AN ASSESSMENT OF POLLUTION EFFECTS OF UNCONTROLLED DUMPSITES IN MINNA, NIGER STATE, NIGERIA

BY

BOLAJI, Ayoola Abiodun

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MARCH, 2011

DECLARATION

BOLAJI Ayoola Abiodun declare that this thesis work was written by me and has not been esented either in whole or part, for the award of any degree anywhere else. All literatures ted have been duly acknowledged in the reference.

02/08/2011

BOLAJI, Ayoola Abiodun **DATE:**

CERTIFICATION

This thesis titled Assessment of Pollution Effects of Uncontrolled Dumpsites in Minna, Niger State; Nigeria by BOLAJI, Ayoola Abiodun (M.Tech/SSSE/2007/1608) meets the regulations governing the award of the degree of Master of Technology (M.Tech.) of the Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

Dr. A.A. Jigam Supervisor	03/08/11 Signature & Date
Dr. A.S. Abubakar Head of Department	16/09/2011 Signature & Date
Prof. H.A. Suberu Dean, School of Science & Science Education	19/09/11 Signature & Date
Prof. (Mrs.) S.N. Zubairu Dean, Postgraduate School	Signature & Date 27/10/2011

DEDICATION

Glory is to GOD for the success full completion of this programme. This piece of work is dedicated to my son, Moyofolaoluwa Bolaji, my heartbeat. Someday, you will know the truth and it will set you free.

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I sincerely acknowledge my Project Supervisor Dr. A.A. Jigam for his personal efforts in scrutinising and correcting all my project work. I give my due respect to my humble Head of Department Dr. A.S. Abubakar. I express my gratitude to the Departmental Postgraduate Coordinator Mallam Saidu Salihu for his assistance. I cannot forget my friends; course mates, all my lecturers and grannyconnections consult for all good things between us.

ABSTRACT

Residents of Minna and its environs are presently exposed to huge heaps of garbage in dumpsite with the attendant nauseating odour and adverse health implications. Results of questionnaire surveys, physical, chemical and microbial analysis of wastes show that percentage land use was highest for residential purposes while transport had the lowest allocation. Households ranged between 6708 and 95393 with average size between 5 and 10 members. Volume of waste generated in the area studied ranged between 242.075 and 3,184,00m^2/year with weight of 205 and 2,800 tonnes annually. The types, compounds and sources of wastes varied from garbage, street and rubbish sources; compounds included cans cobs paper, unwanted cars etc. obtained from households, offices, and workshops. A general trend of very low percentage of households enjoying regular solid waste collection was observed Density of waste ranged between 256 and 296kg/m^3 while moisture content was between 49.7% and 64.8%. High levels of toxic metals including Lead (1.91mg/l), Mercury (1.30mg/l) and Cadmium (1.20mg/l) were detected in well water samples in the vicinity of dumpsites. High bicarbonate levels were also obtained from these samples. Bacterial load was high which species isolated and identified included *E.Coli, Bacillus Subtilis* and pathogens such as *Staph.aureus, Strept.aureus* and *Salmonella typhi*. Fungi included *Aspergillus spp; Fusarium spp. and Penicillin spp.* The results indicate the high pollution potential of uncontrolled dumpsite in Minna and the consequent serious health hazards associated with it. The study will aid the Niger State environmental protection agency in the proper handling of wastes.

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LIST OF SYMBOLS AND ABBREVIATIONS

Conc. Concentration

mg/l Milligrams per Litre

Cfu/100l Colony Forming Units per 100 Litres

Location 1 stands for Map of Nigeria showing Niger State

Location 2 stands for Kpakungu Area

Location 3 stands for Maikunkele Area

Location 4 stands for Maitunbi Area

Location 5 stands for Bosso Estate Area

Location 6 stands for Area Court

Location 7 stands for F-Layout Area

Location 8 stands for Tunga Low-Cost Area

Location 9 stands for Paida Area

Location 10 stands for Barikin-Sale Area

Location 11 stands for Duste Kura Area

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Pollution growth, rising standards of living and the rapid pace of urbanization and industrialization pose many environmental challenges for large cities. These have contributed to an increase in the amount and type of solid wastes generated by different human activities. Waste management has continued to be a major development challenge. Minna residents, particularly those living in the urban areas, are now having constant memories of huge heaps of garbage in dumpsite, especially if they have to cover their noses against all forms of odour when passing by the heaps. There is a general concern that a lot of heterogeneous waste is generated and the volume and types have been on the increase in the state cities (Cointreau, 2006).

