PERFORMANCE EVALUATION OF WATER QUALITY FOR PACKAGED AND UNPACKAGED DRINKING WATER

A thesis submitted towards partial fulfilment of the requirements for the degree of

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Water Resources and Hydraulic Engineering
Course affiliated to Faculty of Engineering &Technology
Jadavpur University

Submitted by
RUPANJANA MITRA

EXAMINATION ROLLNO….M6WRP19008

Under the guidance of

Prof. (Dr.)PANKAJ KUMAR ROY
Professor
School Of Water Resources Engineering,Jadavpur University
and
Prof. (Dr.) ARUNABHA MAJUMDER
Emeritus Professor
School Of Water Resources Engineering,Jadavpur University

School of Water Resources Engineering
M.E.(Water Resources &Hydraulic Engineering)
Course affiliated to Faculty of Engineering and Technology
Jadavpur University, Kol-32, INDIA

M.E. (Water Resources & Hydraulic Engineering) Course affiliated to
Faculty of Engineeringand Technology Jadavpur University Kolkata, india

CERTIFICATE OF RECOMMENDATION

This is to certify that the thesis entitled"**PERFORMANCE EVALUATION OF WATER QUALITY FOR PACKAGED AND UNPACKAGED DRINKING WATER**"is bonafide work carried out by **RUPANJANA MITRA** under our supervision and guidance for partial fulfilment of the requirement for Post Graduate Degree of Master of Engineering in Water Resources & Hydraulic Engineering during the academic session 2018-2019.

THESIS ADVISOR

Prof. (Dr.) Pankaj Kumar Roy

School of Water Resources Engineering, Jadavpur University, Kolkata- 700032

THESIS ADVISOR
Prof. (Dr.) Arunabha Majumder,

School of Water Resources Engineering, Jadavpur University, Kolkata- 700032

DIRECTOR
Prof. (Dr.) Asis Mazumdar

School of Water Resources Engineering

Jadavpur University, Kolkata- 700032

DEAN

Prof. (Dr.) Pankaj Kumar Roy

Faculty of Interdisciplinary Studies, Law & Management
Jadavpur University, Kolkata- 700032

CERTIFICATE OF APPROVAL **

This foregoing thesis is hereby approved as a credible study of an engineering subject carried out and presented in a manner satisfactorily to warranty its acceptance as a pre-requisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not endorse or approve any statement made or opinion expressed or conclusion drawn therein but approve the thesis only for purpose for which it has been submitted.

Committee

_____

Final Examination
for the evaluation of the thesis

_____

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**** Only in case the thesis is approved.**

Declaration of Originality and Compliance of Academic Ethics

I hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, as a part of my Master of Water Resources & Hydraulic Engineering degree during academic session 2018-2019.

All information in this document has been obtained and presented in accordance with academic rules and ethical conduct.

I also declare that, as required by this rules and conduct, I have fully cited and referred all material and results that are not original to this work.

Name: **RUPANJANA MITRA**

Roll Number: **M6WRP19008**

Thesis Title: **PERFORMANCE EVALUATION OF WATER QUALITY FOR PACKAGED AND UNPACKAGED DRINKING WATER**

Signature:

Date:

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Date : May, 2019

Place : SWRE, Jadavpur University,

Kolkata 700032

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Rupanjana Mitra

(Roll No. – M6WRP19008)

Abstract :-

Water is a natural resources which is extremely essential for survival of living organisms. Drinking water needs to be safe from any type of contamination with respect to bacteriological and physio-chemical parameter. With rapid urbanization and increase in population the water demand for drinking and domestic uses are being increased day by day.The inadequacy of protected water supplies in urban areas is a growing problem.Sometimes,urban communities face acute shortage of drinking water.

The present study has been conducted to assess the bacteriological and physiochemical quality status and its effects on public health of (i) Packaged drinking water (ii) KMC Supply water(iii) Water using Individual Purifier (iv)Water using Street Foot Vendors (v) Water using,Treatment Plant Installed by Residential and Commertial Complex (vi)Tubewell water which are available in North Kolkata, South Kolkata ,surrounding areas of North/south Kolkata and different district in West Bengal. All the samples of different category water under this study, laboratory test have been carried out for three (3) water quality parameters i.e Bacteriological test,pH and TDS.

The quality of above mentioned drinking water has been compared with respect to relevant Indian standards IS 10500-2012 (Drinking water specification), IS 14543 - 2004 [Packaged Drinking water (other than natural mineral water) specification and other International standards (World Health Organization-2011 , US EPA-2010 and CANADA Drinking Wate Guideline-Aug.2010).Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out.

(i)Packaged Drinking Water (500/600 Ml. Bottled Packaged) and (20 Lt. Jar.) The (62) nos. samples of Packaged drinking water of different brands were collected from various key locations at Kolkata city and different district in W.B.

(ii) In KMC Supply drinking water:- The (38) nos. samples of KMC Supply drinking water were collected through polyethylene bottles from different areas of Kolkata where supplying water from different treatement plant like Garden Reach, Tala, Dhapa.

(iii) Water using by Individual Purifier(i.e Using RO-UV water purifiers, normal in-built stand alone filters etc.):-The total (45) nos.samples of water were collected through polyethylene bottles from different type of zones i.e(i)Residential,(ii)Commertial,(iii)Institutional and (iv) Official zones.

(iv) Water using,Street Foot Vendors: The total (19) nos.samples of water were collected through polyethylene bottles from different street vendors of Kolkata and other district of West Bengal .

(v) Water using,Treatement Plant Installed by Residential and Commertial Complex: The (21) nos. samples of water were collected in polyethylene bottles

from different Residential and Commertial Complex of Kolkata and surounding areas.

(vi) In case of Tubewell water:-The total (24) nos.samples of water were collected in polyethylene bottles from different areas of North/South Kolkata and other district in West Bengal.

The study showed that all brands of **Packaged drinking water(PDW)** analyzed are of **excellent category** (WQI<50) and **free from coliform** bacteria and thereby **safe** for human consumption. **12.5 %** samples have pH values beyond the limit (6.5-8.5),as per above mentioned IS codes and other International codes. The Study reflected that 93.55 % samples contained (*very low mineral concentration) and 6.45* % samples contained (*low mineral concentration).*

In KMC Supply water all samples (100%) fall under **excellent category (WQI < 50)** and **free from coliform** bacteria thus **safe** for human consumption,whireas only three(3) samples found to have **coliform bacteria**. All samples have pH values within the limit (6.5-8.5)as per above mentioned IS codes and other International codes. But these values indicate that Eight (**8**) samples are acidic.The results also includes, **no samples** with *very low mineral concentration* but, **89.47%** samples contained TDS *low mineral concentration.*

In case of water using by Individual Purifier, the results showed that the water samples collected from Residential Complex(I-1), Institutional areas [I-3 (ii)] and Official sector i.e [I-4(i) and I-4 (iii)] fall under **excellent category (WQI < 50).**Water samples collected from Commertial Complex(I-2) and Institutional ares[I-3(iv)] fall under **Poor Category .**Water samples collected from Institutinal areas [I-3(i)] and [I-3(iii)] fall under **Fair Category** and water samples collected from official sector [I-4 (ii)] fall under **good category.** All samples **free from coliform** bacteria and thereby **safe** for human consumption.

Out of 2.38% samples, have pH values beyond the limit (6.5-8.5) as per above mentioned IS codes and other International codes.But these values indicate that Two(**2**)Samples of Institutional areas , Five (**5)** samples of Official sector are acidic. Again results showed that 36.36% samples contained *very low mineral concentration* and 4.55 % samples contained *low mineral concentration.*

In case of water using,Street Foot Vendors, the results showed that all the water samples (100%) fall under **excellent category (WQI < 50)** but only One(**1**) sample fall under **good category.** All samples **free from coliform** bacteria and **safe** for human consumption. All samples have pH values between the limit (6.5-8.5) as per IS codes and other International codes. But these values indicate that only Three(**3**) samples are acidic.Again results included that 21.05% samples contained *very low mineral concentration* and 63.16 % samples contained *low mineral concentration.*

In case of water using,Treatement Plant Installed by Residential and Commertial Complex, it is observed that all the water samples (100%) fall under **excellent category (WQI < 50).**So **free from coliform** bacteria and **safe** for human consumption.Out of 5.26% samples have pH values beyond the limit (6.5-8.5) as per the IS codes and other International codes. But these values indicate that only One(**1**) sample is acidic. Again results showed that 23.81% samples contained *very low mineral concentration* and 57.14% samples contained *low mineral concentration)*

In case of Tubewell water it is observed that the water samples collected from Sonarpur fall under **Poor Category** whireas water samples collected from Mukundapur and Bose Pukur water tank fall under **Fair Category.** Again water samples collected from Kolaghat at East Midnapur,Birati at north 24 Pargana and Amta at Howrah fall under **good category.** All samples **free from coliform** bacteria and thereby **safe** for human consumption.

All samples have pH values between the limit (6.5-8.5)as per IS codes and other International codes. But these values indicate that **None** of the samples are acidic. Again results reflected that **None** of the samples contained *very low mineral concentration* and *low mineral concentration*. The Tubewell water samples collected from different areas have contained higher TDS value. So, these tubewell water, **due to excessive hardness not desirable and recommended for drinking purpose.**

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION:-

Water is a natural resources which is extremely essential for survival of all living organisms. Life without water is not possible on this planet. That is why drinking water needs to be safe from any type of contamination with respect to bacteriological and physio-chemical parameter. Drinking ware should comply with the requirements of chemical substances and physical characteristics as per concerned Indian standard. As per IS 10500:2012 (Indian standard Drinking water specification), drinking water is defined as the water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

Sources of drinking water in Indian cities are obtained from surface water (river, pond etc.) and ground water (tube-well, dug-well etc). Generally, municipal authorities supply drinking water after treatment of surface water. On the other hand, the ground water obtained through tube-well and dug well are not treated at individual or community.

Contamination of ground water can result in poor drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water supplies, and/or potential health problems . Hence there is always a need for and concern over the protection and management of ground water quality.Ground water monitoring of dug wells and bore wells is one of the most important tools for evaluating the quality of ground water. Chemical analysis of water gives a concept about its physical and chemical composition by some numerical values but for estimating exact quality of water, it's better to depend on water quality index which gives the idea of quality of drinking water. Literature survey reveals that WQI has been reported by different groups of workers . A water quality index (WQI) may be defined as a rating reflecting the composite influence of different water quality parameters. [*Patil V. T et.al*]

With rapid urbanization and increase in population the water demand for drinking and domestic uses are being increased day by day. In urban areas communities face acute shortage of drinking water. Municipal authorities, though take care of maintaining proper quality of drinking water before supply conforming to relevant Indian IS code by means of necessary treatment, sometimes there may have some risk of being contaminated and polluted due to leakage in pile networks and other causes. Ground water is generally considered to be much cleaner than surface water but manmade activities are responsible for its pollution. Such matters deteriorate the quality of water and render it unfit for intended use. The water quality is the most important parameter of any water supply planning. The quality, on the other hand, is a function of physical, chemical and biological parameters. According to WHO, about 80% of all diseases in human being are caused by water.

To minimize the pollution of drinking water and with a view to have zero risk many agencies and entrepreneurs developed different type of water purifiers in order to get pure drinking water at domestic houses, commertial, educational institutions, offices etc. These purifiers are developed based on various technologies such as RO-UV filter and normal stand alone filter. RO filters and normal stand-alone filters are mostly fixed on wall having an input water provision. These two purifiers are very popular now-a-days in urban areas and thereby vendors rush to shell it. In this study, for performance analysis of individual using purifier, quality parameters of drinking water after filtration through them are determined and compare that parameters with respect to IS codes and other International codes.

On the other hand, many entrepreneurs are carrying on business of **packaged drinking water** by means of production and vending in order to argument the situation of shortage of drinking water at urban areas. It becomes most popular among consumers now-a-days owing to good marketing strategy, easy availability everywhere around any urban area and comparatively better quality than any other sources (surface / ground water). 'Packaged Drinking Water (other than packaged natural mineral water) are water for human consumption and may contain minerals, naturally occurring or intentionally added, may contain carbon dioxide, naturally occurring or intentionally added, but shall not contain sugar, sweetness, flavours or other food staffs (*Sudarsan et. all*).

As per IS 45543:2004, - Packaged drinking water means water derived from surface water or underground water or sea water which is subjected to here in under specified treatments, namely, decantation, filtration, combination of filtration, aerations, filtration with membrane filter, depth filter, cartridge filter, activated carbon filtration, demineralization, remineralization, reverse osmosis and packed after disinfecting the water to a level that shall not lead to any harmful contamination in the drinking water by means of chemical agents or physical methods to reduce the number of microorganisms to a level beyond scientifically accepted level for food safety or its suitability. In order to access the quality these packaged drinking water, Water Quality Index (WQI) is considered one of best effective way to fine water quality. Moreover, physio-chemical and bacteriological parameters are compared with respect to acceptable limit as per IS 10500-2012 (Drinking Water Specifications) ,IS 14543-2004, [Packaged Drinking Water (other than packaged natural mineral water) Specifications]. and other International Codes.

Tube-well water is used primarily as a source of drinking water by the vast majority (90%) of the rural population in West Bengal. A tube-well is a small-diameter cased well fitted with a cast iron suction hand pump . These tube-wells have been installed in rural areas of West Bengal at various depths, depending on availability and the level of groundwater. In many cases, immediate environmental conditions are

unfavorable; e.g., the distance of tube-wells from latrines or sewage-contaminated ponds or tanks may be insufficient to avoid contamination of the well water with human-pathogenic bacteria. Tube-wells have failed to protect against gastrointestinal diseases in rural areas despite regular use of tube-well water for drinking. Recent studies have demonstrated that underground water systems are increasingly vulnerable to both microbiological and heavy metal contamination, especially by arsenic,in W.B. Such problems arise even in developed countries.(*www.aem.asm.org/content)*

Shallow tubewells are the primary drinking water source for most rural areas of W.B. Fecal contamination has been detected in tubewells, at low concentrations at the source and at higher levels at the point of use. We conducted a randomized controlled trial to assess whether improving the microbiological quality of tubewell drinking water by household water treatment and safe storage would reduce diarrhea in children <2 years in rural areas of W.B.

Fig- Typical picture of RO Filter

Picture of Normal Stand alone filter

Picture of Normal Stand alone filter

Packaged Drinking Water

1.2 STUDY AREA

The Kolkata Municipal area and its surrounding areas of West Bengal have been identified as study area. Kolkata City lies on longitude 88° 24' East of Greenwich meridian and latitude 22° 32' North of the Equator and located on the east bank of river Hooghly. In addition to being the largest indigenous city in West Bengal, this is an important trade, educational and cultural centre of eastern India. Many industries are established in and around Kolkata city. The total area covered by the city is 185 km^2. The metropolitan region of the city covers an area of 1,886.67 km^2. According to the census conducted in 2011, the population of the city is about 45 Lakh, making it the 7^{th} most populated city in India. The metropolitan region of the city houses a population of more than 141 Lakh and the metropolitan region of the city ranks as the third most populated metropolitan region of the country. The density of population of Kolkata is 24,250/km^2.

This study has given an insight of overall quality status of (i) Packaged drinking water (Different Branded of 500/600 Ml.bottled Pack and 20 Lt. Jar),(ii) KMC Supply water(From Treatment plant Tala, Garden Reach, Dhapa),(iii) Water using Individual Purifier (Using RO-UV water purifiers, normal in-built stand alone filters etc.), (iv)Water using Street Foot Vendors (Collected From Tubewell, Packaged water, KMC Supply),(v) Water using,Treatment Plant Installed by Residential and Commertial Complex where (Different Filter like Iron, Arsenic, Activated Carbon, R.O Treatment Plant are used), (vi)Tubewell water (From Different Collected Source).

All samples of Packaged Drinking water were collected from different shop of Kolkatai.ePicnicGarden,Anandapur,Rubymore,Jadavpur,MadhyamgramChowmatha Junction,ParkCircus,Singur,Hoogly,Shaiktigarh,Burdwan,Ratanpur,Hoogly,Avisar Shopping Mall at Kalikapur Road and different place at Mukundapur.

All samples of KMC Supply water(Garden Reach) were collected from K.P Basu Memorial Bldg.,AurobindoBhabon,Rabindra Bhabon,Faculty of Engg.Bldg,Outside tap of Water Resources Lab.Bldg at Jadavpur University.All samples of KMC Supply(Tala) were collected from Residencial Bldg at C.I.T Road, Beliaghata, Kolkata and Calcutta University,College Street and also samples of KMC Supply(Dhapa) were collected from Rail Bihar Residential Complex at ruby Park.

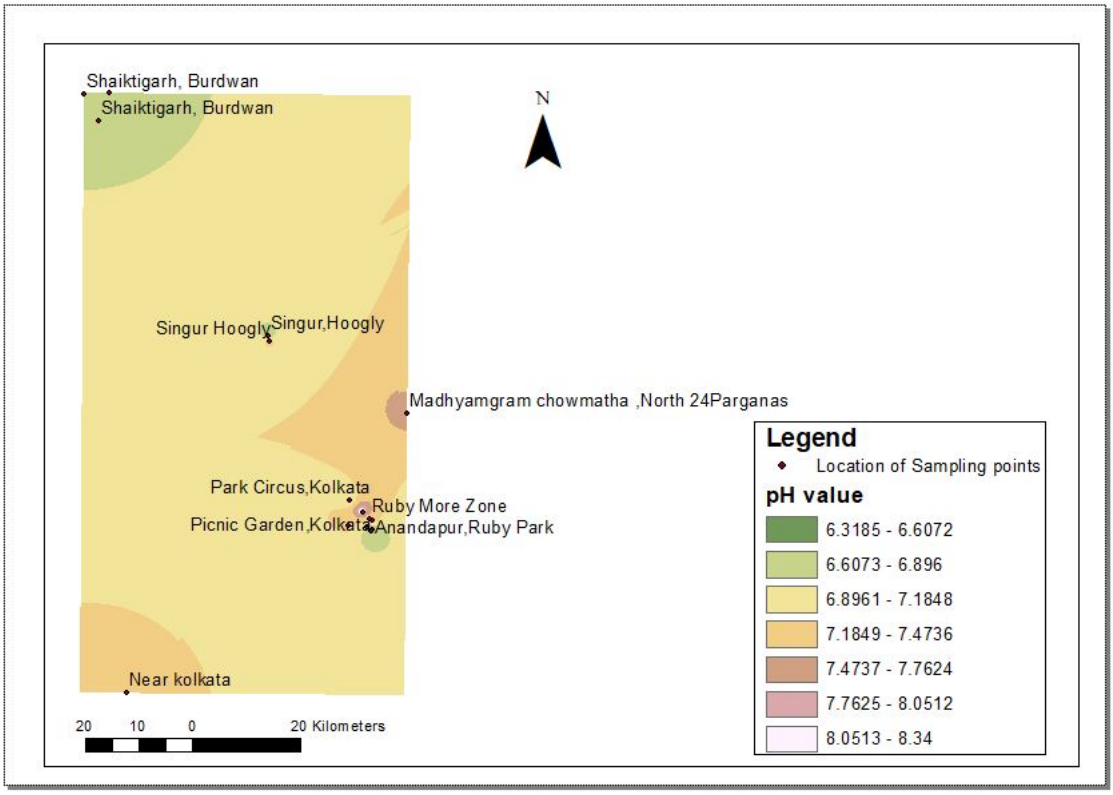
All samples of Water where using Individual Purifier i.e(R.O-UV , Standalone Filter etc.) were collected from Purba Abasan,(FA-Block), Residential Complex opposite to GST Bhabon(Residential),Avisar Shopping Mall at Kalikapur Road (Commertial), Institute of Nursing School at Ruby Hospital,Bijaygarh college at Jadavpur,West Bengal State Centre at Gokhale road, Metrological dept. at J.U(Institutional), ISPAT

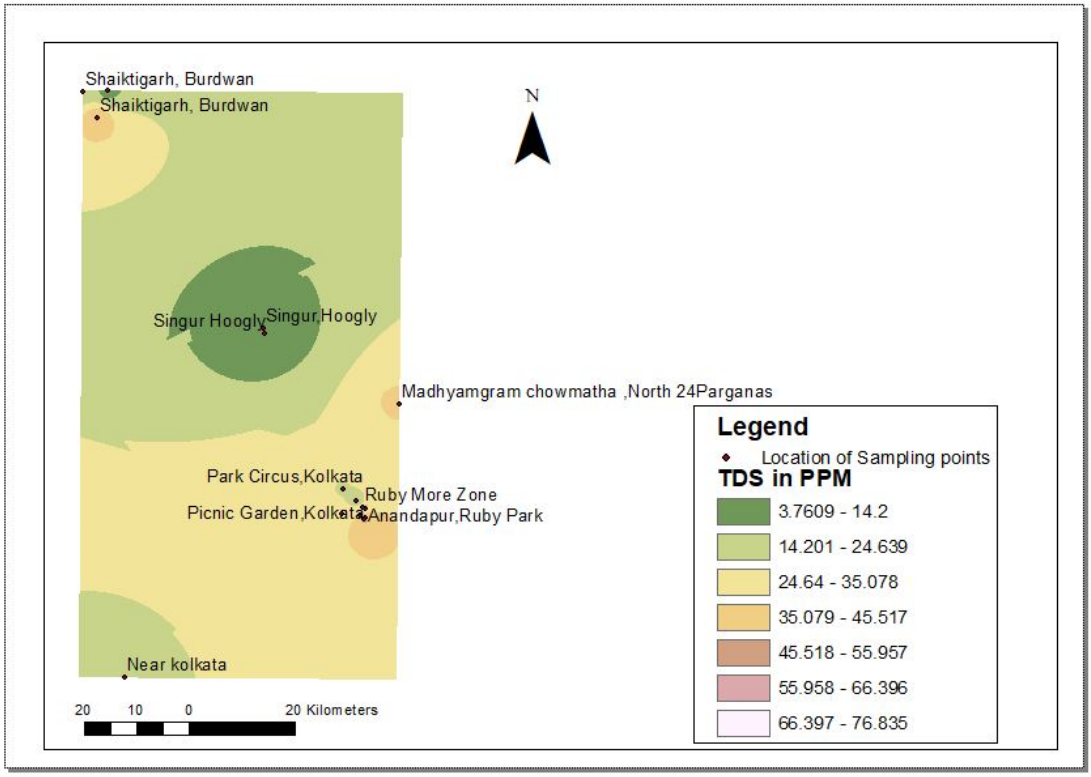
Hospital at Sonarpur, Diagnostic Centre at Sonarpur Station Road and The Institution of Engineers(INDIA) (Official).

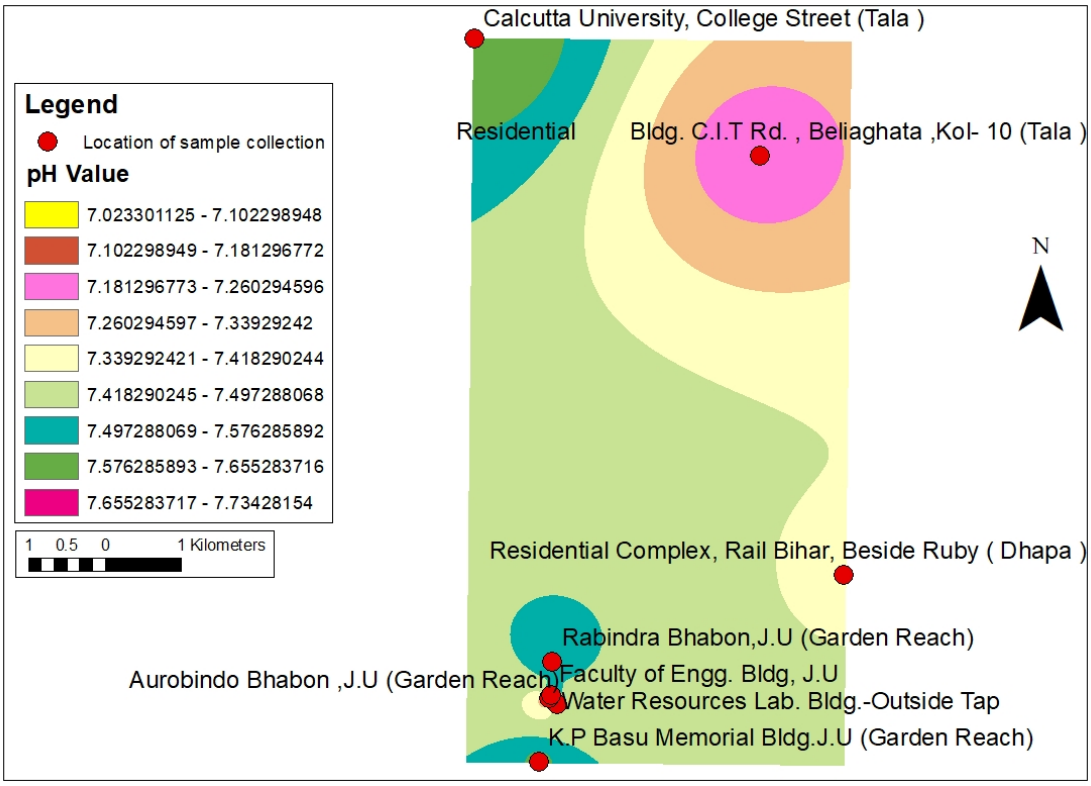
All samples of water using,Street Foot Vendors were collected from Tea shop at Kalikapur Road,Momo shop at 8B,Bus Stand at Jadavpur,Tea shop at 1 No. Gate J.U,Tea shop at Ruby More,Tea shop at Madhyamgram Chowmatha,Chowmin shop near by Rajarhat CC2 and Street vendors at Rantanpur Singur,Hoogly.

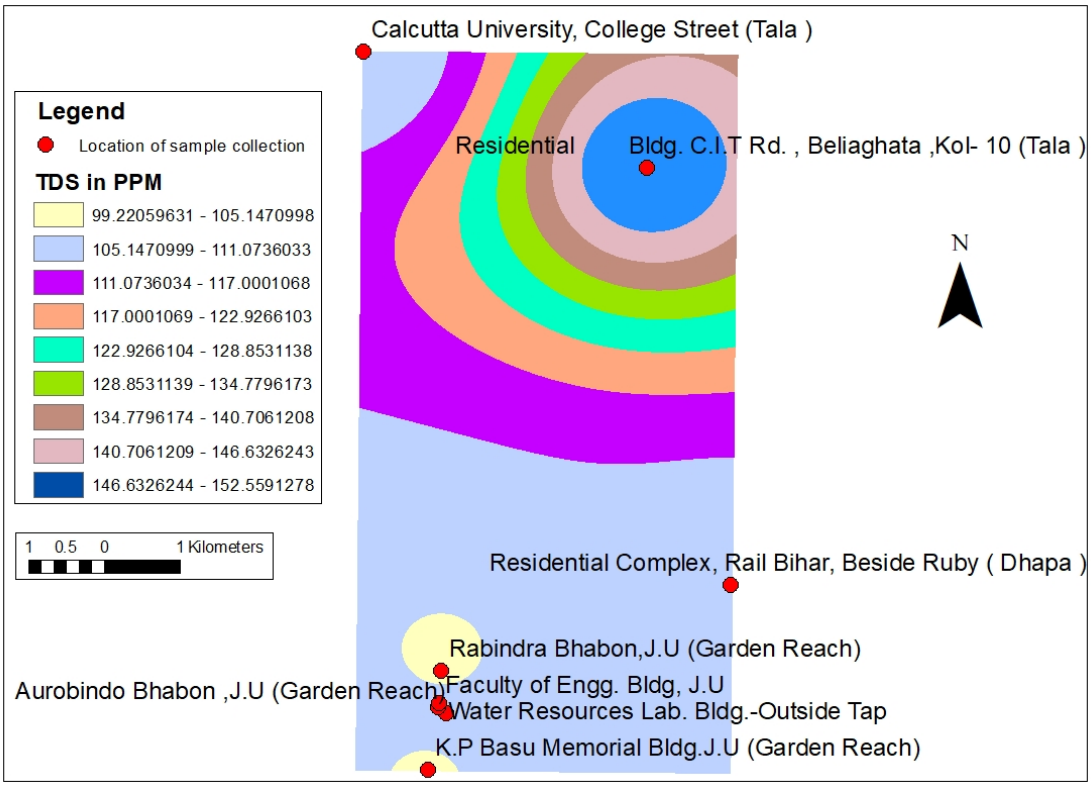
All samples of water using,Treatement Plant Installed by Residential and Commertial Compklex were collected from Rajarhat CC2, Accropolis Mall at Rajdanga Main Road, WIPRO office bldg,Saltlake, AMRI Hospital Mukundapur,High Land Park Residential Complex at Patuli and CENTRAL Shopping Mall at New Town ,Kolkata.

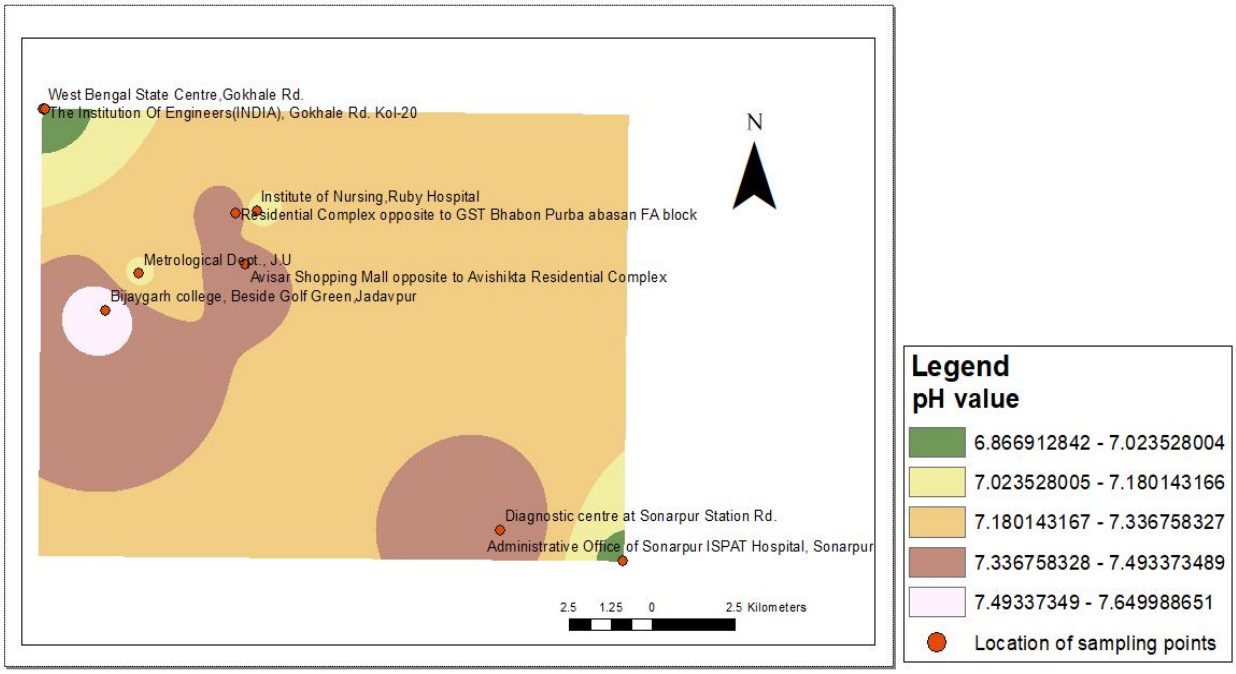
All samples of Tubewell water were collected from near by Green Park Nursing Home at Mukundapur, near by BosePukur water tank, near by 2 no. Kheyadaha Gram Panchayet at Sonarpur,Kolaghat Purba Medinipur, Kali Mandir Premises at Birati,North 24 Pargana and Amta Udaynarayanpur at Howrah.

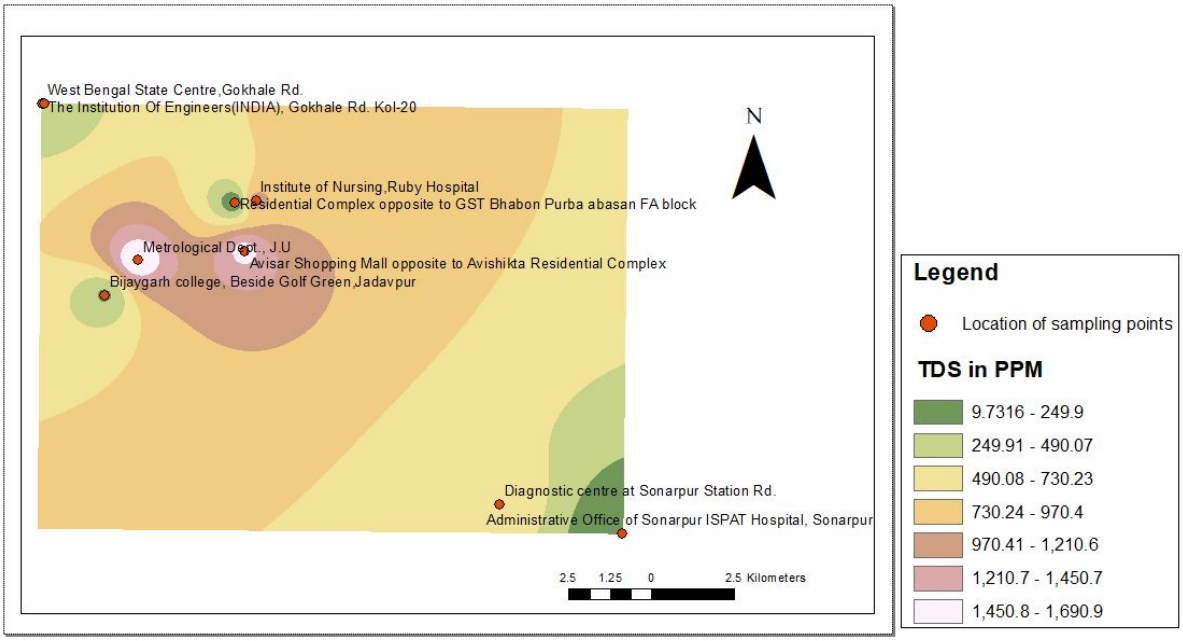

Shaiktigarh, Burdwan
Shaiktigarh, Burdwan
N
Singur Hoogly
Singur,Hoogly
Madhyamgram chowmatha ,North 24Parganas
Park Circus,Kolkata
Ruby More Zone
Picnic Garden,Kolkata
Anandapur,Ruby Park
Near kolkata
20 10 0 20 Kilometers
Legend
Location of Sampling points
pH value
6.3185 - 6.6072
6.6073 - 6.896
6.8961 - 7.1848
7.1849 - 7.4736
7.4737 - 7.7624
7.7625 - 8.0512
8.0513 - 8.34


Shaiktigarh, Burdwan
Shaiktigarh, Burdwan
N
Singur Hoogly
Singur,Hoogly
Madhyamgram chowmatha ,North 24Parganas
Park Circus,Kolkata
Ruby More Zone
Picnic Garden,Kolkata
Anandapur,Ruby Park
Near kolkata
20 10 0 20 Kilometers
Legend
Location of Sampling points
TDS in PPM
3.7609 - 14.2
14.201 - 24.639
24.64 - 35.078
35.079 - 45.517
45.518 - 55.957
55.958 - 66.396
66.397 - 76.835


Calcutta University, College Street (Tala)
Residential
Bldg. C.I.T Rd. , Beliaghata ,Kol- 10 (Tala)
Legend
Location of sample collection
pH Value
7.023301125 - 7.102298948
7.102298949 - 7.181296772
7.181296773 - 7.260294596
7.260294597 - 7.33929242
7.339292421 - 7.418290244
7.418290245 - 7.497288068
7.497288069 - 7.576285892
7.576285893 - 7.655283716
7.655283717 - 7.73428154
1 0.5 0 1 Kilometers
N
Residential Complex, Rail Bihar, Beside Ruby (Dhapa)
Rabindra Bhabon,J.U (Garden Reach)
Aurobindo Bhabon ,J.U (Garden Reach)
Faculty of Engg. Bldg, J.U
Water Resources Lab. Bldg.-Outside Tap
K.P Basu Memorial Bldg.J.U (Garden Reach)


Calcutta University, College Street (Tala)
Residential
Bldg. C.I.T Rd. , Beliaghata ,Kol- 10 (Tala)
Legend
Location of sample collection
TDS in PPM
99.22059631 - 105.1470998
105.1470999 - 111.0736033
111.0736034 - 117.0001068
117.0001069 - 122.9266103
122.9266104 - 128.8531138
128.8531139 - 134.7796173
134.7796174 - 140.7061208
140.7061209 - 146.6326243
146.6326244 - 152.5591278
1 0.5 0 1 Kilometers
N
Residential Complex, Rail Bihar, Beside Ruby (Dhapa)
Rabindra Bhabon,J.U (Garden Reach)
Aurobindo Bhabon ,J.U (Garden Reach)
Faculty of Engg. Bldg, J.U
Water Resources Lab. Bldg.-Outside Tap
K.P Basu Memorial Bldg.J.U (Garden Reach)


West Bengal State Centre,Gokhale Rd.
The Institution Of Engineers(INDIA), Gokhale Rd. Kol-20
Institute of Nursing,Ruby Hospital
Residential Complex opposite to GST Bhabon Purba abasan FA block
Metrological Dept., J.U
Avisar Shopping Mall opposite to Avishikta Residential Complex
Bijaygarh college, Beside Golf Green,Jadavpur
Diagnostic centre at Sonarpur Station Rd.
Administrative Office of Sonarpur ISPAT Hospital, Sonarpur
N
2.5 1.25 0 2.5 Kilometers
Legend
pH value
6.866912842 - 7.023528004
7.023528005 - 7.180143166
7.180143167 - 7.336758327
7.336758328 - 7.493373489
7.49337349 - 7.649988651
Location of sampling points


West Bengal State Centre,Gokhale Rd.
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Residential Complex opposite to GST Bhabon Purba abasan FA block
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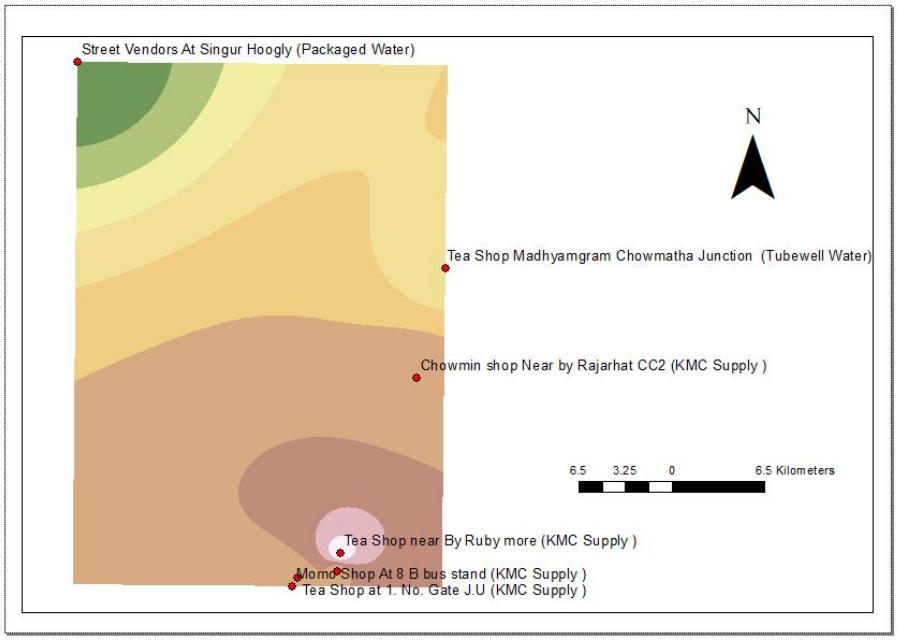
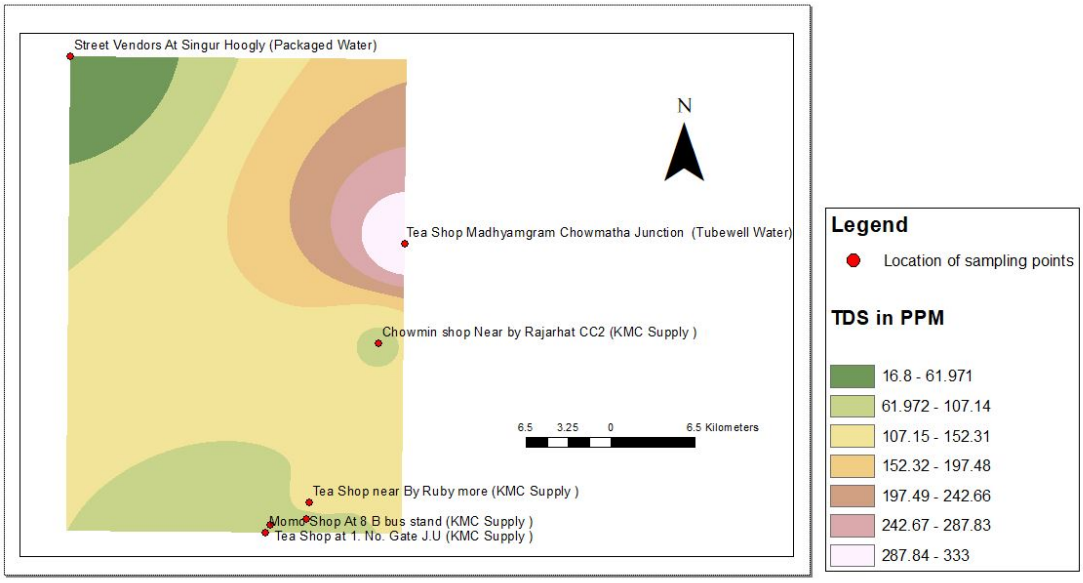
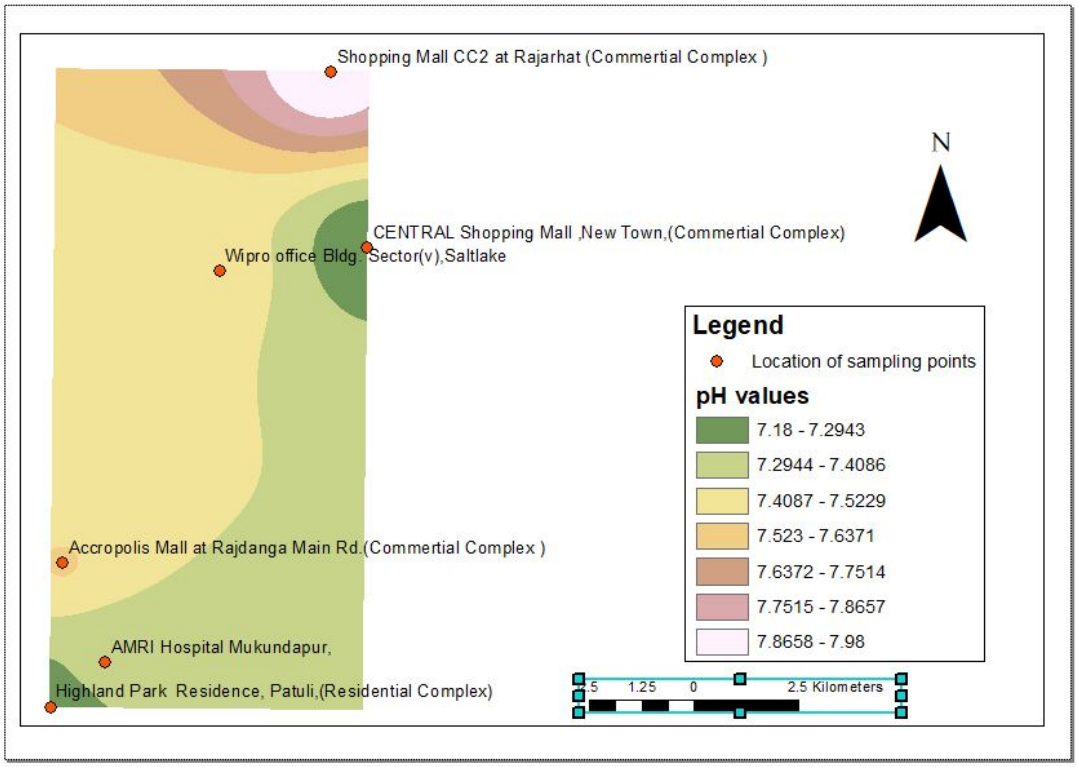
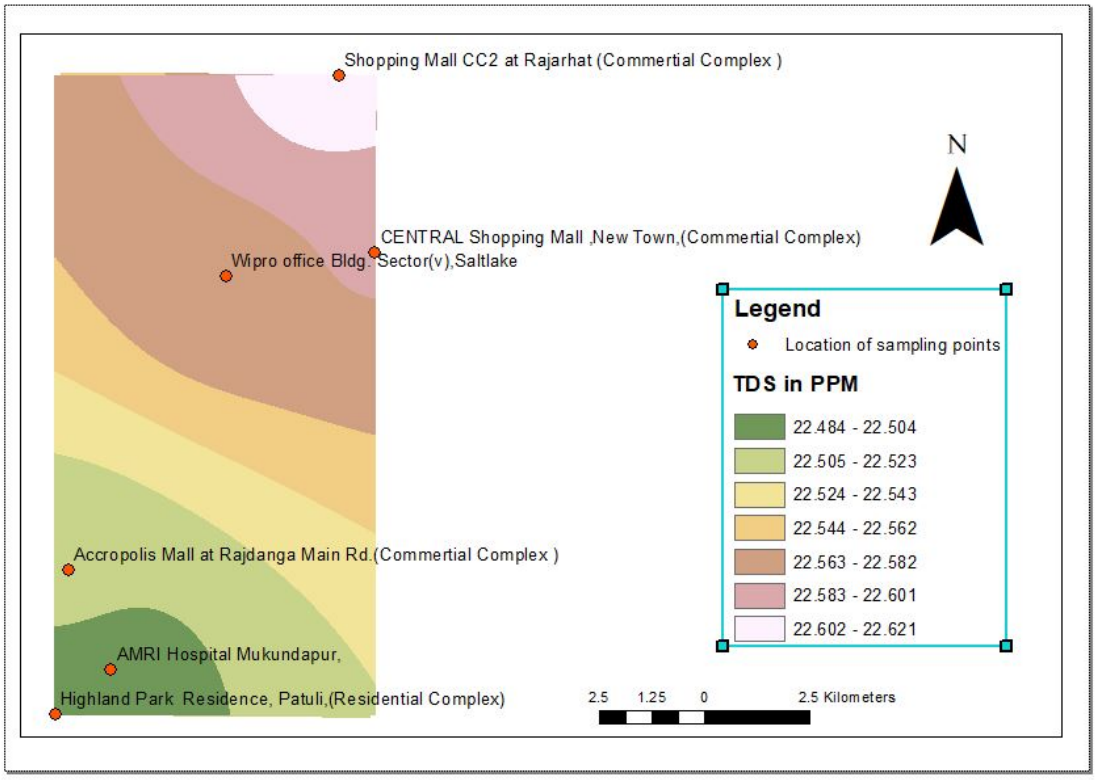
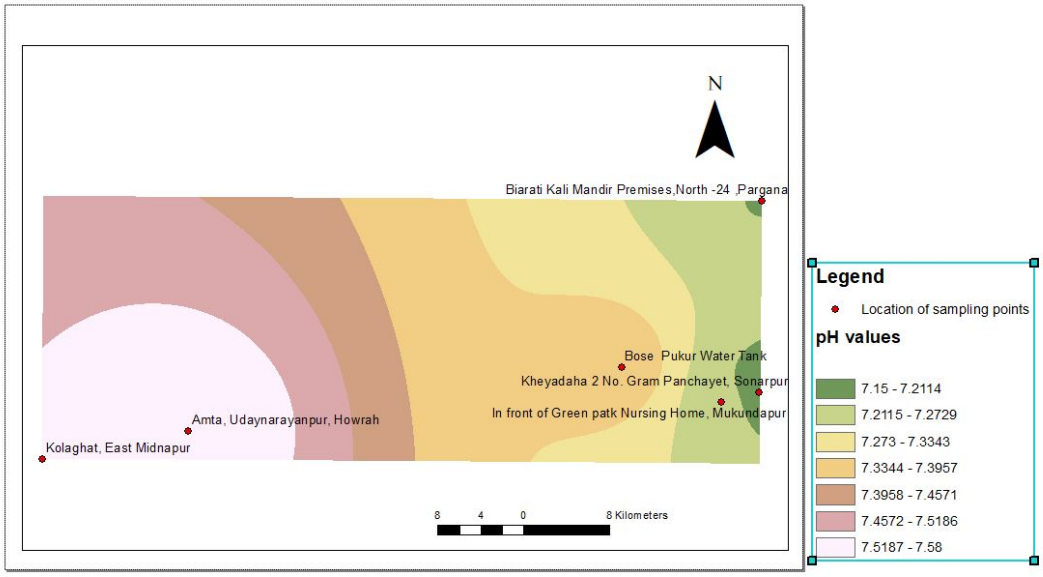
Avisar Shopping Mall opposite to Avishikta Residential Complex
Bijaygarh college, Beside Golf Green,Jadavpur
Diagnostic centre at Sonarpur Station Rd.
Administrative Office of Sonarpur ISPAT Hospital, Sonarpur
N
2.5 1.25 0 2.5 Kilometers
Legend
Location of sampling points
TDS in PPM
9.7316 - 249.9
249.91 - 490.07
490.08 - 730.23
730.24 - 970.4
970.41 - 1,210.6
1,210.7 - 1,450.7
1,450.8 - 1,690.9

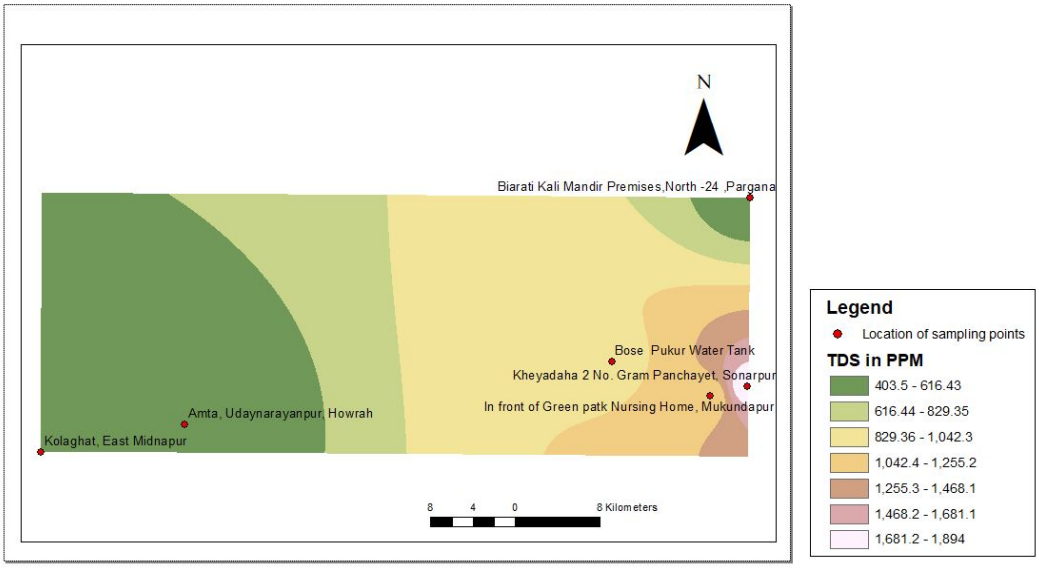

Street Vendors At Singur Hoogly (Packaged Water)
N
Tea Shop Madhyamgram Chowmatha Junction (Tubewell Water)
Chowmin shop Near by Rajarhat CC2 (KMC Supply)
6.5 3.25 0 6.5 Kilometers
Tea Shop near By Ruby more (KMC Supply)
Momo Shop At 8 B bus stand (KMC Supply)
Tea Shop at 1. No. Gate J.U (KMC Supply)
Legend
Location of sampling points
pH value
6.950000286 - 7.023326821
7.023326822 - 7.096653355
7.096653356 - 7.16997989
7.169979891 - 7.243306425
7.243306426 - 7.31663296
7.316632961 - 7.389959494
7.389959495 - 7.463286029
7.46328603 - 7.536612564
7.536612565 - 7.609939098


Street Vendors At Singur Hoogly (Packaged Water)
N
Tea Shop Madhyamgram Chowmatha Junction (Tubewell Water)
Chowmin shop Near by Rajarhat CC2 (KMC Supply)
6.5 3.25 0 6.5 Kilometers
Tea Shop near By Ruby more (KMC Supply)
Momo Shop At 8 B bus stand (KMC Supply)
Tea Shop at 1. No. Gate J.U (KMC Supply)
Legend
Location of sampling points
TDS in PPM
16.8 - 61.971
61.972 - 107.14
107.15 - 152.31
152.32 - 197.48
197.49 - 242.66
242.67 - 287.83
287.84 - 333


Shopping Mall CC2 at Rajarhat (Commertial Complex)
N
CENTRAL Shopping Mall ,New Town,(Commertial Complex)
Wipro office Bldg. Sector(v),Saltlake
Legend
Location of sampling points
pH values
7.18 - 7.2943
7.2944 - 7.4086
7.4087 - 7.5229
7.523 - 7.6371
7.6372 - 7.7514
7.7515 - 7.8657
7.8658 - 7.98
Accropolis Mall at Rajdanga Main Rd.(Commertial Complex)
AMRI Hospital Mukundapur,
Highland Park Residence, Patuli,(Residential Complex)
1.25 0 2.5 Kilometers


Shopping Mall CC2 at Rajarhat (Commertial Complex)
N
CENTRAL Shopping Mall ,New Town,(Commertial Complex)
Wipro office Bldg. Sector(v),Saltlake
Legend
Location of sampling points
TDS in PPM
22.484 - 22.504
22.505 - 22.523
22.524 - 22.543
22.544 - 22.562
22.563 - 22.582
22.583 - 22.601
22.602 - 22.621
Accropolis Mall at Rajdanga Main Rd.(Commertial Complex)
AMRI Hospital Mukundapur,
Highland Park Residence, Patuli,(Residential Complex)
2.5 1.25 0 2.5 Kilometers


N
Biarati Kali Mandir Premises,North -24 ,Pargana
Bose Pukur Water Tank
Kheyadaha 2 No. Gram Panchayet, Sonarpur
In front of Green patk Nursing Home, Mukundapur
Amta, Udaynarayanpur, Howrah
Kolaghat, East Midnapur
8 4 0 8 Kilometers
Legend
Location of sampling points
pH values
7.15 - 7.2114
7.2115 - 7.2729
7.273 - 7.3343
7.3344 - 7.3957
7.3958 - 7.4571
7.4572 - 7.5186
7.5187 - 7.58


N
Biarati Kali Mandir Premises,North -24 ,Pargana
Bose Pukur Water Tank
Kheyadaha 2 No. Gram Panchayet, Sonarpur
In front of Green patk Nursing Home, Mukundapur
Amta, Udaynarayanpur, Howrah
Kolaghat, East Midnapur
8 4 0 8 Kilometers
Legend
Location of sampling points
TDS in PPM
403.5 - 616.43
616.44 - 829.35
829.36 - 1,042.3
1,042.4 - 1,255.2
1,255.3 - 1,468.1
1,468.2 - 1,681.1
1,681.2 - 1,894

1.3 OBJECTIVE :-

The objective of the present study is -

1.To assess the status of water quality of (i) packaged drinking water (Different Branded of 500/600 Ml.bottled Pack and 20 Lt. Jar),(ii) KMC Supply water(From Treatmentplant Tala, Garden Reach, Dhapa),(iii) Water using Individual purifier (Using RO-UV water purifiers, normal in-built stand alone filters etc.), (iv)Water using Street Foot Vendors (collected from Tubewell, Packaged water, KMC Supply),(v) Water using,Treatment Plant Installed by Residential and Commertial Complex where (different filter like Iron, Arsenic, Activated Carbon, R.O Treatment Plant are used), (vi)Tubewell water (from different collected source) which are available in North Kolkata , South Kolkata ,surrounding areas of North/south Kolkata and different District in West Bengal.

