WATER QUALITY CONTROL

A COMPUTER APPROACH

(A CASE STUDY OF THE FCT WATER BOARD)

BY

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DEDICATION

This project is dedicated to the Almighty God for his infinite mercy.

CERTIFICATION

This is to certify that this work is done by Emeh Angela Nkechi and has not been presented else where for any previous application in maths/ computer science.

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ABSTRACT

The project studies water analysis following the recommended W.H.O guidelines on water purification for human consumption.

Most water analysis tables from DAms and water works were collected and compared with standard W.H.O tables.

A program was finally developed to automate the analysis process with same graphs plotted to simulate the data.

CHAPTER ONE

1.1 INTRODUCTION TO WATER QUALITY

Computer is a complex system of electronics which accepts data, processes the data by obeying a set of given instructions. Computer is very important because it is used in many aspects like in industry to store, manipulate and retrieve data. It makes ones work fast, accurately. It is also used to transfer data and keep records in files.

Computer though has been used in other countries in water quality, but in our country computer has not been used in water quality analysis and that is why this kind of study is very important.

The need for water quality to be maintained cannot be over emphasised due to the alarming rates of poor water quality related diseases or water born diseases which include cholera, typhoid, infections hepatitis, guinea-worm, diarrhoeal e t c.

Water quality must be tackled as a result of the severity of these problems. Man has an inexplicably affinity for water and safe water is the foundation of good health.

We worry about water quality because in our environment much of our water has been polluted by industries, domestic, waste, organic waste from industrial plants inorganic industrial wastes which are hazardous. The other sources of water pollution include chromium from metal plating plants and pesticides.

Municipal, waste, sediment from land erosion. These sediments consist of inorganic material washed into stream as a result of farming, construction or mining operation and also depletion of dissolved oxygen.

The poor state of repair of many of the servers allowed the contents to leak into the aquifer which is the other main source of water. The consequences of this state of affairs were

that water sources became increasingly contaminated by sewage thus became objectionable to both sight and smell and contribute to make waterborne diseases rampant in the city.

Carcinogenic hazards arise from the presence of concentration of some organic compounds in water.

There is no substitute of water in many of its use. Water is the most important natural resource and without it life cannot exist and industry cannot operate. Water is an essential pre-requisite for the establishment of a permanent community.

The continual attention to water quality will eradicate water born-diseases.

Temp. of Water	**Saturation Concentration of Oxygen in Water mg/l.**
22	8.8
24	8.5
26	8.2
28	8.0
30	8.2

1.2 MEASUREMENTS OF H_2O QUALITY

(i) BIOCHEMICAL OXYGEN DEMAND

The rate of oxygen used is called Biochemical Oxygen Demand. It is a measure of the amount of oxygen required by bacteria and other microorganisms. Clean water is indicated by a very low rate of use.

Shag of organic decreases oxygen consumption by aquatic microorganisms. The BOD (Biochemical Oxygen Demand) of most domestic sewage is about 250mg/l.

(ii) CHEMICAL OXYGEN DEMAND

Chemical Oxygen Demand is used to oxidized all organics hence thee organics oxidized chemically are faster compared with the one oxidized biologically.

(iii) TOTAL ORGANIC CARBON

The oxidation of organic carbon gives (CO_2) carbon dioxide. This is done by allowing a little of the sample to be burned in a combustion tube and measuring the amount of (CO_2) carbon dioxide emitted.

The total combustion of a sample will yield some significant information on the amount of organic carbon present.

(iv) TURBIDITY

When light transmission is inhibited in the water, it makes the water not to be clear but dirty and this is known as turbid water. Turbidity is of great importance because of the aesthetic considerations in the treatment of water for drinking and also pathogenic organisms can hide on tiny colloidal particles.

(v) COLOUR AND ODOUR

Colour and odour are important measurements in water treatment and are called physical parameters of water quality.

Colour and odour are necessary from aesthetic stand point and they are caused by organic substances like algae or humic compounds. When the water looks coloured or smells bad, everybody will avoid using it.

Colour is measured by comparison with standards, coloured water which is made with potassium chloro platinate when tinted with cobalt chloride nearly resembles colour of many natural water.

Odour is measured by successive dilutions of the sample with odour free water till

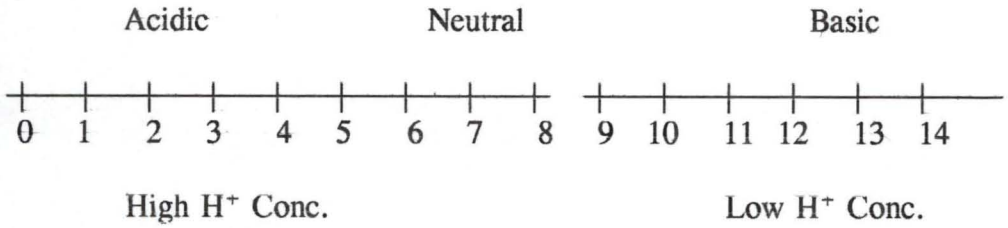
the odour is no longer detectable.

(vi) PH

The PH of a solution is defined as a measure of hydrogen ion concentration. The abundance of hydrogen ions makes the solution acid while less of the hydrogen ion H^+ makes it basic which has an abundance of hydroxide ions OH^-. Quality water suppose to be neutral that is, neither acidic nor basic and an equal concentration of hydrogen ion H^+ and hydroxide ion OH^- are present.

For a neutral solution the hydrogen ion $\{H^+\}$ is 10^{-7} or

PH = 7. The PH range is from 0 to 14.



(vii) BACTERIOLOGICAL MEASUREMENTS

The bacteriological quality of water is important compared with the chemical quality. Lots of diseases are transmitted by water which include typhoid, cholera e.t.c. It is important that water should not be contaminated by pathogens, that is disease-causing organisms and the existence of these organisms has to be determined. The pathogens have specific detection procedure and must be screened individually. The concentration of some organisms are so small and this make their detection impossible. Bacteriological quality is measured by the use of indicator organism. This indicator is a group of microbes called coliform. These coliform are organisms normal to the digestive tracts of warm-blooded animals. Coliform can easily be detected by a simple test and are longer than most known pathogens.

Coliform are universal indicator organisms. The presence of large number of coliform indicates pollution by wastes from warm-blooded animals which may contain pathogenic organisms.

Water with high coliform count should not be consumed. Coliform can be measured as follows:

(a) The sample is filtered through a sterile flat filter thereby capturing any coliform.

(b) The filter is placed in a petri dish which contain sterile agar soaked into the filter. This promotes the growth of coliform.

Water quality control will continue to be vital in safe guarding public health. Water quality control involves the application of biological, chemical and physical principles.

The essential thing is to develop water source to provide an ample supply of water of wholesome equality, that is water that is free from visible suspended matter, excessive colour, taste and odour, objectionable dissolved matter, aggressive constituents, bacteria indicative of faecal pollution.

For drinking water supplies, water must obviously be fit for human consumption that is potable, aesthetically attractive, feasible and suitable.

The side effects of pipe materials on water quality has to be eradicated. The quality of water can be unfavourably affected by the pipe materials through which it is conveyed these effects depends partly on the initial characteristics of the water as well as pipe material which is acidic and low in dissolved solid is particularly likely to attack cement or any metals with which it comes in contact and some of the materials which are dissolved may be harmful to health, besides being aesthetically undesirable.

Iron dissolved from iron, or steel pipe can produce red colour and contribute a metallic taste to water. Lead may be dissolved from lead pipelines still in use in some communities

or from soldered joints in household copper lines.

Plastic pipe under some circumstances may permit organic materials to pass through the wall and contaminate the water being conveyed. Below are the parameters used to measure water quality:-

(i) Dissolved oxygen

(ii) Biochemical oxygen demand

(iii) Chemical oxygen demand

(iv) Total organic carbon

(v) Turbidity

(vi) Colour and odour

(vii) PH

(viii) Solids

(ix) Nitrogen

(x) Phosphates

(xi) Bacteriological measurements, e.t.c.

These are given treatment in section 1.2

Oxygen is fundamental to aquatic life and is poorly soluble in water. The maximum oxygen that can be dissolved in water at normal temperatures is about 9mg/l, and this saturation decreases with increasing water temperature.

Table. 1.1.1:Solubility of Oxygen

Temperature of Water ^{0}C	Saturation Concentration of Oxygen in Water mg/l
0	14.6
2	13.8
4	13.1
6	12.5
8	11.9
10	11.3
12	10.8
14	10.4
16	10.0
18	9.5
20	9.2

1.3 BACTERIOLOGICAL ASSESSMENT OF WATER QUALITY

Bacteriology gives the test for the detections of dangerous faecal pollution. Bacteriological test are necessary for assessment of the bacterial purity and the safety of the water supplies.

(a) Chemical examination is important for eliminating the presence of poisonous metals, radioactive elements, lead which is very dangerous and other harmful substances.

(b) Biological examination deals with the problems concerning taste, odour and filterability which result from the growth of algae.

(c) BACTERIOLOGICAL ANALYSIS OF WATER

The contamination associated with drinking water is by sewage or human excrement. In this case the contamination involved, if one of the contributors are carriers of infectious diseases like typhoid fever or dysentry, the water will be infected and as a result will contain the living micro-organisms which cause the diseases and drinking of such water may result to fresh case. Water polluted by sewage also contain the viruses of poliomyelitis, virus of the Enteron virus group or the virus of infectious hepatitis.

The organisms that is used as indicators of faecal pollution are the coliform group and Escherichia coli. The coliform organisms refers to gram negative, oxidase-negative, non-sporing rods which is capable of growing aerobically on an agar medium having bile salts and able to ferment within 48hrs at 37°C with the production of both acid and gas. Escherichia coli is a coliform organism which is capable of fermenting lactose with the production of acid and gas at both the temperature of 37°C and 44°C in less than 48hrs.

(d) THE EXAMINATIONS OF COLIFORM ORGANISM

Coliforms are the most sensitive indicators for demonstrating the excretal, contamination of water and coliform bacteria are present in large numbers in faeces and sewage and can be detected in numbers as small as one in 100ml of H_2O.

The numbers of coliform and E.coli present has to be estimated to indicate whether the pollution is severe enough as to render the water dangerous.

Coliform assessment is normally performed in two ways:-

(i) By adding measured volumes of water to suitable liquid media.

(ii) By filtering measured volumes of water through membrane filters.

For number one method, measured volumes of water are added to a suitable medium in tubes which are incubated at the temperature of 37°C for 48hours. The number of coliform

bacteria present in 100ml of the samples calculated from the number of tubes showing the presence of acid and gas. This result is called presumptive coliform count and the presumption shows that each tube showing fermentation contain coliform organisms.

The second method is by membrane filtration. In this case, measured volumes of water are filtered through each of two sterile filter membranes which are placed on an absorbent pad and saturated with a suitable liquid. Medium in petri dish. The membranes are incubated at a relatively low temperature for four hours at 30° and then higher temperature, one at 35°C and then higher temperature one at 37°C or 44°C. Acid - producing colonies and gas producers are counted after a total incubation time of 18hours. The result indicates presumptive membrane coliform count and presumptive membrane E.coli count.

The excretal pollution of either human or animal origin is caused by the presence of E.coli in water. The recent pollution is indicated by high counts while remote pollution is indicated by low count and the presence of this E.coli indicates dangerous pollution.

The presence of any coliform organisms in a chlorinated water indicates undesirable material after treatment or inadequate treatment.

Quality water should be free from coliform organisms.

(e) CHLORINATED SUPPLIES

Inefficient chlorination treatment, the water should be free from any coli form organisms.

(i) Unchlorinated supplies

Unchlorinated water are not recommended. The unchlorinated water usually contain E.coli in 100ml.

Water quality should be free from coliform organisms.

1.4 TREATMENT OF WATER QUALITY

The objective of the treatment is to make the water safe and portable.

The contaminants may be present as

(i) Floating or large suspended solids which include leaves, branches e.t.c.

(ii) Small suspended and colloidal solids which include clay, micro-organisms and silt particles.

(iii) Dissolved solids which include alkalinity, hardness, organic acids e.t.c.

(vi) Dissolved gases - include carbondioxide, hydrogen sulphide.

(v) Immiscible liquids - include oils and greases.

The various treatment processes involved in water quality are as follows

(1) Physical processes: This depend on the physical properties of the impurity which include particle size, specific gravity, viscosity. The examples of this process are by screening, sedimentation, filtration, gas transfer.

(2) Chemical processes: In this case, it depend on the chemical properties of the impurity or the chemical properties of the added reagents. The examples of chemical processes include coagulation, precipitation, ion exchange.

(3) Biological processes: Thus utilize biochemical reactions to remove colloidal or soluble impurities which are normally organics. The Aerobic biological processes include activated sludge and biological filtration. The Anaerobic oxidation processes are used for high strength organic waste and for stabilization of organic sludges.

(4) Chlorination: This is used to remove excessive bacteria pollution and final bacteria surviving filtration.

(i) COAGULATION

The impurities in water are usually present as colloidal solids and their removal is done by promoting agglomeration of the particles by flocculation followed by flotation or sedimentation.

Sedimentation is used to remove suspended particles.

The coagulant is a metal salt that reacts with alkalinity in water to produce an insoluble metal hydroxide and it in-corporates the colloidal particles. The precipitate is flocculated to produce settleable solids.

(ii) AEROBIC BIOLOGICAL OXIDATION

The microbial surface allows initial adsorption of colloidal and soluble organics with the synthesis of cells and after a relatively short contact time, the liquid phase contains little residual organic matter which is then oxidised to aerobic end products and the rate of removal of organic matter depend on the phase of the biological growth.

(iii) DISINFECTION

Micro-organisms are small in size and cannot be removed completely by the process of treatment as filtration and coagulation and as such disinfection is required to remove harmful micro-organisms from potable water.

Chlorine is used for the disinfection of water because it is very toxic to micro-organisms and stops their metabolic activities.

(iv) CHEMICAL TREATMENT

The soluble inorganic matter are removed by precipitation or ion-exchange techniques while soluble non-biodegrable organic substances can be removed by adsorption.

(v) CHEMICAL PRECIPITATION

The removal of soluble inorganic materials is done by the addition of suitable reagents which convert the soluble impurities into insoluble precipitates and this can be flocculated and removed by sedimentation.

The amount of removal depends on the solubility of the product, which are affected by factors as PH and temperature.

Chemical precipitation is used in water treatment to remove toxic metals.

(vii) ION EXCHANGE

Ion exchange is used as an alternative to precipitation methods. It is also used for water softening or demineralization in the case of high pressure boiler feed water where high purity water is important.

Natural zeolites normally exchange their sodium ions for magnesium and calcium ion in the water thereby giving removal of hardness completely.

illustrating a zeolite by Na_2X

$$Na^{++}, Mg^{++} + Na_2X \dashrightarrow Ca, Mg + X + 2Na^{+}$$

Ca = Calcium

Mg = Magnesium

Na = Sodium

A salt solution is used to provide a high concentration of sodium ion which is used to reverse the exchange reaction.

$$Ca, Mg + X + 2NaCl \dashrightarrow Na_2X + Ca, Mg + Cl_2$$

Cl_2 = Chlorine.

1.5 TREATMENT METHOD OF WATER QUALITY

The raw water has significant turbidity which is caused by colloidal clay and silt particles. The chemical that is added to the raw water firstly is alum (aluminium sulphate) to neutralize the charge on the particles and to aid in making the tiny particles sticky in order to coalesce and form larger particles called flocs.

This process of charge neutralization is called coagulation. The Aluminium ion that is added as alum are positive charged connected with the negative charged colloids. Then the Aluminium ion react with hydroxide ion to produce aluminium hydroxide $(Al(OH)_2^2$ which is a sticky solid. The process of flocculation is used to bring the neutralized particles and the aluminium hydroxide flocs together. The flocs are settled out after flocculation and this settled flocs form a sludge on the bottom of the tank. The sand filter is used to filter the water and with this sand filter the suspended particles in the water are deposited in the sand.

The water collected after filtration is normally disinfected with chlorine and disinfection is the process of eliminating the remaining micro-organisms in water in which some of this are pathogenic.

The chlorine used is always in correct proportions to water so as to obtain the desired quantity of chlorine in the finished water. Chlorine oxidizes the micro - organisms when it comes in contact with organic matter and reduce the micro - organisms to inactive chlorides. Chlorine is soluble in water and forms hypochlorous acid with water.

$$Cl_2 + H_2O ====== HOCl + H^+ + Cl^-$$

Cl_2 = Chlorine

Chlorine have fluoride to add to water which prevent dental decay in children and young adults.

CHAPTER TWO

PHYSIO-CHEMICAL WATER ANALYSIS

(FCT WATER BOARD CASE STUDY)

2.1 REMOVAL OF SUSPENDED SOLIDS AND COLLOIDS

The presence of different types of solids help to pollute the water and causes clogging of piping and coolant systems. These solids and colloids need to be removed to avoid the problems involved.

The method of separation of solid particles from water include the direct use of gravity in form of sedimentation and the determining factors are the size and specific weight of the particles, also by flotation whereby air bubbles that is introduced into the suspension attach themselves to the particles and then filtration or screening is used.

The table below indicates a number of materials and organisms with their size and a rough estimate of the time needed for these particles to settle.

Particle Diameter (mm)		**Setting time in 1m**
10	gravel	1 second
1	sand	10 seconds
0.1	fine sand	2 minutes
0.01	clay	2 hours
0.001	bacteria	8 days
0.0001	colloidal particle	2 years
0.00001	colloidal particle	20 years

The particles of a litre of good quality water will have a total weight of less than 0.1 mg.

(i) COAGULATION AND FLOCCULATION

(a) Destabilization of a colloidal suspension.

The separation of a colloidal suspension for instance by gravity is done by agglomerating the colloidal matter in order to form lager particles.

The destabilization is achieved by the addition of chemical reagents that nullify the repulsive forces or act on the hydrophily of the colloidal particles, the agglomeration of the neutralized colloids is the result of forces of attraction acting between the particles.

These particles are brought into contact with each other by Brownian movement till they acquire a size of about 0.1 micron.

The reagents used are called coagulants and flocculants.

(b) Coagulants and Flocculants

The polyvalent cationic inorganic salts are used as coagulants.

The trivalent iron and aluminium salts are used for coagulation treatment applied to water.

The coagulating effect is based on the valence of the ion carrying a charge opposite to that of the particles.

The higher the valency the more effective is the coagulating action.

These coagulants due to hydrolysis have the disadvantage of modifying the physio-chemical characteristics like PH value, conductivity of the water treated.

The excess amount of it when used cause big amount of sludge which is not good.

Flocculants

The example of flocculants is the activated silica which is obtained by the

controlled polymerization of silicic acid and is capable of being linked to aluminium salts and has the function of processing drinking water.

(ii) **SETTLING AND CLARIFICATION**

The granular particles and the flocculated particles settle at different rate.

The flocculated particles result from induced agglomeration of colloidal substance in suspension, the rate of settling increases as a result of encountering other finer particles as its dimension increase. While the granular particles settle at constant rate.

(iii) **FLOTATION**

In flotation, the difference in specific mass between solids or liquid droplets and the liquid in which they are suspended are used.

The solid - liquid or liquid - liquid separation is applied to particles that the apparent specific mass (stimulated flotation) is lower than that of the liquid in which they are contained to bring the separation by flotation of solid or liquid particles with a higher density than the liquid, the adhesion between the particles and micro bubbles should be greater than the tendency of the liquid to wet the particles.

(iv) **FILTRATION**

The process of passing a solid - liquid mixture through a porous material like filter that retains the solid and allows the liquid (filtrate) to pass through is known as filtration, surface filtration occurs when the dimensions of the suspended solids are larger than those of the pores whereby the solids are being retained on the filter surface. While when the solids are being retained within the porous mass the process is called filtering in volume.

2.2 The organisation produce water from the dam and treat the water, process it and supply to the city of Abuja.

The aim of the plant is to supply drinking water to the city of Abuja. The method of

processing the quality water from the dam by the organisation is as follows

Aeration, Sedimentation (FlocculationCoagulation

Filtration, disinfection, clear water

Aeration ----> Sedimentation (Flocculation

or Coagulation

(i) **AERATION:** is the process of mixing water with air mechanically to reduce odour and oxidise some compounds.Casted or water fall through steps.

(ii) **SEDIMENTATION**: The process takes place in two different ways; Flocculation and Coagulation. Flocculation is floc formation through the addition of Alum in water and the action of Alum is controlled by Lime. Coagulation is the coming together of the floc to form heavy agglomeries. The sediments of the agglomeries is sedimentation. The tiny unsettled particles goes to the fitters where filtration takes place, then the filtered water is disinfected with chlorine.

When water treatment is finished, the parameters like total hardness of water, methyl orange alkalinity or total alkalinity, PH, temperature, e.t.c of the different kinds of water were analyzed and every parameter is compared with the world health standard.

2.3 THE ANALYSIS OF THE DATA IS DONE IN THE FOLLOWING WAYS

(i) TOTAL HARDNESS

The presence of calcium (Ca^{++}) and magnesium (Mg^{++}) causes total hardness of water.

The principle formation of calcium (Ca^{++}) and magnesium (Mg^{++}) ion complexes with a titrated solution of disodium ethylene diaminetetra-acetate in a PH 10 buffered medium.

The titration end point is detected by means of Eriochrome black T

Reagents used Eriochrome black T (Net) powered form or solution

Net	0.25g
absolute alcohol	100ml

10 buffer solution (Ammonium chloride)

EDTA disodium salt (or complexion)

(ii) Burette is filled with EDTA disodium salt solution to zero level, 100ml of the sample is transfered into Elenmeyer flask, then approximately 20 drops of the k 10 buffer solution and 5 of Net or pinch of powered Net is added. The colour of solution changes to a vinous red in the presence of calcium and magnesium ions. Then EDTA disodium salt solution is added drop by drop until the colour changes pure blue and the total hardness degree is read directly from the burette.

(iii) CHLORIDE ION

Silver Nitrate ($AgNO_3$) solution is used for the test. Silver Nitrate ($AgNO_3$) causes the precipitation of the chloride ions white. The titration end point is detected by the presence of free Ag^{++} ions (Silver ion) it is indicated by the

potassium chromate which precipitates the silver ions (Ag^{++}) as brick-red silver chromate (Ag chromate) the test is effected in a slightly alkaline medium.

