DEVELOPMENT OF A SOFTWARE ON WATER BILLING SYSTEM
(A Case Study of FCT Water Board, Abuja.)

BY

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APPROVAL / CERTIFICATION

This is to certify that this project is an original research work carried out by Sadiq Ike Nasiru. The project has been certified as having met the requirement for the award of a Post Graduate Diploma in Computer Science of the Department of Mathematics and Computer Science, Federal University of Technology, Minna.

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DEDICATION

I dedicate this project to Almighty Allah who "willed" it.

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ABSTRACT

Water is essential for life and living. However, the hygienic one is scarce and expensive to provide. About 70 percent of killer diseases today are waterborne which are in essence preventable.

The perennial water scarcity is no doubt due to wastage, vandalisation and unpreparedness to pay water rates.

The collection, organisation and presentation of this research issues, gives an insight into the water management techniques.

The necessary orientation and incentives is provided to carry out self determination of correct bill by consumers for payment and thereby supportive of the efforts of water agencies for better services.

If seventy percent of earth surface is covered by water, we will only be a fool to be thirsty in the abundance of water.

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CHAPTER 1

INTRODUCTION

1.000 Water for Sustainable Growth: "Nor Any Drop to Drink"

The Ancient Mariner had it nearly right. Water covers most of the globe, but very little of it-about two percent – is freshwater, and most of it is locked up in polar ice. By UN estimates, two-thirds of humanity will face shortages of clean freshwater by the year 2025. Improved management of our precious water resources is an urgent global need.

One is hard put to come up with a problem that fits the definition more precisely than that of the planets stressed water resources. Without sufficient water, the very survival of our species would soon be called into question – as obviously, would any hope of development or decent daily welfare.

It is difficult to say which part of the water equation has the greater urgency – for; in fact, all life is caught up in watery web of daily needs, from humans to animals to the crops that nourish us.

Decreased freshwater supply has encumbered world food harvests, destroyed precious aquatic habitats, and threatened biodiversity. The world's oceans show equal evidence of the track of the human species – fish catches are off, polluted run-off threatens the oceans ability to supply life-giving oxygen. Global climate warning is rogue factor – it could imperil the lives of tens of millions, mostly poor, who have much to fear from even a slight rise in sea level. *(UNU-Work in Progress)*

1.010 Urban Water

The number of urban dwellers on the globe is expected to double to more than five billion people by the year 2025. Between 1950 and 1990, the number of cities having more than one

million people increased almost four-fold, from 78 to 290. By 2025, the number of such cities is likely to double to more than six hundred.

Asia and Africa are now experiencing explosive urban growth at around four percent per year. The provision of clean water and sanitation facilities in the mega-cities of the developing world-places like Lagos, Shanghai, Jakarta and Mexico City- is going to be one of the most challenging tasks faced by development strategists in the 21st century.

Already there are very disquieting signs of inadequate water supply and sanitation in the developing countries. Some of the signs;

- Unsafe water is responsible for 80 percent of all diseases and 30 percent of deaths in the developing world;
- Annually 1.2 billion people suffer from diseases caused by unsafe drinking water or poor sanitation;
- Annually more than four million children die from water born diseases;
- Fifteen percent of children will die before reaching the age of five years due to diarrhea-deaths that might be avoided with reasonable water and sanitation services.

Both quality and quantity are serious urban water concerns. The cities of the world produce huge amounts of sewage – which causes health problems both for humans and for ecosystems. Water-related diseases are prevalent, especially in the poorer parts of developing country cities. Similarly, providing sufficient amounts of water to the growing urban centers is in itself a challenge.

Solutions obviously need to be found on multiple fronts involving a range of stakeholders. Thus far the main emphasis has been on managing water supplies. As new source water all over the world become scarce and more expensive to develop, emphasis needs to shift from supply to demand management. One of the tools will be increasing reliance on water pricing.

Appropriate water pricing could significantly reduce water wasted in all sectors. *(UNU-Work in Progress)*

1.020 WATER SHORTAGE

More than 200 rivers flow through two or more countries. Many lake basins and groundwater aquifers spill across (or under) national boundaries. Some 60 per cent of the world's populations live in the watersheds of these international fresh water systems. There is no enforceable law governing the allocation and use of these international waters. Still, this is an arena that virtually demands United Nations attention.

Providing people with adequate supplies of freshwater is becoming a major problem in many regions of the world owing to concerns like growing population, urbanization and environmental degradation. More rational use of shared resources in international freshwater systems is obviously highly desirable. However, the potential for regional tensions and conflicts over shared freshwater resources is likely to escalate substantially, particularly in arid and semi-arid regions where water is already a constraint to economic growth.

Many concerned observers have been worried about tensions and conflicts among basin countries and international freshwater systems – particularly in a region like the water-short Middle East. The former UN Secretary-General Boutros Boutros-Ghali expressed his fear, on several occasions that war could come to that region as a result of water disputes. In his own native Egypt, it has been axiomatic policy that it would go to war should any country attempt to disrupt the flow of the Nile.

In the early 1990s, Turkey turned sown Syria's request for more water from the Euphrates – a river that watered mankind's earliest agricultural efforts. The then Turkish Prime Minister Suleyman Demirel remarked: "We do not say we should share thei oil resources. They cannot say they should share our water resources". It was not surprising, therefore, when Wally N'Dow, Secretary-General of the United Nations Conference o Human Settlements held in 1996 in Istanbul, commented: "I suspect that in the next 50 years, we will see a shift from oil to water as the cause of great conflicts between nations and peoples."

The freshwater resources and related environments of the world are under enormous stress. The global community is badly in need of modalities to deal with international water bodies in a much better way, both in terms of water quantity and quality. Attaining such goals can be difficult in international water bodies, which is not usually forthcoming. As a result,

many countries are unable to utilize more fully their shared water resources due to unresolved riparian conflicts. *(UNU – Work in Progress)*

1.100 WATER SOURCE CHARACTERISTICS

Water supply sources may be surface water or groundwater. The surface water and groundwater resources of an area typically are closely related and are interconnected by the hydrologic cycle. Because surface water and groundwater are treated differently under federal regulations, knowing the difference is important.

1.110 Hydrologic Cycle

The hydrologic cycle is the constant movement of water above, on, and below the earth surface. Although the hydrologic cycle has neither a beginning nor an end, discussing its principal features by starting with evaporation from vegetation, the oceans, and exposed moist surfaces on the land is convenient. This moisture form clouds that return the water to the land surface on oceans in the form of precipitation.

Precipitation occurs in several forms, including rain, snow, and hail, but only rain is considered here. Initially, rain wets vegetation and other sources; it then begins to infiltrate into the ground. When and if the rate of precipitation exceeds the rate of infiltration, an overland flow occurs. Initial infiltration replaces soil moi ture; excess infiltration percolates slowly, moving downward and laterally to sites of groundwater discharge, such as springs on hillsides, or seeps in the bottoms of streams and lake or beneath the ocean. Water reaching streams, both by overland and groundwater discharge, moves to the oceans, where it is again evaporated to continue the cycle.

The concept of the hydrologic cycle is important in the development of a source water quality management strategy. Contaminants can be introduced into water from various sources throughout the hydrologic cycle. Contaminants may be diluted, concentrated, or carried through the cycle with the water. Source water quality management seeks to minimmise contaminant input to water resources used for sources of drinking water.

1.120 Surface Water Sources

Surface water is the term used to describe water on the land surface. It may be running, such as in streams, rivers, and brooks, or quiescent, such as in lakes reservoirs, impoundments and ponds. Surface water is produced by runoff of precipitation and by groundwater seepage. For regulatory purposes, surface water is defined as all water open to the atmosphere and subject to the surface runoff.

After surface water has been produced, it follows the path of least resistance. A series of brooks, creeks, streams, and rivers caries water from an area of land surface that slopes down toward one primary watercourse. This drainage area is known as a watershed or drainage basin. A watershed is a basin surrounded by a ridge of high ground, called the watershed divide, which separates one drainage area from another.

Source water quality is highly influenced by the point within the watershed where water is diverted for treatment. The quality of streams, rivers, and brooks will vary according to seasonal flow and may change significantly because of precipitation and accidental spills. Lakes, reservoirs, impoundments, and ponds typically have less sediment than rivers but are subject to greater impacts from microbiological activity than river sources.

Quiescent water bodies, whether natural or human made ecosystems. Each is unique and changes in character from year to year. In addition, water bodies, including source water lakes and reservoirs, age over a relatively long period of time as a result of natural processes.

1.130 Groundwater Sources

All water beneath the land surface is referred to as underground, or subsurface, water, although an exact definition for regulatory purposes is undecided at this time. Underground water occurs in two different zones. One zone is immediately below the land surface in most areas, contain both water and air, and is referred to as the unsaturated zone. A zone in which all interconnected openings are full of water, referred to as the saturated zone, almost invariably underlies the unsaturated zone. Water in the saturated zone is the only water to which the name groundwater is correctly applied. Recharge of the saturated zone occurs by percolation of water from the land surface through the unsaturated zone.

All rocks that underlie the earth surface can be classified either as aquifers or as confining beds. An aquifer is a rock unit that will yield water in a usable quantity to a well or spring. In geologic usage, "rock" includes unconsolidated sediments. A confining bed is a rock unit having very low hydraulic conductivity that restricts the movements of groundwater either into or out of adjacent aquifers.

Groundwater occurs in aquifers under two different conditions. Where water only partly fills an aquifer, the upper surface of the saturated zone is free to rise and decline. The water in this type of aquifer is said to be unconfined, and the aquifer is referred to as an unconfined aquifer. Unconfined aquifers are also widely referred to as water table wells. The water level in these wells indicates the position of the water table in the surrounding aquifer.

Where water completely fills an aquifer that is overlain by a confining bed, the water in the aquifer is said to be confined. Wells. In such aquifers are referred to as pressure wells or artesian wells. The water level in artesian wells stands at some height above the top of the aquifer but not necessarily above the land surface, the well is a flowing artesian well. The water level in tightly cased wells open to a confined aquifer stands at the level of the potentiometer surface of the aquifer.

Some groundwater sources may be subject to contamination from surface waters. Springs, infiltration galleries, shallow wells, and other collectors in subsurface aquifers may be hydraulically connected to nearby surface water sources, depending on local geology. For regulatory purposes, these are referred to as groundwater under the direct influence of surface waters.

1.200 FACTORS INFLUENCING SOURCE WATER QUALITY

Both natural and human factors influence the quality of a water source. Management of the quality of source water must begin with the identification of those factors involved that individually or jointly affect the quality of the water source.

The degree of impact of operative factors varies depending on the type and characteristics of the source involved. Surface water, for example, is generally, but not exclusively, more vulnerable to human contamination than groundwater because of its direct exposure to human activity. Vulnerability itself will vary with size and type, for example, river versus lake or impoundment. A surface supply can restore itself more rapidly than a ground supply through seasonal and short-term runoff cycles. The slow rates of movement of groundwater are such that restoration and replenishment may take decades. Variations in weather patterns, i.e., prolonged drought or flood conditions, more directly affect surface water than groundwater. Quality effects will be different for lakes and impoundment than for free flowing rivers, and different for sand and gravel than for rock aquifers. Oil spills may be isolated or captured in the case of surface water, but once present in an aquifer, they are very difficult to remove. A volatile chemical may remain in a groundwater supply, but that same chemical can volatilize out of a surface supply. A source water management program must take into account the nature of the supply as well as the active factors that influence water quality. Factors influencing source water quality are classified as either natural or human.

1.210 Natural Factors

Natural factors cannot be readily controlled and may have a significant impact on the quality of a source water. Factors considered here include climate, watershed characteristics, geology, microbiological growth , fire, saltwater intrusion, and density or Thermal stratification.

1.220 Climate.

The primary effect on water quality caused by climatic condition is that of precipitation. Wet climates or periods of heavy precipitation result in high rates of runoff or flood conditions that can cause re-suspension of sediment and increases in turbidity color, metals, or or other contaminations, the flushing effects on heavy precipitation on watershed can introduce an accumulation of organic compounds through runoff, with deleterious effect on water quality. Under dry condition or prolonged drought condition, lower rates of runoff can cause stagnation, thereby increasing the likelihood of microbiological activity and algal growth. Reduced flows under dry condition exacerbate the impact of point source discharges because of

reduction in the dilution effect and in the assimilative capacity of the water body. Temperature is also an importance climatological factor affecting biological activity rates, oxygen saturation, and mass transfer coefficients. *(Water Quality and Treatment- A hand book of community water supplies- Fourth Edition Ch 4 P.190)*

1.300 Waterborne Disease outbreaks

In the past, infectious were frequently transmitted through contaminated drinking water. Improvements in wastewater disposal practices and the development, protection, and treatment of water supplies have reduced the prevalence of infectious diseases in the united states and other developed countries. To understand the problem of water-related diseases, classifying water-related illness into the following four general groups based on epidemiological considerations is helpful: (1) waterborne diseases, (2) water-washed diseases,(3) water-based diseases, and (4) water-vectored diseases.

Waterborne diseases are those transmitted through the ingestion of contaminated water. The water acts as the passive carrier of the infectious or chemical agent. Classic waterborne diseases are cholera and typhoid fever. Chemical poisonings and methemoglobinemia may also be caused by contaminated water supply systems. In addition, chronic ingestion of low level of some chemical contaminants in drinking water has been associated with adverse health effects, but these association are poorly understood at present. Note that diseases caused by pathogenic bacteria, viruses, protozoans, and helminthes are transmitted through the fecal-oral route from human to animal to human , with drinking water being only one of several possible sources of infection. Diarrheal illness is an important cause of infant mortality and morbidity in developing countries.

Water –washed diseases are related to poor hygienic habits and sanitation. Unavailability of water for washing and bathing contributes to diseases that affect the eye and skin. Water- based diseases are those in which the pathogen spends an essentia part of its life in water or is dependent upon aquatic organisms for the completion of its life cycle. Schistosomiasis and dracontiasis are example of water based diseases . water vectored diseases, such as yellow fever and malaria, are transmitted by insects that breed in water or that bite near water. Although important in the protection of public

health, water washed, water-based, and water –vectored diseases will not be considered in this book, but references are available.

The introduction of colifrom drinking water standards in 1914 underscored the fact that waterborne microorganism diseases outbreaks could be diramatically reduced through source control, filtration , and chlorination. A substantial number of outbreaks do still occur, how ever, and since 1950, there has been a steady increase is presumed to be caused by public awareness and associated increases in reporting of outbreaks Along with this have been improvement in sampling and analytical techniques that allow better reporting . most outbreaks are caused by the use of contaminated, untreated water or by inadequacies in treatment, and the majority tend to occur in small community and noncommunity systems.

Organisms associated with recent diseases outbreaks include the protozoan Giardia lamblia , bacteria such as salmonella, and viral agents such as hepatitis.

1.400 Understanding Health Effects of Chemicals

Every chemical has an effect on living organisms exposed to it. Toxicology, the study of the adverse effects of chemicals on living organisms, provides a means of evaluating and understanding these effects. Although a complete review of toxicology principles is beyond the scope of this chapter, basic concepts needed to understand the information presented in this chapter are presented below.

Living organisms respond in one of two ways when exposed to a chemical. An organism may show an effect that is of no health consequence to the organism. Alternatively , an organism may show an adverse or deleterious effect that is undesirable and threatens the health of the roganism. Some adverse health effects in organisms are immediate (within 24 to 48 hours after exposure), but others are delayed (for example, 10 to 20 years or more for cancer in humans). Adverse effects may be reversible depending upon their nature, the severity of the effect, and the organ affected.

The response of a living organism exposed to a chemical depends upon the chemical dose or exposure level. The higher the dose, the more significant the effect. This is termed the dose-response relationship. Understanding this concept is important because simply knowing that a substance can have a particular toxicological property (i.e it is carcinogenic) is not sufficient in and of itself to assess human health risk. The dose-response relationship must also be known, as well as information concerning human exposure, before a judgement can be made regarding the public health significance of that substance.

A variety of adverse health effects are possible, the following general terms will be used to describe these effects.

Toxic: Causing a deleterious response in a biologic system, seriously injuring function, or producing death. These effects may result from acute conditions (short high-dose exposure), chronic (long-term, low-dose) exposure, or sub-chronic (intermediate-term and dose) exposure.

Neurotoxic: Exerting a destructive or poisonous effect on nerve tissue.

Carinogenic: Causing or inducing uncontrolled growth of aberrant cells into malignant tumours.

Mutagenic: Causing heritable alteration of the genetic material within living cells.

Tetratogenic: causing nonhereditary congenital malformations (birth defects) in offspring.

Pathogenic Organisms

Table 2.3 lists potential waterborne disease causing organisms. Shown are characteristics elements of the disease each organism is associated with.