2.To compared the obtained results of water quality parameters of the above mentioned different category drinking water with the specifications as per 'IS-10500: 2012 for Drinking Water Specifications', 'IS:14543: 2004 for Package Drinking Water Specifications (other than packaged natural mineral water)and international codes like WHO-2011,US EPA-2010 and CANADA Drinking water Guideline-2010.

1.4 SCOPE OF WORK :

The scope of works will comprise of the following :

i. Collected 62 nos.water samples with twelve (12) brands of (500/600 Ml. Bottled Packaged) and Five(5) brands of (20 Lt. Jar.) **of packaged drinking water.**
ii. **In KMC Supply drinking water,** collected Fifteen (15) Nos. Water samples from treatement plant (i.e Garden Reach), Sixteen (16) Nos. Water Samples from treatement plant (i.e Tala) and Seven(7) Nos. water Samples from treatment plant (i.e Dhapa)
iii. **Water using by Individual Purifier(i.e Using RO-UV water purifiers, normal in-built stand alone filters etc.)** collected Nine (9) Nos.Water samples from Residential complex where using (R.O-UV Water Purifier), Twelve (12) Nos. Water Samples from Commertial Complex where using (normal in-built stand alone filters) and Eleven(11) Nos. water Samples from Institutional area (normal in-built stand alone filters or other purifier) and Thirteen(13) Nos, water Samples from Official sector where using (Both RO-UV water purifiers and normal in-built stand alone filters etc).
iv. **Water using,Street Foot Venders** collected Two (2) Nos. Water samples from Tea shop at Kalikapur Road, Two (2) Nos. water samples from Momo

shop at 8B Bus Stand at Jadavpur, Two(2) Nos. water samples from 1 No. Gate,J.U, Two(2) Nos. water samples at Ruby more,Three(3) Nos. water samples from Madhyamgram Chowmatha Junction, Four(4) Nos. water samples from Rajarhut near by CC2 and Four (4) Nos. water samples from Street Vendors at Singur,Hoogly.

v. **Water using,Treatement Plant Installed by Residential and Commertial Complex:** collected Three (3) Nos. Water samples from City Centre-2 at Rajarhut, Three(3) Nos. water samples from Accropolis Mall at Rajdanga Main Road, Five(5) Nos. water samples from WIPRO Office Bldg. sector(v) at Saltlake, Six(6) Nos. water samples from AMRI Hospital at Mukundapur, Two(2) Nos. water samples from HighLand Park Residential Complex at Patuli and Two (2) Nos. water samples from CENTRAL Shopping Mall at New Town,Kolkata.

vi. **In Tubewell water :** collected Four (4) Nos. water samples from near by Green Park Nursing Home at Mukundapur, Four (4) Nos. water samples from near by Bose Pukur water tank, Four(4) Nos. water samples from 2 No. Kheyadaha Gram Panchayet at Sonarpur,Four(4) Nos. water samples from Kolaghat at East Midnapur,Four(4) Nos. water samples from Birati Kali Mandir premises at North 24 Parganas and Four(4) Nos. water samples from Amta Udaynarayanpur at Howrah.

vii. The samples collected on a day were immediately processed for bacteriological analysis in Bacteria detection Kit / total coli form Detection Kit to conform presence of total coli form. H_2S- Strip method (as per IS 1622:1981) was used to find out presence of **total coli form**.

viii. The samples were then analysed for Three(3) different physiochemical and bacteriological parameters as per standard methods (APHA) Guideline.The parameters are **pH**, , **total dissolved solid** (TDS), Total Coliform Bacteria.

Compairing the obtained results of all above mentioned different category of drinking water collected from different zones with the requirement as per specifications of drinking water (IS-10500: 2012), packaged drinking water (other than packaged natural mineral water) (IS:14543: 2004). and other international codes like WHO-2011,US EPA-2010 and CANADA Drinking water Guideline-2010.

ix. Analysis of results for determination of Water Quality Index (WQI) and standard daviation was done to assess the quality of water.

x. Necessary conclusion made based on obtained results of parameters and analysis.

1.5 METHODOLOGY OF THE WORK :

(a) Collection of sample

(I) **Packaged Drinking Water_**(500/600 Ml. Bottled Packaged) and (20 Lt. Jar.) The samples of Packaged water of different brands were collected from various key locations at Kolkata city and different district in W.B. The following information are noted ;

1. Sample No.
2. Date of Collection
3. Location from where the Sample collected
4. Name of the Brand
5. Name of the manufacturer
6. Date of packaging
7. Batch No.

(II) **In KMC Supply drinking water:-** The samples of water were collected through polyethylene bottles from different areas of Kolkata where supplying water from different treatment plant like Garden Reach, Tala, Dhapa and following information are noted ;

1. Sample No.
2. Date of sample Collection
3. Sample Location
4. Latitude and Longitude
5. Name of the KMC Treatement Plant(Garden Reach/Tala/Dhapa)
6. No. Of Persons using this water.
7. How much water is required for daily basis
8. Test and colour of water.

(III**) Water using by Individual Purifier(i.e Using RO-UV water purifiers, normal in-built stand alone filters etc.):-** The samples of water were collected through polyethylene bottles from different of areas i.e (i) Residential,(ii)Commertial,(iii)Institutional and (iv) Official zones .The following information are noted ;-

9. Sample No.
10. Date of sample Collection
11. Sample Location
12. Latitude and Longitude
13. Type of collected source [(Residential(I-1)/Commertial(I-2)/Institutional (I-3)/Official (I-4)]
14. No. Of Persons using this water
15. How much water is required for daily basis
16. Test and colour of water.

(IV**) Water using,Street Foot Venders:** The samples of water were collected through polyethylene bottles from different street venders of Kolkata and other district of West Bengal . The following information are noted ;

1. Sample No.
2. Date of sample Collection
3. Sample Location
4. Latitude and Longitude
5. Name Of the collected source(KMC Water/Tubewell/Packaged water)
6. How much water is required for daily basis

(V**) Water using,Treatement Plant Installed by Residential and Commertial Complex**: The samples of water were collected in polyethylene bottles from different Residential and Commertial Complex of Kolkata and surounding ares. During the sample collection following points were noted :

1) Sample No.
2) Date of sample Collection
3) Sample Location
4) Name of the Residential/Commertial Complex
5) Latitude and Longitude.
6) Use of filter during the treatment process (R.O, Activated carbonFilter ,Iron Filter)
7) No. Of Persons using this water.
8) Test and colour of water.
9) How much water is required for daily basis.

(VI**) In case of Tubewell water**:-The samples of water were collected in polyethylene bottles from different areas of North/South Kolkata and other district in West Bengal. During the sample collection following points were noted :

1. Sample No
2. Date of sample Collection
3. Sample Location
4. Latitude and Longitude
5. Ward No./Dag.No.
6. Owner of Tubewell (Govt./Private)
7. No. Of Persons using this water
8. How much water is required for daily basis.
9. Test and colour of water

b) . Testing of sample

In all the above cases, after collection of sample, immediately the same was tested for presence of total coliform / bacteria by total coliform detection kit / bacteria detection kit (H_2S strip). The result in this process indicated the presence of total coliform or not.

At the same time, the samples were analyzed for physiochemical test for different parameters that is **pH**, , **total dissolved solid** (TDS), as per procedure as laid down in APHA Guideline.

1.6 SURVEY INFORMATION OF PRESENT RESEARCH WORK:-

1.(i). Packaged Drinking Water :--

A.General Information :-

Date of Collection :-	26/11/2018
Name of collected source :-	500 Lt.Bottle Pack (Kinley)
Location of the Collected Source :-	Picnic Garden
Name of City ;–	Kolkata
Test and Colour of water :-	Natural
P.S.: -	Park Circus
District	Kolkata

B.Detail Information :-

Marketed By	Cocacola Company
Manufactured By	Diamond Beverage pvt. Ltd,Taratola Road, Kol-88
Batch no.	130
Date of Packing	30/10/2018

1..(ii). Packaged Drinking Water :--

A.General Information :-

Date of Collection :-	08/12/2018 and 30/01/19
Name of collected source :-	SB AQUA (20 Lt.Jar)
Location of the Collected Source :-	Avisar Shopping Mall at Kalikapur Rd
Name of City ;–	Kolkata
Test and Colour of water :-	Natural
P.S.: -	Patuli
District	kolkata

B.Detail Information :-

Marketed By	SB AQUA Beverage Pvt. Ltd.
Manufactured By	SB AQUA BeveragePvt. Ltd.Sonarpur,Kolkata-150
Batch no.	Not mentioned
Date of Packing	03/11/2018

2.(i) KMC Supply Water :--

A.General Information :-

Date of Collection :-	11/12/18
Name of collected source :-	Rail Bihar Housing Complex
Location of the Collected Source	Rail Bihar Housing Complex,Ruby Park
Name of City ;–	Kolkata
Test and Colour of water :-	Natural and Desirable
P.S.: -	Kasba
District :–	Kolkata

B.Detail information:-

How many person for drinking are used from the water : -	350 Persons
No. of Male, Female and children of this family :-	-
Use of the Homemade Purifier? :-	Yes
Name of the Homemade Purifier:-	Normal Stand alone Purifier
How much water is required for Daily Household ;-	3500 Lpcd (@5Lpcd for drinking &5Lpcd for Cooking) For Indian town &City
Name of the Treatement Plant from where this water is supplied :-	Dhapa Treatment plant, Science City

2.(ii) KMC Supply Water :--

A.General Information :-

Date of Collection :-	16/01/19
Name of collected source :-	Residential Bldg. C.I.T Road,
Location of the Collected Source	Residential Bldg. C.I.T Road, Beliaghata,Kol-10
Name of City ;–	Kolkata
Test and Colour of water :-	Natural and Desirable
P.S.: -	Beliaghata
District	Kolkata

B.Detail information:-

How many person for drinking are used from the water : -	3 Persons
No. of Male, Female and children of this family :-	1-Male, 1-Female, 1-Children
Use of the Homemade Purifier? :-	Yes
Name of the Homemade Purifier:-	Normal Stand alone Purifier
How much water is required for Daily Household ;-	30Lpcd (@5Lpcd for drinking &5Lpcd for Cooking) For Indian town &City
Name of the Treatement Plant from where this water is supplied :-	Tala Treatement Plant

3(i). Water Using Individual Purifier :--

A.General Information :-

Date of Collection :-	20/11/18
Name of collected source :-	PurbaAbasan,FA-Block,Residential Complex,
Type of the collected source	Residential
Location of the Collected Source :-	1582/3,Rajdanga MainRoad,Kol-107
Name of City ;–	Kolkata
Test and Colour of water :-	Natural and Desirable
P.S.: -	Kasba
District	Kolkata

B..Detail information:-

How many people for drinking are used from the water (If Residential) : -	2 Persons
No. of Male, Female and children of this family :-	1-Male, 1-Female
Use of the Homemade Purifier ?:-	Yes
Name of the Homemade Purifier:-	Dr.Aquaguard,R.O-UV with Biotron Technology
How much water is required for Daily Household ;-	20Lpcd (@5Lpcd for drinking &5Lpcd for Cooking) For Indian town &City

3(ii). Water Using Individual Purifier :--

A.General Information :-

Date of Collection :-	22/11/18
Name of collected source :-	Avisar Shopping Mall
Type of the collected source	Commertial
Location of the Collected Source :-	Opposite to Avishikta Residential complex at Kalikapur Road,Kol-78
Name of City ;–	Kolkata
Test andColour of water :-	Undesirable and not satisfied
P.S.: -	Patuli
District	kolkata

B..Detail information:-

How many people for drinking are used from the water?(If Commertial or Other Type) : -	50 Persons
Use of the any Purifier? :-	Normal Stand alone Filter
Name of this Purifier:-	Aquaguard,Eureka Forbes
How much water is required for Dailybasis ;-	1000Lpcd (@20Lpcd for Commertial use of Indian City)

4(i)..Water Using Street Foot Vendors:--

A. .General Information :-

Date of Collection :-	11/12/18
Name of collected source :-	Tea Shop at Ruby More
Location of the Collected Source :-	Ruby More
Name of Vendors :-	Tea Shop
Name of City ;–	Kolkata
Test and Colour of water :-	Natural and Desirable
P.S.: -	Kasba
District :	Kolkata

.

B.Detail information:-

How many people for drinking are used from the water : -	2 Persons
How much water is required for dailybasis ;-	20Lpcd (@10Lpcd for Civic or Public use of Indian City)

4(ii)..Water Using Street Foot Vendors:-

A. .General Information :-

Date of Collection :-	8/12/18
Name of collected source :-	Tea Shop at Madhyamgram Chowmatha junction
Location of the Collected Source :-	Madhyamgram Chowmatha junction
Name of Vendors :-	Tea Shop
Name of City ;–	Kolkata
Test and Colour of water :-	Natural and Desirable
P.S.: -	Madhyamgram
District :	North 24 pargana

. **B.Detail information:-**

How many people for drinking are used from the water : -	3 Persons
How much water is required for dailybasis ;-	30Lpcd (@10Lpcd for Civic or Public use of Indian City)

5(i) Water Treatement Plant installed By Residential and Commertial Complex:-

A.General Information :-

Date of Collection	17/12/18
Name of the Residential / Commertial/Official Complex	Accropolis Mall (Commertial)
Location of the Collected Source	Accropolis Mall, Rajdanga Main Rd. Kol-107
Name of City	Kolkata
P.S.:	Kasba
District :–	Kolkata
Test and Colour of water	Natural and Desirable

B..Detail information:-

How many people for drinking are used from the water : -	1000 approx
How much water is required for Dailybasis	20,000Lpcd (@20Lpcd for Commertial use of Indian City)
How many Filter are used during treatement proces	2 nos.
Name of those filter which are used :-	Iron removal Filter and Activated Carbon Filter

5.(ii) Water Treatement Plant installed By Residential and Commertial Complex:-

A.General Information :-

Date of Collection	16/01/19
Name of the Residential / Commertial/Official Complex	WIPRO Office Bldg.(Official)
Location of the Collected Source	Wipro Office Bldg.Sector-v,Salt Lake
Name of City ;–	Kolkata
P.S.:	Bidhannagar
District :–	Kolkata
Test and Colour of water	Natural

B..Detail information:-

How many people for drinking are used from the water : -	1500 approx
How much water is required for Dailybasis	(67,500-1,35000)Lpcd [@(45to 90)Lpcd for Office use of Indian City]
How many Filter are used during treatement proces	2 Nos.
Name of those filter which are used :-	R.O Treatement Unit and Rain water Harvesting Plant.

6.(i)Tubewell water :--

A.General Information:-

Date of collection	27/11/18
Name of The Village	Kheyadaha
Name of GP	Kheyadaha Gram panchayet
Name of Block	Sonarpur
Topo sheet no/Dag.No.	02
P.S.	Sonarpur
District	Kolkata

B.Detail information:

Type of well examined	Tubewell
Location of residence	Nearby Kheyadaha Gram Panchayet, Sonarpur
. Owner: Private /Government	Private
If drinking sample collected or not collected?	Yes,collected
How many people for drinking is used from the well?	5 persons
How much distance covered to get water for drinking purpose?	Their own premises
No. of person in home	5 Persons
No. of children	2
Use of any homemade water purification process?	No.
.How much water is required for daily house hold?	675Lpcd(@135Lpcd forDrinking,Cooking and other all Domestic uses) for LIG Colonies of small towns.

Live Stock:-

category	Total no
cow	2
buffalow	-
goat	2
poultry	-

6.(ii)Tubewell water :--

A.General Information:-

Date of collection	24/11/18
Name of City	Kolkata
Name of the Block	Mukundapur
Ward no.	109
P.S.	Patuli
District	Kolkata

B.Detail information:

Type of well examined	Tubewell
Location of residence	In Front of Green Park Nursing Home,Mukundapur
. Owner: Private /Government	Govt.
If drinking sample collected or not collected	Frequently collected
How many people for drinking is used from the well	50 persons.
How much water is required for daily house hold?	500Lpcd (@ 5Lpcd for Drinking & 5Lpcd for Cooking) for LIG Colonies of small towns.
How much distance covered to get water for drinking purpose	Walking Distance from their Residence

CHAPTER 2

LITERATURE REVIEW

2.0 LITERATURE REVIEW:-

Sunil J. Wimalawansa, Approximately 25% of the world's population has no access to clean and safe drinking water. Even though freshwater is available in most parts of the world, many of these water sources contaminated by natural means or through human activity. With the population boom and industry expansion, the demand for potable water is ever increasing, and freshwater supplies are being contaminated and scarce. In addition to human migrations, water contamination in modern farming societies is predominantly attributable to anthropogenic causes, such as the over-utilization of subsidized agrochemicals—artificial chemical fertilizers, pesticides, fungicides, and herbicides.In addition, other areas where the groundwater contaminated with fluorides, arsenic, and radioactive material occur naturally in the soil. Although the human body is able to detoxify and excrete toxic chemicals, once the inherent natural capacity exceeded, the liver or kidneys, or both organs may fail. Thus, clean and safe water provided at an affordable price is not only increasingly recognized, Most of the household filters and methods used for water purification remove only the particulate matter. The traditional methods, including domestic water filters and even some of the newer methods such as ultra-filtration, do not remove most of the heavy metals or toxic chemicals from water than can harm humans. The use of reverse osmosis technology and ion exchange methods. Properly designed reverse osmosis methods remove more than 95% of all potential toxic contaminants in a one-step process. This review explains the reverse osmosis method in simple terms and summarizes the usefulness of this technology in specific situations in developing countries.

Susanta Ray,Dr.Prof. Pankaj Kumar Roy, Dr.Prof.Arunabha Majumder. In recent years, packaged drinking water (PDW) has become one of the major sources of drinking water and is very popular among consumers. The study was conducted to assess the bacteriological and physicochemical quality of PDW sold in KoIlkata city, India, and its effects on public health. Further the quality of PDW and KMC supply water has been compared with an average quality of bottled water of some branded companies of advanced countries with respect to relevant Indian and International standards (World Health Organization, IBWA, US FDA and EPA). The samples of 27 types of bottled PDW, 10 types of bubble top can PDW of different Indian brands and 18 samples of KMCsupply water have been collected from different locations of the city. Physicochemical and bacteriological parameters of collected samples have been tested at **School of Water Resources Engineering, Jadavpur University, as per APHA guidelines** and also some parameters have been obtained using different field kit instruments. In the study, no bacteria were found in the entire samples of either PDW or KMC supply water. The study also showed that at least 41% PDW had pH value below 6.5 and was acidic, whereas pH of KMC supplywater was within the acceptable range (6.5–8.5). Both types of PDW were found to be soft,containing low concentration of minerals, total dissolved solids (TDS), calcium

(Ca) andmagnesium (Mg). All PDW showed low TDS values having the averages of 38.26 mg/l (bottled),24.68 mg/l (bubble top can) and the maximum of 117 mg/l. Similarly, all PDW were found with very low “total hardness (TH)” with the maximum value of 76 mg/l, which is much below the standard limit. Long-term consumption of low mineralised PDW may lead to potential risk on public health, like irritation to mucous membranes, increase in Cardiovasculer Disease.

Sudarsan et. al conducted a study in Chennai city to assess the physiochemical and bacteriological quality of packaged water sold in several key locations of study area. The three main source of packaged water included bottled water, sachet and bubble top cans. At the time of study they identified 40 key locations in study area. From each location samples were collected from various vendors and subjected to physical, chemical and bacteriological analysis. World Health Organization (WHO) standards were adopted for calculation of Water Quality Index (WQI). WQI provides an easy and rapid method of monitoring of water quality. Water quality indices revealed that drinking water of Bubble top cans and Sachet were found to be contaminated, comparing to bottled drinking water, so they needs some degree of more treatment before consumption.

Mihayo I.Z. et. al (2012) carried out study to determine the physio-chemical quality of bottled drinking water brands available in retail shops in Mwanza city (Tanzania), and compare with drinking water standards. The results show that water type for different bottled water brands when classified according to TDS ranged from very low concentrations (brands A and B) to low concentrations (brands C, D, E, and F). Based on the classification criteria of total hardness, most brands were considered to have soft water except for brand E which had moderately hard water. The dominant component to all bottled water brands was SO_4 2− accounted 48% to 90% of the total major ions, whereas Cl− accounted for 8% to 25%. Somewhat high contributions up to 20% was observed for Ca2+, while Mg2+ was below 9%, and Fe2+ and NO3 − were below 6%. Brand D has exceptionally high levels for Cl−, NO3 −, and Mg2+ ions. When compared with Tanzania Bureau of Standards (TBS) and World Health Organization (WHO) guidelines for drinking water, analyzed parameters in all brands were within TBS and WHO limit values for drinking water. The study therefore concludes that the analyzed bottled water brands are safe for human consumption.

Ayat Abd-Aljaleel Altekrety,et.al& Yaaroub Faleh AL-Fatlawy The ability of household Reverse Osmosis system to treat three different water sources has been tested within a period of time. Water samples were analyzed before and after treatment with the system for physical, chemical and heavy metals parameters. The results showed that the values of temperature after treatment by R.O household filter increased slightly (29.88 ºC, 29.78 ºC and 30.66 ºC) in tap water, river water and well water respectively. While thevalues of pH decreased after treatment (7.07, 7 and 6.82) tap water, river water and well water respectively. The removal efficiencies

of different parameters that tested during this study in tap water, river water and well water were as following: electricalconductivity(95.2%, 95.4% and 92.9%), total hardness (94.6%, 95.4% and 96.8%), free residual chlorine (100%), calcium (94.1%,95.4% and 97.1%), magnesium (94.2%, 97.0% and 96.4%), potassium (88.6%, 72.7% and 84.9%), phosphate (86.4%,86.8% and 84.3%), nitrite (89.1%, 92.2% and 92.2%), carbonate (100%, 96.9% and 100%), copper (19%, 64.2% and 86.6%),nickel (73.7%, 29.7% and 100%), zinc (38.5%, 83% and 57.6%). The results of this study showed that the Reverse osmosis system was efficient in removing water contaminants with a high value.

Ramakrishnaiah C.R et. al (2009) assessed the water quality index (WQI) for the groundwater of Tumkur taluk. They determined the WQI by collecting groundwater samples and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, they considered 12 parameters such as pH, total hardness, calcium, magnesium, bicarbonate, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides. The WQI for these samples ranged from 89.21 to 660.56. The high value of WQI was found to be mainly from the higher values of iron, nitrate, total dissolved solids, hardness, fluorides, bicarbonate and manganese in the groundwater. They used the results of analyses to suggest models for predicting water quality. Their analysis revealed that the groundwater of that area needed some degree of treatment before consumption, and also to be protected from the perils of contamination.

Rebecca L et. al investigated that many, but not all, of the epidemiological studies published during 1957 to 1979 reported an inverse association between cardiovascular mortality and water hardness. Lower cardiovascular death rates were found in populations where the water supply contained relatively high levels of water hardness or calcium and magnesium compared to populations in areas with low levels. According to them, limited information available about the magnitude of the association or causality. Several reviewers estimated that populations who live in soft water areas may have, at best, a 25% percent excess cardiovascular disease mortality risk than populations in hard water areas.

Hussein Janna1*, Mukhtar D. Abbas2,et.al.These parameters are PH, EC, TDS, Ca, Mg, and TH. Therefore, samples were collected and tested in Al-Qadisiyah Environmental Authority for these local drinking water treatment stations for seven weeks, in order to compare the effluent with the minimum concentrations required for human body according to the health studies and guide lines.The results show that all the drinking waters produced by these stations were below the WHO(BIS) and Iraq standards. The concentrations of Calcium were in the range from 5.3 to 25 mg/l, while the concentrations of magnesium were in the range from 9.5 to 18.2 mg/l. Therefore, drinking water produced from RO stations should be remineralised to increase the concentrations of necessary constituents in order to minimize the risk of

the potential influence of low level concentrations containing calcium carbonate or by adding calcium compounds to the water**.**

Krishna kumar S et. al (2014) studied the geochemical characteristics of groundwater and drinking water quality has been. They collected 24 groundwater samples and analyzed for pH, electrical conductivity, total dissolved solids, carbonate, bicarbonate, chloride, sulphate, nitrate, calcium, magnesium, sodium, potassium and total hardness. The results were evaluated and compared with WHO and BIS water quality standards. The studied results have revealed that the groundwater is fresh to brackish and moderately high to hard in nature. Na and Cl are dominant ions among cations and anions. Chloride, calcium and magnesium ions are within the allowable limit except few samples. According to Gibbs diagram, they observed that the predominant samples fall in the rock–water interaction dominance and evaporation dominance field. The piper trilinear diagram shows that groundwater samples are Na–Cl and mixed CaMgCl type. Based on the WQI results majority of the samples are falling under excellent to good category and suitable for drinking water purposes.

Patil V. T. et. al (2013) collected groundwater samples during November 2009 - February 2010 from five different locations in Amalner town and subjected to comprehensive physicochemical analysis. Water quality index (WQI) values were computed to assess the quality of groundwater with respect to drinking purpose. In their study, groundwater samples from Shivaji Nagar, Dheku road and Weekly market indicated good water quality and fit for drinking purpose and the ground water samples from Shirud naka and Cotton market showed poor water quality as reflected by WQI value. The poor water quality was found mainly due to higher values of EC, TDS, TA, TH and Cl- in ground water.

Col k.C Verma,Lt col A.S Kushwaha: Drinking water supplies are highly variable in their mineral content. While some contribute appreciable amounts of certain minerals either due to natural conditions (Ca,Mg,Se,F,Zn),international additions (F) or leaching from piping (Cu),most provide lesser amounts of nutritionally essential minerals.

Kuchewar A et. al (2012) studied the physio-chemical and microbiological efficiency of locally available low cost (branded/local) water filters used for household drinking purpose. In their work, they selected 5 water filters from local market. Water filters were charged with tap (municipal) water, well water, bore water and lake water samples (one after another) at 100%, 50% and 0% cartilage life of water filters for the period of 10 months from July'11 to April'12. Water sample testing was carried out as per Indian Standard specification for drinking water IS 10500-2004. The parameters pH, temperature, turbidity, alkalinity, total dissolved solid and coliforms count were recorded at 100%, 50% and 0% cartilage life of water filters for the

source water. Flow rate and frequency of cleaning were also recorded for each water filter. **Results showed all water filters were good for removal of organic impurities upto some extent. The water filters failed to reduce TDS, hardness, and chloride.** Most water filters showed 95-98 % microbiological reduction efficiency. These finding suggested that efficiency of water filters should be more to remove micro-organisms from drinking water.

Simon Morr & Esteban Cuartas, MD& Basil Alwattar.et.al: The calcium concentration of water varies from 1 to 135 mg/L across the USA and Canada.Most spring waters were found to have a relatively low calcium concentration, with an average of 21.8 mg/L. Purified waters contain a negligible calcium concentration. Mineral waters, on the other hand, were generally found to contain higher calcium concentrations, an average of 208 mg/L of calcium. Filtration was found to remove a considerable amount of calcium from the water, removing 89% on average. Bottled waters presented with concentrations of calcium covering a very large range. Certain tap and bottled waters present with concentrations of calcium sufficient to exhibit a deleterious effect on bisphosphonate treatment. Alternatively, certain waters may be used as a source of calcium that may provide over 40% of the recommended daily intake for calcium.

Mufid al-hadithi (2012) studied to assess suitability of groundwater quality for drinking purposes in Ratmao –Pathri Rao Watershed, Haridwar District, India by applying Water Quality Index. This was carried out for comprehensive physico-chemical analysis with twenty one groundwater samples, collected from eleven selected site,. Nine parameters were considered for calculating the WQI such as: pH, total hardness, calcium, magnesium, bicarbonate, chloride, nitrate, sulphate, and total dissolved solids. The computed WQI showed that 48% of water sample falls in excellent categories and 48% falls in the good water category. One site located at Teliwala village which represented 4% falls in very poor categories and are not suitable for drinking purposes under normal condition and further action for salinity control is required. The high value of WQI at this site has been found to be mainly due to the higher values of TDS, Ca+2, K+, Cl-, HCo3-, $NO_3$2- and $SO_4$2- where it was found that there is a very high correlation coefficient between them.

Gumashta J et. al (2012) revisited a number of literatures regarding correlation between hardness verses cardiovascular diseases. According to their studies, it is stated that a lower incidence of cardiovascular diseases has been observed in areas with hard water. However, numerous debates and controversies prevailed over time. Some scientists had been trying to correlate cardio-protective factor of hard water while others were working on the toxic factor of soft water. Now the factor unanimously agreed upon can be concluded as Magnesium. The proofs in favour of Magnesium (Mg) come from studies reporting (i) sudden deaths in areas with Mg deficient drinking water, (ii) low myocardial Mg content in sudden death cases, etc.

Magnesium is a structural component of cardiac muscle and is required by as many as 1300 enzymes for different biochemical reactions. It is an important co-factor for ATPase; hence, is needed in every cell.
The modern processed food, **softened drinking water** and over reliance on ready to eat food thus avoiding fruits & green leafy vegetables is an important cause of Mg deficiency. The deficiency of Mg has been reported to cause increase in inflammatory cytokines, endothelial damage and dyslipidemia; all of which are the centre stage for the development of Atherosclerosis, the thickening & hardening of arterial walls. Magnesium, which seems to be the wonder ion can be used for supplementation & fortification. This can prove to be an efficient, effective, replicable and cost effective model for preventing many diseases particularly cardiovascular diseases through public health interventions.

Edema MO et. al (2011) investigated the bacteriological quality of commercial sachet-packed drinking water at point-of-sale in south-western Nigeria with emphasis on pathogenic bacteria in 108 samples tested, in order to evaluate the contribution of this popular product to the increasing incidence of typhoid fever and related illnesses. They used Ten-fold serial dilution of water samples and the pour plate technique to investigate the presence of *Salmonella* and indicator coliform *Escherichia coli* in sachet-packed water samples. Aerobic and total coliforms were also enumerated. Their results showed that **87% of the sachet-packed** water samples examined contained *Salmonella* and/or *Escherichia coli*, indicative of fecal contamination and inadequate water treatment or no treatment at all. Their study also showed that about 65% of the polythene sachets used was not of food-grade quality and imparted polyester taste in the water samples. High aerobic colony counts in the order of 6.0 log CFU/ml was recorded from 93% of water samples examined. *E. coli* counts used as indicator of hygiene criteria were present in the range of 98 and 106 cfu/100ml of water sample, while *Salmonella* counts used as food safety criteria were between $2.12x10^1$ and $2.20x10^1$. These mean values were greater than the international guidelines for drinking water quality. Their findings of this study indicate that sachet-packed water samples examined do not meet microbiological standards for drinking water quality.

Frantisek Kozisek,National Institute of Public Health: In demineralised water is defined as water almost or completely free of dissolved minerals as a result of distillation, deionization, membrane filtration (reverse osmosis or nanofiltration), electrodialysis or other technology. The total dissolved solids (TDS) in such watercan vary but TDS could be as low as 1 mg/L. The electrical conductivity is generally less than 2 mS/m and may even be lower (<0.1 mS/m). However, some countries focused on public health research in this field, mainly the former USSR where desalination was introduced to produce drinking water in some Central Asian cities. It was clear from the very beginning that desalinated or demineralised water without further enrichment with some minerals might not be fully appropriate for

consumption.After evaluating the available health, organoleptic, and other information, the team recommended that demineralised water contain 1.) a minimum level for dissolved salts (100 mg/L), bicarbonate ion (30 mg/L), and calcium (30 mg/L); 2.) an optimum level for total dissolved salts (250-500 mg/L for chloride-sulfate water and 250-500 mg/L for bicarbonate water); 3.) a maximum level for alkalinity (6.5 meq/l), sodium (200 mg/L), boron (0.5mg/L), and bromine (0.01 mg/L).

CHAPTER 3

A VIEW ON DRINKING WATER QUALITY

3.1 Drinking Water Quality

Water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Although three-quarter of the earth's surface is water, only 1% is available for direct use, including drinking, and this often requires treatment before it can be used safely. Pure water can never be available in nature. The precipitation, at the instant of its formation contains no impurities, but during the process of formation and fall through the earth's atmosphere, it may dissolve certain gases, traces of minerals and other substances. When once the precipitation reaches the earth's surface, many more opportunities are presented for the introduction various physical, chemical or bacterial impurities in it. The impurities which water dissolves or picks up as suspended matter may sometimes make it more useful and potable for public uses and especially for drinking, and sometimes it may render it harmful and unfit. For example, certain minerals such as iron, calcium, magnesium, fluorine etc. in small quantities may be useful and good for health of people, because human beings need a certain amount of these elements in their bodies. But when, these materials and others are dissolved in large amounts or in certain combinations, the water may become unfit or less useful for municipal, industrial and other uses. For example, sometimes water may contain toxic or poisonous substances such as arsenic, barium, cadmium, chromium, lead etc., which may be harmful to public health, even if present in low quantities. Similarly, sometimes, the water contains harmful bacteria, the presence of which may cause diseases such as cholera, typhoid, dysentery, gastro-enteritis, hepatitis etc. As per WHO, about 80% of all sickness and diseases in human being in developing countries are caused by unsafe water and inadequate sanitation. Water borne diseases continue to present challenges to public health officials and water suppliers. To ensure safety to public health, economy and other uses it becomes imperative upon the planners and designers of public water supply schemes, to thoroughly check, analysis and treat the raw available water to safe and permissible limits, before supplying to the public. Prevention and control of waterborne diseases through water source protection and proper treatment techniques are critically important.

Thus, with regard to human health, the quality of drinking water is very important and should have a minimum standard with respect to drinking. The provision of clean drinking water has been given priority in the Constitution of India, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the State. In line with the WHO guide lines, India has a standard for drinking water, IS 10500-2012. According to this code, drinking water is defined as 'water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

Improving access to safe drinking-water can result in tangible benefits to health. Every effort should be made to achieve a drinking-water quality as safe as practicable. Safe drinking-water, as per WHO Guidelines, does not represent any significant **risk** to health over a lifetime of consumption. Safe drinking-water is suitable for all usual domestic purposes, including personal hygiene. The nature and form of drinking-water standards may vary among countries and regions.

3.2 Water Quality Parameters:

The treated or untreated water can be checked and analyzed by studying and testing their physical, chemical and biological quality parameters, which are briefly explained below:

3.2.1 Physical Quality of Drinking Water:

The Physical parameters define those characteristics of water that respond to the senses of sight, touch or smell. Suspended solids, turbidity, colour, taste and odour and temperature fall into this category.

Suspended Solid: Solids can be dispersed in water in both suspended and dissolved forms. Although some dissolved solids may be perceived by physical senses, they fall more appropriately under the category of chemical parameters.
Solids suspended in water may consist of inorganic or organic particles. Inorganic solids such as clay, silt and other soil constituents are common in surface water. Organic material such as plant fibres and biological solids (algal cell, bacteria etc.) are common constituents of surface waters. Other suspended material may result from human use of water. Domestic wastewater usually contains large quantities of suspended solids that are mostly organic in nature.
Suspended material may be objectionable in water for several reasons. It is aesthetically displeasing and provides adsorption sites for chemical and biological agents. Suspended organic solids may be degraded biologically, resulting in objectionable by-products.

Turbidity:-Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water when a light is shined through the water sample. The higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid is suspended solids such as include clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, and plankton and other microscopic organisms. Turbidity makes water cloudy or opaque.

Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide food and shelter for pathogens. If not removed, turbidity can promote re-growth of pathogens in the distribution system, leading to waterborne disease outbreaks, which have caused significant cases of gastroenteritis. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. Fortunately, traditional water treatment processes have the ability to effectively remove turbidity when operated properly.

Water Colour:- Pure water is colourless, but water in nature is often coloured by foreign substances. Water whose colour is partly due to suspended matter is said to have apparent colour. Colour contributed by dissolved solids that remain after removal of suspended matter is known as true colour. It may be true that a bit of color in water may not make it harmful to drink, but it certainly makes it unappealing to drink. So, color in our water does matter when it comes to drinking it, as well as in water for other home uses, industrial uses, and in some aquatic environments.

Color in drinking water can be caused by dissolved and suspended materials, and a brown shade in water often comes from rust in the water pipes. Although water can contain contaminants, which are usually removed by water-supply systems, the plus side is that the water we drink likely contains a number of dissolved minerals that are beneficial for human health. And, if we drink "pure" water, such as distilled or deioninzed water, we will notice that it tasts "flat". Most people prefer water with dissolved minerals, although they still want it to be clear.

Coloured water is not aesthetically acceptable to the general public. In fact, consumers tend to choose clear, noncoloured water of otherwise poorer quality over treated potable water supplies with an objectionable colour. Highly coloured water is unsuitable for laundering, dyeing, papermaking, beverage manufacturing etc. Thus, colour of water affects its marketability for both domestic and industrial uses.

Taste and Odour :- The terms taste and odour are themselves definitive of those parameter. Because the sensation of taste and smell are closely related and often confused, a wide variety of tastes and odours may be attributed to water by consumers. Substances that produce an odour in water will almost invariably impart a taste as well. The converse is not true, as there are many mineral substances that produce taste but no odour.
Many substances with which water comes into contact in nature or during human use may impart perceptible taste and odour. These include minerals, metals, salts etc. from the soil, end products from biological reactions and constituents of

wastewater. Inorganic substances are more likely to produce tastes unaccompanied by odour. Alkaline material imparts a bitter taste to water , while metallic salts may give a salty or bitter taste. Organic materials, on the other hand, is likely to produce both taste and odour. Biological decomposition of organics may also result in taste and odour producing liquid and gases (example-H_2S gas, rotten egg smell) in water. Consumers find taste and odour aesthetically displeasing for obvious reasons. Because water is thought of as tasteless and odourless, the consumer associates taste and odour with contamination and may prefer to use a tasteless, odourless water that might actually pose more of a health threat.

Temperature :- Temperature is not used to evaluate directly either potable water or waste water. It is, however, one of the most important parameters in natural surface water system. Temperature exerts a major influence on biological activity and growth. Temperature governs the kinds of organisms that can live in rivers and lakes. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. As temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there are none.

Temperature is also important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the rocks it is in and will therefore have a higher electrical conductivity. It is the opposite when considering a gas, such as oxygen, dissolved in the water. Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life.

Temperature also affects other physical properties of water. The viscosity of water increases with decreasing temperature and vice-versa. The maximum density of water occurs at 4^0C, and density decreases on either side of that temperature, a unique phenomenon among liquids.

3.2.2 Chemical Water-Quality Parameter of Drinking Water

Water has been called the universal solvent and chemical parameters are related to the solvent capabilities of water. Total Dissolved Solids (TDS), Alkalinity, Hardness, pH, chloride, fluoride, metals and nutrients are chemical parameters of concern in water quality management. Some of the basic chemical parameters are discussed in brief in the following :

pH value of Water :- pH is an important measurement of water. Not only does the pH of a stream affect organisms living in the water, a changing pH in a stream can be an indicator of increasing pollution or some other environmental factor.

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units". Water with a pH of 5 is ten times more acidic than water having a pH of 6.

Importance: The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For example, for heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble.

pH and water quality: Excessively high and low pHs can be detrimental for the use of water. High pH causes a bitter taste, water pipes and water-using appliances become encrusted with deposits, and it depresses the effectiveness of the disinfection of chlorine, thereby causing the need for additional chlorine. Low-pH water will corrode or dissolve metals and other substances. Pollution can change pH of water, which in turn can harm animals and plants living in the water.

Total Dissolved Solids (TDS):- Water is a good solvent and picks up impurities easily. Pure water is often called the universal solvent. Dissolved solids" refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulphates) and some small amounts of organic matter that are dissolved in water.

TDS in drinking-water originate from natural sources, sewage, urban run-off, industrial wastewater, and chemicals used in the water treatment process, and the nature of the piping or hardware used to convey the water, i.e., the plumbing. In general, the total dissolved solids concentration is the sum of the cations (positively charged) and anions (negatively charged) ions in the water. Therefore, the total dissolved solids test provides an qualitative measure of the amount of dissolved ions, but does not tell us the nature or ion relationships. Therefore, the total dissolved solids test is used as an indicator test to determine the general quality of the water.

Many dissolved solids are undesirable in water. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, taste and odour. Some chemical may be toxic and some dissolved constituents have been shown to be carcinogenic. Quite often, two or more dissolved substances will combine to form a compound whose characteristics are more objectionable than those of either of the original materials. Not all dissolved substances are undesirable in water. For example, essentially pure, distilled water has a flat taste. Additionally, water has an equilibrium state with respect to dissolved constituents.

Hardness:- The simple definition of water hardness is the amount of dissolved calcium and magnesium in the water. Hard water is high in dissolved minerals, both calcium and magnesium. Hardness is classified as carbonate hardness and non-carbonate hardness, depending on the anion with which it associates. The hardness that is equivalent to the alkalinity is termed as carbonate hardness. The remaining hardness is called non-carbonate hardness. Depending on the hardness of water, after using soap to wash we may feel like there was a film of residue left on our hands. In hard water, soap reacts with the calcium (which is relatively high in hard water) to form "soap scum". When using hard water, more soap or detergent is needed to get things clean. Lathering does not occur until all the hardness ions are precipitated, at which point the water has been 'softened' by the soap.

Many industrial and domestic water users are concerned about the hardness of their water. When hard water is heated, such as in a home water heater, solid deposits of calcium carbonate. This scale can reduce the life of equipment, raise the costs of heating the water, lower the efficiency of electric water heaters, and clog pipes.

But hard water can have some benefits, too. Humans need minerals to stay healthy, and hard drinking water generally contributes a small amount toward total calcium and magnesium human dietary needs. Magnesium hardness, particularly associated with the sulfate ion, has a laxative effect on persons unaccustomed to it. Magnesium concentration of less than 50mg/l is desirable in potable water. Calcium hardness presents no public health problem. In fact, hard water is apparently beneficial to human cardiovascular system.

Alkalinity:- Alkalinity is defined as the quantity of ions in water that will react to neutralize hydrogen ions. Alkalinity is thus a measure of the ability of water to neutralize acids. Alkalinity of water may be due to the presence of one or more of a number of ions. These include hydroxides, carbonates and bicarbonates. **Hydroxide** ions are always present in water, even if the concentration is extremely low. However, significant concentrations of hydroxides are unusual in natural water supplies, but may be present after certain types of treatment. Small amounts of **carbonates** are found in natural water supplies. They may also be found in the water

after lime soda has been used to soften the water. **Bicarbonates** are the most common sources of alkalinity.

Phosphates and silicates are rarely found in natural supplies in concentrations significant in the home. Compounds containing these ions may be used in a variety of water treatment processes. Moderate concentrations of alkalinity are desirable in most water supplies to balance the corrosive effects of acidity. However, excessive quantities cause a number of problems.

In large quantities, alkalinity imparts a bitter taste to water. Strong alkaline water has an objectionable "soda" taste. The principal objection to alkaline water, however, is the reactions that can occur between alkalinity and certain cations in the water. The resultant precipitate can foul pipes and other water system appurtenances.

Highly mineralized alkaline waters also cause excessive drying of the skin due to the fact that they tend to remove normal skin oils. Troublesome amounts of alkalinity can be removed by reverse osmosis, along with other total dissolved solids. Other methods of water treatment also remove total dissolved solids, but they are somewhat less suitable for household use compared to reverse osmosis. These methods are distillation and deionization (demineralization).

Fluoride:- Generally fluoride in nature is associated with a few types of sedimentary or igneous rocks and is seldom found in appreciable quantities in surface water and appears in ground water in only a few geographical regions. Fluoride is toxic to human and other animals in large quantities, while small concentrations can be beneficial.

At low concentrations fluoride can reduce the risk of dental cavities. Concentration of approximately 1.0 mg/l in drinking water help to prevent dental cavities in children. During formation of permanent teeth, fluoride combines chemically with tooth enamel, resulting in harder, stronger teeth that are more resistant to decay. Fluoride is often added to drinking water supplies if sufficient quantities for good dental formation are not naturally present. Excessive intake of fluoride can result in discolouration of teeth. Noticeable discolouration, called mottling, is is common when concentrations in drinking water exceed 2.0 mg/l. adult teeth are not affected by fluoride, although both the benefits and liabilities of fluoride during tooth-formation years carry over into childhood. Excessive dosage of fluoride can also result in bone fluorosis and other skeletal abnormalities. Higher intakes of fluoride taken over a long period of time can result in changes to bone, a condition known as skeletal fluorosis. This can cause joint pain, restriction of mobility, and possibly increase the risk of some bone fractures.

Chloride:- Chloride is widely distributed in nature, generally as the sodium (NaCl) and potassium (KCl) salts. By far the greatest amount of chloride found in the environment is in the oceans.

Sodium chloride is widely used in the production of industrial chemicals such as caustic soda (sodium hydroxide), chlorine, soda ash (sodium carbonate), sodium chlorite, sodium bicarbonate and sodium hypochlorite. Potassium chloride is used in the production of fertilizers.

The presence of chloride in drinking water sources can be attributed to the dissolution of salt deposits, leaching of marine sedimentary deposit, seawater intrusion in coastal areas., effluents from chemical industries, oil well operations, sewage, irrigation drainage etc. Each of these sources may result in local contamination of surface water and groundwater. The chloride ion is highly mobile and is eventually transported into closed basins or to the oceans.

Chloride is an essential element and is the main extracellular anion in the body. It is a highly mobile ion that easily crosses cell membranes and is involved in maintaining proper osmotic pressure, water balance and acid-base balance

The toxicity of chloride salts depends on the cation present; that of chloride itself is unknown. Although excessive intake of drinking-water containing sodium chloride at concentrations above 2.5 g/litre has been reported to produce hypertension, this effect is believed to be related to the sodium ion concentration.

Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism, e.g. in congestive heart failure. Healthy individuals can tolerate the intake of large quantities of chloride provided that there is a concomitant intake of fresh water. Little is known about the effect of prolonged intake of large amounts of chloride in the diet. As in experimental animals, hypertension associated with sodium chloride intake appears to be related to the sodium rather than the chloride ion.

Metals:- All metals are soluble in water to some extent. While excessive amounts of any metal may present health hazards, only those metals that are harmful in relatively small amounts are commonly labeled toxic; other metals fall into non-toxic group. Sources of metals in natural waters include dissolution from natural deposits and discharges of domestic, industrial or agricultural wastewaters. Measurement of metals in water usually made by atomic absorption spectro-photometry.

Non-toxic Metals : In addition to hardness ions, Ca and Mg, other non-toxic metals commonly found in water include, iron, sodium, manganese, aluminium, copper and zinc. Sodium, the most common nontoxic metal found in natural water, is abundant in earth crust and highly reactive with other elements. The salts of sodium are very

soluble in water. Excessive concentration cause a bitter taste in water and are a health hazard to cardiac and kidney patients. It is also corrosive to metal surface in large quantities.