Reagents

Potassium dichromat indicator solution

($K_2Cr_2O_7$) 100g/l

100g of dry potassium dichromat is dissolved in 1,000ml of distilled water

100g of oxalic acid is dissolved in 1,000nl of distilled water

Phenolphthalein (10g/l) ($C_{20}H_{14}O_4$)

10g of phenolphthalein is dissolved in 1,000ml of distilled water

Silver Nitrate ($AgNO_3$), N/25 (0.04N)

7g reagent grade silver nitrate ($AgNO_3$) is crushed and dried to 110°C and let cool indicator

The burette is filled with Silver Nitrate solution ($AgNO_3$)

100ml of the sample is transfered into erlenmeyer flask. Then 3 or 4 drops of phenolphthalein is added. If the water become pink, oxalic acid is added drop by drop until the pink colour disappears. Then 4 or 5 drops of the 10% dichromat potassium solution is added and the colour becomes yellow, then silver nitrate is added until a brick red colour appears and the volume is read.

(iv) Methyl orange alkalinity or total alkalinity

Reagents

Alkali metric reagent acid solution

Hydrochloric acid (HCl)

0.1m solution containing 36.5g of Hydrochloric acid (HCl) per one litre of Hydrochloric acid is prepared. 40ml of the N solution is transfered to a 1,000ml

flask and made up to 1,000ml with 960ml of distilled water sulphuric acid,

0.1m solution containing 49.0g of sulphuric acid (H_2SO_4) per litre is prepared

40ml of the N solution is transferred to 1,000ml flask and made up to 1,000ml with 960ml distilled water

10g of 1% helianthin is dissolved into 1,000ml of distilled water.

PROCEDURE: The burette is filled with the alkali metric reagent up to zero mark,

100ml of the sample is transferred into flask and few drops of helianthin added, then the colour changes immediately from pink to yellow. The alkali metric reagent is added until an orange colour appears

The methyl orange alkalinity (TAC) is read directly from the burette.

(v) Determination of Temperature

The temperature of water is determined with the use of thermometer. The thermometer is immersed in water as soon as the sample of water is collected and measured.

(vi) Determination of PH

PH indicates the hydrogen ion concentration and the value of PH determines its acidity or alkalinity.

The hydrogen ion concentration of water (PH) is determined with the use of Electronic PH meter.

The PH meter is ascertained to be functioning properly before using it. The apparatus is calibrated with one standard buffer solution. The electrode is rinsed before immersing in the sample whose PH is being determined and PH is read to

the nearest tenth of a PH unit.

2.4 STANDARDS OF CHEMICAL AND PHYSICAL QUALITY - TOXIC SUBSTANCES

The table indicates the maximum content of certain dangerous substances in drinking water.

Substances	Provisional maximum Concentrations permissible
Lead (Pb)	0.10mg/l
Selenium (Se)	0.10mg/l
Arsenic (As)	0.05mg/l
Cyanide (CN)	0.05mg/l
Cadmium (Cd)	0.01mg/l
Total Mercury (Hg)	0.01mg/l

When the content of any one of these substances exceeds the limit shown the water cannot be distributed to the public for use.

In fluorides the recommended maximum concentrations allowed is as follows

Mean annual Daytime temp (^{0}C)	Recommended maximum and minimum Concentration for fluorides (in F) (Mg/L)	
	Minimum Concentration	Maximum Concentration
10.0 - 12.0	0.9	1.7
12.1 - 14.6	0.8	1.5
14.7 - 17.6	0.8	1.3
17.7 - 21.4	0.7	1.2
21.5 - 26.2	0.7	1.0
26.3 - 32.6	0.6	0.8

2.5 WORLD HEALTH ORGANISATION DRINKING WATER STANDARDS

CHARACTERISTICS	HIGHEST DESIRABLE LEVEL	MAXIMUM PER-MISABLE LEVEL
Total solids (mgK)	500	1500
Colour (H)	5	50
Taste odour	Unobjectionable	-
Odour	Unobjectionable	-
Turbidity (FTU)	5	25
Chloride (mg/l)	200	600
Iron (mg/l)	0.1	1
Manganese (mg/l)	0.05	0.5
Copper (mg/l)	0.05	1.5
Zinc (mg/l)	5	15
Calcium (mg/l)	75	200
Magnesium (mg/l)	30	150
Sulphate (mg/l)	200	400
Total hardness ($CaCO_3$) (mg/l)	100	500
Nitrate(as NO_3)mg/l	45	-
Phenol (mg/l)	0.001	0.002
Anionic detergent	0.02	
	0.9-1.7(mean temp 12^0C	
	0.6-0.8(mean temp 32^0C	1.0
Fluoride (mg/l)		
PH (units)	7 - 8	min6.5 max 9.2
Arsenic (mg/l)	-	0.05
Cadmium (mg/l)	-	0.01
Chromium (6+)(mg/l)	-	0.05
Cyanide (mg/l)	-	0.05

2.6 AERATION

(i) Water is aerated to remove excess gases which include hydrogen sulphide (H_2S) and this gas gives foul taste.

Oxygen causes problem in the clarifiers where the floc try to rise to the surface and also in the filters where it cause false clogging carbon dioxide (CO_2) makes water aggressive when the water is short of oxygen, the effect of aeration is as follows;

To oxidise ferrous and manganous ions

To nitrify ammonia under certain conditions

To increase the oxygen content which make the water more palatable. Further more the addition of oxygen to water that is rich in ammonia or sulphates facilitate control of anaerobiosis and prevents corrosion of metal pipes.

(ii) CLARIFICATION

The degree of clarification differs with the turbidity and colour of the water and its suspended colloidal organic solids content.

As a result of these factors it takes the form of complete coagulation, flocculation, clarification and filtration. Partial coagulation, micro-flocculation and filtration.

The addition of a coagulant lowers the negative electric potential of the particles in the water which gives complete coagulation of the colloids, and this lead to optimum clarification after flocculation, settling and filtration.

The addition of small quantity of coagulant gives partial coagulation of the colloids with the formation of fine floc and this can be separated by filtration.

(iii) FILTRATION

Filtration is taken as a finishing process which can be improved by further treatment.

Water with high organic matter content including quantities of iron improved by carrying out coagulation - flocculation clarification process at different PH values followed by filtration process. The dose of coagulant indicates the final turbidity after filtration.

(iv) DISINFECTION

The disinfecting agent is added to the water to ensure water quality which is free from putrid bacteria and pathogenic germs that satisfies official standards and tests based on Escherichia coli.

Faecal streptococci and sulphite - reducing clostridium.

Chlorine or calcium hypochlorite is used if the water to be disinfected contains no organic matter or chemical pollutants which is likely to form compounds that can give foul taste to the water. The amount of chlorine added to the water should not be too high, if it is high, the taste of chlorine is removed by partial destruction with hyposulphite or sulphur dioxide.

Chlorine or hypochlorite with granular activated carbon are used before final treatment to remove the taste - carrying organic matter and excess chlorine is destroyed by catalysis.

(v) ULTRA - VIOLET RAYS

Are an effective disinfecting agent and destroy large numbers of viruses as far as they are applied to a thin stream of water and sufficient power. The water should be clear, free from turbidity, colourless and must not contain any iron, organic colloids, planktonic micro-organisms which can form deposits on the pipes.

2.7.1 F.C.T water bard provide healthy and adequate water for human consumption and industrial use and is created in October, 1989.

The objectives of the Board include the followings

(a) To control, manage, install, maintain all water works and services vested or to be vested on the Board by the minister of Federal Capital Territory.

(b) To ensure the supply of potable water of adequate quantity and quality for the territory at an economic rate.

(c) To harness all water resources of the Territory for economic development.

(d) To encourage the conduct of research for the purpose of carrying out its functions.

(e) To submit the results of such research to the Hon. Minister for policy formation control in the Territory.

2.7.2 ORGANISATIONAL STRUCTURE

The Board has five main departments in its organisational structure with the director and five heads of department under the director.

These Head of Departments oversee the day to day activities of the developments. The Heads of Department are answerable to the Director who is the Chief Executive of the Board.

The five departments are as follows:

(i) PLANNING AND OPERATIONS

This department is in charge of water connections and maintenance of pipe lines and also deal with statistics.

(ii) RURAL DEVELOPMENT

This department deal with Rural Water thereby providing Boreholes in places where there is no water. The department also deal with geophysical survey, and in this case they test

the soil texture whether it will be suitable for digging bore hole or not.

In the area of Rural mobilization, the department makes sure that borehole is made available in all the rural areas.

(iii) FINANCE AND SUPPLIES

This department controls the Board's Finance. The department deals with salaries, that is payment of staffs salaries and other charges, revenue collection, supplies e.t.c.

(iv) COMMERCE

This department deals with Billing and Distribution the department bills the customers and listen to complain. The Billing system they use is the Automotive Billing system which involve debit and credit.

They credit the account as the customers pays in, there is number assigned to the customers, each of the plot no is written down in each of the location, the Bills are printed at the end of the months and distribution is made, while payment is made to the payment revenue there is provision for the date of payment. Some people charge on flat rate or metre reading.

The department deal with revenue generation, water connection and processing.

Also disconnection of water for those that refuse to pay their bill.

(v) PERSONNEL

The personnel department is in charge of general administration and staff matters. This also deals with recruitment and discipline, supervise the punctuality of staffs, training, promotion of staff, security and general welfare of staffs.

In this department, the legal unit, public relations are included.

The registry deals with staff records and files.

(vi) CITY WATER SUPPLY

USUMA DAM

The primary source of water supply to the city and its environs is the lower Usuma Dam.

Dam

This dam is constructed in 1984 and has a reservoir of a maximum capacity of 100 million cubic meters and is equipped with water treatment plant that is having a designed capacity of 5,000 cubic metres of water per hour.

The dam is sited on a virgin land where there is no human activity, ensuring non pollution of the environment and is free from industrial impurity.

The dam is located at about the highest point of the territory and feeds the water treatment plant by gravity. The dam is provided with a pumping station in order to pump raw water from the main dam to the water works in the extreme drought situation when the reservoir water level is severely depleted.

(ix) THE WATER TREATMENT PLANT

The treatment plant is located in such a position that it can supply the city by gravity it has a designed capacity of 5,000m^3 hr.

The location of the plant enables the water to move by gravity from the plant to the water storage. Tanks and the treatment plant consists of permanent structures necessary for the conventional water treatment processes. The water treatment plant is provided with well equipped laboratory where all relevant quality control analysis is being carried out daily.

The quality of water produced by the Board and supplied to the consumer by the Board is normally compared with the World Health Standard and has been within the range approved by the World Health Organisation (WHO).

The different stages of water treatment process are as follows;

(i) **Aeration:**

This is the removal of odour from raw water by mixing it with natural air. The process help to improve the colour and the taste of the water.

(ii) **Chemical Dosing:**

The process deals with the adding of chemicals to the aerated water as to make dissolved and suspended impurities settle down.

The chemicals used at this stage are Aluminium sulphate, chlorine and Hydrated Lime.

(iii) **Clarification:**

The water goes into the clarifier pulsafors after the aeration and chemical dosing where coagulation and flocculation takes place.

The flocs aggregate are trapped in the sludge blanket while the clarified water is conveyed to the sand filters.

(iv) **Rapid Filtration:**

Rapid filtration is the removal of impurities that cannot settle down through coagulation and flocculation. The settled water passes through the sand filter where smaller particles are removed.

(v) **Disinfection:**

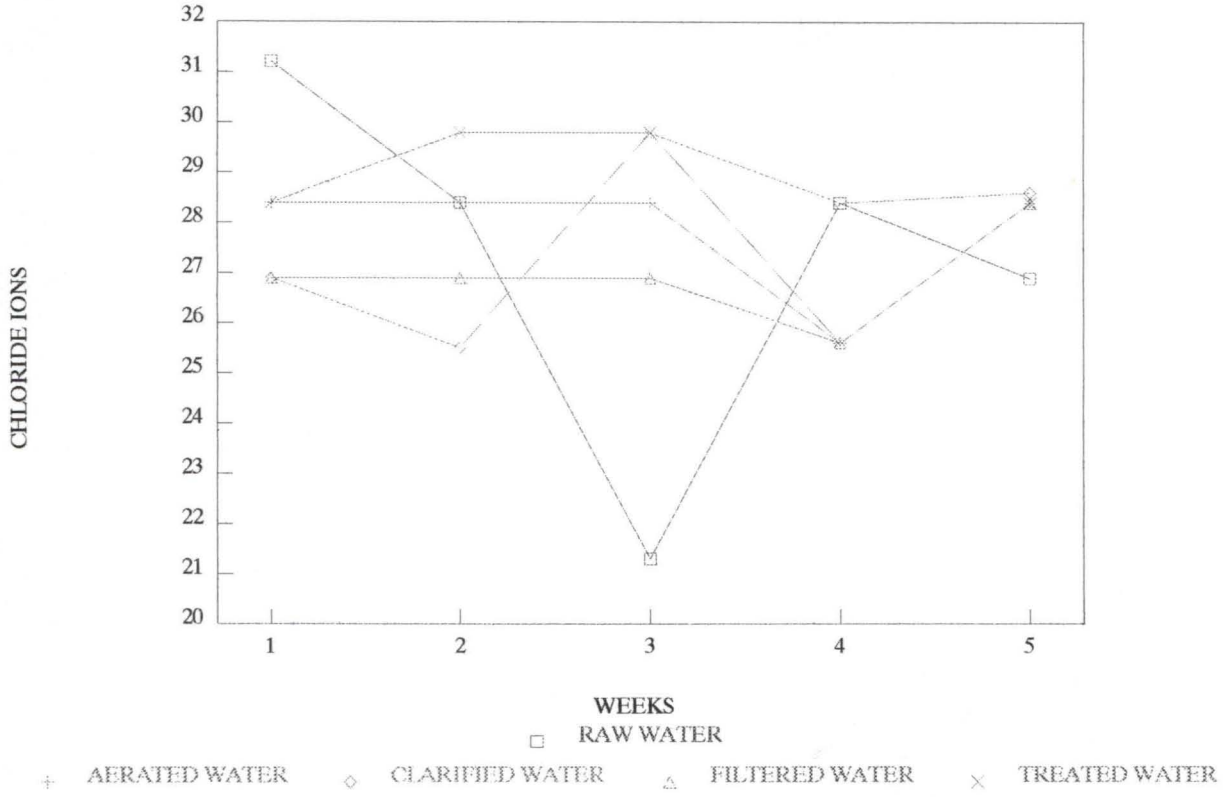
This is the final stage of water treatment where chlorine in gaseous or powered from is added to the water with the view of killing all the bacteria that survived the earlier processes of treatment.

Lime is also added in order to improve the quality of the water before delivery it to the consumer finally.

	CL				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	31.2	28.4	26.9	26.9	28.4
2	28.4	28.4	25.5	26.9	29.8
3	21.3	28.4	29.8	26.9	29.8
4	28.4	25.6	28.4	25.6	25.6
5	26.9	28.4	28.6	28.4	28.4

GRAPH OF CHLORIDE IONS

AGAINST WEEKS

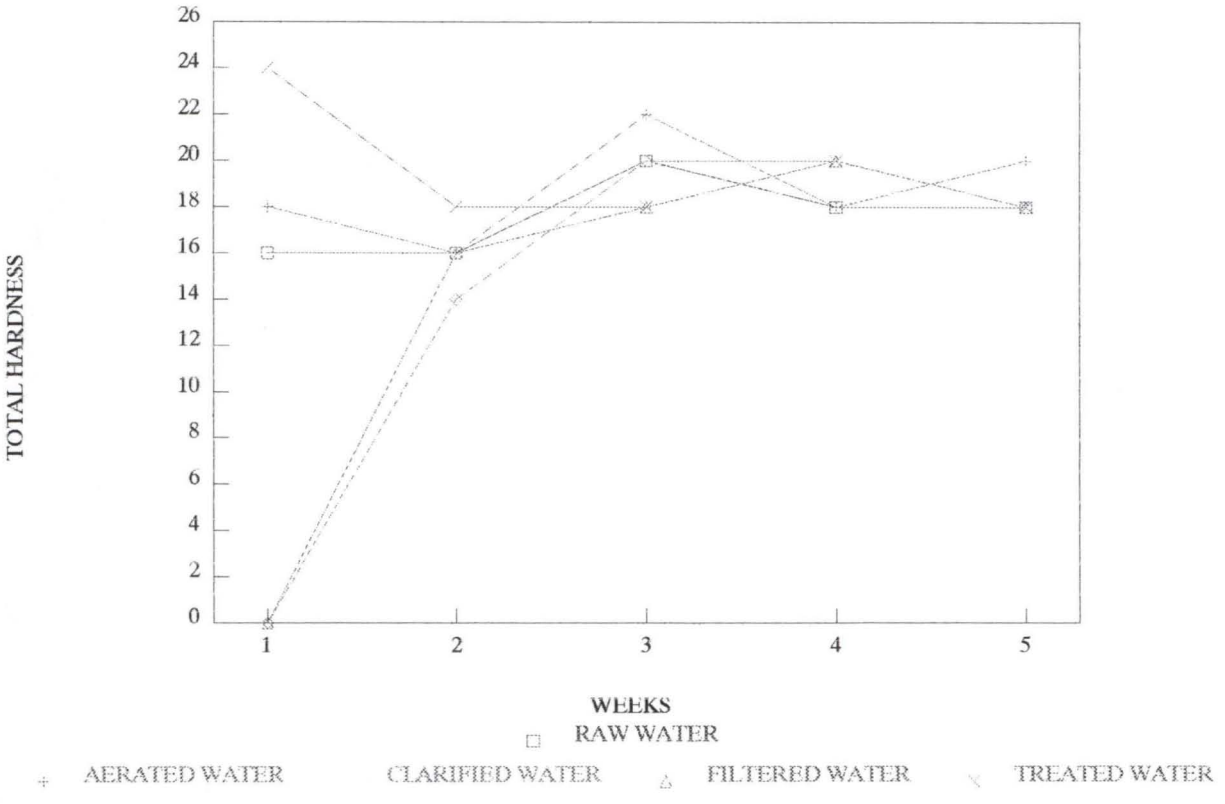


30

	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	18	0	0	24
2	16	16	14	16	18
3	20	22	20	18	18
4	18	18	20	20	20
5	18	20	18	18	18

GRAPH OF TOTAL HARDNESS

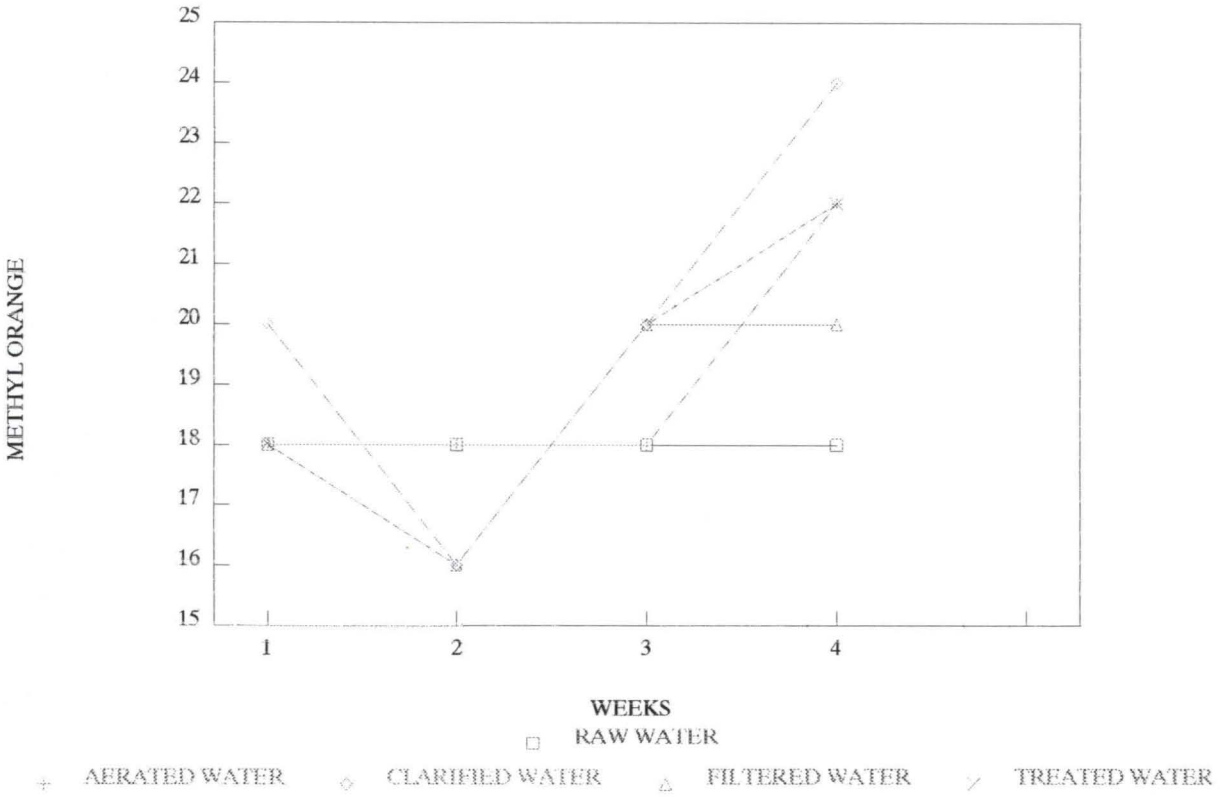
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	18	18	20	18	18
2	18	18	16	16	16
3	18	18	20	20	20
4	18	22	24	20	22

