ASSESSMENT OF WASTEWATER MANAGEMENT AND SANITATION IN A TYPICAL SUBURB: CASE STUDY OF KUBWA, ABUJA

BY

ADAMA. JOSEPHAT NGWUJA

PGD/AGRIC ENGR/2000/2001/133
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FED. UNIVERSTY OF TECHNOLOGY
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ADAMA, JOSEPHAT NGWUJA

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DEPT OF AGRIC. ENGINEERING

FUT MINNA

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CERTIFICATION

This is to certify that this project work was carried out by Josephat N. Adama of soil and water conservation Engineering (option) PGD/Agric Engr/2000/2001/133 of Department of Agric. Engineering Federal University of Technology, Manna.

Engr (Mrs) D. Z. Osunde
Supervisor

Engr. (Dr) D. Adgidzi
HOD

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ABSTRACT

For an optimum clean environment, devoid of odour and unhealthy refuse management both of which lead to health hazards, careful sanitation procedures are imminent. This suggests why this topic " The assessment of wastewater management and sanitation in a typical suburb; case study of Kubwa" was chosen for research. The research shows that the total population of Kubwa is 97,000 inhabitants with six zones. Zone six has the largest population of 25,000 inhabitants and zone five having the lowest population of 10,185 inhabitants. The result from questionnaire administration shows that sanitation of Kubwa is very poor. Data from table 6 shows that zone 6 is facing a maximum health hazard while zone 4 still maintains a clean environment. Finally, a study was undertaken by visiting different wastewater treatment plants in Abuja and based on the study, it was considered that Kubwa is well overdue to be allocated one big central sewage treatment facility or at least five small units of sewage treatment facilities in the zones.

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CHAPTER ONE

1. INTRODUCTION

Wastewater management and sanitation is a brand topic in water and wastewater engineering which deals with collection, treatment, and disposal of all waters termed waste which has been used in homes, educational institutions, business and industrial establishments. This work is aimed at assessing and improving the sanitation of a given environment.

Scientifically and health wise, sewage and wastewater including human excrement should not be deposited on the surface of the soil since its properties are usually not acceptable to the inhabitants who produce them. The offensive nature of wastewater properties includes bad appearance, odour, and health hazards.

The problem of wastewater management in Kubwa is remote and this arose due to poor arrangement and poor suburban organization. Prior to 1982, Kubwa was a mere Gwari settlement, located on the map of Abuja, the Federal Capital Territory. This settlement is situated around 9°9' North of the Equator and 7°19' East of Greenwich meridian. Kubwa started to grow in population in 1982 when two major settlements in the city center: Maitama and Kukwaba were forced to resettle. Their new locations are what are now known as new Maitama and new Kukwaba in Kubwa village. Their original locations were left for federal government officers to build up and settle. This went on simultaneously with the building and settlement of junior staff of Federal Capital Development authority (FCDA) and Ministry of Federal Capital Territory (MFCT) who could not be housed in the city center of Wuse and Garki as these workers vacated field base in Suleja to Abuja. With this arrangement, the building of phase 1 and phase 2 of Kubwa was effected – Abuja Master plan – 1994

Worse still, when the government of General Ibrahim B.Babangida shifted the seat of federal government from Lagos to Abuja in December 1991, it seemed as if hell was broken loose .in Kubwa. All civil servants and public officers, who were forced to leave Lagos for Abuja and could not find places to sleep in the city; all forced their way to Kubwa, the nearest satelite town to the city center today. This made the staff of FCDA development control to make fast money as people purchased building plots randomly. In effect, one plot was sometimes sold to three different people. Businessmen trooped in and a twinkle of an eye, the population of Kubwa nearly outgrew the population of the city center. This led to the problem of sanitation of Kubwa and the disposal of both solid and liquid wastes of Kubwa turned to unsightly situation.

Solid wastes from homes litter the streets and some residents use bush method for disposal of their feaces. The use of pit latrine and septic tanks dominate in all the buildings in different zones of Kubwa even as more phases: phase 1, phase 11 site 11 extension and other built estates continue to rise up daily in the town of Kubwa. For this purpose, though the town has existed for less than twenty years now, the evident pollution of drinking water conveyance by odour and other properties of wastewater have been detected. This leads to the idea of tackling this problem before it assumes an alarming rate.

The idea of how to handle this health hazard in the developed world was not just concluded in a day. In the United States of America for instance, the first legislation on how to improve wastewater disposal was enacted in 1948 (Brian & Eddy 1974). Series of legislation followed and a reasonable legislation on a possible efficient disposal of wastewater and its preservation for other uses like swimming, irrigation, fish and shellfish breeding was finally made in 1983. This legislation included "That by the end of 1985, no

solid, liquid or chemical pollutants are to be discharged into the United States bodies of water". (Brian & Eddy 1974).

1.1 OBJECTIVES

The objective of this research is to assess the existing methods of wastes and wastewater collection, treatment, and disposal in Kubwa and make recommendation for future improvement. The specific objectives are:

1. To compare the present method of disposing human excrement with a more efficient method of using the central sewage system.
2. To assess the idea of reusing the treated water from sewage for other uses like swimming, irrigation, fish and shellfish breeding.

1.2 LIMITATIONS

In most of our towns and villages, sewage treatment facilities are not available and this is why care should be taken not to build up a facility that will not be used. It becomes an economic waste if a waste treatment facility is built without properly serving the purpose for which it was built. In view of the nature of this topic under review, a new topic in engineering field, the additions to past research will be limited. As this topic is new, textbooks and journals from where ideas are developed are limited. In the same manner, experts in wastewater management are few in this part of the world and this creates limitations to this research. However the few textbooks and experts met will act as sources of encouragement. The result, which will be collected from various aspects of the methodology, will be kept for future researchers who may like to undertake studies on the same topic.

1.3 **JUSTIFICATION**

The need for the proposal of this project in Kubwa cannot be over emphasized. For now the solid waste and wastewater disposal in Kubwa is becoming intolerable. Household

refuse litter the streets and wastewater from residential service mains, most of which have failed, mix up with these solids producing colloidal and decayed liquid/solid mixture whose odour alone shows danger of health hazards that may follow.

The need is as well justified when reference is made to the method of disposal of human excrement in the zones. The use of water closet (WC) with septic tanks and soak away pits as collecting and end media was found to be 72% of the overall population. Pit latrine serves a group of residents, up to 5% of the population, while 23% of the population make use of open bush method for the disposal of their feaces.

If this facility is built, it will enhance the sanitary condition of Kubwa.

CHAPTER TWO

LITERATURE REVIEW

According to Fair et al (1958), wastewater system includes:-

1. Collection works
2. Treatment works
3. Outfall or Disposal works

Since the idea of wastewater management was borne, efforts have been on the increase to continuously improve the management of wastewater. If the process is followed strictly, this method will result in the improved sanitation of a particular environment.

The following definitions are included for reference and clarity as recorded by Fair et al (1958).

- Domestic Sewage: This is the water carried waste from the homes or residential houses. They include wastewater from
    a. Kitchen
    b. Bathroom
    c. Laundry
    d. Lavatory.
- Industrial Sewage: This includes sewage from manufacturing and industrial establishments.
- Municipal Sewage: This include both domestic and industrial sewage.
- Combined system of sewerage: This is a system where the household sewage industrial sewage is disposed through the same sewer line with storm run off.
- Separate system of Sewage: This is a system where the household sewage or industrial sewage is disposed through a separate sewer line while the storm run off is disposed through a separate sewer line.

Usually flows in sewers and drain lines are made to proceed continuously downhill. The only exception is where pumping stations and force mains are interpolated to lift

flows through force mains into higher conduits. The advantage of this type of construction includes:

1. Avoiding costly construction of deep conduits in flat or bad grounds.
2. Transferring wastewaters from low – lying sub areas to main drainage schemes on a higher ground. Sewers are not intended to flow under pressure. If they were, wastewater would have to be forced into them through individual building services. The property drains or their inverts would have to be placed far enough below cellar level to keep sewage from backing into basement and spilling out of fixtures.

   Hydraulically, sewers are designed as open channels flowing partly full or atmost just filled. The materials used for sewer channels are: - Vitrified –clay pipes for small sewers and concrete or masonry pipes or conduits for large pipes. In fully watered regions of the earth, the collected wastewaters are normally discharged into nearby water courses after suitable treatment. This is referred to as disposal by dilution.