Iron and manganese quite frequently occur together and present no health hazard at concentrations normally found in natural waters. Iron and manganese in very small quantity may cause colour problem. Some bacteria use iron and manganese compounds for an energy source and resulting slime growth may produce taste and odour problem.

Other nontoxic metals are generally found in very small quantities in natural water and most would cause taste problems long before toxic levels are reached.

Toxic Metals : Toxic metals are harmful to humans and other organisms in small quantities. Toxic metals that may be dissolved in water include arsenic, barium, cadmium, lead, mercury and silver. Cumulative toxins such as arsenic, cadmium, lead and mercury are particularly hazardous. Fortunately, toxic metals are present in only minute quantities in most natural water system. Although arsenic contamination in ground water in the Ganga- Brahmaputra fluvial plains in India and Padma-Meghna fluvial plains in Bangladesh and its consequences to the human health have been reported as one of the most serious issues of health hazards. Also, in many other countries, arsenic problem in ground water is a burning problem with respect to human health.

3.2.3 Microbiological Water Quality Parameter

The principal groups of microorganisms in natural water include protists, plants and animals. Many bacteria, viruses and protozoa are causative organisms for some of the more virulent diseases transmitted to humans directly through water and indirectly through contaminated food.

Assay and confirmation of the presence of the causative agent of waterborne diseases are lengthy and time consuming. Instead of specific analyses, coliform organisms have been used to determine the biological characteristics of natural waters. The coliform group of bacteria are aerobic and/or facultative gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose to gas. *Escherichia coli* is commonly used as an indicator organism. This organism is present in the intestine of warm-blooded animals, including humans. Therefore the presence of *Escherichia coli* in water samples indicates the presence of fecal matter and then the possible presence of pathogenic organisms of human origin. The concentration of indicator organisms is reported in MPN/100 mL (MPN = most probable number).

Other enteric organisms that are also considered indicator organisms are fecal streptococci (*Streptococcus faecalis*) and clostridia (*Clostridium perfringens*).[*Garg, S.K]*

3.3 Water Quality Requirement :

Water quality requirements vary according to the proposed use of the water. Water unsuitable for one use may be quite satisfactory for another and water may be deemed acceptable for particular use if water of better quality is not available. Water quality requirements should not be confused with water quality standards. Set by potential user, water quality requirements represent a known or assumed need and are based on the prior experience of the water user. Water Quality Standards are set by a governmental agency and represent a statutory requirement.

3.4 Water Quality Standards :

As per WHO guidelines, the safe drinking-water does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages. The greatest risk of waterborne disease are found among infants and young children, people who are living under unsanitary conditions and the elderly. Safe drinking-water is suitable for all usual domestic purposes, including personal hygiene.

Standards for drinking water have evolved over years as knowledge of the nature and effects of various contaminants has grown. Currently, it is considered desirable that drinking water be free of suspended solids and turbidity, that it be tasteless and odourless, that dissolved inorganic solids be in moderate quantities, and that organic, toxic substances, and pathogen be absent. The World Health Organization (WHO) has established minimum criteria for drinking water that all nations are urged to meet. In line with WHO criteria, India has also published standard code of practice referred as : IS 10500 -2012 , “Drinking Water - Specification”.

This standard specifies the acceptable limits and the permissible limits in the absence of alternate source. It is recommended that the acceptable limit is to be implemented as values in excess of those mentioned under ‘Acceptable’ render the water not suitable. Such a value may, however, be tolerated in the absence of an alternative source. However, if the value exceeds the limits indicated under ‘permissible limit in the absence of alternate source’, the sources will have to be rejected.

I) As per IS 10500 -2012 (drinking water – specification) ‘Drinking water’ is defined as the water which is intended for human consumption for drinking and cooking purposes from any source and it includes water (treated or untreated) supplied by any means for human consumption.

According to this code, drinking water shall comply with the specified requirements of Physical Parameters, Chemical Parameters in terms of substances undesirable in

excessive amounts, Toxic Substance parameters and Radioactive substance parameters. Some important parameters and their requirement are briefly stated in the following table. Besides, drinking water shall also comply with bacteriological, requirements, virological requirements and biological requirements.

Table:- Organoleptic and Physical Parameters

Sl. No.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Remarks
1	Colour	Hazen units, *Max*	5	15	Extended to 15 only, if toxic substances are not suspected
2	Odour		Agreeable	Agreeable	
3	***p*H value**		6.5 – 8.5	No relaxation	
4	Taste		Agreeable	Agreeable	
5	**Turbidity**	NTU, *Max*	1	5	Test to be conducted only after safety has been established
6	**Total Dissolved Solids (TDS),**	mg/l, *Max*	500	2000	

Out of the above physical parameters, three parameters i.e. pH value, Turbidity and TDS test were conducted for determination of the actual values in the samples of drinking water under the study.

Table:- General Chemical Parameters Concerning Substances Undesirable in Excessive Amounts

Sl. No.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Remarks
1	**Chloride** (as Cl)	mg/l, *Max*	250	1000	
2	**Fluoride** (as F)	mg/l, *Max*	1	1.5	
3	**Total hardness** (as	mg/l, *Max*	200	600	

	CaCO3),				
4	Aluminium (as Al)	mg/l, *Max*	0.03	0.2	
5	Ammonia (as total ammonia-N)	mg/l, *Max*	0.5	No relaxation	
6	Calcium (as Ca)	mg/l, *Max*	75	200	
7	Copper (as Cu)	mg/l, *Max*	0.05	1.5	
8	Free residual chlorine	mg/l, *Min*	0.2	1	
9	Iron (as Fe)	mg/l, *Max*	0.3	No relaxation	
10	Magnesium (as Mg)	mg/l, *Max*	30	100	
11	Manganese (as Mn)	mg/l, *Max*	0.1	0.3	
12	Nitrate (as NO_3)	mg/l, *Max*	45	No relaxation	
13	Sulphate (as SO_4)	mg/l, *Max*	200	400	
14	Total alkalinity as calcium carbonate	mg/l, *Max*	200	600	
15	Zinc (as Zn)	mg/l, *Max*	5	15	

Another nine characteristics are not stated here, for which IS 10500-2012 may be referred to. Out of the above chemical parameters, first three parameters i.e. **Chloride**, **Fluoride** and **Total hardness** test were conducted for determination of the actual values in the samples of drinking water under the study.

With regard to other parameters e.g. parameters concerning Toxic substances (arsenic, mercury, lead etc) as well as radioactive substances, the above mentioned IS code may be referred, where requirement (acceptable limit) and permissible limits of each substance is specified.

Bacteriological Requirements:

(1) Ideally, all samples of drinking water should be free from Coliform organisms, biological organisms and all type of microscopic organisms. As per IS 10500-2012 the Bacteriological parameters required for drinking water is as follows:

Sl. No.	Organisms	Requirements
(i)	All water intended for drinking: a) E. Coli or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
(ii)	Treated water entering the distribution system : a) E. Coli or thermotolerant coliform bacteria b) Total coliform bacteria	(a) Shall not be detectable in any 100 ml sample (b) Shall not be detectable in any 100 ml sample
(iii)	Treated water in the distribution system : a) E. Coli or thermotolerant coliform bacteria b) Total coliform bacteria	(a) Shall not be detectable in any 100 ml sample (b) Shall not be detectable in any 100 ml sample

In my study, only H_2S strip method was conducted to determine presence of coliform bacteria in the water samples. In this test, it was confirmed if the coliform bacteria was present or absent.

II) **Packaged Drinking-Water :** Bottled water is widely available in both industrialized and developing countries. Consumers may have various reasons for purchasing packaged drinking-water, such as taste, convenience or fashion and easily availability. For many consumers, however, safety and potential health benefits are important considerations.

International standards for bottled packaged drinking-water

The *Guidelines for Drinking-water Quality* provide a basis for derivation of standards for all packaged waters. Codex Alimentarius Commission (CAC) of WHO has developed relevant *Standards for Natural Mineral Waters and Bottled/Packaged Waters* to cover packaged drinking-water other than natural mineral waters, that describe the product and its compositional and quality factors, including limits for certain chemicals, hygiene, packaging and labeling.

In line with the above standard of WHO, government of India also published a standard code of practice as refers to **IS 14543:2004 (Packaged Drinking Water**

(Other than Packaged Natural Mineral Water), where minimum standard criteria of packaged drinking water are stated to ensure the quality and standard of packaged drinking water in the country. Meanwhile, IS 10500 (Code of Drinking water) has been last revised in 2012, and to correlate this code, the aforesaid drinking water code of practice (IS 14543:2004) also need to be revised. As per to IS 14543:2004 [Packaged Drinking Water (Other than Packaged Natural Mineral Water – specification], 'Packaged drinking water" is defined as the water derived from surface water or underground water or sea water which is subjected to specified treatments, namely, decantation, filtration, combination of filtration, aerations, filtration with membrane filter depth filter, cartridge filter, activated carbon filtration, demineralization, re-mineralization, reverse osmosis and packed after disinfecting the water to a level that shall not lead to any harmful contamination in the drinking water by means of chemical agents or physical methods to reduce the number of microorganisms to a level beyond scientifically accepted level for food safety or its suitability. It shall be filled in sealed containers of various compositions, forms and capacities that is suitable for direct consumption without further treatment. In case remineralization is a part of the treatment process, the ingredients used shall be food grade quality and conform to the requirements of the *Prevention of Food Adulteration Act,* 1954 and the Rules framed thereunder.

Requirements : According to this code, packaged drinking water shall comply with the following Microbiological requirements and also with the requirement of Physical Parameters, Chemical Parameters in terms of substances undesirable in excessive amounts, Toxic Substance parameters and Radioactive substance parameters. Some important parameters and their requirement are briefly shown in the following tables.

Table:- Microbiological Requirements:

Sl. No.	**Organisms**	**Requirements**
(i)	E. Coli or thermotolerant coliform bacteria	Shall be absent in any 250 ml sample
(ii)	Coliform bacteria	Shall be absent in any 250 ml sample
(iii)	Faecal streptococci and Staphylococcus aureus,	Shall be absent in any 250 ml sample
(iv)	Sulphite reducing anaerobes	Shall be absent in any 50 ml sample

For other Microbiological Requirements the relevant code may be referred to.

In my study, only H_2S strip method was conducted to determine presence of coliform bacteria in the water samples. In this test, it was confirmed if the coliform bacteria was present or absent.

Table:- Organoleptic and Physical Parameters

Sl. No.	Characteristic	Unit	Requirement (Acceptable Limit)	Remarks
1	Colour	Hazen units, *Max*	2	Requirement -**5**, as per IS 10500-2012
2	Odour		Agreeable	Same values as of IS 10500-2012
3	***p*H value**		6.5 – 8.5	
4	Taste		Agreeable	
5	**Turbidity**	NTU, *Max*	2	Requirement -**1**, as per IS 10500-2012
6	**Total Dissolved Solids (TDS),**	mg/l, *Max*	500	Same value as of IS 10500-2012

Out of the above physical parameters, three parameters i.e. pH value, Turbidity and TDS test were conducted for determination of the actual values in the samples of packaged drinking water under the study.

Table:- General Chemical Parameters Concerning Substances Undesirable in Excessive Amounts

Sl. No.	Characteristic	Unit	Requirement (Acceptable Limit)	Remarks
1	**Chloride** (as Cl)	mg/l, *Max*	200	Requirement -**250** as per IS 10500-2012
2	**Fluoride** (as F)	mg/l, *Max*	1	Same value as of IS 10500-2012
3	**Total hardness** (as CaCO3),	mg/l, *Max*	-	Not specified in IS 14543:2004
4	Aluminium (as Al)	mg/l, *Max*	0.03	Same values as of IS 10500-2012
5	Calcium (as Ca)	mg/l, *Max*	75	
6	Copper (as Cu)	mg/l, *Max*	0.05	
7	Free residual chlorine	mg/l, *Min*	0.2	
8	Iron (as Fe)	mg/l, *Max*	0.1	Requirement -**0.3** as per IS 10500-2012

9	Magnesium (as Mg)	mg/l, *Max*	30	Same values as of IS 10500-2012
10	Manganese (as Mn)	mg/l, *Max*	0.1	
11	Nitrate (as NO_3)	mg/l, *Max*	45	
12	Sulphate (as SO_4)	mg/l, *Max*	200	
13	Total alkalinity as calcium carbonate	mg/l, *Max*	200	
14	Zinc (as Zn)	mg/l, *Max*	5	

Another eleven characteristics are not stated here, which may be seen at IS 14543:2004. Out of the above chemical parameters, first three parameters i.e. **Chloride**, **Fluoride** and **Total hardness** tests were conducted for determination of the actual values in the samples of packaged drinking water under my study.

With regard to other parameters e.g. parameters concerning Toxic substances (arsenic, mercury, lead etc) as well as radioactive substances, the above mentioned IS code may be referred, where requirement (acceptable limit) of each substance is specified.

CHAPTER 4

A BRIEF REVIEW ON POPULAR TECHNOLOGIES FOR DOMESTIC WATER FILTER

4.1 Advanced Modern Water Purification Methods:

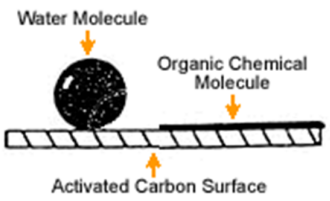
Water filtration by definition simply means to strain out the impurities from a water source. The larger the impurity particulate, the easier it is to filter. The opposite is true: the smaller the impurity particulate, the harder it is to remove. Thus, the size of the filter pore and the durability of the filtering element are important to the filter's longevity and its ability to perform. Most filtering elements are made of ceramic, glass fiber, hard-block carbon, or materials that resemble compressed surgical paper.

Some of the better purification methods include the **activated carbon** and **reverse osmosis** and **Iron Removal Filter.**The best contribution that carbon makes to filtration technology is its ability to reduce chemical quantities, poor taste, odors and many pollutants. Because carbon is only mildly effective in filtering out particulates and microorganisms, it is mostly used as a second or third stage filter in home and portable water use. It is seldom used as a stand-alone filtering, and often times, used in conjunction with reverse osmosis. Reverse osmosis, which uses a semipermeable membrane filter to separate the water from contaminants.

Reverse osmosis is highly effective in removing several impurities from water such as total dissolved solids, turbidity, asbestos, lead and other toxic heavy metals, radium, and many dissolved organic. The process will also remove chlorine, and can also remove nuclear radiation such as radioactive plutonium or strontium in the drinking water. Therefore, reverse osmosis combined with activated carbon seems to be the most advanced water purification method developed so far.

4.1.1 Activated Carbon

Activated carbon (AC) is a natural material derived from bituminous coal, lignite, wood, coconut shell etc., activated by steam and other means, and each one have different adsorption properties (e.g. bituminous carbon for high chlorine reduction capacity). Some manufacturers use various blends of carbon to achieve specific water quality and contaminants reduction (e.g. coconut shell carbon for "sweet taste").



Activated carbon surface properties are both hydrophobic and oleophilic; that is, they “hate” water but “love” oil. When flow conditions are suitable, dissolved chemicals in water flowing over the carbon surface “stick” to the carbon in a thin film while the water passes on.

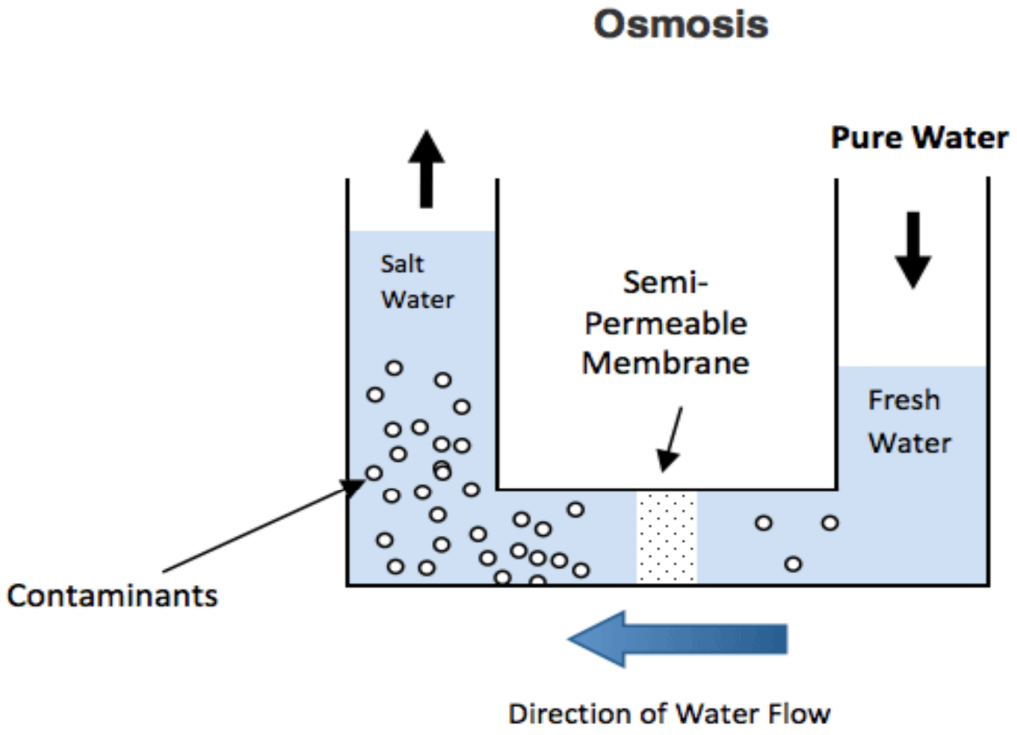
This process is called ***adsorption.*** As a result of the adsorption process, activated carbon is an effective method in removing chlorine and it's by-products (TTHM's) and

volatile organic compounds (carbon based VOC's). Both, man-made and naturally occurring including among others. *[www.fluidsystems.in]*

4.1.2 Reverse Osmosis (R.O.):

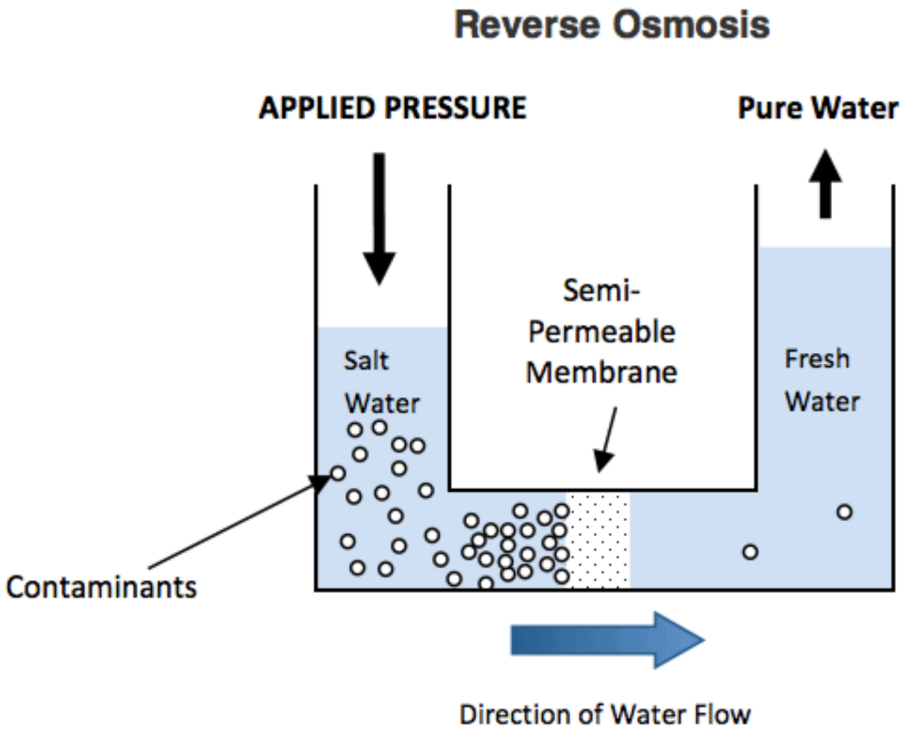
Reverse Osmosis is a technology that is used to remove a large majority of contaminants from water by pushing the water under pressure through a semi-permeable membrane. Reverse osmosis, commonly referred to as RO, is a process where we demineralize or deionize water by pushing it under pressure through a semi-permeable reverse osmosis membrane.

Osmosis : To understand the purpose and process of Reverse Osmosis have to first understand the naturally occurring process of Osmosis. Osmosis is a naturally occurring phenomenon and one of the most important processes in nature. It is a process where a weaker saline solution will tend to migrate to a strong saline solution. Examples of osmosis are when plant roots absorb water from the soil and our kidneys absorb water from our blood. Below is a diagram which shows how osmosis works. A solution that is less concentrated will have a natural tendency to migrate to a solution with a higher concentration.



A semi-permeable membrane is a membrane that will allow some atoms or molecules to pass but not others. A simple example is a screen door. It allows air molecules to pass through but not pests or anything larger than the holes in the screen door.

Reverse Osmosis is the process of Osmosis in reverse. Whereas Osmosis occurs naturally without energy required, to reverse the process of osmosis we need to apply energy to the more saline solution. A reverse osmosis membrane is a semi-permeable membrane that allows the passage of water molecules but not the majority of dissolved salts, organics, bacteria and pyrogens. However, it is needed to 'push' the water through the reverse osmosis membrane by applying pressure that is greater than the naturally occurring osmotic pressure in order to desalinate (demineralize or deionize) water in the process, allowing pure water through while holding back a majority of contaminants. A diagram outlining the process of Reverse Osmosis is given below. When pressure is applied to the concentrated solution, the water molecules are forced through the semi-permeable membrane and the contaminants are not allowed through.



How does Reverse Osmosis work?

Reverse osmosis works by using a high pressure pump to increase the pressure on the salt side of the RO and force the water across the semi-permeable RO membrane, leaving almost all (around 95% to 99%) of dissolved salts behind in the reject stream. The amount of pressure required depends on the salt concentration of the feed water. The more concentrated the feed water, the more pressure is required to overcome the osmotic pressure.

As the **feed water** enters the RO membrane under pressure (enough pressure to overcome osmotic pressure) the water molecules pass through the semi-permeable membrane and the salts and other contaminants are not allowed to pass and are

discharged through the concentrate stream, which goes to drain or can be fed back into the feed water supply in some circumstances to be recycled through the RO system to save water. The water that makes it through the RO membrane is called **permeate or product water** and usually has around **95% to 99%** of the dissolved salts removed from it.

What will Reverse Osmosis remove from water?

Reverse Osmosis is capable of removing up to 99%+ of the dissolved salts (ions), particles, colloids, organics, bacteria and pyrogens from the feed water (although an RO system should not be relied upon to remove 100% of bacteria and viruses). An RO membrane rejects contaminants based on their size and charge. Any contaminant that has a molecular weight greater than 200 is likely rejected by a properly running RO system. Likewise, the greater the ionic charge of the contaminant, the more likely it will be unable to pass through the RO membrane. For example, a sodium ion has only one charge (monovalent) and is not rejected by the RO membrane as well as calcium for example, which has two charges.

Likewise, this is why an RO system does not remove gases such as CO_2 very well because they are not highly ionized (charged) while in solution and have a very low molecular weight. **Because an RO system does not remove gases, the permeate water can have a slightly lower than normal pH level depending on CO2 levels in the feed water as the CO2 is converted to carbonic acid**. Reverse Osmosis is very effective in treating brackish, surface and ground water for both large and small flows applications.

RO Cleaning

RO membranes will inevitably require periodic cleaning, anywhere from 1 to 4 times a year depending on the feed water quality. As a general rule, if the normalized pressure drop or the normalized salt passage has increased by 15%, then it is time to clean the RO membranes. If the normalized permeate flow has decreased by 15% then it is also time to clean the RO membranes.

Summary

Reverse Osmosis is an effective and proven technology to produce water that is suitable for many

industrial applications that require demineralized or deionized water. Further post treatment after the RO system such as mixed bed deionization can increase the quality of the RO permeate and make it suitable for the most demanding applications. Proper pretreatment and monitoring of an RO system is crucial to preventing costly repairs and unscheduled maintenance. With the correct system design, maintenance program, and experienced service support, RO system should provide many years of high purity water.[www.indiamart.com]

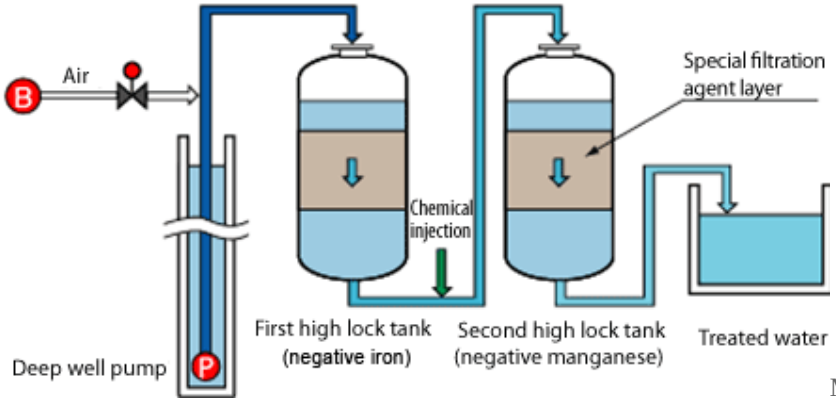
4.2 Iron Removal Filter:-

On water:-

In Ground Water or tubewell Water Presence of iron has always been a matter of concern.Presence of this element in water does not pose a risk to human health.But it can cause unpleasing taste,odour and staining,which is not accepted in most of applications in domestic use as well as commertial and industrial use; therefore,oxidation filtration often known as iron removal process is employed to remove naturally occuring iron from water.For this complete iron removal process an iron removal filter is utilized for domestic(home) and light applications portable iron removal filter is enough,while for commertial and industrial use large iron removing(deironing) plant is required.

Iron Removal Working Principle-The process through which iron is removed from water is known as Oxidation Filtration that involves the oxidation of the soluble forms of iron (Fe) and manganese (Mn) to their soluble forms and then removal by filtration. The oxidant chemically oxidizes the iron and manganese (forming a particle), and kills iron bacteria and any other disease-causing bacteria that may be present after that the filter removes the iron and manganese particles.

Iron Removal Plants Manufacturer



Many water have exceed contain of iron which may be harmful to domestic and industrial application. Presence of iron in the water will change the colour & taste of water. Iron exists in the following forms Insoluble iron, soluble iron, Organic iron and Combination of all. Using Manganese dioxide and other supporting media iron remove from water. Manganese dioxide work as strong oxidize agent.

Our simple but well engineered dual media filter acclaims stringent design, High performance, less pressure drop across the bed, longivity, optimum utilization of surface area ensure us to gain more and more satisfaction. [*www.fluidsystems.in]*

CHAPTER 5

MATERIALS AND METHODS

5.0 MATERIALS AND METHODS:

At first the collected samples were tested for presence of total coliform / bacteria in total coliform detection kit / bacteria detection kit. Standard H_2S strips were used to determine whether the water sample had contained coliform bacteria or not. Thereafter, physio-chemical analysis was carried out. The samples were analyzed using the Standard Methods (APHA) Guideline. The primary parameters as considered pH and total dissolved solid (TDS).The pH was measured by using Digital pH meter and TDS was measured by Digital TDS meter.

5.1 METHOD OF BACTERIOLOGICAL EXAMINATION OF DRINKING WATER BY

H_2S STRIP TEST KIT :

H_2S Strip Test is a simple device based on hydrogen sulphide indicator bacteria for carrying out bacteriological examination of drinking water.

5.1.1 H_2S Paper Strip Method :

The Hydrogen Sulphide Paper Strip Method developed by Manja et al. (1982) is an onsite testing method for assessing the microbial quality of drinking water, based on detection of hydrogen sulphide producing bacteria rather than the coliform bacteria. Human faeces contain a high concentration of sulphate reducing bacteria and some of the enteric bacteria such as Salmonella, Proteus, Citrobacter and some strains of lebsiella,also produce hydrogen sulphide.

Sterilized paper strip treated with media is kept in sterilized glass bottle. The water sample is filled in the bottle and kept for 24 to 48 hours at room temperature (25 to 37C).If bacteria are present in the sample, they produce hydrogen sulphide, which convert the colour of water sample into black.

5.1.2 Procedure Followed :

As per H_2S Paper Strip manufacturer's specification and instruction filled the water sample in the tube containing H_2S Paper Strip, upto the identified mark. The sample tube was kept in a biological incubator at a constant temperature of 37.5^0C for 24 hours. At the end of this period, the water samples which showed black colour indicated presence of bacteria. On the other hand, the sample free from bacteria indicated no colour changes after the said incubation period.

5.2 METHOD OF TOTAL DISSOLVED SOLID (TDS) TEST IN LABORATORY (BY DIGITAL TDS METER) :

Reagent Used :

No such reagent is used.

Glass Apparatus : (i) Beaker-100ml

TDS Meter :Digital TDS Meter Model 651E is extremely for fast and accurate determination of Total Dissolved Solids in a liquid. The use of solid state technology and IC circuitry makes this instrument versatile and reliable.

***Technical Specification*:**

Range	:	5 Ranges
		0-200 ppm
		0-2000 ppm
		0-20.00 ppt (20000 ppm)
		0-2000.00 ppt (2 million ppm)
Resolution	:	0.1 ppm
Accuracy		1 % FS + 1 digit
Cell Constant	:	Adjustable with indication on display
Temperature Compensation	:	0-50^{o} C
TDS Cell	:	Platinum Dip Type.
Display	:	3 $^{1}/_{2}$ digital LED display
Power	:	230 ± 10% AC, 50 Hz
Dimensions	:	275 x 175 x 75 mm
Weight	:	2 Kg.

Photo of Digital TDS Meter:

[*Ref.SWRE Lab.J.U*]

Front Panel Control:

Digital Display : A 3 $^{1}/_{2}$ digital LED display that reads Total Dissolved Solids.

Function Switch : This is a 3 position switch with following function:

i. In the CHECK position, the meter should display 1000 ignoring position of the decimal point. If necessary, the reading with CAL control was adjusted provided ad the back of the instrument.

ii. In the TDS position it measured total dissolved solids in the solution.

iii. In the CELL CONSTANT position, the display indicates the cell constant at which the instrument has been set.

Range Switch : This switch is used for selecting one of the 5 ranges of TDS.

Cell Constant : This control is used to set the instrument as per actual cell constant of the TDS cell. Bring the function switch at cell constant position and with the help of the constant knob, bring the reading to the actual value of the TDS cell in use.

Temperature : With this control, the temperature compensation between 0-50^{o}C can be adjusted.

Back Panel Controls:

ON/OFF : This is used to ON or OFF the instrument.

CAL Control : This potentiometer is used to adjust the display to 1000 when the

function switch is at check position.

Input Connection :Two banana sockets are the input of the instrument. The TDS cell lead fitted with banana plug is these sockets for connecting the TDS cell to the instrument.

Fuse : 100Ma fuse is used to control the current from the power supply to the instrument.

Connection of the TDS Cell:

a. The TDS cell thoroughly with distilled was washed.
b. The TDS cell leads to the input sockets at the back of the instrument was filled.

Description of the procedure:

To measure the TDS of any solution following under mentioned steps:

i. The cell was rinsed was solution whose TDS value is to be determined.
ii. The TDS cell was dipped in the solution under test.
iii. The function switch was set to 'CHECK' position.
iv. Display must read 1.000(respective of the decimal).If it dose not be so then adjust to 1.000 by rotating the CAL control provided at the back.
v. The function switches to was set Cell Constant position.
vi. The cell constant value of the TDS cell was set by Cell Constant control.
vii. The temperature control was set to the actual temperature of the solution.
viii. Now the range switch was set at position where maximum resolution is obtained.
ix. The display was read. This is the exact value of TDS at 25^0C.

5.3 METHOD OF MEASURE pH IN LABORATORY (BY Digital pH Meter):

Electrometric Method: The electrometric method which is considered standard is given by a Glass Electrode Method. The Glass Electrode Method is relatively immune to the interference from color, turbidity and other previously mentioned factors. It is suitable for very exact estimation (+/-0.1 pH unit).

The measurement of pH is performed electrometrically using a pH meter. The electrode should never be allowed to dry out and therefore must be returned to a beaker or bottle of either pH4 buffer or standard electrode filling solution between measurements. In the absence of either of these solutions, distilled water can be used but the electrode should not be stored for any great length of time in this. The principal of the probe requires the glass electrode to adsorb a layer of the sample on to its surface. The resultant potential difference being a function of the hydrogen ion (H^+) concentration in the sample and the electrolyte contained within the electrode.

Prior to measurement the pH meter is calibrated using a freshly made buffer solution (pH 7) and the slope of the electrode adjusted against a ph 4 buffer. Temperature compensation is adjusted manually according to the ambient sample temperature. The electrode is thoroughly rinsed with distilled water before each measurement. Water samples should be collected in a clean glass beaker well flushed with the sample and the electrode allowed to stand for several minutes without agitation before the pH value is determined.

Photo of Digital pH Meter

[*Ref. SWRE Lab.J.U*]

Description of Procedure :

a) The test cell is filled with KCL solution
b) The temperature is adjusted to the test temperature 25^{o} C
c) Standard buffer solution is taken. If there is any discrepancy between the actual pH value and the pH value obtained in the scale we have to adjust it and bring it to the actual value by operating the buffer switch.
d) We have to standardize the entire pH meter between the range (4.01 to 7.0) or (7.0 to 9.2).
e) After this standardization process we should take the water sample in the glass bucket and measure its pH value from the scale.

5.4 Materials and Methods:-

5.4.1..20 lt. Jar and 500/600 ml. Bottled Packaged Drinking Water
Lab:School of Water Resources Engineering, Jadavpur University

SL. No.	Sample No.	Name Of the Product	Marketed By	Manufactured By	Batch no.	Manufactured Date	Date of Sample Collection	Collection Location	Period Of Testing
1.	B1	Kinlay	Cocacola Company	Diamond Beverage pvt. Ltd,Taratola Road, Kol-88	130	30/10/18	26/11/18	Picnic Garden	26-28 Nov. 2018
2.	B2	Raindrops	Prince Food &Beverage,Kishan Market,Jagadhipota,Sonarpur,Kol-152	DFB Agro,Kalyani Expressway,Shyamnagar	08/09	26/10/18	26/11/18	Anandappur,Beside Ruby Park	26-28 Nov.2018
3.	B3	Bislary	Orient Beverage Ltd.	Orient Beverage Ltd.,Howrah	296	23/11/18	3/12/18	Ruby Park Zone	3-12 Dec. 2018
4.	B4	Amust	Amust Water Products (P) Ltd.Vill-Prasastha,Domjur,Howrah	Amust Water Products (P) Ltd.Vill-Prasastha,Domjur,Howrah	H/01/18	01/11/18	3/12/18	Jadavpur Zone	3-12 Dec. 2018
5.	B5	Bizaree	M/s Ghosal Foods & Beverages	M/s Ghosal Foods & Beverages, Balivara (H.K.Bhatta Road), North 24 Pargana	BT11114	01/11/18	8/12/18	Madhyamgram chowmatha Junction	8 – 12 Dec 2018

6.	B6	Aqua Dollar	Oceania Beverages, Survey park, Kolkata-75, Mumbai	Atul Enterprise. Buroshibtala Main Road, Kolkata-38	Ilegible	November 2018	14/12/2018	Park Circus Zone	14-27 Dec.2018
7.	B7	Aquafina	PEPSICO	Varun Beverages Ltd., 24 PGS (S), Kolkata-700084	BA 168	20/11/2018	25/12/2018	Singur ,Hoogly	27Dec. 2018 – 4th Jan. 2019
8.	B8	Blazes	Parle Agro Pvt. Ltd.	Keventer Agro Ltd., Barasat, 24 PGS(N)	1137	11/11/2018	25/12/2018	Shaiktigarh, Burdwan	27 Dec.2011 8—4th Jan.2019
9.	B9	Pabitra	MAA TARA Beverages,Md.Bazar, Birbhum	Pabitra Beverages,Ramchandpur,Kol-104	19	19/12/2018	25/12/2018	-----Do---	4th-9th Jan.2019
10	B10	Aqua Diamond	M/s Pal & Co., South Station Road, Agarpara, Kol-109	M/s Pal & Co., South Station Road, Agarpara, Kol-109	02	03/12/18	25/12/2018	Shaiktigarh, Burdwan	4th-9th Jan.2019
11	B11	Safe n Sip	Anwesa Enterprises, 16, India Exchange Place, Kolkata-700001	Rupasi Industries, 31, A. K. Mukherjee Road, Kolkata-700090.	166	06/12/2018	25/12/2018	-----Do---	---do---
12.	B12	Rain	Priyansh, P-121/6, Beneras Road, PO-Netajigarh, Liluah, howrah	Atul enterprise, 6, Buroshibtala Main road, Kol-38.	Not mentioned	25/12/2018	05/01/2019	Singur ,Hoogly	9th -11th Jan.2019
13.	P1	SB AQUA	SB AQUA BEVERAGE PVT. LTD.	SB AQUA BEVERAGE PVT. Ltd Sonarpur,Kolkata-150	Not mentioned	03/11/2018	08/12/2018 and 30/01/19	Avisar Shopping Mall at Kalikapur	8-12 Dec.2018 & 30 th

								Rd.	Jan.-6th Feb.2019
14,	P2	Raindrops	Prince Food & Beverage, Kishan market, Jagadhipota, Sonarpur, Kolkata-152	DFB Agro, Kalyani Expressway, Shyam Nagar	08/09	26/12/2018	11/01/2019	Hadiarhut Mukundapur	11-16 Jan.2019
15.	P3	Splash Crystal	Saha Purifiers & Beverages Co. Badu, Kolkata -128	Saha Purifiers & Beverages Co. Badu, Kolkata -128	SP/L/07	18/12/2018	30/01/2019	Ahalyanagar,Mukundapur	30 th Jan-6 th Feb.2019
16.	P4	Test me	Kolkata	Kolkata	Not mentioned	27/02/2019	01/03/2019	Shop at Green Park Nursing Home,Mukundapur	Only 1st March 2019
17.	P5	Aqua Millar	Eureka Forbes, Mumbai	Swachha Beverages Pvt. Ltd. Howrah	Not mentioned	20/02/2019	01/03/2019	Purbalok ,Mukundapur	Only 1st March 2019

5.4.2..Kolkata Municipal Corporation Water Supply :--

Lab:School of Water Resources Engineering, Jadavpur University

SL. No	Sample No.	Date of sample Collection	Sample Location	Latitude (N)	Longitude(E)	Name Of The KMC Treatment Unit	No. Of Persons using this water	Test and colour of water	Period of Testing
1.	K1(i)	20/11/18	K.P Basu Memomorial Bldg, ,J.U	22.49	88.37	Garden Reach	250	Natural	On That day evening
2.	K1(ii)	22/11/18	Aurobindo bhabon,J.U	22.4968	88.3722	Garden Reach	750	_	On That day evening
3.	K1(iii)	24/11/18	Rabindra Bhabon,J.U	22.5018	88.3716	Garden Reach	550	_	On That day evening
4.	K3	27/11/18	Rail Bihar Housing Complex,Ruby Park	22.512	88.406	Dhapa,Science City	350	_	27 to 28 Nov. 2018
5.	K3	11/12/18	Rail Bihar Housing Complex,Ruby Park	22.512	88.406	Dhapa,Science City	350	_	11 to 27 Dec. 2018
6.	K1(iv)	11/01/19	Faculty of engg. Bldg. J.U Campus	22.4975	88.3712	Garden Reach	250	Natural	11 to 16Jan.2019
7.	K2(i)	16/01/19	Residential Bldg. C.I.T Road, Beliaghata,Kol-10	22.5614	88.3961	Tala, Paikpara	3	Natural	16 to 18Jan. 2019
8.	K1(v)	18/01/19	Out side tap of water Resources Lab. Bldg	22.4979	88.3714	Garden Reach	550	Natural	18 to 21Jan. 2019
9.	K1(iv)	30/01/19	Faculty of engg. Bldg. J.U Campus	22.4975	88.3712	Garden Reach	250	Natural	30th Jan. to 6th Feb. 2019
10.	K1(ii)	8/02/19	Aurobindo bhabon,J.U	22.4968	88.3722	Garden Reach	750	_	Only 8 th Feb. evening

11.	K2(ii)	16/01/19	Calcutta University Campus,College Street	22.5752	88.3624	Tala, Paikpara	1000	_	16th to 18th Jan. 2019	
12.	K2(ii)	30/01/19	Calcutta University Campus,College Street	22.5752	88.3624	Tala, Paikpara	1000	_	30th Jan.to 6th Feb.2019	
13.	K2(i)	01/03/19	Residential Bldg. C.I.T Road, Beliaghata,Kol-10	22.5614	88.3961	Tala, Paikpara	3	Natural	1 st to 3rd.March.2019	
14.	K2(i)	18/04/19	-DO-	22.5614	88.3961	Tala, Paikpara	3	Natural	Only 18th April,2019	

5.4.3.. Water using By Individual Purifier :--

Lab:School of Water Resources Engineering, Jadavpur University

SL. No	Sample No.	Date of sample Collection	Sample Location	Latitude (N)	Longitude (E)	Water using by self purifier collected from the source (Residential(I-1),Commertial(I-2),Institutional (I-3),Official (I-4)	No. Of Persons using this water	Test and colour of water	Period of Testing
1.	I-1	20/11/18	Residential Complex, opposite to GST Bhabon	22.5133	88.3973	Residential	4	Natural and Desirable	20 to 22 Nov.2018
2.	I-2	22/11/18	Avisar Shopping Mall ,Opposite to Avishikta Residential complex	22.5	88.4	Commertial	50	Undesirable and not satisfied	22 to 24 Nov.2018
3.	I-1	28/11/18	Residential Complex, opposite to GST Bhabon	22.5133	88.3973	Residential	4	Natural and Desirable	28 Nov.2018
4.	I-2	28/11/18	Avisar Shopping Mall ,Opposite to Avishikta Residential complex	22.5	88.4	Commertial	50	Undesirable and not satisfied	28 Nov.2018
5.	I-3(i)	14/12/18	Institute of Nursing,Ruby Hospital	22.5137	88.4031	Institutional	150	Moderately satisfied	14 to 27Dec.2018
6.	I-4(i)	14/12/18	Administrative office of sonarpurISPAT Hosputal	22.4236	88.5025	Official	200	Undesirable and unsatisfied	14 to 27 Dec.2018
7.	I-4(i)	9/01/19	Administrative office of sonarpur ISPAT Hosputal	22.4236	88.5025	Official	200	Undesirable and unsatisfied	9 th to 11 th Jan.2019
8.	I-1	11/01/19	Residential Complex, opposite to GST Bhabon	22.5133	88.3973	Residential	4	Natural and Desirable	11 to 18 Jan.2019
9.	I-2	16/01/19	Avisar Shopping Mall ,Opposite to Avishikta Residential complex	22.5	88.4	Commertial	50	Undesirable and not satisfied	16 to 18 Jan.2019

10.	I-2	30/01/19	Avisar Shopping Mall ,Opposite to Avishikta Residential complex	22.5	88.4	Commertial	50	Undesirable and not satisfied	30 th Jan (.Eve.)2019
11.	I-4(ii)	30/01/19	Office of Diagnostic Centre, Sonarpur station Road	22.4316	88.4692	Official	30-50	Moderately satisfied	30 th Jan. to 6 th Feb.2019
12.	I-3(ii)	6/02/19	Bijaygarh Institution ,school,Jadavpur	22.4882	88.3622	Institutional	300	Desirable and Moderately satisfied	6 th to 8 th Feb 2019
13.	I-3(iii)	16/04/19	West Bengal State Centre,Gokhale Road.	22.54	88.3452	Institutional	50-100	Desirable and Moderately satisfied	Only 18 th April,2019
14.	I-4(iii)	16/04/19	Office of The Institution of Engineers(INDIA) Gokhale Road,Kol-20	22.54	88.3456	Official	150-200	Natural and Desirable	Only 18 th April,2019
15.	I-3(iv)	18/04/19	Metrological Dept.J.U	22.4976	88.3711	Institutional	Not using now.	Undesirable and not satisfied	Only 18 th April,2019

5.4.4 Water Using By Street Foot Vendors :--

Lab:School of Water Resources Engineering, Jadavpur University

SL. No	Sample No.	Date of sample Collection	Sample Location	Latitude(N)	Longitude(E)	Name Of the Source Of KMC Water or others	Period of Testing
1.	V1	20/11/18	Tea Shop at Kalikapur Road	22.5	88.4	KMC Supply (Garden Reach)	On That day evening
2.	V2	20/11/18	Momo Shop At 8B Bus stand Jadavpur	22.496	88.375	KMC Supply (Garden Reach)	On That day evening
3.	V1@	22/11/18	Tea shop at 1 No. gate J.U	22.491	88.371	KMC Supply (Garden Reach)	On That day evening
4.	V2@	11/12/18	Tea Shop at Ruby More	22.512	88.402	KMC Supply (Dhapa,Science City)	11to 12 Dec.2018
5.	V3	8/12/18	Tea Shop At Madhyamgram Chowmatha junction.	22.691	88.468	Tubewell Water	8 to 27 Dec.2018
6.	V4	17/12/18	Chowmin shop Near by Rajarhat-CC2	22.622	88.45	KMC Supply (Dhapa,Science City)	17 to 21 Dec.2018
7.	V5	27/12/18	Street Vendors ,Singur ,hoogly	22.821	88.236	Using packaged Drinking Water	27 Dec.2018 tp 4 th Jan 2019

5.4.5 _Water Using,Treatment Plant Installed By Residential and Commertial Complex :--

Lab:School of Water Resources Engineering, Jadavpur University

SL. No.	Sample No.	Date of sample Collection	Sample Location	Latitude (N)	Longitude(E)	Use of filter Before supply (R.O, Activated carbonFilter)	No. Of Persons using this water	Test and colour of water	Period of Testing
1.	S1	17/12/18	Shopping Mall, City Centre-2 ,Rajarhut	22.621	88.451	Iron removal Filter and Arsenic removal Filter	1000 approx	Natural	17 to 21 Dec. 2018
2.	S2	17/12/18	Accropolis Mall, Rajdanga Main Rd. Kol-107	22.515	88.393	Iron removal Filter and Activated Carbon Filter	1000 approx	Natural	17 to 21 Dec. 2018
3.	S3	16/01/19	Wipro Office Bldg.Sector-(v),Salt Lake	22.578	88.427	R.O Treatement Unit and Rain water Harvesting Plant.	1500 approx	-Do-	16 to 18 Jan. 2018
4.	S4	08/02/19	AMRI Hospital, Mukundapur	22.4936	88.4021	Iron removal Filter	2500 approx	-Do-	8 to 12 Feb. 2019
5.	S4	28/02/19	AMRI Hospital, Mukundapur	22.4936	88.4021	-Do-	2500 approx	-Do-	28 Feb. to 1st March 2019
6.	S3	01/03/19	Wipro Office Bldg.Sector-vi,Salt Lake	22.578	88.427	R.O Treatement Unit and Rain water Harvesting Plant.	1500 approx	-Do-	1st to 3 rd March. 2019
5.	S4	17/04/19	AMRI Hospital, Mukundapur	22.4936	88.4021	Iron removal Filter	2500 approx	-Do-	18 Apr.. to 20th Apr. 2019
7.	S5	17/04/19	Highland Park Residential Complex,Patuli	22.484	88.3903	Iron Filter and R.O Treatement unit	2500 approx	-Do-	18 Apr.. to 20th Apr. 2019
8.	S6	17/04/19	Central Shopping Complex, New Town	22.5831	88.4588	R.O Treatement Unit	1000 approx	-Do-	18 Apr.. to 20th Apr. 2019

5.4.6 Tubewell Water :--

Lab:School of Water Resources Engineering, Jadavpur University

SL. No	Sample No.	Date of sample Collection	Sample Location	Latitude and Longitude)(N/E)	Ward No./Dag.No.	Owner of Tubewell (Govt./Private)	No. Of Persons using this water	Test and colour of water	Period of Testing
1.	T1	24/11/18	In Front of Green Park nursing Home,Mukundapur	22.4938/88.4077	Ward No.-109	Govt.	100	Test-Undesirable,Colour Raddish	24 to 26 Nov. 2018
2.	T2	26/11/18	Bose Pukur Water Tank	22.523/88.324	Ward No.-91	Govt.	350	Natural and moderately desirable	26 Nov. to 11 Dec. 2018
3.	T3	27/11/18	Kheyadaha 2 No. gram panchayet,Sonarpur	22.502/88.439	Dag. No.-2No.Kheyadaha Gram Panchayet	Private	5	Undesirable	27 Nov. 29 Nov.2018
4.	T4	3/12/18	Mandir Premuses,Kolaghat ,East Midnapur	22.4464/87.8383	Dag.No-360,Mouza-Pulsita	Govt.	150	Natural and desirable	3rd to 5th Dec. 2018
5.	T5	8/12/18	Kali Mandir premises,Birati,North 24 Parganas.	22.662/88.442	Ward No.-605	Mandir committee, Private	150	Natural and desirable	8 th to 12 Dec. 2018
6.	T6	11/12/18	Amta ,Udaynarayanpur, Howrah	22.4697/87.9607	Dag.No-261,Mouza-Rowta,Block-Amta	Residential Bldg. Private	10	Natural and desirable	11 to 12 Dec. 2018

CHAPTER 6

ANALYSIS OF RESULTS

6.1 ANLYSIS OF RESULTS:-

For analysis of results, the values of different water quality parameters e.g. bacteriological, physical and chemical parameters are determined at laboratories. As discussed earlier, prior to starting of laboratory testing samples were collected properly. Water quality is a function of bacteriological and different physical (pH, odour, turbidity etc.) and chemical (total hardness, chloride, etc.) parameters present in the water. After determination of all these parameter in water, the same needs to be compared with respect to acceptable and permissible limit as specified in relevant IS code of practice. In case of drinking water, obtained either from different type of filters or packaged water, IS 10500-2012 (Drinking Water Specifications) is referred to compare the said parameters. For packaged drinking water, the results are also compared with the acceptable limit as laid down in IS : 14543 : 2004 [Package Drinking Water Specifications (other than packaged natural mineral water)]. While getting performance of filters the water quality parameters of water before and after filtration are compared for each purifier. Thereafter, the average performance of each type of purifiers can be found out at a glance. Further, composite quality of water can be assessed by calculating Water Quality Index considering composite effect of various parameters.

6.1.1 Water Quality Index (WQI): Water Quality Index of drinking water is regarded one of the most effective tool to communicate water quality (C.R.Ramakrishnaiah *et al.*). Overall quality of drinking water including packaged drinking water can be assessed with this.. Water quality Index is defined as a rating reflecting the composite influence of different water quality parameters, which is calculated from the point of view of suitability of water for human consumption. The data obtained through quantitative analysis and IS water quality standards have been used for calculating WQI.

The purpose of calculating WQI and comparing it with standard acceptable value to assess drinking water contamination and variation of drinking water quality in different packaged water and that of both pre-filter and post-filter water obtained before and after purification by RO filter, normal stand alone water filter as well as candle filter.

For computing WQI three steps are followed. In the first step, each parameter has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes. In this study 7 (seven) parameter have been selected for the analysis. More the number of parameter more will be the better assessed value of WQI. The maximum weight of 5 has been assigned to the parameter coliform due to its relative importance in water quality. The principal risk to human health derives from fecal contamination. In some countries there may also be hazards associated with specific chemical contaminants such as manganese and fluoride, but the levels of these substances are unlikely to change significantly with

time. In contrast, the potential for fecal contamination is much more if it leads untreated. Hardness has given the minimum weight as this parameter may not much harmful.