GRAPH OF METHYL ORANGE

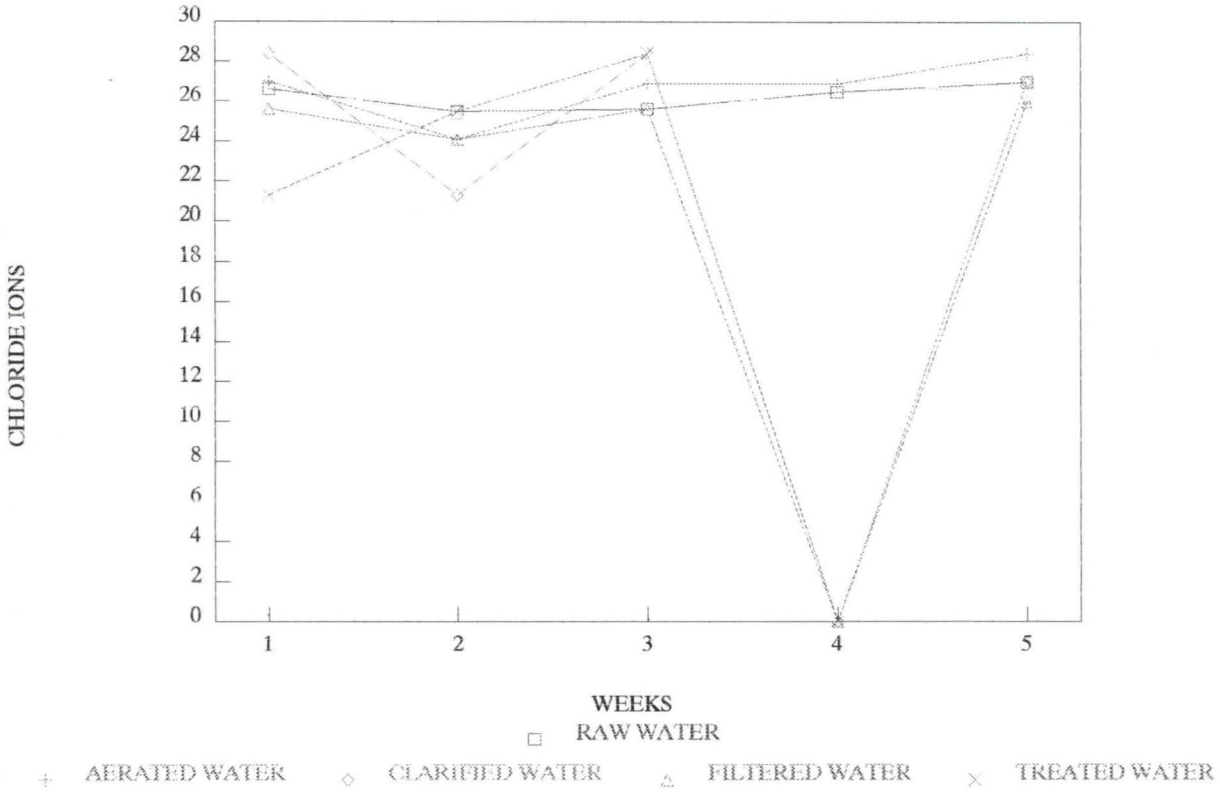
AGAINST WEEKS



	CL IONS				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	26.6	26.98	28.4	25.6	21.3
2	25.5	24.1	21.3	24.1	25.5
3	25.6	26.9	28.4	25.6	28.4
4	26.5	26.9	0	0	0
5	27	28.4	27	26	26

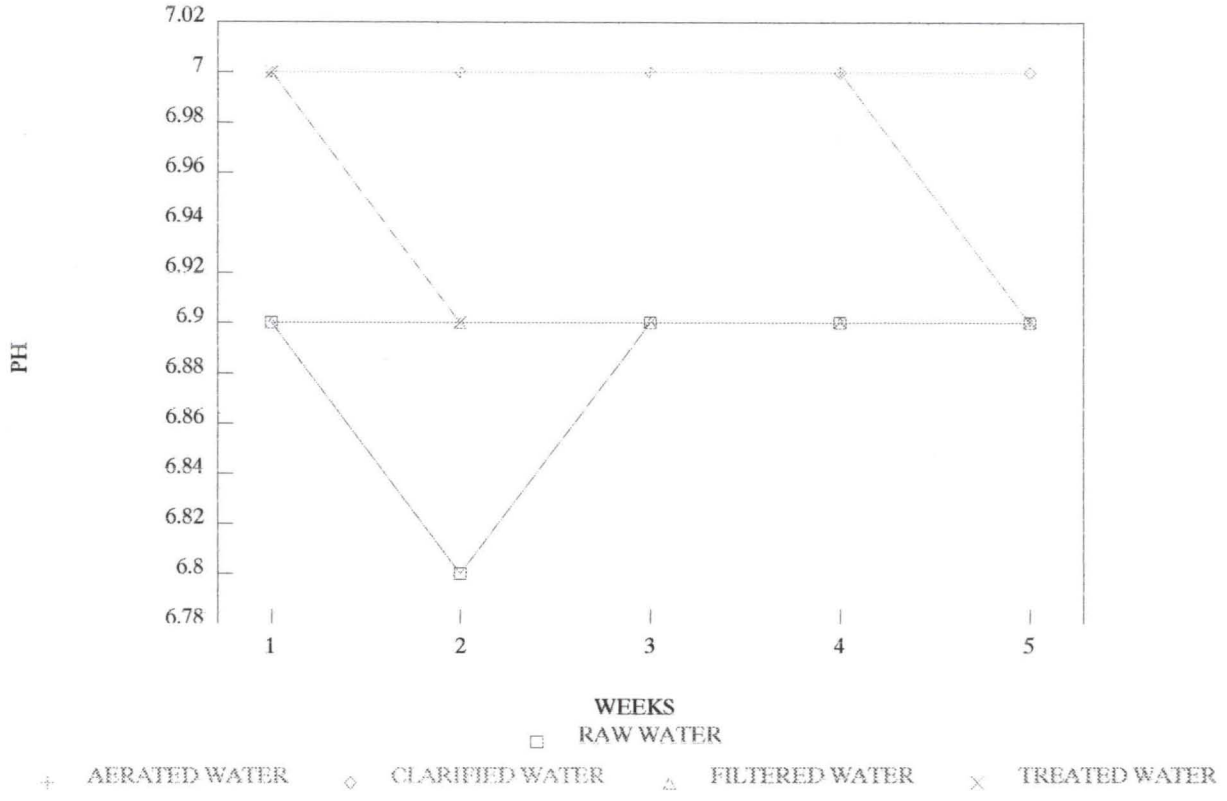
GRAPH OF CHLORIDE IONS

AGAINST WEEKS



02-02-97	PH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	6.9	7	7	6.9	7
2	6.8	7	7	6.9	6.9
3	6.9	7	7	6.9	6.9
4	6.9	7	7	6.9	6.9
5	6.9	6.9	7	6.9	6.9

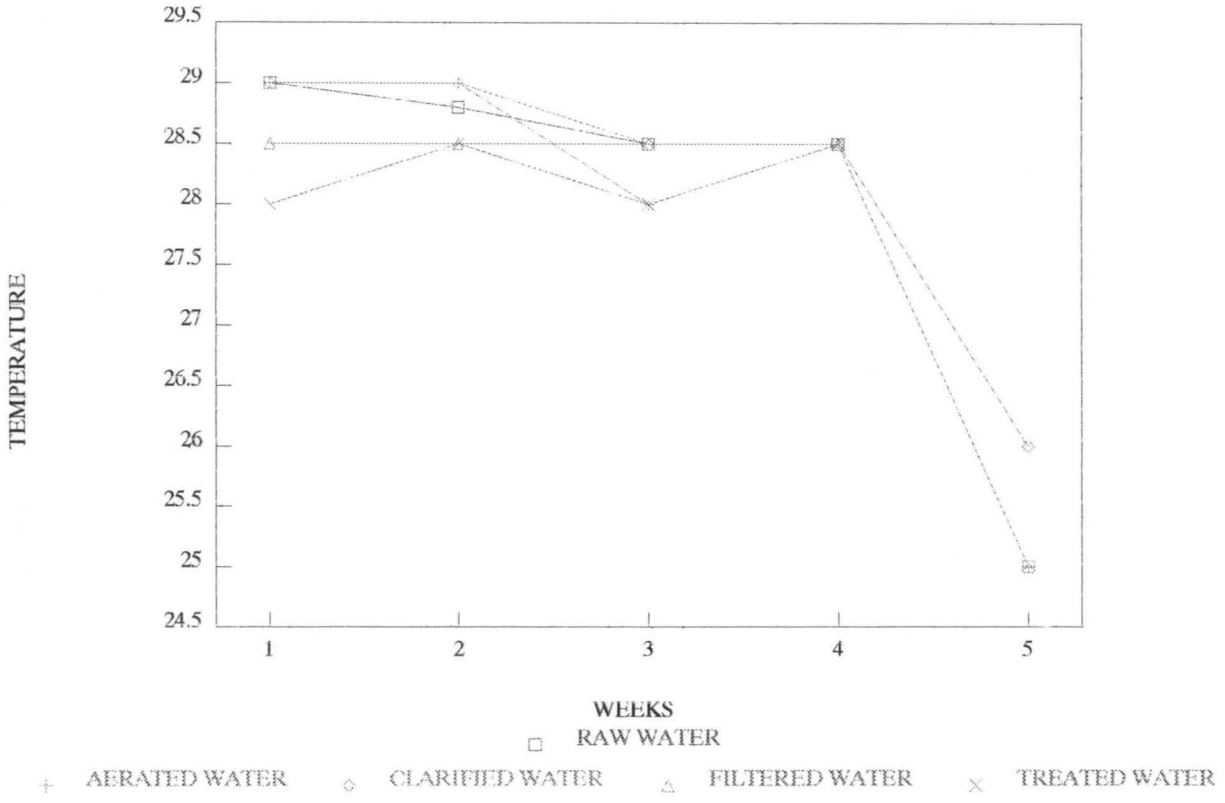
THE GRAPH OF PH AGAINST WEEKS



	TEMP				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	29	29	29	28.5	28
2	28.8	29	29	28.5	28.5
3	28.5	28	28.5	28.5	28
4	28.5	28.5	28.5	28.5	28.5
5	25	25	26	25	26

GRAPH OF TEMPERATURE

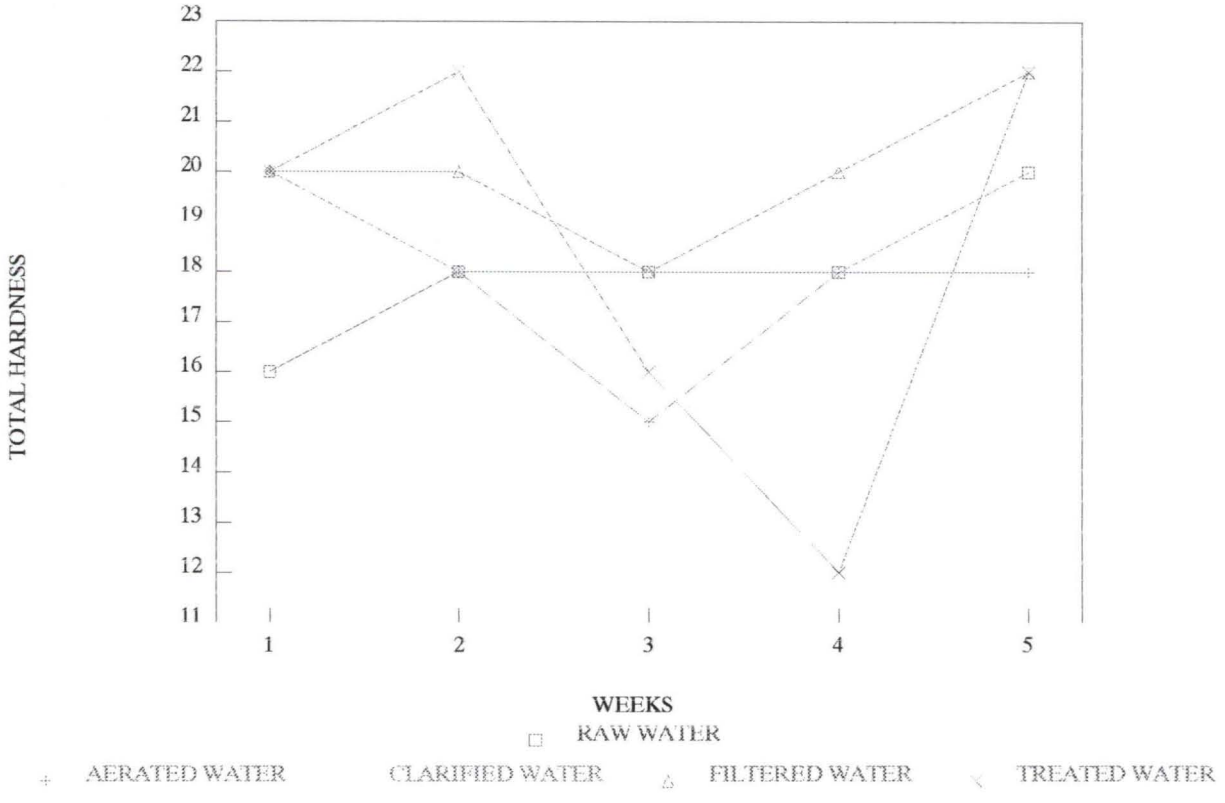
AGAINST WEEKS



	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	20	20	20	20
2	18	18	18	20	22
3	18	15	18	18	16
4	18	18	18	20	12
5	20	18	20	22	22

GRAPH OF TOTAL HARDNESS

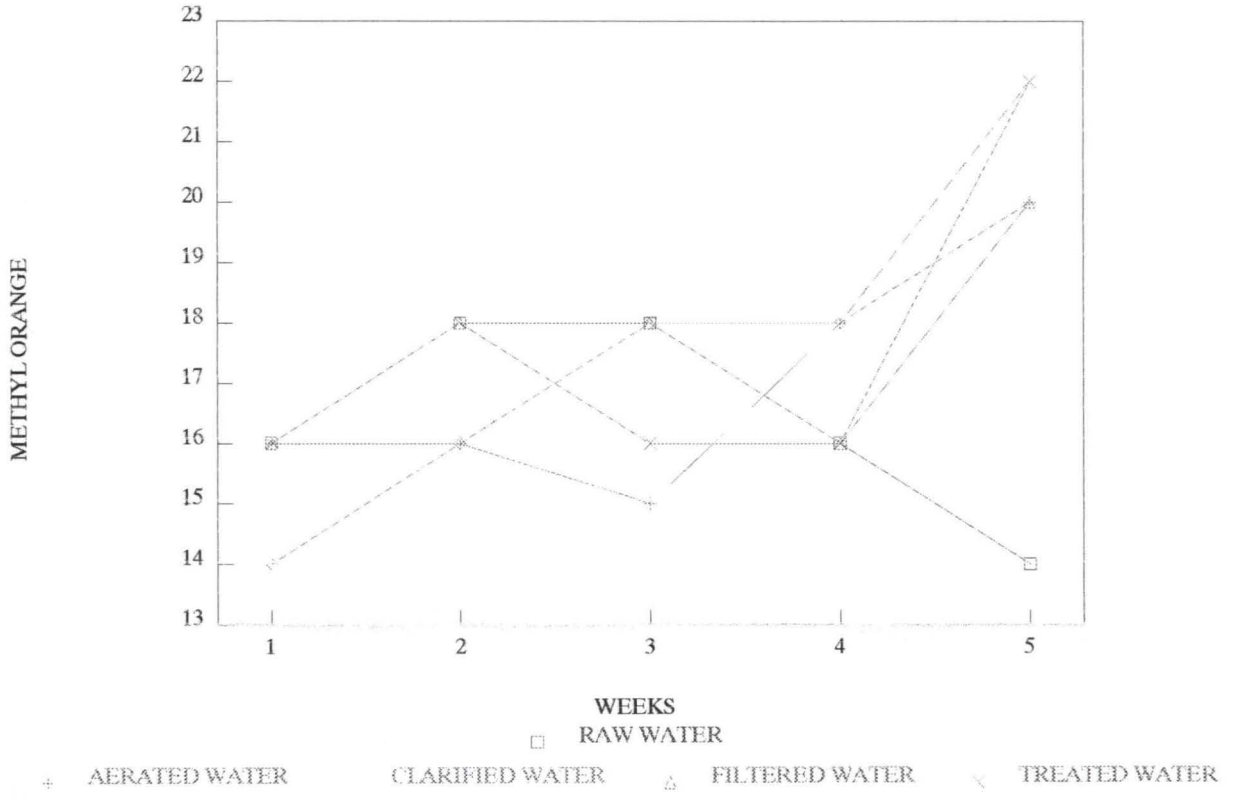
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	16	14	16	16
2	18	16	16	18	18
3	18	15	18	18	16
4	16	18	18	16	16
5	14	20	22	20	22

GRAPH OF METHYL ORANGE

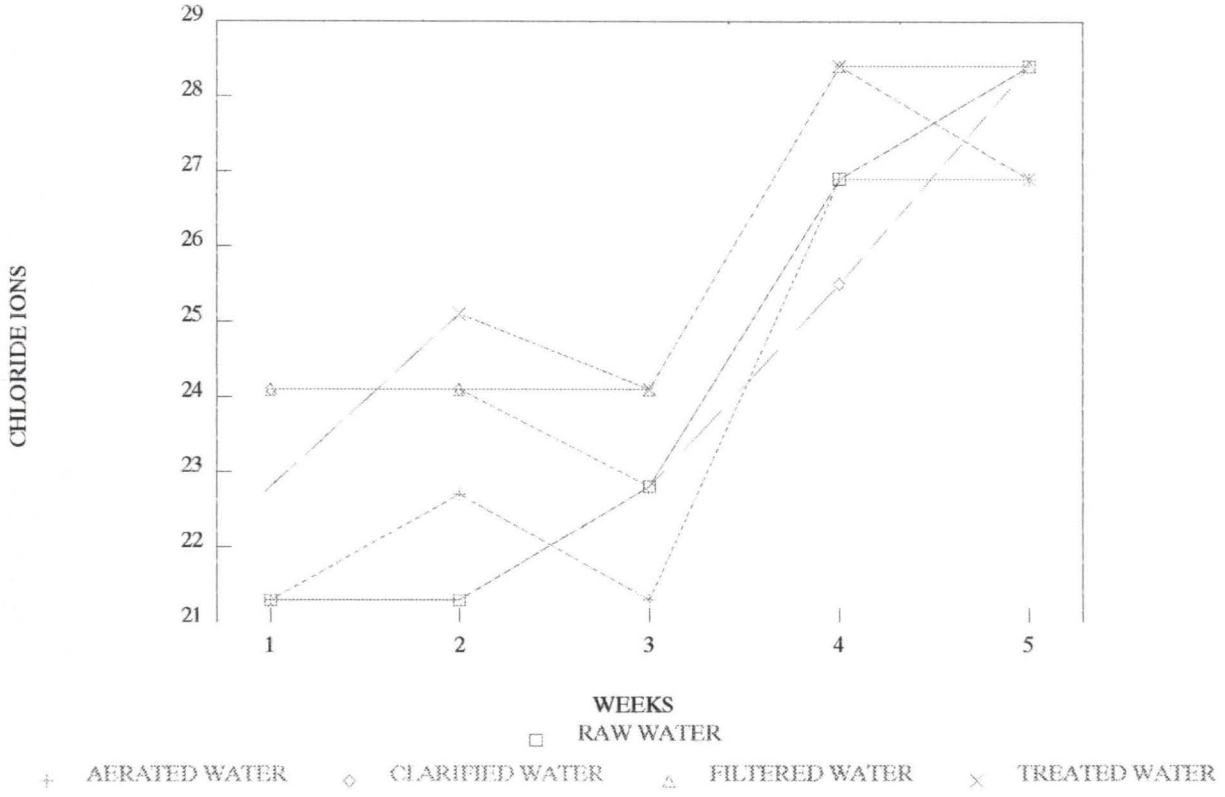
AGAINST WEEKS



	CL IONS				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	21.3	21.3	24.1	24.1	22.8
2	21.3	22.7	24.1	24.1	25.1
3	22.8	21.3	22.8	24.1	24.1
4	26.9	26.9	25.5	28.4	28.4
5	28.4	26.9	28.4	28.4	26.9

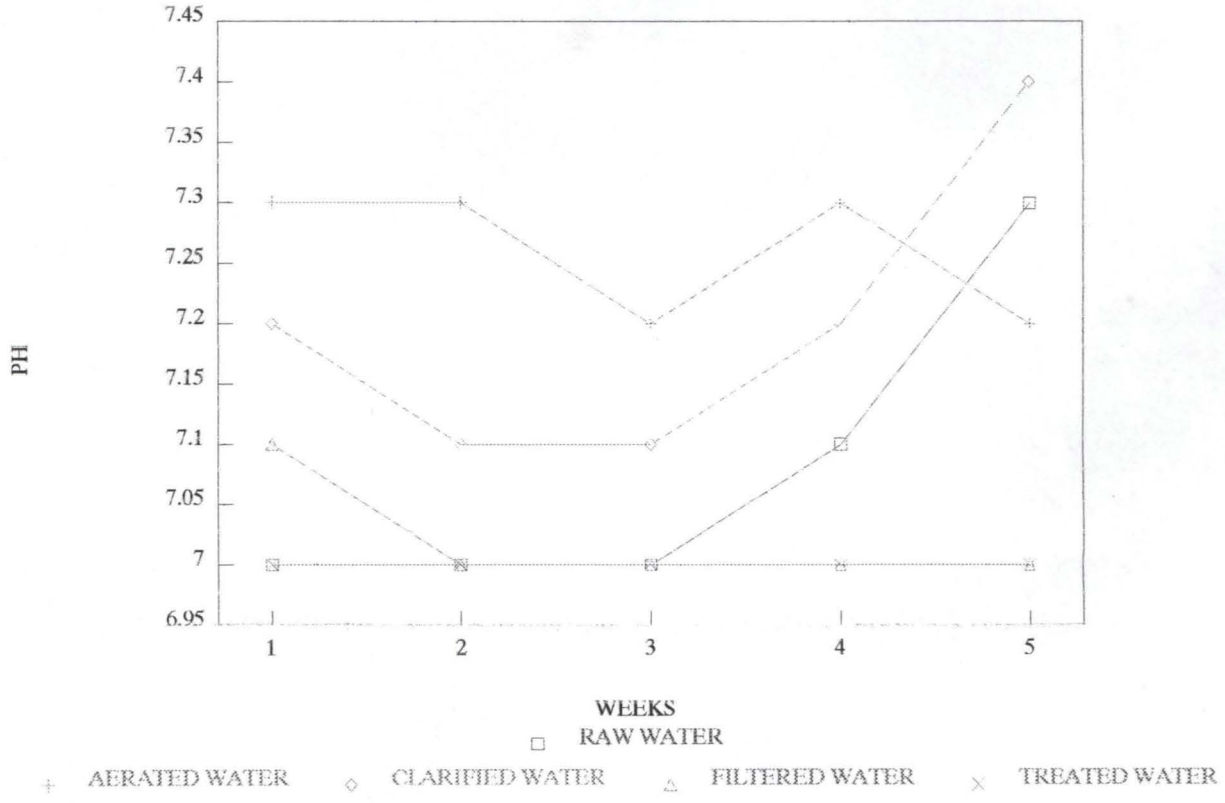
GRAPH OF CHLORIDE IONS

AGAINST WEEKS



03-03-97	PH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	7	7.3	7.2	7.1	7
2	7	7.3	7.1	7	7
3	7	7.2	7.1	7	7
4	7.1	7.3	7.2	7	7
5	7.3	7.2	7.4	7	7