Potential Waterborne Disease-causing Organisms

Name of Organism	**Major disease**	**Major reservoirs and or group (primary sources)**

Bacteria		
Salmonella typhi	*Typhoid fever*	*Human faeces*
Salmonella paratyphi	*Paratyphoid fever*	*Human faeces*
Other salmonella	*Salmonelosis*	*Human and animal faeces*
Shigella	*Bacillary dysentery*	*Human faeces*
Vibrio cholerae	*Cholera*	*Human faeces*
Enteropathogenic E. Coli	*Gastro enteritis*	*Human faeces*
Yersinia enterocolitica	*Gastroentiritis*	*Human and animal faeces*
Campylobacter jejuni	*Gastroentiritis*	*Human and animal faeces*
Legionella pneumophila	*Acute respiratory illness*	*Thermally enriched waters*
Mycobacterium tuberculosis	*Ttuberculosis*	*Human respiratory exudat*
Other atypical mycobacteria	*Pulmonary illness*	*Soil and water*
Opportunistic bacteria	*Variable*	*natural waters*
Enteric Viruses		
Enteroviruses		
Polioviruses	*Poliomyelitis*	*Human faeces*
Coxsackieviruses A	*Aseptic meningitis*	*Human faeces*
*Coxsackieviruses **B***	*Aseptic meningitis*	*Human faeces*
Echoviruses	*Aseptic meningitis*	*Human faeces*
Other Enteroviruses	*Encephalitis*	*Human faeces*
Reoviruses	*Mild upper respiratory and gastro intestinal illness*	*Human and animal faeces*
Rotaviruses	*Gastroentritis*	*Human faeces*
Adenoviruses	*Upper respiratory and Gastrointestinal illness*	*Human faeces*
Hepatitis A virus	*Infectious hepatitis*	*Human faeces*
Norwalk and related GI viruses	*Gastroentritis*	*Human faeces*
Protozoans		
Acanthamoeba castellani	*Amoebic meningoencephalities*	*Soil and water*
Balantidium coli	*Balantidosis(dysentery)*	*Human faeces*
Cryptosporidium	*Cryptosporidiosis*	*Human and animal faeces*
Entamoeba hystolitica	*Amoebic dysentery*	*Human faeces*
Giardia lamblia	*Giardiasis (gastroenteritis)*	*Human and animal faeces*
Naegleria fowleri	*Primary amoebic meningoencephalitis*	*Soil and water*
Algae (blue green)		
Anabaena flos-aqua	*Gastroentiritis*	*Natural waters*

Microcystis aeruginosa	*Gastroentiritis*	*Natural waters*
Alphanizomenon flos-aqua	*Gastroenteritis*	*Natural waters*
Schizotrix calciola	*Gastroentiritis*	*Natural waters*

(Water Quality and Treatment – A handbook of community water supplies – Fourth Edition- Ch.2 P.64)

1.500 SIGNIFICANCE OF THE STUDY

This research is carefully designed to accommodate some issues that are indirectly related to the subject of this study for the benefit of both water agencies and consumers alike.

It gives an insight into the complex web of various interactive forces of human efforts, cost of material acquisition and natural and environmental influence before the provision of safe and hygienic water is made available with that ease we often think is all so easy to get. This will enable us to really appreciate the inputs of the various water agencies and assist them in the efficient management of the invested human and material resources for the delivery of a safe, regular and efficient water supply.

The individuals, interest groups and various water agencies both governmental and non governmental is provided with the basic understanding on what a pure and safe water is, the sources of hygienic water, the common causes of water pollution and water related diseases. Efforts is also made to highlight some basic mitigation against water pollution and water treatment against water borne diseases.

1.600 OBJECTIVE OF THE STUDY

This study is aimed at bringing into focus the enormous human and material undertakens it takes to provide and make available safe water for human consumption and domestic uses. This is with a view to making consumers assist the relevant agencies in providing this essential facility regularly by paying their water rates regularly and promptly too.

It also serves to determine the veracity of water charges that may be provided by the FCT water board in order to avoid undue exploitation of the consumers by the Board.

It provides the basis for a self determination of the water bill based on the meter reading.

The knowledge of the amount payable per cubic meter of water consumed will make the consumers to avoid water wastage and encourage prudent use of water supply.

The water billing system machinery of the FCT water board can be complemented by this programme in event of system break down and vice versa. This will eliminate the accumulation of debt arising from non distribution of water bill promptly.

1.700 DEFINITION OF TERMS

Commercial - This is a category of water consumers that uses their subscription to FCT water board for commercial purposes such as Hotels, Restaurant, Block industry etc, who has a meter of their own and are thus charged in isolation for water consumed.

Commercial Flat Rate - This is a collective bill sent to business premises that house a number of commercial businesses such as restaurant, car wash, dry cleaner, tie & die and caterers etc., that has no meter.

Industrial - Industrial consumers refers to manufacturing industry premises which enjoys water extension from the FCT water board such as block making industries, Ceramic and chemical industries etc.

Enhanced Domestic Supply - This is a category of water extension to consumers in a settlement similar to family compound and small housing estate etc.

Domestic Metered Premises - It refers to houses especially of bungalow in a design that has an allocated meter of their own and billed in isolation.

Domestic Flat Rate – Domestic flat rate category of consumers describes those resident in a type of building similar to a block of house which contains a number of flats that has no meter.

Public Institutions - These are the establishments set up by the Government and in which govermnent is responsible for the settlement of their bill over water consumed. They are further categorised as follows:

i. **Government Offices-** This are houses and rooms which are owned by goverrunent and are used for management and administrative purposes.

ii. **Government Hospital &** Clinic-These are accomodation that houses government's owned health service centers.

iii. **Schools** -Government schools are the institutions of education from the primary to tertiary owned and financed by the government.

iv. **Government Quarters -** Government quarters are the accomodation that houses government personnel. They are further divided into their various number of 1 bedroom through 5 bedroom accomodation.

Treatment – This refers to the processing of hitherto impure water for safe drinking.

Mitigation – Reffers to preventive measures against contamination of pure water.

1.800 SCOPE AND LIMITATION

This project work was conceived and undertaken by author and oblivious of any prior subject undertaken. Therefore, the topic is being studied from its foundation.

However, because of the varying interacting factors, units and departments which are working together for one organisational objective of transporting and distribution of safe water, it will amount to digression to study the organisation whollistically bearing in mind the theme of the project which is the "development of software for water billing system". Therefore, the scope of the study will be confined to this subject. It will. cover all the categories of water consumers such as commercial, commercial flat rate, industrial,

enhanced domestic supply, domestic metered premises, domestic flat rate, public institution, government quarters and water tankers.

Since connection fees does not amount to a bill payable on the quantity of water consumed, it will not be considered in the water bill determination software module. Consideration will however be given to the connection fee in the main menu of the program development for the purpose of completeness in the area of software coverage.

The statistical analysis of the water treatment is another interesting area of study which unavoidably fall outside the justification of this study. It is hoped that learning that area outside will give an opportunity to another prospective researcher a room to deal with that subject exhaustively.

CHAPTER 2

LITERATURE REVIEW

2.000 INTRODUCTION

Water occurs naturally on earth surface. One characteristic property of free natural water is it's continual motion, impacted primarily by input of radiant energy from the sun which causes evaporation and subsequent condensation which falls back as rain. This also rubs off on it's abundance in an area.

Abundant supply of water or lack of it attract or dissuades settlement the world over. The undisputable fact that 'water is life' will forever remain true and relevant in view of the fact that LIFE as is known cannot exist without water, perhaps this accounts for the mention in the report of the Akinola Aguda Committee on the relocation of the federal capital that;

"we are fully conscious of the necessity for the existence at or quite close to the location for the capital of adequate water supply. In our view, this is most desirable, but what is perhaps, of greater importance is the possibility for " manufacturing and delivering the required water of the right quality and in sufficient quantity for efficient functioning of the capital territory (meeting domestic, industrial and environmental needs)"

A location where there is an adequate natural water supply of the right quality or a location near such a place is most desirable. Here we have taken into consideration not only surface water and adequate rain water. This abundance not with-standing, water in it's natural form has to be processed and purified in order to meet up with the portability standard set up by the World Health Organisation (WHO). In this regard portable water has to be free from odour, taste, colour, bacteria and all harmful chemicals must be reduced to the barest minimum hence the greater and growing interest of governments and other related agencies in all issues relating to water supply and sanitation. From the inception in 1976 water supply in the city was managed by a sub-directorate in the Department of Engineering Services of

the Federal Capital Development Authority. This later led to the establishment of FCT Water Resources Agency in October 1989.

In 1995, the Agency was re-designated FCT Water Board in line with it's responsibilities and further charged to take over the rural water supply activities of the Directorate for Food, Road and Rural Infrastructures (DFRRI). The Board is charged with the following responsibilities:

1 . To control, manage, install, maintain all water works and services vested or to be vested on the Agency by the Minister of FCT.
2. To ensure the supply of portable water of adequate quantity and quality for the Territory at an economic rate.
3. To harness all water resources of the Territory for economic development.
4. To encourage the conduct of research for the purpose of carrying out it's functions.
5. To submit the results of such research to the Hon. Minister for policy formulation relating to water supply and pollution control in the Territory.

Water is unique and it is the uniqueness of it's physical and chemical characteristic that has made it possible for life on earth. Life and human activities are so dependent on water that it could be concluded without any gain saying that life would be impossible without water. No wonder a large portion of the efforts of space explores had been devoted to finding water as a due to existence of life on other planets. So far, there has not been a report to confirm existence of water the way it is on earth nor has life in any form similar to that of this planet earth, been confirmed. Water is therefore a commodity which must be highly cherished and handled with care. Infact many philosophers have postulated, perhaps to underscore the importance of water, increase of tension.between nations sharing common water sources over water - rights.

Nigeria is a lucky country having been endowed with abundant fresh water resource, both surface and ground water. Two of the major international rivers of the sub-region i.e the river Niger and the river Benue empty into Nigeria with large network of tributaries and rivulets. It is estimated that Nigeria has about 300 billion cubic meters of water reserve, 20% of which is from ground water sources.

There are many types of natural water found on earth's surface.

a. Rainwater

This is the purest natural water,' and if collected in a country district, it contains oxygen, nitrogen and carbon dioxide (dissolved as the rain drops pass through the atmosphere) and only a small amount of dissolved solid (0.005%).

b. River Water

This is where many domestic supplies are obtained, will obviously contain the same gaseous impurities and also any solids which the water has dissolved as it passed over the soil. The amount and kind of impurity will depend, therefore, on the type of soil over which it flows. If the water flows over impervious materials such as granite. the river water may nearly be as impure as the rain water.

c. Spring Water

This is water derived from ground water which is exposed to the surface and contains. solid impurities.

d. Sea Water

This is a large body of water into which all the impurities eventually go, and hence the solid content of sea water is usually high, (3.6%). The solids which are found in natural waters are mainly the sulphates, and hydrogen carbonates of calcium and magnesium, together with smaller amount of sodium chloride. Silicates, nitrates, ammonium salts as well as gaseous impurities already mentioned as being present in rain water. Of the solid impurities, the most are calcium sulphate and calcium hydrogen carbonate.

2.100 Composition Of Natural Water

The composition of underground water depends on the conditions of their formation. The composition of rain waters, which is concentrated in valleys or artificial water storage basins, is determined by:

* The amount of precipitation;
* The cleanliness of the atmosphere;

* Hydrogeologic characteristic of the rock of the catchment basin and
* Method of water accumulation.

The components of natural waters may include salts organic substance gases, dispersed impurities, hydrobionts, bacteria and viruses. Natural water may also contain suspended clay, sand,. gypsum, ana lime particles, various organic substances, silicic acid, iron Ill hydroxide, fulvic acids, humates etc, in colloidal state, and truly dissolved substances mainly mineral salts which enrich water ions.

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In contrast to surface waters, ground waters are usually characterised.by low contents of organic substances, and appreciable concentrations of mineral slats and some times dissolved gases (H_2S, $C0_2$). If surface water interact with ground waters, the later would have an elevated oxidation susceptibility.

However inspite of the abundance of water, it is still a scarce resources due to human activities and attitude towards our environment. It is quite unfortunate that an average Nigeria has a care free attitude towards water with little concern for it's quality and conservation. Water has always been used as the receptor of all wastes from industries. It has been used as if the resource is inexhaustible and that it's pollution assimilative capacity is infinite. This practice effectively reduces the availability of clean and safe water and it affect the health of our people and that of aquatic ecosystem. In some parts of this country the, level of pollution from land based sources is so great. It is estimated that most of the health problems in the country are traceable to water borne diseases or hygienic practices including drinking of pollute water.

However, government is aware of the increase human pressure on the available fresh water resources, g rowing at a rate much faster than the rate of population increase. It is therefore in recognition of this fact and of importance of fresh water to the Nigeria citizenry that

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various government levels have appropriate water policy goals, the thrust of which is the provision of adequate and good quality water to meet all our needs. In this regard government places high priority on water use efficiency in order to achieve sustainable development objective.

2.200 WATER DISTRIBUTION

The purpose of a water supply distribution system is to deliver to each consumer a safe drinking water that is also adequate in quantity and acceptable in terms of taste, odor, and appearance. Distribution of high-quality drinking water has been a major concern for many centuries. In early times, the primary objectives was to provide delivery of adequate amounts of water to centralized fountains and other locations designated for public gathering plus restricted areas of official residences. Water flow naturally was dependent on gravity and the discharge from springs and from mountain stream diversions.

Historically, the initial distribution network of pipes was a response to existing community needs that eventually created a legacy of problems of inadequate supply and low pressure as the population density increased. To resolve the problem of increased water demand along the distribution routes, reservoir storage was created. Pressure pumping to move water to far reaches of the supply lines and standpipes was incorporated to afford relief from surges of pressure in pipelines.

In some areas, population growth exceeded the capacity of a water resource so that other source of water were incorporated and additional treatment plants were built to feed into the distribution network. Another response was to consolidate neighboring water systems and interconnect the associated distribution pipe networks.

2.210 CITY WATER SUPPLY

DAM

USUMA DAM

The lower Usuma Dam currently remains the primary source of water supply to the city and it's environs. Constructed in 1984, the dam has a reservoir of maximum capacity of 100

million cubic meters and is equipped with water treatment plant having designed capacity of 5,000 cubic metres of water per hour.

The Dam is located within the higher altitude areas of the territory and is sited on a virgin location and where there is no human activity thereby ensuring non pollution of the environment and free from industrial impurity.

JABI DAM

The Jabi water works was designed to provide temporary water supply to the new Federal City Abuja before the commencement of the Usuma Dam water works. It provides 300 cubic metres per hour of portable water. The product is pumped in two directions. It served the 500 cubic metres tank in Life Camp and 2700 cubic metres tank on the hill in Asokoro district.

2.220 STORAGE RESERVOIRS

Water use in a community varies hourly as a reflection of the activities of the general public and local industries. While industrial uses of potable water are more constant and predictable, expecting water treatment operations to gear production to those frequent and sudden changes in water demand from all consumers is impractical. For this reason, storage reservoirs are an essential element of the distribution network. These water supplies reserves supplement water flows in distribution during periods of fluctuating demand on the system, providing storage of water during off-peak periods, equalize operational water pressures, and augment water supply from production wells that must be pumped at a uniform rate. Storage reservoirs also provide a protective reserve of drinking water to guard against discontinuance of water treatment during oil spills in the source water, flooding of well fields, and transmission line or power failure. An important secondary consideration is sufficient storage capacity calculated to be adequate for fire emergencies.

KUBWA WATER SUPPLY

Water supply in Kubwa is from a 12000m^3 storage tank located on high ground behind the town. The tank takes it's water directly from the water tank at the Usuma Dam.

KARU/NYANYA WATER SUPPLY

Water supply in Karu and Nyanya is from a storage tank capacity 10,000m^3 located in the Karu hills. The tank takes it's source from the Asokoro tank. The Karu tank supplies water by gravity to the residents of Karu and Nyanya.

AIRPORT WATER SUPPLY

The Abuja International Airport is serviced by a 10,000m^3 storage tank also located at the Airport. The tank takes it's water source from the Usuma Dam through a pipe network.

GWAGWALADA WATER SUPPLY

The Gwagwalada water treatment plant serves consumers in Gwagawalada. The plant has a capacity of 180 cubic metres per hour and has been in operations since 1981.

RURAL WATER SUPPLY

The FCT has an estimated number of 800 rural communities with an average population of 1,500 each. At least three water points are used to serve each of these communities.

In order to ensure adequate portable water supply to the rural communities, extensive provision of hand pump operated boreholes and motorized miniwater schemes to larger rural communities.*(Abuja Water News Vol2 No. 5 1999)*

2.230 FACTORS CONTRIBUTING TO MICROBIAL QUALITY DETERIORATION

Factors contributing to deterioration of microbial quality may be associated with source water quality, treatment process or distribution network operation and maintenance. Each of these areas is reviewed in the following sections.

2.231 <u>Source Water Quality</u> - Bacteria in distributed water mostly originate in the source water. High-quality groundwater may be characterized as containing less than 1 coliform per 100 ml and a heterotrophic bacterial population that is often less than 10 organisms per milliliter, even in waters that reach the growth stimulating temperature of 10^0C or more. These microbial qualities show little fluctuation, because of groundwater aquifer protection

from surface contamination. Some groundwater, however is not insulated from surface contamination. Agricultural fertilizer runoff can contain nitrate, and improperly isolated landfills may introduce a variety of organics, many of which are biodegradable. In such situations, bacterial populations in the groundwater become excessive, resulting in 1,000 to 10,000 heterotrophic bacteria per milliliter. Groundwater containing a high concentration of iron or sulfur compounds provides nutrients for a variety of nuisance bacteria that may become so numerous as to restrict water flow from a well. Where groundwater is poorly protected from contamination by storm-water runoff and wastewater effluents, coliforms and pathogens may be introduced into disinfections barriers exits.