In the second step, the relative weight (Wi) is computed from the following equation:

$$Wi = wi / \sum_{i=1}^{i=n} wi$$

Where, Wi is the relative weight, wi is the weight of each parameter and 'n' is the number of parameters. Calculated relative weight (Wi) values of each parameter are also given in following table.

In the third step, a quality rating scale (qi**)** for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result multiplied by 100:

$$qi = (Ci / Si) \times 100$$

where 'qi' is the quality rating, 'Ci' is the concentration of each chemical parameter in each
water sample and Si is the Indian drinking water standard for each parameter according to the guidelines of the BIS 10500, 2012 / BIS 14543 : 2004.

For computing the WQI, the Sub Index (SI) is first determined for each parameter, which is then used to determine the WQI as per the following equation :

$$SIi = Wi \cdot qi$$
$$WQI = \sum SIi$$

'SIi' is the sub-index of ith parameter; qi is the rating based on concentration of ith parameter and n is the number of parameters. The computed WQI values are classified into five types, "excellent water" to "water, unsuitable for drinking".

Table : Relative weightage of physiochemical and biological parameters.

Sample No.	Parameter	Requirement as per Indian Standard (Si)	Weight (wi)	Relative weightage (Wi)	Observed Results (Ci)	Quality Rating Scale qi=(Ci/Si)x 100	Sub-Index Sli=(Wi . qi)
1	Coliform (MPN/250 ml)	Absent	5	0.385	Absent		
	pH	6.5-8.5	4	0.308			
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308			
		Total	**13**	**1.00**	**Water Quality Index (WQI)**		**Σ**

Table : Water quality classification based on WQI value

Range of WQI Values	Type of water for drinking purpose
< 50	Excellent
50 - 75	Good
75 - 100	Fair
100 - 200	Poor
200 - 300	Very poor
> 300	Unsuitable for drinking

6.2 OBSERVED RESULTS AT LABORATORY:

6.2.1 Packaged Driking Water (20Lt. Jar +500/600 Ml. Bottled Packed)

Parameter Tested		1		2	3
		Coliform Bacteria (MPN)		pH	TDS (mg/l)
Method of test		By H_2S Strip	IS 1622-1996	3025-1984 (Part-16)	3025-1984 (Part-16)
Accepted Limit as per IS : 10500 : 2012 *		Shall not be detectable in any 100 ml sample		6.5 – 8.5	500
Accepted Limit as per IS : 14543 : 2004 #		Shall be absent in any 250 ml sample		6.5 – 8.5	500
Accepted Limit as per I WHO Standard-2011		Shall be absent in any 100 ml sample		6.5 – 8.5	600
Accepted Limit as per CANADA Drinking Water Guideline-Aug. 2010		Shall be absent in any 100 ml sample		7 – 10.5	≤ 500
Accepted Limit as per US EPA-2010		Not more than 5% of monthly samples valid		6.5 – 8.5	500
Sample No.	Sample Name				
B1 (i)	**Kinley**	Ab	<2	8.71	13.60
B 1 (ii)	-DO-	Ab	<2	8.11	13.72
B 1 (iii)	-DO-	Ab	<2	8.20	13.96
B 1 (iv)	-DO-	Ab	<2	-	13.90
B 2 (i)	**Raindrops**	Ab	<2	7.06	19.15
B 2 (ii)	-DO-	Ab	<2	7.70	18.62
B 2 (iii)	-DO-	Ab	<2	8.00	19.14
B 2 (iv)	-DO-	Ab	<2	-	18.73
B 3 (i)	**Bislary**	Ab	<2	7.28	26.5
B 3 (ii)	-DO-	Ab	<2	7.31	26.3
B 3 (iii)	-DO-	Ab	<2	7.30	25.7
B 3 (iv)	-DO-	Ab	<2	-	26.1

B 4 (i)	**Amust**	Ab	<2	7.35	25.6
B 4 (ii)	-DO-	Ab	<2	7.32	25.7
B 4 (iii)	-DO-	Ab	<2	7.14	25.8
B 5 (i)	**Bizaree**	Ab	<2	7.68	36.5
B 5 (ii)	-DO-	Ab	<2	7.73	36.8
B 5 (iii)	-DO-	Ab	<2	7.07	37.2
B 5 (iv)	-DO-	Ab	<2	7.83	-
B 6 (i)	**Aqua Dollar**	Ab	<2	6.74	23.4
B 6 (ii)	-DO-	Ab	<2	6.75	23.6
B 6 (iii)	-DO-	Ab	<2	7.29	23.3
B 7 (i)	**Aqua Fina**	Ab	<2	7.07	3.70
B 7 (ii)	-DO-	Ab	<2	7.63	3.77
B 7 (iii)	-DO-	Ab	<2	7.19	3.78
B 7 (iv)	-DO-	Ab	<2	-	3.80
B 8(i)	**Blazes**	Ab	<2	7.05	18.44
B 8 (ii)	-DO-	Ab	<2	7.63	18.37
B 8 (iii)	-DO-	Ab	<2	7.16	17.88
B 8 (iv)	-DO-	Ab	<2	-	17.75
B 9(i)	**Pabitra**	Ab	<2	7.05	10.10
B 9 (ii)	-DO-	Ab	<2	6.71	10.12
B 9 (iii)	-DO-	Ab	<2	6.81	10.01
B 9 (iv)	-DO-	Ab	<2	6.29	10.12
B 10(i)	**Aqua Diamond**	Ab	<2	7.45	44.3
B 10 (ii)	-DO-	Ab	<2	6.94	44.5
B 10 (iii)	-DO-	Ab	<2	6.67	44.2
B 10 (iv)	-DO-	Ab	<2	6.40	44.9
B 11(i)	**Safe n Sip**	Ab	<2	7.40	18.70
B 11 (ii)	-DO-	Ab	<2	6.79	18.82
B 11 (iii)	-DO-	Ab	<2	6.71	18.39
B 11 (iv)	-DO-	Ab	<2	6.50	18.47
B 12(i)	**Rain**	Ab	<2	6.53	10.57
B 12 (ii)	-DO-	Ab	<2	6.22	10.75
B 12 (iii)	-DO-	Ab	<2	6.99	10.44
B 12 (iv)	-DO-	Ab	<2	7.05	10.49
P 1 (i)	**Sb Aqua**	Ab	<2	7.88	24.7
P 1 (ii)	-DO-	Ab	<2	7.52	24.8
P 1 (iii)	-DO-	Ab	<2	7.74	20.6
P 1 (iv)	-DO-	Ab	<2	7.60	20.8
P 1 (v)	-DO-	Ab	<2	6.96	21
P 1 (vi)	-DO-	Ab	<2	6.78	21.1
P 1 (vii)	-DO-	Ab	<2	6.81	-
P 2 (i)	**Rain Drops**	Ab	<2	6.36	23.6
P 2 (ii)	-DO-	Ab	<2	6.55	23.7
P 2 (iii)	-DO-	Ab	<2	6.73	24.0
P 2 (iv)	-DO-	Ab	<2	7.01	-
P 3 (i)	**Splash Crystal**	Ab	<2	6.86	10.35

P 3 (ii)	-DO-	Ab	<2	5.63	10.50
P 3 (iii)	-DO-	Ab	<2	-	13.66
P 3 (iv)	-DO-	Ab	<2	-	13.42
P 4 (i)	**Test Me**	Ab	<2	7.03	79.0
P 4 (ii)	-DO-	Ab	<2	-	80.7
P 5(i)	**Aqua Millar**	Ab	<2	6.30	70.0
P 5 (ii)	-DO-	Ab	<2	-	70.4

Note : Ab = Absent ; P = Present;

* Drinking Water Specifications

Package Drinking Water Specifications (other than packaged natural mineral water)

1.TYPICAL CALCULATION OF WATER QUALITY INDEX (WQI) OF PACKAGED (20 Lt. Jar + 500/600 Ml. Bottoled)DRINKING WATER :-

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
500/600 Ml.Bottled Package Drinking Water							
B 1	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	8.34	128.31	39.52
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	13.795	2.76	0.85
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**40.37**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
20 Lt. Jar Package Drinking Water							
P 1	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.33	112.77	34.73
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	22.17	4.43	1.36
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**36.095**

TABLE 6.2.1(a)- : WATER QUALITY INDEX OF PACKAGE DRINKING WATER (20 Lt Jar + 500/600 Ml. Bottled Packaged Water:-

Sample No.	Sample name	Water Quality Index (WQI	Type of water for Drinking	Remarks
B-1	Kinley	40.37	Excellent	
B-2	Raindrops	37.12	Excellent	
B-3	Bislary	36.18	Excellent	
B-4	Amust	36.03	Excellent	All samples of packaged water are R.O purifiers water and Excellent category for drinking
B-5	Bizaree	38.19	Excellent	
B-6	Aqua Dollar	34.28	Excellent	
B-7	Aqua Fina	34.80	Excellent	
B-8	Blazes	35.61	Excellent	
B-9	Pabitra	32.46	Excellent	
B-10	Aqua Diamond	35.29	Excellent	
B-11	Safe n Sip)	33.61	Excellent	
B-12	Rain	32.38	Excellent	
P-1	Sb Aqua	36.095	Excellent	
P-2	Rain Drops	33.02	Excellent	
P-3	Splash Crystal	30.36	Excellent	
P-4	Test Me	38.23	Excellent	
P-5	Aqua Millar	34.17	Excellent	
	Avg.(WQI)	**35**		

Water quality classification based on WQI values :--

Range of WQI Values	Type of water for drinking purpose
< 50	Excellent
50 - 75	Good
75 - 100	Fair
100 - 200	Poor
200 - 300	Very poor
> 300	Unsuitable for drinking

TABLE 6.2.1 (b)- : STATISTICAL DESCRIPTION OF PACKAGE DRINKING WATER (20 Lt Jar + 500/600 Ml. Bottled Packaged Water):

Sample No.	Sample name	pH(2),TDS(2)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
B-1	Kinley	pH(3),TDS(4)	8.34(± 0.32)	13.795 (± 0.17)
B-2	Raindrops	pH(3),TDS(4)	7.59(± 0.48)	18.91(± 0.28)
B-3	Bislary	pH(3),TDS(4)	7.296(± 0.02)	26.15(±0.12)
B-4	Amust	pH(3),TDS(3)	7.27(± 0.11)	25.7(±0.1)
B-5	Bizaree	pH(4),TDS(3)	7.58(±0.34)	36.83(± 0.35)
B-6	Aqua Dollar	pH(3),TDS(3)	6.93(± 0.31)	23.43(0.15)
B-7	Aqua Fina	pH(3),TDS(4)	7.296(±0.29)	3.76(± 0.04)
B-8	Blazes	pH(3),TDS(4)	7.28(±0.31)	18.11(± 0.35)
B-9	Pabitra	pH(4),TDS(4)	6.72(±0.32)	10.09(± 0.05)
B-10	Aqua Diamond	pH(4),TDS(4)	6.87(±0.45)	44.48(±0.31)
B-11	Safe n Sip)	pH(4),TDS(4)	6.85(±0.22)	18.595(± 0.19)
B-12	Rain	pH(4),TDS(4)	6.697(±0.39)	10.56(±0.14)
P-1	Sb Aqua	pH(7),TDS(6)	7.33(± 0.46)	22.17(± 2.0)
P-2	Rain Drops	pH(4),TDS(3)	6.66(0±.28)	23.77(± 0.21)
P-3	Splash Crystal	pH(2),TDS(4)	6.25(± 0.87)	11.98(±1.80)
P-4	Test Me	pH(2),TDS(2)	7.03(-)	79.85(±1.20)
P-5	Aqua Millar	pH(2),TDS(2)	6.30(-)	70.2(± 0.28)

IDENTIFICATION O F SAMPLE:-

TABLE 6.2.1 (c)- : PACKAGE DRINKING WATER (20 Lt. Jar + 500/600 Ml. Bottled Packaged Water) :-

Sample No.	Sample Name
500/600 Ml.Bottled Packaged Drinking Water	
B-1	(Kinley)
B-2	(Raindrops)
B-3	(Bislary)
B-4	(Amust)
B-5	(Bizaree)
B 6	Aqua Dollar
B-7	(Aqua Fina)
B-8	(Blazes)
B-9	(Pabitra)
B-10	(Aqua Diamond)
B-11	(Safe n Sip)
B-12	(Rain)

Sample No.	Sample Name
20 Lt. Jar Packaged Drinking Water	
P-1	(Sb Aqua)
P-2	(Rain Drops)
P-3	(Splash Crystal)
P-4	(Test Me)
P-5	(Aqua Millar)

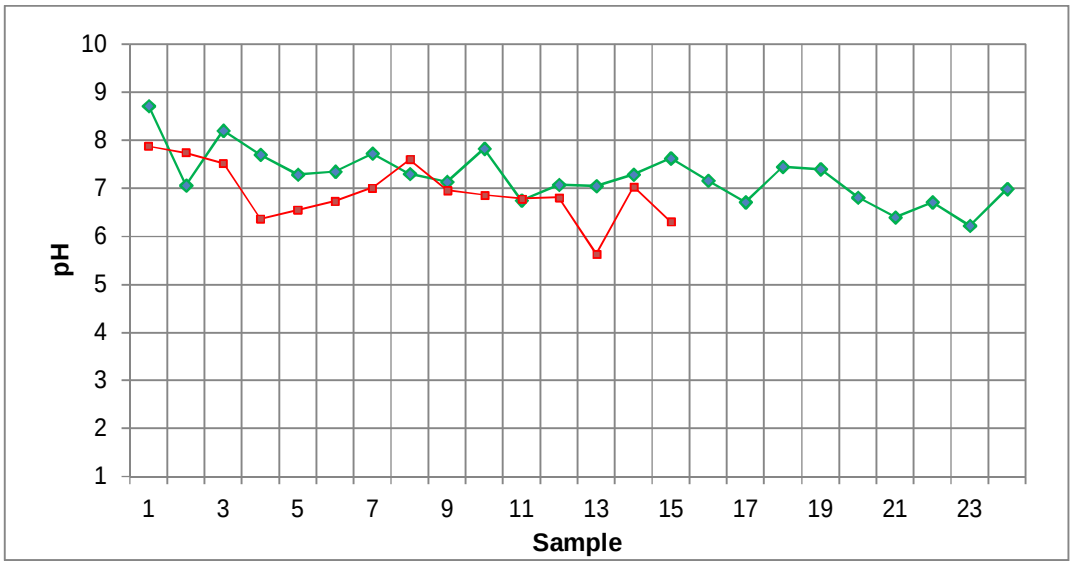


Fig.6C i) pH valueVs Samples of Packaged (500/600 Ml Bottled +20 Lt.Jar) Drinking Water

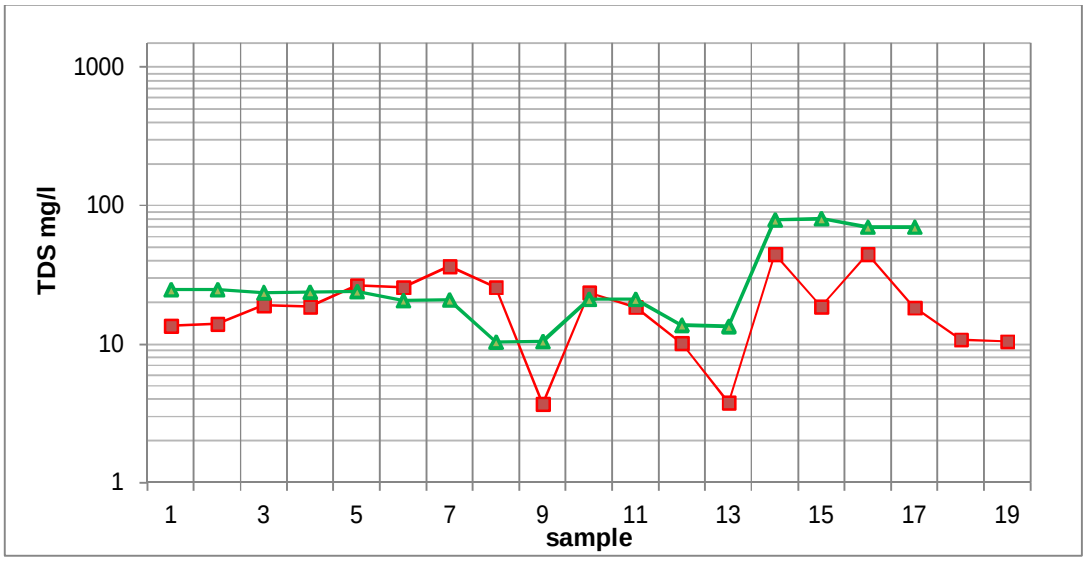


Fig. 6C ii) TDS (mg/l) Vs Samples of Packaged (500/600 Ml Bottled +20 Lt.Jar) Drinking Water

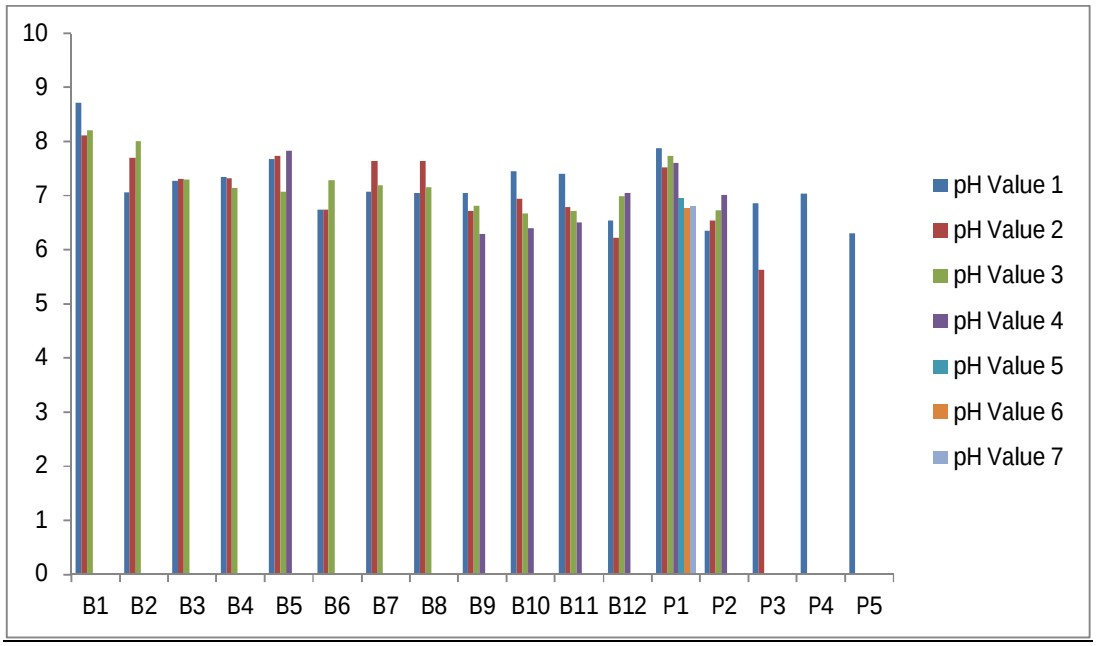


Fig.6.2.1(i)Determined pH Value of Packaged Drinking Water

(20lLt.Jar&500/600ml.Bottle)

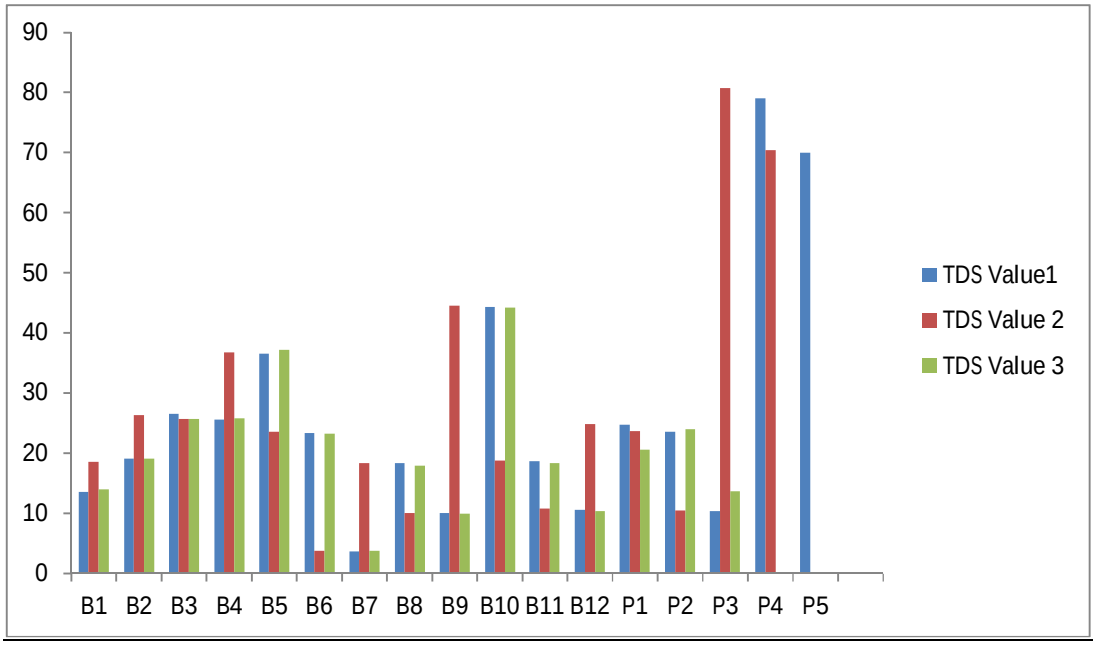


Fig.6.2.1(ii)Determined TDS Value of Packaged Drinking Water

(20l Lt.Jar&500/600ml.Bottle)

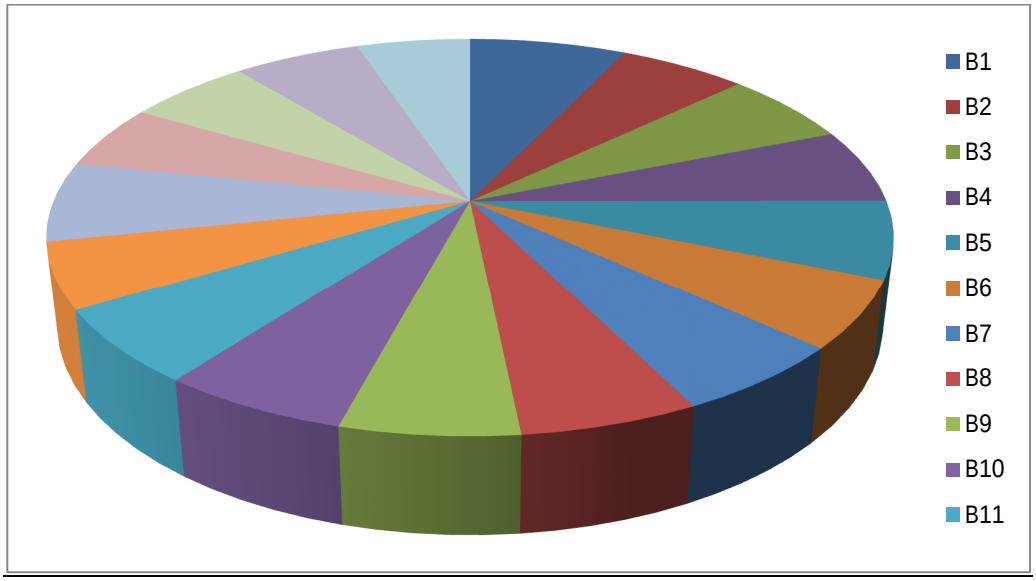


Fig.6.2.1(iii) Determined pH Value of Packaged Drinking Water(20l Lt.Jar&500/600ml.Bottle

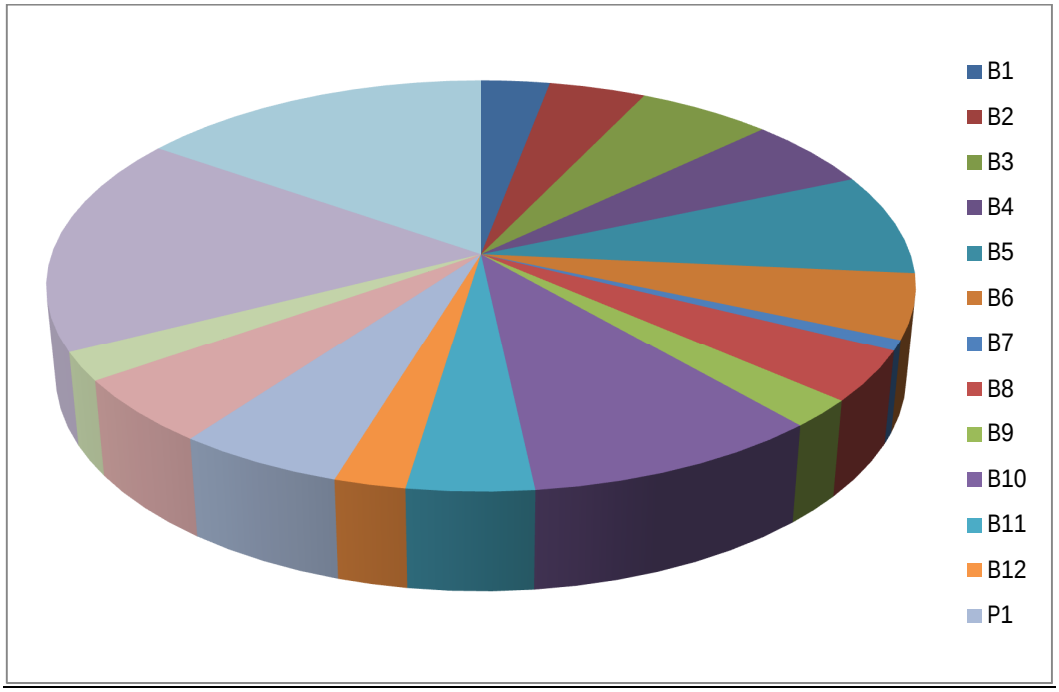


Fig.6.2.1(iv) Determined TDS Value of Packaged Drinking Water(20lLt.Jar&500/600ml.Bottle)

6.2.2 KMC Supply Water :-

Parameter Tested		1		2	3
		Coliform Bacteria (MPN)		pH	TDS (mg/l)
Method of test		By H_2S Strip	IS 1622-1996	3025-1984 (Part-16)	3025-1984 (Part-16)
Accepted Limit as per IS : 10500 : 2012 *		Shall not be detectable in any 100 ml sample		6.5 – 8.5	500
Accepted Limit as per IS : 14543 : 2004 #		Shall be absent in any 250 ml sample		6.5 – 8.5	500
Accepted Limit as per I WHO Standard-2011		Shall be absent in any 100 ml sample		6.5 – 8.5	600
Accepted Limit as per CANADA Drinking Water Guideline-Aug. 2010		Shall be absent in any 100 ml sample		7 – 10.5	≤ 500
Accepted Limit as per US EPA-2010		Not more than 5% of monthly samples valid		6.5 – 8.5	500
Sample No.	**Name of Collected Source and Treatement Plant**				
K1 (i)	**K.P Basu Memorial Bldg., J.U (Garden Reach)**	Ab	<2	7.47	102.9
K 1 (ii)	-DO-	Ab	<2	7.72	-
K1 (i)	**Aurobindo Bhawan ,J.U (Garden Reach)**	prasent	2	7.48	102.8
K 1 (ii)	-DO-		<2	7.61	107.8
K 1 (iii)	-DO-		<2	7.41	108.6
K1 (i)	**Rabindra Bhawan, J.U (Garden Reach)**	Ab	<2	7.53	99.2

K1 (ii)	-DO-	Ab	<2	7.60	-
K1 (i)	**Faculty of Engg. Bldg, J.U .(Garden Reach)**	Ab	<2	6.78	110.5
K1 (ii)	-DO-	Ab	<2	6.94	110.7
K 1 (iii)	-DO-	Ab	<2	6.76	111.6
K 1 (iv)	-DO-	Ab	<2	6.90	111.7
K 1 (v)	-DO-	Ab	<2	7.41	110
K 1 (vi)	-DO-	Ab	<2	-	109.8
K 1 (vii)	-DO-	Ab	<2	-	113
K 1 (viii)	-DO-	Ab	<2	-	114
K1 ((i)	**Water Resources Lab. Bldg.- Outside Tap .(Garden Reach)**	Ab	<2	7.78	111.8
K1 ((ii)	-DO-			7.86	112.2
K 2 (i)	**Residential Bldg. C.I.T Rd. , Beliaghata ,Kol- 10 (Tala)**	Present	2	6.75	105.3
K 2 (ii)	-DO-	Ab	<2	7.54	104.6
K 2 (iii)	-DO-	Ab	<2	7.36	104.8
K 2 (iv)	-DO-	Ab	<2	7.72	104.5
K 2 (v)	-DO-	Ab	<2	6.95	193.9
K 2 (vi)	-DO-	Ab	<2	6.98	195.2
K 2 (vii)	-DO-	Ab	<2	-	199.2
K 2 (viii)	-DO-	Ab	<2	-	213
K 2 (i)	**Calcutta University, College Street (Tala)**	Ab	<2	7.43	105.0
K 2 (ii)	-DO-	Ab	<2	7.27	105.1

K 2 (iii)	-DO-	Ab	<2	7.98	106.4
K 2(iv)	-DO-	Ab	<2	8.20	106.5
K 2 (v)	-DO-	Ab	<2	7.69	106.2
K 2 (vi)	-DO-	Ab	<2	7.32	105.7
K 2 (vii)	-DO-	Ab	<2	7.62	106.8
K 2 (viii)	-DO-	Ab	<2		107.1
K 3(i)	**Residential Complex, Rail Bihar, Beside Ruby (Dhapa)**	Present	2	7.77	104.8
K 3(ii)	-DO-	Ab	<2	7.21	105.0
K 3 (iii)	-DO-	Ab	<2	7.58	105.1
K 3 (iv)	-DO-	Ab	<2	7.62	105.3
K 3 (v)	-DO-	Ab	<2	6.81	109.2
K 3(vi)	-DO-	Ab	<2	-	109.7
K 3 (vii)	-DO-	Ab	<2	-	107.5

2. TYPICAL CALCULATION OF WATER QUALITY INDEX (WQI) OF KMC Supply WATER :-

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
KMC Supply (Garden Reach) Drinking Water (Aurobindo Bhabon, J.U)							
K 1	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.50	115.38	35.54
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	106.4	21.28	6.55
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**42.09**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
KMC Supply (Tala) Drinking Water (Residence at C.I.T Rd, Beliaghata, Kol- 10)							
K 2	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.22	111.08	34.21
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	152.56	30.51	9.397
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**43.61**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
KMC Supply (Dhapa) Drinking Water (Rail Bihar Residential Complex Beside Ruby)							
K 3	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.398	113.69	35.06
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	106.66	21.33	6.57
		Total	**13**	**1.000**	**Water Quality Index (WQI)**		**41.63**

TABLE 6.2.2(a)- : WATER QUALITY INDEX OF KMC SUPPLY DRINKING WATER

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
K 2	Residential Bldg. C.I.T Rd. , Beliaghata ,Kol- 10 (Tala)	43.61	Excellent	KMC Supply Drinking water(Tala) are of Excellent category for drinking
K 2	Calcutta University, College Street (Tala)	42.74	Excellent	

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
K 3	Residential Complex, Rail Bihar, Beside Ruby (Dhapa)	41.63	Excellent	KMCSupply Drinking water(Dhapa)are of Excellent category for drinking

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
K1	K.P Basu Memorial Bldg., J.U (Garden Reach)	42.33	Excellent	
K1	Aurobindo Bhawan ,J.U (Garden Reach)	42.09	Excellent	All KMC Supply Drinking water(Garden Reach) are of Excellent category for drinking
K1	Rabindra Bhawan, J.U (Garden Reach)	41.98	Excellent	
K1	Faculty of Engg. Bldg, J.U .(Garden Reach)	39.84	Excellent	
K1	Water Resources Lab. Bldg.-Outside Tap .(Garden Reach)	43.95	Excellent	
	Avg.(WQI)	**42**		

TABLE 6.2.2 (b)- : STATISTICAL DESCRIPTION OF KMC SUPPLY DRINKINGWATER :-

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(0 (σ)	Mean TDS value with standard deviation(((σ)
K 2 (i)	Residential Bldg. C.I.T Rd. , Beliaghata ,Kol- 10 (Tala)	pH(6),TDS(8)	7.22(±0.38)	152.56(±51.4)
K 2 (ii)	Calcutta University, College Street (Tala)	pH(7),TDS(8)	7.64(±0.35)	106.1(±0.77)

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviati±on(σ)	Mean TDS value with standard deviation(σ)
K 3	Residential Complex, Rail Bihar, Beside Ruby (Dhapa)	pH(5),TDS(7)	7.398(±0. 39)	106.66(±2.12)

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
K1 (i)	K.P Basu Memorial Bldg., J.U (Garden Rich)	pH(2),TDS(2)	7.595(±0.18)	102.99 (--)
K1(ii)	Aurobindo Bhawan ,J.U (Garden Rich)	pH(3),TDS(3)	7.50(±0.10)	106.4(±3.14)
K1(iii)	Rabindra Bhawan, J.U (Garden Rich)	pH(2),TDS(2)	7.57(±0.05)	99.2(--)
K1 (iv)	Faculty of Engg. Bldg, J.U .(Garden Rich)	pH(5),TDS(8)	6.96(0.±26)	111.41(±1.48)
K1 (v)	Water Resources Lab. Bldg.- Outside Tap .(Garden Rich)	pH(2),TDS(2)	7.82(±0.06)	112(±0.28)

IDENTIFICATION O F SAMPLE

TABLE 6.2. 2(c)- : KMC SUPPLY DRINKING WATER

Sample No.	Name of Collected Source
K 2 (i)	Residential Bldg. C.I.T Rd. , Beliaghata ,Kol- 10 (Tala)
K 2 (ii)	Calcutta University, College Street (Tala)

Sample No.	Name of Collected Source
K 3	Residential Complex, Rail Bihar, Beside Ruby (Dhapa)

Sample No.	Name of Collected Source
K1 (i)	K.P Basu Memorial Bldg., J.U (Garden Rich)
K1 (ii)	Aurobindo Bhawan ,J.U (Garden Rich)
K1(iii)	Rabindra Bhawan, J.U (Garden Rich)
K1 (iv)	Faculty of Engg. Bldg, J.U .(Garden Rich)
K1 (v)	Water Resources Lab. Bldg.- Outside Tap .(Garden Rich)

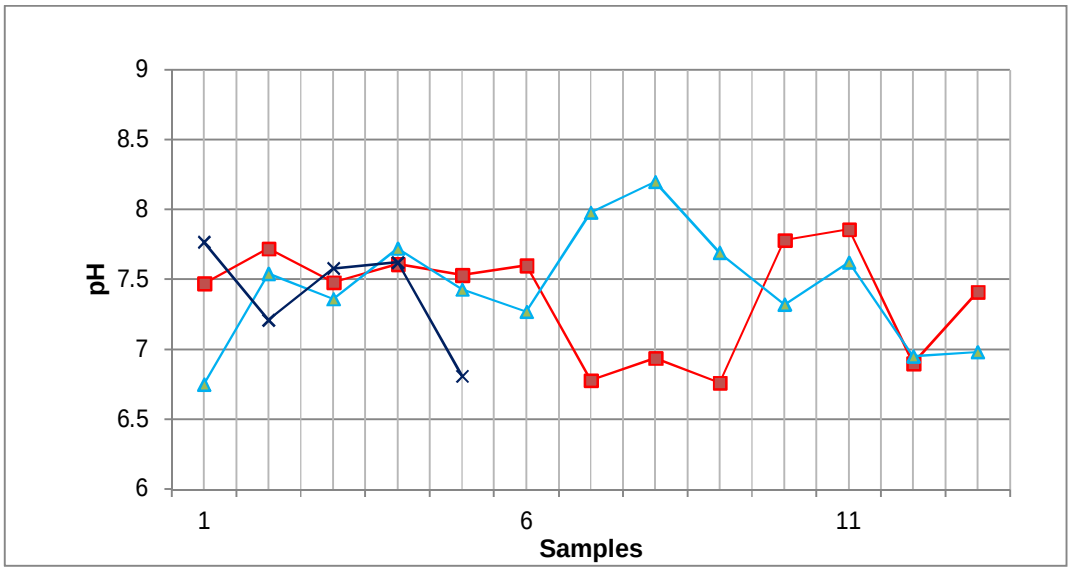


Fig. 6D i) pH value Vs Samples of KMC Supply Drinking Water

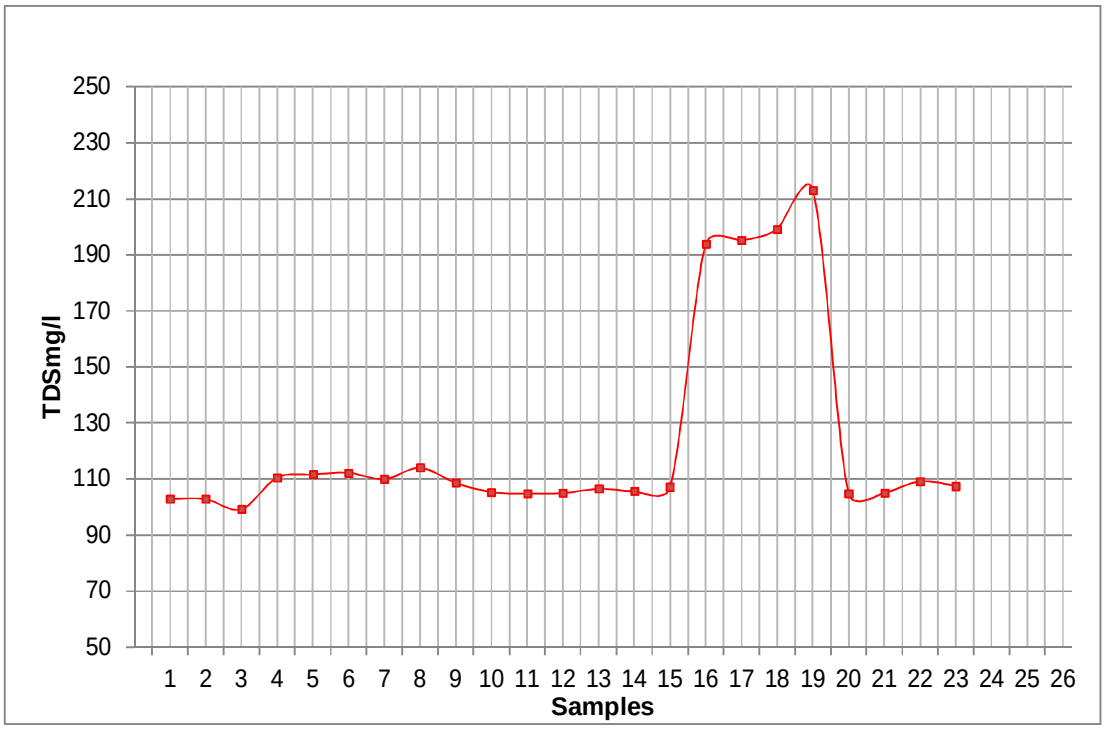


Fig.6D ii) TDS (mg/l) Vs Samples of KMC Supply Drinking Water

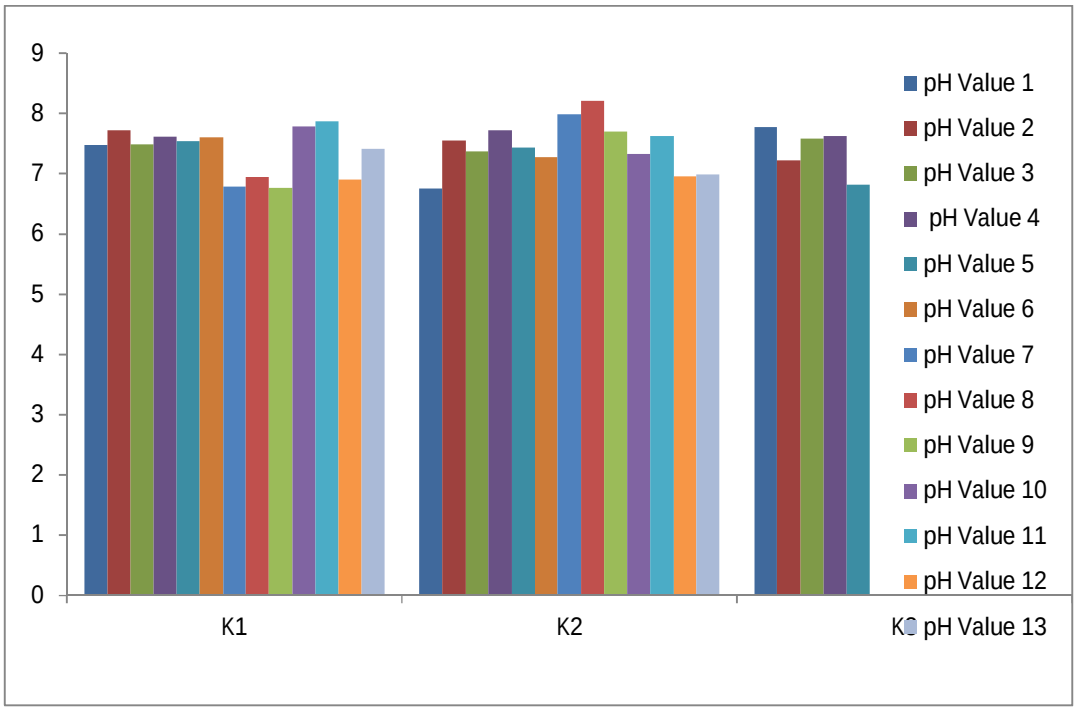


Fig.6.2.2(i) Determined pH Value of KMC Supply Drinking Water

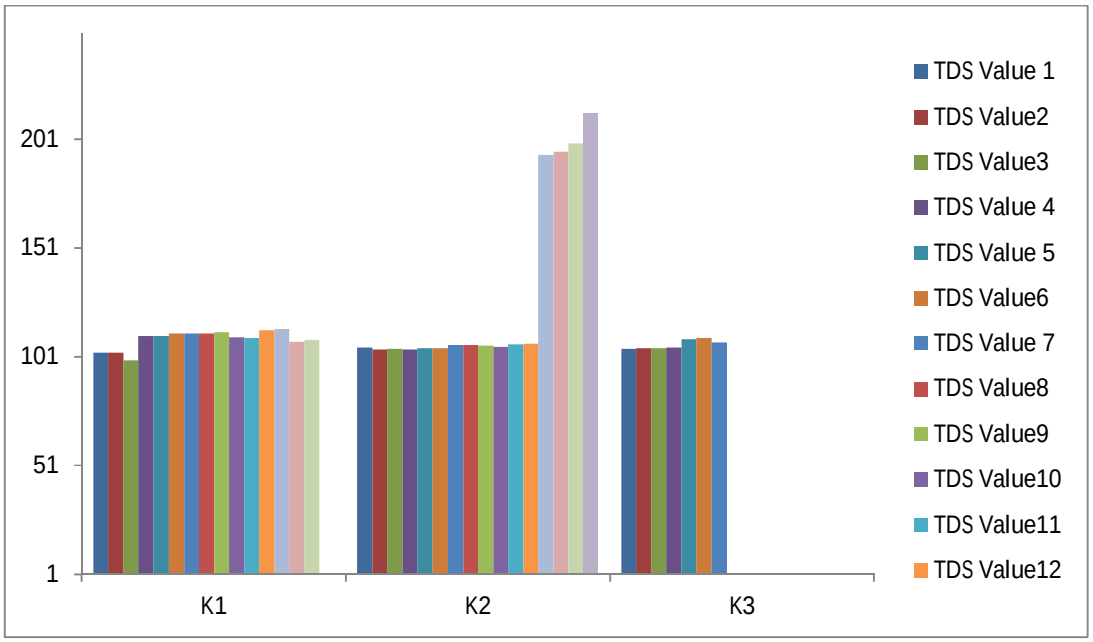


Fig.6.2.2(ii) Determined TDS Value of KMC Supply Drinking Water

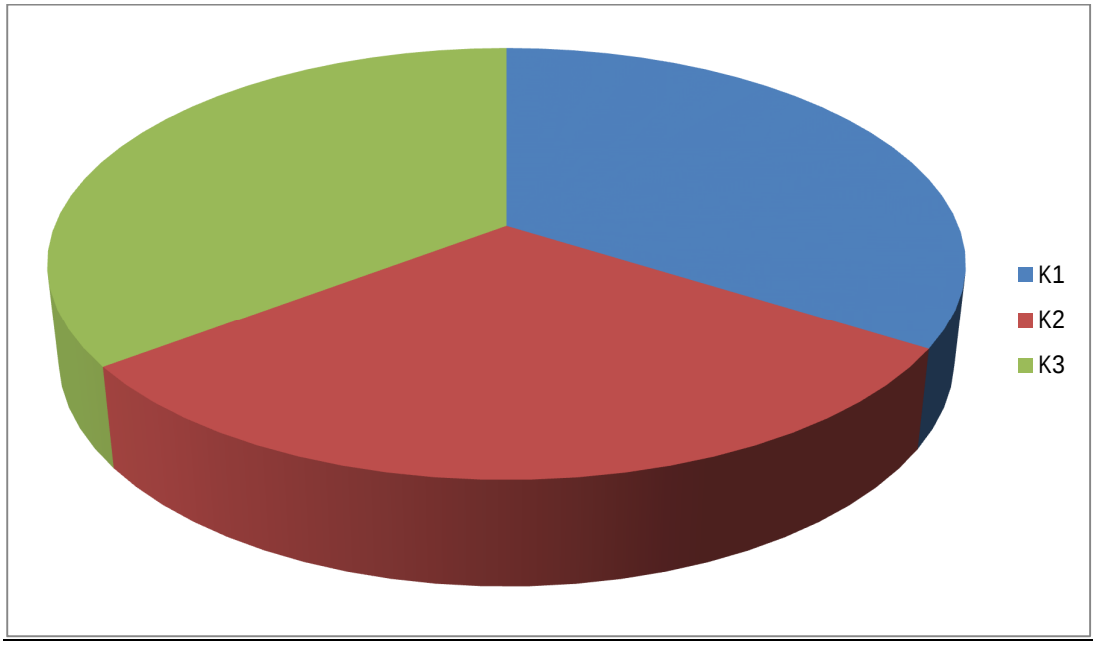


Fig.6.2.2(iii) Determined pH Value of KMC Supply Drinking Water

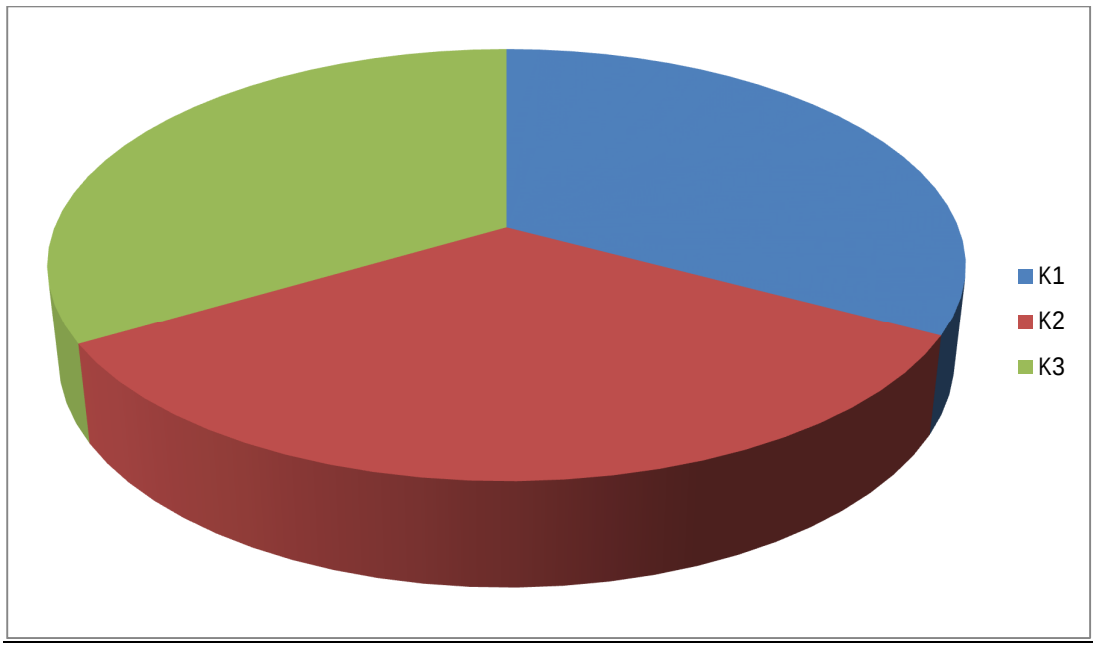


Fig.6.2.2(iv) Determined TDS Value of KMC Supply Drinking Water

6.2.3 Water Using By Individual Purifier :-

Parameter Tested		1		2	3
		Coliform Bacteria (MPN)		pH	TDS (mg/l)
Method of test		By H_2S Strip	IS 1622-1996	3025-1984 (Part-16)	3025-1984 (Part-16)
Accepted Limit as per IS : 10500 : 2012 *		Shall not be detectable in any 100 ml sample		6.5 – 8.5	500
Accepted Limit as per IS : 14543 : 2004 #		Shall be absent in any 250 ml sample		6.5 – 8.5	500
Accepted Limit as per I WHO Standard-2011		Shall be absent in any 100 ml sample		6.5 – 8.5	600
Accepted Limit as per CANADA Drinking Water Guideline-Aug. 2010		Shall be absent in any 100 ml sample		7 – 10.5	≤ 500
Accepted Limit as per US EPA-2010		Not more than 5% of monthly samples valid		6.5 – 8.5	500
Sample No.	Name of Collected Source and Type of Source				
I-1 (i)	**Purba Abasan,FA-Block Residential Complex opposite to GST Bhawan (Residential)**	Ab	<2	7.36	46.2
I-1 (ii)	-DO-	Ab	<2	7.70	46.3
I-1 (iii)	-DO-	Ab	<2	7.06	42.5
I-1 (iv)	-DO-	Ab	<2	8.37	47.2
I-1 (v)	-DO-	Ab	<2	7.23	48.0
I-1 (vi)	-DO-	Ab	<2	7.02	51.7
I-1 (vii)	-DO-	Ab	<2	7.09	51.9
I-1 (viii)	-DO-	Ab	<2	7.77	41.8
I-1 (ix)	-DO-	Ab	<2	7.80	42.2
I-2 (i)	**Avisar Shopping Mall, Opposite to Avishikta**	Ab	<2	7.37	1610