   Treatment before disposal removes unsightly and putrescible matters stabilizes degradable substance and removes or destroys disease-producing organisms in suitable degree. Another important consideration is the economical conservation of water and land resources whose lives are not to be impaired Fair et al. (1958)

2.1 SOURCES OF WASTEWATER

According to Metcalf & Eddy (1991), the principal sources of domestic wastewater in a community are:-

1. Residential Areas
2. Commercial Districts

Other important sources include institutional and recreational facilities. Wastewater flow rates for small systems may differ from large systems, which is to take charge of large populations.

For many residential areas, wastewater flow rates are commonly determined on the basis of population density and the average per capita contribution of wastewater for large residential areas. It is often advisable to develop flow rates on the bases of land use areas and anticipated population densities. Where possible, these rates should be based on actual flow data from selected similar residential areas. In the past, the preparation population projection for use in estimating wastewater flow rate was often the responsibility of the engineer, but today such data are usually available from local, regional and state planning agencies.

Commercial wastewater flow rates are generally expressed in gal/acre-day (m^3 /ha-day) and are based on existing or anticipated future development or comparative data. Average unit flow rates allowance for commercial development normally range from 800 to 1500gal/acre-day (7.5 to 15m^3/ha-day). Because unit flow rates can vary widely for commercial facilities, every effort should be made to obtain record from similar facilities. It is stressed that flow rates vary with the region, climate and type of facility. The actual records of institutions are the best source. Wastewater flow rates from recreational facilities are highly seasonal – McJunkin & Stensel (1964).

Wastewater flow originally contains minerals and organic matter and this is added the following burden of human excrement, paper, soap, dirt, food waste (garbage) and other substances. Some of the waste matters remain in suspension; some go into solution and others become finely divided that they acquire the properties of colloidal particles. Much of the waste substance are organic and useful to saprophytic microorganisms i.e.

organisms of decay. It follows that domestic sewage is unstable, biodegradable and putrescible and may generate offensive odour.

Industrial sewage: This varies in composition with industrial operations. Some are relatively clean, rinse waters; others are heavily laden with organic or mineral matters with corrosive, poisonous, inflammable or explosive substances. Some industrial wastes are so objectionable that they should not be admitted into public sewerage system, others contain so little and such unobjectionable waste matter that it is safe to discharge them into storm drains or directly to natural bodies of water – McJunkins & Stensel (1964).

It is important to treat wastewater since some contain toxic materials that destroy the conveying conduits. For example, fats, lime, hair, and fibres adhere to sewers and clog them. Acids and Hydrogen Sulphide destroy cement, concrete and metals while hot wastes crack tiles and masonry conduits. Some poisonous chemicals disrupt biological treatment, kill useful aquatic life and endanger water supplies. Flammable and explosive liquor impair the life span of structures through which they flow while toxic gases or vapours are hazardous to workmen and operators of sewage work and occasionally to householders. For this purpose, treatment of wastewater must be carried out.

To improve the wastewater disposal of kubwa, all these sources, which agglomerate and enlarge as they leave the individual housing units, should be carefully analyzed. The house-to-house wastewater discharge should be known so that the sizes and types of collecting and conveying sewer pipes to be adequate for the flow should be provided.

2.2 MATERIAL NEEDED IN WASTEWATER TREATMENT AND DISPOSAL

According to Babbitt & Baumann (1958), the smallest diameter of public sewer in North America is 200mm, smaller sizes of pipes clog quickly and are hard to clean. These sewer pipes are to be made of cast iron, asbestos cement, PVC pipes,

UPVC pipes and other suitable materials. To reduce infiltration of ground water, sewers laid without performed joints in wet grounds must be under drained or should be made of the above materials. Sewers are normally laid deep during installation:

1. To protect them from breakages by traffic shock.
2. To keep them from freezing.
3. To permit them drain the lowest fixture in the premises served. Babbit & Baumann(1958).

Apart from the pipes of the above prescriptions, which form the collection and conveyance materials for wastewater, other materials are also needed in the system set up. Usually the flow is expected to terminate from the sewer line to a treatment plant. In the plant chamber, a combination of materials ease the work involved in the plant system. A combination of different tanks arranged in series treat the sewage deposited from sewer lines. The materials in this section include: -

1. Racks and Screens
2. Floatation tanks
3. Detritus tanks
4. Settling tanks or sedimentation basins
5. Chemical flocculation or precipitation tanks
6. Trickling filters
7. Activated sludge tank
8. Disinfectant Chemical s e.g. Chlorine
9. Centrifuges and vacuum filters
10. Flash driers
11. Incinerators
12. Sludge thickeners or floculators
13. Sludge retorts

These are the materials used to treat wastewater, as they are collected in the treatment chambers from conveying sewers.

2.3 ECONOMIC AND FINANCIAL IMPLICATIONS

In keeping with water works practice, the construction of wastewater systems from ground up, or their improvement and extension progresses from preliminary studies through financing, design and construction to operation, maintenance and repair. The per capita investment in sewerage systems varies with system type, topography, hydrology, and geology of the communities served. The nature, volume and proximity of receiving waters, need for sewage treatment, availability and cost of labour and materials, size and character of the community are the determining factors – Rowan & Asano (1960)

Sewage treatment facilities cannot be sited in a community where the population is low. The government agencies in charge of municipal master plan take into consideration the financial support of a community before a unit of sewage treatment facility is sited. This is because of the high cost of building this facility. In kubwa the case under discussion, serious thought is being given to this type of project because of the daily population increase in the town of kubwa in FCT. Consideration is also being given to available space. If care is not taken, in no distant future, all the available spaces that will be suitable for siting sewage treatment work will be overtaken by residential houses.

In addition to the above factors, sewage treatment works are relatively twice as expensive compared to water purification works of the same volume. The collecting system of domestic sewage is however about half as expensive compared to pure water collection works. The planning of wastewater treatment facility should only arise when the population is very large. The traditional

method of disposing sewage into the ground has been very useful in many communities in different parts of the world. The absorptive capacity of the soil is of controlling importance. However, the absorptivity of the soil is highly increased if settlable waste matters are first removed e.g. by sedimentation, combined with digestion and consolidation of the deposited sludge scum.

2.4 THE OBJECTIVES OF WASTEWATER TREATMENT

Methods of wastewater treatment were first developed in response to the concern of public health and the adverse conditions caused by the discharge of wastewater to the environment. (Metcalf & Eddy 1991). Also important as cities continued to grow in the United States is the limited availability of land for wastewater treatent and disposal, principally by irrigation and intermittent infiltration. These are methods, which were commonly used in 1900s. The purpose of developing other methods of treatment was to accelerate the forces of nature under controlled conditions in treatment facilities of comparatively smaller size.

In general, from 1900 to the early 1970s, treatment objectives were concerned with

1. The removal of suspended and floatable materials
2. The treatment of biodegradable organics
3. Elimination of pathogenic organisms.

From the early 1970s to about 1980, wastewater treatment objectives were based primarily on aesthetics and environmental concerns. The earlier objectives of BOD suspended solids, and pathogenic organisms' reduction continued, but at higher level. Removal of nutrient such as nitrogen and phosphorus also began to be addressed especially in some inland streams and lakes. A major effort was undertaken by both

state and federal agencies to achieve more effective and widespread treatment of wastewater to improve the quality of the surface waters. Metcalf & Eddy (1991).

This effort resulted in part from

1. An increased understanding of the environmental effects caused by wastewater discharges.
2. A developmental knowledge of the adverse long-term effects caused by the discharge of some of the specific constituents found in water.
3. The development of national concern for environmental protection. The result of these efforts was a significant improvement in the quality of surface waters.

Since 1980, because of the increased scientific knowledge and an expanded information base, wastewater treatment has begun to focus on the health concerns related to toxic and potentially toxic chemicals released to the environment. The water quality improvement objectives of the 1970s have continued, but the emphasis has shifted to the definition and removal of toxic and trace compounds that may cause long term health effects. As a consequence, while the treatment objectives remain valid today, the required degree of treatment has increased significantly and additional treatment objectives and goals have been added. Therefore treatment objectives must go hand in hand with the water quality objectives or standards established by the federal, state and regional regulatory authorities – Metcalf & Eddy (1991).

2.5 PROCESSES INVOLVED IN TREATING WASTEWATER

The treatment of wastewater is carried out in stages to achieve disludging of harmful microbes from the wastewater before the water is discharged into a body of water or discharged through a combined system of sewerages. This wastewater, which is to be treated, is usually disposed in a common and economic

way. The treatment before disposal is aimed at removing dangerous and unsightly waste from households and industrial wastewaters. If wastewater is disposed without treatment, then it constitutes potential nuisance and dangers at the collecting bodies of water.