Surface water source are subject to a variety of bacterial contaminants introduced by storm-water runoff over the watershed and the upstream discharges of demostic and industrial wastes. While impoundments and lakes provide water volume and buffering capacity to dilute bacterial contamination and thereby reduce density fluctuations, counterproductive factors must be considered. Lake turnovers, decaying algal blooms, and bacterial nutrient conditions deteriorate water quality and introduce a wide range of organisms (some of which may be pathogens) to the source water intake that may pass through marginal treatment processes or improperly operated treatment systems.

2.232 <u>Treatment processes</u> - Water supplies using a single treatment barrier (disinfection) for surface water treatment will not prevent a variety of organisms (algae protozoan, and multicellular worms and insect larvae) from entering the distribution system. While many of these organism are not immediately killed by disinfectant concentrations and contact times (C-T values) suited to controlling coliforms and virus, they eventually die because of lack of sunlight (algae) or adverse habitat (multicellular worms and insect larvae). Disinfection is also less effective on a variety of environmental organisms that include spore formers (*Clostridia)*, acid-fast bacteria, gram-positive organisms, pigmented bacteria, gram-positive organisms, pigmented bacteria, fungi, yeast, and protozoan cysts. And of these more resistant organisms may be found in the pipe environment.

Filtration is an important treatment barrier for protozoan cysts *(entamoeba, giardia and cryptosporidium)*, being more effective than the usual disinfectant concentration and contact times. Improperly operated filtration systems have been responsible for releasing

concentrated numbers of entrapped *cysts (giardia and cryptosporidium)* as a result of improper filter backwashing procedures or filter bypasses and channelization. Filter sand may become infested with nematodes from stream or lake bottom sediments that shed into the process water and the distribution system. While nematodes are not pathogenic, they may harbour viable athogens ingested from source water or filter media beds.

Properly operated water treatment processes are effective in providing a barrier to coliforms and pathogenic microorganisms reaching the distributing systems. This does not however preclude the passage of nonpathogenic organisms through the treatment train. Investigation of heterotrophic bacterial population revealed that a 4 log (99.99 percent) or better reduction can occur through conventional treatment processes (storage, chlorination, coagulation, settling, and rapid sand filtration) for many of these organisms. A less significant reduction of the subpopulation of the subpopulation of pigmented organisms in the heterotrophic flora occurs, however, so that these organisms may predominate the residual densities of detectable bacteria after processing and become the dominant strains in the distributed water. In one study, yellow orange and yellow pigmented bacteria were consistently present in distributed water at a site 40km from water treatment plant. Pigmented bacteria also occurred in waters containing a free chlorine residual (although in reduced numbers), indicating the possibility that these organisms are either chlorine resistant or chlorine tolerant.

The effects that granular activated carbon (GAC) filtration or biological activated carbon treatment have on distributed water quality is largely undocumented. Several coliforms species (Klebsiella, Enterobacter and Citrobacter) have been found to colonize GAC filters, regrow during warm water and discharge into the process effluent. Activated carbon particles have also been detected in finished water from several water plants using powder activated carbon or GAC treatment. Over 17 percent of finished water samples examined from nine water treatment facilities contained activated carbon particle fines colonized with coliform bacteria. These observations confirm that activated carbon fines provide a transport mechanism by which microorganism penetrate treatment barriers and reach the distributed systems. Other mechanisms that could be involved in protected transport of bacteria into the distribution system include aggregates or clumps of organisms released from colonization sites in GAC filtration by passage of coagulants.

Furthermore, heterotrophic bacteria densities on distributed water from a full scale treatment train using GAC were found to be significantly higher than in water than in water from a similar full scale treatment train that did not employ GAC. Upon entering the pipe network, persistence and re-growth of these organisms will be influenced by the same factors that also impact disinfectant effectiveness: habitat locations, water temperature, PH, and assimilable organic carbon concentrations. *(Water Quality & Treatment – A hand book of community water supplies – Fourth Edition P. 1116)*

2.300 MITIGATION: Source Water Quality Management

The decline in quality of drinking water sources became a concern when population growth and industrial development produced a concentration of society's waste that imperiled public health. The need to protect both public health and minimmise the cost of public water supply leads to the practice of source water quality management.

Source water quality management vis-a-vis Mitigation is defined as the science and the practice of protecting surface water and the ground water resources used for production of drinking water, both present and future. The public must be provided with water of the highest quality for drinking and general municipal uses. The control of source water quality both facilitates the economical production of safe drinking water and enhances it's value. Source water quality management provides a means to determine impacts on drinking water sources resulting from both natural factors and human activities, to estimate the immediate and long term effects of such impacts to prevent the occurrence of public water and supply system problems that are difficult or expensive to correct.

The importance of source water quality management is evident as competition grows for the world's finite water resources. A new emphasis on source control as an effective management technique has occurred as a result of society's interest in and concern with health, aesthetic, and recreational aspects of water resources. Public water supply system, faced with the possibility of having to install expensive treatment facilities to meet increasingly stringent standards required by regulatory agencies, are recognizing that effective source water protection programs can be an important factor on offsetting potentially high costs of treatment.

Source water quality management is the first step in ensuring an adequate supply of safe drinking water and should be integral element in every water utility operation. The principles of source water quality management, however apply to all portable water sources, including large river basins and regional aquifer systems.

2.301 Source Water and Transmission

Mitigation measures relating to source water and transmission range from providing alternative sources, to protecting wellheads, to retrofitting dams or aqueducts. The following section provides mitigation actions for surface water and groundwater sources.

Surface Water Sources

The components of surface water sources include watersheds, surface sources (such as rivers), reservoirs, and dams.

Reservoirs

Finished water reservoirs may be located near the beginning of a distribution system, but most often they are situated in suburban areas. Local topography plays an important part in determining the use of low-level or high-level reservoirs. Underground storage basins are usually formed by excavation, while ground-level reservoirs are constructed by earth embankment. Such reservoirs are lined with concrete, Gunite, asphalt, or a plastic sheet over the sides and bottom to prevent or reduce water loss in storage. In earthquake zones, reinforced concrete or a series of flat bed steel compartments are mandatory. Reinforced concrete is often selected because of its minimal rate of deterioration from water contact. Elevated storage tanks and prevent corrosion.

Tanks constructed of redwood are common in the western United States, being used by small communities, recreational areas (state and federal), mobile home parks, and motels. Many of these redwood structures are plastic or fiberglass lined to prevent leakage and bacterial colonization in the redwood pores. Investigation of redwood storage reservoirs has revealed that the coliform, *Klepsiella Pneumoniae* can colonize such structures. This coliform metabolizes the leached-out wood sugars (cyclitols) from the staves as a source of nutrient. The problem is most acute in new redwood tanks and can be controlled by maintaining a

free-chlorine residual of 0.2 to 0.4mg/L until the nutrient supply is leached away with tank usage over a 2-years period. More details are provided in the section on water supply storage.

Care must be taken to prevent potential contamination of the high-quality water entering storage reservoirs and standpipes. One area of concern is in the application of coating compounds over the inner walls of tanks to maintain tank integrity. Organic polymer solvents in bituminous coating materials may not entirely evaporate even after several weeks of ventilation. As a consequence, the water supply in storage may become contaminated from the solvent-charged air and from contact at the sidewall. Some of these compounds are assimilable organics that support re-growth of heterotrophic bacteria during warm-water periods. Linear materials, also used to prevent water loss, may contain bitumen, chlorinated rubber, epoxy resin, or tar epoxy resin that will eventually be colonized by microbial growth and slime development. PVC film and PVC coating materials are other sources of microbial activity. Nonhardening sealants (containing polyamide and silicone) used in expansion joints should no be overlooked as a possible source of microbial habitation.

Water volumes in large reservoirs mix and interchange slowly with water that is actually distributed to service lines. Standpipes, in contrast, provide a fluctuating storage of water during a down surge, thereby providing surge relief in the system. Abrupt changes in water flow that sometime occur during surge relief can cause the steady state nature of sediment deposits to become unstable, releasing viable bacteria from biofilm sites into the main flow of water.

Reservoirs of treated water should be covered whenever possible to avoid recontamination of the supply from bird excrements, air contaminants, and surface water runoff. The health concern with bird excrement is that this wildlife may be infected with *Salmonella* and protozoans pathogenic to man. Within the wildlife population in every area (as us true for any community of people), constant supply of infected individuals exists that shed pathogenic organisms in their fecal excretions. Sea gulls are scavengers and often are found at landfill locations and waste discharge sites searching for food, which is often contaminated with a variety of pathogens. At night, birds frequently turn inland to aquatic

areas, such source water impoundments and open finished water reservoirs, to roost, thereby introducing pathogens through their fecal excrements.

Air pollution contaminants and surface water runoff can contribute dirt, decaying leaves, lawn fertilizers, and accidental spills to a water supply that is not covered. Such materials increase the productivity of the water by providing support to food-chain organisms and nitrogen phosphate requirements for algal blooms. This degrades the treated water quality.

Covered distribution system storage structures also are subject to occasional contamination because of air movement in or out of the vents as a result of water movement in the structure. During air transfer, the covered reservoir is exposed to fallout of dust and air pollution contaminants from the inflowing air. Vent ports or conduits from the service reservoir to the open air should be equipped with suitable air filters to safeguard the water quality from airborne contaminants. Birds and rodents may also gain access through air vents that have defective screen protection. Birds or rodent excrement around the vents may enter the water supply and become transported into the distribution system before dilution and residual disinfection is able to dissipate and inactivate the associated organisms.

Large-scale watershed damage from hurricanes, earthquake landslides, fires, flooding or volcanic eruptions is difficult to mitigate. For example, stabilizing slopes vulnerable to landslides could be a Herculean task. And the effort might do more damage to the watershed in the long run, especially if vegetation is disturbed. Watersheds are best left undisturbed. Watersheds should be monitored to determine whether conditions exist that could contribute to disaster hazards. Such conditions include illegal dumps, buildup of flammable material, hazardous-materials spills, and construction activities that cause erosion. Find out which agency is responsible for fire suppression in the watershed area. Coordinate a fire-suppression plan with the agency. For example, if chemical fire retardants could contaminate source water, find out who should be called if a fire is spotted.

Mitigation actions for watershed damage or contamination over wide areas include providing automated monitoring equipment, using alternative sources or intakes, and changing treatment of the source water at the plant. An example of the latter would be to have an additional settling basin available.

Mitigation of smaller-scale contamination of watersheds or surface water sources from hazardous-materials spills is best handled by an emergency spill response plan. Elements of the plan include notification, containment, and cleanup.

The effects of disaster hazards on open reservoirs can be mitigated by controlling access, identifying alternative sources, providing alternative intake-structure locations, and providing flexible treatment facilities. Access can be controlled by installing fences, gates, and signs; closing unnecessary roads; and increasing security patrols.

Dams have come under close scrutiny because of the potential damage and loss of life caused by a failure. Retrofitting dams includes raising the dam's height to accommodate higher design floods and seiche, increasing spillway capacity to provide for design floods, and improving the structural strength to withstand seismic forces. Earlier studies had shown that an arch dam would be overstressed by seismic design loads for the area.

Intake structure damage can be mitigated by providing temporary bypass pumps; having filtration materials, such as boom floats or screens, on hand; providing multiple intakes; strengthening the structures to resist wind or earthquake hazards; and making sure access to the structures is available by such means as a boat. Valves or other methods to drain or shut off flow to the system should be redundant, hazard-resistant, and properly maintained.

Groundwater and Wells

Methods of mitigating groundwater contamination potential include identifying alternative water sources, providing shutoff valves, maintaining adequate setbacks from sewage pipes and disposal systems, and installing wellhead protection and well seals. A spill-response plan and hazardous-waste disposal plan are also recommended to mitigate groundwater contamination. Earthquakes can produce a change in hydrogeology; deep aquifers are less of a problem.

Many natural-disaster hazards will cause power outages to the well pumps. A system should send the location of the wells to the electric-power provider, and request that the wells be a priority for service. Also, the pumps should have backup electrical power generators with adequate fuel on hand. *(Emergency Planning for Water Utility Management – AWWA manual P. 38)*

2.400 WATER TREATMENT

A water treatment plant should be designed to produce a continous supply of safe drinking water regardless of raw water characteristics and the environmental conditions. Thus, the application of space-age technology in the process design and subsystem selection is not always the best approach. The ultimate plant design has a system and subsystem that are proved to be simple, effective, reliable, durable and cost effective. This basic philosophy is applicable to all circumstances and cases.

2.410 Treatment Plant: Basic Approach.

Treatment facilities are composed of highly complex components critical to system operation. Fundamental to the design of reliable water treatment facilities should be the philosophy that failure of any component will not put the entire facility out of service.

In a worst-case scenario, the treatment plant will be off-line. In fact, it may be necessary to isolate the facility from the system, as in cases of contamination at the plant. Be sure isolation valves are installed and their locations well marked. Mitigation for the off-line scenario includes providing alternative treatment, such as increasing production in another facility in the system or identifying alternative sources of treated water from adjacent systems. Another measure is to provide a bypass with disinfection capability.

Treatment facilities should generally be fire-resistant. The local fire department is a good resource; request that they regularly inspect the facility.

Treatment facilities are often located near floodplains or in flood-prone areas. Facility design should include a hydrologic and hydraulic analysis.

Design engineer as should study the following basic rules prior to design work.

1. Carefully evaluate the local conditions.
2. Create a reasonably conservative design that is cost effective to construct.
3. Apply the best knowledge and skill to the design.

4. Design a plant that is easy and safe to construct, as well as simple and safe to operate.
5. Allow for maximmum operational flexibility and minimal operations and maintenance costs.
6. design a plant site that is esthetically pleasing and does not have a negative impact on the environment.
7. Acquire a plant site that adequately satisfies the basic criteria and is free of all potential disasters.
8. Do not be feel embarrassed to obtain help from qualified associates, consultants, or specialists; an engineer should only perform services that are in his /her area of competence.
9. Be certain that the project meets all pertinent legal requirements and engineering standards.
10. Respect the wishes of the owner.

A water treatment process is an assemblage of unit processes that is created to effectively produce an abundant supply of safe drinking water the treatment system generally consists of four or more interrelated and compatible components. Since the unit processes must be interrelated, the operation of each component affects the performance of the others, that is, the entire system.

2.420 Common water treatment processes

The phrase "common water treatment processes" connotes a system that combines the processes of coagulation, flocculation, sedimentation, filtration, disinfection with the necessary process control and instrumentation measures. Until the mid-20th century the design of water treatment plant was handled exclusively by civil engineers and emphasis was placed on the hydraulic, foundation, and structural aspects of design. It is therefore understandable why these early treatment plants tend to lack chemical engineering, microbiological, electrical, mechanical and architectural considerations. consequently the performance of these plants do not always meet expectations of the design and are not always aesthetically pleasing. The present trend is to have sanitary engineers design the treatment processes and the overall plant design because they are familiar with a broader range of subjects.

The efficient and successful execution of a modern water treatment design is dependent on the concerted efforts of various specialists. The team members must therefore pool their knowledge and skill so that the performance and interaction of each component are designed in a complementary manner. This type of communication is essential because the design of each component affects the design of the entire treatment system.

The cost effectiveness of the design phase may be improved by establishing a value engineering team, in addition to the design team. The project members may also opt to include both construction experts and experienced plant operators (of plants similar to the plant being designed).

2.421 General Considerations

When designing basic treatment process units, the most important considerations are the fundamental design philosophy, the design procedures, and control over the design phase of the project. However, certain items must be established at the early stage of any design project: plant layout, process diagrams, hydraulic profile across the plant. The project engineer and manager are responsible for establishing these items based on some basic rules and considerations. A few of the more important general design concepts are listed below.

a. ***Plant Layout-*** The plant layout is primarily dictated by the topography of the plant site. Thus, poor site selection severely restricts the choice of alternative layouts. The design phase should only refine the preliminary layout, which was established in the pre-design stage. The design phase focuses on the anticipated traffics flow and operator movement, on establishing hydraulic balance among the process units and basins, on the aesthetics of the plant, and the location of the main control building should be situated as near as possible to the treatment process, filters, and chemical feed system.

Two important considerations must be addressed during work on the plant layout. The first is to provide a single chemical application point for all pretreatment process units. The second is to provide a single chemical feed point to the filter influent for all the filters and to use this same scheme for the combined filters water prior to the clear-wells. Although special attention must be given to the yard pipings and the layout of the process units, the single-point application scheme is recommended because it significantly simplifies the chemical

feed system and provides uniform water quality control . If the chemicals are divided to more than two points, the design will require additional feeders or flow splitting devices such as " rotameters" and the feed rate to each process unit must also be paced to the actual process flow rates.

b. Process Diagram- The process diagram is the fundamental basis for the design work. This is especially true for the design of the instrumentation and control systems and the subsystems. A basic process diagram should be established during the preliminary design phase and refined at the beginning of the final design phase. The instrumentation and control specialist and the mechanical specialist may then commence with their design work.