	Residential Complex (Commertial)				
I-2 (ii)	-DO-	Ab	<2	7.47	1615
I-2 (iii)	-DO-	Ab	<2	7.28	1628
I-2 (iv)	-DO-	Ab	<2	7.25	1621
I-2 (v)	-DO-	Ab	<2	7.45	1610
I-2 (vi)	-DO-	Ab	<2	7.28	1620
I-2 (vii)	-DO-	Ab	<2	7.56	1474
I-2 (viii)	-DO-	Ab	<2	7.79	1438
I-2 (ix)	-DO-	Ab	<2	7.33	1476
I-2 (x)	-DO-	Ab	<2	-	1481
I-2 (xi)	-DO-	Ab	<2	-	1457
I-2 (xii)	-DO-	Ab	<2	-	1426
I-3 (i)	**Institute of Nursing School of Ruby Hospital (Institutional)**	Ab	<2	6.83	1102
I-3 (ii)	-DO-	Ab	<2	7.54	1110
I-3 (iii)	-DO-	Ab	<2	6.79	1029
I-3 (i)	**Bijaygarh College, Beside Golf Green (Institutional)**	Ab	<2	7.61	221
I-3 (ii)	-DO-	Ab	<2	7.53	220
I-3 (iii)	-DO-	Ab	<2	7.84	221
I-3 (iv)	-DO-	Ab	<2	7.61	-
I-3 (i)	**West Bengal State Centre , Gokhale Rd.(Institutional)**	Ab	<2	7.02	689
I-3 (ii)	-DO-	Ab	<2	7.22	715
I-3 (i)	**Metrological Dept. J.U (Institutional)**	Ab	<2	7.06	1667
I-3 (ii)	-DO-	Ab	<2	7.22	1715
I-4 (i)	**Administrative Office of Sonarpur ISPAT Hospital (Official)**	Ab	<2	7.31	8.05
I-4 (ii)	-DO-	Ab	<2	7.37	8.11
I-4 (iii)	-DO-	Ab	<2	6.97	11.93
I-4 (iv)	-DO-	Ab	<2	6.26	10.11
I-4 (v)	-DO-	Ab	<2	6.59	10.15
I-4 (vi)	-DO-	Ab	<2	7.18	9.77

I-4 (vii)	-DO-	Ab	<2	7.27	9.91
I-4 (i)	**Diagnostic Centre at Sonarpur Station Rd. (Official)**	Ab	<2	7.32	625
I-4 (ii)	-DO-	Ab	<2	7.34	626
I-4 (iii)	-DO-	Ab	<2	7.49	618
I-4 (iv)	-DO-	Ab	<2	7.64	619
I-4 (i)	**The Institution of Engineers (INDIA),Gokhale Rd,Kol-20 (Official)**	Ab	<2	6.68	43.1
I-4 (ii)	-DO-	Ab	<2	6.98	46.1

3.TYPICAL CALCULATION OF WATER QUALITY INDEX (WQI) OF WATER USING BY INDIVIDUAL PURIFIER:-

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Individual Purifier – Purba Abasan,FA-Block,Residencial Complex Opposite to GST Bhabon							
I-1 (Residential)	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.49	115.23	35.49
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	46.42	9.284	2.86
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**38.35**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Individual Purifier – Avisar Shopping Mall Opposite to Avishikta Residential Complex.							
I-2 (Commertal)	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.42	114.15	35.16
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	1538	307.6	94.74
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**129.90**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi . q_i)$
Water Using By Individual Purifier – Institute of Nursing, Ruby Hospital							
I- 3 (Institutional	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.05	108.46	33.41
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	1080.33	216.07	66.55
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**99.96**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi . q_i)$
Water Using By Individual Purifier –Administrative Office of Sonarpur ISPAT Hospital, Sonarpur							
I- 4 (Official)	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	6.99	107.54	33.12
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	9.72	1.94	0.599
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**33.72**

TABLE6.2. 3(a)- : WATER QUALITY INDEX OF WATER USING BY INDIVIDUAL PURIFIER

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
I-1	Purba Abasan,(FA-Block),Residential Complex opposite to GST Bhabon	38.35	Excellent	All samples collected from this zone are R.O purifiers water and Excellent category for drinking

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
I-2	Avisar Shopping Mall opposite to Avishikta Residential Complex	129.90	Poor	All samples collected from this zone are Normal Stand alone filtered water and poor category for drinking

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
I-3	Institute of Nursing,Ruby Hospital	99.96	Fair	All RO purifier water are of Excellent category for drinking and Normal Stand alone filtered water are Fair Category or Poor category depending on collected raw water characteristics of different zones.
I-3	Bijaygarh college, Beside Golf Green,Jadavpur	49.84	Excellent	
I-3	West Bengal State Centre,Gokhale Rd.	76.98	Fair	
I-3	Metrological Dept., J.U	137.995	Poor	

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
I-4	Administrative Office of Sonarpur ISPAT Hospital, Sonarpur	33.72	Excellent	All RO purifier water are of Excellent category for drinking and Normal Stand alone filtered water are Good Category depending on collected raw water characteristics of different zones.
I-4	Diagnostic centre at Sonarpur Station Rd.	73.62	Good	
I-4	The Institution Of Engineers(INDIA), Gokhale Rd. Kol-20	35.11	Excellent	
	Avg.(WQI	**75**		

TABLE 6.2.3(b)- : STATISTICAL DESCRIPTION OF WATER USING BY INDIVIDUAL PURIFIER

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
I-1	Purba Abasan,FA-Block,Residential Complex opposite to GST Bhabon	pH(9),TDS(9)	7.49(±0.45)	46.42(±3.8)

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
I-2	Avisar Shopping Mall opposite to Avishikta Residential Complex	pH(8),TDS(12)	7.42(±0.17)	1538(±84.4)

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value in ppm with standard deviation(σ)
I-3 (i)	Institute of Nursing,Ruby Hospital	pH(3),TDS(3)	7.05 (± 0.42)	1080.33(±44.6)
I-3(ii)	Bijaygarh college, Beside Golf Green,Jadavpur	pH(4),TDS(3)	7.65(0±.13)	220.67(±0.58)
I3(iii)	West Bengal State Centre,Gokhale Rd.	pH(2),TDS(2)	7.12(±0.14)	702(±18.4)
I3(iv)	Metrological Dept., J.U	pH(2),TDS(2)	7.14(±0.11)	1691(±33.9)
Sample No.	**Name of Collected Source**	**No. of Samples(N)**	**Mean pH value with standard deviation(σ)**	**Mean TDS value with standard deviation(σ)**
I-4(i)	Administrative Office of Sonarpur ISPAT Hospital, Sonarpur	pH(7),TDS(7)	6.99(±0.42)	9.72(±1.3)
I-4(ii)	Diagnostic centre at Sonarpur Station Rd.	pH(4),TDS(4)	7.45(±0.15)	622(± 4.1)
I-4(iii)	The Institution Of Engineers(INDIA), Gokhale Rd. Kol-20	pH(2),TDS(2)	6.83(±0.21)	44.6(±2.12)

IDENTIFICATION O F SAMPLE:-

TABLE 6.2.3(c)- : WATER USING BY INDIVIDUAL PURIFIER :-

Sample No.	Name of Collected Source
I-1	Purba Abasan,FA-Block,Residential Complex opposite to GST Bhabon

Sample No.	Name of Collected Source
I-2	Avisar Shopping Mall opposite to Avishikta Residential Complex

Sample No.	Name of Collected Source
I-3(i)	Institute of Nursing,Ruby Hospital
I-3(ii)	Bijaygarh college, Beside Golf Green,Jadavpur
I-3(iii)	West Bengal State Centre,Gokhale Rd.
I-3(iv)	Metrological Dept., J.U
Sample No.	**Name of Collected Source**
I-4(i)	Administrative Office of Sonarpur ISPAT Hospital, Sonarpur
I-4(ii)	Diagnostic centre at Sonarpur Station Rd.
I-4(iii)	The Institution Of Engineers(INDIA), Gokhale Rd. Kol-20

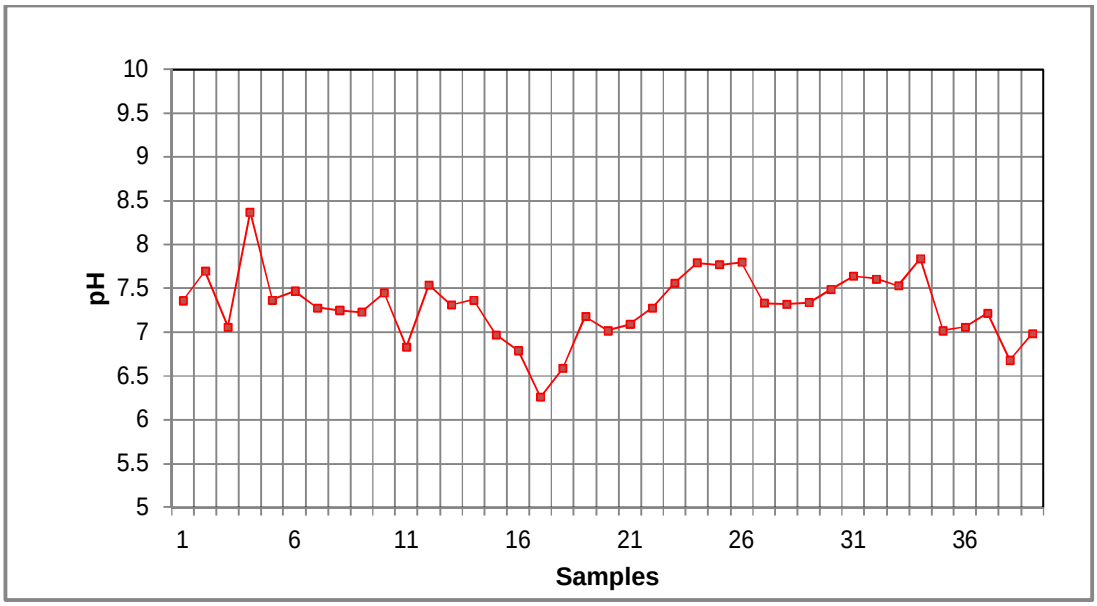


Fig.6E i) pH Value Vs Samples of Water Using Individual Purifier

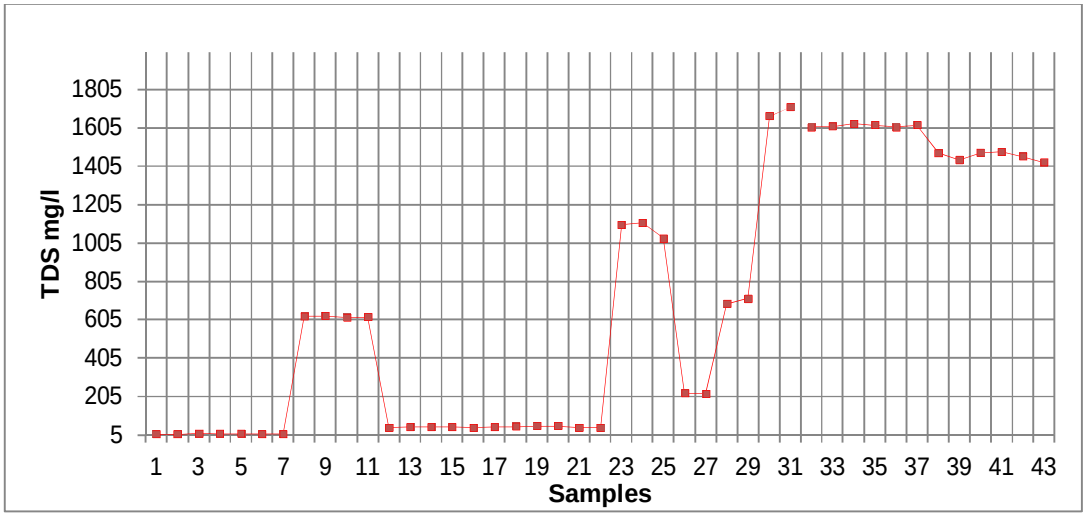


Fig. 6E ii) TDS (mg/l) Vs Samples of Water Using Individual Purifier

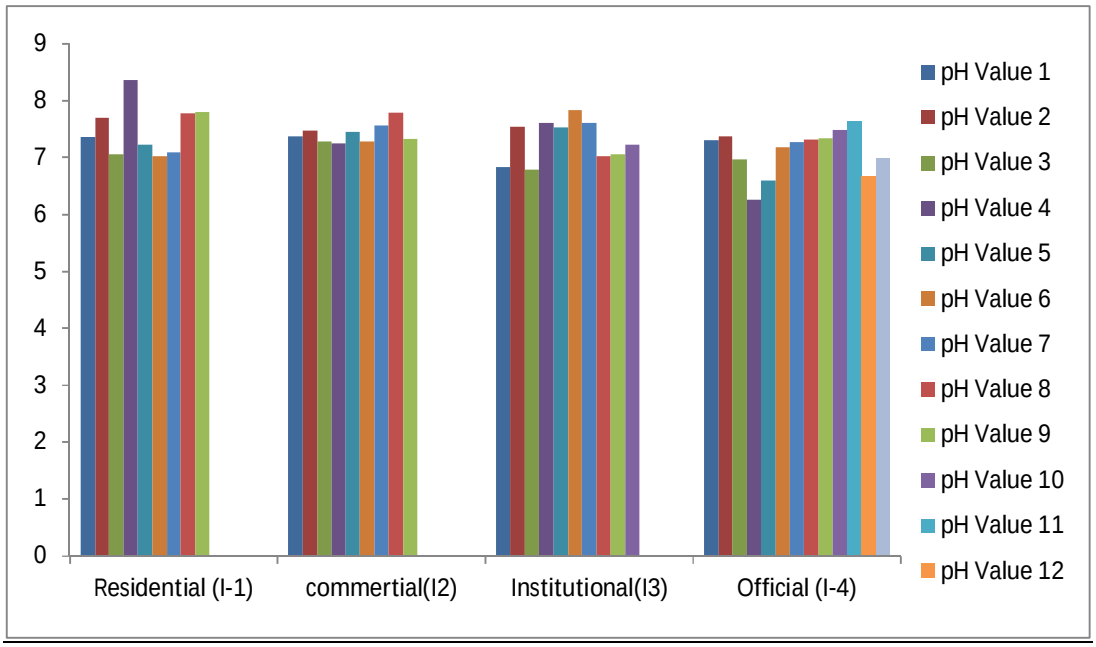


Fig.6.2.3(i) Determined pH Value of Water Using Individual Purifier

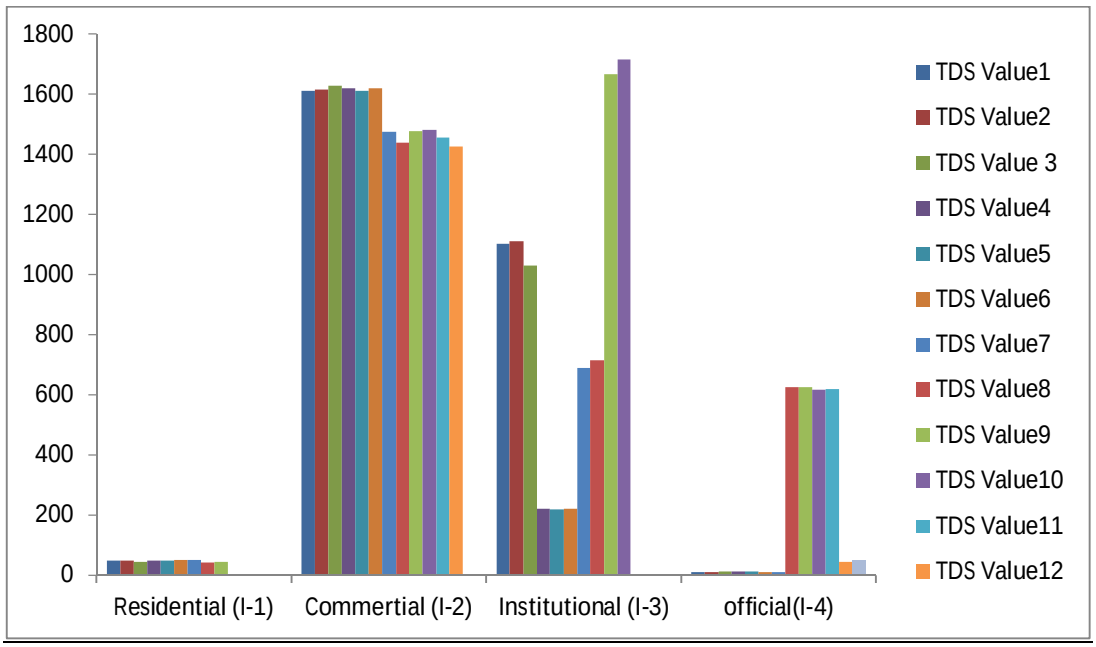


Fig.6.2.3(ii) Determined TDS Value of Water Using Individual Purifier

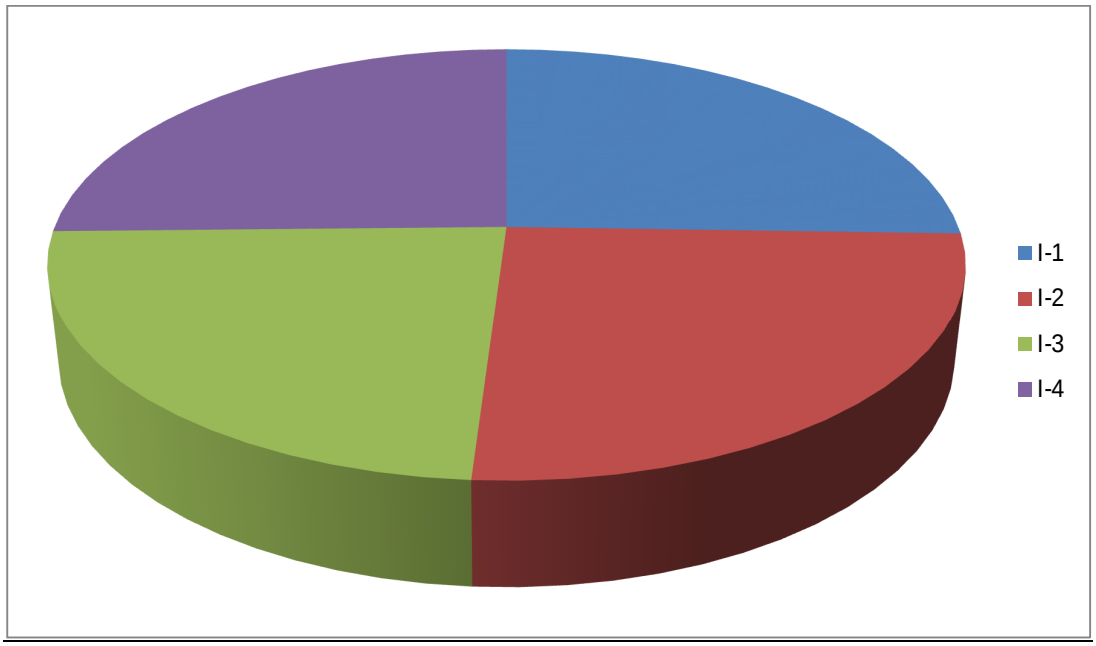


Fig.6.2.3(iii) Determined pH Value of Water Using Individual Purifier

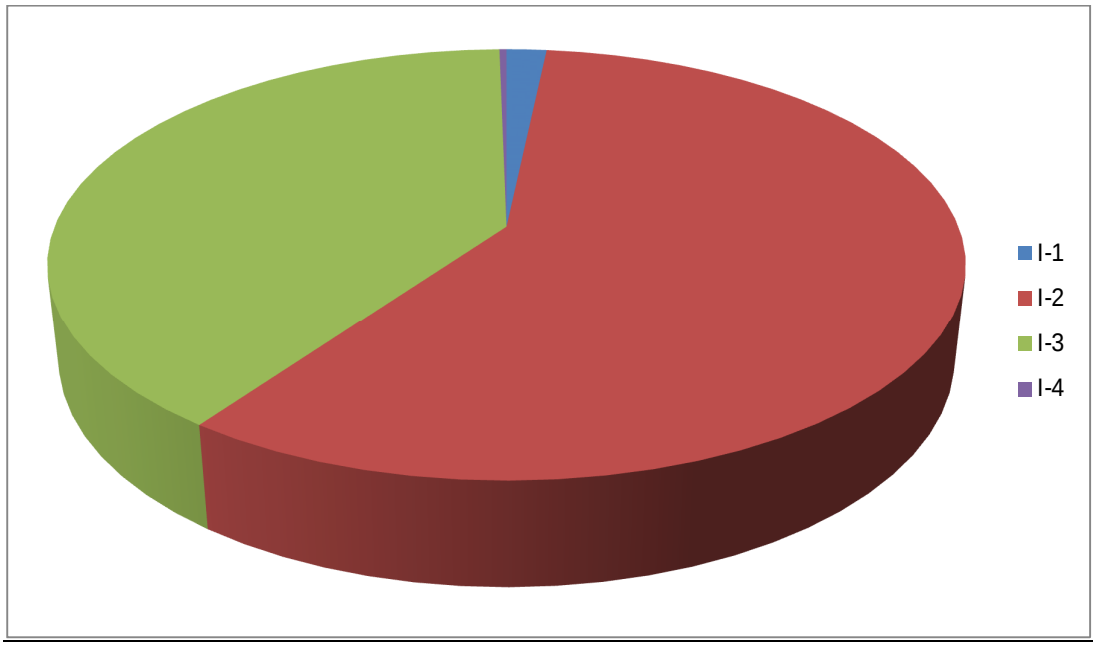


Fig.6.2.3(iv) Determined TDS Value of Water Using Individual Purifier

6.2.4. Water Using By Street Foot Vendors :-

Parameter Tested		1		2	3
		Coliform Bacteria (MPN)		pH	TDS (mg/l)
Method of test		By H_2S Strip	IS 1622-1996	3025-1984 (Part-16)	3025-1984 (Part-16)
Accepted Limit as per IS : 10500 : 2012 *		Shall not be detectable in any 100 ml sample		6.5 – 8.5	500
Accepted Limit as per IS : 14543 : 2004 #		Shall be absent in any 250 ml sample		6.5 – 8.5	500
Accepted Limit as per l WHO Standard-2011		Shall be absent in any 100 ml sample		6.5 – 8.5	600
Accepted Limit as per CANADA Drinking Water Guideline-Aug. 2010		Shall be absent in any 100 ml sample		7 – 10.5	≤ 500
Accepted Limit as per US EPA-2010		Not more than 5% of monthly samples valid		6.5 – 8.5	500
Sample No.	Name of Collected Source and Type of Water				
V 1 (i)	**Tea Shop at Kalikapur Rd.,((KMC Supply**)	Ab	<2	7.26	102.8
V 1 (ii)	-DO-	Ab	<2	7.42	-
V 1 @ (i)	**Tea Shop at 1. No. Gate J.U (KMC Supply**)	Ab	<2	7.34	105.4
V 1 @ (ii)	-DO-	Ab	<2	7.40	-
V 2 (i)	**Momo Shop At 8 B bus stand (KMC Supply)**	Ab	<2	7.22	80.6

V 2 (ii)	-DO-	Ab	<2	7.39	-
V 2 @ (I)	**Tea Shop near By Ruby more (KMC Supply)**	Ab	<2	7.60	114.0
V 2 @ (ii)	-DO-	Ab	<2	7.61	-
V 3 (i)	**Tea Shop Madhyamgram Chowmatha Junction (Tubewell Water)**	Ab	<2	7.37	335
V 3 (ii)	-DO-	Ab	<2	7.43	336
V 3(iii)	-DO-	Ab	<2	6.78	328
V 3 (iv)	-DO-	Ab	<2	-	-
V 4 (i)	**Chowmin shop Near by Rajarhat CC2 (KMC Supply**)	Ab	<2	7.02	99.8
V 4 (ii)	-DO-	Ab	<2	7.56	100.0
V 4 (iii)	-DO-	Ab	<2	7.53	99.8
V 4 (iv)	-DO-	Ab	<2	-	99.9
V 5 (i)	**Street Vendors at Singur Hoogly (Packaged Water**)	Ab	<2	6.68	16.70
V 5 (ii)	-DO-	Ab	<2	6.78	17.01
V 5 (iii)	-DO-	Ab	<2	7.39	16.71
V 5 (iv)	-DO-	Ab	<2	-	16.78
		Ab	<2		

4 .TYPICAL CALCULATION OF WATER QUALITY INDEX (WQI) OF WATER USING BY STREET FOOT VENDORS :-

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Street Foot Vendors—Momo Shop at 8B Bus Stand , Jadavpur							
V 2	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.31	112.46	34.64
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	80.6	16.12	4.96
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**39.60**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Street Foot Vendors—Tea Shop at Madhyamgram Chowmatha Junction, North 24 Parganas.							
V 3	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.19	110.62	34.07
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	333	66.6	20.51
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**54.58**

TABLE 6.2. 4(a)- : WATER QUALITY INDEX OF WATER USING BY STREET FOOT VENDORS :-

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
V 1	Tea Shop at Kalikapur Rd.,((KMC Supply)	41.11	Excellent	All samples using Street vendors collected from KMC Supply are of Excellent category for drinking and other samples collected from Tubewell are Good Category.
V 1 @	Tea Shop at 1. No. Gate J.U (KMC Supply)	41.41	Excellent	
V 2	Momo Shop At 8 B bus stand (KMC Supply)	39.60	Excellent	
V 2 @	Tea Shop near By Ruby more (KMC Supply)	43.08	Excellent	
V 3	Tea Shop Madhyamgram Chowmatha Junction (Tubewell Water)	54.58	Good	
V 4	Chowmin shop Near by Rajarhat CC2 (KMC Supply)	41.07	Excellent	
V 5	Street Vendors At Singur Hoogly (Packaged Water)	33.96	Excellent	
	Avg.(WQI)	**42**		

TABLE 6.2. 4(b)- : STATISTICAL DESCRIPTION OF WATER USING BY STREET FOOT VENDORS :-

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
V 1	Tea Shop at Kalikapur Rd.,((KMC Supply)	pH(2),TDS(2)	7.34(±0.11)	102.8(-)
V 1 @	Tea Shop at 1. No. Gate J.U (KMC Supply)	pH(2),TDS(2)	7.37(±0.04)	105.4(-)
V 2	Momo Shop At 8 B bus stand (KMC Supply)	pH(2),TDS(2)	7.31(±0.12)	80.6(-)
V 2 @	Tea Shop near By Ruby more (KMC Supply)	pH(2),TDS(2)	7.61(±0.01)	114(-)
V 3	Tea Shop Madhyamgram Chowmatha Junction (Tubewell Water)	pH(3),TDS(3)	7.19(±0.36)	333(±4.36)
V 4	Chowmin shop Near by Rajarhat CC2 (KMC Supply)	pH(3),TDS(4)	7.37(±0.30)	99.875(±0.096)
V 5	Street Vendors at Singur,Hoo Hoogly (Packaged Water)	pH(3),TDS(4	6.95(±0.38)	16.80(±0.14)

IDENTIFICATION O F SAMPLE:-

TABLE 6.2. 4(c)- : WATER USING BY STREET FOOT VENDORS :-

Sample No.	Name of Collected Source
V 1	Tea Shop at Kalikapur Rd.,((KMC Supply)
V 1 @	Tea Shop at 1. No. Gate J.U (KMC Supply)
V 2	Momo Shop At 8 B bus stand (KMC Supply)
V 2 @	Tea Shop near By Ruby more (KMC Supply)
V 3	Tea Shop Madhyamgram Chowmatha Junction (Tubewell Water)
V 4	Chowmin shop Near by Rajarhat CC2 (KMC Supply)
V 5	Street Vendors at Singur Hoogly (Packaged Water)

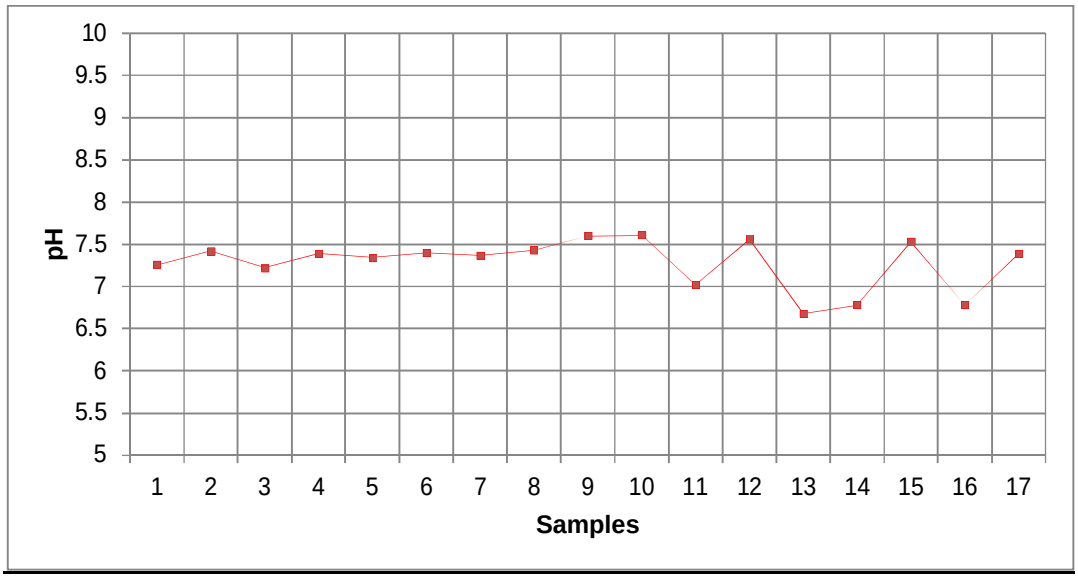


Fig. 6F i) pH Value Vs Samples of Water Using Street foot Vendors

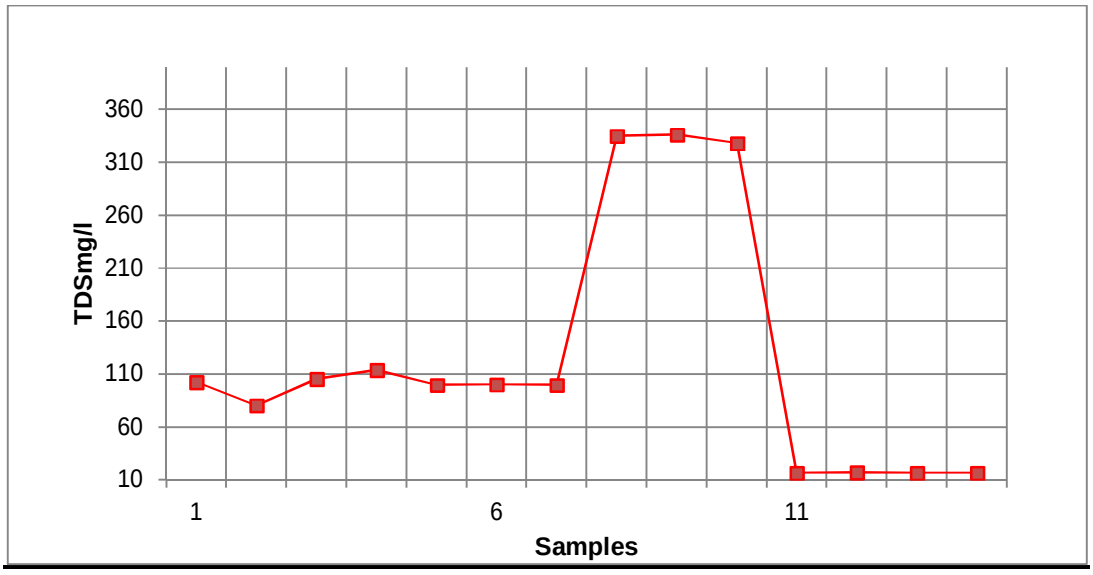


Fig. 6F ii) TDS (mg/l) Vs Samples of Water Using street Foot Vendors

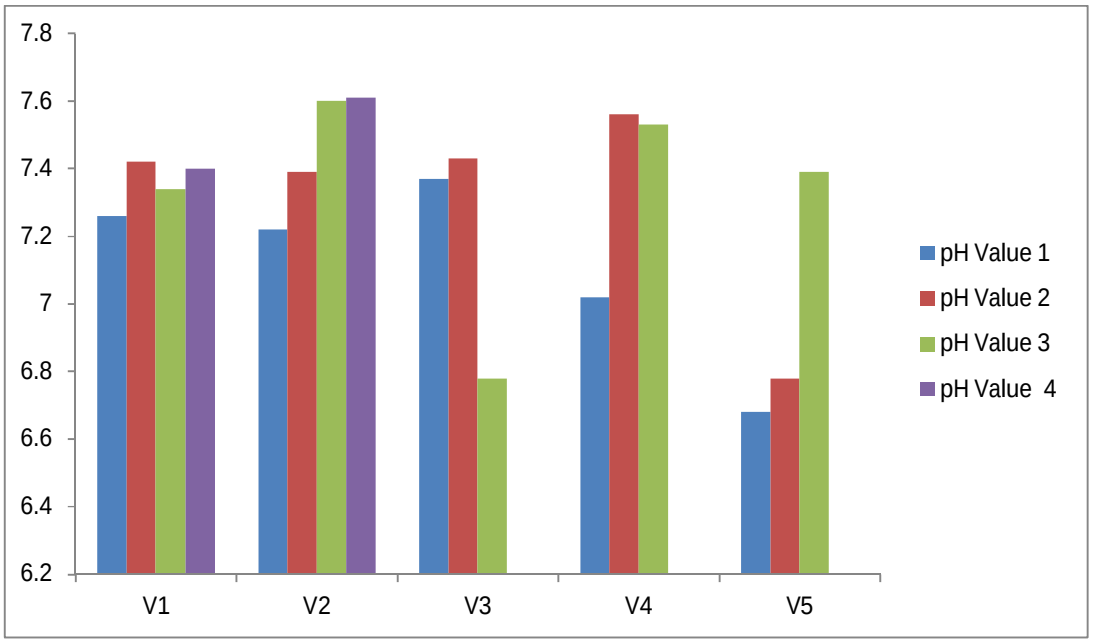


Fig.6.2.4(i) Determined pH Value of Water Using Street foot Vendors

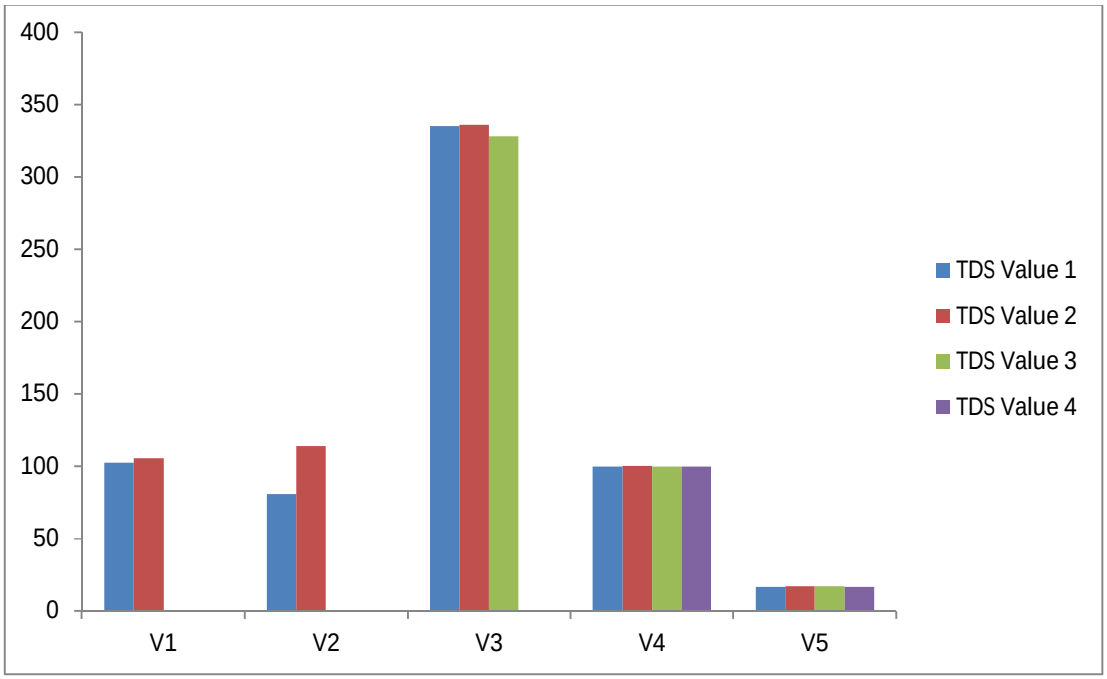


Fig.6.2.4(ii) Determined TDS Value of Water Using Street Foot vendors

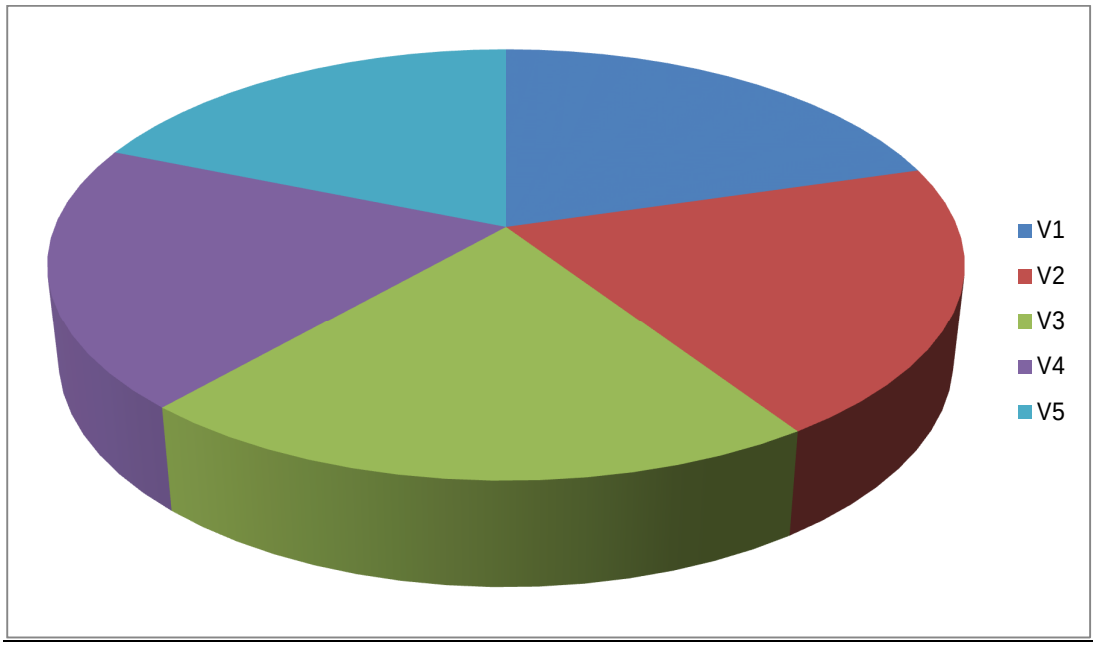


Fig.6.2.4(iii) Determined pH Value of Water Using Street Foot vendors

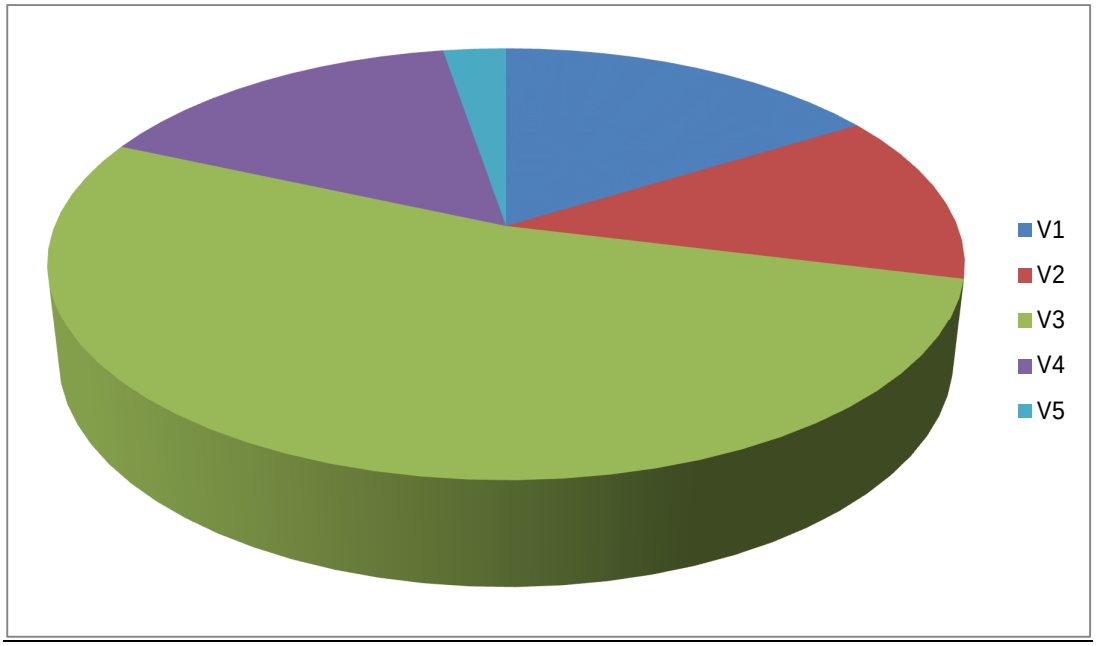


Fig.6.2.4(iv) Determined TDS Value of Water Using Street Foot vendors

6.2.5 Water using,Treatement Plant Installed By Residential and commertial Complex :-

Parameter Tested		1		2	3
		Coliform Bacteria (MPN)		pH	TDS (mg/l)
Method of test		By H_2S Strip	IS 1622-1996	3025-1984 (Part-16)	3025-1984 (Part-16)
Accepted Limit as per IS : 10500 : 2012 *		Shall not be detectable in any 100 ml sample		6.5 – 8.5	500
Accepted Limit as per IS : 14543 : 2004 #		Shall be absent in any 250 ml sample		6.5 – 8.5	500
Accepted Limit as per l WHO Standard-2011		Shall be absent in any 100 ml sample		6.5 – 8.5	600
Accepted Limit as per CANADA Drinking Water Guideline-Aug. 2010		Shall be absent in any 100 ml sample		7 – 10.5	≤ 500
Accepted Limit as per US EPA-2010		Not more than 5% of monthly samples valid		6.5 – 8.5	500
Sample No.	Name and Type of Collected Source				
S1 (i)	**Shopping Mall CC2 at Rajarhat (Commertial Complex)**	Ab	<2	7.85	103.2
S1 (ii)	-DO-	Ab	<2	8.14	103.8
S1 (iii)	-DO-	Ab	<2	7.95	103.0
S 2(i)	**Accropolis Mall at Rajdanga Main Rd.(Commertial Complex)**	Ab	<2	7.31	110.9
S 2(ii)	-DO-	Ab	<2	7.58	109.9
S 2(iii)	-DO-	Ab	<2	7.70	110.2

S 3 (i)	**Wipro office Bldg. Sector(v),Saltlake .(Commertial Complex)**	Ab	<2	7.70	11.43
S 3 (ii)	-DO-	Ab	<2	7.09	11.21
S 3 (iii)	-DO-	Ab	<2	8.01	11.70
S 3 (iv)	-DO-	Ab	<2	8.16	11.78
S 3 (v)	-DO-	Ab	<2	6.25	23.7
S 4 (i)	**AMRI Hospital Mukundapur, .(Commertial Complex)**	Ab	<2	7.36	57.3
S 4 (ii)	-DO-	Ab	<2	7.57	57.8
S 4 (iii)	-DO-	Ab	<2	7.03	124.6
S 4 (iv)	-DO-	Ab	<2	7.43	126.0
S 4 (v)	-DO-	Ab	<2	-	129.8
S 4 (vi)	-DO-	Ab	<2	-	136.6
S 5 (i)	**Highland Park Residence, Patuli,(Residential Complex)**	Ab	<2	7.20	68.0
S 5 (ii)	-DO-	Ab	<2	7.15	70.8
S 6 (i)	**CENTRAL Shopping Mall ,New Town,(Commertial Complex)**	Ab	<2	7.13	71.4
S 6 (ii)	-DO-	Ab	<2	7.25	75.4
		Ab	<2		
		Ab	<2		

5 .TYPICAL CALCULATION OF WATER QUALITY INDEX (WQI) OF WATER USING,TREATEMENT PLANT INSTALLED BY RESIDENTIAL AND COMMERTIAL COMPLEX :-

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Treatement Plant Installed By Residential and Commertial Complex—WIPRO Office Bldg.,Sector-v, Salt Lake.							
S 3	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.44	114.46	35.25
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	13.96	2.79	0.859
		Total	**13**	**1.000**	**Water Quality Index (WQI)**		**36.11**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Treatement Plant Installed By Residential and Commertial Complex—Highland Park Residential complex , Patuli.							
S 5	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.18	110.46	34.02
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	69.4	13.88	4.28
		Total	**13**	**1.000**	**Water Quality Index (WQI)**		**38.3**

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Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Water Using By Treatement Plant Installed By Residential and Commertial Complex—CENTRAL Shopping Mall, New Town, Kolkata.							
S 6	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.19	110.62	34.07
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	73.4	14.68	4.52
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**38.59**

TABLE 6.2.5(a)- : WATER QUALITY INDEX OF WATER USING BY TREATEMENT PLANT INSTALLED BY RESIDENTIAL AND COMMERTIAL COMPLEX:-

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
S1	Shopping Mall CC2 at Rajarhat (Commertial Complex)	44.18	Excellent	
S2	Accropolis Mall at Rajdanga Main Rd.(Commertial Complex)	42.48	Excellent	All samples collected from different Residential and Commertial Complex (where treatement plant itself)the processed water are of Excellent category for drinking.
S3	Wipro office Bldg. Sector(v),Saltlake .(Commertial Complex)	36.11	Excellent	
S4	AMRI Hospital Mukundapur, .(Commertial Complex)	41.32	Excellent	
S5	Highland Park Residence, Patuli,(Residential Complex)	38.295	Excellent	
S6	CENTRAL Shopping Mall ,New Town,(Commertial Complex)	38.59	Excellent	
	Avg.(WQI)	**40**		

TABLE 6.2.5(b)- :STATISTICAL DESCRIPTION OF WATER USING, TREATEMENT PLANT INSTALLED BY RESIDENTIAL AND COMMERTIALCOMPLEX

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
S 1	Shopping Mall CC2 at Rajarhat (Commertial Complex)	pH(3),TDS(3)	7.98(±0.15)	103.33(±0.42)
S 2	Accropolis Mall at Rajdanga Main Rd.(Commertial Complex)	pH(3),TDS(3)	7.53(±0.19)	110.33(±0.51)
S 3	Wipro office Bldg. Sector(v),Saltlake .(Commertial Complex)	pH(5),TDS(5)	7.44(±0.78)	13.96(±5.45)
S 4	AMRI Hospital Mukundapur, .(Commertial Complex)	pH(4),TDS(6)	7.35(±0.23)	105.35(±37.3)
S 5	Highland Park Residence, Patuli,(Residential Complex)	pH(2),TDS(2)	7.18(±0.04)	69.4(±1.98)
S 6	CENTRAL Shopping Mall ,New Town,(Commertial Complex)	pH(2),TDS(2)	7.19(±0.08)	73.4(±2.83)

IDENTIFICATION O F SAMPLE:-

TABLE 6.2.5(c)- : WATER TREATEMENT PLANT INSTALLED BY RESIDENTIAL AND COMMERTIAL COMPLEX

Sample No.	Name of Collected Source
S1	Shopping Mall CC2 at Rajarhat (Commertial Complex)
S 2	Accropolis Mall at Rajdanga Main Rd.(Commertial Complex)
S 3	Wipro office Bldg. Sector(v),Saltlake .(Commertial Complex)
S 4	AMRI Hospital Mukundapur, .(Commertial Complex)
S 5	Highland Park Residence, Patuli,(Residential Complex)
S 6	CENTRAL Shopping Mall ,New Town,(Commertial Complex)

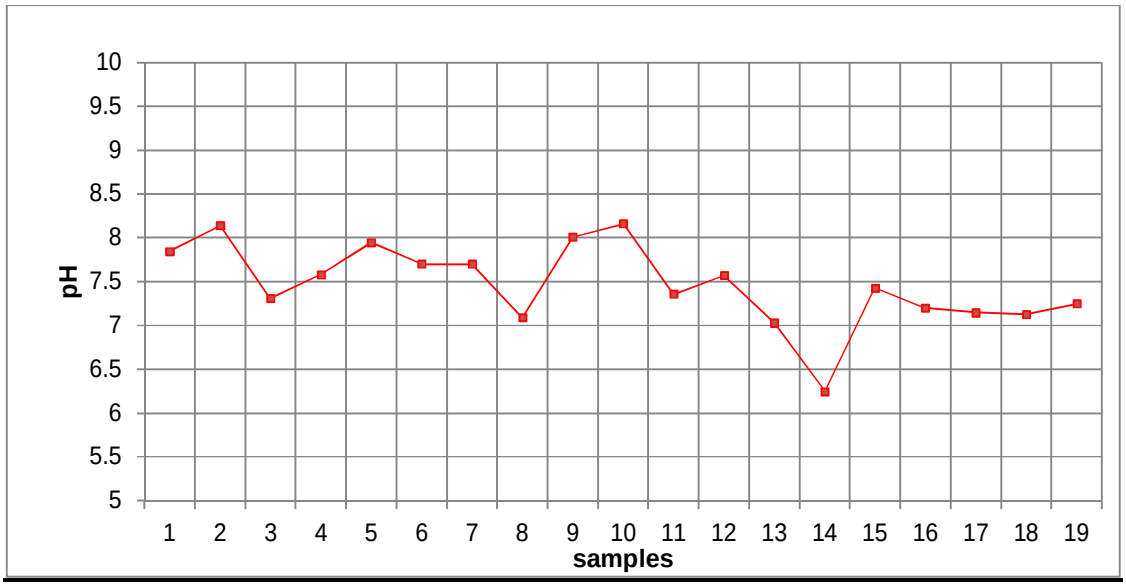


Fig.6G i) pH Value Vs Samples of Water Using Treatement Plant installed By Residential and Commertial Complex

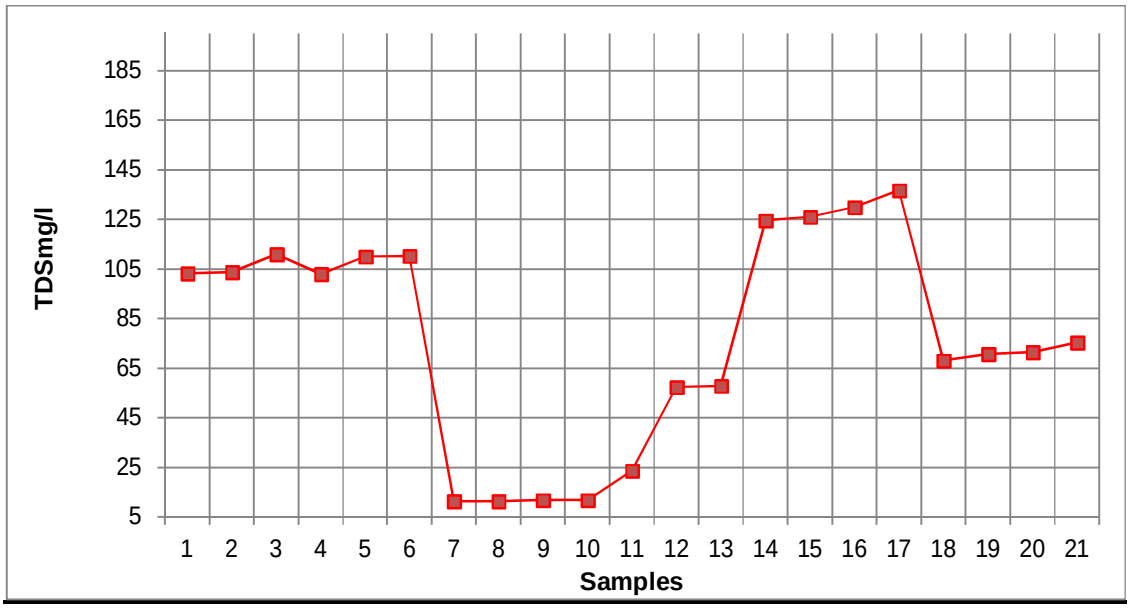


Fig. 6G ii) TDS (mg/l) Vs Samples of Water Using Treatement Plant installed By Residential and Commertial Complex