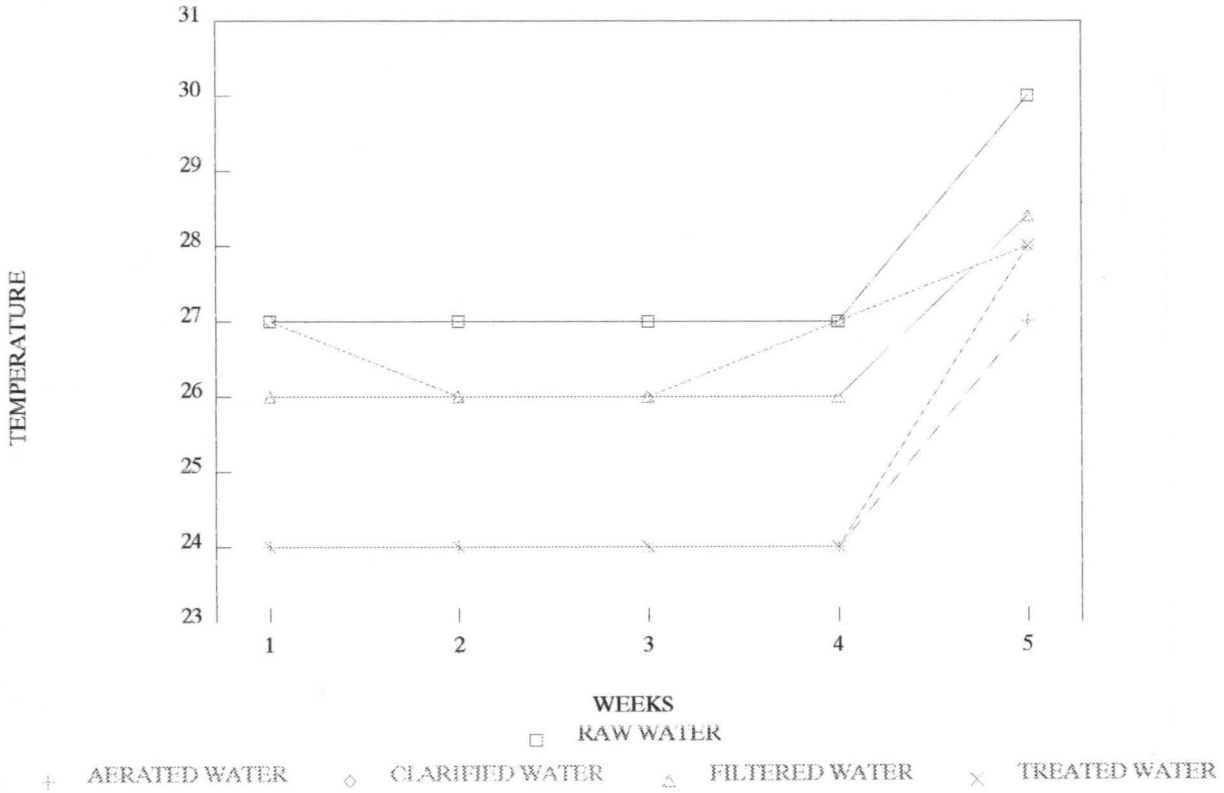
GRAPH OF PH AGAINST WEEKS



	TEMP				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	27	24	27	26	24
2	27	24	26	26	24
3	27	24	26	26	24
4	27	24	27	26	24
5	30	27	28	28.4	28

GRAPH OF TEMPERATURE

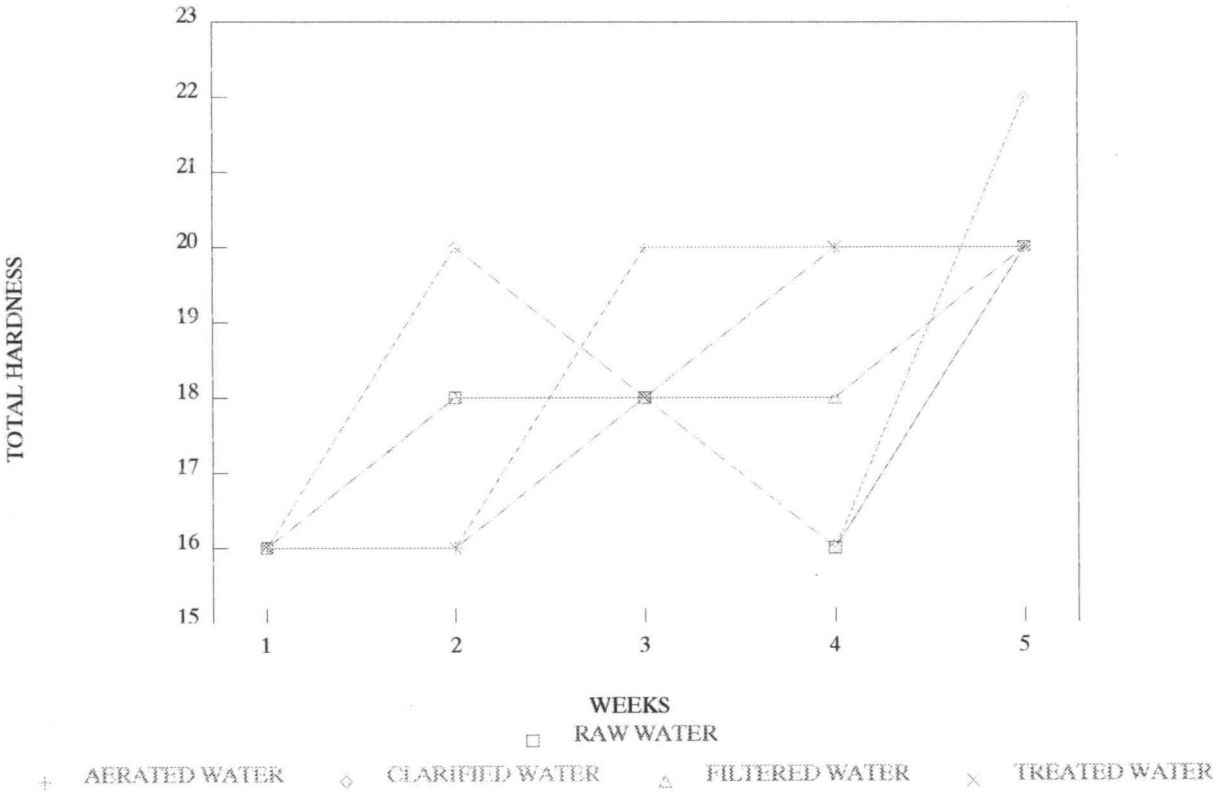
AGAINST WEEKS



	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	16	16	16	16
2	18	16	20	18	16
3	18	20	18	18	18
4	16	20	16	18	20
5	20	20	22	20	20

GRAPH OF TOTAL HARDNESS

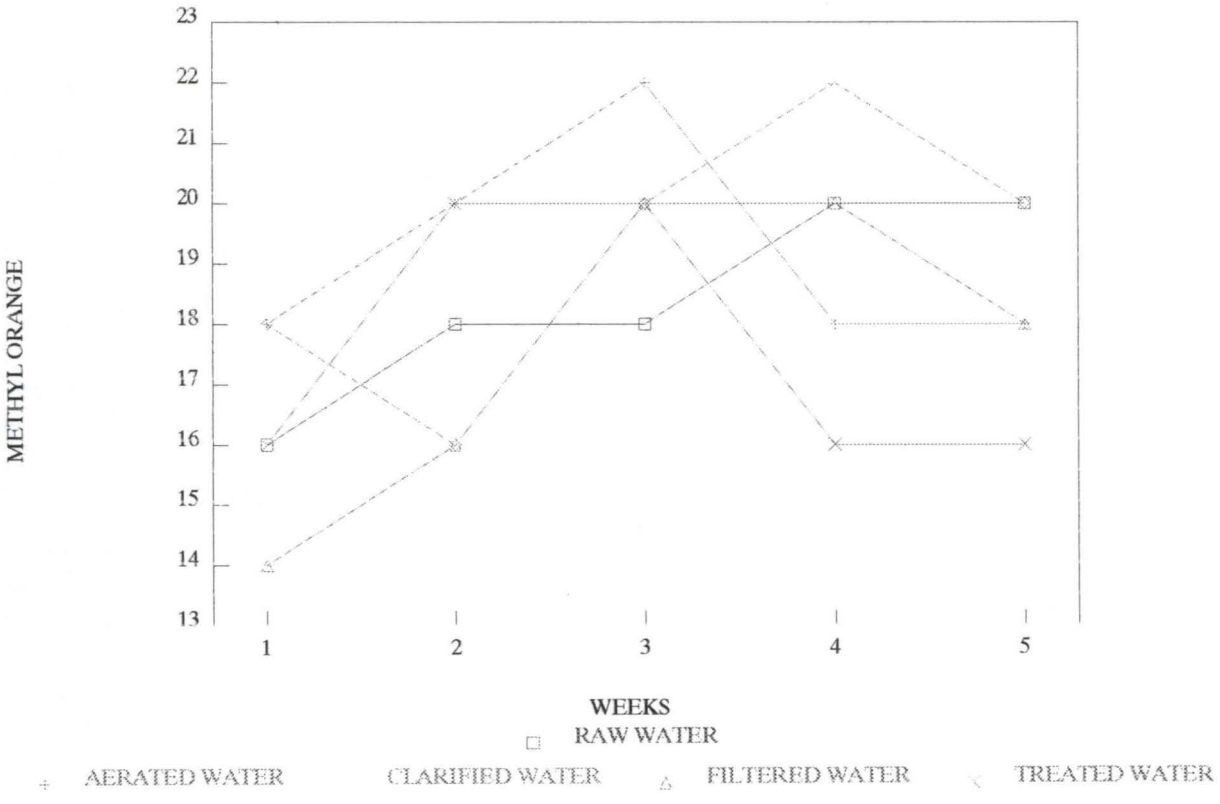
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	18	18	14	16
2	18	20	16	16	20
3	18	22	20	20	20
4	20	18	22	20	16
5	20	18	20	18	16

GRAPH OF METHYL ORANGE

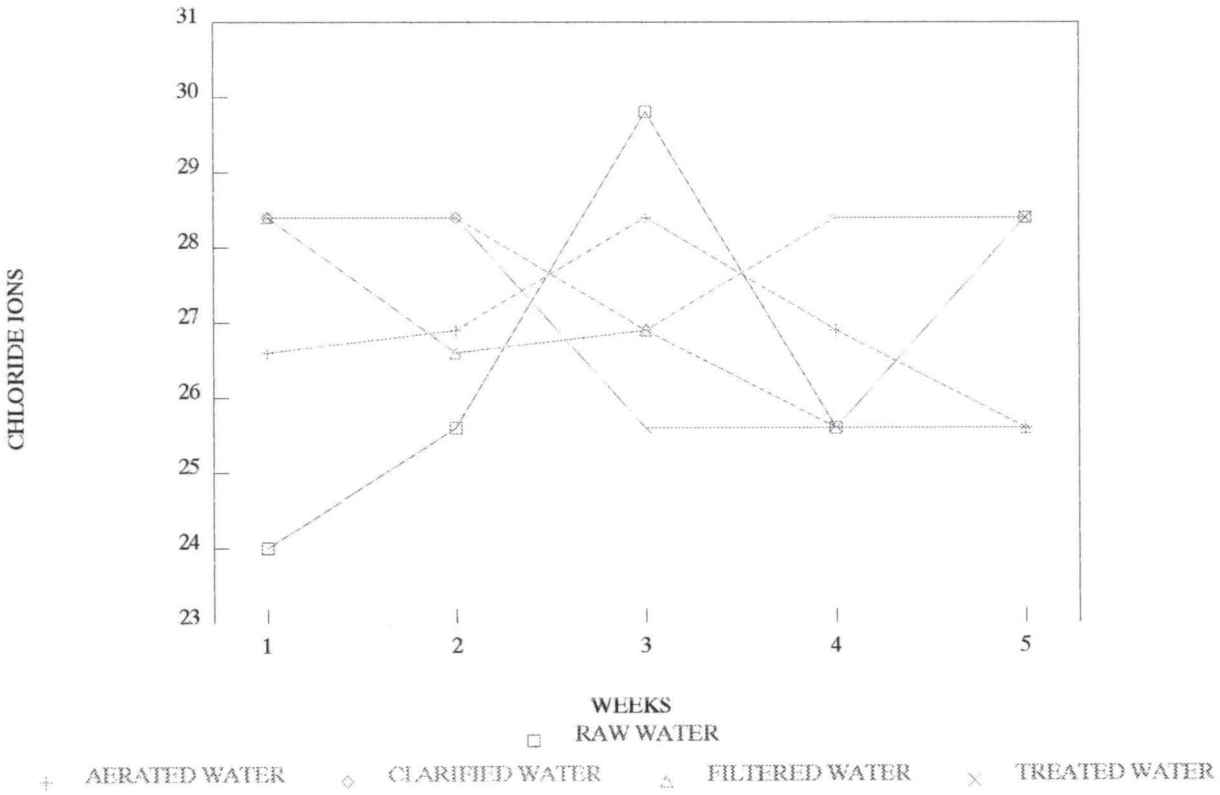
AGAINST WEEKS



	CL				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	24	26.6	28.4	28.4	28.4
2	25.6	26.9	28.4	26.6	28.4
3	29.8	28.4	26.9	26.9	25.6
4	25.6	26.9	28.4	25.6	25.6
5	28.4	25.6	28.4	25.6	28.4

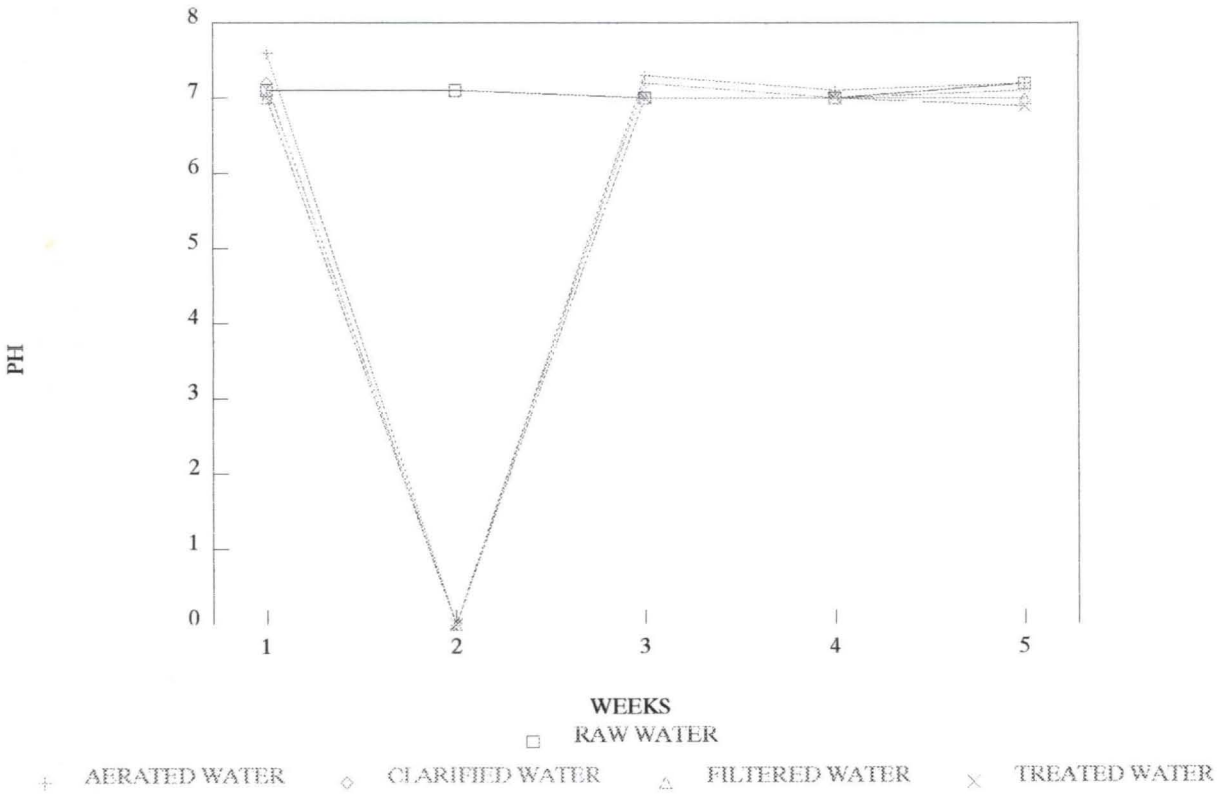
GRAPH OF CHLORIDE IONS

AGAINST WEEKS



APRIL'97	PH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	7.1	7.6	7.2	7	7
2	7.1	0	0	0	0
3	7	7.3	7.2	7	7
4	7	7.1	7	7	7
5	7.2	7.2	7.1	7	6.9

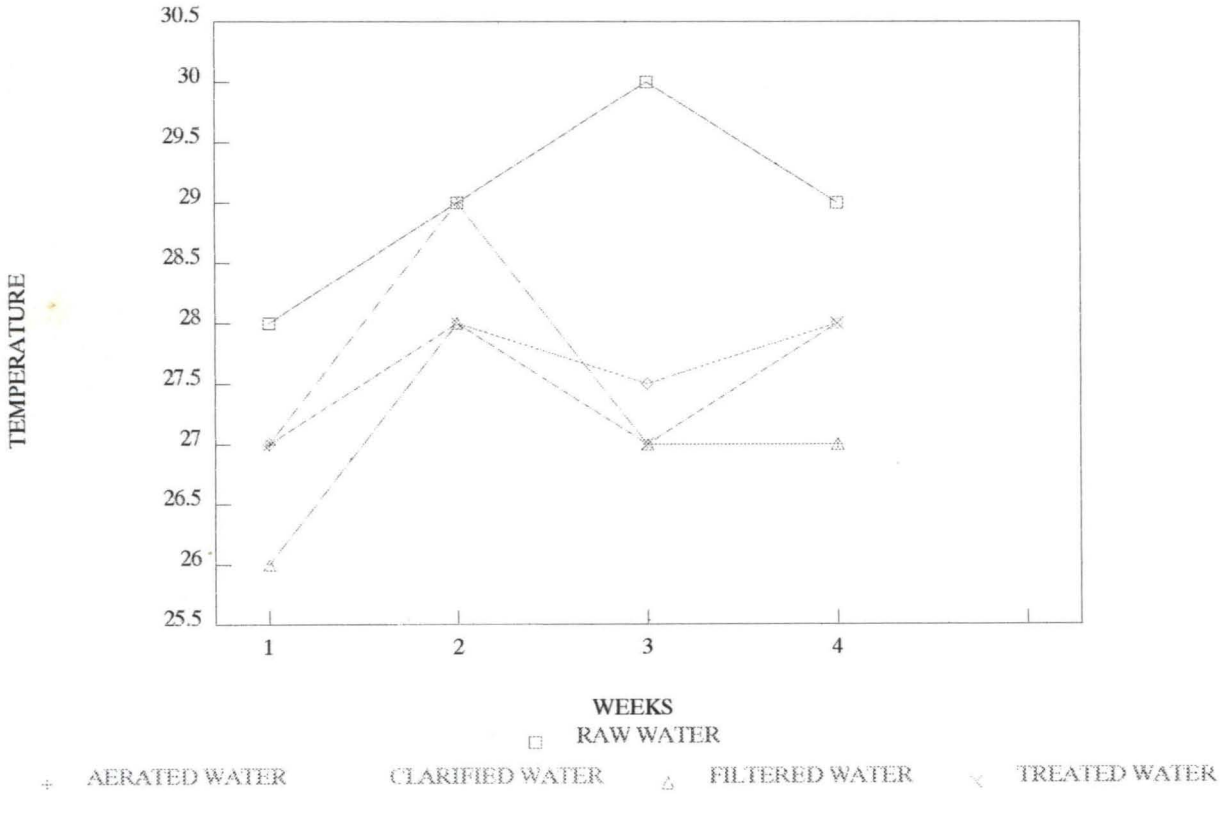
GRAPH OF PH AGAINST WEEKS



	TEMP				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	28	27	27	26	27
2	29	29	28	28	28
3	30	27	27.5	27	27
4	29	27	28	27	28

