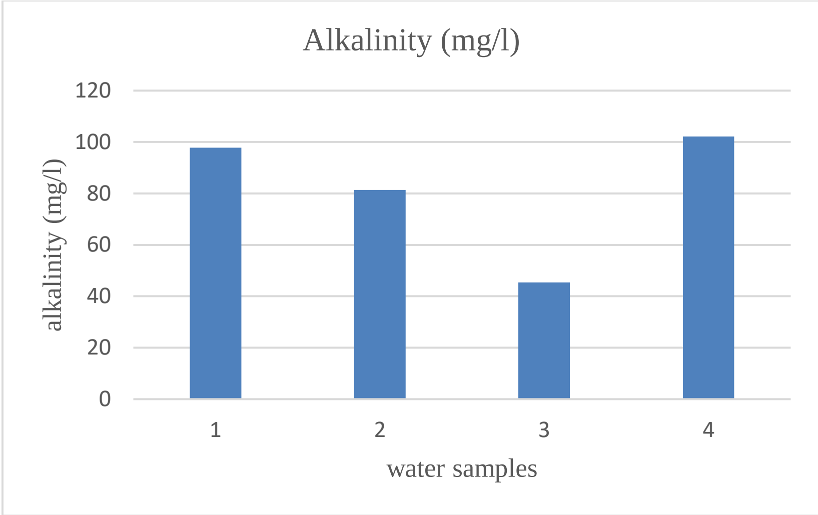
(Fig.3.d)



(Fig.3.e)



(Fig.3.f)



(Fig.3.g)

4.4 Results for Surface Water- Autumn season.

The table underneath demonstrates the assessed aftereffect of the surface water amid the long stretch of August to September.

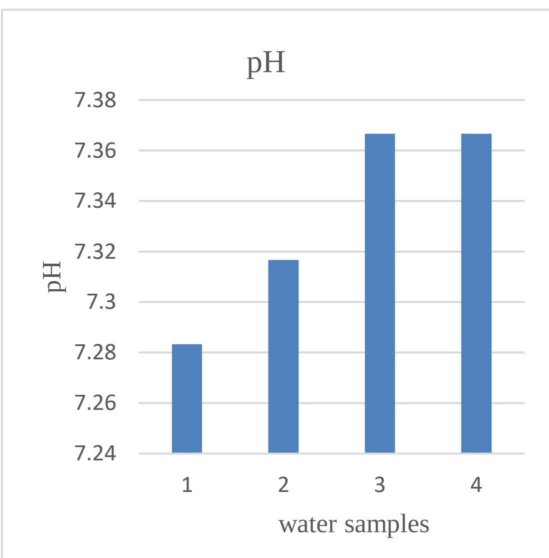
Parameters	Sites				BIS standard	IS:10500:1991
	S1	S3	S4	S8	Permissible	Desirable
pH	7.3	7.3	7.4	7.4	6.5-8.5	
Dissolved oxygen (mg/l)	6.3	7.0	6.9	6.9	4	
Conductivity(µmhos/cm)	96.1	117.2	148.7	221		
Turbidity(NTU)	0	0	0	0	10NTU	5NTU
Chloride Content(mg/l)	10.5	12.2	14.6	15.8	1000(mg/L)	250(mg/L)
Total Hardness(mg/l)	90.2	100.1	123.3	142.5	600(mg/L)	300(mg/L)
Acidity(mg/l)	23.3	25.5	23.3	23.2		
Alkalinity (mg/l)	83.1	90.1	91.2	105.1	600(mg/L)	200(mg/L)
Water quality index(WQI)	50.2	50	56.1	65.3		

Table 6: Results for Surface Water- Autumn season.

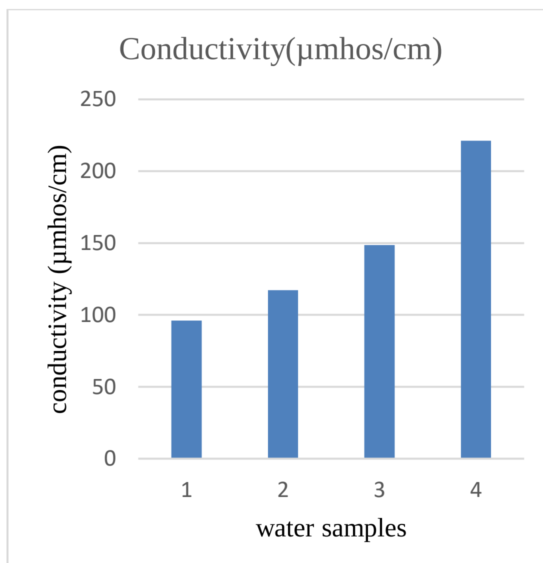
- pH and DO is both within the permissible limit.
- Conductivity is slightly higher again. The reason is due to chlorination of water thereby increasing the ionic activities of water which leads to increase in the conductivity of water.
- Total hardness and alkalinity is low due to less content of magnesium and calcium content.
- The chloride content of all testing focuses are inside admissible points of confinement.

4.4.1 Figures of Surface water – Autumn season

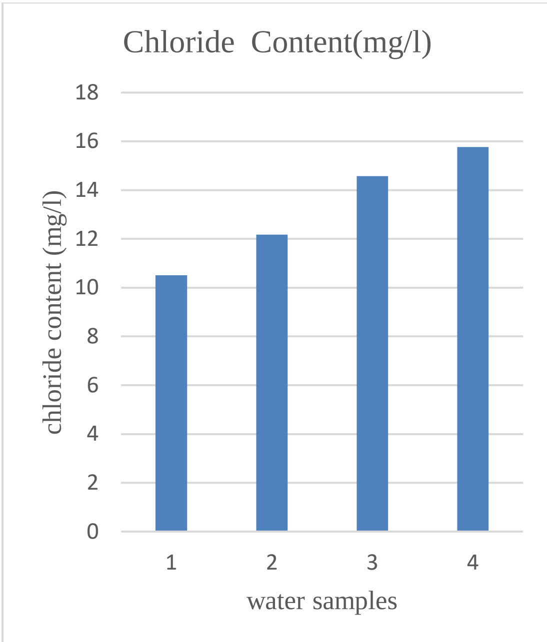
Figure 4



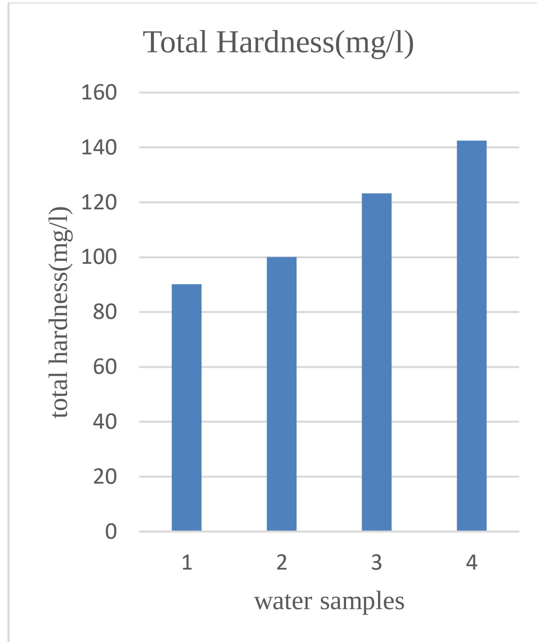
(Fig.4.a)