In the treatment of wastewater before irrigation, full recovery of the water value of the sewage is intended with as much recovery of the fertilizing value as is consistent with:

1. Avoiding the spread of diseases by crops grown on the sewage – irrigated lands or animals pastured on them.
2. Preventing nuisance such as unsightliness and bad odour around disposal areas.
3. Optimizing in an economic sense, sewage disposal costs and agricultural returns – Rowan & Asano (1960)

2.6 INFILTRATION/INFLOW OF WASTEWATER

Definitions - Infiltration is the water entering a sewer system including sewer service connections from the ground through such means as defective pipes, pipe joints, manholes or manhole connections.

Steady flow: This is water discharged from cellar and foundation drains, cooling water discharges and drains from springs and swampy areas. This type of inflow is steady and is identified and measured along with infiltration - Metcalf & Eddy (1991).

Direct flow:- These are the types of inflow that have direct storm water runoff connection to the sanitary sewer and causes an almost immediate increase in waste water flows.

Total inflow: The sum of the direct inflow at any point in the system plus any flow discharged from the system upstream through overflows, pumping stations, bypasses and the like.

Delayed inflow:- This is stormwater that may require several days or more to drain through the sewer system. This category can include the discharge of sump pumps from cellar drainage as well as slowed entry of the surface water through manholes in ponded area – Metcalf & Eddy (1991).

2.7 RATES OF INDUSTRIAL WASTEWATER FLOWS

Non-domestic wastewater flow rates from industrial sources vary with the type and size of the facility, the degree of wastewater reuse and the onsite wastewater treatment methods. Extremely, high peak flow rates may be reduced by the use of domestic tanks and equalization basins. Alternatively, for estimating industrial flow rates where the nature of the industry is known, a typical data range is always used. For industries without internal recycling, or reuse programmes, it can be assumed that about 85 to 95 percent of the water used in the various operations and processes will become wastewater. For large industries with internal water reuse programmes, separate estimates must be made. Metcalf & Eddy (1991).

2.8 DISPOSAL OF WASTEWATER FLOW

An important aspect to consider in the management of waste water is its disposal. There are different methods of disposing wastewater and each possesses its own advantages and disadvantages. Two major types are common.

(1) Disposal into receiving waters and (2) Disposal onto land.

1. Disposal into receiving waters:- Outfalls into receiving water should terminate well below water-mark. Sewage or effluent is dispersed effectively when a number of outlets, called diffusers are (1) Spaced sufficiently far apart to prevent interference and (2) situated at or near the bottom of the receiving water. This is to keep the generally warmer and lighter sewage from spreading over the receiving water in a persistent way.

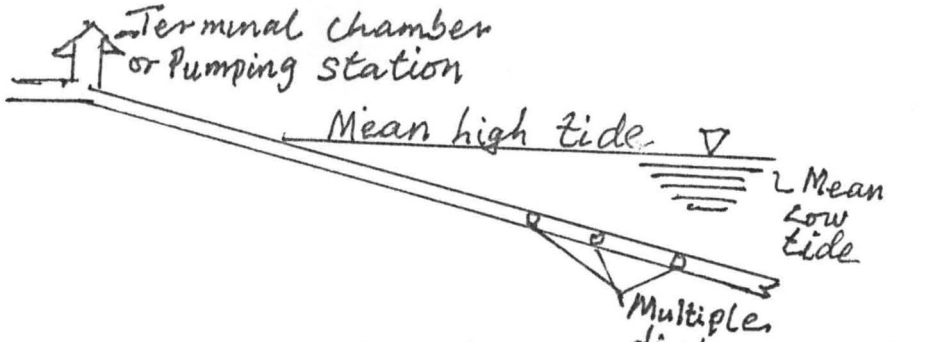


Fig. A1 Disposal of treated wastewater into receiving water.

Density difference make themselves felt especially in marine outfalls. Strength, direction and dimension of prevailing currents and the likelihood of their reaching water-works intakes; bathing places, shelfish laying, and other important spots are matters of study:

Whatever the relative dilution is, the forces of natural purification or self-purification, inherent in natural bodies of water can, in the cause of time and distance, ultimately return the receiving water close to its original state of cleanliness. However, the enrichment of lakes, ponds and impoundages with plant nutrients and the resulting ecological changes in receiving waters of this kind are quite another thing.

Fair etal (1958).

In a sense, natural purification is the prototype of biological treatment. Inherent metabolic activities remain aerobic so long as the rate of oxygen supply is not outbalanced by the rate of oxygen demand. The turbulence of streams usually keeps their running water aerobic. Heavily polluted streams may become, for a time at least, black, unsightly, septic and malodorous bodies of water in which the normal aerobic, clean-water flora and fauna have given way to different, generally less acceptable assemblage of living things. Where emphasis is on water supply, recreational enjoyment of water, and conservation of fish and other useful aquatic life, dilution or treatment becomes urgent. Fair etal (1958).

2. Disposal onto Land:

Objectives of terminal discharge of sewage onto land or into the soil are safe disposal and possibly croppage. In municipal practice, disposal by irrigation can seldom compete economically with discharge into receiving waters unless the water resource of the region are poor and large tracts of suitable land can be acquired cheaply. Whether sewage should be treated before irrigation depends upon local and hygienic considerations. There is the obvious hazard of contaminating food raised on soil irrigated with this sewage water or infections to animals that pasture on the land. There is rather a special method of discharging settled sewage into the ground through agricultural tile pipes. This disposal of sewage which emanates from isolated dwellings is known as subsurface irrigation and can be quite safe. Fair et al (1958).

In one sense, shallow earth basins holding sewage for a number of days and called sewage lagoons or stabilization ponds are purposely inundated or water logged irrigation areas producing suspended (algal) rather than rooted crops.

2.9 PROSPECTS OF SEWAGE TREATMENT PLANT.

The prospects of sewage treatment plant project are numerous. Once the criteria for siting the project are met, its efficiency often meets the needs of the people.

1. The use of sewage treatment plant eliminates the possibility of odour within the metropoly since the skill used in coupling the members are high
2. The fear of failure of the disposal system is eliminated, even if this may occur, it will be far from the homes and will not form nuisance to the users.

3. Where proper instructions are given out for operation, the failure of sewage treatment facility does not occur frequently and as such it takes a long period before maintenance will be required.

4. This facility provides portable water which when discharged into a flowing stream can be used for irrigation without contaminating the crops planted on the irrigated plots.

5. The water produced by this treatment can also be used for irrigating savanna grasslands where cattle can pasture without infections.

The directional movement of the sewage is from the homes to the sewer lines. This goes to the municipal sewer line that terminates at the screw pump. It then goes through series of sieving and passes through a metre gauge to the aeration ponds. After treatment in those series of ponds, the water passes the chlorinating unit and is finally discharged into a flowing stream or disposed on the surface of ground (oral explanations from an expert). A design diagram of sewage treatment plant is attached as an appendix to this write up. See pg. 41.

2.10 CHEMICAL PRECIPITATION.

According to Manglik etal (1988) chemical precipitation in wastewater treatment involves the addition of chemicals to alter the physical state of dissolved and suspended solids and to facilitate their removal by sedimentation. In some cases, the alteration is slight and removal is effected by entrapment within a voluminous precipitate consisting primarily of the coagulant itself.

Another result of chemical addition is a net increase in the dissolved constituents in the wastewater. Chemical process in conjunction with various physical operations has been developed for the complete secondary treatment of untreated wastewater. This includes the removal of either nitrogen or phosphorus or both. Other chemical processes have also been developed to remove

phosphorus by chemical precipitation and are designed to be used in conjunction with biological treatment. Manglik et al (1988).

In the past, chemical precipitation was used to enhance the degree of suspended solids and BOD removal.

1. Where there were seasonal variations in the concentration of wastewater.

2. Where an intermediate degree of treatment was required, and

3. As an aid to the sedimentation process. Since 1970, the need to provide more removal of the organic compounds and nutrients (nitrogen and phosphorus) contained in wastewater has brought about renewed interest in chemical precipitation.

Over the years a number of different substances have been used as precipitants. The most common chemicals apart from chlorine are:- Alum, ferric chloride, ferric sulphate, lime and ferrous sulphate. The degree of classification obtained depends on the quantity of chemicals used and the care with which the process is controlled. It is possible by chemical precipitation to obtain a clean effluent, substantially free from matter in suspension or in the colloidal state. Manglik etal (1988).

Chemicals that have been used for the removal of phosphorus include metal salts and lime. The most common metal salts used are ferric chloride and aluminum sulphate (alum). Ferrous sulphate and ferrous chloride which are available as by-products of steel making operations are also used.