GRAPH OF TEMPERATURE

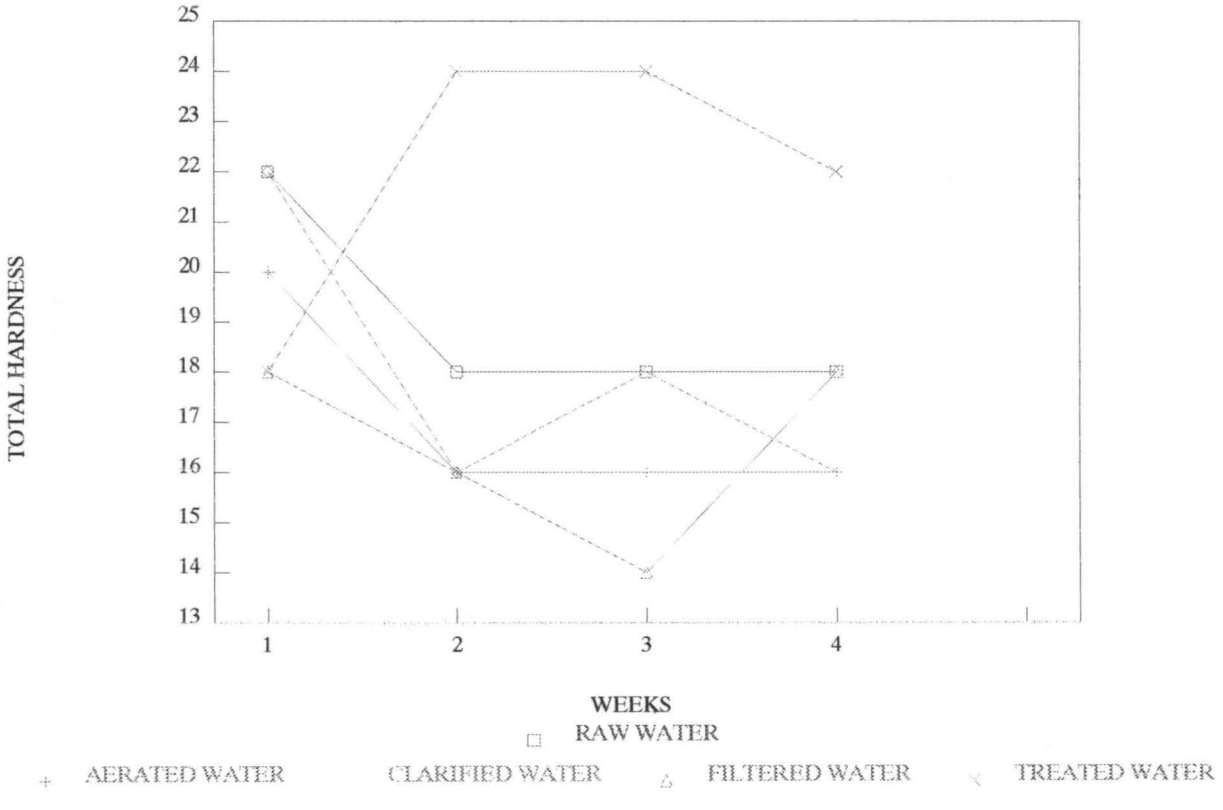
AGAINST WEEKS



	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	22	20	22	18	18
2	18	16	16	16	24
3	18	16	18	14	24
4	18	16	16	18	22

GRAPH OF TOTAL HARDNESS

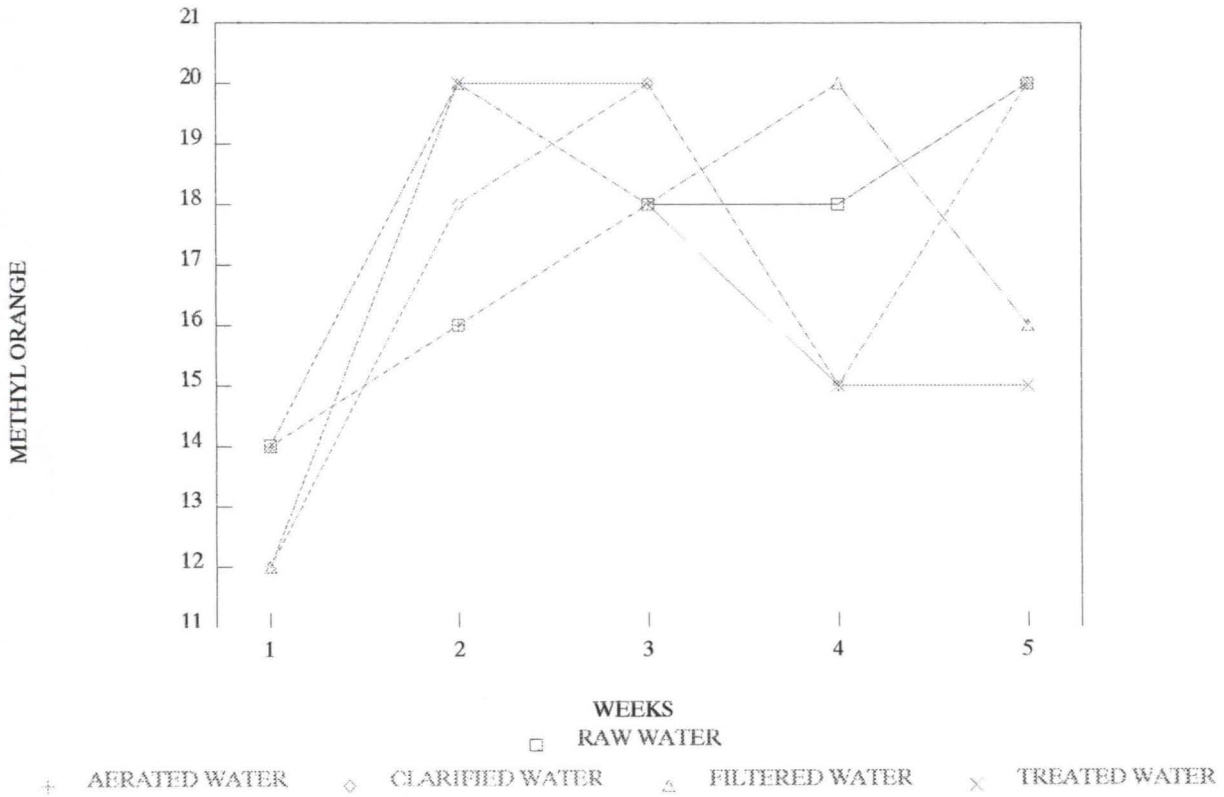
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	14	14	12	12	14
2	16	16	18	20	20
3	18	18	20	18	20
4	18	15	15	20	15
5	20	20	20	16	15

GRAPH OF METHYL ORANGE(ALKALINITY)

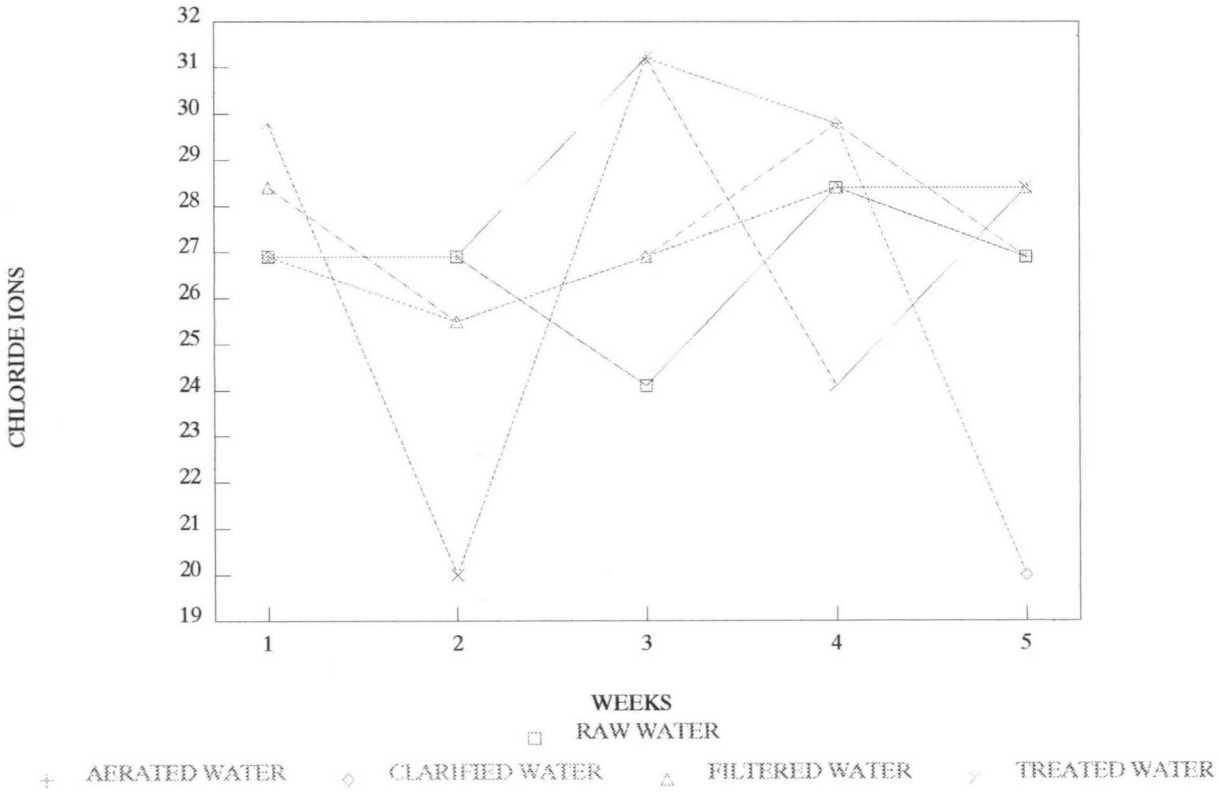
AGAINST WEEKS



	CL				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	26.9	26.9	26.9	28.4	29.8
2	26.9	26.9	25.5	25.5	20
3	24.1	31.2	26.9	26.9	31.2
4	28.4	29.8	29.8	28.4	24.1
5	26.9	26.9	20	28.4	28.4

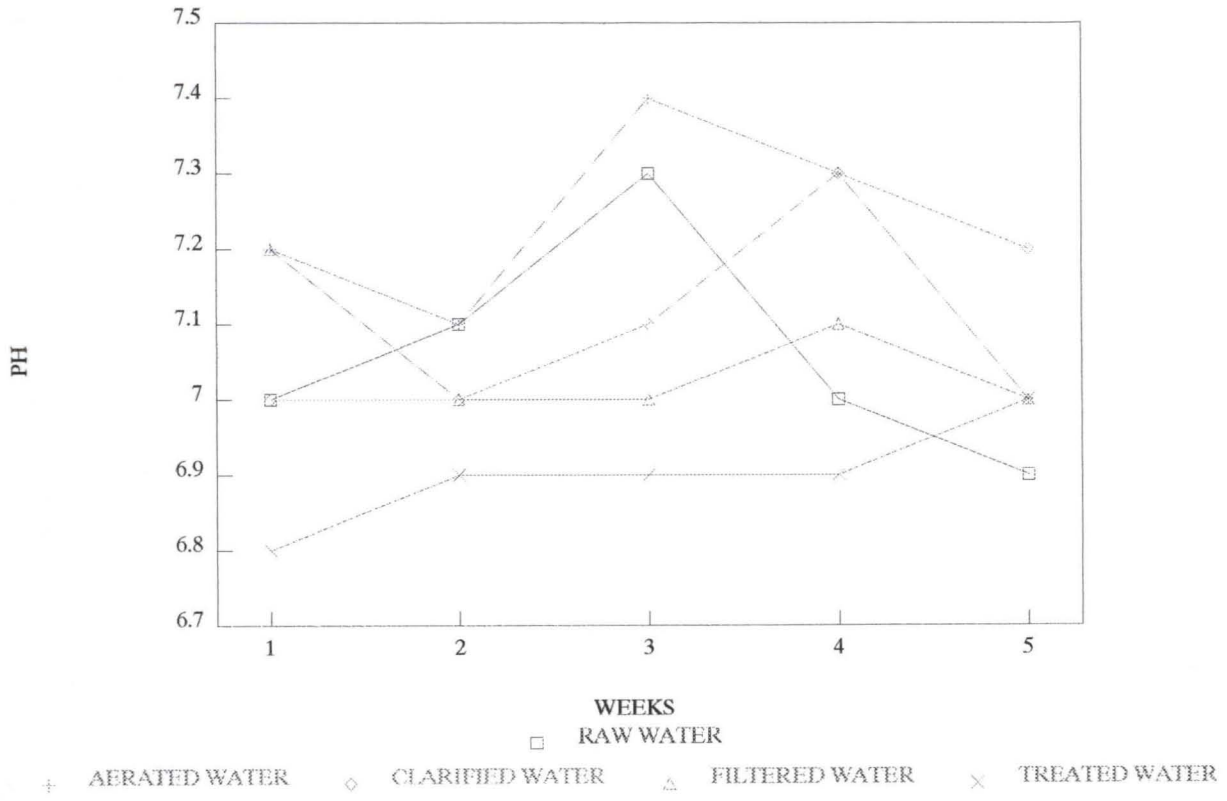
GRAPH OF CHLORIDE IONS

AGAINST WEEKS



MAY'97	PH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	7	7.2	7	7.2	6.8
2	7.1	7.1	7	7	6.9
3	7.3	7.4	7.1	7	6.9
4	7	7.3	7.3	7.1	6.9
5	6.9	7	7.2	7	7

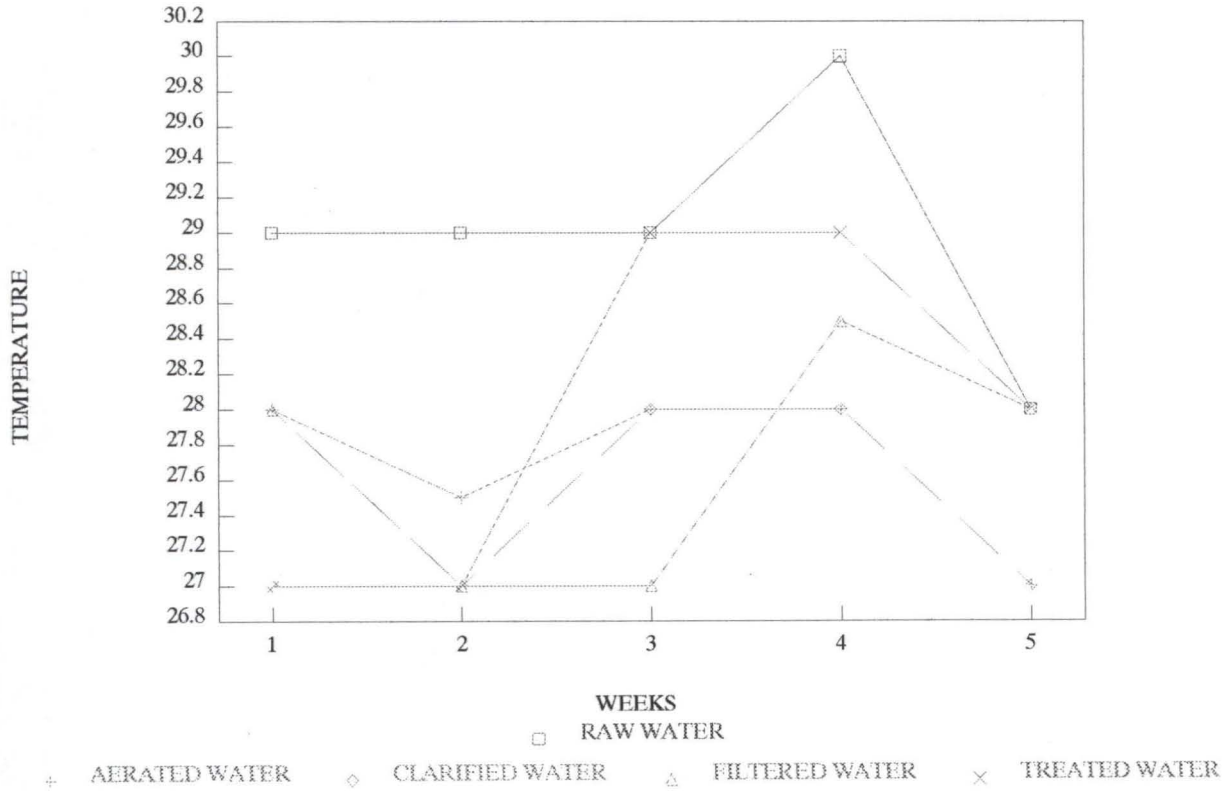
GRAPH OF PH AGAINST WEEKS



	TEMP				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	29	28	27	28	27
2	29	27.5	27	27	27
3	29	28	28	27	29
4	30	28	28	28.5	29
5	28	27	27	28	28

GRAPH OF TEMPERATURE

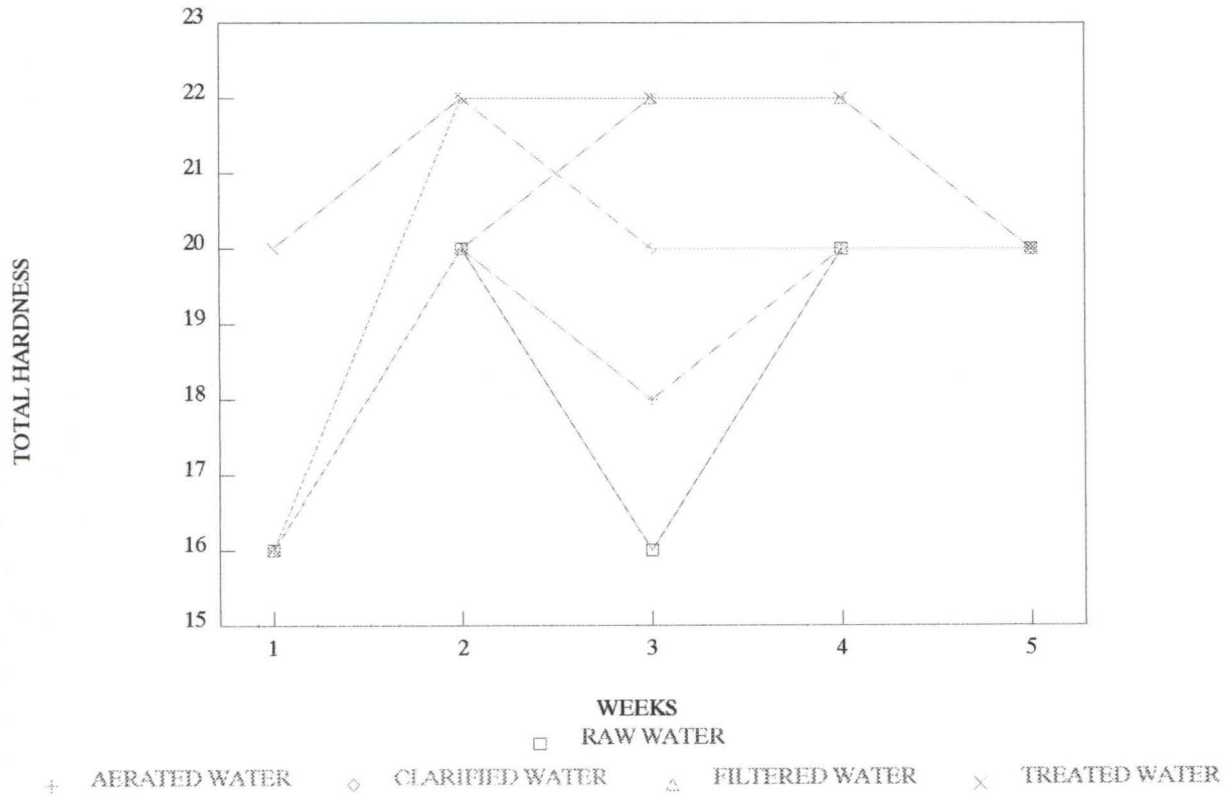
AGAINST WEEKS



	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	16	16	16	20
2	20	20	22	20	22
3	16	18	20	22	22
4	20	20	20	22	22
5	20	20	20	20	20

GRAPH OF TOTAL HARDNESS

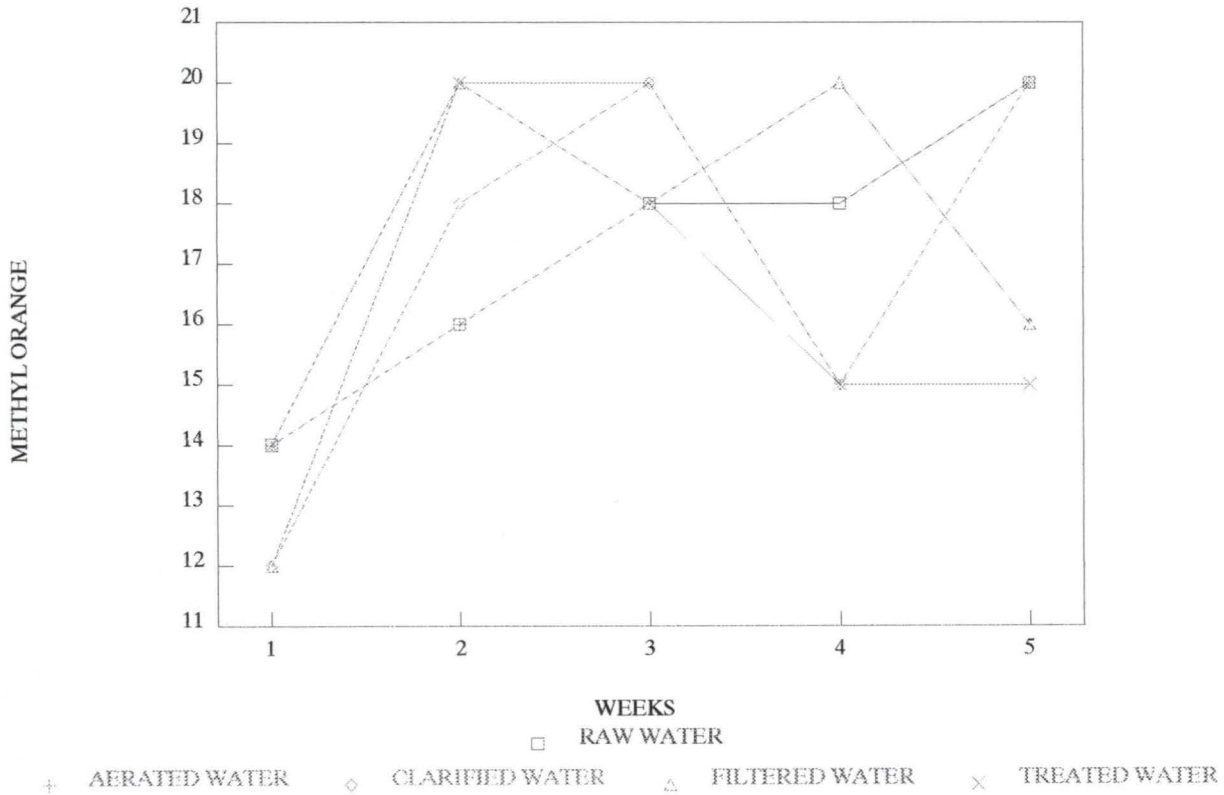
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	14	14	12	12	14
2	16	16	18	20	20
3	18	18	20	18	20
4	18	15	15	20	15
5	20	20	20	16	15