The process diagram should include the following items: (1) all unit processes in the correct sequence ; (2)all major pipe connections with the flow directions; (3) all chemicals that are to be used and the application point (s) of each; (4) all major water sampling points that are necessary to maintain quality control ; (5) the location and size of all major flow meters, valves, and connecting pipes in the process train; (6) the location of all major pumps, blowers, screens, and other such items of the process train; and (7) the control points for the pressure, water level, flow rate, and water quality of the process. *(Integrated Design of Water Treatment Facilities P.48)*

2.422 General Consideration for Contamination Prevention

Today, community expansion plans are fully developed and include the engineering of utility service so that careful consideration is given to meeting future projected water supply needs. Advanced planning provides the opportunity to design the pipe network as a grid with a series of loops to avoid dead ends. The objective is to produce a circulating system capable of supplying high-quality water to all areas yet designed that any section may be isolated for maintenance, repair, or decontamination without interrupting service to all other areas.

To ensure delivery of a high-quality municipal potable water supply to each consumer, management of public water supply systems must be continually vigilant for any intrusions of contamination in the distribution network and the occurrence microbial degradation. This job is complicated by the very nature of a distribution system: a network of mains, fire hydrants, valves, auxiliary pumping, chlorination substations, storage reservoirs, standpipes

and service lines. Following the intrusion of microbial contamination, any of these component parts may serve as a habit suitable for colonization, by certain microorganisms in the surviving flora. The persistence and possible re-growth of organisms in the pipe network is influenced by a variety of environmental conditions that include physical and chemical characteristics of the water, system age, variety of pipe materials, and the availability of sites suitable for colonization. *(Water Quality and Treatment – A handbook of community water supplies- Fourth Edition*
P. 1114)

Mitigation of potential hazards effects for treatment components will be discussed in the following sections.

2.423 *Facility Structures*

Treatment plant structures and other water system structures, such as pump stations, are often single-story, symmetrical, shear-wall buildings that perform well in earthquakes, high winds, and other disasters. Design considerations and mitigation actions include the following.

a. Earthquake - use reinforced masonry and other hazard-resistant construction avoid liquefiable soils for structure foundations and avoid using dissimilar foundation types when adding onto a structure

A. Earthquake and wind

Make sure roof and wall connections, and roof and foundation connections are adequate correct modifications that may have weakened structures, such as removed bracing or bearing walls cut for doors

B. Vandalism

Have adequate locks, window security, and lighting install intrusion-prevention devices, such as electronic keys, identificationcard checkers, 10-key code units, joint 10-card/10-key checkers, and noncontact-type identification-card checkers to control access to the strategic facilities of the system (AWWARF and JWWA 1993) install situation display monitors that consist of closed-circuit television systems with high-sensitivity image pickup tubes,

including camera and sound collectors; as well as alarm systems with ultrasonic, heat, or beam sensors, and magnetic switches to detect intruders (AWWARF and JWWA 1993)

C. *Electrical Power and Instrumentation*

Standby power should be available for such critical components as pumps and controls. A duplicate power supply from a distinct power distribution point following different routing is one method. Specific mitigation actions for electrical power and instrumentation components and backup power include the following:

i. Transformers Anchor ground-level units to the foundation pads and protect from flooding. Securely anchor pole-mounted transformers to the pole. Make sure the pole is secure in the ground. Transformer aerial conductors must be protected from swinging shorts in earthquakes and high winds.

ii. Emergency generators. Anchor generators directly to the floor, or use snubbers" on vibration-isolated bases. Keep portable generators at various locations in the system to avoid a complete loss of standby power. Operate generators regularly under load. Review and maintain the support system: fuel, cooling, starting power, and exhaust.

iii. Electric cabinets. Anchor to the floor and at the top using angle clips on the wall or other secured structural element.

iv. Motors. Provide automatic shutdown to avoid voltage or phase fluctuation that may cause damage.

v. Batteries. Batteries for backup instrumentation power or starting generators should be firmly anchored to prevent toppling. They should be off the floor to prevent water damage.

vi. ***Telemetry.*** A radio system with adequate backup power can provide a replacement for broken cables or downed phone lines. Provide lightning-strike protection if needed.

vii. Computers. Larger computers located on top of a special computer floor can be base isolated to prevent damage from a floor collapse. Also, the floor can be strengthened to resist seismic forces. Desktop computers can be secured to desks with Velcro or Quake Grip-type restraints. Be sure to backup computer files and keep them at separate locations.The effects of computer failure can be minimized by providing the utility with the following elements:

- off-site backup for the computer system
- a preventive-maintenance program for hardware
- an uninterruptible power supply to protect the source of power for the computer hardware
- adequate computer room security
- compatible computer hardware components
- written procedures for testing software and operational problems
- adequate training for programmers
- control of operating files and documentation by data processing personnel
- virus and "hacker" prevention
- lightning-strike protection
- anchored, suspended ceilings

D. *Equipment, Chemical Storage, and Piping*

Most equipment and chemical storage containers in a treatment plant will become damaged from sliding and toppling. Simply anchoring or restraining equipment and containers can prevent much of the damage. Equipment supported on legs should have angle braces installed on the legs for additional strength. Waterproof plastic sheeting should be stockpiled in case the equipment or chemicals become exposed to the elements.

Piping damage due to sliding or toppling equipment will also be reduced by anchoring. Providing flexible connections can reduce piping damage as well. Some specific subcomponents and mitigation actions are described below.

i. Chlorine and chemical containers. Chlorine cylinders (150-Ib [70-kgl) should be restrained at the top and bottom. Consider using sodium hypochlorite as an alternative to chlorine. One-ton (1000-kg) containers should be anchored with chain binders or nylon straps. Check with tank and container manufacturers for the proper method of restraint.
Chlorine systems can be designed and constructed with an automatic backup. A chlorine leak and control system can indicate the extent and location of a leak, actuate chlorine scrubbers, shut down equipment, and isolate affected areas.

ii. Buried tanks. Tanks subject to sinking or floating in liquefiable soils, or during flooding, can be restrained to reduce damage. Soils can also be stabilized.

iii. Piping supported on rods from ceilings. To resist damage from swinging, support piping in three directions at right angles. Do the same for chlorine tubing.

iv. Pipe appurtenances. Appurtenances such as valves rising vertically from pipe tend to act as pendulums that amplify ground motion. Anchor the appurtenances.

v. Buried piping at building edge. Provide flexible connections for differential settlement and differential lateral movement.

Vi Laboratory equipment and chemicals. Lab equipment and chemicals stored on shelves should be provided with restraints, such as lips on the shelves or a bar installed across the face of the shelves.

E. Process Basins Or Tanks

Mitigation of damage to process tanks is best handled in the design phase. Retrofitting tanks is difficult and often the only way to mitigate damage is by reconstruction.

The design of treatment facility tanks should include flexibility and redundancy (Hamann and Suhr 1980). For example, provide multiple connections between tanks to provide alternative configurations of tanks in series.

Specific earthquake design considerations of process tanks include the following:

- provide breakaway design or other appropriate methods for submerged elements or baffles to allow easy replacement
- use appropriate codes and design methods for concrete tanks
- perform a geotechnical investigation, stabilize the soil as necessary, and use the appropriate foundation

- design with neutral buoyancy, keep the tank full, or use piles to hold in place

a. Storage Tanks

As with process basins, the best time to mitigate damage from a disaster on a storage tank is during the design stage. Design considerations include the following:

- use appropriate design values for earthquake, wind, and other live loads
- perform geotechnical, geologic, and seismological studies to evaluate foundation designs
- provide adequate freeboard baffling and strength against sloshing
- provide correctly positioned isolation valves
- provide pipe flexibility
- make provisions for security, such as fences, gates, lighting, alarms, and locked valves and hatches
- ensure access is available in case of flooding or other disaster hazards

Existing tanks should be evaluated for structural soundness and performance during disasters. Specific mitigation actions for existing tanks of various types include those listed below.

i. Wire-wrapped concrete tanks. Check for vertical-cracking delamination and water corrosion staining on the outside of the tank. Cheek for installation of seismic cables.

ii. Steel standpipes and ground storage tanks. Install or upgrade anchors or stiffeners. Upgrade the foundation if inadequate. Check the capability of walls to handle additional stress.

iii. Horizontal tanks. Upgrade support to carry loads in three directions at right angles.

iv. Elevated steel tanks. Upgrade with additional foundation strength, base isolation, and lateral support. Upgrade the steel structures and allow the bracing to yield before a connection failure.

F. *Distribution*

Mitigating disaster effects on the distribution component of a system can be difficult because of the numerous and widely distributed components. Mitigating effects on pumping stations was previously discussed in the section on source water and transmission. Computers are useful in gathering information through regional networks to determine problem areas and damage. They can also be effective in monitoring and controlling emergency valves, and keeping inventories on equipment and suppliers. The case study below presents an example of how such a system works.

a. Pipelines, Valves, and Other Appurtenances

Methods of design and types of material can mitigate disaster effects on these essential distribution system components.

i. Pipeline design, construction, and upgrading. As with other system components, mitigating hazards is easiest in the design and construction phase.

- use the most current pipe available (pipe materials are continually being improved)
- avoid installation in liquefiable soils and, where required, avoid areas prone to flooding and landslides
- use pipe materials suitable for the soil conditions and expected hazard route pipelines at right angles when crossing known faults
- use flexible expansion joints at fault crossings and where soils change to liquefiable soils

- use compressible backfill material and shallow cover when crossing known faults to permit pipe/soil movement

- stabilize soils with vibroflotation, stone columns, grouting, compaction, or other methods

- use pile supports where required

- provide operational flexibility and redundancy

- build in emergency-response capability, such as isolation valves, check valves, and automatic valves

- have a cross-connection control program

- Upgrading existing pipelines should begin with those segments identified as

critical in the vulnerability assessment. When upgrading pipeline segments, use the design considerations listed above for new pipelines. See Figure 4-5 for an example of a damage-mitigation procedure.

The performance of pipeline materials and joint types in earthquake hazards has been documented in many studies. The following is a summary of the results of some of those studies.

In general, steel, ductile-iron, and polyethylene pipe will accommodate more ground deformation than cast-iron or asbestos-cement pipe. Restrained joints provide continuity to pipelines to keep them intact in moderate ground movement. Bell-and-spigot type joints allow flexibility, but can easily be pulled apart.

High-performance pipelines, such as electric-arc-welded steel, restrained-joint segmented steel, polyethylene, or restrained-joint ductile-iron, can accommodate permanent ground deformation up to approximately 20 in. (500 mm). Average- to high-strength materials, such as restrained-joint PVC or restrained-joint concrete cylinder pipe, can handle permanent

ground deformation up to approximately 4 in. (100 mm). Average-strength pipelines, such as unrestrained-joint ductile-iron, PVC, concrete cylinder, reinforced concrete, cement, asbestos-cement, and segmented steel pipe, can accommodate ground deformation of less than 1.5 in. (40 mm) or up to the bell-and-spigot insertion length allowance. Average- to low-strength pipelines (tolerating less than 0.75 in. 120 mm] of ground deformation) include cast iron, vitrified clay, unreinforced concrete, and gas-welded steel. Low-strength (less than 0.4 in. [10 mm] tolerance) pipelines include cast-iron or vitrified clay with mortared or leaded joints.

ii. Valves and other appurtenances. Provide positive flexible connections to reduce earthquake effects. Also important is an active preventive-maintenance program. Such a program should include identification of critical valves, locating them in the field, and establishing reference points for location. Valve inspection and repair should be done on a regular schedule.

iii. Repair. Quick repair of broken mains and service lines is crucial in emergencies. Maintain adequate stockpiles of such materials as repair clamps, sleeves, pipe, and valves. This is especially important for materials that take a long time to deliver. The material should be stored properly to resist hazards from disasters such as earthquakes, hurricanes, floods, tornados, and vandalism. Also, maintain and have access to tools and debris-removal equipment.

b. System Control

Implement reliable system monitoring and control systems. The monitoring system should gather information on pressures and flows. The control system should allow isolation of areas damaged in earthquakes.

c. *Interagency Connections*

An interagency distribution system connection is a physical connection between the water sources operated by adjacent water agencies (Boyle 1980). The typical interconnections consist of valves and a meter, and a structure that can be a simple in-ground vault or an aboveground pumphouse. If the two water systems operate at significantly different pressures, a pump or regulator will be needed at the interconnection to reduce the pressure

differential. A written agreement between agencies should specify the conditions of use, necessary notifications before use, construction and maintenance responsibilities, and operational procedures. Raw water transfer between agencies may also be considered.

d. Administration, Transportation And Communication

Administration facilities, equipment, and records are vital to the operation of a water system. Structures that house the administrative functions should meet applicable building codes or should be retrofitted to meet minimum disaster needs. This will not only protect the structures, equipment, and records located inside, but will help protect personnel too.

Many of the specific recommendations for mitigating disaster effects found in the earlier discussion of treatment facilities can apply to administration facilities. Particularly important is keeping backup copies of customer information, system maps and records, and the emergency plan at other locations. Also critical is security of the facility and computer system.

Damage to the transportation system, including road infrastructure and vehicles, will occur in many disasters. Mitigation actions include identifying alternative methods of access to system facilities, making sure vehicle storage structures are disaster-resistant and have auxiliary power and maintaining adequate supplies of fuel and spare parts.

Communication disrupt ions due to phone and electric outages are difficult to mitigate. The most common alternative is to communicate by two-way radio. Be sure to have enough radios and batteries. Mitigating effects on telemetry was discussed in the earlier section on treatment. Communication lines need to be open to other lifeline agencies and the mass media. Consider contacting amateur radio groups to provide emergency communications. *(Emergency Planning for Water Utility Management – AWWA manual P.40)*

CHAPTER THREE

3.000 SYSTEM ANALYSIS

3.010 SYSTEM CONCEPT

A system is an integration of elements all working together to accomplish some specific purpose. A business system therefore consist of business resources such as personnel, machines, materials and money functioning together to accomplish some business objectives.

It consist of all interacting elements which are used as inputs and processed to yield a usefull outcome called outcome. However, for the purpose of human error and lack of reliability in these processes the use of manual operation in this regard can be substituted with an automated design in a machine equipped with an appropriate objective procedures, called a computer system.

3.020 COMPUTER SYSTEM

A computer is an electronic device which accepts data input and processes it by following a set of instructions to yield an efficient and accurate result called an information. A computer is made up of three primary components i.e. the physical component (Hardware), the instructions (Software) and the human effort it takes to make it operational (Humanware).

Before the advent of the present automated procedure scheme called a computer system, the art of computing has existed with the idea of counting of numbers mentally or with the help of some counting aids such as the counting of fingers, sticks, stones, marked strokes on the wall or on the sand etc. The concept of revolutionizing the art of computing started with a computing device called Abacus. Since the emergence of Abacus, different intellectuals in their different areas of human endeavours have contributed their own intellect at one stage or the other to what now metamorphosed into the world of computer system and information superhighway.

3.030 CLASSIFICATION OF COMPUTERS

Computers can generally be classified according to some classification owing to their peculiarities. The categories into which computers can be grouped are as follows;

3.031 GENERATIONS

The development of modern digital computers is generally classified into generations according to generations. The computers in a generation share a common technology.

a. First Generation -Between late 1940s and 1950s the first generation of computers used Vacuum tube as the source of electronic element which controls the internal operation of the computer. Magnetic drum was used by the system as a means of storage. Use of punched cards became so common. Mauline and symbolic language became the language of the computer. The calculation speed were in the region of 5,000 basic arithmetic operations per second. The examples of the first generation computers are Whirlwind, IBM 701 and UNIVAC etc.

b. Second Generation - The second generations of computers employed the use of solid state transistor. With the replacement of Vacuum tube with transistors it greatly reduced the size of the computers, computers became faster, had increased storage capacity and required low power consumption. The Magnetic tapes and disks are supplementary memory invention. The Low level language (symbolic language) was in use. The second generation of computers were able to attain a speed of up to 100,000 instructions per second.

c. Third Generation - Third generation computers were brought about by the development of the Integrated Circuit (IC) in late 1960s. The IC technology made it possible to put thousand of transistor, diodes and resistors on a tiny silicon chip. Large Scale Integration (LSI) later made it possible to pack thousands of transistors and related devices on a single Integrated Circuit. LSI made possible the fabrication of microprocessor chips and semi conductor memories. During this period there was also a corresponding development of commercial software houses. These software houses developed computer softwares for sale to users eg. Pascal, BASIC and FORTRAN.

d. Fourth Generation - The fourth generation of computers were developed in 1980. The most distinctive difference with the third generation computers is their Very Large Scale Integration (VLSI) of components. This development meant that 4^{th} generation of computers were also cheaper to produce. The proliferation of reliable and inexpensive home computer systems called Micro computers and concomitant advances in programming have resulted in the growth of computer networks.

e. Fifth Generation - The development of the Japanese industrial Robots introduced the era of the fifth generation. Government of developed countries have been spending millions of dollars into research for the development of the fifth generation of computers. The direction of researches includes the development of far more smaller components, Artificial intelligence (speech incorporation) and Expert system (judgement and decision) etc.