The precipitation of phosphorus from wastewater can occur in a number of different locations within a process arrangement. The general locations where phosphorus can be removed may be classified as (1) pre-

precipitation, (2) co – precipitation and (3) Post-precipitation. New York (1988).

2.11 CONTROL OF NUTRIENTS.

Nitrogen and phosphorus are the principal nutrients of concern in treated waste water discharges. Discharges containing nitrogen and phosphorus may accelerate the eutrophication of lakes and reservoirs and may stimulate the growth of algal and rooted aquatic plants in shallow streams. In addition to being aesthetically unsightly, the presence of algae and aquatic plants may interfere with the beneficial uses of the water resources. This becomes particular when they are used for water supplies, fish propagation and recreation. Significant concentrations of nitrogen in treated effluents may also have other adverse effects including depleting dissolved oxygen in receiving waters, exhibiting toxicity towards aquatic life and affecting chlorine disinfection efficiency. This presents a wastewater hazard and affects the suitability of wastewater for reuse. The control of nitrogen and phosphorus is becoming increasingly important in water quality management and in the design of waste water treatment plants.

In selecting a nutrient control strategy, it is important to assess the characteristics of the untreated wastewater, the type of existing wastewater facility, and the level of nutrient control required. The need for seasonal versus year – round nutrient removal must also be considered. The approaches used for nutrient control may involve the addition of a single process for control of specific nutrients eg adding alum or the precipitation of phosphorus. This may also involve the integration of nutrient removal with the main biological treatment system.

Various treatment methods have been used employing chemical, physical and biological systems to limit or control the amount and form of nutrients discharged by the treatment system. In the recent years, a number of biological treatment processes have been developed for removal of phosphorus alone or in combination with nitrogen. These processes have considerable appeal to designers and operators because the use of the chemicals has been eliminated or reduced substantially: Burdick etal (1988).

CHAPTER THREE

3.1 RESEARCH METHODOLOGY

In the course of this work, the research methodologies followed are:

1. Practical survey and analysis of the area under study is made to find the approximate number of population in various zones of Kubwa. This will also include developing a master plan of Kubwa Town showing its physical features and political divisions.
2. The use of questionnaires to seek the mind of the inhabitants of kubwa. This may demand about the existing state of sanitation in kubwa, the problems encountered due to lack of adequate sanitation facility in kubwa and possible ways of improvement.
3. A visit is also carried out to the few existing wastewater treatment and disposal facilities in Abuja like the central sewage system located in Wuye District near Julius Berger main yard. There will also be a visit to the treatment plants under construction at Utako and Wupa districts in Abuja. Consultation with staff and experts will be carried out on wastewater treatment plants to get the practical details orally on how the system works.

Abuja Environmental Protection Board (AEPB) will be visited to know the systems with which they handle solid wastes in the satellite towns of Abuja.

3.2 APPROXIMATE ESTIMATE OF THE POPULATION OF KUBWA

The method used in finding the approximate estimate of the population of the residents of Kubwa was a rigorous task. Since the satellite town is a large one, the following strategies were used to simplify the exercise.

1. Consultation were carried out with the Federal Capital Territory (FCT) Water Board offices in the different zones since they keep the data of the number of existing residential houses in each zone.
2. An additional effort was made by choosing four counting agents in each zone except zone 2 and zone 6 where six counting agents were chosen for the purpose of the counting.
3. These commissioned enumerators then grouped the houses among themselves and carried out house-to-house visitation to physically count the occupants of the houses.
4. Finally they assembled the number of the population of residents as enumerated from each zone
5. This data was at last submitted for use as the authentic approximate population of the inhabitants of kubwa during this survey and for the purpose of this research.

3.3 QUESTIONNAIRE ADMINISTRATION

A questionnaire was raised to seek the opinion of the residents of kubwa in connection with general sanitation of kubwa and the sewage disposal in particular. The questions that were asked were grouped under sub-headings and in most cases multiple choice answers were supplied to ease assessment. A copy of the questionnaire is attached as an appendix to this write up for reference.

The questionnaires, which were produced, were two hundred in all; thirty copies were distributed in the zones except zone 6 where forty copies were distributed for data collection. The questionnaires were left with the respondents for three days for understanding and proper assessment before collection. These were then collected and

the information therein assembled in a data sheet before pie charts and tables were employed to represent the information clearly.

The questionnaires were distributed to intelligent, educated adults who are between the ages of 30yrs and 50yrs. Some questionnaires were returned while others were not returned. Some questions in the returned questionnaires were not answered.

Table 1: Number of questionnaire distribution

ZONE	1	2	3	4	5	6	TOTAL
NO. DISTRIBUTED	30	30	30	30	30	40	190
NO. COLLECTED	22	18	20	17	24	28	129

The assessment is based on the number that was returned.

3.4 INDUSTRIAL VISITATION TO WASTEWATER TREATMENT PLANTS

In the course of the research for details of this write up, visitations were carried out to some wastewater treatment facilities in Abuja. During these visitations, small sized units of sewage treatment facilities were covered.

1. In each of the plants visited, there were always efforts to know much about the properties and working principles of the facilities.
2. A walk around the different set ups that make the complete system was carried out.
3. As questions were asked and answers made, efforts were made to put down as much as possible, most of the explanations that are given about the working principles of the facilities.
4. After visiting the small sized facilities which are already existing and are used in the city center, the date of 11th April 2002 was scheduled by the Abuja branch of

the Nigeria Society of Engineers (NSE) to visit the bigger facilities which were under construction at Wuye, Utako and Wupa districts of Abuja phase 11.

During a comprehensive study of Utako sewage treatment plant, the following were observed:

1. That the treatment plant is not just a machine or a set of machines coupled together at a point or in a building for the purpose of treating sewage that comes through the municipal sewer line to the plant.
2. That the treatment plant or facility is a combination of different coupled machines at different locations performing specific functions in the treatment of sewage. These different units as observed range from screw pumps, filtering unit, metre gauge, aeration ponds, chlorination unit, and the computer section. It is from the computer section that all the components of the sewage treatment plant are operated and controlled.
3. That the facility occupies such a large area of land that care should be taken while selecting a site for this type of facility.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 RESULT OF POPULATON ESTIMATE

The number of the population of the inhabitants of kubwa summed up are as represented in the table below

Table 2: Population distributions in the zones

ZONE	POPULATION
1	12,000 Inhabitants approximately
2	22,300 "
3	14,700 "
4	12,815 "
5	10,815 "
6	25,000 "
TOTAL	**97,000** "

Discussion:

The above table presents the population of kubwa satellite town. As shown, some zones are more populated than the rest. Zone six with the largest population is the first settlement from where the expansion started. The relocation of Maitama and Kukwaba from the city center to kubwa village sparked off this expansion in 1982 and ever since this zone has been on the lead. Contrary to what obtains in zone six, zone five has a problem of expansion since its land space was compressed by zone six, zone one and the express way. It was only recently that this zone started growing again as development started at phase 2 site 2 extension Northwards, see the master plan of kubwa for clarity. Zone one was one of the first estates to be built. Though densely populated its expansion is limited because of the Kubwa River at the North and the expressway at the south. Zone

two covers large area of land and therefore has high population, zone three is limited in space while zone four is a new estate which started to spring up in 1994. The possibilities of building a sewage treatment plant depends on the overall population and on the population of the zones

CONNOTATION

The master plan of kubwa satellite town showing these zones as political division is included in this subsection for more understanding. See fig. 1

4.2 RESULTS FROM THE QUESTONNAIRE ADMINISTRATION

The result obtained from the questionnaire after careful analysis is as follows

Table 3: **Existing state of sanitation in kubwa , summary from all the zones.**

Very Effective	Effective	Poor	Very poor	Total	Proportion
0	40	58	18	116	Figures
	34%	50%	16%	100%	Percentage