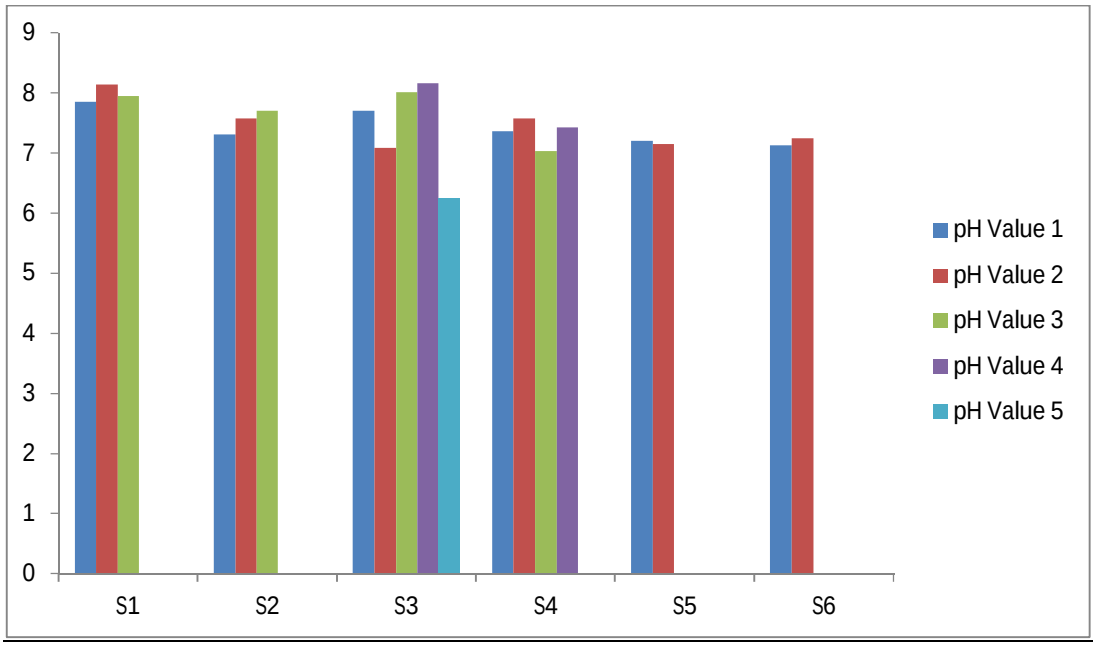


Fig.6.2.5(i) Determined pH Value of Water Using, Treatement Plant Installed By Residential and Commertial Complex

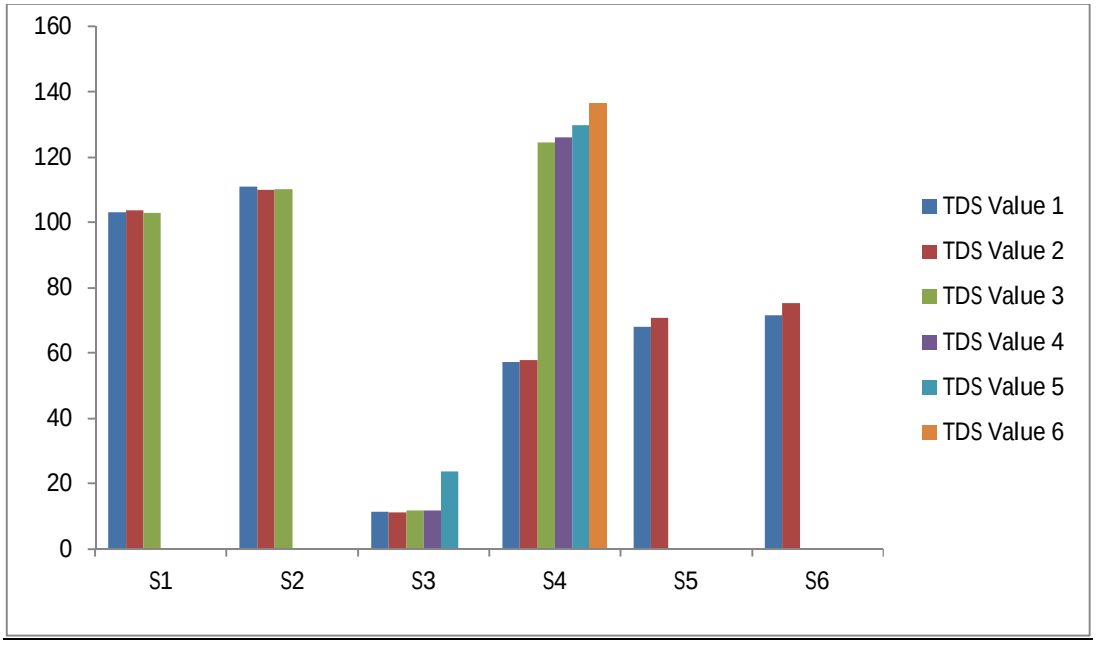


Fig.6.2.5(ii) Determined TDS Value of Water Using, Treatement Plant Installed By Residential and Commertial Complex

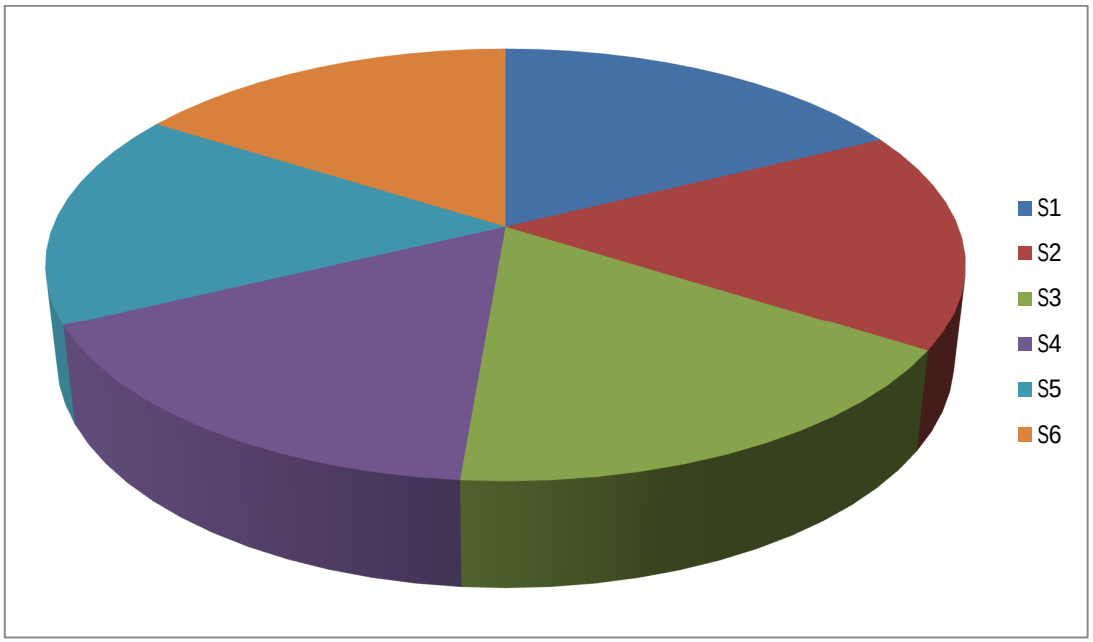


Fig.6.2.5(iii) Determined pH Value of Water Using, Treatement Plant Installed By Residential and Commertial Complex

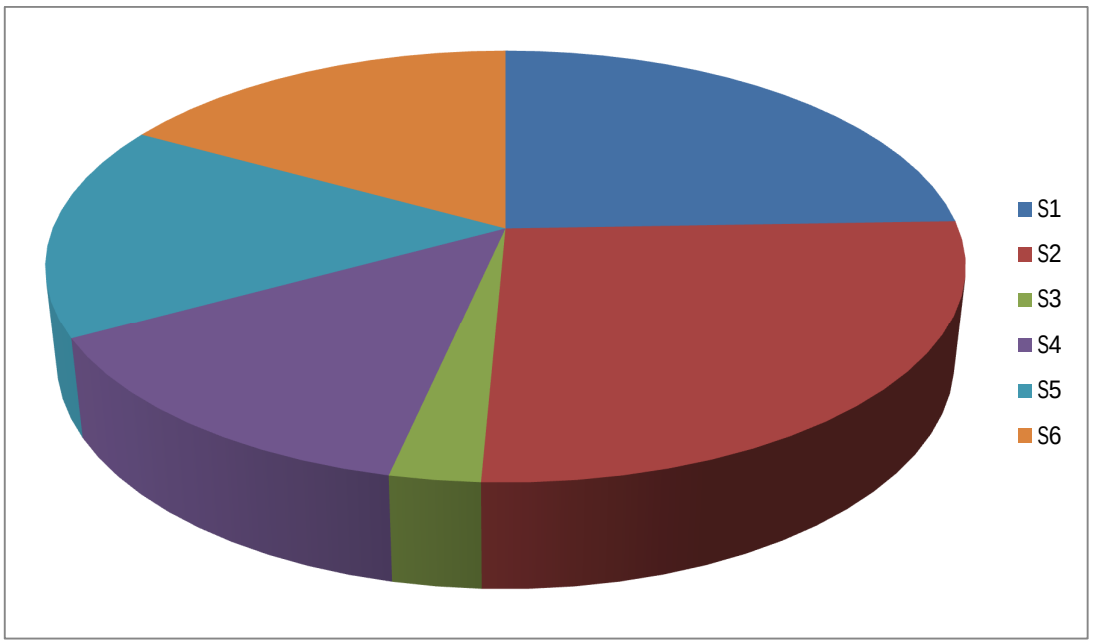


Fig.6.2.5(iv) Determined TDS Value of Water Using, Treatement Plant Installed By Residential and Commertial Complex

6.2.6.Tubewell Water:-

Parameter Tested		1		2	3
		Coliform Bacteria (MPN)		pH	TDS (mg/l)
Method of test		By H_2S Strip	IS 1622-1996	3025-1984 (Part-16)	3025-1984 (Part-16)
Accepted Limit as per IS : 10500 : 2012 *		Shall not be detectable in any 100 ml sample		6.5 – 8.5	500
Accepted Limit as per IS : 14543 : 2004 #		Shall be absent in any 250 ml sample		6.5 – 8.5	500
Accepted Limit as per I WHO Standard-2011		Shall be absent in any 100 ml sample		6.5 – 8.5	600
Accepted Limit as per CANADA Drinking Water Guideline-Aug. 2010		Shall be absent in any 100 ml sample		7 – 10.5	≤ 500
Accepted Limit as per US EPA-2010		Not more than 5% of monthly samples valid		6.5 – 8.5	500
Sample No.	Name of Collected Source				
T 1 (i)	**In front of Green patk Nursing Home, Mukundapur**	Ab	<2	7.12	1046
T 1 (ii)	-DO-	Ab	<2	7.13	1054
T 1 (iii)	-DO-	Ab	<2	7.00	1043
T 1 (iv)	-DO-	Ab	<2	7.81	-
T 2 (i)	**Bose pukur Water Tank**	Ab	<2	7.43	967
T 2(ii)	-DO-	Ab	<2	7.55	969
T 2 (iii)	-DO-	Ab	<2	7.30	943

T 2 (iv)	-DO-	Ab	<2	7.29	938
T 3 (i)	**Kheyadaha 2 No. Gram Panchayet, Sonarpur**	Ab	<2	7.14	1892
T 3 (ii)	-DO-	Ab	<2	7.20	1896
T 3 (iii)	-DO-	Ab	<2	7.10	-
T 3 (iv)	-DO-	Ab	<2	7.15	-
T 4 (i)	**Kolaghat, East Midnapur**	Ab	<2	7.52	412
T 4 (ii)	-DO-	Ab	<2	7.60	415
T 4 (iii)	-DO-	Ab	<2	7.45	-
T 4 (iv)	-DO-	Ab	<2	7.50	-
T 5 (i)	**Biarati Kali Mandir Premises,North -24 ,Pargana**	Ab	<2	7.06	450
T 5 (ii)	-DO-	Ab	<2	7.14	451
T 5 (iii)	-DO-	Ab	<2	7.28	448
T 5 (iv)	-DO-	Ab	<2	7.36	-
T 6 (i)	**Amta, Udaynarayanpur , Howrah**	Ab	<2	7.54	403
T 6 (ii)	-DO-	Ab	<2	7.60	404
T 6 (iii)	-DO-	Ab	<2	7.52	-
T 6 (iv)	-DO-	Ab	<2	7.65	-

6 .TYPICAL CALCULATION OF WATER QUALITY INDEX (WQI) OF TUBEWELL WATER :-

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Tubewell Water--In Front Of Green Park Nursing Home, Mukundapur							
T 1	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.265	111.85	34.42
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	1047.67	219.53	64.54
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**98.96**

Table : Relative weightage of physiochemical and biological parameters and Water Quality Index (WQI).

Sample No.	Parameter	Requirement as per Indian Standard (S_i)	Weight (w_i)	Relative weightage (W_i)	Observed Results (C_i)	Quality Rating Scale $q_i=(Ci/Si)x100$	Sub-Index $SI_i=(Wi.q_i)$
Tubewell Water—Kheyadaha 2 No. Gram Panchayet, Sonarpur							
T 3	Coliform (MPN/250 ml)	Absent	5	0.384	Absent	0.00	0.00
	pH	6.5-8.5	4	0.308	7.15	110.00	33.88
	Total Dissolved Solids (TDS) (mg/l)	500	4	0.308	1894	378.8	116.67
	Total		**13**	**1.000**	**Water Quality Index (WQI)**		**150.55**

TABLE 6.2. 6(a)- : WATER QUALITY INDEX OF TUBEWELL WATER

Sample No.	Name of Collected Source	Water Quality Index (WQI)	Type of water for Drinking	Remarks
T 1	In front of Green patk Nursing Home, Mukundapur	98.96	Fair	All samples collected from different zones of Kolkata and W.B are Fair, Poor and Good category depending on raw ground water characteristics of that areas.
T 2	Bose Pukur Water Tank	93.80	Fair	
T 3	Kheyadaha 2 No. Gram Panchayet, Sonarpur	150.55	Poor	
T 4	Kolaghat, East Midnapur	61.10	Good	
T 5	Biarati Kali Mandir Premises,North -24 ,Pargana	61.86	Good	
T 6	Amta, Udaynarayanpur, Howrah	60.78	Good	
	Avg.(WQI)	**88**		

TABLE 6.2. 6(b)- : STATISTICAL DESCRIPTION OF TUBEWELL WATER

Sample No.	Name of Collected Source	No. of Samples(N)	Mean pH value with standard deviation(σ)	Mean TDS value with standard deviation(σ)
T1	In front of Green patk Nursing Home, Mukundapur	pH(4),TDS(3)	7.27(±0.37)	1047.67(±5.69)
T2	Bose Pukur Water Tank	pH(4),TDS(4)	7.39(±0.12)	954.25(±16.03)
T3	Kheyadaha 2 No. Gram Panchayet, Sonarpur	pH(4),TDS(2)	7.15(±0. 04)	1894(±2.83)
T4	Kolaghat, East Midnapur	pH(4),TDS(2)	7.52(±0.06)	413.5(±2.12)
T5	Biarati Kali Mandir Premises,North -24 ,Pargana	pH(4),TDS(3)	7.21(±0.14)	449.67(±1.53)
T6	Amta, Udaynarayanpur, Howrah	pH(4),TDS(2)	7.58(±0.06)	403.5(±0.71)

IDENTIFICATION O F SAMPLE:-

TABLE 6.2.6(c) : TUBEWELL WATER

Sample No.	Name of Collected Source
T 1	In front of Green patk Nursing Home, Mukundapur
T 2	Bose Pukur Water Tank
T 3	Kheyadaha 2 No. Gram Panchayet, Sonarpur
T 4	Kolaghat, East Midnapur
T 5	Biarati Kali Mandir Premises,North -24 ,Pargana
T 6	Amta, Udaynarayanpur, Howrah

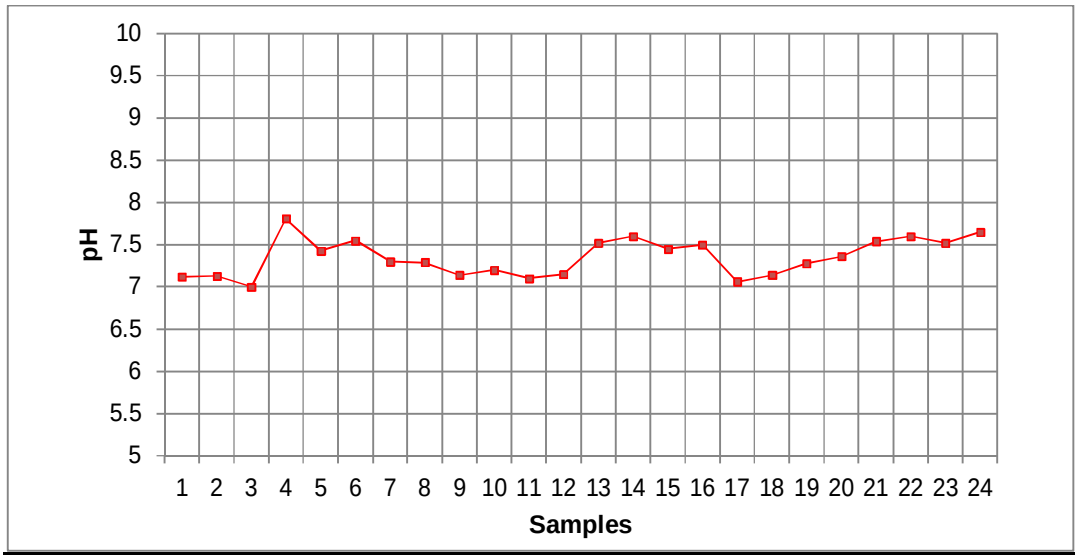


Fig 6H i) pH Value Vs Samples of Tubewell Water

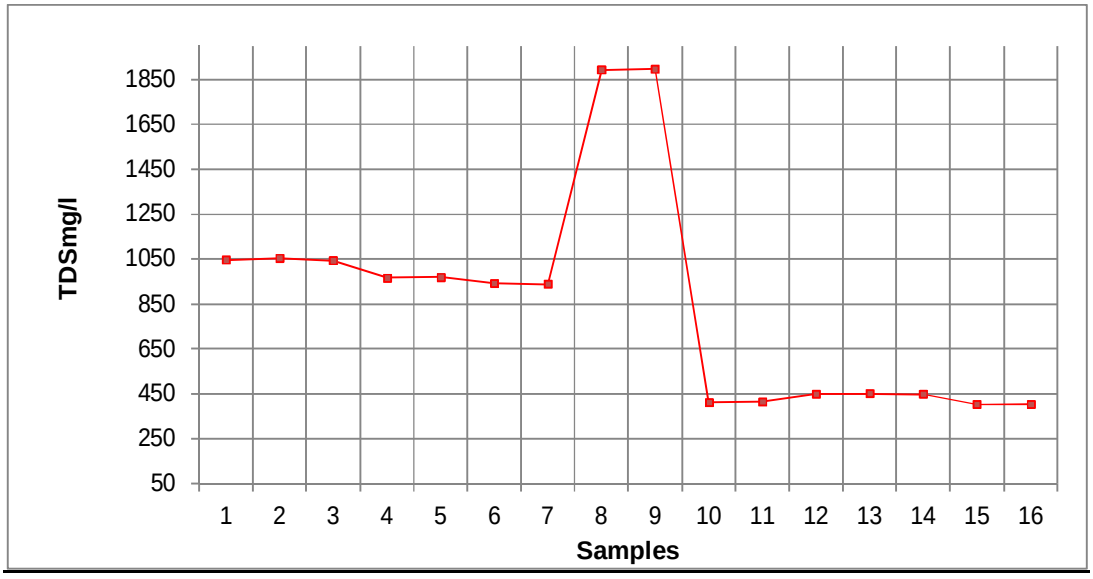


Fig. 6H ii) TDS (mg/l) Vs Samples of Tubewell Water

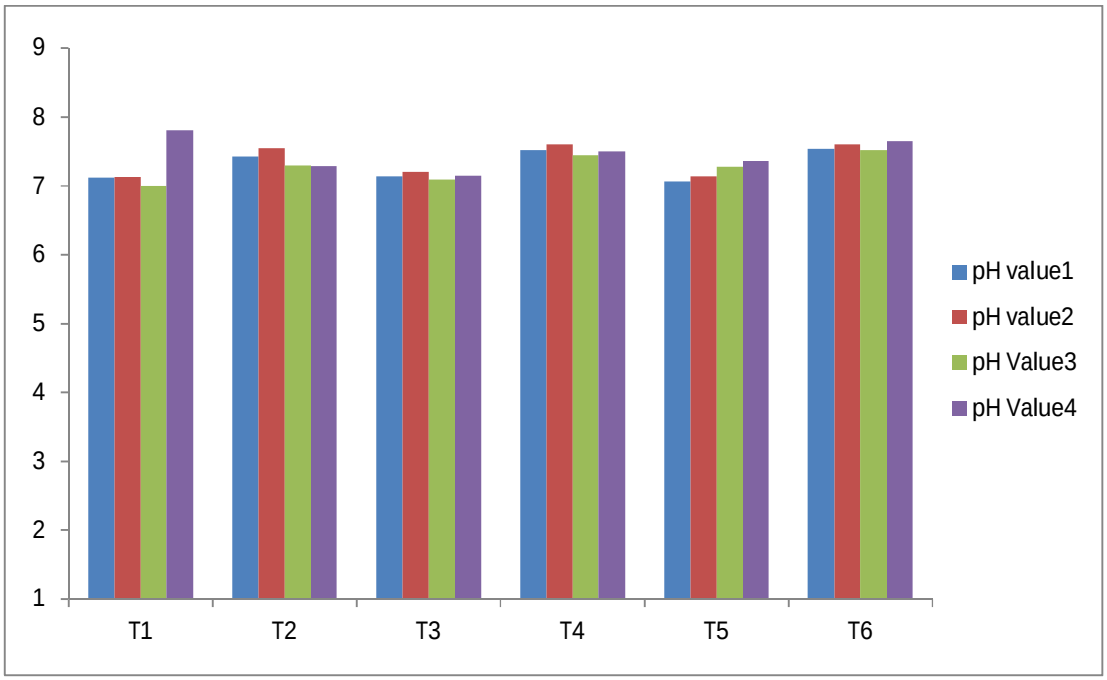


Fig.6.2.6(i) Determined pH Value of Tubewell Water

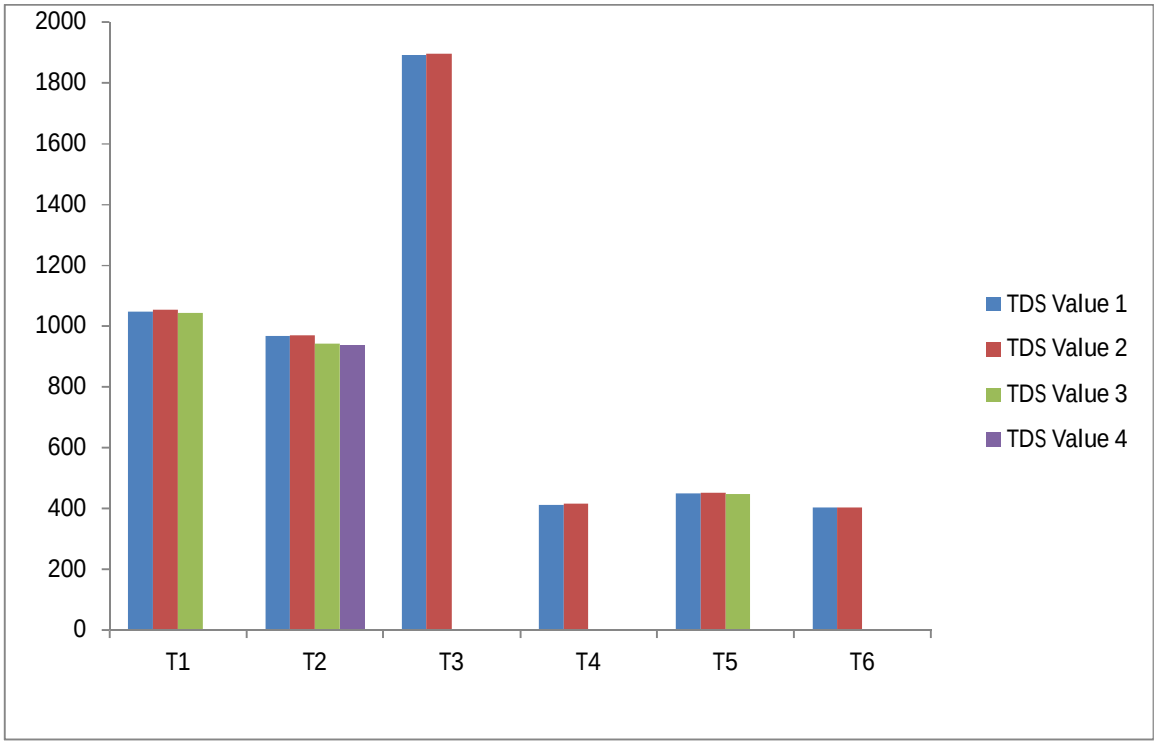


Fig.6.2.6(ii) Determined TDS Value of Tubewell Water

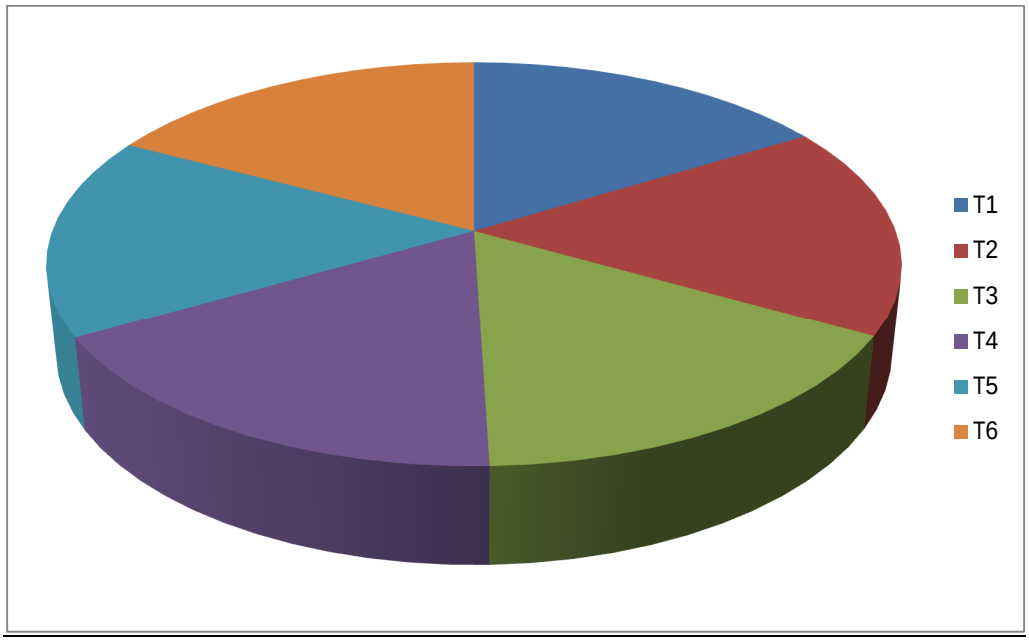


Fig.6.2.6(iii) Determined pH Value of Tubewell Water

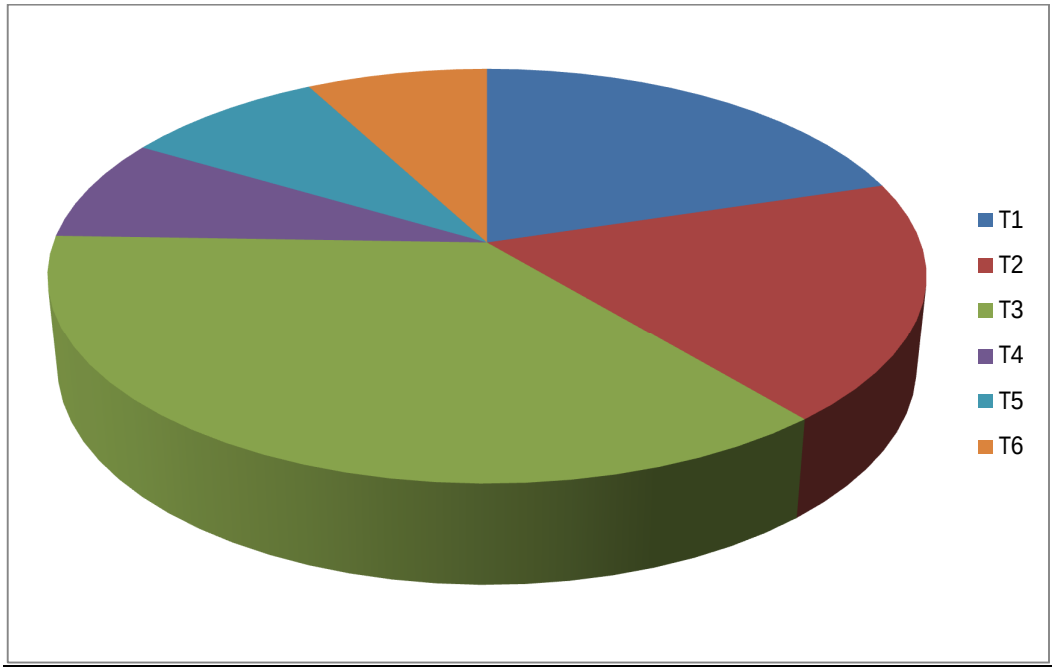


Fig.6.2.6(iv) Determined TDS Value of Tubewell Water

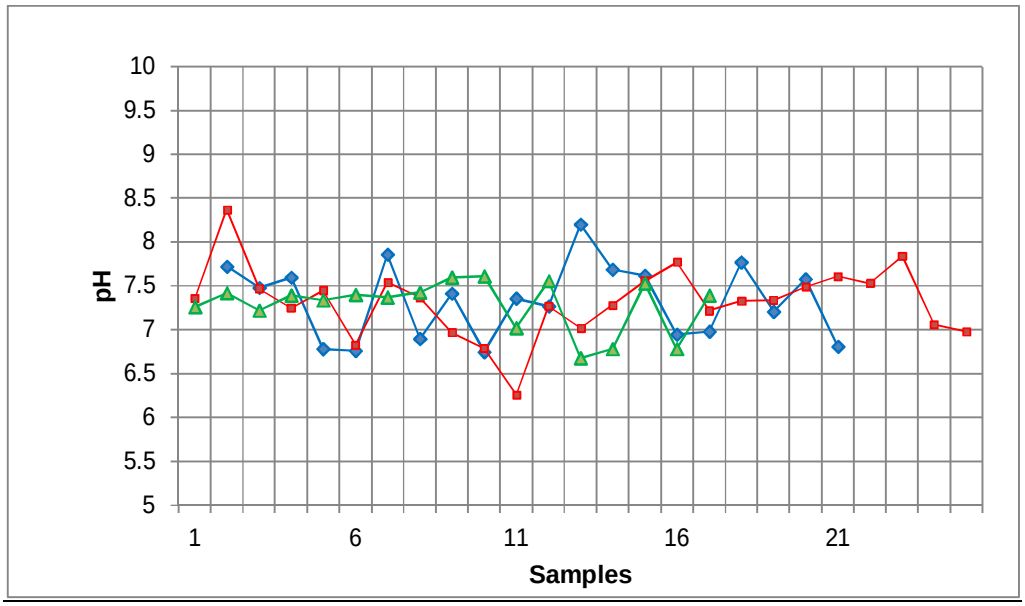


Fig. 6I i) Comparison Detrmnd.pH Value of KMC Supply Vs Individual Purifier Vs Street vendors water

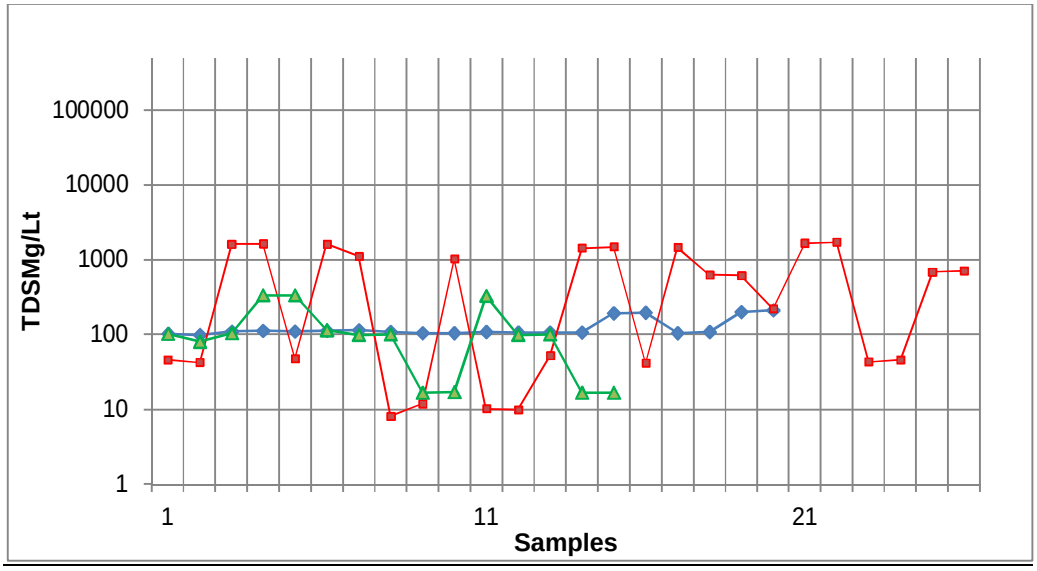


Fig. 6I ii) Comparison Detrmnd.TDS(Mg/lt) Value of KMC Supply Vs Individual Purifier Vs Street vendors water

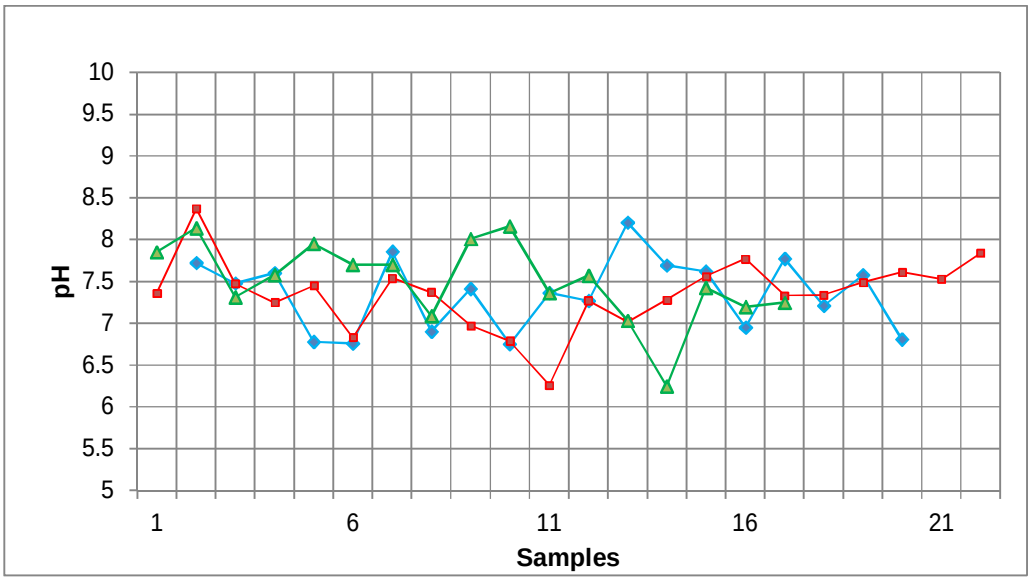


Fig. 6J i) Comparison Detrmnd. pH Value of KMC Supply Vs Individual Purifier Vs Self Treatement water

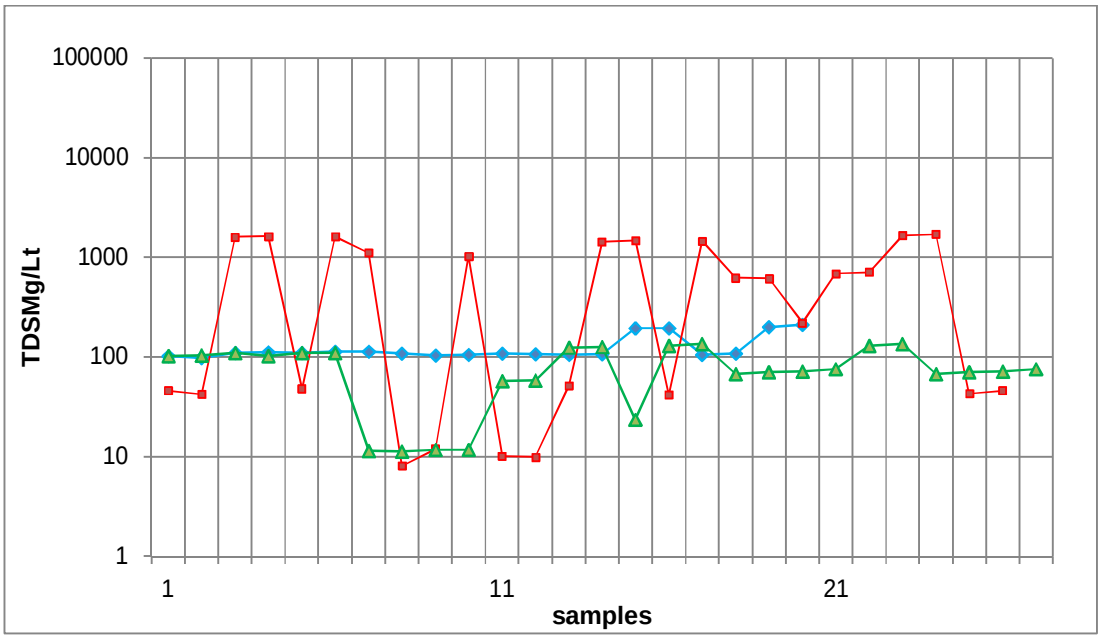


Fig. 6J ii) Comparison Detrmnd. TDS(Mg/lt) Value of KMC Supply Vs Individual Purifier Vs Self Treatement water

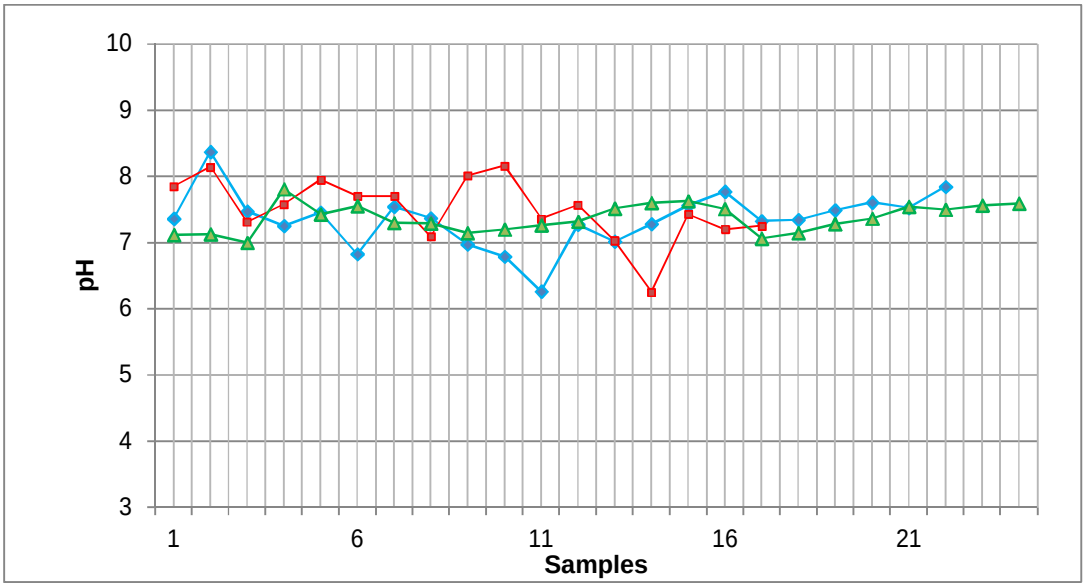


Fig. 6K i) Comparison Detrmnd. pH Value of Individual Purifier Vs Self Treatement water Vs Tubewell water

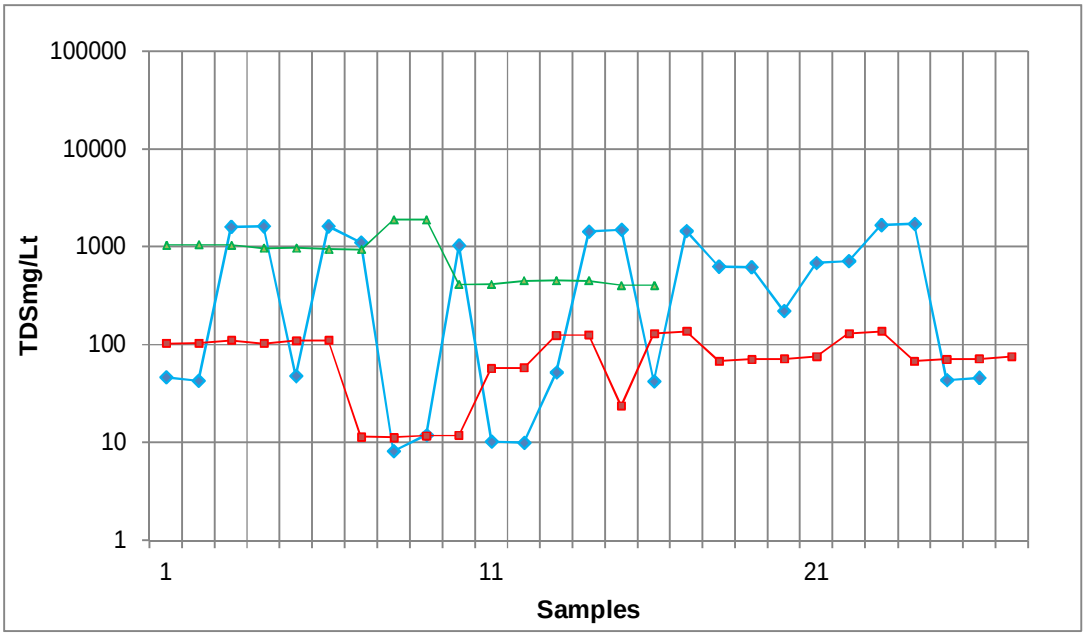


Fig. 6K ii) Comparison Detrmnd. TDS (Mg/Lt.) Value of Individual Purifier Vs Self Treatement water Vs Tubewell water

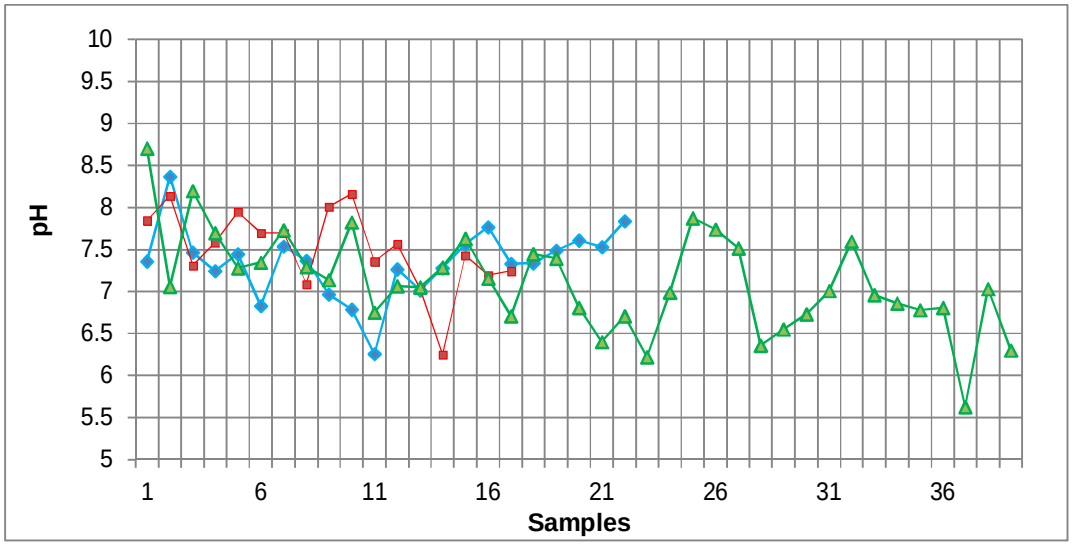


Fig. 6L i) Comparison Detrmnd. pH Value of Individual Purifier Vs Self Treatement water Vs Packaged water

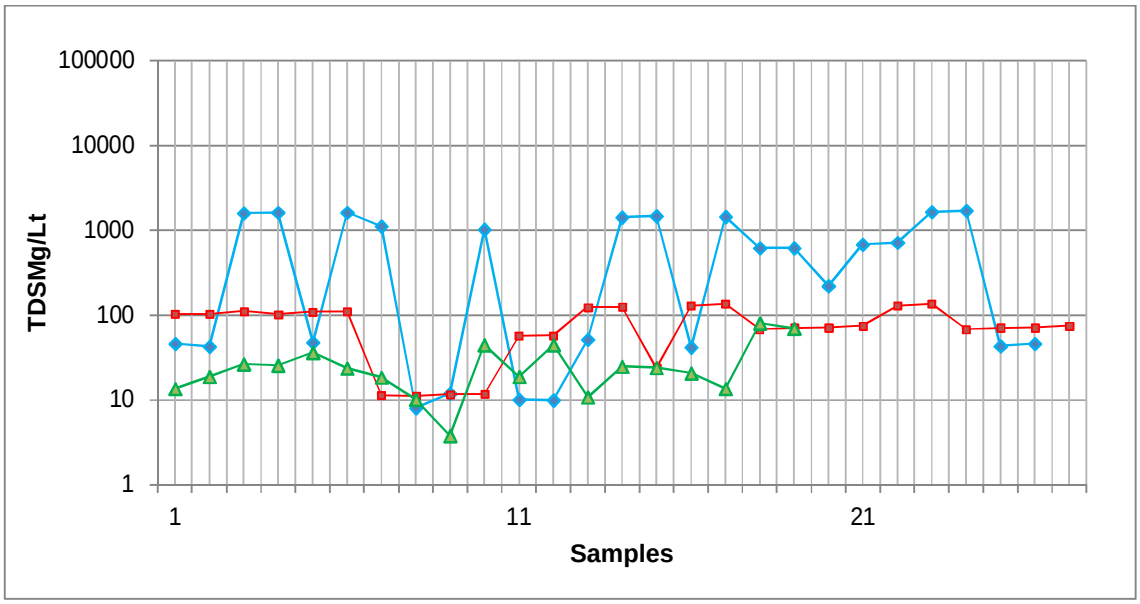


Fig. 6L ii) Comparison Detrmnd. TDS (Mg/Lt.) Value of Individual Purifier Vs Self Treatement water Vs Packaged water

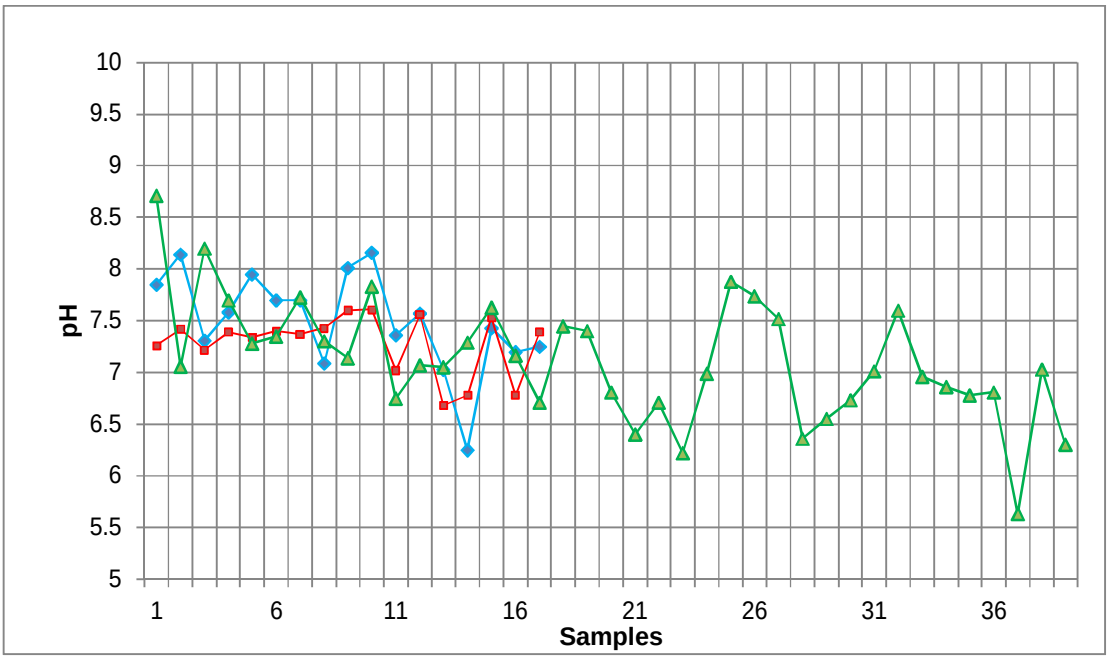


Fig. 6M i) Comparison Detrmnd. pH Value of Self Treatement water Vs street vendors water Vs Packaged water

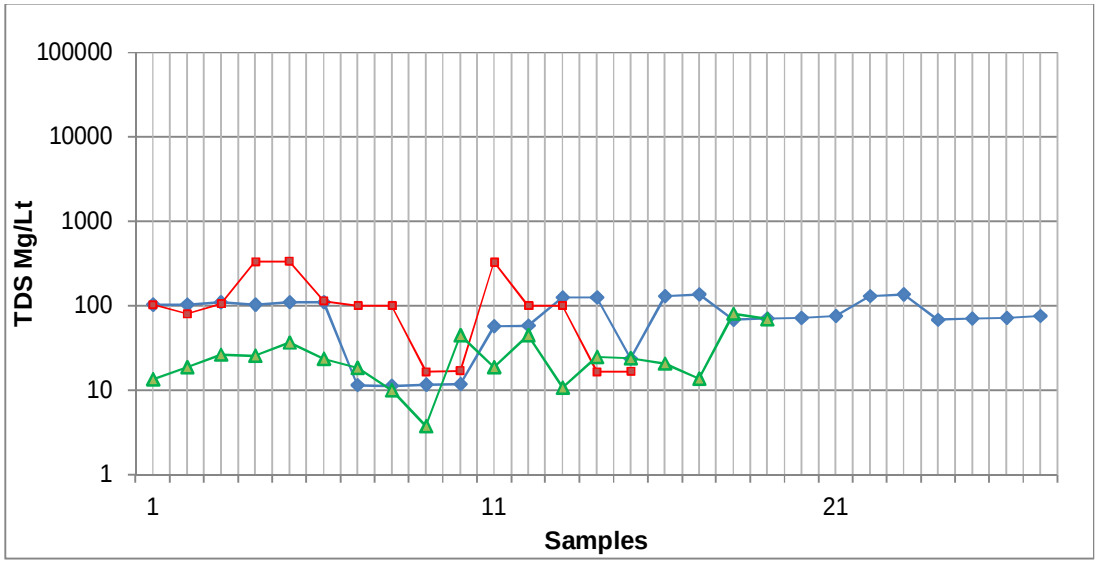


Fig. 6M ii) Comparison Detrmnd. TDS (Mg/Lt.) Value of Self Treatement water Vs street vendors water Vs Packaged water