3.032 CLASSIFICATION ACCORDING TO SIZES

In terms of size computers can be classified according four categories i.e Supercomputer, Mainframes, Minicomputer and Microcomputer. These four types also differ in price, amount of memory, processing capabilities and speed.

a. Super Computers are the most powerful machines available in the mid 1980s. They are faster and the most expensive computers. Super computers must be capable of performing at least 10 million arithmetic operations per second. Some Super computers have the capability to process Seismic data. Auto manufacturer use super computer for the simulation of accident on video screens, airflow around an airplane at different speed and altitude. Meterologists also it to study the formation of tornadoes. Phycists use it to study the result of explosions of nuclear weapons etc.

b. Mainframe is a large computer commonly used in business industry. They are used to solve highly sophisticated problems. They have large memory capacity, high speed and generate a fair amount of heat thus requiring cooling system. It allows the sharing of it's resources by numerous users in a network. A mainframe computer costs millions of dollars and largely in use by governments, large corporations and universities.

c. Minicomputer is a small computer with many capabilities of a mainframe, but generally with lower physical size, storage, speed, memory and price. They can also store into and retrieve from the same type input and output device as mainframe.

d. Micro Computer is the lowest and least expensive computers currently available. This is the type of computers often found in homes, classrooms and small businesses. It is often reffered to as Personal Computers (PC). It is of the lowest price, memory, speed and complexity.

3.033 CLASSIFICATION ACCORDING TO TYPES

The three types of computers are Analogue, Digital and Hybrid.

a. Analogue - Anlogue computers operates and processes data on continuous variables such as temperature, speed, amount of current flowing through an electric conductor and chemical composition of petroleum products etc. It does not contain memory since it measures or compares data and or value. They are ideally used in control systems and simulation eg Car speedometer, Thermometer etc.

b. Digital Computer - Digital computers operates on discrete data. A digital signal is has only a discrete number of interpretations usually two, symbolically represented by True or False, No or Yes and 0 or 1 etc. Digital computers are more widely used in Communication system, Expert system and Artificial intelligence eg Remote sensor and Cellular phones etc.

c. Hybrid Computer - This is a result of a cross breed between the Analogue and Digital systems principle. Hybrid computers are more powerful and therefore solve more sophisticated problems. Hybrid computers offer more control capabilities than Analogue. Hybrid computers play a major role in the design of US space shuttle by NASA.

3.034 CLASSIFICATION ACCORDING TO PURPOSE OF USE

In terms of purpose of use, computers can be classified into two classes i.e General and Special purpose.

a. Special Purpose - A special purpose computer is designed for solving a particular problem. Example of special purpose computer are calculators, electronic type-writer or weapon guidance system.

b. General Purpose - General purpose computers are used to solve a wide variety of problems such as payroll computation, graphics and games etc.

3.040 INTRODUCTION TO COMPUTER SOFTWARE

Software is the term used to describe a set of instructions written in computer own language for the performance of a task of a repetitive nature especially. It is also refers to all programs that are used in a particular computer installation.

3.041 TYPES OF SOFTWARE

The two basic types of software are:

1. System software.
2. Applications software.

a. System Software

This is the software provided by the computer manufacturer. Much of this software will be programs which contribute to the control and performance of the computer system. Such programs are given the collective name systems software. Any one of these programs is a system program.

i. Operating Systems - An operating system is a suite of programs which takes over the operation of the computer to the extent of being able to allow a number of programs to be run on the computer without human intervention by an operator.

ii. Translators - These are programs that translates programs written in a high level language into machine language for execution on the computer system.

iii. Utilities And Service Programs - Utilities are systems programs which provide a useful service to the user of the computer by providing facilities for performing common tasks of a

routine nature. Examples of utility programs include Copy compression program such as ARJ, Disk repair disk.

iv. Data Base Management Systems (DBMS) - A Database Management System is a complex software system which constructs, extends and maintains a database.

b. Applications Software

Applications programs may be provided by the computer manufacturer or supplier, but in many cases the users produce their own applications program called user programs (eg, payroll programs, stock control programs, etc.). The execution of an individual applications program is often called a job. Sometimes a job may be divided into smaller units called tasks. A job may comprise program + data. Most applications program can only work if used in conjunction with the appropriate systems programs.

3.050 PROGRAMMING LANGUAGES

Software is written in a programming language that is supported on a target computer. The earliest computer programs were written in the actual language of the computer, machine language. Nowadays, however, the programmer writes his programs in a programming language which is relatively easy to learn and this program is translated into the language of the machine before being used for operational purposes. This translation is done by the computer. Programming languages are broadly classified into three groups;

a. Machine language itself.
b. Low-level languages.
c. High-level languages.

a. Machine Language

This a sequence of instruction codes written in binary digits for direct execution by the computer. The computer typically has a set of operation codes which are also expressed in binary and which act on operand that are also provided in binary digits. Each instruction is immediately executed as it is entered into the computer. Programming in machine language is tedious, time consuming and inefficient.

b. Low-Level Programming Language

Low-level programming entails writing a program in symbolic language provided by the computer manufacturer. The symbolic language is then translated by a translator called assembler into the machine code for execution. Source program is the name given to the program written in symbolic language. Object program is the name given to the program in machine language produced by the assembly process.

c. High-Level Languages

These are languages that allow the programmer to write a source program in almost English like statements. They are generally problem oriented **and** easy to understand. A high-level language source program is interpreted by an interpreter and executed or compile into machine language for subsequent execution.

3.060 TRANSLATORS

A translator is program that translate a source program written in a high-level language into machine language suitable for execution on the target computer.

3.061 TYPES OF TRANSLATORS

a. Assembler program.

An assembler is a program which the computer uses to produce a machine language program from a program written in symbolic (assembly) language.

b. Compiler.

A compiler is a program which translate or ("compiles") a source language program into machine language. The compiler translates the whole of the high-level language source program a machine code object program prior to the object program being loaded into main memory and executed.

c. Interpreter

An interpreter is a program which translates and executes each statement of a source language program.

3.100 THE EXISTING SYSTEM

a. Operation

FCT Water Board is an extra ministerial parastatal engaged in the supply and distribution of good quality and portable water in the FCT. The organisation grew in response to the urbanisation and growth in population influx in Abuja and the surrounding satellite towns. The organisation provides goods and services to it's customers and receives income for doing so. Only the category of consumers who enjoys are piped water distribution system are made to pay for water consumed. The rural community dwellers who enjoy Pumped Borehole water facility and the Motorised Water scheme users are not charged for the services.

b. Commerce

The commercial department is in charge of the reading of meters installed in the water distribution pipes connected to block of houses, as subscribed to by the customers. Those consumers that are not having meter connected to their water supply pipes are charged on a flat rate. At the end of every month they dispatched their staff (Meter Readers) to their various areas of coverage to record the meter reading. These records are taken back to the commercial department for onward transmission to the computer room to be fed into the computer system.

c. Computer Activities

FCT Water Board has an existing computerised system, in a network structure. There exists a computer room which coordinates the activities of every other departments in that regard. The computer room is equiped with a few computers and installed with a developed and customised software using the Microsoft Access for inter-disciplinary use of the organisation. The programme includes Automatic Billing System (ABS), Personnel Records, Payroll. Stock Control etc.

As soon as the meter readings are entered into the ABS for the various consumers their bills are automatically determined and printed into the existing bill format. The computed bills are automatically reflected in the Commercial and account section records of the organisation. The bills are subsequently served to the various consumers.

d. Bill Distribution

Once a consumer bill is prepared, Bill distributors in the commercial department are expected to dispatch the bills to the various consumers. On the bill is a warning which compels the consumers to settle their bills within ten day of the receipt of the bills.

e. Bill Settlement

In order to settle the bill, the amount and the bill are taken to the account section. The record of the customer is promptly updated with the payment in the account section and simultaneously reflected in the Commercial section and the Computer room.

The data flow diagram of the billing system in use is as shown above. It is necessary to use data flow diagram (DFD) for the analysis of the billing system, because the DFD shows the flow of data between the various subsystem of the operating and accounting department to the entire organisation.

3.110 PROBLEMS OF THE EXISTING SYSTEM

Analysis was carried out with the over all objectives of the establishment and the details of how each relevant department operates. Consideration was given to the flow of information between Commercial and Accounting system. The following problems were uncovered as inherent in the existing system.

1. Bills are not served to the consumers promptly. Accumulated debt over a period of time becomes difficult to be paid by the customers.

2. Bill forms are printed by the organisation. Thus the entries in the forms are only filled into it by the AB S software. Exhaustion in the available stock of the bill forms brings about a delay in the determination and distribution of bills until a new stock is made available As a matter of materials management strategy, bills for several month are at times combined on a form with a view to ration the stock.

3 . Consumers don't know their level of water consumption and the rate in order to bring them to a more prudent way of water usage thereby conserving the amount payable on water rates.

4. Because consumers don't know the bills determination formulae, they can not compute their monthly consumption rate for a prompt payment and are therefore compelled to wait for as long as it takes the bill to arrive before they can be paid actually.

5. A break down in the network will mean a break down in communication between the customers and the commercial department. Such a break in communication means a loss of time, money and input and cost the same to be put back into shape.

6. Since then customers are not informed, they are not protected against undue exploitation by the board agents from over charges on water rates.

.7. The existing system is not quite effective in terms of cost.

3.200 FEASIBILITY STUDY

A study of the cost of undertaking and introducing the new system and the viability of the new system was made on the following grounds.

a. Technical – The equipment that will be needed for the new system are already in use in the existing system and therefore will only be adopted in the new system. The use of this equipments are going to be made in a very simple form. Therefore, the resources will not be over stretched as the requirements of the old system are greater than the new system.

b. Operational – The new system can be introduced and executed while the existing system is still preserved and operational. Therefore, they both offer a supportive and complementary role to each other in event of any system failure. This is without compromising the quality of result.

c. Economic

The new system is cheaper in terms of cost of undertaken, running cost and maintenance cost. The existing system resources and requirements in place are already in excess of what

is required for the new system. Therefore, a lot of money will be conserved and saved in terms of material acquisition, training and running cost with the new system.

3.300 METHODOLOGY

The subject of this study which is the development of software on water billing system is the basis of determination of the method of data collection and analysis used in this case.

The essential ingredient (data) required that have been put to use in this case is the existing method of determination of the quantity and rate for water consumption. A blank Water bill form was obtained as well as a copy of already prepared bill ready for distribution for the purpose of a comparative study.

Site inspection was conducted on their meter reading equipment and installations, existing computer systems and software in use.

Verbal interview with the staff of the organization was one of the methods employed.

Manuals, Seminar papers and source documents were also obtained from the Board as well as other relevant organizations such as the Ministry of Water Resources and UNDP.

A thorough analysis of data collected was done and all relevant information were extracted and used. The new system was designed using the analysis tools uncovered.

3.400 COST AND BENEFIT ANALYSIS

It is necessary to bring into focus and examine the economic worthwhile and viability of the new system necessary for a change over. It should be recalled that the organization is already out of a manual system to an automated operation procedure. Therefore the essential ingredients and cost needed for the new system are already incurred at the time of the changeover from manual to automated system.

Cost

However, we undertake at this stage to examine an alternative and better method of utilizing the available resources more efficiently and effectively while underwriting the cost of

undertaking. Therefore, we shall look at the cost effectiveness of the new system only in terms of cheaper and easier alternative software being introduced as all necessary cost of equipment, installation, personnel and operating cost have been incurred and will be adopted and maintained.

a. Benefit

Longer system life

The existing system resources can be said to be quite rich already when compared to little requirement specifications it takes to operate the new system. The new system does not use all the available resources let alone overstretch the resources. This factor contributes in the longevity of the system life.

Faster System

The system run time will be shorter and enhanced by the luxurious system resources when compared to the little system resources required by the new system.

Saves cost.

A lot of maintenance and training costs will be saved since there are no further training is needed for the personnel to undertake the job as all the basic skill needed had been acquired in the existing system.

Saves data.

A corrupt program file in the application program can stop the existing system from performing. However, so long as the computer operating system is still functional the new system can be operated. However, if necessary it can be refreshened.

Parallel operation

The new system can be operated along side the existing system independently.

3.500 INPUT/OUTPUT SPECIFICATION

Input

Data will be transcripted into the computer system through keyboard from the source form and document. Since the program is a DOS based program, the designed software can still be used in a computer system without the use of a Mouse as an input device. Data can also be read into the system from a diskette. The format for data collection from the consumer points are incorporated in the software design. This can always be printed whenever the available stock is exhausted without resorting to the printing press in order to replenish the stock.

Output

Information can be obtained from the system with the aid of computer monitor for viewing and editing. Information can also be printed on a sheet of paper using computer printers. The format for the output is already part of the design in the new system. There may not be any need for the printing of output formats for the bill.

3.600 CHANGEOVER

Transfer of operation from the existing system to the new system may not necessarily be carried out entirely. The new system works the same and the same procedure as the existing system. It is only the operation environment that differs. It is therefore, practicable to run the two systems along side each other. This is called parallel running.

However, for the purpose of saving operational cost and saving the system resources during operation the new system can be used or adopted in event of the existing system breakdown.

3.700 PROGRAMMING LANGUAGE USED.

This project was implemented using QBASIC because it is more readily available virtually in every system. Having this program in your system is as easy as having MSDOS in your computer.

The programming language just as its names implies "Beginners All-purpose Symbolic Instruction Code" is the simplest and one of the most widely learnt and applied computer

programme. Hence it will be a little more easily applicable and modified or updated by a whole lot of computer literate in a need to make it reflect the demands of the time.

3.800 SYSTEM REQUIREMENT

The system requirements to run this program are down to earth simple, cheap and common in all the components.

- The memory requirement to' run this software is 640K.
- A minimum of 10MB hard disk is sufficient to run MSDOS.
- A CPU of about 25MHZ processing speed is sufficient to load MSDOS and run QBASIC.
- The software requires QBASIC version 4.5 and above.

CHAPTER FOUR

SYSTEM DESIGN

4.000 INTRODUCTION

System design involves the logical specification of how a system should work. A new. billing system for FCT water board will be designed using the analysis tools uncovered in the preceding chapter. The new system would be computerised consisting of the following improvement over the existing system.

1. The bill format and information will be printed out all together by the software.

2. The software will be cheaply available and operational in all most all computer system available to both consumers and FCT water board.

3. The system will enhance faster, more extensive testing and review o.f records than the existing system.

4. The financial cost and space consumed by printed forms will be saved. The format for all documents should be stored and used repeatedly. This gives advantage of maximum speed and accuracy.

5. A break down in the existing system will be taken over and complemented by the new software.

6. The system will be understood and can be operated by the operation and accounts personnel as well as consumers, thereby eliminating opportunities for frauds as a result of check balance revenue provided.

7. The activities of inter departments can be compressed into a unit because of the available general know how.

8. The system should be used friendly, by providing error messages and commands.

9. The new system should reduce the cost of undertaken more than half of the cost of undertaken and maintenance of the existing system.

4.100 OPERATIONAL MANUAL

- At the C:\> prompt type **CD DOS** and press Enter key.
- Type **Qbasic Billware** and press Enter key.

If you have the programme in your DOS directory.