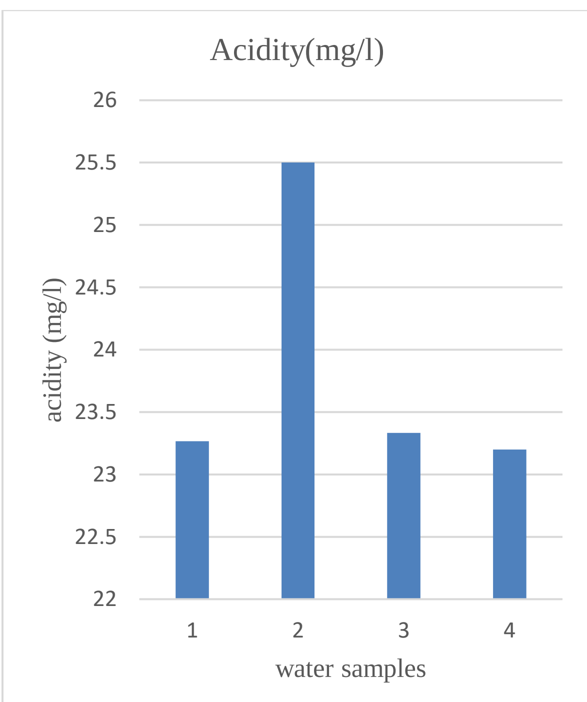
(Fig.4.b)



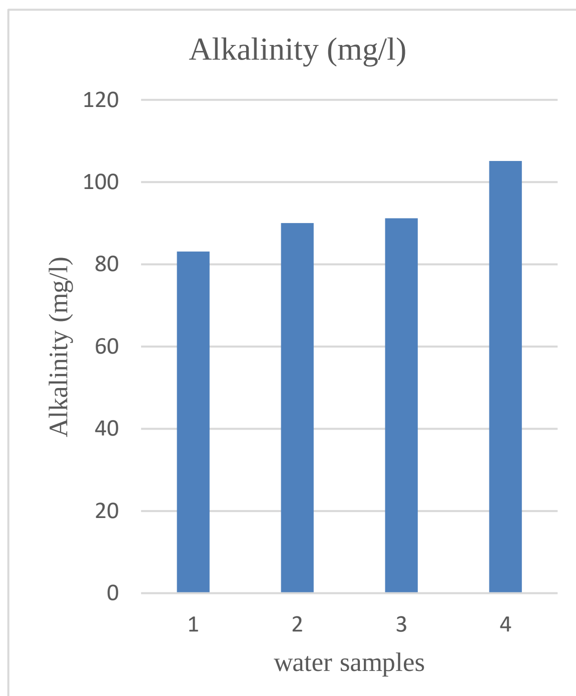
(Fig.4.c)



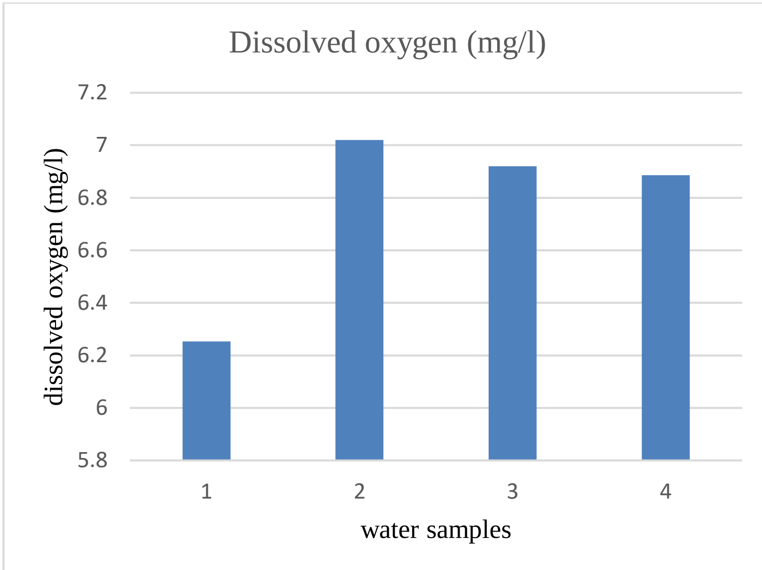
(Fig.4.d)



(Fig.4.e)



(Fig.4.f)



(Fig.4.g)

4.5 Results for Surface Water- Winter season.

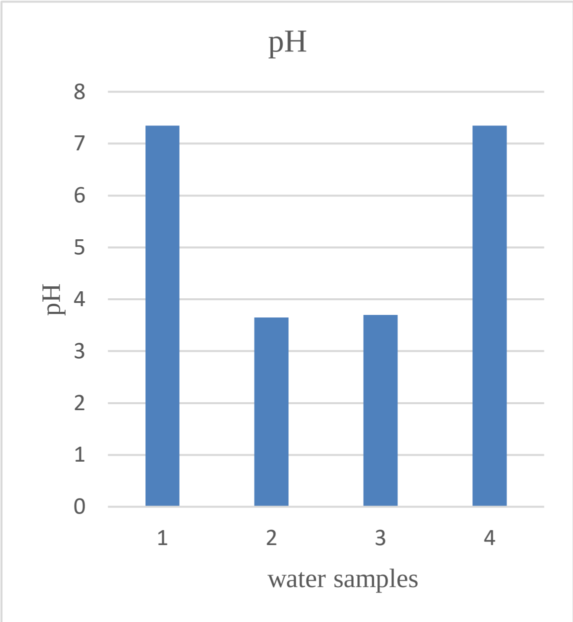
Parameters	Sites				BIS standard IS:10500:1991	
	S1	S3	S4	S8	Permissible	Desirable
pH	7.35	7.65	7.7	7.35	6.5-8.5	
Dissolved oxygen (mg/l)	7.55	3.9	3.8	7.75	4	
Conductivity(µmhos/cm)	92.45	50.15	151.55	316.1		
Turbidity(NTU)	0	0	0	0	10NTU	5NTU
Chloride Content(mg/l)	13.95	9.15	6.1	16.5	1000(mg/L)	250(mg/L)
Total Hardness(mg/l)	54.75	21.5	54.5	90.75	600(mg/L)	300(mg/L)
Acidity(mg/l)	30.5	20.5	11	33.5		
Alkalinity (mg/l)	105.25	55.25	70	127.25	600(mg/L)	200(mg/L)
Water quality index(WQI)	45.8	58.5	72.5	73.3		

Table7: Results for Surface Water- Winter season.