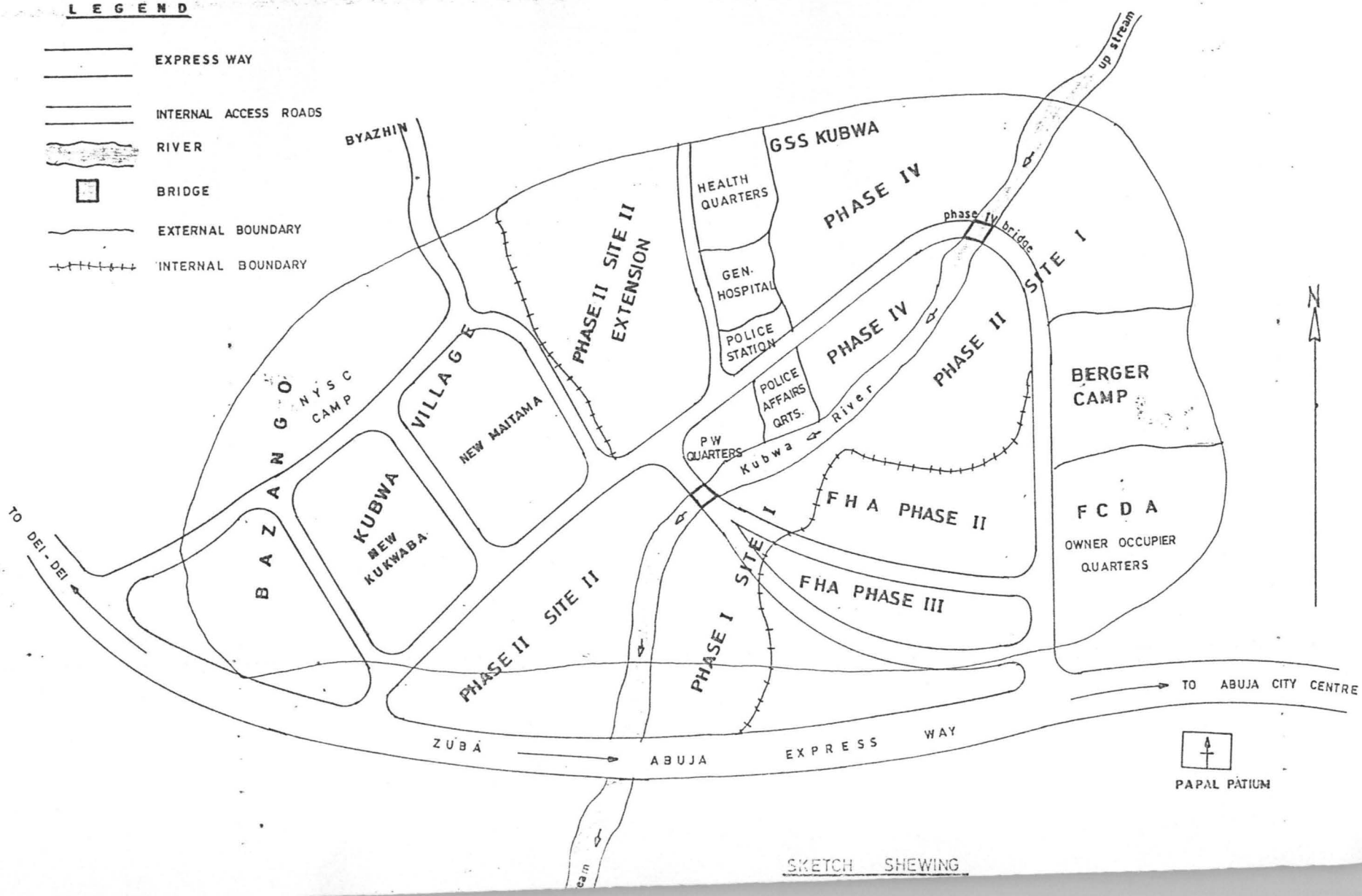
Discussion:

The result shows that half of the population in all the zones agrees that sanitation in kubwa is in a poor condition. Only about one third attested to the existing sanitation being effective while about one sixth completely condemned the sanitation arrangement in the town.

Table 4: **Method of Sewage Disposal In The Zones**

Method	Septic Tank	Pit Latrine	Bush method	Total
Number	80	6	25	111
Percentage	72%	5%	23%	100%

This result is also an average obtained from the zones combined together.



SKETCH SHEWING

As shown in the table, the majority of the inhabitants use septic tank for their sewage disposal but as the percentage of open air method (Bush Method) is up to 23%, this is injurious to health and something must be done to salvage the situation.

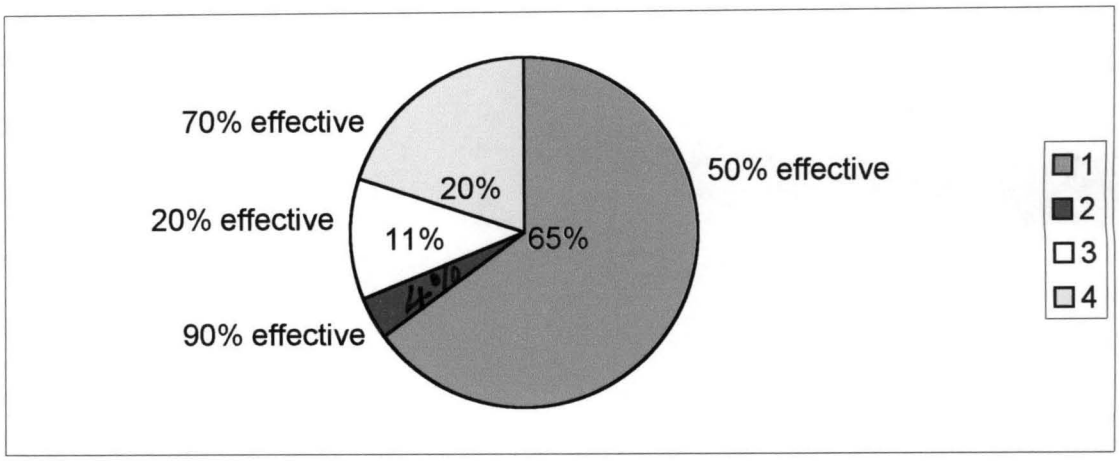


Fig. 2 Percentage effectiveness of the disposal system generally

Discussion:

As shown in fig 2, 65% of the population attest that the disposal system currently used is midway okay in terms of effectiveness. Only few people give the effectiveness pass mark.

Table 5: Possible Causes of Failure of the Existing Septic - Tank Method

	Figure	Percentage
Attitude of the people to the usage	26	21%
System Inefficiency	36	29%
Overloading the System	64	50%
Total	124	100%

As shown in the table, the existing general system for disposing sewage is overloaded. This may be why appreciable percentage takes to bush method to decongest the existing septic tank method.

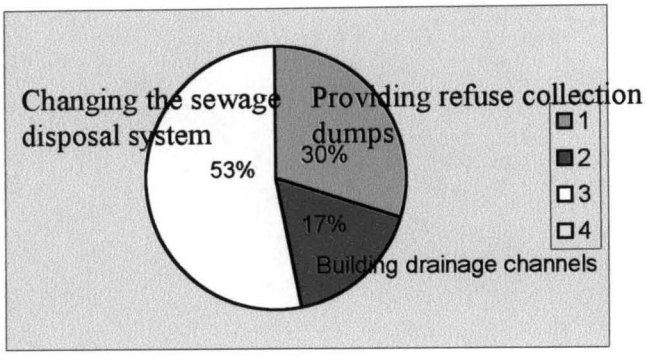


Fig. 3 **How to improve the general sanitation of kubwa**

Discussion:

Respondents to question E shows that more than half of the population wants an alternative disposal system from septic tank, which will provide more effective care to the health of the people.

Table 6: **Problems Encountered Due To Lack of Sanitation in Each Zone**

ZONE	PROBLEM 1 Uncomfortable odour from septic tank		PROBLEM 2 Streets littered with refuse		PROBLEM3 Breeding of mosquito causing malaria	
	Fig.	Percentage	Fig.	Percentage	Fig.	Percentage
Zone 1	20	21%	20	18%	22	21%
Zone 2	15	16%	10	9%	15	14%
Zone 3	15	16%	20	18%	12	11%
Zone 4	5	5%	10	9%	6	6%
Zone 5	15	16%	22	20%	15	15%
Zone 6	25	26%	28	26%	35	33%
Total	95	100%	110	100%	105	100%

The result of question F shown in the table explains the existing situation in the zones. It is evident that zone six which started existing before the other zones is gradually turning into a ghetto suburb. All the streets in this zone are failing and the septic tank built between 1980 and 1981 are being overloaded thereby creating way for epidemics. The same situation is obtainable in zone one which started existing from the same period. Zones two and three were built later in 1990 while zone four which stated development in 1994 is yet to experience the poor sanitation plaguing the other zones.