Or

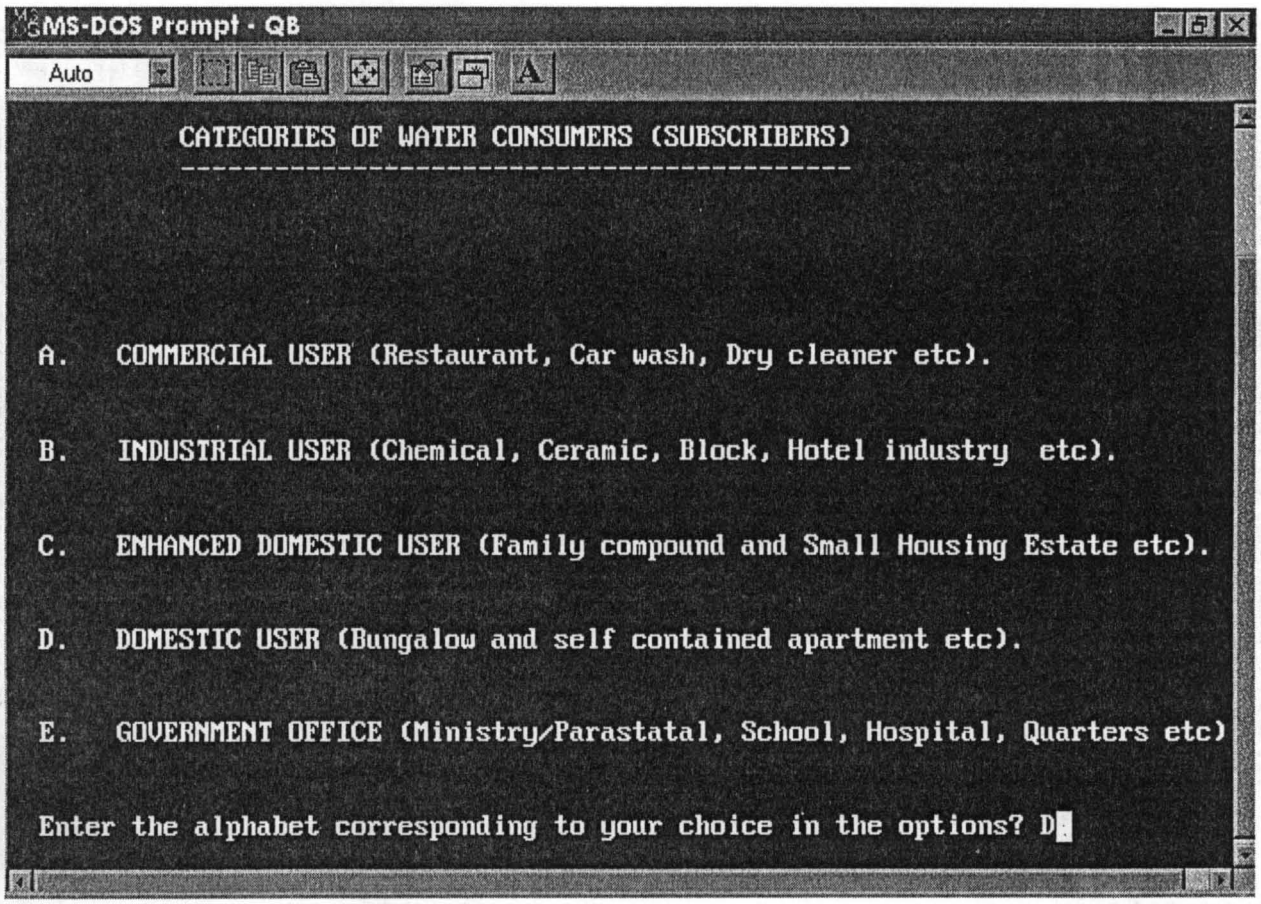
- At the C:\> prompt type **CD DOS** and press Enter key.
- Type **Qbasic** and press Enter key and open from drive A:

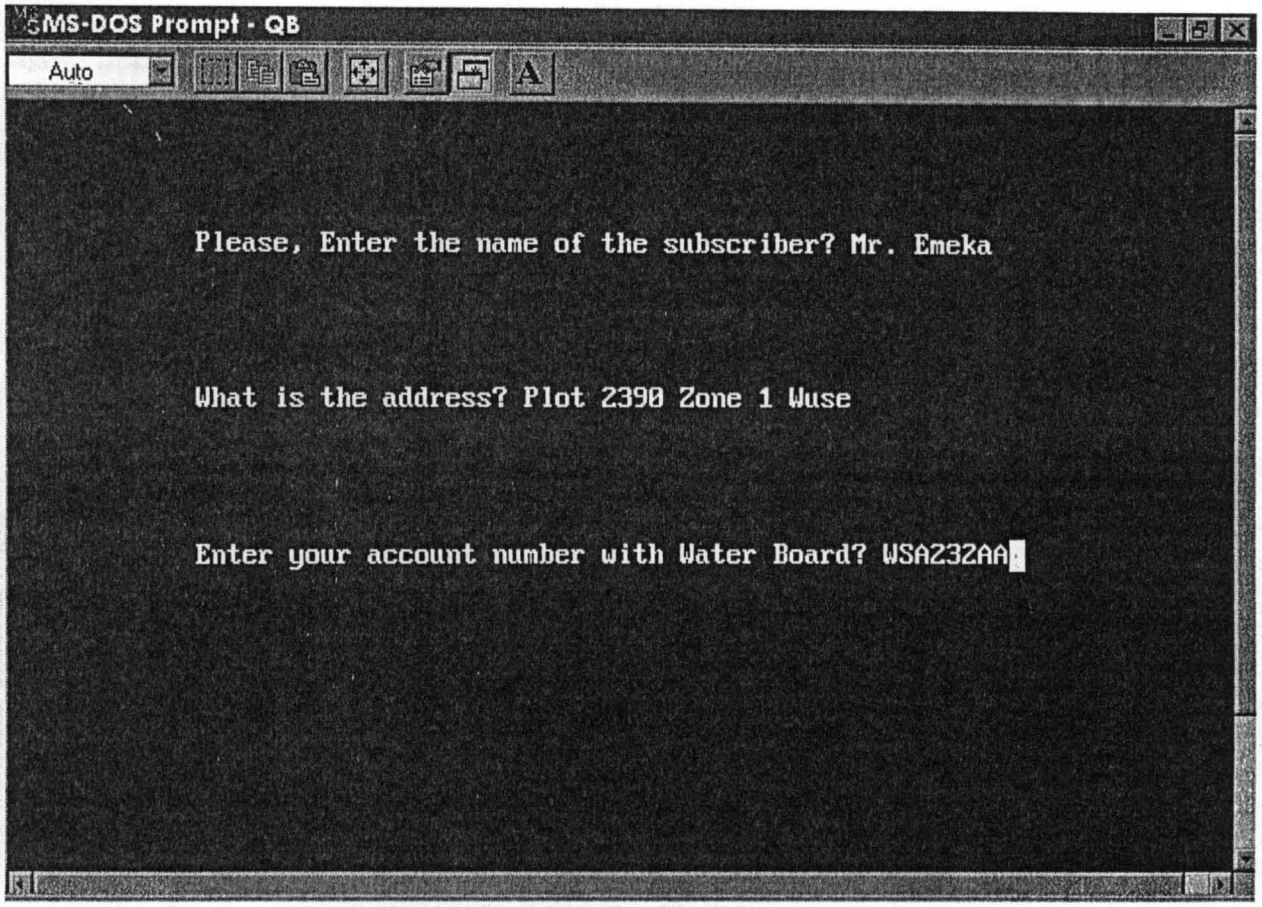
If you have the programme in your diskette.

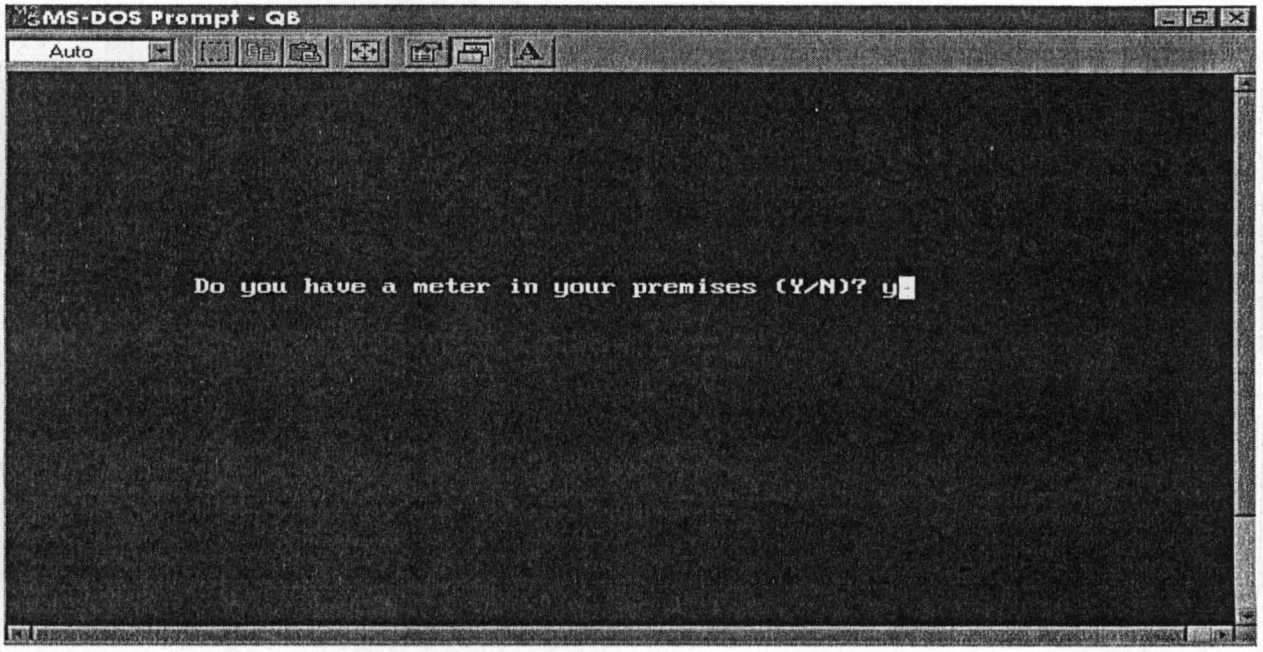
4.200 INPUT DATA

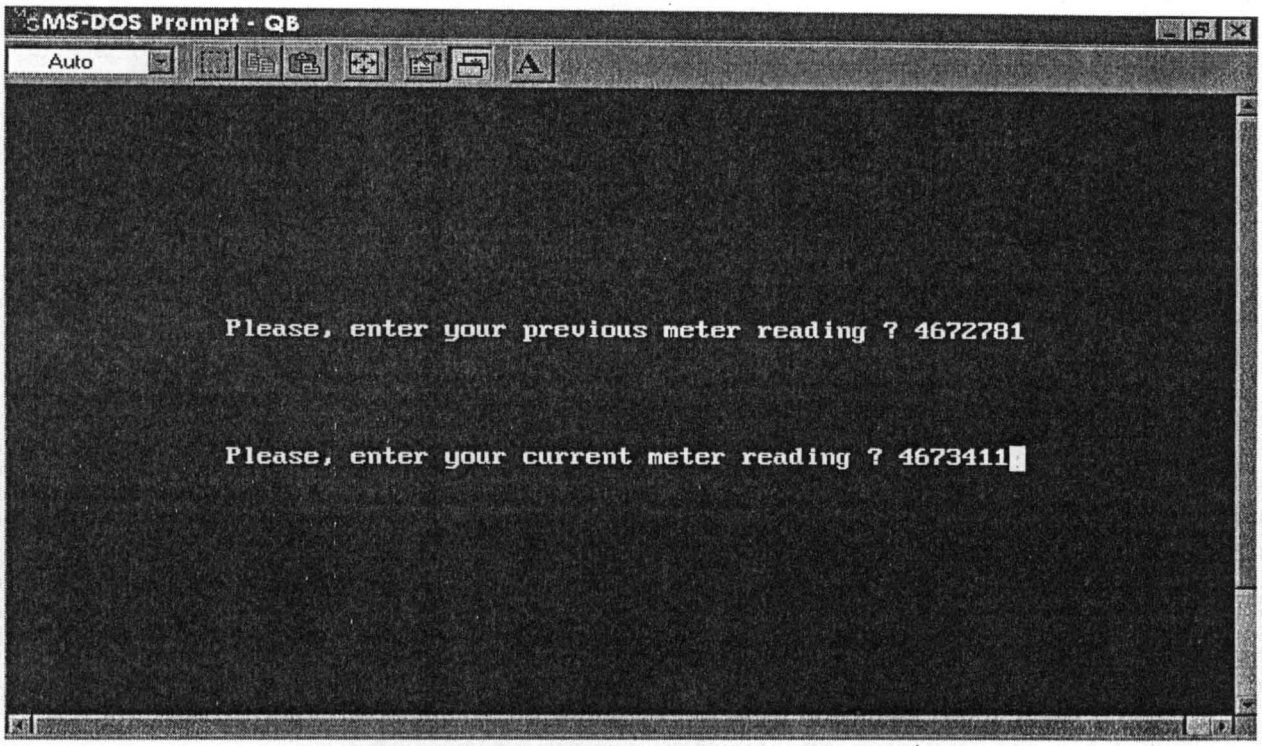
A sample real time data used to test the efficiency of the program developed copied at run time and attached for thorough scrutiny or test of the program's correctness and reliability. The sample input data chosen has been selected to represent the two categories of billing system i.e Flat rate and Meter rates. The sample data used have been obtained from a selected consumer bill produced by the FCT W ater Board's Automated Billing System served to consumers for the month of September and October.

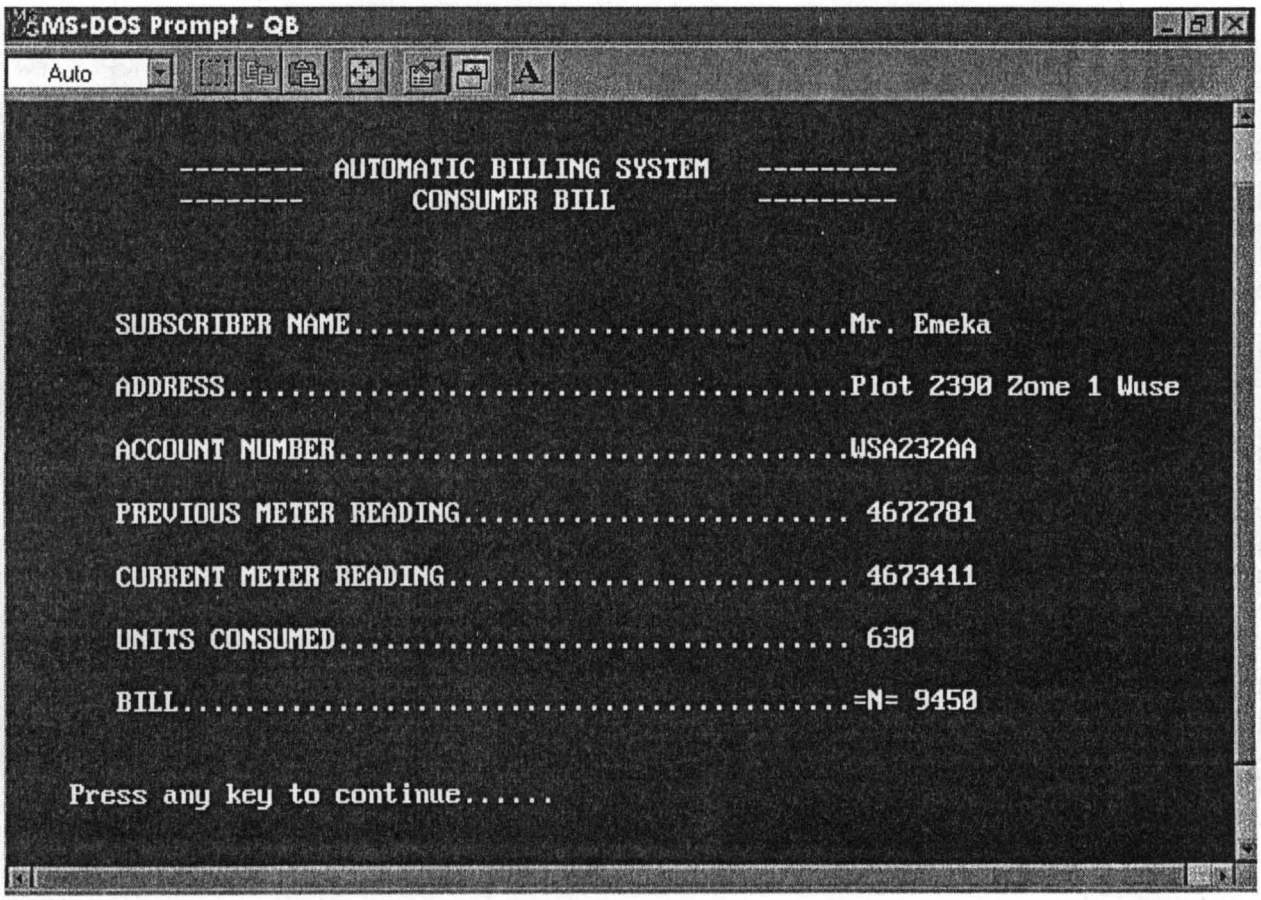
4.300 SAMPLE DATA FOR A BILL BASED ON METER READING

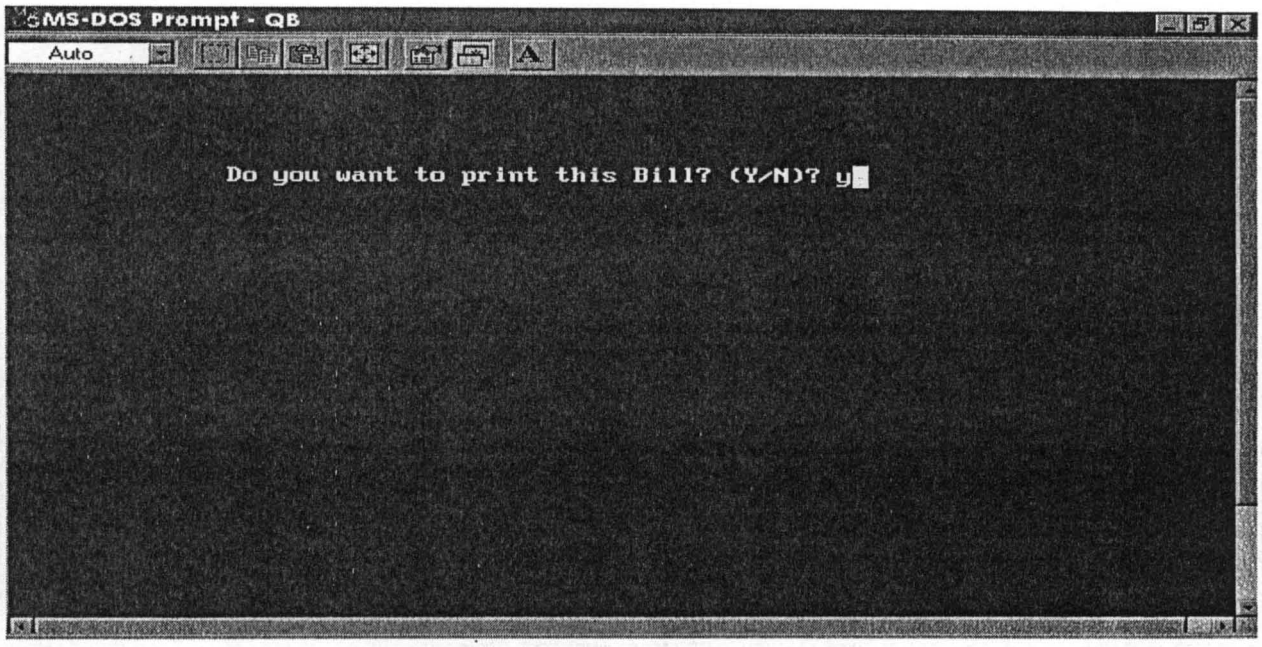



MS-DOS Prompt - QB
Auto
Please, Enter the name of the subscriber? Mr. Emeka
What is the address? Plot 2390 Zone 1 Wuse
Enter your account number with Water Board? WSA232AA