Generally speaking, dumpsite is one of the prominent methods of waste disposal around the globe, but some under-developed and developing countries still continue to practice uncontrolled open dumping of waste. These uncontrolled dumpsites pose a relatively high threat to the various elements of the environment in comparison with the conventional engineered landfills that are used in many developed countries. However, some closed, un-engineered landfills do exist in developing countries. This research presents a novel approach to compare the pollution potential of uncontrolled dumpsite using an index (Corbitt, 2004).

Dumpsites are one of the most popular forms of waste disposal, primarily because they are the least expensive way to dispose of waste. More than four-fifths of municipal solid waste is disposed of in dumpsite. Dumpsites are rapidly filling up all around the country, however and the majority of them will close by 2010. Also, many have waste problems that are serious health threats. As of 1983, there were 184 dumpsite listed, or proposed to be listed, on the Superfund National Priorities List (NPL).

A dumpsite is a means of disposing of waste. In a dumpsite, waste is spread in layers on a piece of property, usually on marginal or sub marginal land. The objective is to spread the layers and then compact them tightly, greatly reducing the volume of the waste. The waste is then covered by soil. Problems that are encountered in open dumping, including insects, rodents, safety hazards, and fire hazards, can be avoided with land filling. A dumpsite should not be located in areas with high groundwater tables. Leachate migration control standards must be followed in the design, construction, and operation of dumpsites during the use of the facility and during the post closure period (Munn, 2006).

Much of the waste in a dumpsite will decompose through biological and chemical processes that produce solid, liquid, and gaseous products. Food wastes degrade rapidly, whereas plastics, glass, and construction wastes do not. The most common types of gas produced by the decomposition of the wastes are methane and carbon dioxide. Methane, which is produced by anaerobic decomposition of land filled materials, is hazardous because it is explosive. Depending on the dumpsite composition, gases can be recovered and utilized in the generation of power or heat. Dumpsite recovery science is a new technology that is utilized in many parts of the United States. Sadly, in many places, wetlands and other lands considered to be marginal were used for landfills. Only now are people becoming aware of the value of wetlands and other areas that were used especially with regard to sensitive habitats, biodiversity, and impacts on groundwater.

After a dumpsite has reached capacity, it is closed for waste deposition and covered. In some cases it can be used as pasture, as cropland, or for recreational purposes. Maintenance of the closed dumpsite is important to avoid soil erosion and excess runoff into desirable areas (Morgan, 2007).

An environmental index known as the Leachate pollution index (LPI) to quantify and compare the Leachate contamination potential of municipal dumpsites in a given geographical area was developed and reported elsewhere. The LPI integrates complex analytical data and generates a single number expressing the potential of a dumpsite to pollute the Leachate-receiving environment. This index is based on the concentration of 18 pollutants of the Leachate and their corresponding significance. That means, for calculating the LPI of a dumpsite, concentration of these 18 parameters are to be known. However, sometimes the data for all the 18 pollutants included in the LPI may not be available to calculate the LPI. In this paper, the errors involved in calculating the LPI due to the no availability of data are reported. The Leachate characteristic data of a municipal dumpsite in New Delhi, India have been used to estimate these errors. Based on this study, it can be concluded that the errors may be high if the data for the pollutants having significantly high or low concentration are not available. However, LPI can be reported with a marginal error if the concentrations of the no available pollutants are not completely biased (Davis, 2003).

1.2 Statement of the Problem.

Despite various efforts, it is becoming clear that present systems of waste management have not been able to satisfy community needs for an acceptable cleaning level, as in reducing the general health and environmental impacts of waste. Moreover, Niger state efforts have not been able to improve the general aesthetic appearance of city landscapes. Evidences of increasing frustration are reflected in;

i. Persistent waste accumulation that is evident in various location of the urban centres. These locations are consistently liable to various vectors (rodents and insects) and foci to severe environmental pollution, repulsive and very bad smell and disgusting appearance. When they are burnt on location, these accumulations have negative environmental and health impacts and implications.
ii. Ineffective and environmentally unsound handling, treatment and recycling of waste that often result in health risks to workers
iii. Indiscriminate and open dumping with its attendant high environmental and health risks.
iv. Continued confusion about roles and responsibilities for waste management among stakeholders

1.3 Purpose and Significance of the Study

It was in view of the above problem statement that the research undertakes a survey of waste generation and management in Minna, Niger State Capital. So has to evaluate the current institutional arrangement for waste management in state. Sensitizing stakeholders like State Environmental Protection Agency, Urban Development, Non-Governmental Organizations, Private Sectors and Individuals on roles and responsibilities for waste management strategy.