GRAPH OF METHYL ORANGE ALKALINITY

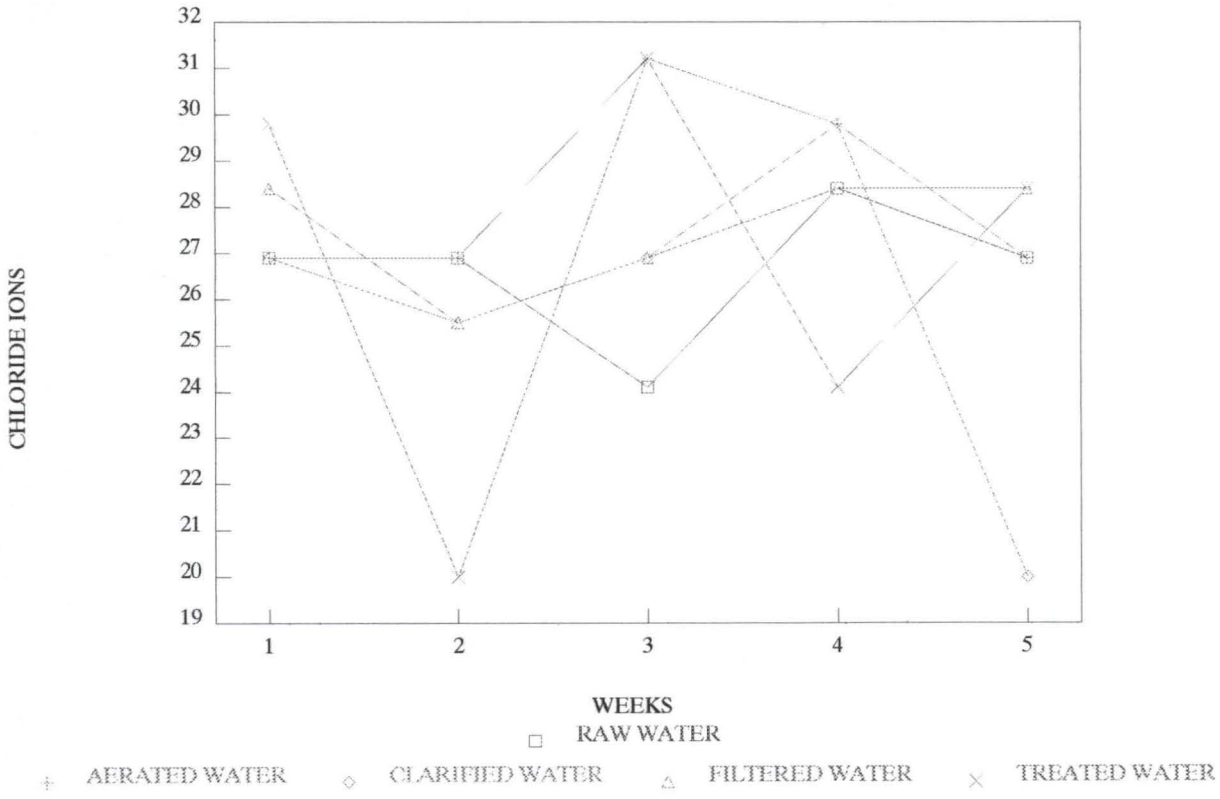
AGAINST WEEKS



	CL				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	26.9	26.9	26.9	28.4	29.8
2	26.9	26.9	25.5	25.5	20
3	24.1	31.2	26.9	26.9	31.2
4	28.4	29.8	29.8	28.4	24.1
5	26.9	26.9	20	28.4	28.4

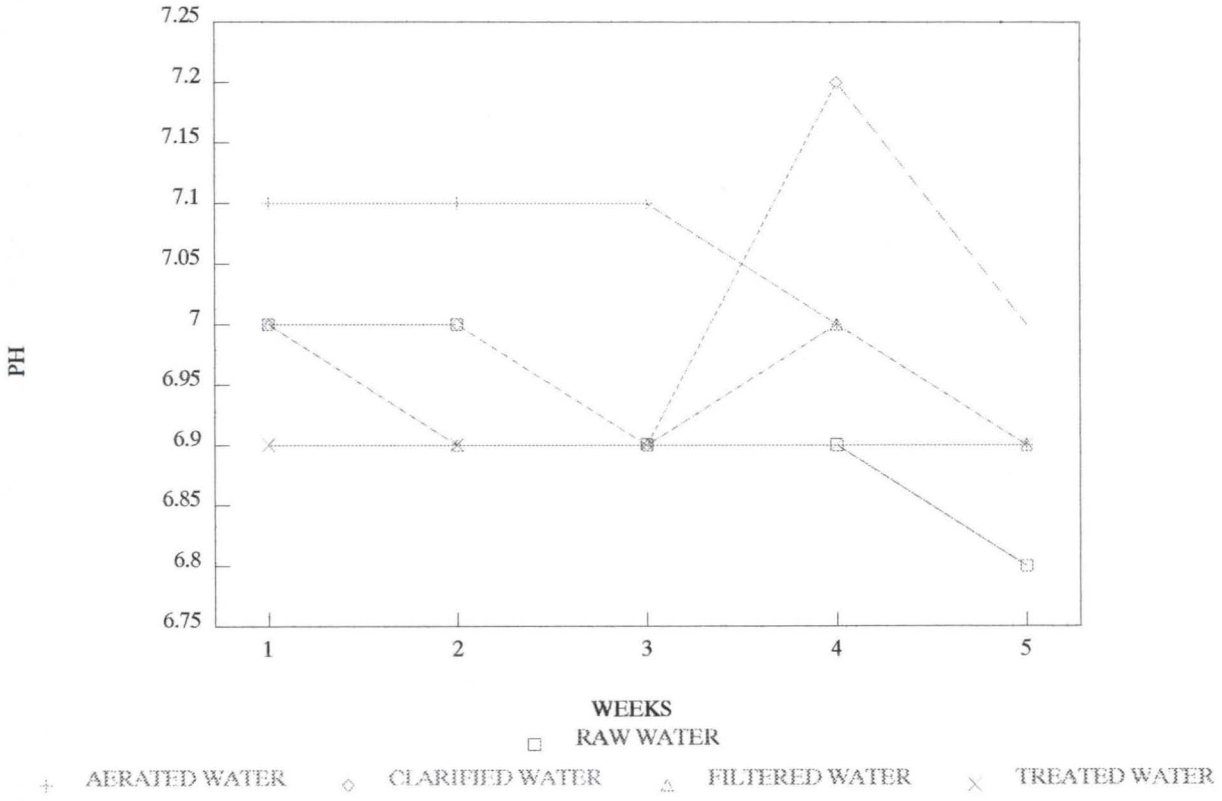
GRAPH OF CHLORIDE IONS

AGAINST WEEKS



JUNE'97	PH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	7	7.1	7	7	6.9
2	7	7.1	7	6.9	6.9
3	6.9	7.1	6.9	6.9	6.9
4	6.9	7	7.2	7	6.9
5	6.8	6.9	7	6.9	6.9

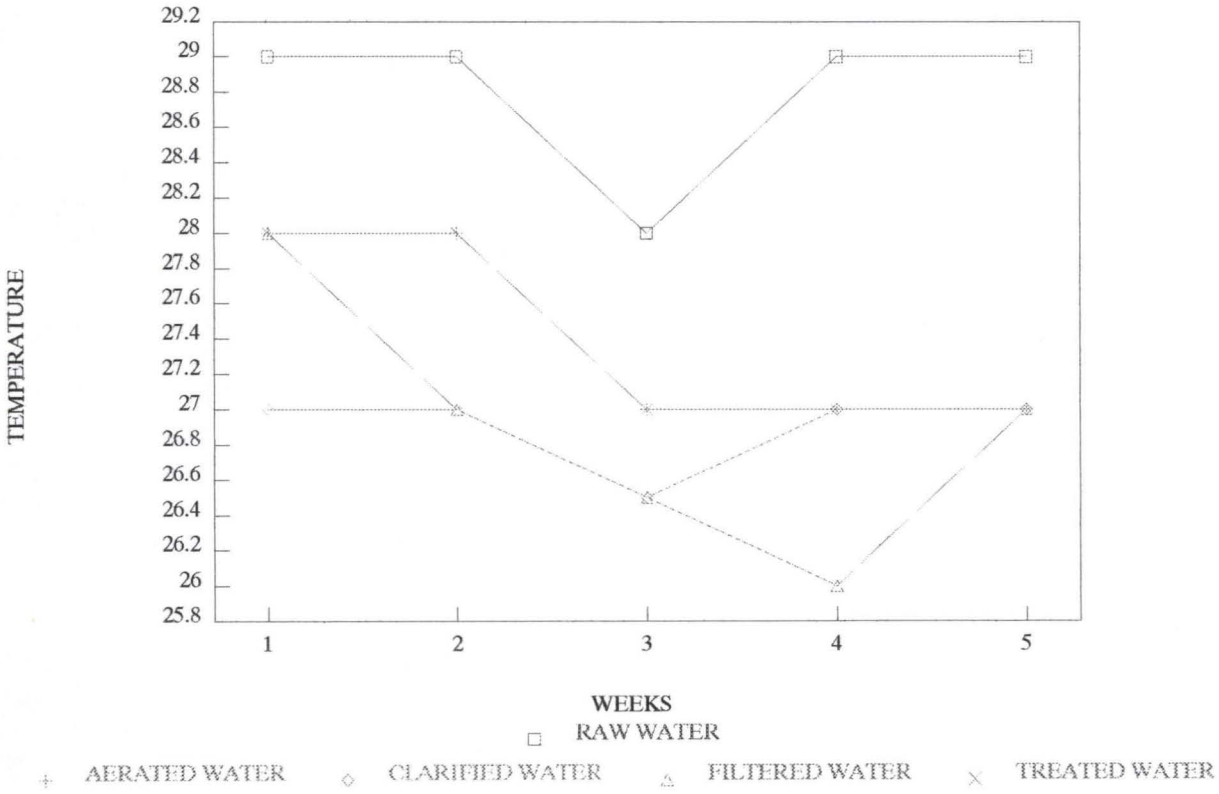
GRAPH OF PH AGAINST WEEKS



	TEMP				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	29	28	27	28	28
2	29	28	27	27	28
3	28	27	26.5	26.5	27
4	29	27	27	26	27
5	29	27	27	27	27

GRAPH OF TEMPERATURE

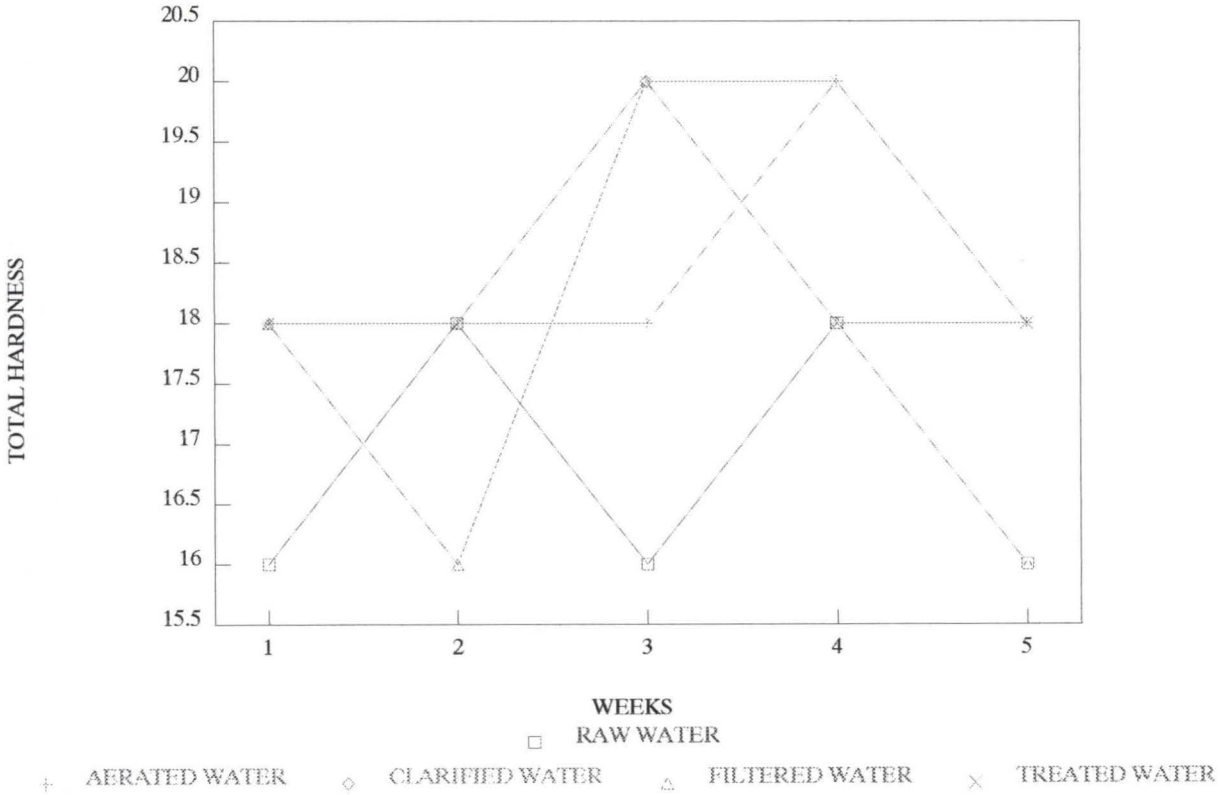
AGAINST WEEKS



	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	16	18	18	18	18
2	18	18	18	16	18
3	16	18	20	20	20
4	18	20	18	18	20
5	16	18	18	16	18

GRAPH OF TOTAL HARDNESS

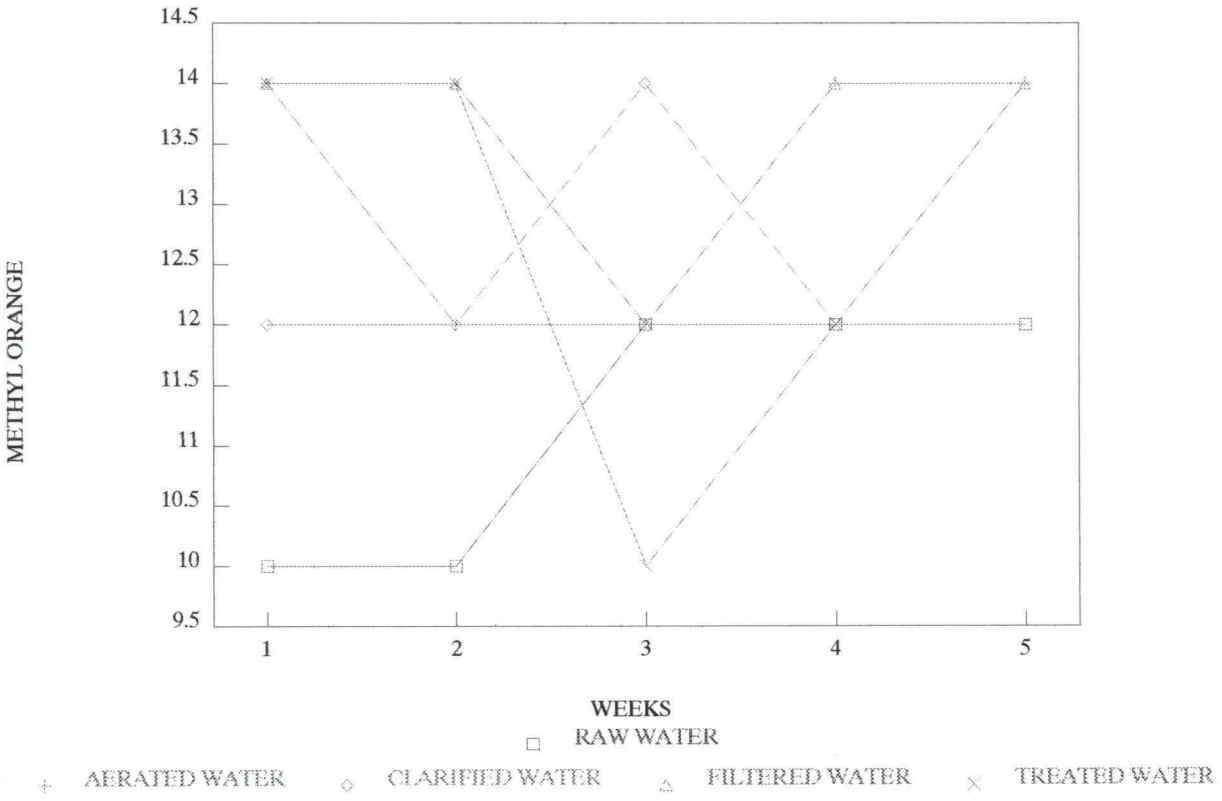
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	10	14	12	14	14
2	10	12	12	14	14
3	12	12	14	12	10
4	12	14	12	14	12
5	12	14	12	14	14

GRAPH OF METHYL ORANGE ALKALINITY

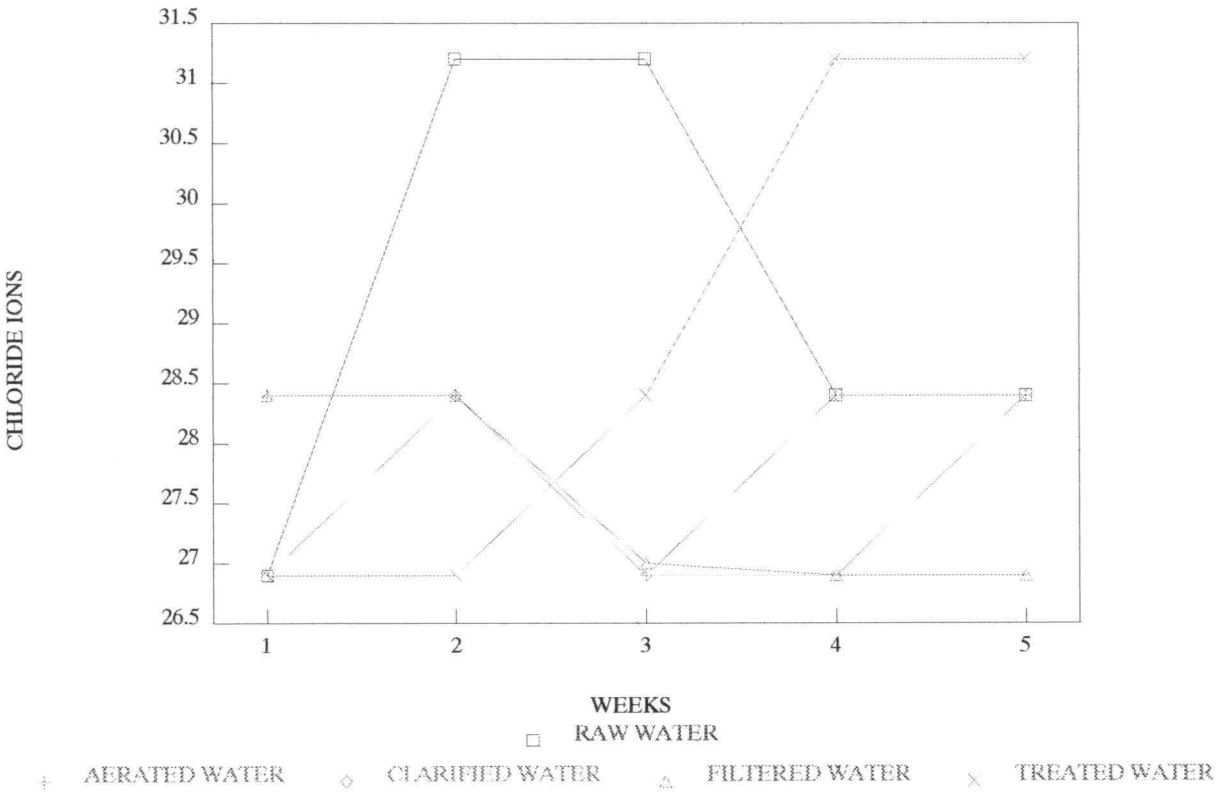
AGAINST WEEKS



	CL IONS				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	26.9	28.4	26.9	28.4	26.9
2	31.2	28.4	28.4	28.4	26.9
3	31.2	26.9	26.9	27	28.4
4	28.4	28.4	26.9	26.9	31.2
5	28.4	28.4	28.4	26.9	31.2

GRAPH OF CHLORIDE IONS

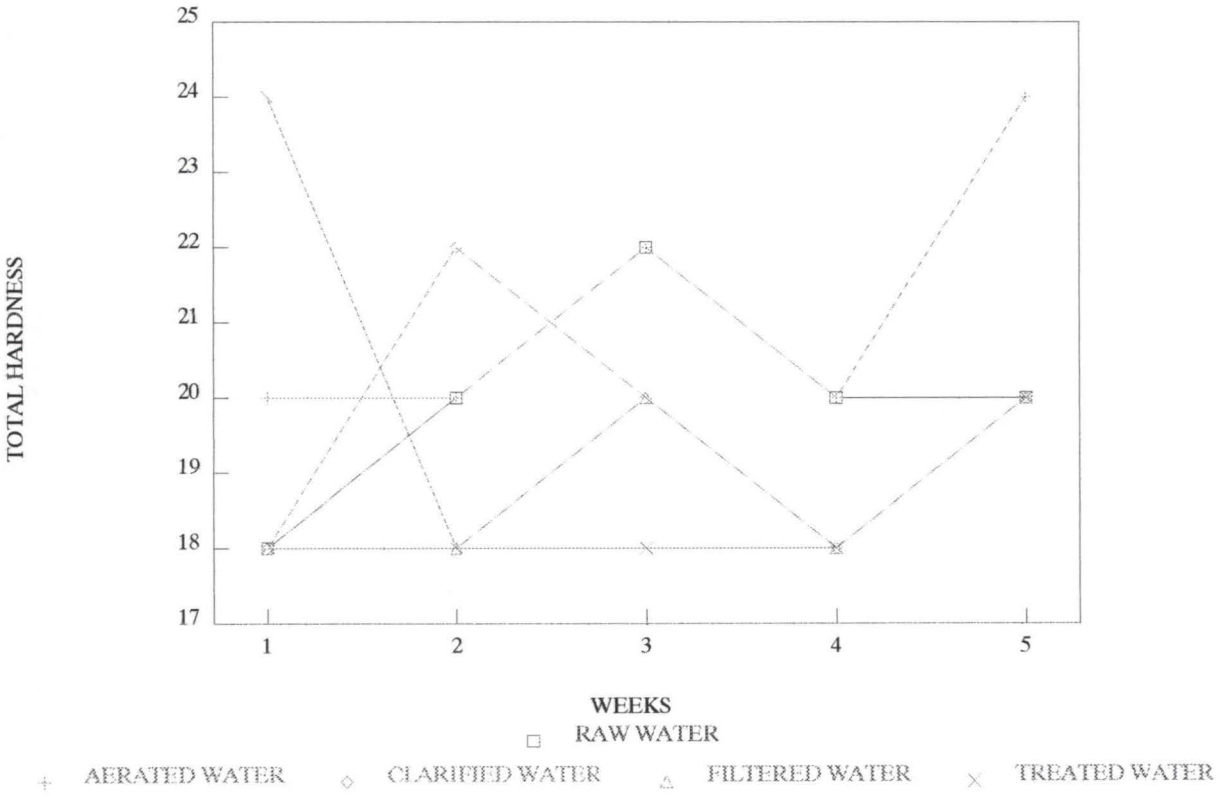
AGAINST WEEKS



	TH				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	18	20	18	18	24
2	20	20	22	18	18
3	22	22	20	20	18
4	20	20	18	18	18
5	20	24	20	20	20