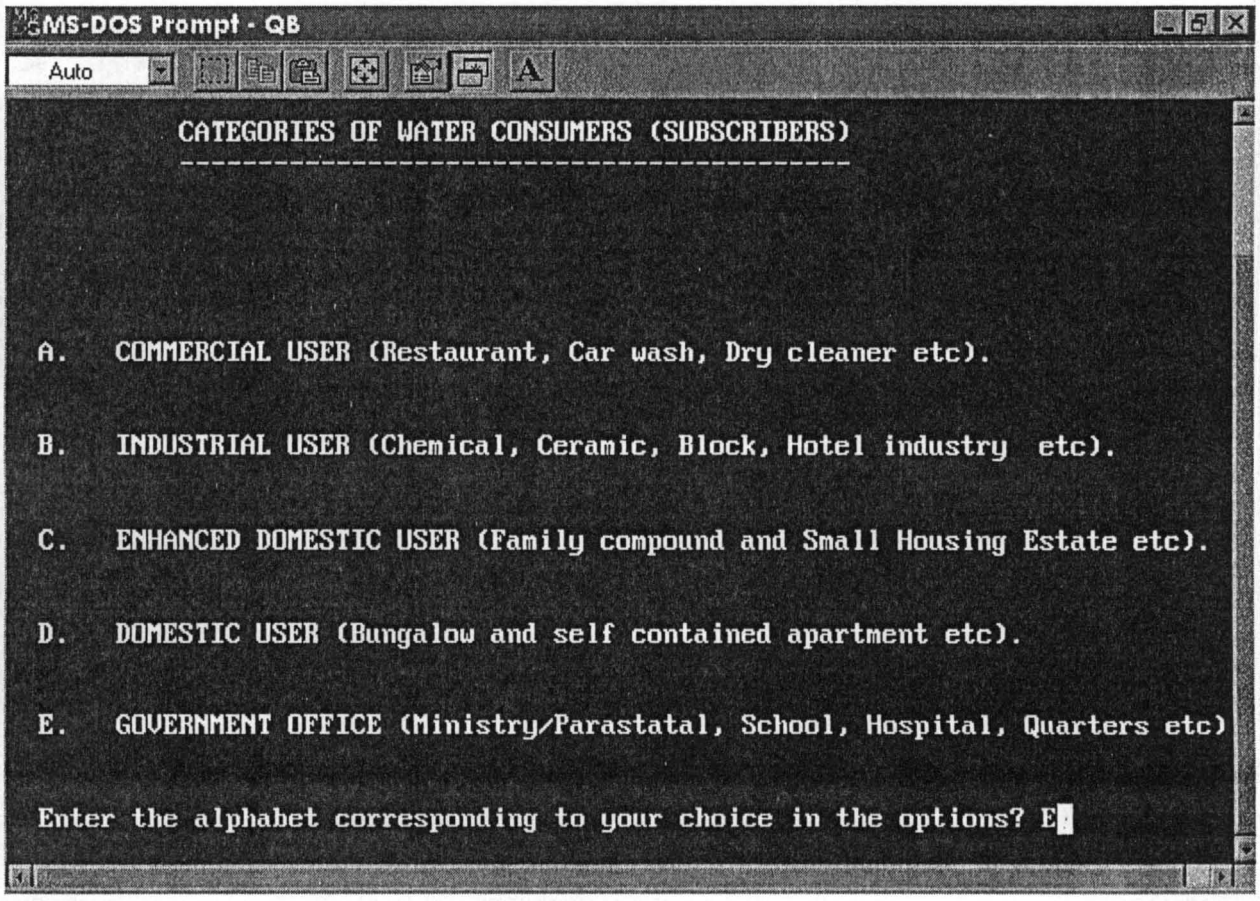

MS-DOS Prompt - QB
Auto
Do you have a meter in your premises (Y/N)? y

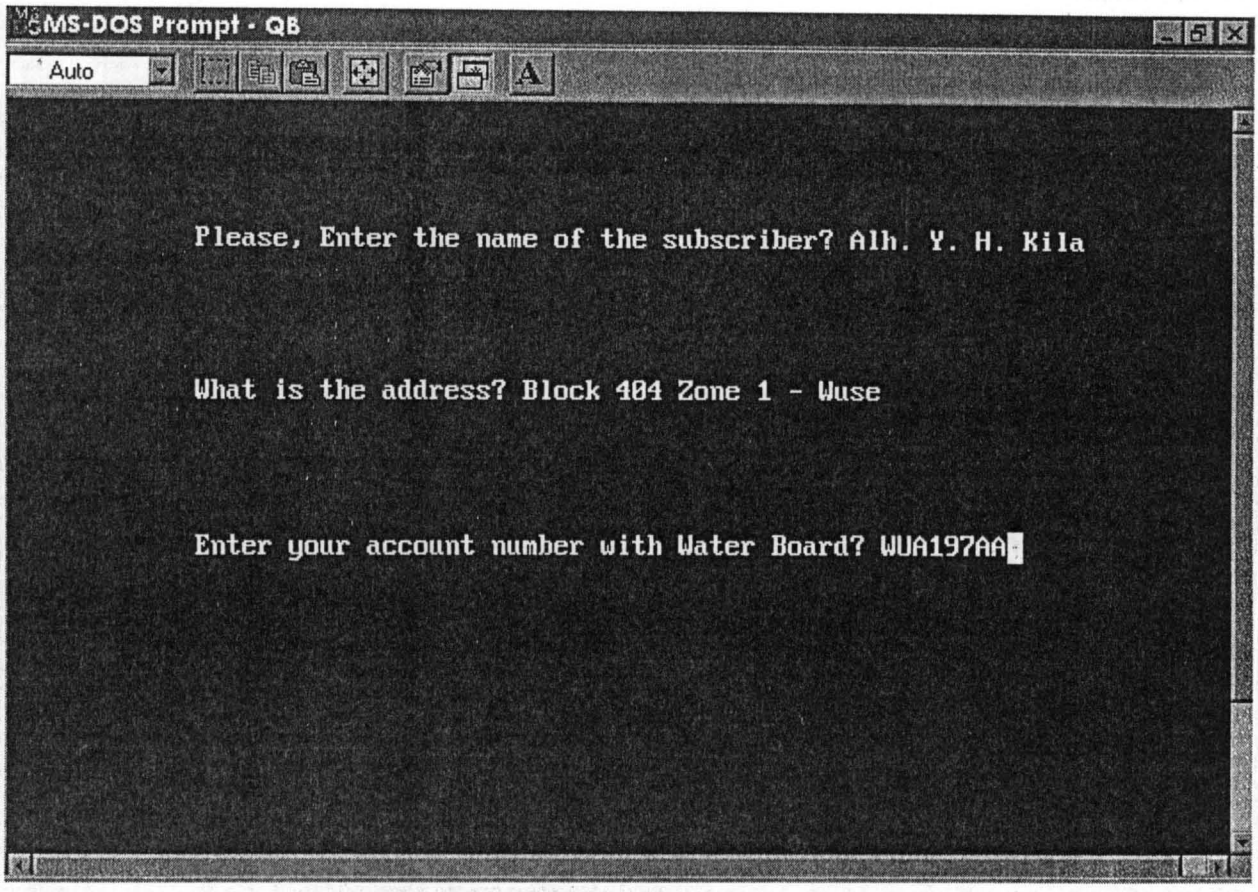

MS-DOS Prompt - QB
Auto
Please, enter your previous meter reading ? 4672781
Please, enter your current meter reading ? 4673411

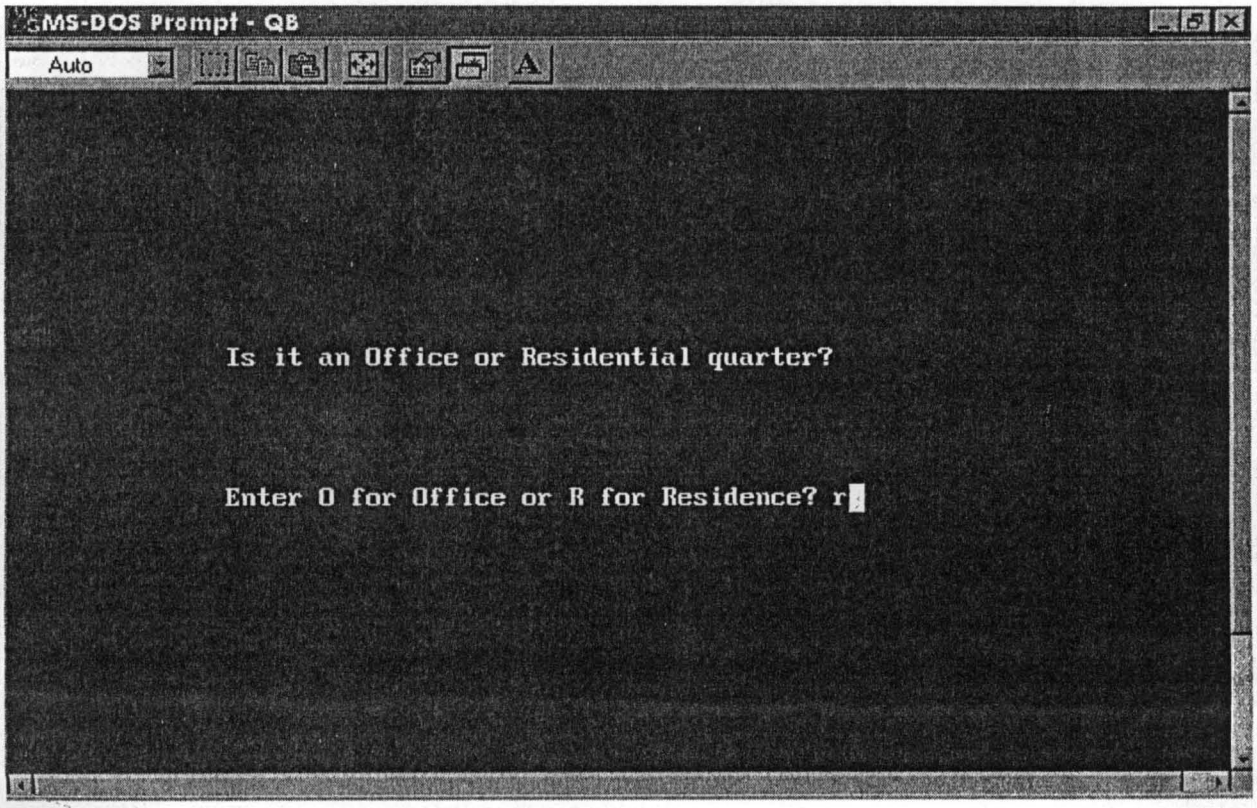

MS-DOS Prompt - QB
Auto
-------- AUTOMATIC BILLING SYSTEM ---------
-------- CONSUMER BILL ---------
SUBSCRIBER NAME.....Mr. Emeka
ADDRESS.....Plot 2390 Zone 1 Wuse
ACCOUNT NUMBER.....WSA232AA
PREVIOUS METER READING..... 4672781
CURRENT METER READING..... 4673411
UNITS CONSUMED..... 630
BILL.....=N= 9450
Press any key to continue.....

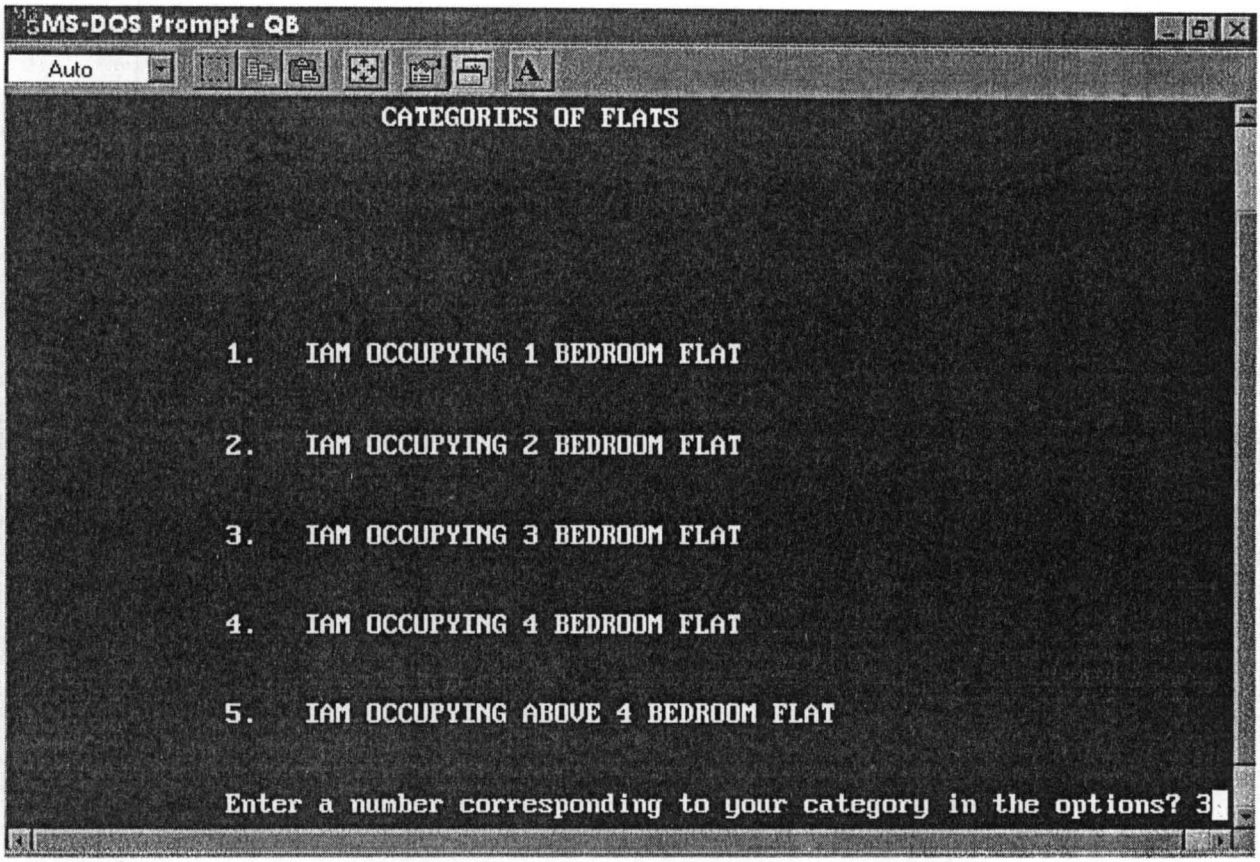


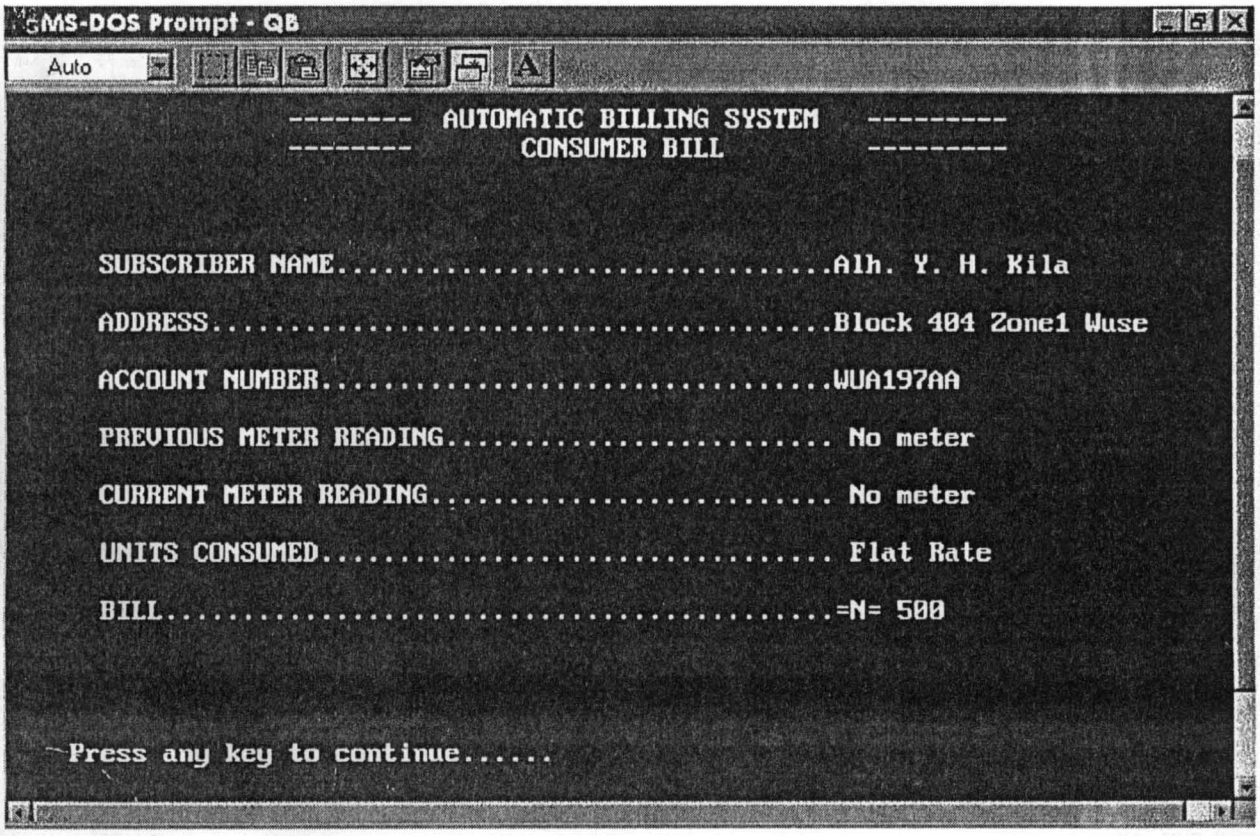
4.400 SAMPLE DATA FOR A BILL BASED ON METER READING




MS-DOS Prompt - QB
Auto
Please, Enter the name of the subscriber? Alh. Y. H. Kila
What is the address? Block 404 Zone 1 - Wuse
Enter your account number with Water Board? WUA197AA