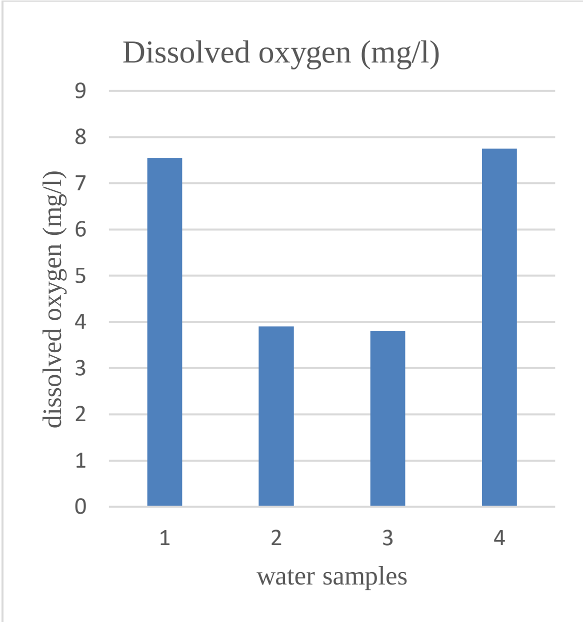
- pH stands in the permissible limit.
- Conductivity is slightly less. The reason is due to temperature. In winter due to low temperature, conductivity of water decreases.
- Dissolved oxygen is less than the permissible limit. The colder the water, the more oxygen can be dissolved in the water. DO concentrations at one location are usually higher in the winter than in the summer.
- Total hardness and alkalinity is low due to less content of magnesium and calcium content.

4.5.1 Graphs of Surface water – Winter season

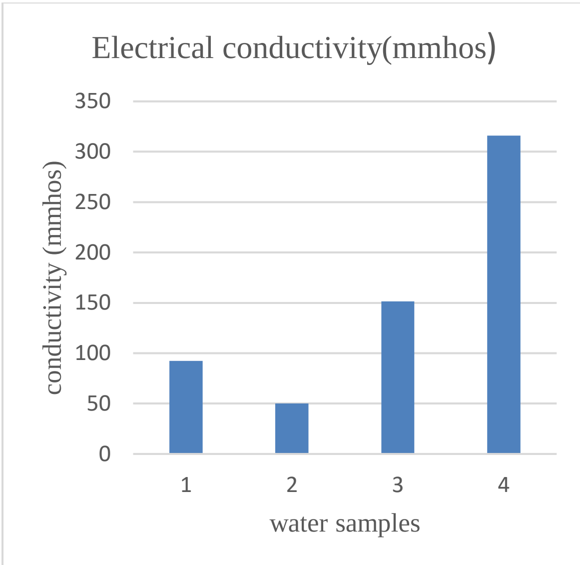
Figure 5



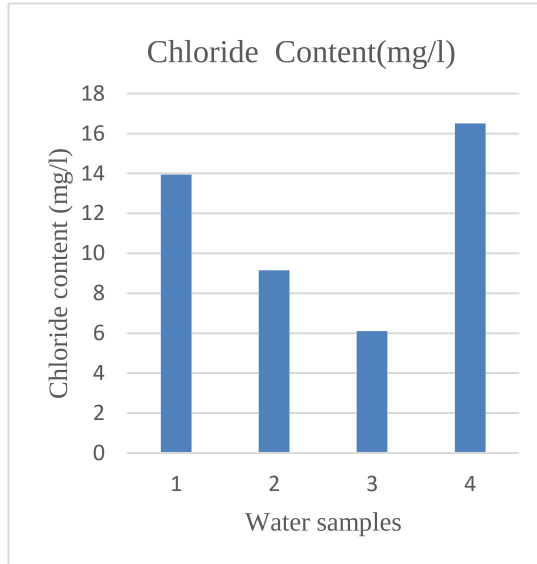
(Fig.5.a)



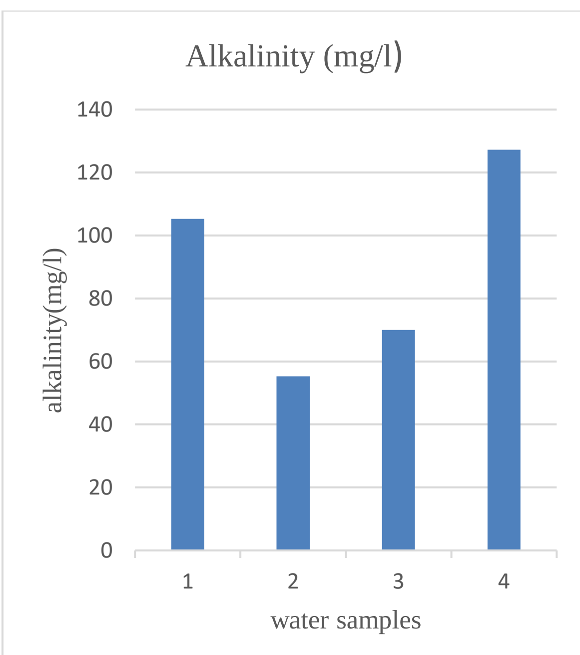
(Fig.5.b)



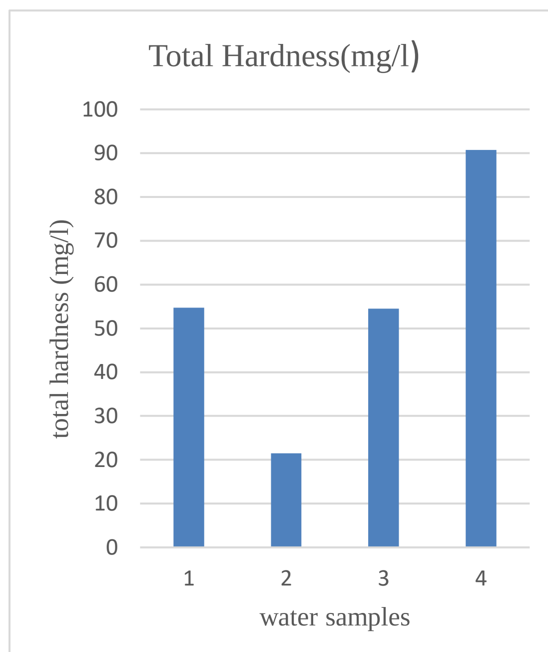
(Fig.5.c)



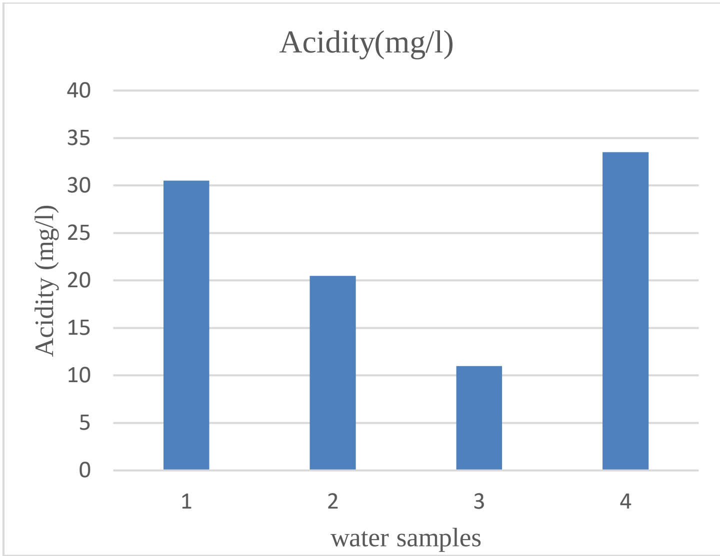
(Fig.5.d)