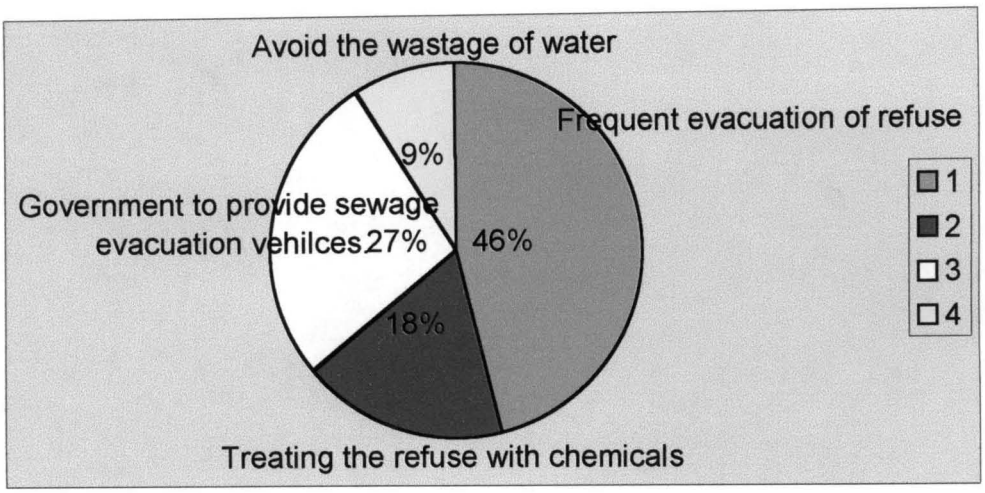


Fig. 4 **Planned solution to the sanitation Problem**

The pie chart above answers the question of the solution that will be planned to improve the sanitation of the town. Almost half of the populace were of the opinion that the refuse dumps will be evacuated frequently while about a third of the populace opined that sewage evacuation vehicles should be used to evacuate the septic tank pending the time the sewage treatment plant will be constructed.

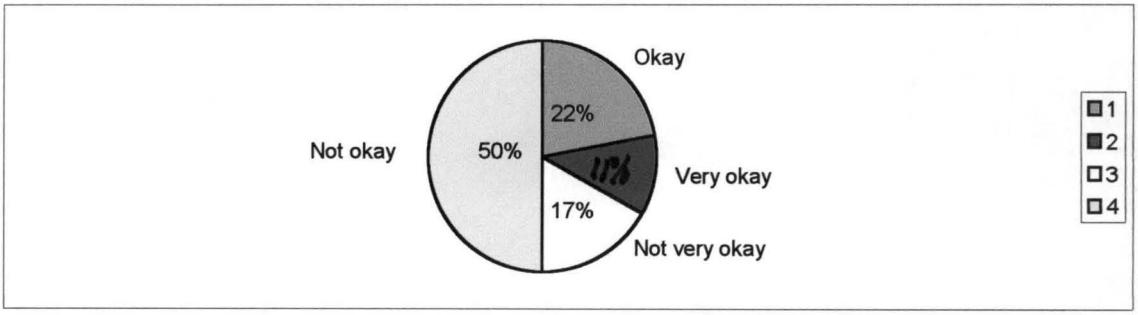


Fig. 5 **The effectiveness of wastewater disposal through septic tanks**

The analysis of question H indicates that the opinion of the people is that disposal through septic tank is not okay. This too suggests the use of alternative method that is more functional.

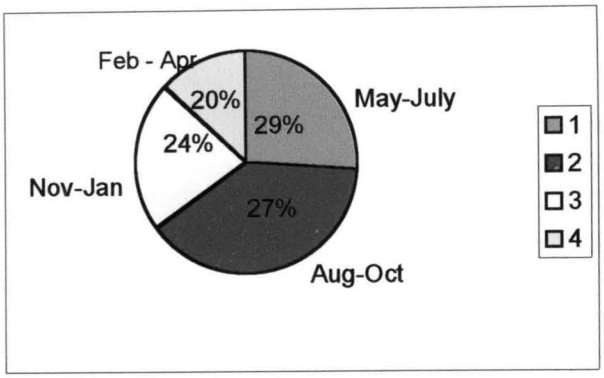


Fig. 6 **The period when odour oozes out from the septic tank most**.

The pie chart indicates that two-fifth of the population observed the odour leakage most during the months of May to July, and least during November to January

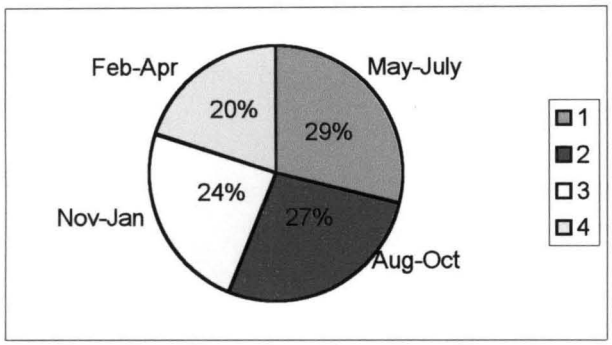


Fig. 7 **The period when the streets are littered most.**

The pie chart presents the period when the streets are littered most. The dry season months of November to April are lower than the rainy season months of May to October because the refuse are burnt if the evacuation vehicles of Abuja Environmental Protection Board is not regular, but in the rainy season, these refuse will continue to remain until they are evacuated.

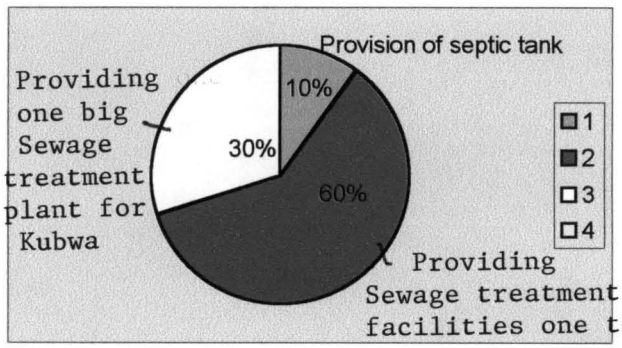


Fig.8 **How to improve the sewage disposal in Kubwa**

The opinion of the people in this improvement of the sewage disposal show that about two-third want the sewage treatment plants to be provided in small units to each zone , while one-third want a big central sewage treatment plant.

Table 7: How to improve the sanitation of the streets and the surrounding of Kubwa

	Figure	Percentage
AEPB to evacuate refuse from residents	40	36%
AEPB to evacuate refuse from strategic centres	60	55%
The refuse should be burnt regularly	10	9%
Total	110	100%

The result in the table informs that the people want Abuja Environmental Protection Board (AEPB) to be regular in evacuating the refuse. People interviewed orally explained that the burning of the refuse disturbs the health of the people since the smokes spread to the nearby residential houses and markets. The fire has also spread to the nearby buildings in two occasions in zone six and zone two.

4.3 RESULT OF THE INDUSTRIAL VISITATION

Explanations and results were obtained during the visitation to the sewage treatment plants. These included data collection and explanations on the working principle of the plants. Explanation on the existing units and those under construction show that the functioning units at different parts of the city and those under construction each has the following capacities

Table 8: **The Existing Sewage Treatment Plants And Their Capacities In Population Equivalent (PE)**

S/N	Location	Capacity in Population Equivalent (PE)
1	Garki unit 1	6,000
2	Garki unit 2	12,000
3	Wuse unit 1	8,000
4	Wuse unit 2	13,000
5	Wuse unit 3	16,000
6	Maitama unit 1	8,000
7	Maitama unit 2	14,000
8	Maitama unit 3	18,000
9	Wuye unit	50,000
10	Utako unit	100,000
11	Wupa unit	700,000

The table shows the capacities of the units of the treatment plants at the time of construction excluding the population increase, which is expected. Comparing the population equivalent or capacities of these units to the population of the zones in Kubwa , it could be deduced that the small units of the treatment plants at these districts of Garki, Wuse , Maitama can be built in the zones existing in kubwa, since the established population estimates fall in the same range with the different units in town. Alternatively, a central treatment plant with equivalent capacity to that sited at Utako could also be useful and convenient to kubwa since the population equivalent of 100,000 people is comparable to 97,000 people found to be resident in kubwa, in addition to the sharp increase in population.

4.3.1 Some detailed enquiry was carried out on the Utako treatment unit. In the explanation that followed, these results were proffered

Table 9: Aeration ponds

Pond number	Volume M^3	Resident time hrs	Number of Aerators	Total power installed (hp)
1	15,600	37.5	8	200
2	35,000	84	5	85
3	39,000	95	5	85

As shown on the table, the first pond though has the smallest volume was allocated the highest number of aerators and highest power supply. This explains the aggressive function of this first pond, which receives the raw sewage from the municipal's sewer line. The treatment and separation is very violent since much of the impurities and living organisms are expected to be destroyed in the first pond before the effluent is transferred to the second pond after one and half days resident time.