1.4 Scope and Limitation of the Study

This research focuses on an assessment of pollution potentials of uncontrolled dumpsite in Minna the Niger State Capital.

The findings of the study will be based primarily on data collected from field work.

1.5 Aim and Objectives of the Study

The Research is aimed at assessing the level of pollution potentials of uncontrolled dumpsite in Minna area, the state capital of Niger State. The objectives are;

i. Determining the level of waste pollution in the vicinity of uncontrolled dumpsite areas
ii. To ascertain the extent of contamination by the waste in the soil and water.
iii. To identify each component of the contaminants in waste
iv. Protect the Environmental health of the urban population, particularly the poor who suffer most from waste management

1.6 Description of the Study Area

Minna is a city (estimated population 304,113 in 2007) in west central Nigeria. It is the capital of Niger State, one of Nigeria's 36 federal states, and is the headquarters of Chanchaga Local Government Area.

1.6.1Geography

Minna is connected to neighbouring cities by road. Abuja, the federal capital, is only 150 km away. Minna is also connected by railroad to both Kano in the north and Ibadan and Lagos to the south. The city also has an airport.

1.6.2 Economy

Cotton, guinea corn, and ginger are the main agricultural products of the city. The economy also supports cattle trading, brewing, Shea nut processing and gold mining. Traditional industries and crafts in Minna include leather work, metalworking, and cloth weaving.

1.6.3 History

Archaeological evidence suggests settlement in the area dates back to about 47,000-37,000 years ago. Muslim culture filtered into Minna by way of the ancient Saharan trade routes and the city contains many mosques and Muslim organizations. Minna is the home of Nigeria's former Military President Gen. Ibrahim B. Babangida, and of former Head of State Gen. Abdulsalami Abubakar. Dr. Mu`azu Aliyu Babangida resides in Minna as the present governor of Niger State. He is to serve for four years (2007–2011).

1.6.4 Education

Minna is also the seat of the Federal University of Technology Minna, which is located in Gidan-Kwano Bosso Local Government areas, Ibrahim Babangida University in Lapai Local Government Areas, Niger State College of Education in Chanchaga Local Government Areas and many more high institutions within the State.

1.7 Justification of the Study

The population growth, rising standard of living and the rapid pace of urbanization and industrialization has brought about some environmental problems as established by (Bodkin and Keller, 2003). The purpose of this study is to assess the extent to which the pollution potentials index of uncontrolled dumpsite has affected the environment in the downstream of Minna. The essence is to create awareness for environmental and waste resource managers, who may want to select site for waste disposal in their quest for planning an environmental friendliness.

1.8 Methods and Scope of Study

In order to achieve the aims and objectives of the study three weeks comprehensive field work of Minna was conducted with the aids of three types of questionnaires in these categories;

1 Environmental Care Project for Household Member

2 Environmental Care Project for Stall/shops Member

3 Environmental Care Project for Environmentalist Strictly Member

And Comprehensive Analysis was carried out on Soil & Water close to the dumpsite in Minna.

1.9 Research Hypothesis

The hypothesis for this project is;

(1) Null hypothesis (H_o); the pollution potentials index of uncontrolled dumpsite d in Minna area of Niger State has effect on the populace

(2) Alternative hypothesis (H_1); the pollution potentials index of uncontrolled dumpsite in Minna area of Niger State has no effect on the populace.