(Fig.5.e)



(Fig.5.f)



(Fig.5.g)

4.6 Results for Surface Water- spring season.

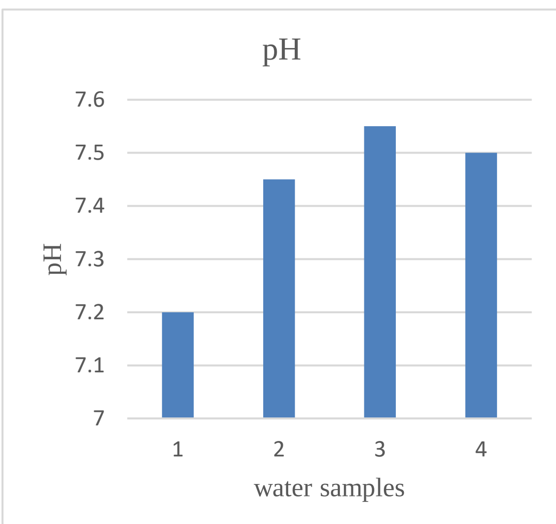
Parameters	Sites				BIS standard	IS:10500:1991
	S1	S3	S4	S8	Permissible	Desirable
pH	7.2	7.3	7.4	7.5	6.5-8.5	
Dissolved oxygen (mg/l)	8.0	7.67	7.8	6.35	4	
Conductivity(µmhos/cm)	103.4	381.4	118.7	268.5		
Turbidity(NTU)	0	0	0	0	10NTU	5NTU
Chloride Content(mg/l)	18.6	19.6	12	19.05	1000(mg/L)	250(mg/L)
Total Hardness(mg/l)	33.4	81.9	28.4	99.05	600(mg/L)	300(mg/L)
Acidity (mg/l)	34.5	34.75	28.9	46.15		
Alkalinity (mg/l)	97.8	81.4	45.4	102.15	600(mg/L)	200(mg/L)
Water quality index(WQI)	43.1	80.4	48	74.7		

Table 8: Results for Surface Water- spring season.

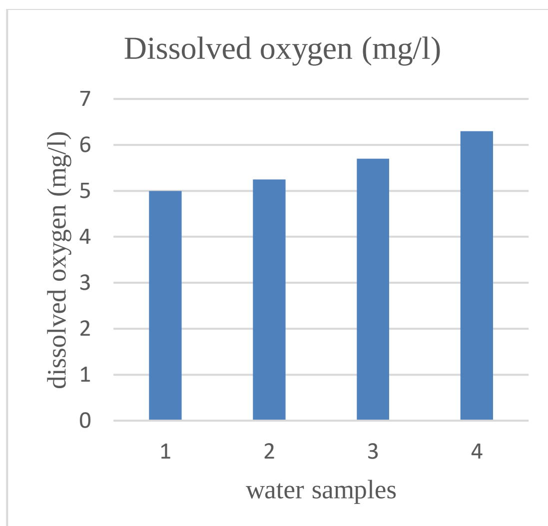
- pH and DO are both within the permissible limit.
- Conductivity is slightly higher again. The reason is due to chlorination of water thereby increasing the ionic activities of water which leads to increase in the conductivity of water.
- Chloride content is within the desirable range which is good for drinking water purpose.
- Total hardness and alkalinity is low due to less content of magnesium and calcium content

4.6.1 Graphs of surface water – spring season

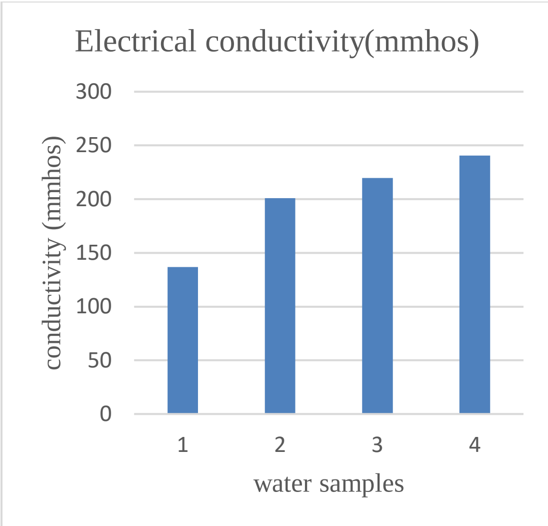
Figure 6

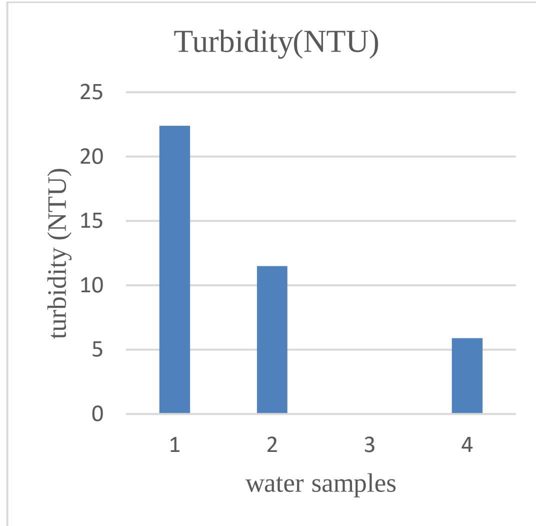


(Fig.6.a)



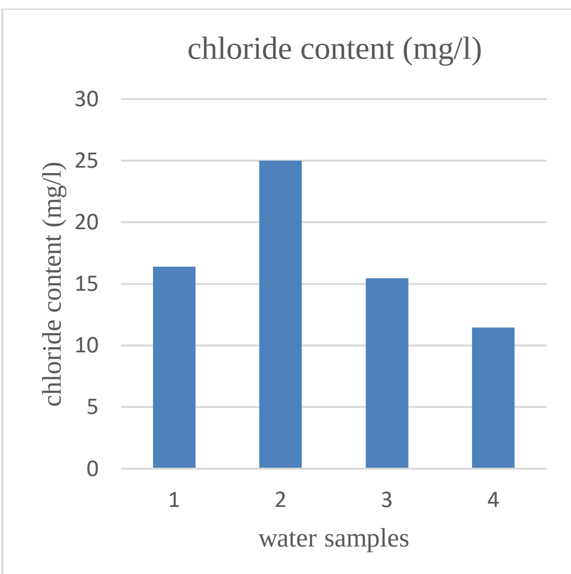
(Fig.6.b)