The number of aerators and power installation in the subsequent ponds are less since the destructive rate of the organisms here has been reduced.

Table 10. **The capacity of organic load reduction in each pond**.

Pond number	BOD reduction (max kg/h)
1	150
2	65
3	65
Total	280

This table further explains the discussion in table 9 above. The organic load (BOD) reduction in the first pond is as high as 150kg /h due to the violent reactions taking place in this pond, while 65kg/h is achieved in the second and third ponds respectively. It was explained from the analysis that the installed aeration capacity is quite large and it will be capable of taking care of surge organic loads, as well as of an increased load for population growth.

Table 11: **The capacity of effluent polishing pond**

The characteristics of this pond is summarized thus

Capacity M^3	Resident time
39,000	4 days

The effluent-polishing pond is the last pond through which the wastewater passes before flowing through a device where the water is finally disinfected with chlorine. In this pond

the treatment is gradual and the wastewater rests in this pond for four days. During this period any impurity that has not been filtered in the aerated ponds is polished. The water at this stage becomes comparable to most flowing streams and can be used for irrigation and for the breeding of fish and shellfish.

CHAPTER FIVE

CONCLUSION

A comprehensive study of the management of wastewater and sanitation of kubwa has been conducted. The study includes

1. A systematic approach to the estimation of the approximate number of the population of people in kubwa.
2. The use of questionnaires to seek the mind of the residents of kubwa concerning the existing state of sanitation in kubwa, its problems and ways of providing solutions to these problems of poor sanitation
3. Visitation to wastewater treatment plants in the city center and the developing districts. These accorded the opportunity of pin pointing the type and size of the treatment plants that will be recommended for kubwa.

   As research was made on these methods, the results that were obtained provided the opportunity to make recommendations for the type of sewage disposal facility that will be suitable for kubwa.

   The population of 97000 (ninety seven thousand) inhabitant was estimated, but broken into zones, the population ranges from 10,000 in the least populated zone to 25.000 in the most populated zone. The general opinion shows an ineffective method of sanitation in kubwa generally especially in zones six, one and two. There were reasons why the facilities in these zones were failing and this is due to long age, non-maintenance, and over usage. There were visitations to sewage treatment plants where the working principle of these facilities were studied in detail, and from the explanations that followed an idea was obtained on the size of the unit that can be sited in kubwa to satisfy its sewage disposal demand.

CHAPTER SIX

RECOMMENDATION

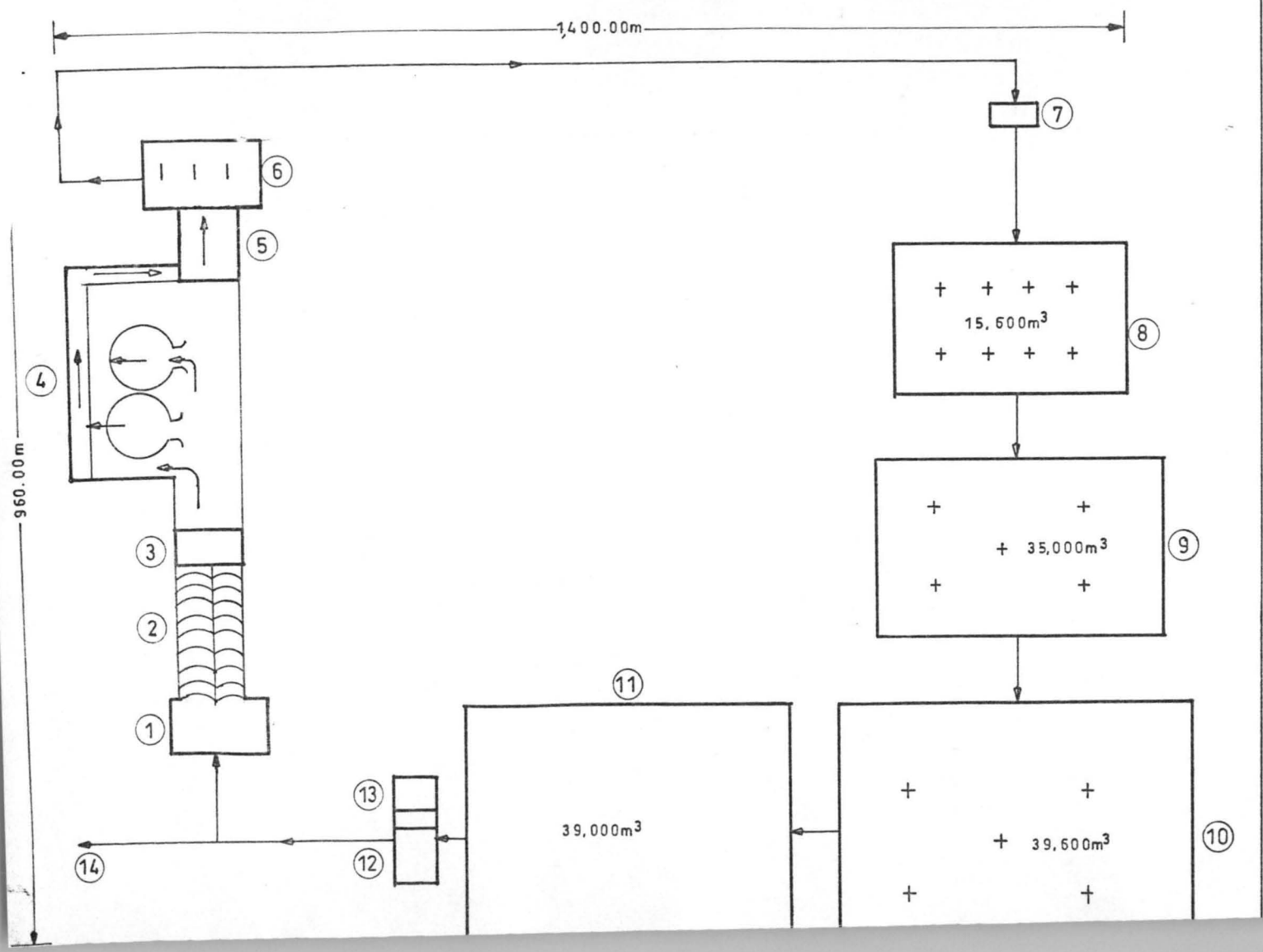
The research in this project has exposed a wide range of issues concerning the disposal of wastewater and sanitation in kubwa. Having detailed the different methods of improving the sanitation of this town, effort should be made to achieve durable solution to wastewater disposal in Kubwa.

1. The responses sent in by respondents to questionnaires suggest that the siting of wastewater treatment facility is due for kubwa to improve wastewater disposal of the satellite town.
2. The Abuja Environmental Protection Board should take into consideration the population of kubwa and double their efforts in the evacuation of solid refuse from the streets and other open areas of Kubwa, which residents are currently using as temporal refuse dumps.
3. Time has come when the Federal Capital Development Authority, (FCDA) Department of Development control should focus attention to Kubwa to control its development by putting an embargo on the allocation of plots pending the time sanitation facilities would have been made available for kubwa satellite town.
4. This topic is new in waste disposal method and is therefore recommended that this idea be made to reach policy makers in government. This will help excel the construction of this type of waste disposal in our cities and satellite towns such as Kubwa.

References

- Babbit H.E & E.R Baumann (1958) Sewarage and sewerage treatment; Wiley New York 8th Edition pp 16 – 25.
- Brian H.C & H.P Eddy (1991), Environmental Pollution, Wiley & Sons International 2nd Edition Vol. 2, pp 221 – 226.
- Burdick CR, D.R. Refling and H.D. Stensel (1988) Advanced biological treatment to Archieve Nutrient Removal - Journal WPCF Vol. 54 No. 7 pp 8 – 12.
- Fair B.M, Geye J.C & D.A. Okun (1958), Water supply and wastewater Removal; Wiley & Sons International 2nd Edition, Vol.1 pp 3 – 16 to 3 – 29.
- FCDA Development control publication – Abuja master plan (1994). The Development of Abuja 3rd Edition pp 156 – 160.
- Journal (1988) Principles and practice of Nutrient removal from municipal wastewater – The soap and detergent association – New York pp 16 – 18.
- Manglik P.K, J.R. Johnson, T. Asano and G. Tehnobanoglous (1988) Effects of particles on chlorine disinfection of wastewater proceedings on water reuse. AWWA Research foundation, Derner Co.
- McJunkin F.E. & H.D. Stensel (1964), population forecasting by Sanitary Engineers, J. Sanitary Engineering Division ASCE Vol. 90 pp 8 – 12.
- Metcalf L. E & Eddy H.P (1991) Wastewater Engineering 3rd Edition pp 42 - 46.
- Rowan T.N and T. Asano (1960) – Wastewater treatment – Disposal and Reuse, McGraw Hill & Sons Vol. 1 pp 160 – 163.