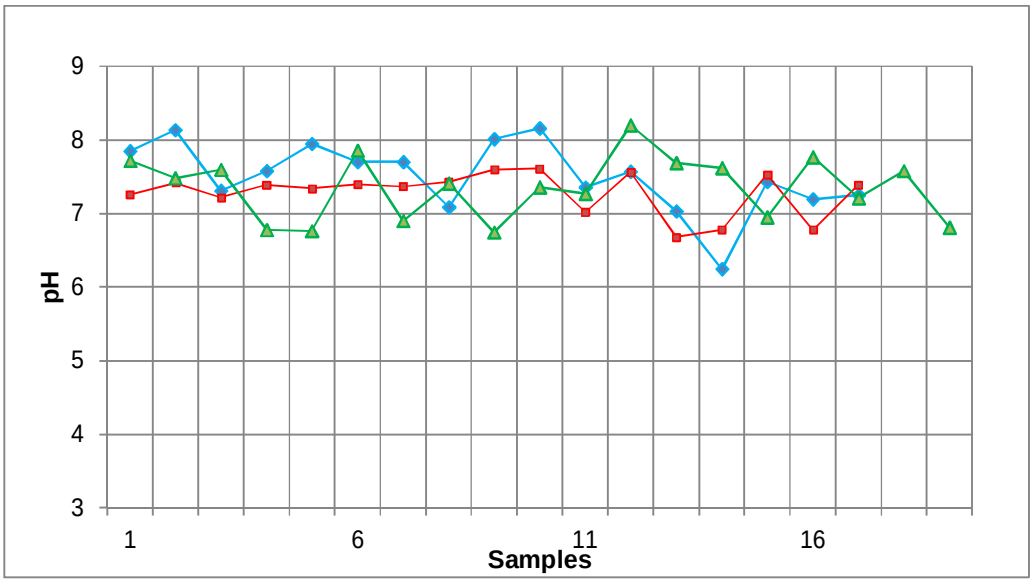


Fig. 6N i) Comparison Detrmnd. pH Value of Self Treatement water Vs street vendors water Vs KMC water

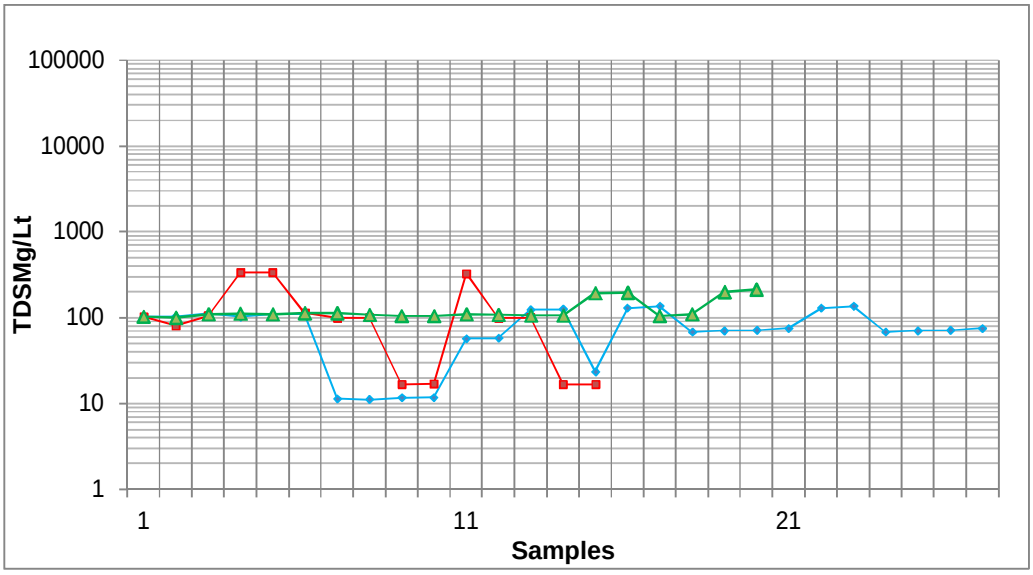


Fig. 6N ii) Comparison Detrmnd. TDS (Mg/Lt.) Value of Self Treatement water Vs street vendors water Vs KMC water

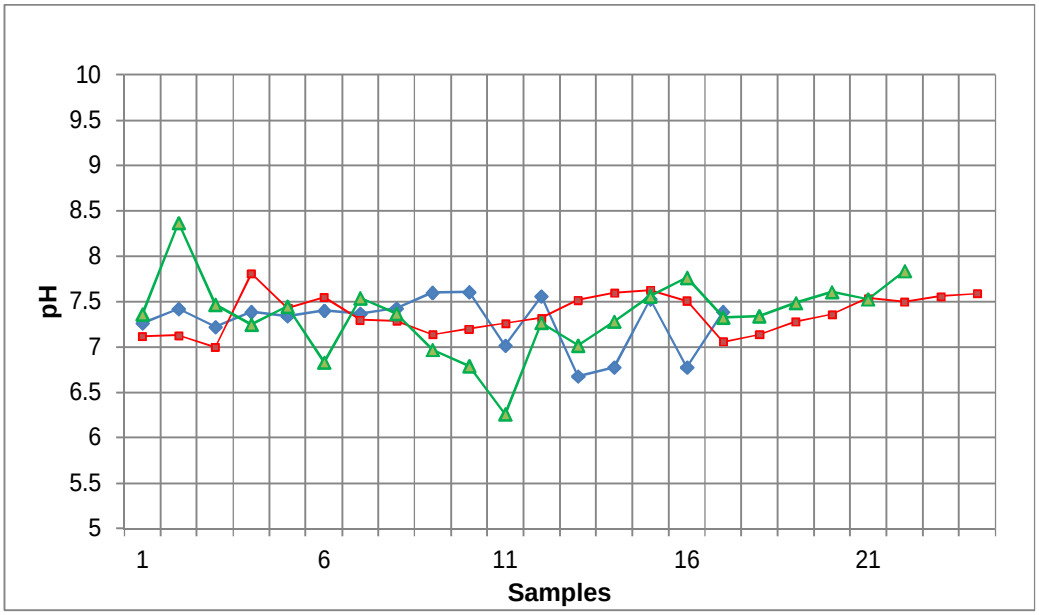


Fig. 6O i) Comparison Detrmnd. pH Value of street vendors water Vs Tubewellwater Vs Individual Purifier water

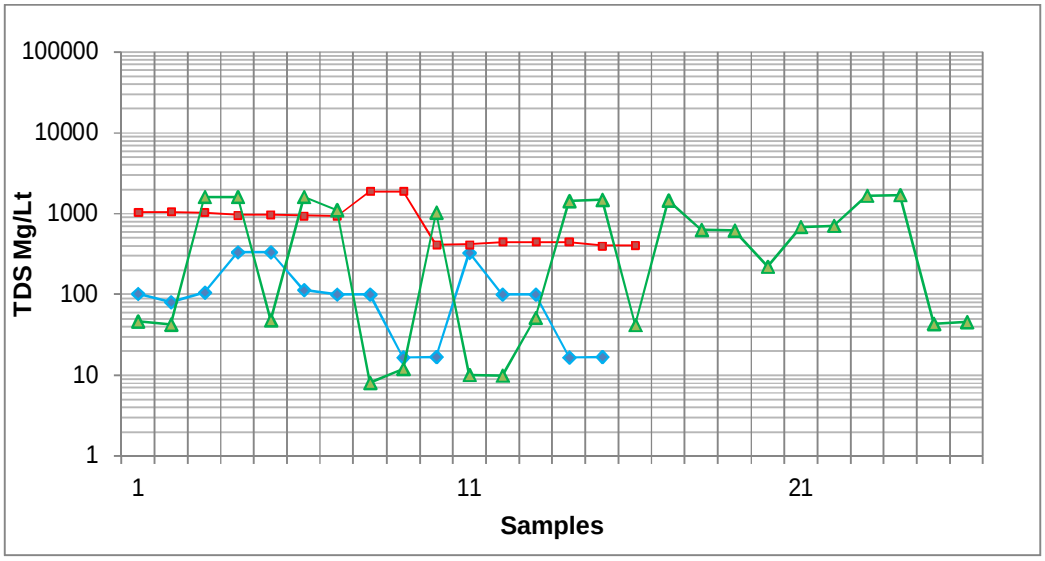


Fig. 6O ii) Comparison Detrmnd. TDS (Mg/Lt.) Value of street vendors water Vs Tubewell water Vs Individual Purifier water

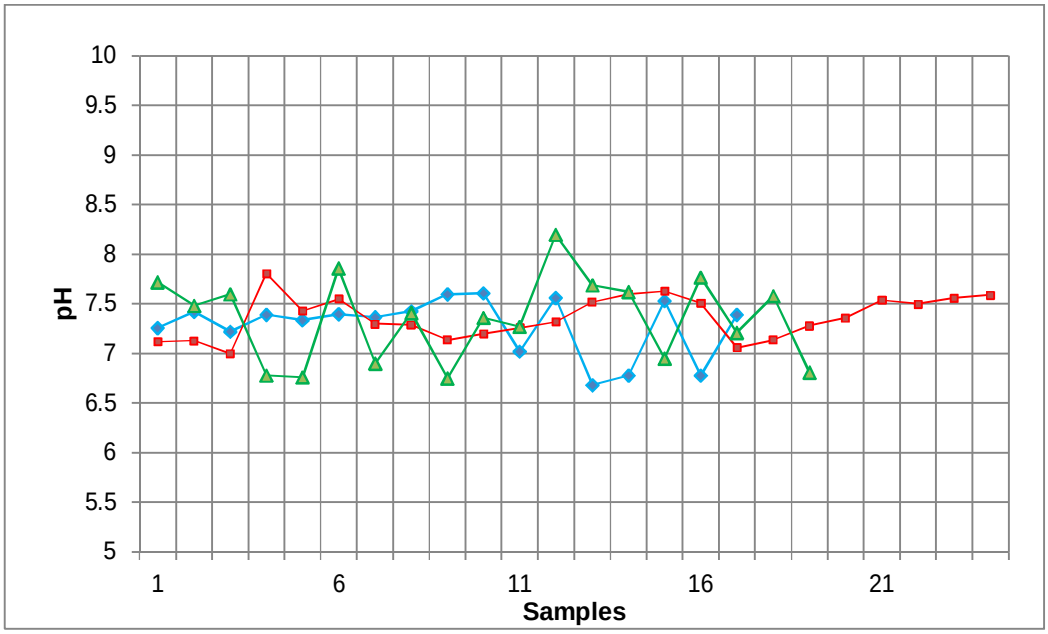


Fig. 6P i) Comparison Detrmnd. pH Value of street vendors water Vs Tubewell water Vs KMC water

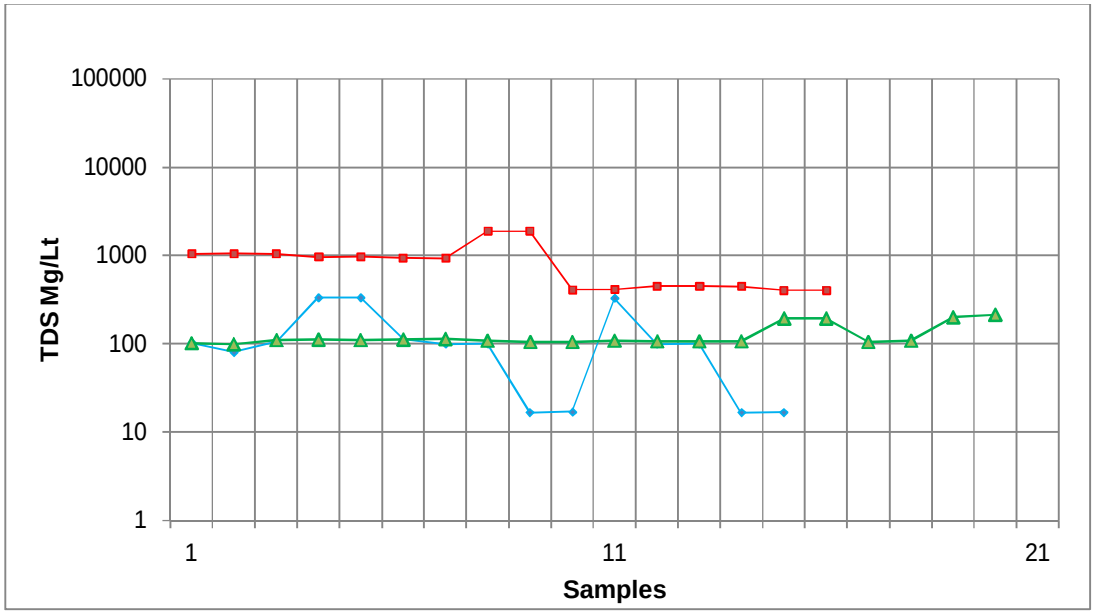


Fig. 6P ii) Comparison Detrmnd. TDS (Mg/Lt.) Value of street vendors water Vs Tubewell water Vs KMC water

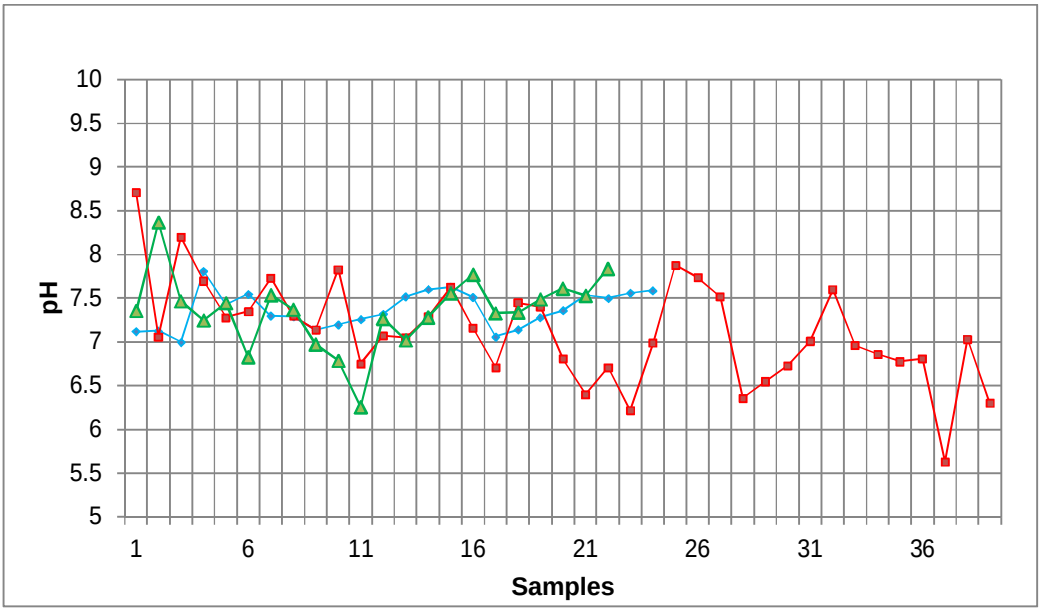


Fig. 6Q i) Comparison Detrmnd. pH Value of Tubewell water Vs Packaged water Vs Individual Purifier water

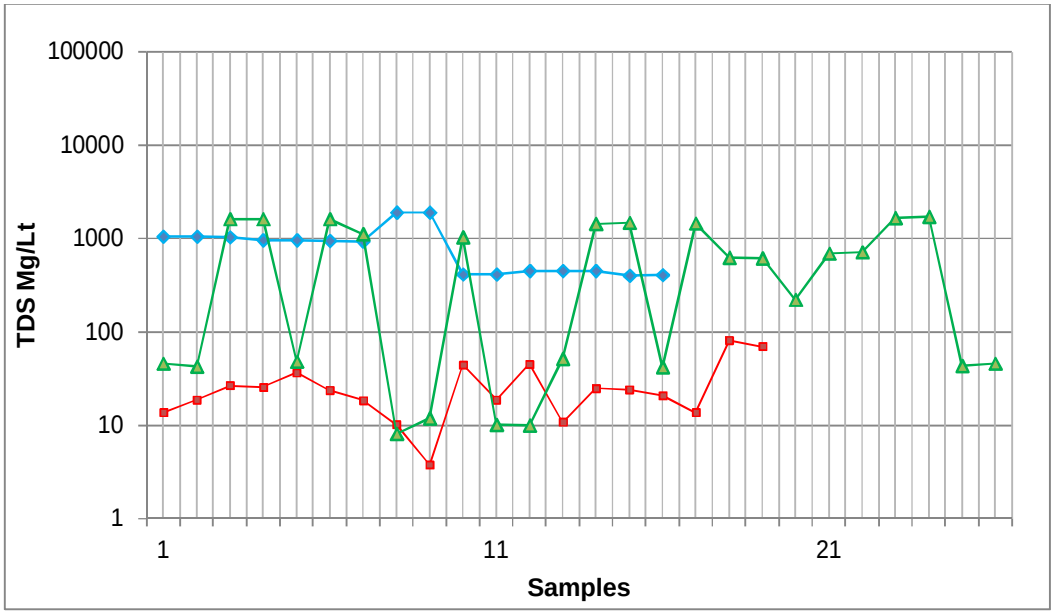


Fig. 6Q ii) Comparison Detrmnd. TDS (Mg/Lt.) Value Tubewell water Vs Packaged water Vs Individual Purifier water

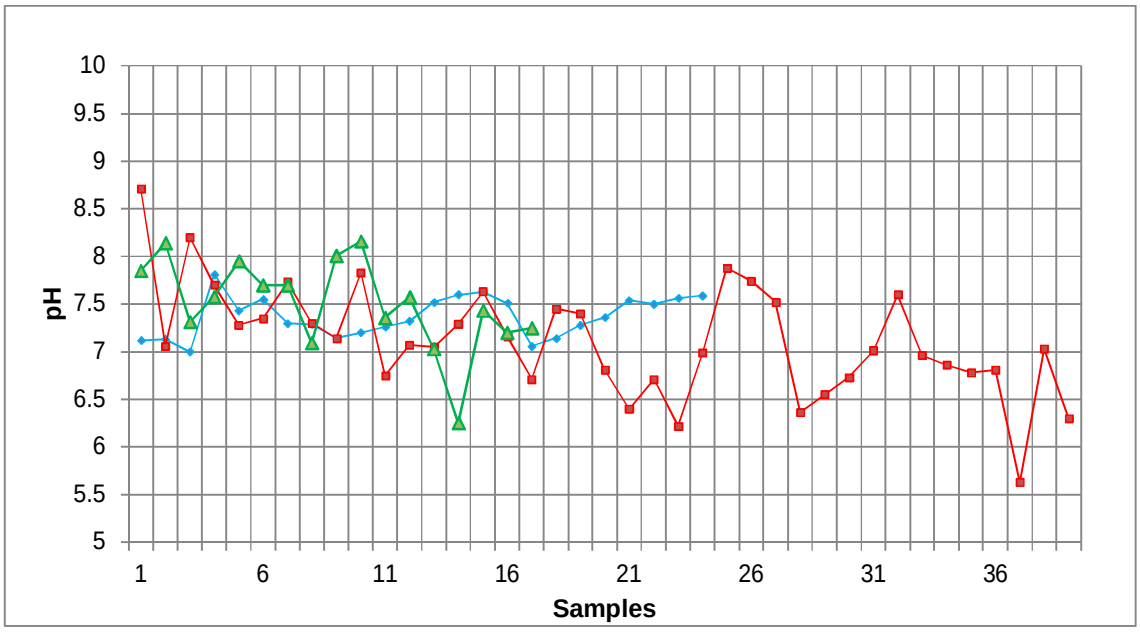


Fig. 6R i) Comparison Detrmnd. pH Value of Tubewell water Vs Packaged water Vs Self Treatement water

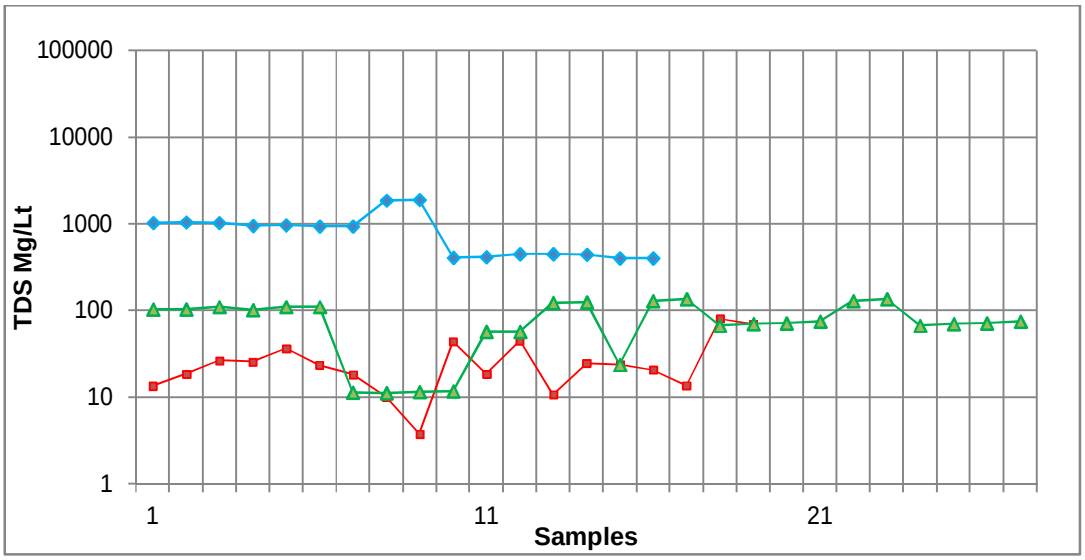


Fig. 6R ii) Comparison Detrmnd. TDS (Mg/Lt.) Value Tubewell water Vs Packaged water Vs Self Treatement water

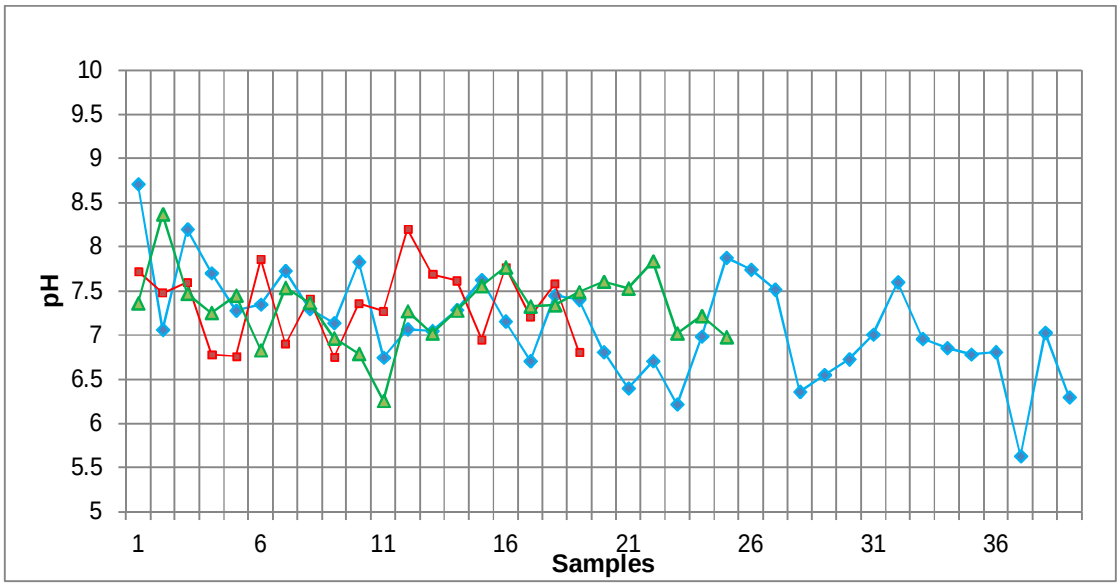


Fig. 6S i) Comparison Detrmnd. pH Value of Packaged water Vs KMC water Vs individual Purifier Water

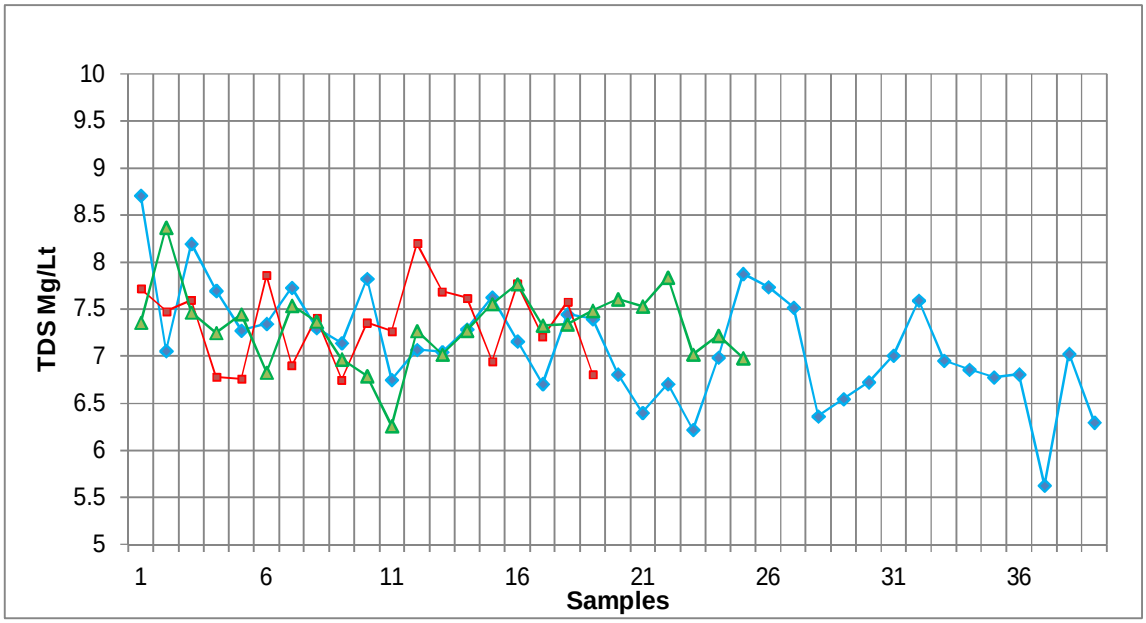


Fig. 6S ii) Comparison Detrmnd. TDS (Mg/Lt.) Value Packaged water Vs KMC water Vs Individual Purifier Water

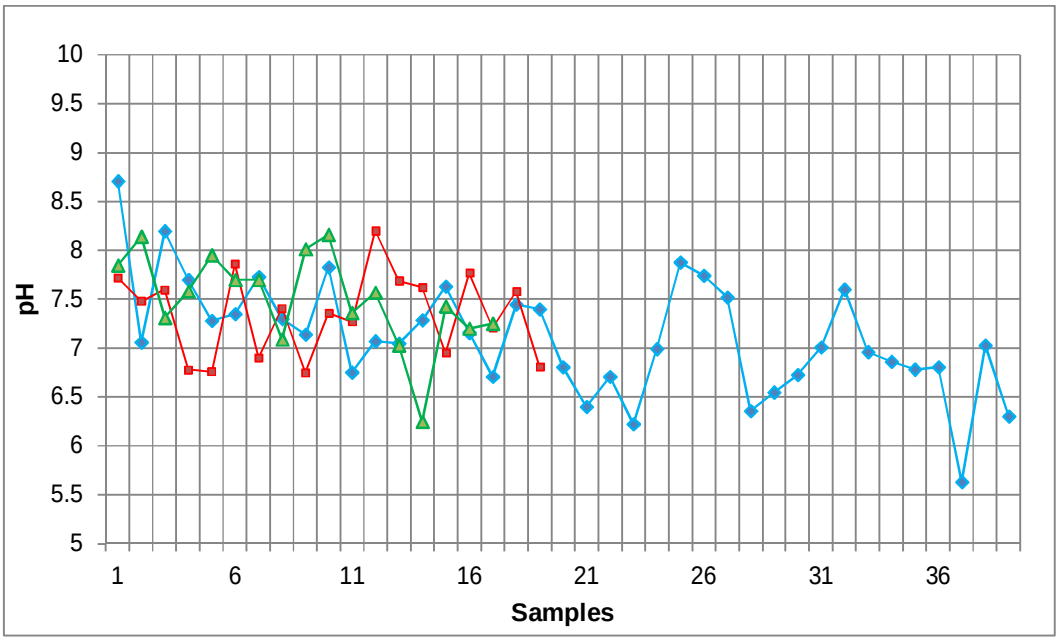


Fig. 6T i) Comparison Detrmnd. pH Value of Packaged water Vs KMC water Vs Self Treatement Water

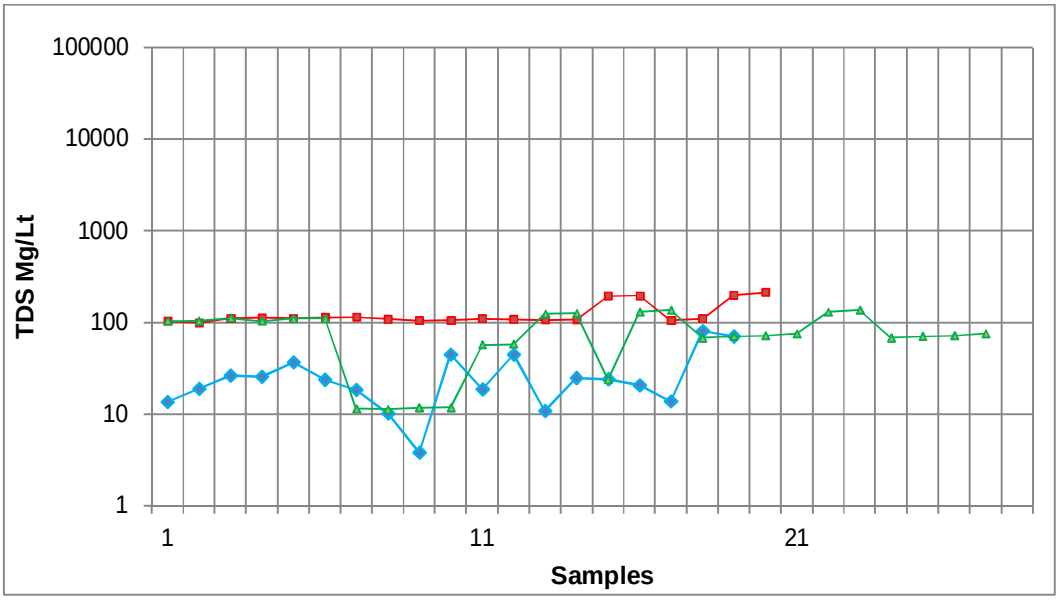


Fig. 6T ii) Comparison Detrmnd. TDS (Mg/Lt.) Value Packaged water Vs KMC water Vs Self Treatement Water

CHAPTER 7

DISCUSSION

7.0 DISCUSSION :-

Based on the analysis of results as detailed in Chapter-6 above, following discussion and deliberation are made on status of(i) Packaged drinking water (Different Branded of 500/600 Ml.bottled Pack and 20 Lt. Jar),(ii) KMC Supply water(From Treatment plant Tala, Garden Reach, Dhapa),(iii) Water using Individual purifier (Using RO-UV water purifiers, normal in-built stand alone filters etc.), (iv)Water using Street Foot Vendors (Collected From Tubewell, Packaged water, KMC Supply),(v) Water using,Treatment Plant Installed by Residential and Commertial Complex where (Different Filter like Iron, Arsenic, Activated Carbon, R.O Treatment Plant are used), (vi)Tubewell water (From Different Collected Source) which are available in North Kolkata , South Kolkata ,surrounding areas of North/south Kolkata and Different District in West Bengal.

7.1PACKAGED DRINKING WATER (20Lt.Jar+500/600 Ml. Bottled Packed):-

In case of packaged drinking water,Twelve (12) brands of 500/600 Ml. Bottled Packaged and Five(5) brands of 20 Lt. Jar with total 62 Nos. water samples were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out. On the basis of the WQI values, it is observed that all the water samples (100%) fall under **excellent category (WQI < 50)** and average WQI value is 35. The detailed results, analysis thereof, comparisons of Three parameters with respect to that as stipulated in IS 10500-2012 (Drinking water specification) and IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], and Other Inter- National Code like CANADA Drinking water Guideline-Aug.2010 ,US EPA-2010 have been done which are shown in previous chapter (Analysis of Results) through tabulated form, graphical representation etc. Besides following findings have also been observed:

Coliform bacteria : No samples found to have presence of coliform organism, which indicate safe for drinking as per microbiological parameter's point of view.

pH : According to Statistical Description , [500/600 Ml.Bottled Packed i.e (B1 to B12) where results demonostrate that the Mean pH Value ranging from(6.69 to 8.34) with S.D (σ) ranging from(± 0.02 to ± 0.48).and also [20 Lt.Jar Packaged i.e(P1 to P5) where Mean pH value ranging from(6.25 to 7.33) with S.D (σ) ranging from (± 0.28 to ±0.87).

Out of 12.5 % samples have pH values beyond the limit (6.5-8.5), which does not conform to IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], other International

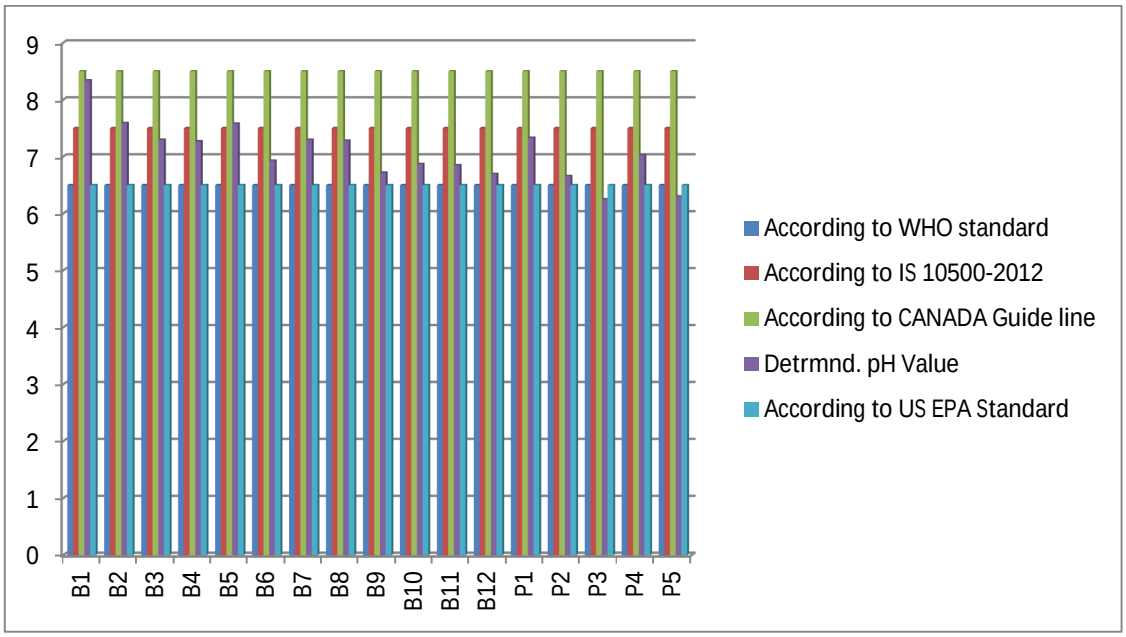
Codes and WHO Guideline-2011. These values indicate that Twenty Three (23)samples of packaged drinking water (bottled + Jar) are acidic and other Samples are Alkaline. Balance 87.5 % of samples have pH between 6.5 and 8.5 conforming to the above mentioned IS codes.and other codes.

Again 41.07% Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 58.93 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid which is generally obtained after filtered by RO purifiers. From these results it can be assumed that all these packaged drinking water might have been manufactured through RO water filters.

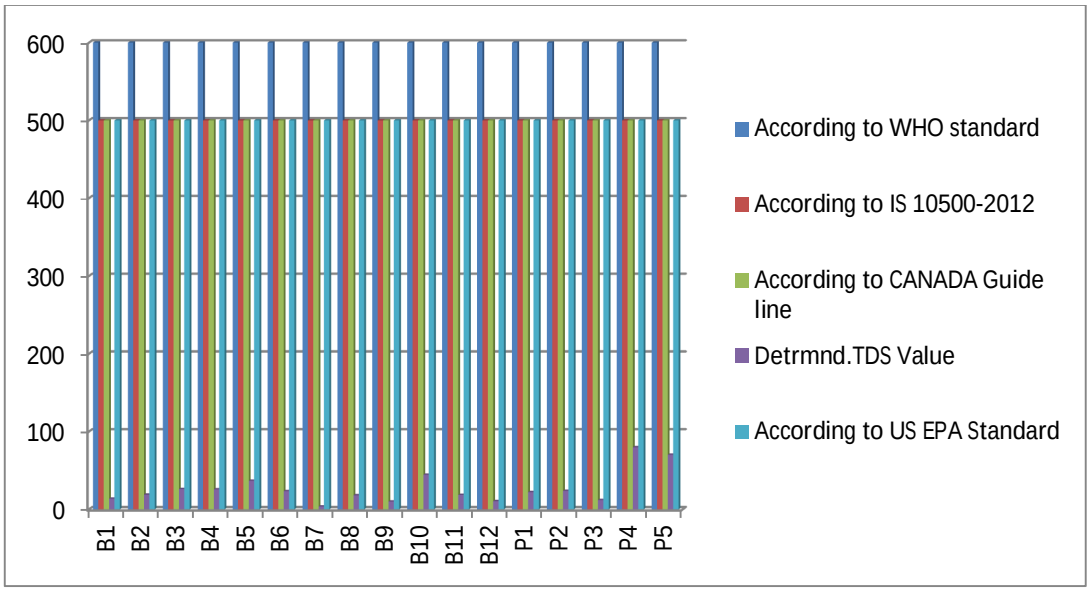
TDS :According to Statistical Description , [500/600 Ml.Bottled Packed i.e (B1 to B12) where results demonostrate that the Mean TDS Value ranging from(3.76 to 44.48 ppm) with S.D (σ) ranging from(±0.04 to ± 0.35).and also [20 Lt.Jar Packaged i.e(P1 to P5) where Mean TDS value ranging from(11.98 to 79.85) with S.D (σ) ranging from (±0.21 to ± 2.0).

.All samples found to have TDS within the acceptable limit (500 mg/l) as per aforesaid IS codes , International Codes.and WHO Guideline-2011. 70.97 % samples have TDS below 25 mg/l, 22.58% samples have TDS between 25 and 50 mg/l, Balance 6.45 % samples have TDS between 50 and 100 mg/l.

That is, 93.55% samples contained TDS below 50 mg/l (*very low mineral concentration; <50 mg/l, Ref. EU mineral water directive*) and 6.45% samples contained TDS between 50 and 120 mg/l (*low mineral concentration, TDS 50-500 mg/l*).



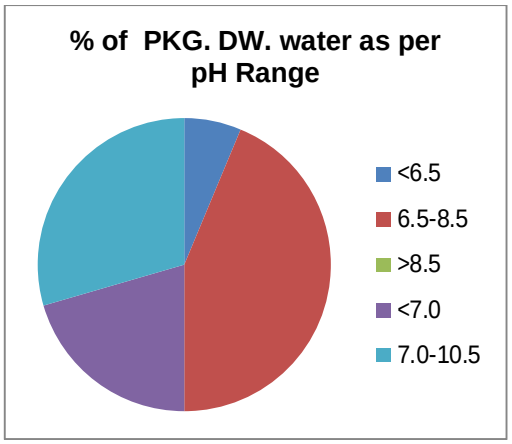
Comparison of Determined pH Value Of Packaged Water w.r.t. Requirement as per IS Codes and other International Code

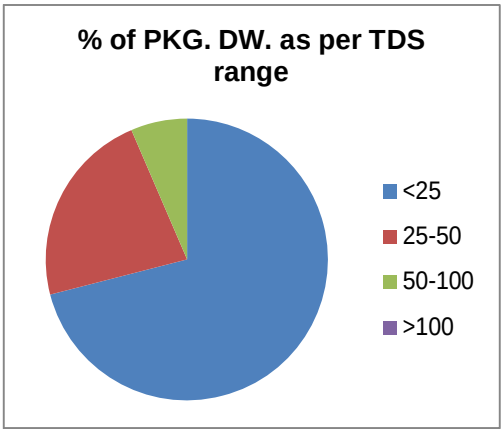


Comparison of Determined TDS Value Of Packaged Water w.r.t. Requirement as per IS Codes and other International Codes

Percentage of different parameters observed in Package Drinking Water:-

Sl. No.	Parameter & (Unit)	Requirement : as per					Range	Percentage (%) of observed values
		IS: 10500-2012	IS: 14543-2004	WHO Guideline -2011	CANADA Drinking Water Guideline Aug.-2010	US-EPA Aug. 2010		Packaged Drinking Water(20Lt. Jar +500/600 Ml. Bottled Packed)
1	pH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	7.0 – 10.5	6.5 – 8.5	< 6.5	12.5
							6.5 – 8.5	87.5
							> 8.5	-
							<7.0	41.07
							7.0-10.5	58.93
2	TDS (mg/l)	500	500				< 25	70.97
							25 – 50	22.58
				500	≤500	500	50 – 100	6.45
							>100	-





7.2 KMC SUPPLY DRINKING WATER :-

In case of KMC Supply drinking water, collected Fifteen (15) Nos. Water samples from treatement plant (i.e Garden Reach), Sixteen (16) Nos. Water Samples from treatement plant (i.e Tala) and Seven(7) Nos. water Samples from treatement plant (i.e Dhapa) were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out. On the basis of the WQI values, it is observed that all the water samples (100%) fall under **excellent category (WQI < 50)** and average WQI value is 42. The detailed results, analysis thereof, comparisons of Three parameters with respect to that as stipulated in IS 10500-2012 (Drinking water specification) and IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], and Other Inter- National Code like CANADA Drinking water Guideline-Aug.2010 ,US EPA-2010 have been done which are shown in previous chapter (Analysis of Results) through tabulated form, graphical representation etc. Besides following findings have also been observed:

Coliform bacteria : Thirty Three(33) samples found to have absent of coliform organism, which indicate safe for drinking as per microbiological parameter's point of view.But only Three(3) samples, collected from (i) Aurobindo Bhabon,J.U (K1-Garden Reach) ii) Rersidence at C.I.T Road,Beliaghata (K2-Tala) (iii) Rail Bihar Residencial complex at Ruby (K3-Dhapa) found to have present in **coliform bacteria**.,which may be due to **non-cleaning of filter and Pipeline or lack of chlorine concentration** for a long time.

pH : According to Statistical Description , [KMC Supply Water i.e (K1-Garden Reach)] where results demonostrate that the Mean pH Value ranging from(6.96 to 7.82) with S.D (σ) ranging from(±0.05 to ±0.26)., [KMC Supply Water i.e(K2-Tala)] where Mean pH value ranging from(7.22 to 7.64) with S.D (σ) ranging from (±0.35 to ± 0.38).and [KMC Supply Water i.e.(K3- Dhapa)] where Mean pH value 7.398 with S.D (σ) be (±0.39).

All samples have pH values within the limit (6.5-8.5), which conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification] and other International Codes and also WHO Guideline-2011. But these values indicate that Four(4)samples of Garden Reach, Three(3) Samples of Tala and One(1) sample of Dhapa KMC Supply drinking water are acidic and other Samples are Alkaline.

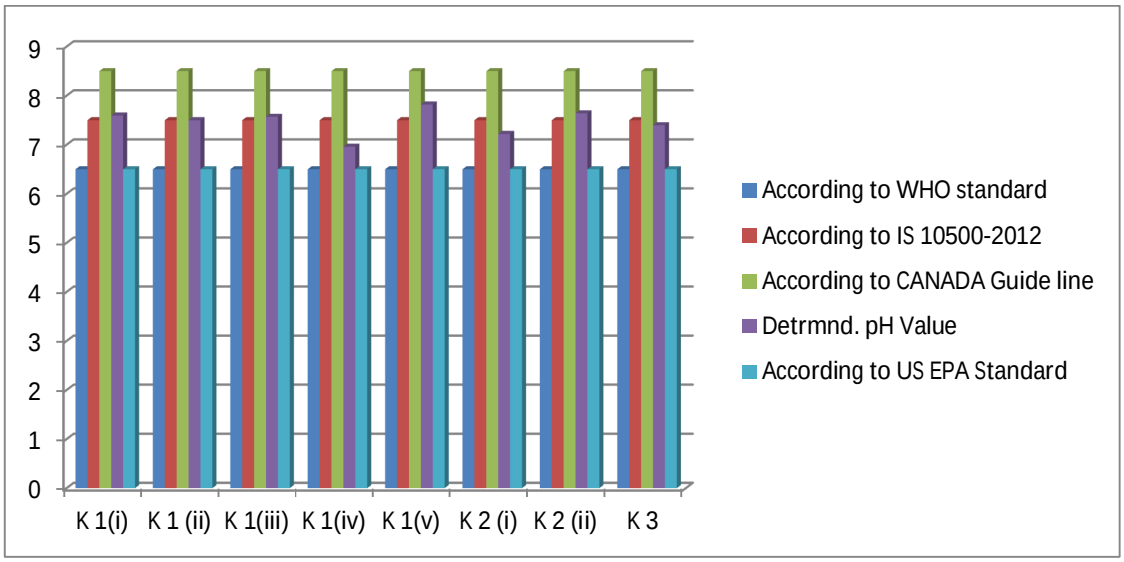
Again 25% Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 75 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA

Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid which is generally obtained after filtered by RO purifiers. From these results it can be assumed that all these collected source of KMC Supply water might have been used homemade RO water filters.

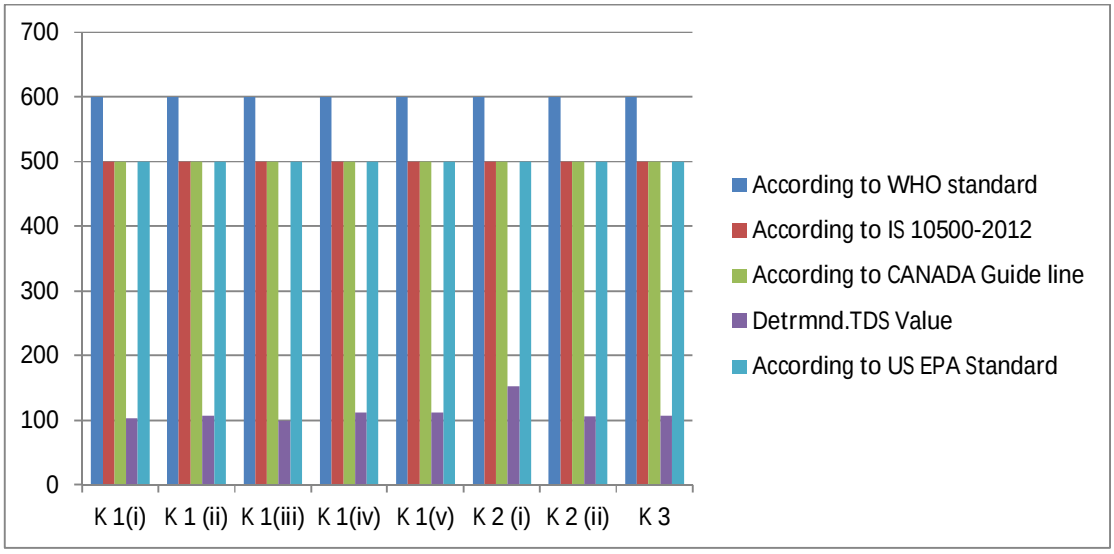
TDS :.. According to Statistical Description , [KMC Supply Water i.e (K1-Garden Reach)] where results demonostrate that the Mean TDS Value ranging from(99.2 to 112 ppm) with S.D (σ) ranging from(±0.28 to±3.14)., [KMC Supply Water i.e(K2-Tala)] where Mean TDS value ranging from(106.1 to 152.56 ppm) with S.D (σ) ranging from (±0.77 to± 51.4).and [KMC Supply Water i.e.(K3- Dhapa)] where Mean TDS value 106.66 ppm with S.D (σ) be(±2.12)

All samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes and WHO Guideline-2011. 2.63 % samples have TDS value below 100 ppm , 86.84% samples have TDS value between (100 to 150) ppm, 7.89 % samples have TDS value between(150 to 200)ppm and balance 2.63% of Samples have TDS value above 200 ppm.

That is, No samples contained TDS below 50 mg/l (*very low mineral concentration; <50 mg/l, Ref. EU mineral water directive*) and 89.47% samples contained TDS between 50 and 120 mg/l (*low mineral concentration, TDS 50-500 mg/l*).