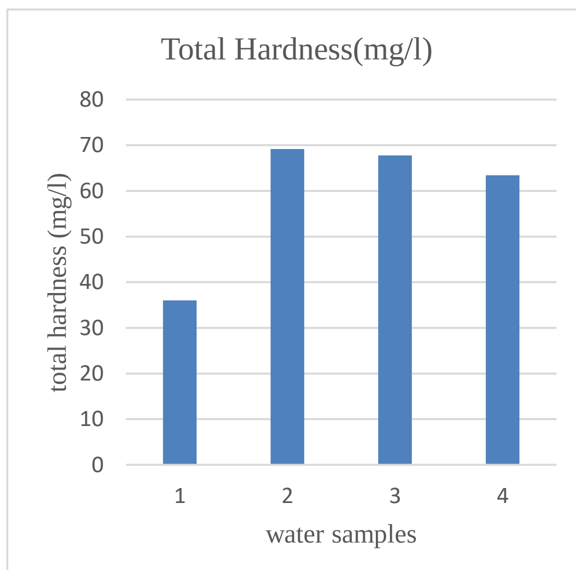




(Fig.6.c)

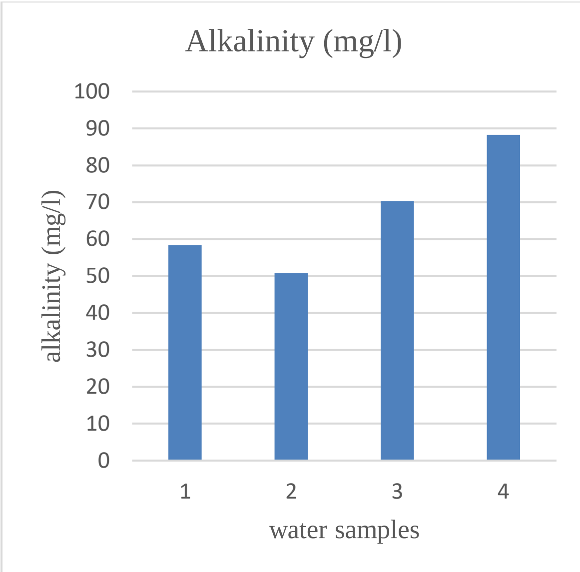
(Fig.6.d)



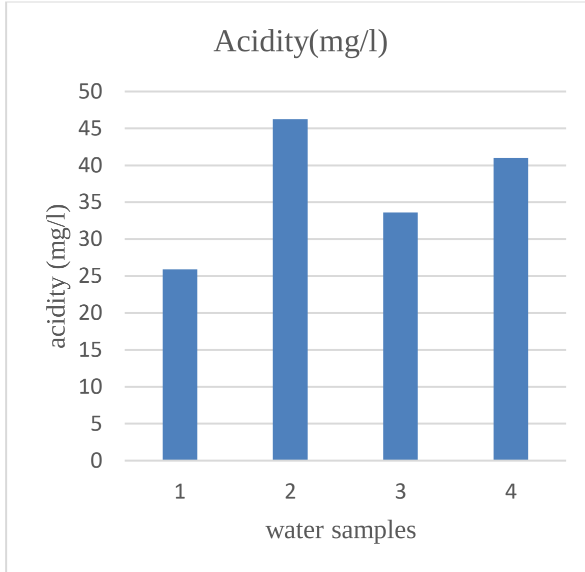


(Fig.6.e)

(Fig.6.f)



(Fig.6.g)



(Fig.6.h)

4.7 Results for Surface water from period of August 2017 to May 2018

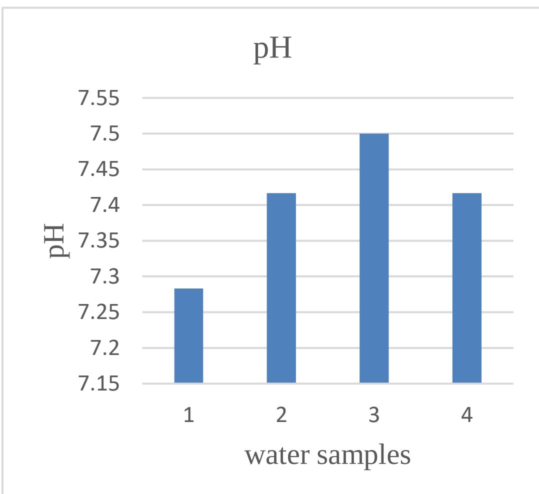
Parameters	**Sites**				**BIS standard**	**IS:10500:1991**
	S1	**S3**	**S4**	**S8**	**Permissible**	**Desirable**
pH	7.3	7.6	7.5	7.4	6.5-8.5	
Dissolved oxygen (mg/L)	7.3	6.2	6.2	7	4	
Conductivity(µmhos/cm)	97.3	182.9	139.65	268.5		
Turbidity(NTU)	0	0	0	0	10NTU	5NTU
Chloride Content(mg/L)	14.35	13.65	10.9	17.2	1000(mg/L)	250(mg/L)
Total Hardness(mg/L)	59.5	67.8	68.7	110.8	600(mg/L)	300(mg/L)
Acidity(mg/L)	29.4	26.9	21.1	34.3		
Alkalinity (mg/L)	95.4	75.6	68.9	111.5	600(mg/L)	200(mg/L)
Water quality index(WQI)	46.5	65.7	58.7	70.8		

Table 9: Results for Surface water from period of August 2017 to May 2018

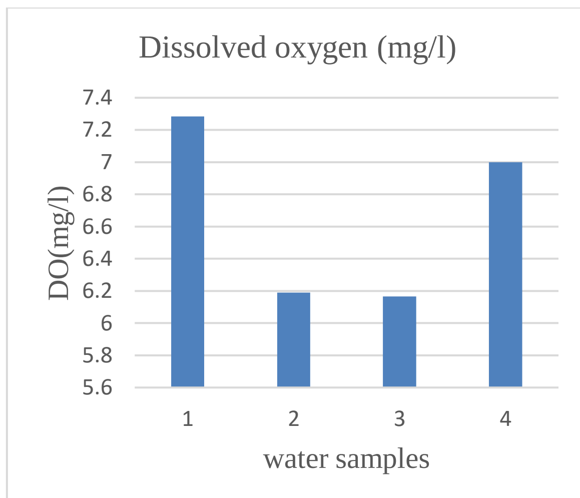
- Both pH and dissolved oxygen level are within the permissible limits.
- Conductivity is slightly greater than the permissible value and that could be due to ionic activity and increased temperature.
- Chloride content is well within the desirable limit.
- Total hardness is slightly less and the reason could be due to less content of magnesium and calcium at the source of water.