GRAPH OF TOTAL HARDNESS

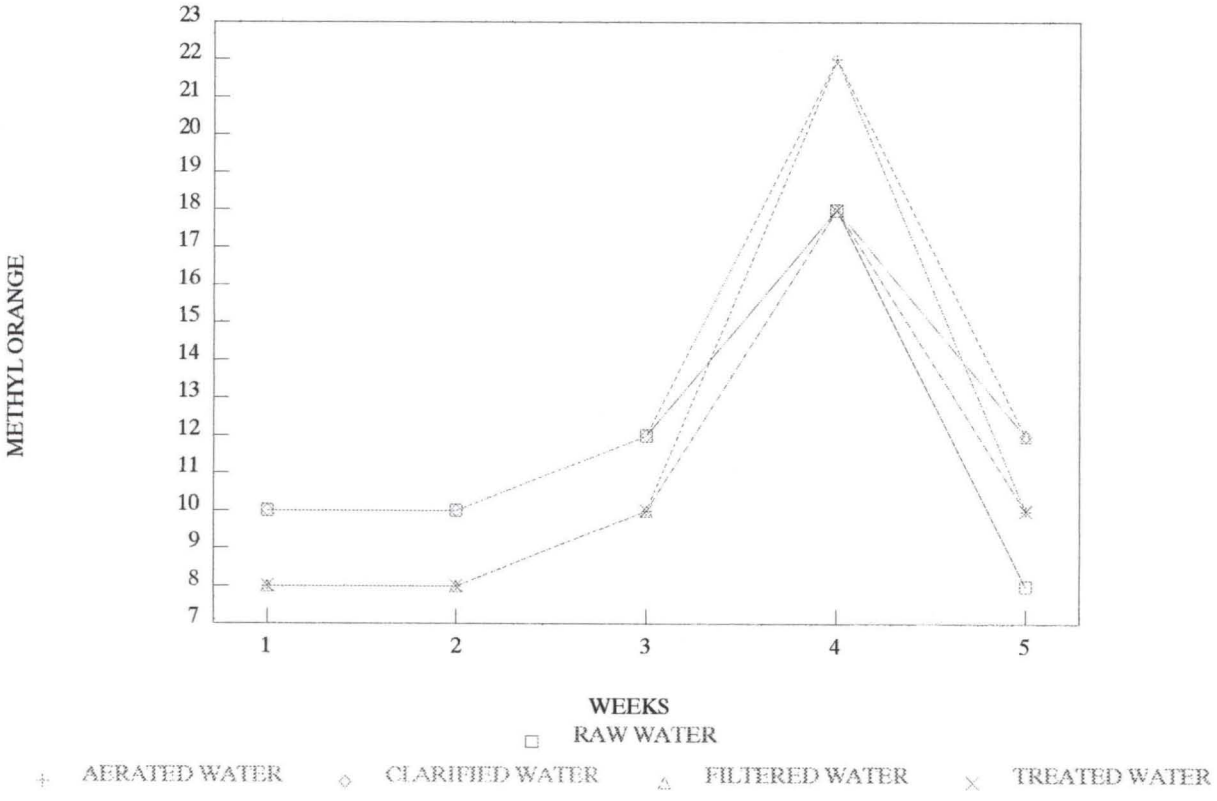
AGAINST WEEKS



	MN				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	10	8	10	8	8
2	10	8	10	8	8
3	12	10	12	10	10
4	18	22	22	18	18
5	8	10	12	12	10

GRAPH OF METHYL ORANGE

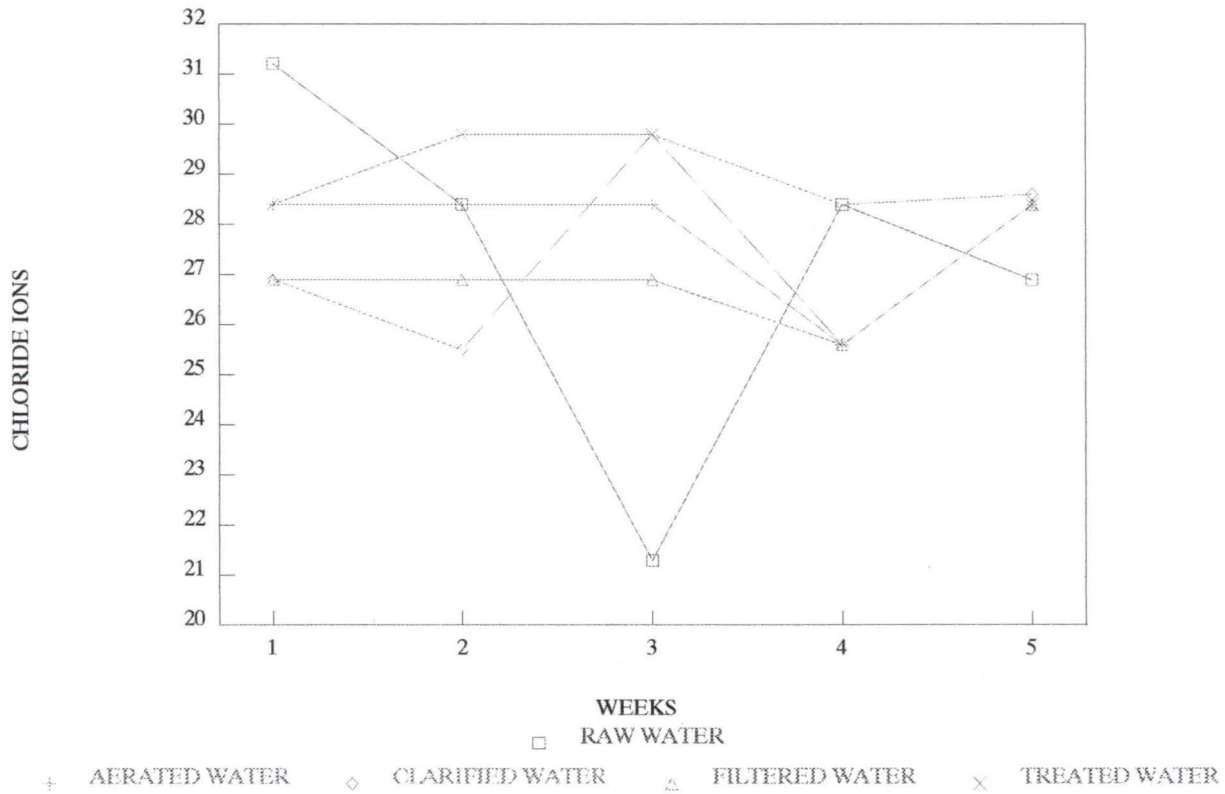
AGAINST WEEKS



	CL				
WEEKS	RAW	AERATED	CLARIFIED	FILTERED	TREATED
1	31.2	28.4	26.9	26.9	28.4
2	28.4	28.4	25.5	26.9	29.8
3	21.3	28.4	29.8	26.9	29.8
4	28.4	25.6	28.4	25.6	25.6
5	26.9	28.4	28.6	28.4	28.4

GRAPH OF CHLORIDE IONS

AGAINST WEEKS



GRAPHS INTERPRETATION

PH OF WATER

Figure 1 shows the PH of water supplies in FCT Abuja. The results revealed that the PH of the raw water ranged from 6.8 to 7.0 while that of the aerated ranged from 6.9 to 7.3 it was also observed that the clarified and filtered water had PH ranging from 6.8 to 7.0 while the treated had PH of 6.9 - 7.0.

Generally the PH tends to neutrality and is within the ranged recommended by W.H.O.

TEMPERATURE OF WATER

Figure 2 shows the temperature of water supplies in FCT Abuja. The results revealed that the temperature of the raw water ranged that the temperature of the aerated ranged from 23°c to 25°c. It was observed also that the clarified and filtered water had temperature ranging from 24 to 27°c. While the treated had temperature of 23°c to 25°c.

This implies that the temperature is within the range recommended by W.H.O.

TOTAL HARDNESS OF WATER

Figure 3 shows the total hardness of water supplies in FCT Abuja. The results revealed that the total hardness of the raw water ranged from 16 mg/l to 20 mg/l while that of the aerated ranged from 16mg/l to 22mg/l. It was observed that the clarified and filtered water had total hardness ranging from 0 to 20mg/l while the treated had total hardness of 18mg/l to 24mg/l. This shows that the total hardness is within the range recommended by W.H.O.

METHYL ORANGE ALKALINITY

Figure 4 shows the methyl orange alkalinity of water supplies in FCT Abuja.

The results revealed that the methyl orange alkalinity of the raw water ranged 18 while that of aerated water ranged from 18 to 22. It was observed that the clarified and filtered water hand the alkalinity ranging from 16 to 24.

While the treated water had the alkalinity of 16 to 22.

This indicates that the parameter conformed with W.H.O acceptable standards for drinking water.

CHLORIDE ION

Figure 5 shows the chloride ion of water supplies in FCT Abuja. The results revealed that the chloride ion of the raw water ranged from 25.5mg/l to 27mg/l while that of the aerated ranged from 24.1mg/l to 28.4mg/l.

It was also observed that the clarified and filtered water had chloride ion ranging from 0 to 28.4mg/l and filtered water had chloride ion ranging from 0 to 28.4mg/l.

Generally all five parameters of the water examined conformed with the international acceptable standards for drinking water.

CHAPTER THREE

PROGRAM DESIGN

The program for data updating is expected to accept data from the user and transfer such data into an already existing file. The user is prompted by the computer to enter into an already formatted screen the following:-

NAME, TEMPERATURE, METHYL ORANGE ALKALINITY,TOTAL HARDNESS AND CHLORIDEION, which are read into memory variables. Then the computer prompts the user to save with an option of yes or No. On condition that the option is yes, are contents of memory variable transfered to their corresponding fields in the file. The user is next instructed to continue with a yes or No option. If the option is No, the program terminates otherwise the whole process is repeated.

For the purpose of continuity, a " Do WHILE. T.....ENDO" loop is used to automate the process.

The program to compare and write out the result of the analysis of treated water with W.H.O standard is designed for (a) screen output (b) Printer output. Two existing files are opened one for W.H.O standard, and the other containing result analysis of the treated, and other types of water. The computer is instructed to the 2 files.

Next the computer is instructed to compare the analysis of the treated water against that of W.H.O standard taking into cognisance a specified tolerable range. The comparison is done using conditional IF.....END if statements, such comparison is for Temperature, methyl orange alkalinity Total hardness and chloride ion. At the end of which program terminates.

The program is provided with a sub-menu to enable one see output on screen or from printer.

(c) Program design for viewing file contents of your analysis is designed for (a) Screen output (b) Printer output.

The computer prompts the user to enter current date. Such a date will be saved into memory variable. A header is thus printed with date while file contents with existing fields are all printed out for viewing the program is provided with a sub- menu for screen or printer output to enable user choose which to use at any point in time.

3.2 SUMMARY OF PROGRAM

The entire program written for this pirpose is summarised in one program like a subrouti ne program in basic languages. This is titled "MAIN MENU" in which a list of all programs to be used is shown on the screen. The user is prompted by the computer to pick any program of interest for se. this is achieved by the se of the (DO CASE -- ED CASE) stucture and imputed in a (DO WHILE -- ED DO LOOP). The advantage of this program is that quicker access to any program is achieved.

FILE STRUCTURE

A file structure in dbase is a description and definition of type of fields one use. The description entails the various names of fields to be used, while the definition involves defining ones' field types, field widths, Dec, index, etc. A file structure must be defined before you can create one.

A file structure consists of the following

FIELD NAME:- Usually contains character, and does not take more than 10 character

FIELD TYPE:- Usually defines the kind of data to be entered in the field e.g character, Numeric, date logical etc.

FIELD WIDTH:-Specifies the maximum number of data length to be entered.

DEC: Usually for Numeric data e.g salary with decimals.

INDEX:- Determines whether a file is to be indexed on a particular field, an option of Y or N (Yes or No) is provided.

The file structure for the W.H.O (World Health Organisation) and water analysis file is shown below.

WHO

FIELD NAME	FIELD TYPE	FIELD WIDTH	DEC	INDEX
W. TYPE	C	20	N	N
LEVEL	C	10	N	N
TEMPERATURE	N	4	N	N
METH-ORAN	N	4	N	N
T- HARD	N	4	N	N
CHL IRON	N	4	N	N
PH	N	10	Y	N

A Total of seven field are used

WATER ANALYSIS TABLE

FIELD NAME	FIELDTYPE	FIELDWIDTH	DEC	INDEX
W. TYPE	C	20	N	N
TEMPERATURE	N	10	N	N
METH-ORAN	N	4	N	N
T- HARD	N	4	N	N
CHL IRON	N	4	N	N
PH	N	10	N	N
WATERCODE	N	4	N	N
WATER	C	10	N	N

A Total of Nine field are used

Fast programming

Easy to understand programming language

Up to 256 files can be created etc.

PROGRAMMING LANGUAGE

Writing a program involves the use of certain techniques and codes. Programs like Basic, Pascal, Fortran and their different version are very good for scientific and mathematical applications. The problem arises when a user can not understand the code at times not only in running but to effect changes where necessary. These three programs are also deficient for holding very large volumes of data and allowing a user to use more than one file at the same time in a program, without closing a previous file for this reason it was considered necessary by the writer to use program language which will be convenient not only for the analyst, but also for the consumption of management. A database program language was chosen.

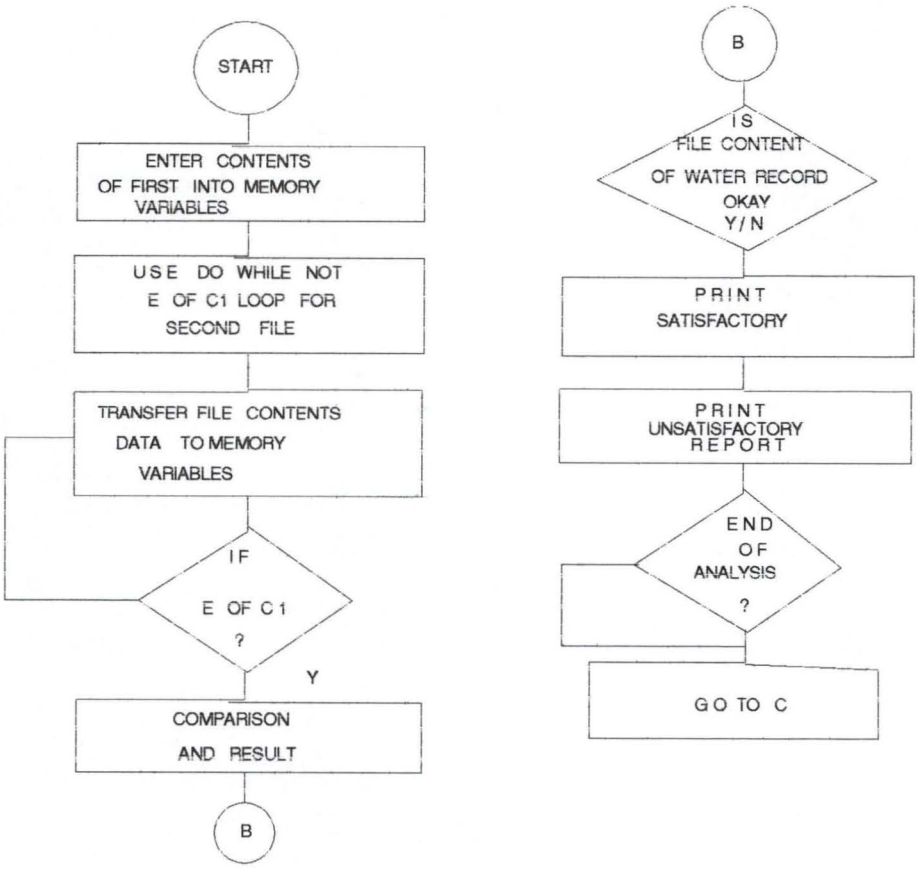
The dbase package chosen was dbase(iv) in preference to other packages like cobol Foxpro, Oracle, dbaseIII etc. The reason is that dbase iv combine a lot of other features of other programs and manages their deficiencies effectively. The features include the following.

(1) It can activate up to 99 files at a time

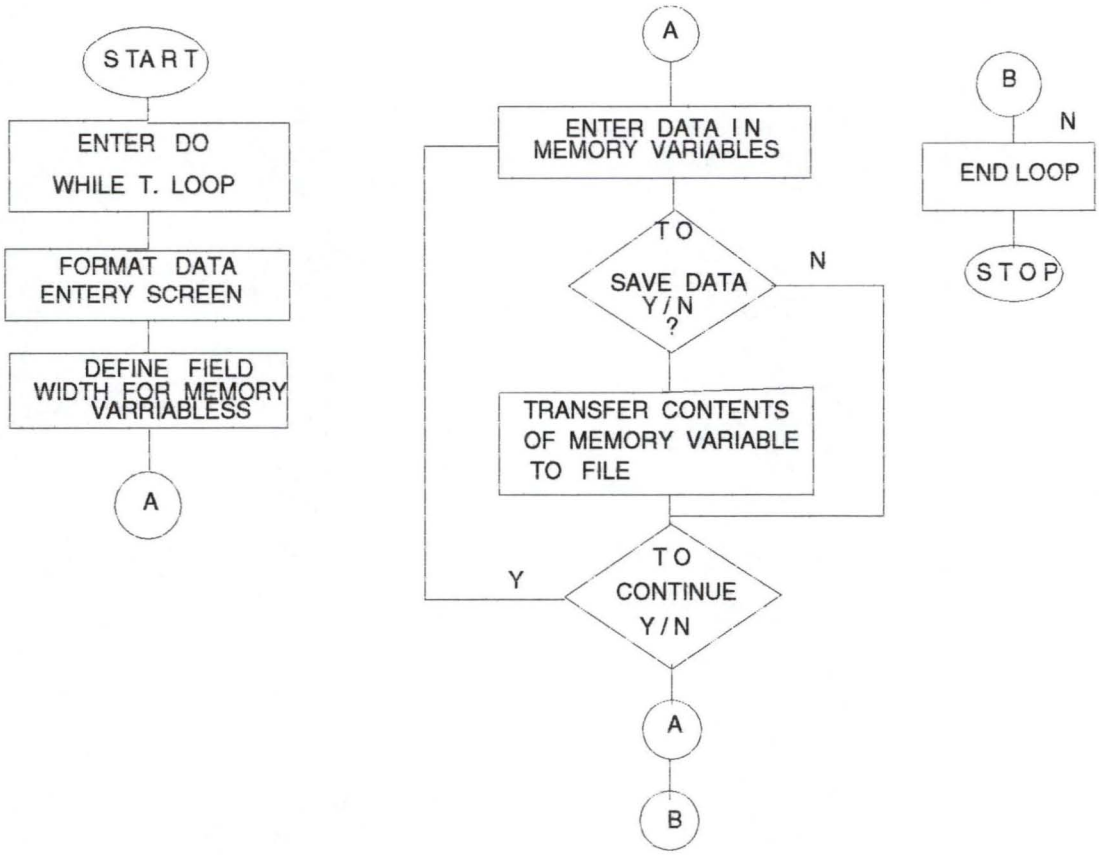
(2) Easy to use end inter active control centre