MS-DOS Prompt - QB
Auto
Is it an Office or Residential quarter?
Enter O for Office or R for Residence? r


MS-DOS Prompt - QB
Auto
CATEGORIES OF FLATS
1. IAM OCCUPYING 1 BEDROOM FLAT
2. IAM OCCUPYING 2 BEDROOM FLAT
3. IAM OCCUPYING 3 BEDROOM FLAT
4. IAM OCCUPYING 4 BEDROOM FLAT
5. IAM OCCUPYING ABOVE 4 BEDROOM FLAT
Enter a number corresponding to your category in the options? 3


MS-DOS Prompt - QB
Auto
-------- AUTOMATIC BILLING SYSTEM ---------
-------- CONSUMER BILL ---------
SUBSCRIBER NAME.....Alh. Y. H. Kila
ADDRESS.....Block 404 Zone1 Wuse
ACCOUNT NUMBER.....WUA197AA
PREVIOUS METER READING..... No meter
CURRENT METER READING..... No meter
UNITS CONSUMED..... Flat Rate
BILL.....=N= 500
Press any key to continue.....

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.000 INTRODUCTION

As a result of close examination of the Water and it's usage and relevance to human survival in the subject of this study, we have come to terms with some salient fact deduced from the analogy here in outlined in the conclusion and recommendation.

5.100 CONCLUSION

Water is the very essence of life. It is life wire of both the living and the non living organisms on earth. It covers about eighty person of earth surface. It is as useful as it is dangerous to life on earth and perhaps in other planets. This is quite evident in the missions of the Astrologers to the moon in recent times to exploit the possibility of life and existence in the moon with specific reference to availability of water and in the right quantity.

The importance of water to man himself as well as other living organism can not be over emphasized. Right from the cell tissues to the blood component, aeration, food needs and conducive atmospheric condition of life and living are to a large extent influenced by the world water supply.

It is also not an overstatement as evident from the foregoing that water occupies the highest percentage of the earth surface. From the atmospheric environments, to the earthly rocks and surfaces as well as under the earth. Ironically, it is however one of the most scarce human utility. One of the most essential usefulness and human dependence on water is hinged on the provision of pure and good quality water in sufficient quantity for human consumption and domestic uses. Since most of the world waters are considered impure for human consumption because of their mix with the atmospheric impurities they need to be converted appropriately to safe water for human use.

Water borne diseases is one of the most prominent diseases and common cause of human ill health and death. To say the least, a thirsty man will in absence of good water will take the risk of endangering his health and venture to the use of any available water however dangerous. With the advent water treatment sciences and technology it implies that water borne diseases are now avoidable source of death and health hazards.

Water treatment for human safe water provision and consumption is quite expensive. This perhaps accounts for the reason why governments mostly shoulder the responsibility for the establishment of the institutions for the provision of portable hygienic water to it's citizens as a non profit making venture. In the characteristic human nature, anything provided freely is often not valued and therefore not protected or jealously guarded. The governments gesture in this major undertaken is not quite complimented by the people as this scarce commodity is often made to waste by the undiscerning users. This is noticeable in some instances of vandalized water pipes by the construction workers, unrepaired broken pipes in homes and around the communities as well as some uncaring attitiude of some individuals who opened up water taps without caring to lock after use.

If the government ever fails in it's responsibility to provide this essential utility to the community at large at any point in time for any reason will earn public disgust and outrage. This will eventually peter to nothing all the governments efforts and endeavours before now. Therefore, the people should be made to see and value this onerous responsibility of the government and appreciate it for the purpose of continuity.

5.200 RECOMMENDATION

If the government is to continually enjoy the support and confidence of the people in it's ability to continually provide a qood quality and safe water in sufficient quantity to the people, the consumers should themselves be involved in the provision and management of this essential but scarce commodity. This can be achieved by adopting the outlined strategies,

Water agencies should keep and maintain accurate records of water subscribers and the facilities. This is with a view to appropriately determine the unit cost the of water provision. The cost determined should be made to be borne by the consumers.

The consumers should be made to see how much it cost them by a unit water used. The people should also be promptly notified of any changes in their tariff. And a prompt and correct bill should always be dispatched to the consumers as at when due.

The consumers should be provided with the appropriate formular for the determination of the bill especially the billing software provided so as to enable the users themselves determine their correct charges and pay promptly when their bill is not forthcoming from the water agency. The will also show the open door policy of the water agency management and thereby earn the people's confidence.

As a matter of deliberate policy, investment in that sector should be deregulated to allow competition among providing companies so as to bring about competing product and services qualities at a competing price.

The should be a government backed concerted effort of the Water agencies to educated the masses on the dangers and prevalent diseases in the surrounding waters. This will be an eye opener to the people that, water from the available water agency is about the only safe and hygienic source of water supply available to them.

The people should be enlightened by the water agency to see the high level of cost of water treatment and provision which they enjoy with ease. Therefore, there must be an appropriate punishment for the users around observed places of water wastage either as a result of vandalisation or negligence.

5.300 REFERENCE

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```
ame$(25), Address$(50), accno$(10), bill(30), PMreading(15), CMreading(15)
tar1, tar2, tar3, tar4, tar5, tar6, tar7, tar8, tar9, tar10, tar11, tar12,
40, 8000, 40, 20, 15, 2000, 8000, 15, 5000, 220, 350, 500, 800, 2000
N 1
E 5, 10
"            YOU ARE WELLCOME TO                    "
E 6, 10
"            ===================                    "


E 13, 7
"         AUTOMATED BILLING SYSTEM            "
ON
IER(2) GOSUB 5
LE INKEY$ = "": LOOP

I 12
E 5, 27
"=== M E N U ==="

E 8, 12
"CATEGORIES OF WATER CONSUMERS (SUBSCRIBERS)"
E 9, 12
"-----------------------------------------"
 15, 1
"  A.   COMMERCIAL USER (Restaurant, Car wash, Dry cleaner etc)."

"  B.   INDUSTRIAL USER (Chemical, Ceramic, Block, Hotel industry  etc)."

"  C.   ENHANCED DOMESTIC USER (Family compound and Small Housing Estate e

"  D.   DOMESTIC USER (Bungalow and self contained apartment etc)."

"  E.   GOVERNMENT OFFICE (Ministry/Parastatal, School, Hospital, Quarters

"  Enter the alphabet corresponding to your choice in the options"; choice
$ = UCASE$(choice$)
 CASE choice$
$ = "A"

 5, 13
 Please, Enter the name of the subscriber"; name$
 10, 13
'What is the address"; Address$
 15, 13
'Enter your account number with Water Board"; accno$

 5, 15
'Do you have a meter in your premises (Y/N)"; Meter$
 = UCASE$(Meter$)
er$ = "Y" THEN
 10, 15
 Please, enter your previous meter reading "; PMreading
```

```
E 15, 15
 "Please, enter your current meter reading "; CMreading
= CMreading - PMreading
= unit * tar1
100
F Meter$ = "N" THEN
= tar2


E 15, 35
 "Wrong entry made"
E 25, 5
 "Press any key to Retry......"
LE INKEY$ = "": LOOP
.2
F
:00
   CASE IS = "B"
  CLS
  LOCATE 5, 13
  INPUT "Please, Enter the name of the subscriber"; name$
  LOCATE 10, 13
  INPUT "What is the address"; Address$
  LOCATE 15, 13
  INPUT "Enter your account number with Water Board"; accno$
  CLS
  LOCATE 10, 15
  INPUT "Please, enter your previous meter reading "; PMreading
  LOCATE 15, 15
  INPUT "Please, enter your current meter reading "; CMreading
  unit = CMreading - PMreading
  bill = unit * tar3
  GOTO 100
S = "C"

 5, 13
'Please, Enter the name of the subscriber"; name$
 10, 13
'What is the address"; Address$
 15, 13
 Enter your account number with Water Board"; accno$
 20, 13
 Please, enter your previous meter reading "; PMreading
 25, 13
 Please, enter your current meter reading "; CMreading
 CMreading - PMreading
 unit * tar4
 0
  = "D"
 CLS
 LOCATE 5, 13
 INPUT "Please, Enter the name of the subscriber"; name$
 LOCATE 10, 13
 INPUT "What is the address"; Address$
 LOCATE 15, 13
 INPUT "Enter your account number with Water Board"; accno$
 CLS
 LOCATE 10, 13
 INPUT "Do you have a meter in your premises (Y/N)"; Meter$
 Meter$ = UCASE$(Meter$)
```

```
IF Meter$ = "Y" THEN
CLS
LOCATE 10, 15
INPUT "Please, enter your previous meter reading "; PMreading
LOCATE 15, 15
INPUT "Please, enter your current meter reading "; CMreading
unit = CMreading - PMreading
bill = unit * tar5
GOTO 100
ELSEIF Meter$ = "N" THEN
bill = tar6
ELSE
CLS
LOCATE 15, 35
PRINT "Wrong entry made"
LOCATE 25, 5
PRINT "Press any key to Retry......"
DO WHILE INKEY$ = "": LOOP
GOTO 15
END IF
GOTO 200
$ = "E"

5, 13
'Please, Enter the name of the subscriber"; name$
10, 13
What is the address"; Address$
15, 13
Enter your account number with Water Board"; accno$

10, 15
Is it an Office or Residential quarter?"
15, 15
Enter O for Office or R for Residence"; pick$
 UCASE$(pick$)
$ = "O" THEN

3, 20
CATEGORIES OF PUBLIC INSTITUTIONS"
4, 20
--------------------------------"
0, 5
.. GOVERNMENT OFFICE (Ministry and Parastatals etc.)"
5, 5
. GOVERNMENT HEALTH INSTITUTION (Hospital, Clinic and Dispensary etc.)"
0, 5
. GOVERNMENT EDUCATIONAL INSTITUTION (Primary - Higher institution etc.)
5, 2
nter the number corresponding to your choice in the options"; optn
ASE optn
CASE IS = 1
bill = tar7
GOTO 200
CASE IS = 2
CLS
LOCATE 10, 15
INPUT "Please, enter your previous meter reading "; PMreading
LOCATE 15, 15
INPUT "Please, enter your current meter reading "; CMreading
unit = CMreading - PMreading
```

```
   bill = unit * tar8
   GOTO 100
   CASE IS = 3
   bill = tar9
   GOTO 200
   CASE ELSE
   CLS
   LOCATE 15, 35
   PRINT "Wrong entry made"
   LOCATE 25, 5
   PRINT "Press any key to Retry......"
   DO WHILE INKEY$ = "": LOOP
   GOTO 55
   END SELECT
   ELSEIF pick$ = "R" THEN
S
E 5, 25
 "CATEGORIES OF FLATS"
E 13, 15
 "1.   IAM OCCUPYING 1 BEDROOM FLAT "
E 16, 15
 "2.   IAM OCCUPYING 2 BEDROOM FLAT"
E 19, 15
 "3.   IAM OCCUPYING 3 BEDROOM FLAT"
E 22, 15
 "4.   IAM OCCUPYING 4 BEDROOM FLAT"
E 25, 15
 "5.   IAM OCCUPYING ABOVE 4 BEDROOM FLAT"
E 28, 15
 "Enter a number corresponding to your category in the options"; num
T CASE num
   CASE IS = 1
   bill = tar10
   GOTO 200
   CASE IS = 2
   bill = tar11
   GOTO 200
   CASE IS = 3
   bill = tar12
   GOTO 200
   CASE IS = 4
   bill = tar13
   GOTO 200
   CASE IS = 5
   bill = tar14
   GOTO 200
   CASE ELSE
   CLS
   LOCATE 15, 35
   PRINT "Wrong entry made"
   LOCATE 25, 5
   PRINT "Press any key to Retry......"
   DO WHILE INKEY$ = "": LOOP
   GOTO 60
   END SELECT
   ELSE
   CLS
   LOCATE 15, 35
   PRINT "Wrong entry made"
   LOCATE 25, 5
```

```
   PRINT "Press any key to Retry......"
   DO WHILE INKEY$ = "": LOOP
   GOTO 53
   END IF
ELSE

E 15, 35
 "Wrong entry made"
E 25, 5
 "Press any key to Retry......"
ILE INKEY$ = "": LOOP
5
ELECT
LS
E 5, 4
 "          --------  AUTOMATIC BILLING SYSTEM   ---------"
E 6, 4
 "          --------        CONSUMER BILL        ---------"


 "        SUBSCRIBER NAME.................................."; name$

 "        ADDRESS.........................................."; Address$

 "        ACCOUNT NUMBER..................................."; accno$

 "        PREVIOUS METER READING..........................."; PMreading

 "        CURRENT METER READING............................"; CMreading

 "        UNITS CONSUMED..................................."; unit

 "        BILL.....................................=N="; bill
 25, 5
"Press any key to continue......"
LE INKEY$ = "": LOOP

 5, 15
'Do you want to print this Bill? (Y/N)"; print$
 = UCASE$(print$)
nt$ = "Y" THEN

 5, 4
 "          --------  AUTOMATIC BILLING SYSTEM   ---------"
 6, 4
 "          --------        CONSUMER BILL        ---------"


 "        SUBSCRIBER NAME.................................."; name$

 "        ADDRESS.........................................."; Address$

 "        ACCOUNT NUMBER..................................."; accno$

 "        PREVIOUS METER READING..........................."; PMreading

 "  iv    CURRENT METER READING............................"; CMreading
```

```
T "       UNITS CONSUMED......................................"; unit
T
T "       BILL.....................................=N="; bill

F
ND
LS
E 3, 13
 "       --------  AUTOMATIC BILLING SYSTEM   ---------"
E 4, 13
 "       --------        CONSUMER BILL        ---------"


 "       SUBSCRIBER NAME....................................."; name$

 "       ADDRESS............................................."; Address$

 "       ACCOUNT NUMBER....................................."; accno$

 "       PREVIOUS METER READING..... No meter"

 "       CURRENT METER READING..... No meter"

 "       UNITS CONSUMED..... Flat Rate"

 "       BILL.....................................=N="; bill
 25, 5
"Press any key to continue....."
LE INKEY$ = "": LOOP

 5, 15
"Do you want to print this Bill? (Y/N)"; print$
 = UCASE$(print$)
nt$ = "Y" THEN

 3, 13
 "       --------  AUTOMATIC BILLING SYSTEM   ---------"
 4, 13
 "       --------        CONSUMER BILL        ---------"


 "       SUBSCRIBER NAME....................................."; name$

 "       ADDRESS............................................."; Address$

 "       ACCOUNT NUMBER....................................."; accno$

 "       PREVIOUS METER READING..... No meter"

 "       CURRENT METER READING..... No meter"

 "       UNITS CONSUMED..... Flat Rate"

 "       BILL.....................................=N="; bill

50  v
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