4.7.1 Graphs for surface water from period of August 2017 to May 2018

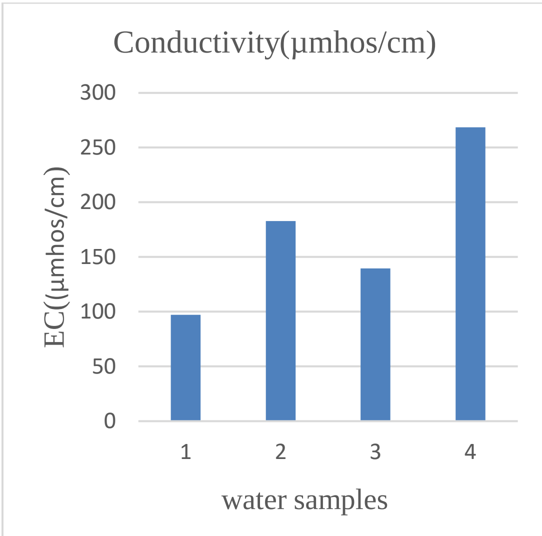
Figure 7



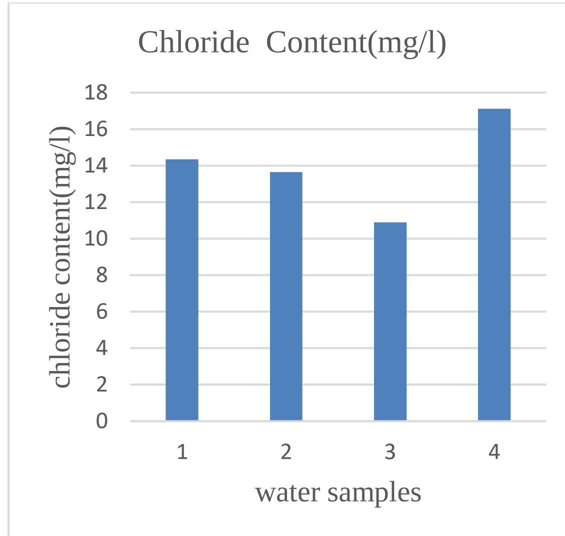
(Fig.7.a)



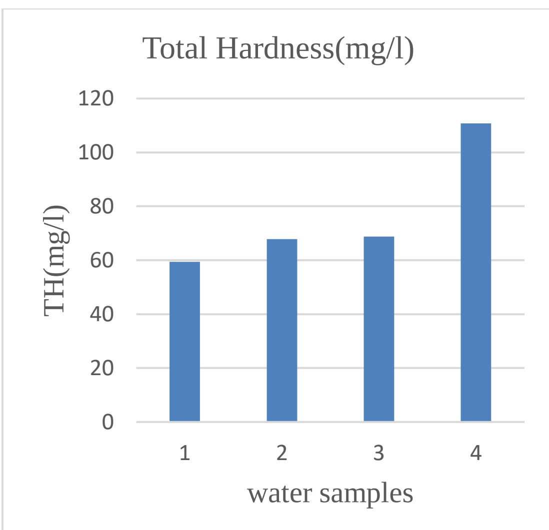
(Fig.7.b)



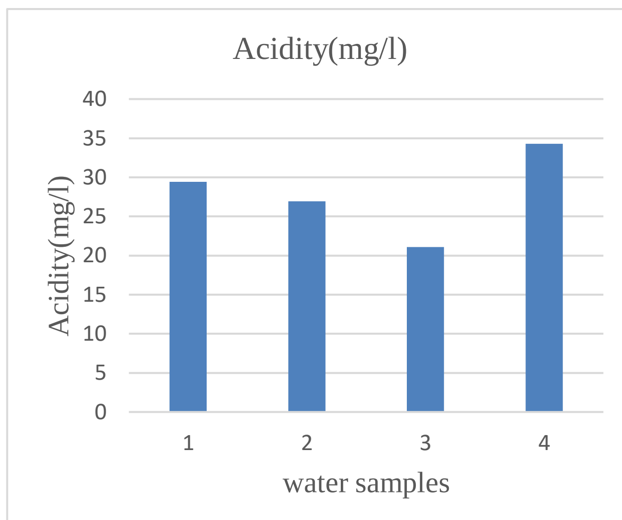
(Fig.7.c)



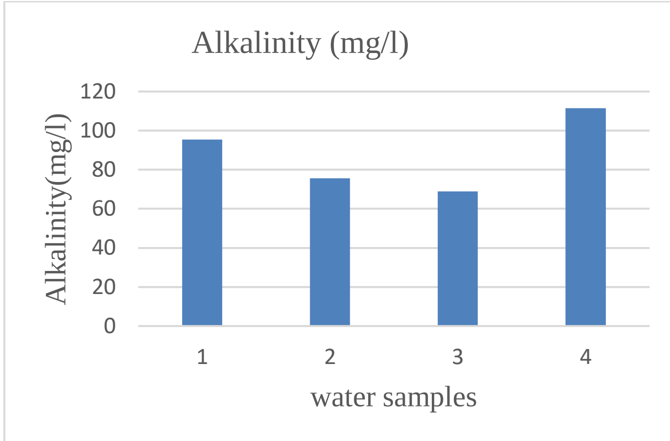
(Fig.7.d)



(Fig.7.e)



(Fig.7.f)



(Fig.7.g)

4.8 Results for sub surface water from period of August 2017 to May 2018

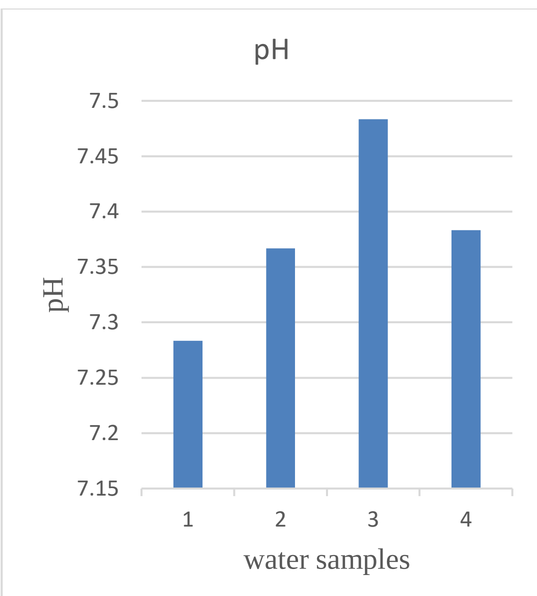
Parameters	Sites				BIS standard IS:10500:1991	
	S2	**S5**	**S6**	**S7**	**Permissible**	**Desirable**
pH	7.3	7.4	7.5	7.4	6.5-8.5	
Dissolved oxygen (mg/L)	5.0	5.4	6	5.5	6.5-8.5	
Conductivity(µmhos/cm)	128.0	150.9	152.2	213.0	180(µmhos/cm)	114(µmhos/cm)
Turbidity(NTU)	15.7	7.6	1.0	4.35	10NTU	5NTU
Chloride Content(mg/L)	14.5	15.6	14.0	16.1	1000(mg/L)	250(mg/L)
Total Hardness(mg/L)	61.6	69.7	77.9	83.1	600(mg/L)	300(mg/L)
Acidity(mg/L)	22.35	30.3	24.2	33.7		
Alkalinity (mg/L)	70.8	56.9	71.3	97.9	600(mg/L)	200(mg/L)
Water quality index(WQI)	59.1	61.6	61.0	70		