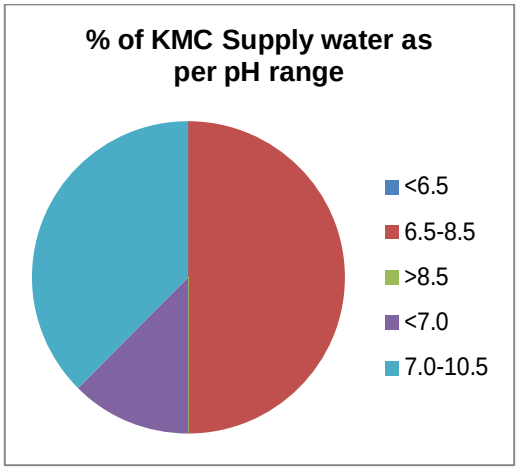
Comparison of Determined pH Value Of KMC Supply Water w.r.t. Requirement as per IS Codes and other International Code

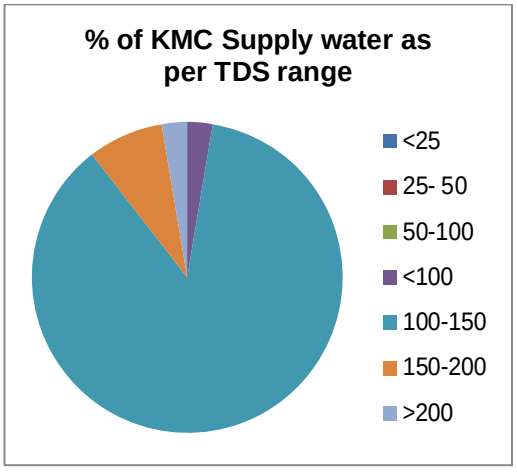


Comparison of Determined TDS Value Of KMC Supply Water w.r.t. Requirement as per IS Codes and other International Codes

Percentage of different parameters observed in KMCSupply Drinking Water:-

Sl. No.	Parameter & (Unit)	Requirement : as per					Range	Percentage (%) of observed values
		IS: 10500-2012	IS: 14543-2004	WHO Guideline -2011	CANADA Drinking Water Guideline Aug.-2010	US-EPA Aug. 2010		KMCSupply Drinking Water
1.	pH	6.5 – 8.5	6.5 – 8.5				< 6.5	-
				6.5 – 8.5	7.0 – 10.5	6.5 – 8.5	6.5 – 8.5	100
							> 8.5	-
							<7.0	25
							7.0-10.5	75
2.	TDS (mg/l)	500	500				< 100	2.63
							100 – 150	86.84
				500	≤500	500		
							150 – 200	7.89
							>200	2.63





7.3 WATER USING BY INDIVIDUAL PURIFIER :-

In case of water using by Individual Purifier(i.e Using RO-UV water purifiers, normal in-built stand alone filters etc.) collected Nine (9) Nos.Water samples from Residential complex where using (R.O-UV Water Purifier), Twelve (12) Nos. Water Samples from Commertial Complex where using (normal in-built stand alone filters) and Eleven(11) Nos. water Samples from Institutional area (normal in-built stand alone filters or other purifier) and Thirteen(13) Nos, water Samples from Official sector where using (Both RO-UV water purifiers and normal in-built stand alone filters etc) were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out. On the basis of the WQI values, it is observed that the water sample collected from Residential Complex(I-1) fall under **excellent category (WQI < 50),**Water sample collected from Commertial Complex(I-2) fall under **Poor Category (WQI be129.90) i.e** ranging between (100 to 200),Water samples collected from Institutinal areas [I-3(i)] and [I-3(iii)] fall under **Fair Category(WQI be 99.96 and 76.98) i.e** ranging between(75 to 100),water samples collected from Institutional areas [I-3 (ii)] fall under **excellent category (WQI < 50** and water samples collected from Institutional ares[I-3(iv)] fall under **Poor Category (WQI be137.995) i.e** ranging between (100 to 200).It is also observed that the water samples collected from Official sector i.e [I-4(i) and I-4 (iii)] fall under **excellent category (WQI < 50** and water samples collected from official sector [I-4 (ii) fall under **good category(WQI be 73.62) i.e** ranging between (50 to 75) . The total average WQI value is 75. The detailed results, analysis thereof, comparisons of Three parameters with respect to that as stipulated in IS 10500-2012 (Drinking water specification) and IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], and Other Inter- National Code like CANADA Drinking water Guideline-Aug.2010 ,US EPA-2010 and WHO Guideline-2011 have been done which are shown in previous chapter (Analysis of Results) through tabulated form, graphical representation etc. Besides following findings have also been observed:

Coliform bacteria : No samples found to have presence of coliform organism, which indicate safe for drinking as per microbiological parameter's point of view.

pH :According to Statistical Description, Residential complex[I-1]where results demonostrate that the Mean pH Value 7.49 with S.D (σ) be (±0.45)., Commertial Complex [I-2] where Mean pH value 7.42 with S.D (σ) be (±0.17), Institutional areas i.e [I-3(i),(ii),(iii),(iv)] where Mean pH value ranging from (7.05 to 7.65) with S.D (σ) ranging from ±(0.11 to ±0.42).and Official sector i.e[I-4 (i),(ii),(iii)]where Mean pH Value ranging from (6.83 to7.45) with S.D (σ) ranging from (±0.15 to ±0.42).

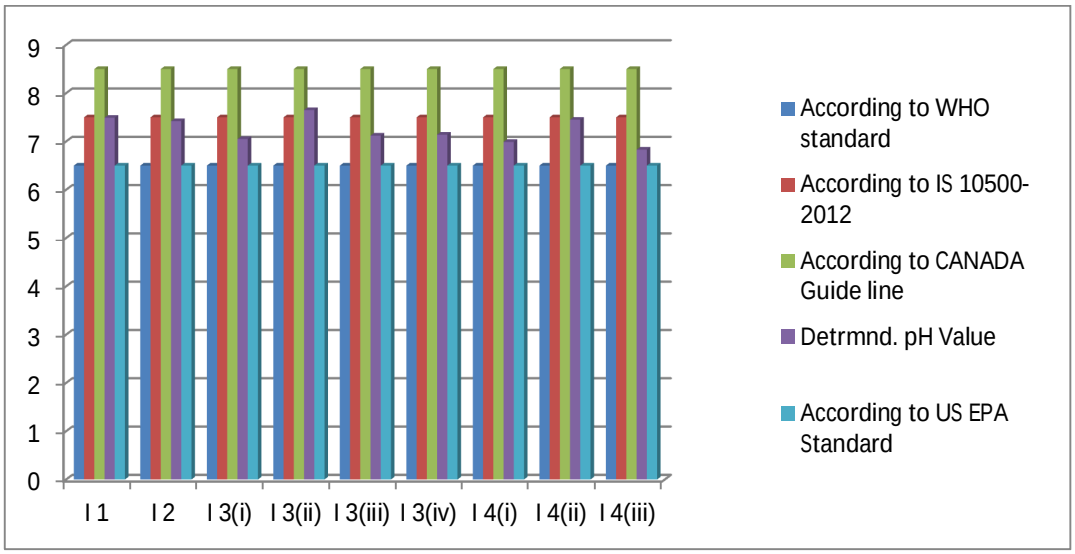
Out of 2.38% have pH values beyond the limit (6.5-8.5), which does not conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification] and other International Codes and also WHO Guideline-2011. But these values indicate that No samples of(Residential Complex (I-1) and Commertial Complex (I-2) are acidic. But Two(2)Samples of Institutional areas , Five (5) samples of Official sector are acidic. and other Samples are Alkaline. Balance 97.62 % of samples have pH between 6.5 and 8.5 conforming to the above mentioned IS codes.and other codes.

Again 16.67 % Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 83.33 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid which is generally obtained after filtered by RO purifiers. From these results it can be assumed that all these collected source from different zones might have been used RO water filters.

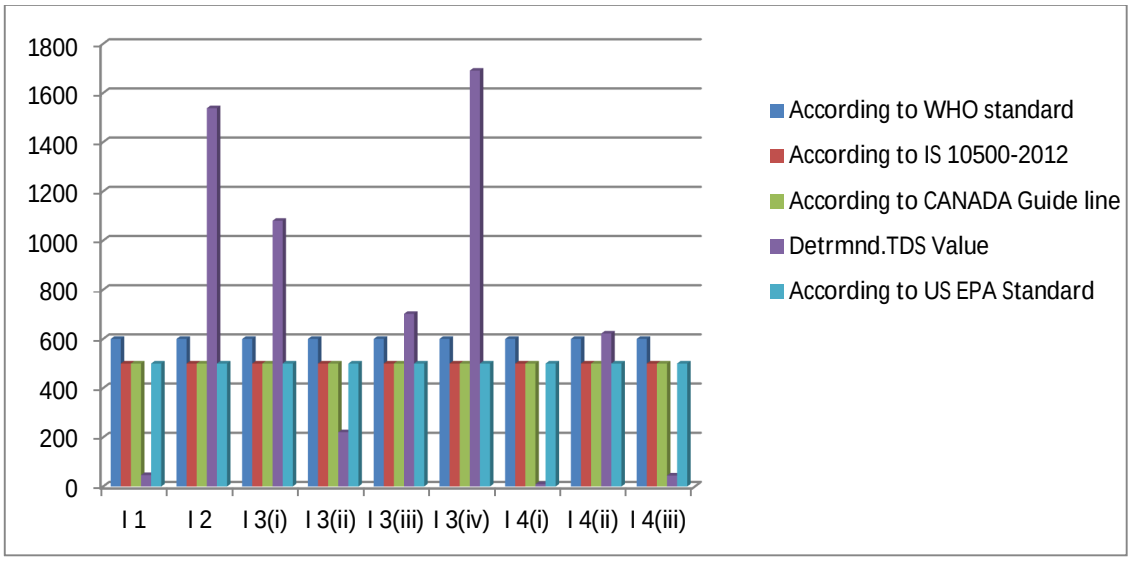
TDS: According to Statistical Description, Residential complex [I-1]where results demonostrate that the Mean TDS Value 46.42 with S.D (σ) be (±3.8)., Commertial Complex [I-2] where TDS value 1538 ppm with S.D (σ) be (±84.4), Institutional areas i.e [I-3(i),(ii),(iii),(iv)] where Mean TDS value ranging from (220.67 to 1691 ppm) with S.D (σ) ranging from (±0.58 to± 44.6).and Official sector i.e[I-4 (i),(ii),(iii)]where Mean TDS Value ranging from (9.72 to 622) with S.D (σ) ranging from (±1.3 to ±4.1)

Out of 47.72 % samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011..and balance 52.27% of samples within permissible limit (<2000ppm in absence of alternate source). 15.91 % samples have TDS below 25 mg/l, 20.45% samples have TDS between 25 and 50 mg/l, 4.55 % samples have TDS between 50 and 100 ppm, .20.45 % of samples have TDS between (200 to 750 ppm), (max.715 ppm) .20.45 % of samples have TDS between (1000 to 1500 ppm), (max. 1481ppm) and balance 18.18% of samples have TDS between (1500 to 2000 ppm), (max. 1715 ppm).

That is, 36.36 samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and 4.55 % samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 mg/l*).



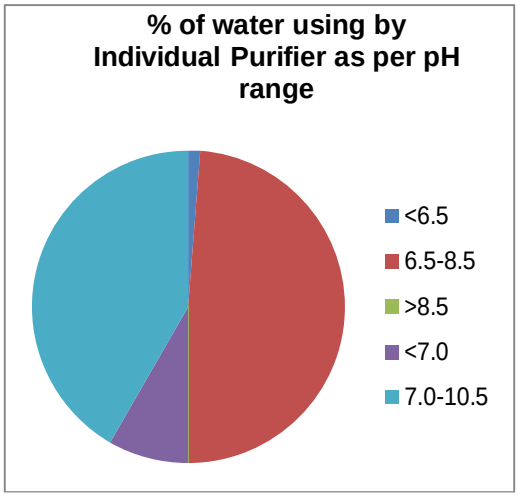
Comparison of Determined pH Value, Using Individual Purifier Water w.r.t. Requirement as per IS Codes and other International Code

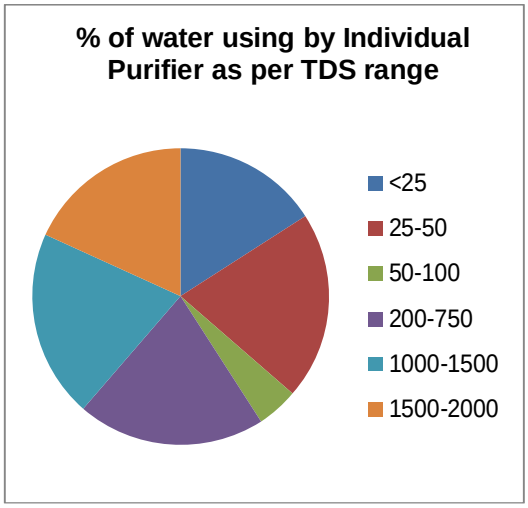


Comparison of Determined TDS Value , Using Individual Purifier Water w.r.t Requirement as per IS Codes and other International Codes

Percentage of different parameters observed in water using By Individual Purifier:-

Sl. No.	Parameter & (Unit)	Requirement : as per					Range	Percentage (%) of observed values
		IS: 10500-2012	IS: 14543-2004	WHO Guideline -2011	CANADA Drinking Water Guideline Aug.-2010	US-EPA Aug. 2010		Water using By Individual Purifier
1	pH	6.5 – 8.5	6.5 – 8.5				< 6.5	2.38
				6.5 – 8.5	7.0 – 10.5	6.5 – 8.5	6.5 – 8.5	97.62
							> 8.5	-
							<7.0	16.67
							7.0-10.5	83.33
2	TDS (mg/l)	500	500				< 25	15.91
							25 – 50	20.45
				500	≤500	500	50 – 100	4.55
							200 – 750	20.45
							1000-1500	20.45
							1500-2000	18.18





7.4 WATER USING BY STREET FOOT VENDERS :-

In case of water using,Street Foot Venders collected Two (2) Nos. Water samples from Tea shop at Kalikapur Road, Two (2) Nos. water samples from Momo shop at 8B Bus Stand at Jadavpur, Two(2) Nos. water samples from 1 No. Gate,J.U, Two(2) Nos. water samples at Ruby more,Three(3) Nos. water samples from Madhyamgram Chowmatha Junction, Four(4) Nos. water samples from Rajarhut near by CC2 and Four (4) Nos. water samples from Street Venders at Singur,Hoogly ,were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out. On the basis of the WQI values, it is observed that all the water samples (100%) fall under **excellent category (WQI < 50)** but only One(1) sample fall under **good category(WQI be 54.58) i.e** ranging between (50 to 75) and average WQI value is 42. The detailed results, analysis thereof, comparisons of Three parameters with respect to that as stipulated in IS 10500-2012 (Drinking water specification) and IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], and Other Inter- National Code like CANADA Drinking water Guideline-Aug.2010 ,US EPA-2010, WHO Guideline-2011 have been done which are shown in previous chapter (Analysis of Results) through tabulated form, graphical representation etc. Besides following findings have also been observed.

Coliform bacteria : No samples found to have presence of coliform organism, which indicate safe for drinking as per microbiological parameter's point of view.

pH :According to Statistical Description, water using, Street Foot Vendors collected from different source of different areas i.e(Tubewell, KMC Supply, Packaged water) where results demonostrate that the Mean pH value ranging from (6.95 to 7.61) with S.D (σ) ranging from (±0.01 to ±0.38).

All samples have pH values between the limit (6.5-8.5), which conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 - 2004 [Packaged Drinking water (other than natural mineral water) specification] , other International Codes and also WHO Guideline-2011. But these values indicate that only Three(3) samples of different zones are acidic and other Samples are Alkaline.

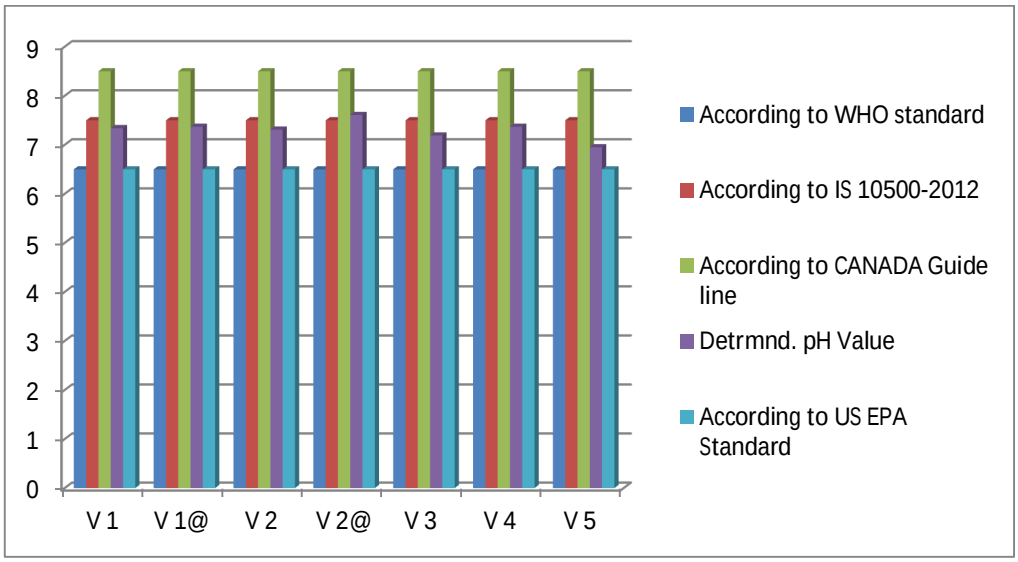
Again 17.65 % Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 82.35 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA

Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid.

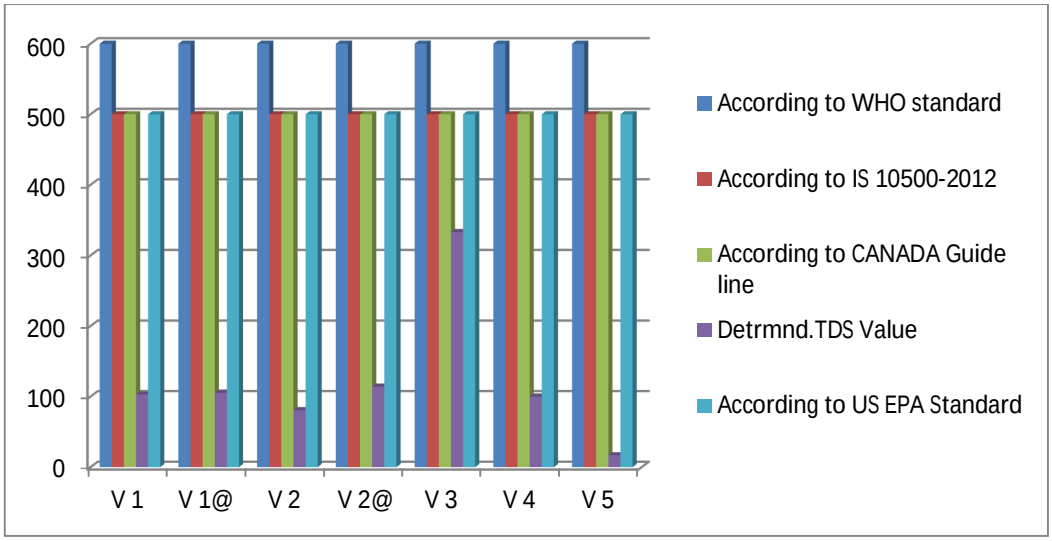
TDS: According to Statistical Description, water using, Street Foot Venders collected from different source of different areas i.e(Tubewell, KMC Supply, Packaged water) where results demonostrate that the Mean TDS value ranging from (16.8 to 333) with S.D (σ) ranging from (±0.096 to ±4.36).

All samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011. 21.05 % samples have TDS below 25 mg/l, 26.32% samples have TDS between 50 and 100 ppm, 52.63 % of samples have TDS between (100 to 400 ppm), (max.336 ppm).

That is, 21.05% samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and 63.16 % samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 ppm*).



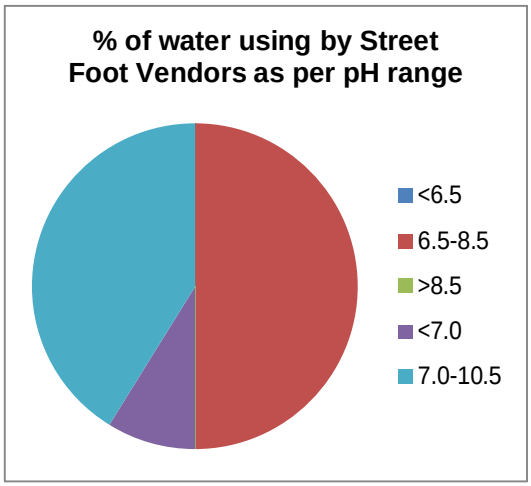
Comparison of Determined pH Value Of Street Foot Vendors Using Water w.r.t. Requirement as per IS Codes and other International Code

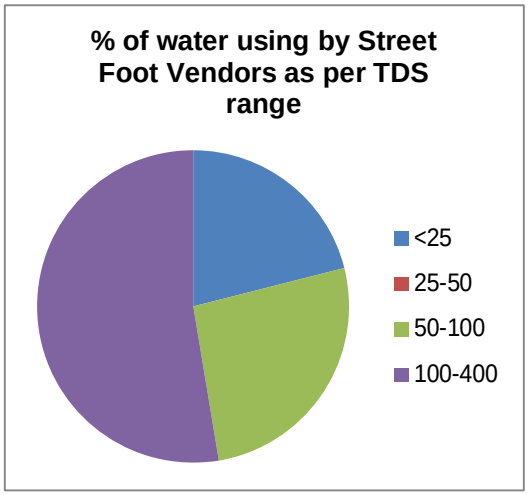


Comparison of Determined TDS Value Of Street Foot Vendors Using Water w.r.t. Requirement as per IS Codes and other International Codes

Percentage of different parameters observed in Water using by Street Foot Vendors:-

Sl. No.	Parameter & (Unit)	Requirement : as per					Range	Percentage (%) of observed values
		IS: 10500-2012	IS: 14543-2004	WHO Guideline -2011	CANADA Drinking Water Guideline Aug.-2010	US-EPA Aug. 2010		Water using by Street Foot Vendors
1	pH	6.5 – 8.5	6.5 – 8.5				< 6.5	-
				6.5 – 8.5	7.0 – 10.5	6.5 – 8.5	6.5 – 8.5	100
							> 8.5	-
							<7.0	17.65
							7.0-10.5	82.35
2	TDS (mg/l)	500	500				< 25	21.05
							25 – 50	-
				500	≤500	500	50 – 100	26.32
							100 – 400	52.63





7.5 WATER USING, TREATEMENT PLANT INSTALLED BY RESIDENTIAL AND COMMERTIAL COMPLEX :-

In case of water using,Treatement Plant Installed by Residential and Commertial Complex collected Three (3) Nos. Water samples from City Centre-2 at Rajarhut, Three(3) Nos. water samples from Accropolis Mall at Rajdanga Main Road, Five(5) Nos. water samples from WIPRO Office Bldg. sector(v) at Saltlake, Six(6) Nos. water samples from AMRI Hospital at Mukundapur, Two(2) Nos. water samples from HighLand Park Residential Complex at Patuli and Two (2) Nos. water samples from CENTRAL Shopping Mall at New Town,Kolkata were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out. On the basis of the WQI values, it is observed that all the water samples (100%) fall under **excellent category (WQI < 50)** and average WQI value is **40.** The detailed results, analysis thereof, comparisons of Three parameters with respect to that as stipulated in IS 10500-2012 (Drinking water specification) and IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], and Other Inter- National Code like CANADA Drinking water Guideline-Aug.2010 ,US EPA-2010, WHO Guideline-2011 have been done which are shown in previous chapter (Analysis of Results) through tabulated form, graphical representation etc. Besides following findings have also been observed.

Coliform bacteria : No samples found to have presence of coliform organism, which indicate safe for drinking as per microbiological parameter's point of view.

pH :According to Statistical Description, water using, Treatement Plant Installed by Residential and Commertial Complex collected samples from different complex where results demonostrate that the Mean pH value ranging from (7.18 to 7.98) with S.D (σ) ranging from (±0.04 to ±0.78).

Out of 5.26% samples have pH values beyond the limit (6.5-8.5), which does not conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification] , other International Codes and also WHO Guideline-2011. But these values indicate that only One(1) sample is acidic and other Samples are Alkaline.

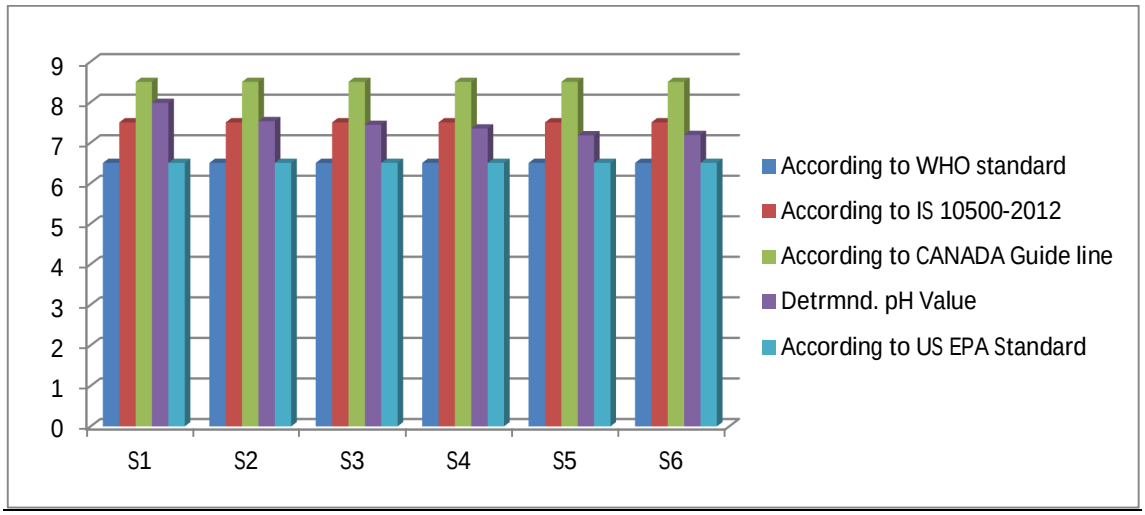
Again 5.26 % Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 94.74 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA

Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid which is generally obtained either filtered by RO purifiers or R.O Treatement Unit.

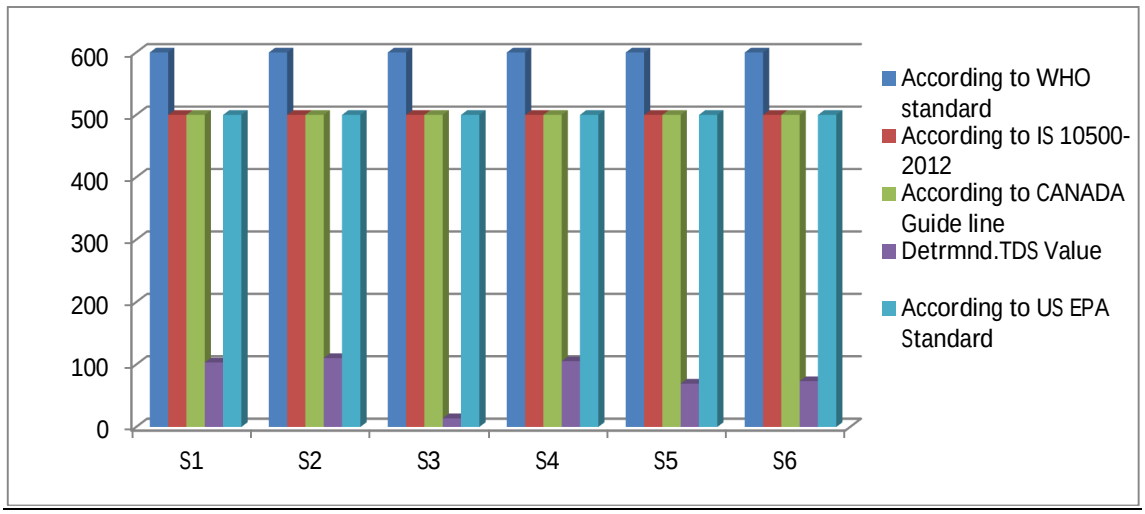
TDS: According to Statistical Description, water using, Treatement Plant Installed by Residential and Commertial Complex collected samples from different complex where results demonostrate that the Mean TDS value ranging from (13.96 to 110.33 ppm) with S.D (σ) ranging from (±0.42 to ±37.3).

All samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011. 23.81 % samples have TDS below 25 ppm, 28.57 % samples have TDS between (50 to 100) ppm,(max.75.4 ppm). Balance 47.62 % of samples have TDS between (100 to 150 ppm), (max.136.6 ppm).

That is, 23.81% samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and 57.14% samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 mg/l*).



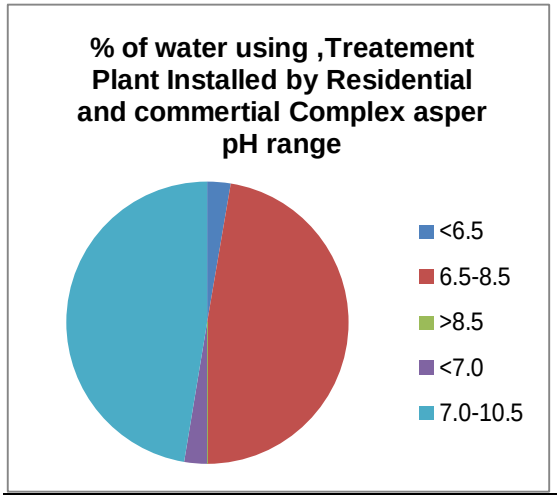
Comparison of Determined pH Value Of Water Using, Treatement Plant Installed By Residential and Commertial Complex w.r.t. Requirement as per IS Codes and other International Codes

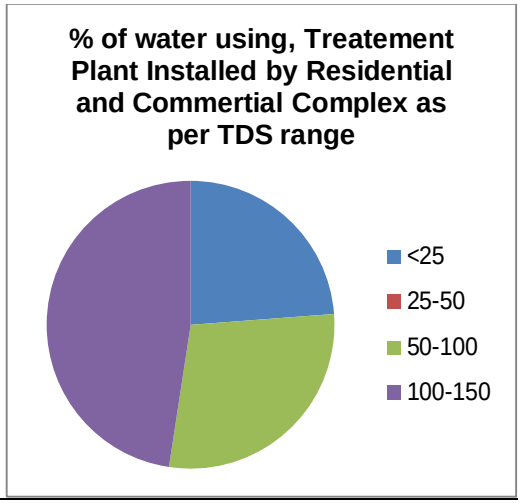


Comparison of Determined TDS Value Of Water Using, Treatement Plant Installed By Residential and Commertial Complex w.r.t. Requirement as per IS Codes and other International Codes

Percentage of different parameters observed in water using, Treatement Plant Installed by Residential and Commertial Complex:-

Sl. No.	Parameter & (Unit)	Requirement : as per					Range	Percentage (%) of observed values
		IS: 10500-2012	IS: 14543-2004	WHO Guideline -2011	CANADA Drinking Water Guideline Aug.-2010	US-EPA Aug. 2010		water using, Treatement Plant Installed by Residential and Commertial Complex
1	pH	6.5 – 8.5	6.5 – 8.5				< 6.5	5.26
				6.5 – 8.5	7.0 – 10.5	6.5 – 8.5	6.5 – 8.5	94.74
							> 8.5	-
							<7.0	5.26
							7.0-10.5	94.74
2	TDS (mg/l)	500	500				< 25	23.81
							25 – 50	-
				500	≤500	500	50 – 100	28.57
							100 – 150	47.62
							>100	-





7.6 TUBEWELL WATER :

In case of Tubewell water collected Four (4) Nos. water samples from near by Green Park Nursing Home at Mukundapur, Four (4) Nos. water samples from near by Bose Pukur water tank, Four(4) Nos. water samples from 2 No. Kheyadaha Gram Panchayet at Sonarpur,Four(4) Nos. water samples from Kolaghat at East Midnapur,Four(4) Nos. water samples from Birati Kali Mandir premises at North 24 Parganas and Four(4) Nos. water samples from Amta Udaynarayanpur at Howrah were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out. On the basis of the WQI values, it is observed that the water sample collected from 2 No.Kheyadaha Gram Panchayet at sonarpur fall under **Poor Category (WQI be150.55) i.e** ranging between (100 to 200),Water samples collected from two zones i.e near by Greenpark Nursing Home at Mukundapur and near by Bose Pukur water tank fall under **Fair Category(WQI be 98.96 and 93.80) i.e** ranging between(75 to 100),water samples collected from three zones i.e Kolaghat at East Midnapur,Birati Kali Mandir Premises at north 24 Pargana and Amta udaynarayanpur at Howrah fall under **good category(WQI be 61.10, 61.86 and 60.78) i.e** ranging between (50 to 75) . The total average WQI value is **88.** The detailed results, analysis thereof, comparisons of Three parameters with respect to that as stipulated in IS 10500-2012 (Drinking water specification) and IS 14543 - 2004 [Packaged Drinking water (other than natural mineral water) specification], and Other Inter- National Code like CANADA Drinking water Guideline-Aug.2010 ,US EPA-2010 and WHO Guideline-2011 have been done which are shown in previous chapter (Analysis of Results) through tabulated form, graphical representation etc. Besides following findings have also been observed.

Coliform bacteria : No samples found to have presence of coliform organism, which indicate safe for drinking as per microbiological parameter's point of view.

pH :According to Statistical Description, Tubewell water samples collected from different zones of North/south Kolkata and different district of West Bengal where results demonostrate that the Mean pH value ranging from (7.15 to 7.58) with S.D (σ) ranging from (±0.04 to ±0.37).

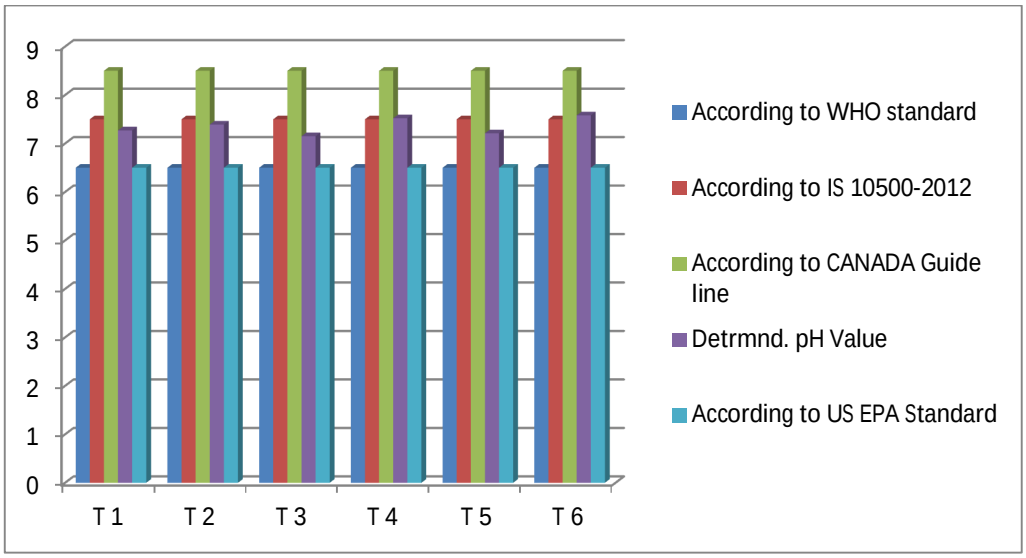
All samples have pH values between the limit (6.5-8.5), which conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 - 2004 [Packaged Drinking water (other than natural mineral water) specification] , other International Codes and also WHO Guideline-2011. But these values indicate that No sample is acidic. But One(1) sample is Neutral value and other Samples are Alkaline.

All samples i.e (100%) of samples have pH Values between (7 -10.5) which conforming to the above mentioned CANADA Drinking water Guideline,Aug-2010.

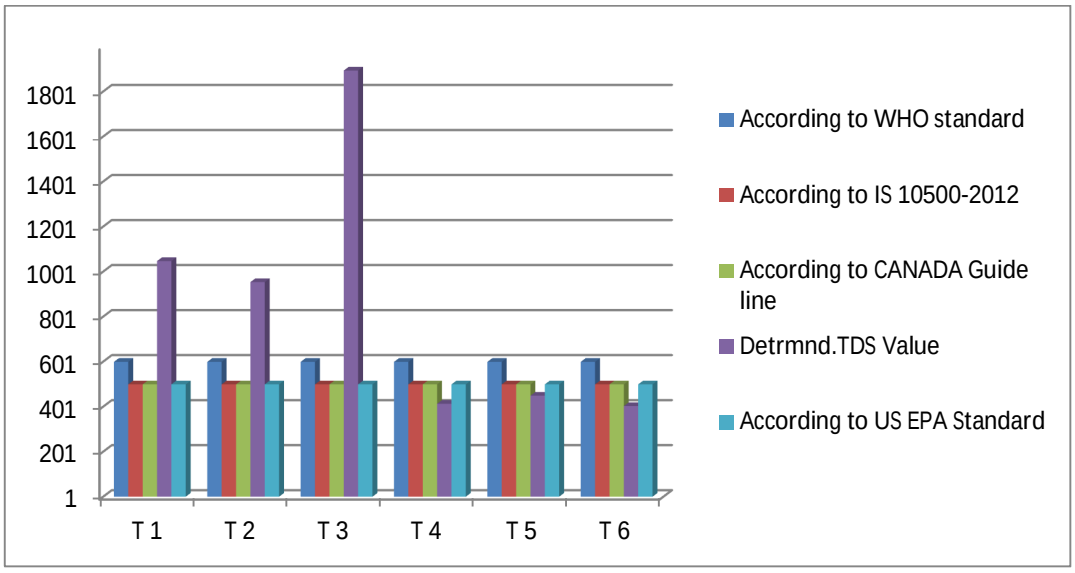
TDS: According to Statistical Description, Tubewell water samples collected from different zones of North/south Kolkata and different district of West Bengal where results demonostrate that the Mean TDS value ranging from (403.5 to 1894 ppm) with S.D (σ) ranging from (±0.71 to ±16.03).

Out of 43.75 % samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011..and balance 56.25% of samples within permissible limit (<2000ppm in absence of alternate source). No samples have TDS below 25 mg/l, No samples have TDS between 25 and 50 mg/l, No samples have TDS between 50 and 100 ppm, .43.75 % of samples have TDS between (400 to 500 ppm), (max.451 ppm) .25 % of samples have TDS between (500 to 1000 ppm), (max. 969 ppm), 18.75% of samples have TDS between (1000 to 1200 ppm), (max. 1054 ppm) and balance 12.5% of samples have TDS between (1500 to 2000 ppm), (max. 1896 ppm).

That is, None of the samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and also None of the samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 ppm*).



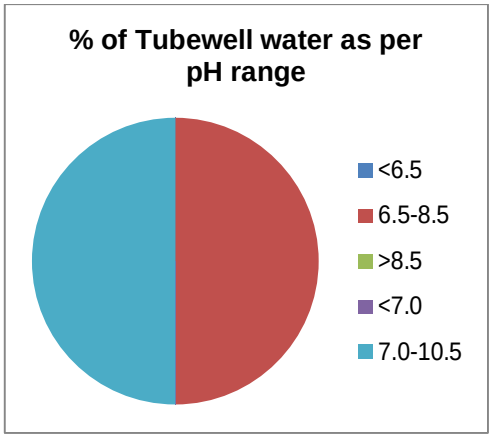
Comparison of Determined pH Value Of Tubewell Water w.r.t. Requirement as per IS Codes and other International Code

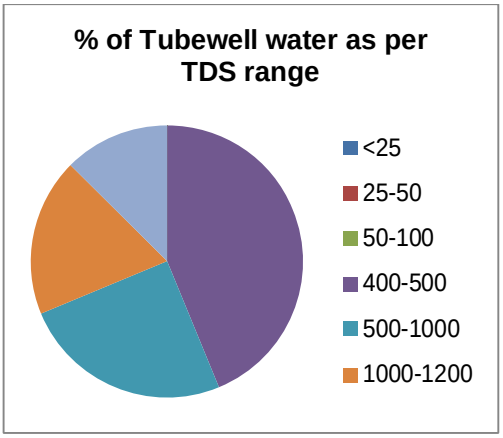


Comparison of Determined TDS Value Of Tubewell Water w.r.t. Requirement as per IS Codes and other International Codes.

Percentage of different parameters observed in Tubewell Water:-

Sl. No.	Parameter & (Unit)	Requirement : as per					Range	Percentage (%) of observed values
		IS: 10500-2012	IS: 14543-2004	WHO Guideline -2011	CANADA Drinking Water Guideline Aug.-2010	US-EPA Aug. 2010		Tubewell Water
1	pH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	7.0 – 10.5	6.5 – 8.5	< 6.5	-
							6.5 – 8.5	100
							> 8.5	-
							<7.0	-
							7.0-10.5	100
2	TDS (mg/l)	500	500				< 25	-
							25-50	-
				500	≤500	500	50-100	-
							400-500	43.75
							500 – 1000	25
							1000 – 1200	18.75
							1500-2000	12.5





CHAPTER 8

CONCLUSION

8.0 CONCLUSION :-

This study has given an insight of overall quality status of (i) packaged drinking water (Different Branded of 500/600 Ml.bottled Pack and 20 Lt. Jar),(ii) KMC Supply water from Treatment plant (Tala, Garden Reach, Dhapa),(iii) Water using Individual purifier (Using RO-UV water purifiers, normal in-built stand alone filters etc.), (iv)Water using Street Foot Vendors (Collected From Tubewell, Packaged water, KMC Supply),(v) Water using,Treatment Plant Installed by Residential and Commertial Complex where (Different Filter like Iron, Arsenic, Activated Carbon, R.O Treatment Plant are used), (vi)Tubewell water (From Different Collected Source), which are available in North Kolkata ,South Kolkata, surrounding areas of North/south Kolkata and Different District in West Bengal.

For all the cases, laboratory tests were conducted against each water sample to determine Three(3) water quality parameters i.e (presence of coliform bacteria, pH, TDS). Based on the result, the water quality index (WQI) and Standard Deviation(σ) has been worked out.

8.1PACKAGED DRINKING WATER (20Lt.Jar+500/600Ml.Bottled Packed):-

In case of packaged drinking water,Twelve (12) brands of 500/600 Ml. Bottled Packaged and Five(5) brands of 20 Lt. Jar with total 62 Nos. water samples were collected and tested in laboratory for determination of Three water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS). In this cases, the results showed that all brands of PDW analyzed are of **excellent category** (WQI<50) and **free from coliform** bacteria and thereby **safe** for human consumption. Regarding other observed parameters, salient points are as under:

***pH*:** Out of 12.5 % samples have pH values beyond the limit (6.5-8.5), which does not conform to IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification], US-EPA Standard and WHO Guideline-2011. These values indicate that Twenty Three (23)samples of packaged drinking water (bottled + Jar) are acidic. For other 87.5% brands, pH values found to be within the acceptable range as per above Codes.

Again 41.07% Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010.Balance 58.93 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline.

TDS: All samples found to have TDS within the acceptable limit (500 mg/l) as per aforesaid IS codes , International Codes.and WHO Guideline-2011.

Out of 93.55 % samples contained TDS below 50 ppm (*very low mineral concentration),6.45* % samples contained TDS between 50 and 120 ppm (*low mineral concentration).*

So, The Packaged Drinking water being soft and low mineral concentration.(Ca,Mg ete.).For long term consumption of this water may lead to increase in cardiovascular diseases and other health problems.Hence this study recommends regular monitoring and survey by concerned government authority and to aware both manufacturers and consumers about this water.

8.2 KMC SUPPLY DRINKING WATER :-

In case of KMC Supply drinking water, collected Fifteen (15) Nos. Water samples from treatement plant (i.e Garden Reach), Sixteen (16) Nos. Water Samples from treatement plant (i.e Tala) and Seven(7) Nos. water Samples from treatement plant (i.e Dhapa) were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS). It is observed that all the above cases, the results showed that all samples (100%) fall under **excellent category (WQI < 50).** and **free from coliform** bacteria and thereby **safe** for human consumption.But only three(3) samples collected from three zones found to have present in **coliform bacteria**.,which may be either **non-cleaning of filter and Pipeline** for a long time.or **lack of chlorine concentration.**

***pH*:** All samples have pH values within the limit (6.5-8.5), which conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 - 2004 [Packaged Drinking water (other than natural mineral water) specification] and other International Codes and also WHO Guideline-2011. But these values indicate that Four(4)samples of Garden Reach, Three(3) Samples of Tala and One(1) sample of Dhapa KMC Supply drinking water are acidic.

Again 25% Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 75 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline. So these values indicate that Four(4)samples of Garden Reach, Three(3) Samples of Tala and One(1) sample of Dhapa KMC Supply drinking water are acidic as per CANADA Standard.

TDS: .All samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes and WHO Guideline-2011.

That is, None of samples contained TDS below 50 mg/l (*very low mineral concentration; <50 mg/l, Ref. EU mineral water directive*) and 89.47% samples contained TDS between 50 and 120 mg/l (*low mineral concentration, TDS 50-500 mg/l*).

So, **the KMC supply water** is highly satisfied and desirable for drinking purpose.

8.3 WATER USING BY INDIVIDUAL PURIFIER :-

In case of water using by Individual Purifier(i.e Using RO-UV water purifiers, normal in-built stand alone filters etc.) collected Nine (9) Nos.Water samples from

Residential complex where using (R.O-UV Water Purifier), Twelve (12) Nos. Water Samples from Commertial Complex where using (normal in-built stand alone filters) and Eleven(11) Nos. water Samples from Institutional area (normal in-built stand alone filters or other purifier) and Thirteen(13) Nos, water Samples from Official sector where using (Both RO-UV water purifiers and normal in-built stand alone filters etc) were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

It is observed that the above cases, the results showed that the water sample collected from Residential Complex(I-1) fall under **excellent category (WQI < 50),**Water sample collected from Commertial Complex(I-2) fall under **Poor Category (WQI be129.90)** ,Water samples collected from Institutinal areas [I-3(i)] and [I-3(iii)] fall under **Fair Category(WQI be 99.96 and 76.98)** ,water samples collected from Institutional areas [I-3 (ii)] fall under **excellent category (WQI < 50** and water samples collected from Institutional ares[I-3(iv)] fall under **Poor Category (WQI be137.995).** It is also observed that the water samples collected from Official sector i.e [I-4(i) and I-4 (iii)] fall under **excellent category (WQI < 50** and water samples collected from official sector [I-4 (ii) fall under **good category(WQI be 73.62).** All samples **free from coliform** bacteria and thereby **safe** for human consumption.But the samples collected from that commertial complex and Institutional areas[I-3(iv)] are undesirable and not recommended for drinking purpose.

pH: Out of 2.38% have pH values beyond the limit (6.5-8.5), which does not conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification] and other International Codes and also WHO Guideline-2011. But these values indicate that No samples of(Residential Complex (I-1) and Commertial Complex (I-2) are acidic. But Two(2)Samples of Institutional areas , Five (5) samples of Official sector are acidic.

Again 16.67 % Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 83.33 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline.But these values indicate that, No samples of(Residential Complex (I-1) and Commertial Complex (I-2) are acidic. But Two(2)Samples of Institutional areas , Five (5) samples of Official sector are acidic as per CANADA Standard.

TDS: 47.72 % of samples found to have TDS within the acceptable limit (500 ppm)as per IS codes , International Codes.and WHO Guideline-2011.and balance 52.27% of samples within permissible limit (<2000ppm in absence of alternate source).

That is, 36.36 samples contained TDS below 50 ppm (very low mineral concentration; <50 ppm, Ref. *EU mineral water directive*) and 4.55 % samples

contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 mg/l*).

The study recommends R.O purifier water with respect to removal percentage of different minerals and hardnass is substantially high and after filtration the water converted from soft to moderate hard, which may lead to increase in cardiovascular disesses and other health problems on long term consumption.But filtered water from Normal stand alone filter is excessive hard which is undiserable and not satisfactory.

8.4 WATER USING BY STREET FOOT VENDERS :-

In case of water using,Street Foot Venders collected Two (2) Nos. Water samples from Tea shop at Kalikapur Road, Two (2) Nos. water samples from Momo shop at 8B Bus Stand at Jadavpur, Two(2) Nos. water samples from 1 No. Gate,J.U, Two(2) Nos. water samples at Ruby more,Three(3) Nos. water samples from Madhyamgram Chowmatha Junction, Four(4) Nos. water samples from Rajarhut near by CC2 and Four (4) Nos. water samples from Street Venders at Singur,Hoogly ,were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

On the basis of the WQI values, it is observed that the above cases, the results showed that all the water samples (100%) fall under **excellent category (WQI < 50)** but only One(1) sample fall under **good category(WQI be 54.58) i.e** ranging between (50 to 75) and all samples **free from coliform** bacteria and thereby **safe** for human consumption.

pH:All samples have pH values between the limit (6.5-8.5), which conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 - 2004 [Packaged Drinking water (other than natural mineral water) specification] , other International Codes and also WHO Guideline-2011. But these values indicate that only Three(3) samples of different zones are acidic and other Samples are Alkaline.

Again 17.65 % Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 82.35 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid.

TDS: All samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011.

That is, 21.05% samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and 63.16 % samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 ppm*).

So,the study recommends the Strret Vendors using water is diserable when using KMC Supply or tubewell water but undiserable when using packaged water.

8.5 WATER USING, TREATEMENT PLANT INSTALLED BY RESIDENTIAL AND COMMERTIAL COMPLEX :-

In case of water using,Treatement Plant Installed by Residential and Commertial Complex collected Three (3) Nos. Water samples from City Centre-2 at Rajarhut, Three(3) Nos. water samples from Accropolis Mall at Rajdanga Main Road, Five(5) Nos. water samples from WIPRO Office Bldg. sector(v) at Saltlake, Six(6) Nos. water samples from AMRI Hospital at Mukundapur, Two(2) Nos. water samples from HighLand Park Residential Complex at Patuli and Two (2) Nos. water samples from CENTRAL Shopping Mall at New Town,Kolkata were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

On the basis of the WQI values, it is observed that all the water samples (100%) fall under **excellent category (WQI < 50)** and all samples **free from coliform** bacteria and thereby **safe** for human consumption.

pH Out of 5.26% samples have pH values beyond the limit (6.5-8.5), which does not conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification] , other International Codes and also WHO Guideline-2011. But these values indicate that only One(1) sample is acidic and other Samples are Alkaline.

Again 5.26 % Samples have pH Values below 7.00 which does not conform to CANADA Drinking Water Guideline Aug-2010. Balance 94.74 % of samples have pH between (7 -10.5) which conforming to the above mentioned CANADA Guideline.The below ranged pH value (<6.5) may be due to dissolved CO_2 converted to carbonic acid which is generally obtained in R.O Treatement Plant.

TDS: All samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011.

That is, 23.81% samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and 57.14% samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 ppm*). **So,the study recommends** that, the processed water by self treatement (R.O plant or others) are highly satisfied but not recommended for long term consumption.

8.6 TUBEWELL WATER :

In case of Tubewell water collected Four (4) Nos. water samples from near by Green Park Nursing Home at Mukundapur, Four (4) Nos. water samples from near by Bose Pukur water tank, Four(4) Nos. water samples from 2 No. Kheyadaha Gram Panchayet at Sonarpur,Four(4) Nos. water samples from Kolaghat at East Midnapur,Four(4) Nos. water samples from Birati Kali Mandir premises at North 24 Parganas and Four(4) Nos. water samples from Amta Udaynarayanpur at Howrah were tested in laboratory for determination of Three(3) water quality parameters of each (i.e. presence of coliform bacteria, pH, TDS).

On the basis of the WQI values, it is observed that the water sample collected from 2 No.Kheyadaha Gram Panchayet at sonarpur fall under **Poor Category (WQI be150.55)**, Water samples collected from two zones i.e near by Green park Nursing Home at Mukundapur and near by Bose Pukur water tank fall under **Fair Category(WQI be 98.96 and 93.80)** ,water samples collected from three zones i.e Kolaghat at East Midnapur,Birati Kali Mandir Premises at north 24 Pargana and Amta udaynarayanpur at Howrah fall under **good category(WQI be 61.10, 61.86 and 60.78)** and all samples **free from coliform** bacteria and thereby **safe** for human consumption.

pH : All samples have pH values between the limit (6.5-8.5), which conforming to the above mentioned Code IS 10500-2012 (Drinking water specification) , IS 14543 -2004 [Packaged Drinking water (other than natural mineral water) specification] , other International Codes and also WHO Guideline-2011. But these values indicate that No sample is acidic. But One(1) sample is Neutral value and other Samples are Alkaline.

All samples i.e (100%) of samples have pH Values between (7 -10.5) which conforming to the above mentioned CANADA Drinking water Guideline,Aug-2010.

TDS: Out of 43.75 % samples found to have TDS within the acceptable limit (500 ppm) as per aforesaid IS codes , International Codes.and WHO Guideline-2011..and balance 56.25% of samples within permissible limit (<2000ppm in absence of alternate source). No samples have TDS below 25 mg/l, No samples have TDS between 25 and 50 mg/l,

That is, None of the samples contained TDS below 50 ppm (*very low mineral concentration; <50 ppm, Ref. EU mineral water directive*) and also None of the samples contained TDS between 50 and 120 ppm (*low mineral concentration, TDS 50-500 mg/l*).**So, the study recommends that**, the Tubewell water samples collected from different areas have contained much TDS value.(Ca,Mg,Na,CO3,HCO3 etc.) which is causes of excessive scaling in pipes and appliances. So,these tubewell water, due to excessive hardness not **recommended and undesirable for drinking purpose.**

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