(3) Unbuilt functions

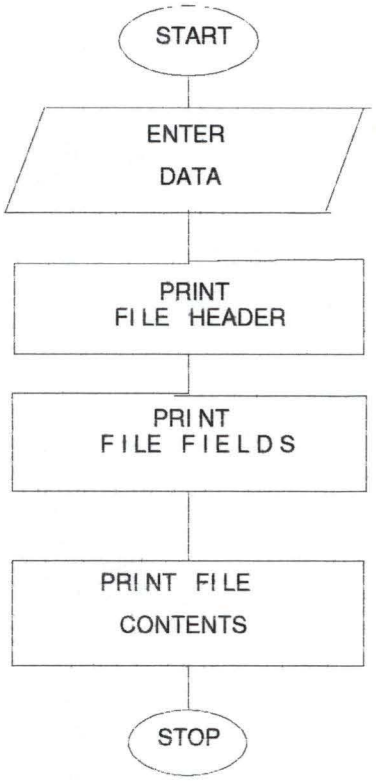
WATER TEST ANALYSIS

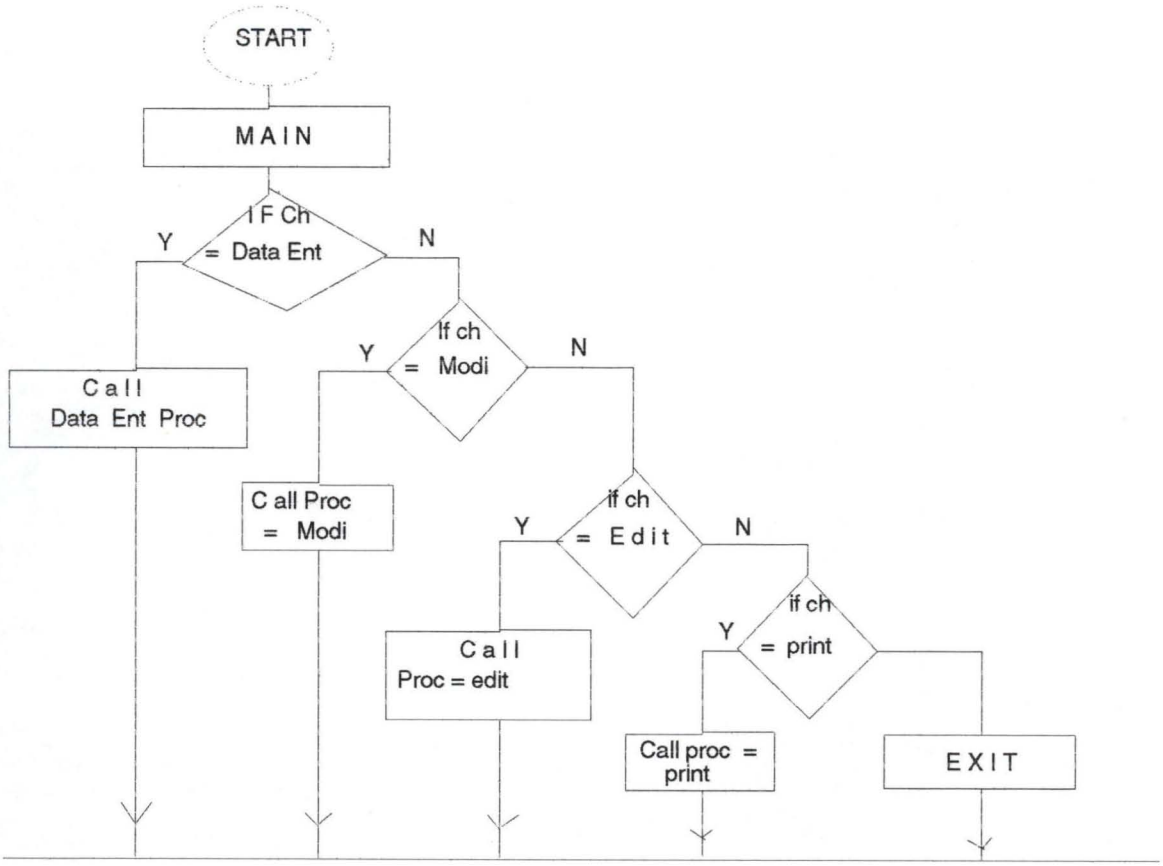


ALGORITHM DATA UPDATING



VIEWING FILE CONTENTS




START
MAIN
IF Ch
= Data Ent
Y
N
Call
Data Ent Proc
If ch
= Modi
Y
N
C all Proc
= Modi
if ch
= Edit
Y
N
Call
Proc = edit
if ch
= print
Y
Call proc =
print
EXIT

JANUARY,98

PH

WEEKS	RAW H_20	AERATE D H_20	CLARIFIED H_20	FILLERS H_20	TREATED H_20
1	6.8	6.9	6.9	6.9	6.8
2	6.7	6.9	6.8	6.9	6.8
3	6.8	6.9	6.8	6.8	6.9
4	6.9	7.1	7.0	7.0	6.9
5	6.8	6.9	7.0	6.8	6.8

TEMP

WEEKS	RAW H_20	AERATE D H_20	CLARIFIED H_20	FILLERS H_20	TREATED H_20
1	26	24	24.5	24	26
2	26	23.0	23.5	24.5	24
3	26	24	24	24	25
4	26.5	24	25	25	24
5	26	24.5	25.0	24	25

CHLORIDE ION CL

WEEKS	RAW H_20	AERATE D H_20	CLARIFIED H_20	FILLERS H_20	TREATED H_20
1	31.2	28.4	26.9	26.9	28.4
2	28.4	28.4	25.5	26.9	29.8
3	21.3	28.4	29.8	26.9	29.8
4	28.4	25.6	28.4	25.6	25.6
5	26.9	28.4	28.6	28.4	28.4

TH

WEEKS	RAW H_20	AERATE D H_20	CLARIFIED H_20	FILLERS H_20	TREATED H_20
1	18	20	18	18	24
2	20	20	22	18	18
3	22	22	20	20	18
4	20	20	18	18	16
5	20	24	20	20	20

METHY/ORANGE Mn

WEEKS	RAW H_20	AERATE D H_20	CLARIFIED H_20	FILLERS H_20	TREATED H_20
1	10	8	10	8	8
2	10	8	10	8	8
3	12	10	12	10	10
4	18	22	22	18	18
5	8	10	12	12	10

FEBRUARY,98

PH

WEEKS	RAW WATER	AERATED	CLARIFIED	FILLERS	TREATED
1	6.8	6.9	6.9	6.8	6.8
2	6.8	7	7.1	6.8	6.9
3	6.8	7	7	6.9	6.8
4	7	7.2	7.3	6.8	6.8
5	7	7.3	7.3	6.9	6.9

TEMPERATURE

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	28	26	26	27	26
2	26	27	28	28	26
3	28	27	27	28	26
4	28	27	26.8	28	26.5
5	28.5	27	27.5	27	27

CHLORIDE ION

WEEKS	RAIN WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	31.2	26.98	28.4	31.4	26.9
2	26.9	28.4	31.2	29.8	28.4
3	26.9	25.6	26.9	29.8	29.8
4	29.8	28.4	29.8	29.8	31.2
5	25.6	26.9	26.9	28.4	26.9

TOTAL HARDNESS (TH)

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	16	20	20	16	14
2	18	20	22	18	20
3	18	18	20	22	18
4	18	18	22	20	22
5	18	22	22	20	20

METHYL ORANGE ALKALINITY

WEEKS	RAIN H_20	AERATED	CLARIFIED	FILTERED	TREATED
1	12	10	10	10	12
2	12	12	10	10	10
3	10	10	12	10	8
4	8	10	10	8	10
5	12	12	10	12	10

MARCH 98 PH

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	7.4	7.2	7.2	7	7
2	7.2	7.2	7.4	7.2	7.2
3	7.6	7.6	7.6	6.9	7.2
4	7.4	7.3	7	7.2	7.0
5	7.4	7.4	7.2	7.2	7.2

TEMPERATURE

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	27	25	26	27	26
2	27.5	25	24	26	25
3	26.5	26.5	26.5	28	29
4	28	28	27	27	28
5	31	31	29	29	29

CHLORIDE ION

WEEKS	RAIN WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	25.6	26.6	26.9	26.9	26.9
2	26.9	25.5	26.9	27.8	28.4
3	28.4	31.2	31.2	28.4	29.8
4	29.8	28.4	26.9	28.4	28.4
5	28.4	29.8	28.4	28.4	31

TOTAL HARDNESS (TH)

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	22	22	22	20	20
2	22	20	24	22	20
3	22	16	18	20	18
4	20	22	20	20	20
5	20	20	22	20	20

METHYL ORANGE ALKALINITY

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	8	8	10	10	10
2	10	10	12	10	10
3	12	10	10	12	12
4	10	12	12	10	10
5	10	10	10	10	10

APRIL 98 PH

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	7.4	7.3	7.4	7.3	7.2
2	7.2	7.4	7.4	7.3	7.2
3	7.1	7.4	7.4	7.3	7
4	6.8	7.2	7.3	6.8	6.8
5	6.8	6.8	7.2	6.8	6.8

TEMPERATURE

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	29.5	27	27	28	28
2	30	28	28	28.5	29
3	31	29	30	29.5	29
4	30	29	29	28	29
5	30	28	27.7	27	28

CHLORIDE ION

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	28.4	28.4	29.8	31.2	31.2
2	29.8	28.4	28.4	28.5	31.2
3	31.2	29.8	28.4	28.4	31.2
4	28.4	25.5	28.4	21.3	35.5
5	25.6	25.6	25.6	25.6	25.6

TOTAL HARDNESS (TH)

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	22	20	20	22	24
2	20	12	22	20	20
3	18	20	18	20	20
4	18	18	18	18	16
5	18	20	22	20	20

METHYL ORANGE ALKALINITY

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	10	12	12	10	10
2	10	12	10	10	10
3	12	10	10	10	10
4	10	12	10	10	10
5	8	6	6	6	6

MAY,98 PH

WEEKS	RAW WATER	AERATED	CLARIFIED	FILLERS	TREATED
1	6.8	6.8	7.2	6.8	6.8
2	6.9	7.2	7.3	7.1	7
3	7	7.4	7.3	7	6.9
4	6.9	7.3	7.4	7.1	7
5	6.8	7.2	7.3	6.8	6.8

TEMPERATURE

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	30	28	28	28	28
2	29	27.5	28	27	27
3	29	28	28.5	28.5	28
4	30	27	27	28	28
5	29.4	27.9	28	28	28

CHLORIDE ION

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	26.9	28.4	28.4	31.2	
2	28.4	26.98	28.4	28.4	
3	26.9	28.4	26.9	26.9	
4	26.9	25.6	22.8	22.8	
5	22.8	27.9	24.1	24.1	

TOTAL HARDNESS (TH)

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	20	20	24	20	20
2	20	22	20	20	22
3	20	20	20	22	20
4	18	20	22	20	20
5	20	24	22	20	22

METHYL ORANGE ALKALINITY

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	6	8	6	6	6
2	6	6	8	6	6
3	10	8	8	10	10
4	6	8	8	8	8
5	6	8	8	8	6

JUNE 98 PH

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	6.8	6.8	7.2	7.2	6.8
2	6.9	7.2	7.3	7	7
3	7.2	7.2	7.3	7.2	7
4	7	7	7.2	7.3	7

TEMPERATURE

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	28	28	28	28	
2	31.2	26.5	27.5	28	
3	29.8	28	28	27	
4	26.98	28	27	26	

CHLORIDE ION

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	28.4	25.5	25.5	29.8	28.4
2	31.2	29.8	26.9	26.9	28.4
3	29.8	28.4	29.8	28.5	29.8
4	26.98	24.1	26.9	31.5	31.2

TOTAL HARDNESS (TH)

WEEKS	RAIN WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	8	20	18	16	18
2	18	20	28	24	24
3	18	20	22	22	26
4	24	22	22	20	18

METHYL ORANGE ALKALINITY

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	8	6	8	8	10
2	4	8	8	6	6
3	6	6	6	6	6
4	6	6	6	6	6

APRIL 98 PH

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	7.4	7.3	7.4	7.3	7.2
2	7.2	7.4	7.4	7.3	7.2
3	7.1	7.4	7.4	7.3	7
4	6.8	7.2	7.3	6.8	6.8
5	6.8	6.8	7.2	6.8	6.8

TEMPERATURE

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	29.5	27	27	28	28
2	30	28	28	28.5	29
3	31	29	30	29.5	29
4	30	29	29	28	29
5	30	28	27.7	27	28

CHLORIDE ION

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	28.4	28.4	29.8	31.2	31.2
2	29.8	28.4	28.4	28.5	31.2
3	31.2	29.8	28.4	28.4	31.2
4	28.4	25.5	28.4	21.3	35.5
5	25.6	25.6	25.6	25.6	25.6

TOTAL HARDNESS (TH)

WEEKS	RAW WATER	AERATED	CLARIFIED	FILTERED	TREATED
1	22	20	20	22	24
2	20	12	22	20	20
3	18	20	18	20	20
4	18	18	18	18	16
5	18	20	22	20	20

METHYL ORANGE ALKALINITY

WEEKS	RAW H_20	AERATED	CLARIFIED	FILTERED	TREATED
1	10	12	12	10	10
2	10	12	10	10	10
3	12	10	10	10	10
4	10	12	10	10	10
5	8	6	6	6	6

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APPENDIX

```
*MAIN MENU PROGRAM
SET TALK OFF
SET ECHO OFF
SET STATUS OFF
SET CONSOLE OFF
DO WHILE .T.
@3,20 TO 16,59 DOUBLE
@4,35 SAY " MAIN MENU "
@5,35 TO 5,43
@6,22 SAY "A. DATA  UPDATING"
@8,22 SAY "B. WATER FILE (SCREEN)"
@10,22 SAY "C.WATER FILE (PRINTER)"
@12,22 SAY "D.WATER ANALYSIS(SCREEN)"
@14,22 SAY "E.WATER ANALYSIS (PRINTER)"
CHOICE = " "
@15,22 SAY "CHOOSE A,B,C,D OR E "
@15,40 GET CHOICE RANGE A,E
READ
@3,20 CLEAR TO 16,59
 DO CASE
  CASE CHOICE = "A"
  DO SD
  CASE CHOICE ="B"
  DO PT
  CASE CHOICE = "C"
  DO SUB
  CASE CHOICE = "D"
  DO POUR
  CASE CHOICE = "E"
  DO ANG
  OTHERWISE
  RETURN
 ENDCASE
ENDDO
SET TALK ON
RETURN
```

```
*PROGRAM FOR WATER TEST ANALYSIS (SCREEN OUTPUT)
SET TALK OFF
SET BORDER TO "*"
@0,17 TO 18,63
MDATE = CTOD (" / / ")
@2,2 SAY "DATE:" GET MDATE
READ
SET DEVICE TO SCREEN
SELECT 1
USE WATER
GO 11
SELECT 2
```

```
USE WHO
SELECT 1
DO WHILE .NOT. EOF ()
KA = TEMP
B = MN
C = TH
D = CL
E = PH
SKIP
SELECT 2
MA = TEMPERAT
MB = METH_IND
MC = T_HARD
MD = CHLIRON
ME = PH
SKIP
NA = TEMPERAT
NB = METH_IND
NC = T_HARD
ND = CHLIRON
NE = PH
SKIP
ENDDO
IF KA >=MA .AND.KA<=NA
 K = "OKAY"
ELSE
 K = "REPEAT"
ENDIF
IF B  >=MB.AND.B<=NB
 KR = "OKAY"
ELSE
 KR = "REPEAT"
ENDIF
IF C >=MC .AND.C<=NC
 S ="OKAY"
ELSE
  S = "REPEAT"
ENDIF
IF D >= MD .AND.D<=ND
 SR = "OKAY"
ELSE
 SR = "REPEAT"
ENDIF
IF E>= ME .AND.E<=NE
 F = "OKAY"
ELSE
  F = "REPEAT"
ENDIF
SET DEVICE TO FILE PR.TXT
@1,25 SAY "WATER TEST ANALYSIS FOR"
@1,49 SAY MDATE
@2,25 SAY "--------------------------------"
@3,19 SAY "NAME"
@3,55 SAY "ANALYSIS"
```

```
@4,19 SAY "------"
@4,55 SAY "-------"
@5,19 SAY "TEMPERATURE"
@5,55 SAY K
@7,19 SAY "METHYL INDICATOR"
@7,55 SAY S
@9,19 SAY "TOTAL HARDNESS"
@9,55 SAY KR
@11,19 SAY "CHLORIDE IRON"
@11,55 SAY SR
@13,19 SAY "PH"
@13,55 SAY F
SET DEVICE TO SCREEN
SET TALK ON
SET BORDER TO " "
CLOSE DATABASES
RETURN

*PROGRAM FOR WATER TEST ANALYSIS (SCREEN OUTPUT)
SET TALK OFF
SET BORDER TO "*"
@0,17 TO 18,63
DATE = CTOD (" / / ")
@2,2 SAY "DATE:" GET DATE
READ
SET DEVICE TO SCREEN
SELECT 1
USE WATER
GO 11
SELECT 2
USE WHO
SELECT 1
DO WHILE .NOT. EOF ()
KA = TEMP
B = MN
C = TH
D = CL
E = PH
SKIP
SELECT 2
MA = TEMPERAT
MB = METH_IND
MC = T_HARD
MD = CHLIRON
ME = PH
SKIP
NA = TEMPERAT
NB = METH_IND
NC = T_HARD
ND = CHLIRON
NE = PH
SKIP
ENDDO
IF KA >=MA .AND.KA<=NA
```

```
 K = "OKAY"
ELSE
 K = "REPEAT"
ENDIF
IF B  >=MB.AND.B<=NB
 KR = "OKAY"
ELSE
 KR = "REPEAT"
ENDIF
IF C >=MC .AND.C<=NC
 S ="OKAY"
ELSE
  S = "REPEAT"
ENDIF
IF D >= MD .AND.D<=ND
 SR = "OKAY"
ELSE
 SR = "REPEAT"
ENDIF
IF E>= ME .AND.E<=NE
 F = "OKAY"
ELSE
  F = "REPEAT"
ENDIF
@1,30 SAY "WATER TEST ANALYSIS"
@2,30 SAY "----------------------"
@3,19 SAY "NAME"
@4,19 SAY "----"
@3,55 SAY "ANALYSIS"
@4,55 SAY "-------"
@5,19 SAY "TEMPERATURE"
@5,55 SAY K
@7,19 SAY "METHYL INDICATOR"
@7,55 SAY S
@9,19 SAY "TOTAL HARDNESS"
@9,55 SAY KR
@11,19 SAY "CHLORIDE IRON"
@11,55 SAY SR
@13,19 SAY "PH"
@13,55 SAY F
SET TALK ON
SET BORDER TO " "
CLOSE DATABASES
RETURN
**************************
USE WATER
DATE = CTOD(" \ \ \ ")
@3,5 SAY "DATE" GET DATE
READ
@5,1
DO WHILE .NOT. EOF()
DISPLAY NEXT 4
WAIT
ENDDO
```

```
USE
RETURN

*PROGRAM FOR DATA UPDATING
SET TALK OFF
SET STATUS OFF
USE WATER
GO TOP
DO WHILE .T.
@2,20 TO 18,59 DOUBLE
@3,34 SAY "DATA UPDATING"
@4,34 TO 4,47
NAME = SPACE (20)
MPH = 0
MTEMP = 0
AMIND = 0
MHARD = 0
MHLIRON  = 0
MCODE = 0
MCLASS = SPACE (10)
@5,22 SAY "WATER TYPE" GET NAME
@6,22 SAY "PH" GET MPH  PICT "999.99"
@7,22 SAY "TEMPERATURE" GET MTEMP  PICT "999"
@8,22 SAY "MET.IND" GET AMIND  PICT "999"
@9,22 SAY "HARDNESS" GET MHARD  PICT "999"
@10,22 SAY "CHLORIDE IRON" GET MHLIRON PICT "999"
@11,22 SAY "WATER CODE" GET MCODE PICT "999"
@12,22 SAY "WATER CLASS" GET MCLASS
READ
CH = SPACE (1)
@13,32 SAY "TO SAVE (Y/N)" GET CH  PICT "!"
READ
IF CH = "Y"
 LOCATE FOR WATERTYPE = NAME
 REPLACE PH WITH MPH,TEMP WITH MTEMP
 REPLACE MN WITH AMIND,TH WITH MHARD
 REPLACE CL WITH MHLIRON,WATERCODE WITH MCODE
 REPLACE WATERCLASS WITH MCLASS
ELSE
 @15,32 SAY "RECORD NOT FOUND"
ENDIF
RESP = SPACE (1)
@15,32 SAY "TO CONTINUE (Y/N)" GET RESP PICT "!"
READ
IF RESP = "Y"
 @2,20 CLEAR TO 18,60
 LOOP
ELSE
 EXIT
ENDIF
ENDDO
USE
SET TALK ON
SET STATUS ON
```

```
RETURN
* PROGRAM TO PRINT OUT FILE CONTENTS
   SET TALK OFF
   SET STATUS OFF
   _pspacing = 2
   USE WATER
   GO TOP
   MDATE = CTOD (" \ \ ")
   @3,5 GET MDATE
   READ
   *SET PRINTER ON
   ? "WATER ANALYSIS TABLE RECORD" AT 21  STYLE "BU"
   ? MDATE AT 47 STYLE "BU"
   ?
   ? "PH"AT 13,"TEMP" AT 20,"MN" AT 26
   ?? "CLI" AT 30,"TH" AT 35, "W.TYPE" AT 39
   ?? "W.CODE " AT 53 ,"W.CLASS" AT 64
   ?
"-------------------------------------------------------------"
AT 13
   DO WHILE .NOT. EOF()
   ?STR(PH) AT 5,STR(TEMP) AT 14,MN AT 18
   ??STR( CL) AT 22,STR(TH) AT 26,WATERTYPE AT 39
   ??STR( WATERCODE) AT 48,WATERCLASS AT 67
   SKIP
   ENDDO
   SET TALK ON
   *SET PRINTER OFF
   ?
   USE
   RETURN
```

WATER ANALYSIS TABLE RECORD

23/12/98

PH	TEMP	MN	CLI	TH	W.TYPE	W.CODE	W.CLASS
7	26	18	31	20	RAW WATER	1	RW
6	26	18	30	20	AERATD WATER	2	AW
0	0	0	0	0	CLARIFIED WATER	0	
0	0	0	0	0	FILTERED WATER	0	
0	0	0	0	0	TREATD WATER	0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	

WATER ANALYSIS TABLE RECORD

23/12/98

PH	TEMP	MN	CLI	TH	W.TYPE	W.CODE	W.CLASS
7	26	18	31	20	RAW WATER	1	RW
6	26	18	30	20	AERATD WATER	2	AW
0	0	0	0	0	CLARIFIED WATER	0	
0	0	0	0	0	FILTERED WATER	0	
0	0	0	0	0	TREATD WATER	0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	

WATER ANALYSIS TABLE RECORD

23/12/98

PH	TEMP	MN	CLI	TH	W.TYPE	W.CODE	W.CLASS
7	26	18	31	20	RAW WATER	1	RW
6	26	18	30	20	AERATD WATER	2	AW
0	0	0	0	0	CLARIFIED WATER	0	
0	0	0	0	0	FILTERED WATER	0	
0	0	0	0	0	TREATD WATER	0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	

WATER ANALYSIS TABLE RECORD

23/12/98

PH	TEMP	MN	CLI	TH	W.TYPE	W.CODE	W.CLASS
7	26	18	31	20	RAW WATER	1	RW
6	26	18	30	20	AERATD WATER	2	AW
0	0	0	0	0	CLARIFIED WATER	0	
0	0	0	0	0	FILTERED WATER	0	
0	0	0	0	0	TREATD WATER	0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	
0	0	0	0	0		0	