Table 10: Results for sub surface water from period of August 2017 to May 2018

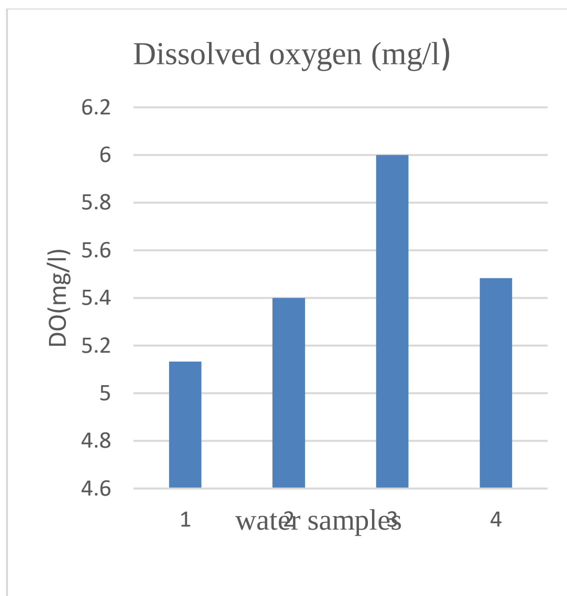
- pH is within the permissible limit.
- Dissolve oxygen level is also within the permissible limit.
- Turbidity value is different for different sources and it could be due to water originating from beneath the surface either not separated appropriately or has a few contaminations.
- The reason may be that water originating from beneath the surface is either not separated appropriately or has a few contaminations.

4.8.1 Graphs for sub surface water from period of August 2017 to May 2018

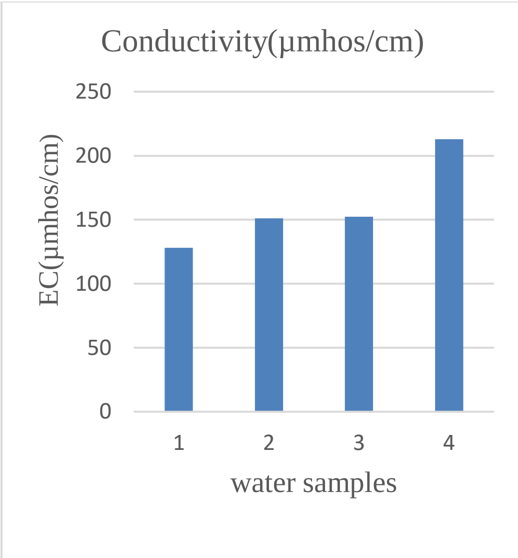
Figure 8



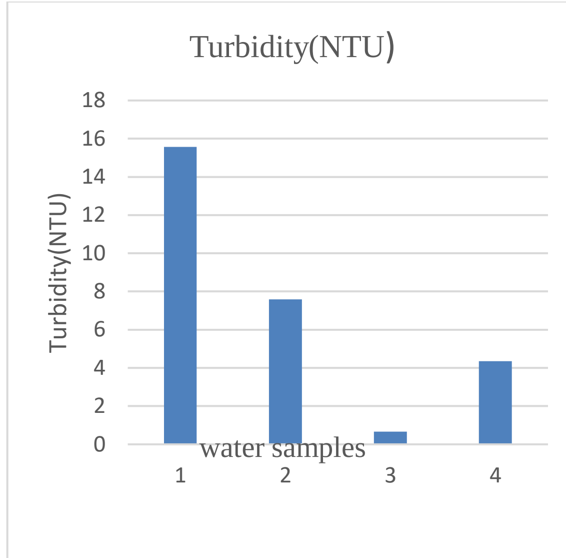
(Fig.8.a)



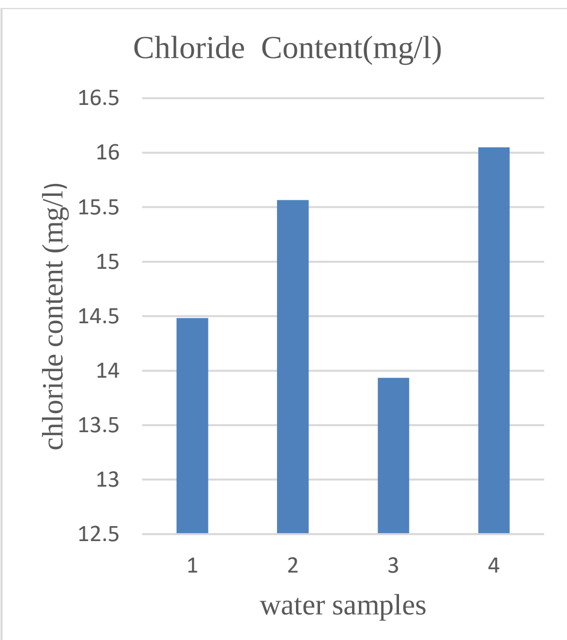
(Fig.8.b)



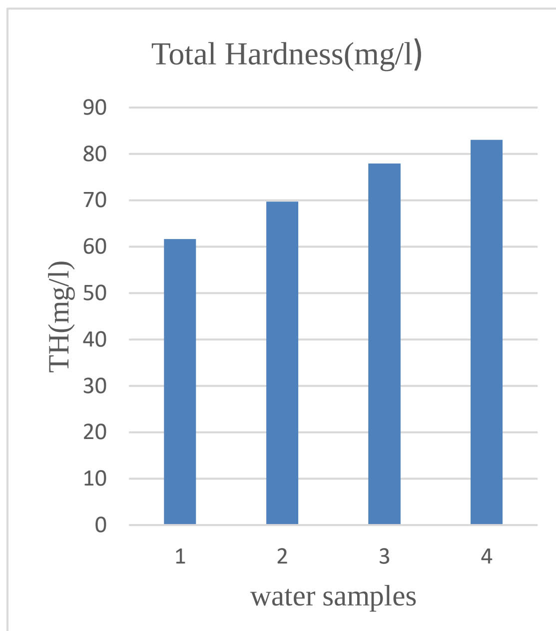
(Fig.8.c)



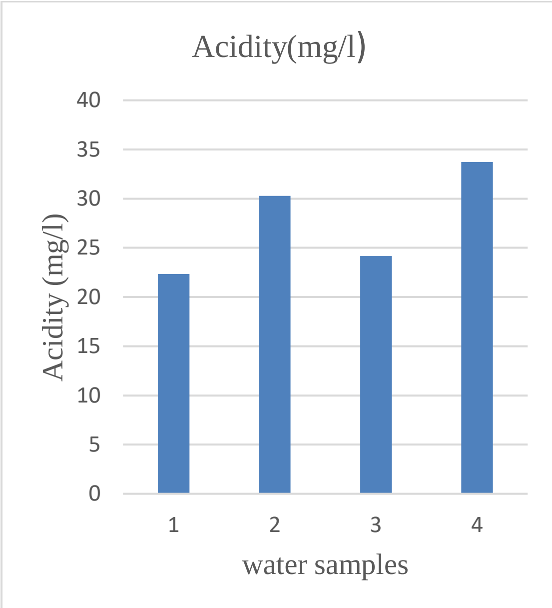
(Fig.8.d)