Appendix 1



LEGEND

1. RAW WASTE WATER COLLECTION SUMP.
2. SCREW PUMP CHANNEL
3. BAR SCREEN
4. SAND TRAP
5. WET PIT
6. PUMP ROOM
7. FLOW RATE MEASURING GUAGE
8. AERATED POND 1
9. " " 2
10. " " 3
11. POLISHING "
12. CHLORINATION TANK
13. " ROOM
14. EFFLUENT DISCHARGED TO STREAM

++ ++ AERATING MACHINE

→ DIRECTION OF FLOW

Appendix II

QUESTIONNAIRE ON THE "ASSESSMENT OF WASTEWATER MANAGEMENT AND SANITATION OF KUBWA – ABUJA

This study is part of a post Graduate Diploma (PGD) project and is designed to obtain information on the Solid Waste/Wastewater Management and Sanitation of Kubwa. The study covers the different zones in Kubwa viz – zone 1 (phase 1 site 1), zone 2. Phase 2 site 1, Berger camp, FCDA owner occupier), Zone 3 (F.H.A. phase 2, & phase 3) Zone 4 (FHA – phase 4, Police Affairs Quarters & Health Quarters,) Zone 5 (phase 2 site 2 & phase 2, site 2 extension). Zone 6 (Kubwa village – Maitama, Kukwaba and Bazango). You are kindly required to complete the questionnaires as accurately as possible. All responses will surely be kept confidential and respondents shall be duly acknowledged in the final write up.

A. BACKGROUND INFORMATION OF RESPONDENTS.

1. Name:……

2. Sex:……

3. Zone of residence:……

4. Age: Below 30 years, 30-40 years, 40-50 years, above 50 years.

5. Occupation: Civil servant, Businessman, Farming, others.

6. Level of Education: Primary, Secondary, Post Secondary.

7. Knowledge of wastewater treatment facility; very little, Little, good, very good.

8. How long have you lived in the zone, <5 years, 5-10 years, >10 years.

B. EXISTING STATE OF SANITATION IN KUBWA GENERALLY.

1. How do you rate the effectiveness of the existing state of sanitation in Kubwa (a) Very effective (b) Effective (c) Poor (d) Very poor.

2. What method of sewage disposal is existing in your zone of residence (a) Septic tank, (b) Pit latrine (c) Bush method.
3. What is the percentage effectiveness of sewage disposal in your zone of residence. (a) 20% (b) 50% (c) 70% (d) 90%.
4. If the effectiveness is below 50%, what do you think is responsible (a) Attitude of people to the existing system, (b) System inefficiency, (c) Overloading the system, (d) all of the above.
5. Which way in your own mind can the general sanitation of Kubwa be improved?
   a) Building drainage channels, (b) Building refuse collection centers in the zones (c) Changing the type of sewage disposal system in Kubwa, (d) the present state is okay.

C. PROBLEMS ENCOUNTERED DUE TO LACK OF SANITATION.

1. In your own view, what do you think is the problems encountered due to lack of sanitation in the zones.

Zone	Problem
1	
2	
3	
4	
5	
6	

2. In which ways do you think these problems can be minimized or eradicated.

Zone	Possible solution
1	
2	
3	
4	
5	
6	

UTAKO
100,000 PE SEWAGE TREATMENT PLANT

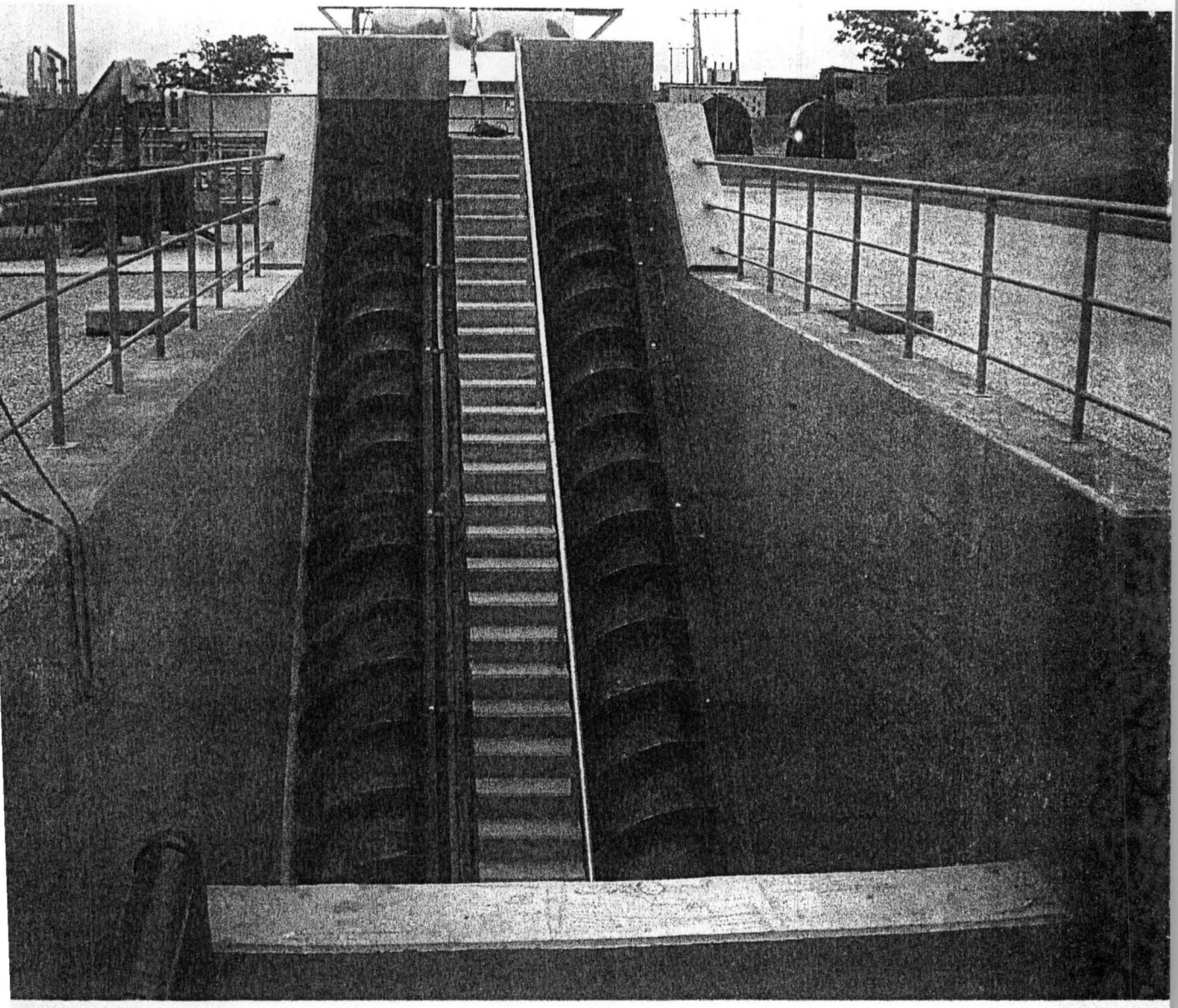


PLATE 1: **SCREW PUMPS**

3. Do you think the present sewage/wastewater disposal through septic tanks around houses is okay for the people in your zone. (a) Very okay (b) Okay, (c) Not okay (d) Not very okay.

4. In your own opinion which period do you perceive the odour from the septic tanks most.

   (a) Nov-Jan, (b) Feb-April, (c) May – July, (d) Aug-Oct.

5. The streets become more littered with waste during which period

   (a) Nov-Jan, (b) Feb-Apr. (c) May –July (d) Aug – Oct.

D. THE NEED FOR IMPROVEMENT.

1. What steps do you think is necessary to improve the sanitation of Kubwa.

   (a) The provision of septic tank to every building.

   (b) Providing a central sewage system for Kubwa.

   (c) Providing the sewage treatment facilities in small units to the zones.

   (d) Putting one septic tank for about ten houses.

2. In which way do you think the streets and surroundings of Kubwa should be kept tidy.

   (a) The Abuja environmental Protection Board (AEPB) should be commissioned to evacuate the refuse direct from the residents.

   (b) The refuse should be kept at strategic centers to be evacuated occasionally by AEPB.

   (c) The refuse should be collected and burnt regularly.

   (d) A central refuse dump should be provided in the zones for burning regularly.