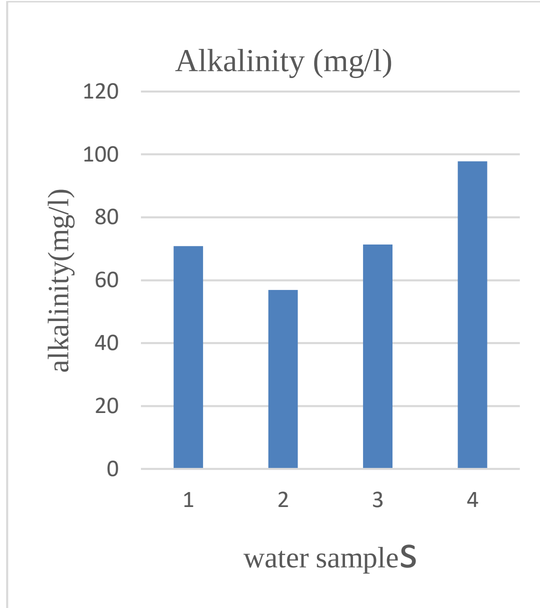
(Fig.8.e)



(Fig.8.f)



(Fig.8.g)



(Fig.8.h)

4.9 Water Quality Indexing

As per the water quality index (WQI) values, the water can be classified into five categories that is;

- (<50) - Excellent water
- (50–100) - Good water
- (100–200) - Poor water
- (200– 300) - Very poor water
- (>300) - Unsuitable for drinking purposes.

Table 11: Water Quality Indexing.

Sampling points	Quality in autumn	Quality in winter	Quality in spring
1	50.2	45.8	43.1
2	60.5	55.7	58.4
3	50	58.5	80.4
4	56.1	72.5	48
5	64.1	48.4	69.1
6	44.3	57.4	71.4
7	54.1	71.5	71.1
8	65.3	73.3	74.7

(Table 11.a)

Sampling points	Quality in autumn	Quality in winter	Quality in spring
1	Good	Excellent	Excellent
2	Good	Good	Good
3	Good	Good	Good
4	Good	Good	Good
5	Good	Good	Good
6	Good	Good	Good
7	Good	Good	Good
8	Good	Good	Good

(Table 11.b)

4.10 Method used in water quality indexing.

Table 12: Calculation of water quality index for autumn season for sample 2.

Sr.No	Parameters	Observed value	Standards(S_n)	Unit weight(W_n)	Quality rating (Qn)	$W_n * Q_n$
1	pH	7.4	6.5-8.5	0.219	26.6	5.8
2	Dissolved oxygen (mg/L)	4.9	5	0.3723	101.1	37.6
3	Conductivity(µmhos/cm)	125.1	300	0.371	41.7	15.4
4	Turbidity(NTU)	8.3	5	0	166	0
5	Chloride Content(mg/L)	15.2	250	0.0074	6.08	0.05
6	Total Hardness(mg/L)	88.2	300	0.0062	29.4	0.2
7	Acidity(mg/L)	21.4				0
8	Alkalinity (mg/L)	76.3	120	0.0155	63.6	0.9
				$\sum W_n$=0.9	$\sum q_n$=434.5	$\sum W_n q_n$=60.3

Water quality index = $\frac{\sum Wnqn}{\sum Wn}$ = 60.5

All the values are in mg/l except for pH and electrical conductivity.

For the calculation of water quality index, six important parameters are chosen. The WQI has been calculated by using the standards of world health organization and bureau of Indian standard (BIS) and Indian council for medical research. The weighted arithmetic index method is used for calculation for WQI.

The quality rating or sun index is calculated by using following expression,

$$Q_n = \frac{100*(Vn - Vio)}{Sn - Vio}$$

Where:

Q_n=quality rating for the n^{th} water quality parameter.

V_n = observed value

V_{io} = ideal value for n^{th} parameter for pure water (i.e., 0 for all parameters except for pH and DO (7.0 and 14.6mg/L respectively).

Sn = Standard permissible value for n^{th} parameter.

4.10 Discussions

Since we are performing test on the water samples collected from hilly area, it showed lesser content of chlorides compared to those in the plain region. There are not much significant variations in the results. The chloride content of water may increase when the sewage and the industrial waste water find their way into the raw water. pH stands in the permissible limit. Low pH of surface water of various water sources may be due to dilution effect of rain water during rainy season.

Conductivity in some sources, as spring often has the highest flow volume, conductivity can be lower at that time than in the winter despite the differences in temperature. In water with little to no inflow, seasonal averages are more dependent on temperature and evaporation. Turbidity is low in some water sample. The reason might be that water coming from below the surface has fewer impurities. Change in turbidity might be due to rainfalls and dry season. Another possible cause may be due to dust from road maintenance going on near the water sources. There is decrease in hardness which shows that the salts of calcium and magnesium are less. The change in dissolved oxygen (DO) might be due to temperature differences.

As the temperature decreases, solubility of oxygen increases thereby increasing the dissolved level. The increasing value of alkalinity might be due to less rainfall. Rainfall ranges from slightly acidic to acidic. When it comes in contact with water sources, water becomes more acidic thereby reducing alkalinity. The increase in acidity in month October might be due to heavy rainfall during that period.

Chapter 5

Conclusion

We herewith came to the conclusion that the parameters expertise an amendment down the lane, on the craggy space like Shimla and Solan goose. Water has been analyzed and characterized consequently. Changes are ascertained and reasons are ordered to compensate the degrading quality.

1. There's an amendment of acidity thanks to temperature distinction.

2. pH is modified thanks to salts of carbonates and bicarbonates which could strike the water within the sort of stone, rocks or another supply.

3. Hardness is additionally ascertained to be increasing resulting in a lot of of Ca and atomic number 12 salts within the water down the lane.

5. Increasing conduction is that the reason of randomness of ions and dissociation of ions too.

6. pH scale is within the close to neutral vary as acidity and pH counter one another by their own reason of existence.

7. Waste total is decreasing owing to the microorganism growth, increase in temperature that ends up in usage of element by the atmosphere or aquatic life overwhelming a lot of DO.

8. Chlorides are arbitrarily ever-changing relying upon the supply of carbonates and bicarbonates.

9. Conjointly there's an amendment within the summers and winters as in summers extreme temperature brings upon the changes down the lane as a result of on the mountains, down the lane, temperature shows a forceful amendment.

10. Conjointly the amendment within the surface water is hefty as compared to surface water owing to the maintained temperature underground. However hardness, alkalinity, conduction, and turbidness encompasses an amendment and high values somewhere thanks to presence of filtration beds which may add on to their characteristics. Salts are high owing to presence of some or the opposite bed below composed of unwanted material.

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