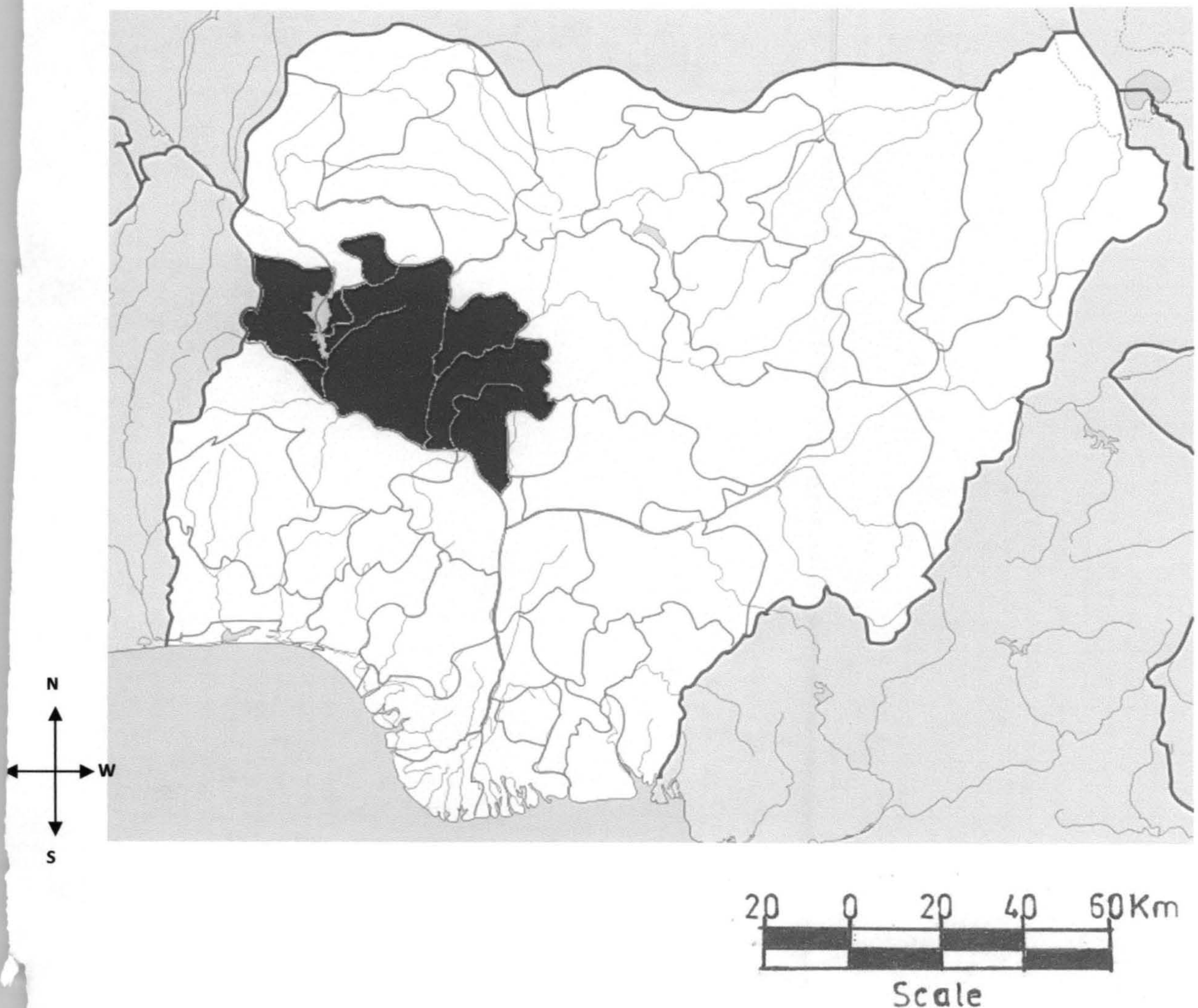

Fig 1.1: The Map of Nigeria Showing Niger State

Source: Surveyor Department Minna

Plate I. Dumpsite in Kpakungu Area of Chanchaga Local Government Area

Plate II. Dumpsite in Maikukele area of Bosso Local Government Area

Plate III. Dumpsite in Maitunbi Area of Bosso Local Government Area

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Plate X. Dumpsite in Duste Kura Area of Bosso Local Government Area

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Concept Review

The developed world have moved on a bit from filling the nearest available hole in the ground. Dumpsite in European Union must now be designed to take one of three categories of waste (hazardous, inert, or other), must be separated from the water table and must have equipment to collect the methane coming off the biodegradable waste. That's the theory at least – there are still thousands of illegal or poorly –performing dumpsites in the European Union. As for developing countries the sight of the poorest strata of society picking over the piles of open-air rubbish is unfortunately a reality as well as a favourite subject for documentary (Davis and Cornwell, 2002).

To some people, a perfect or utopian system for waste disposal would be a technology that is capable of accepting an unlimited amount of waste and safety containing it forever outside the sphere of human life. This is an impossible dream and is not environmentally sound (Kulear, 2004).

In the past waste was usually accumulated in open dumps, where the refuse was piled up without being covered or otherwise protected. Although thousands of open dumps have been closed in recent years and new open dumps banned in United Sate and many other countries, many are still being used worldwide. Dumps have been located wherever land is available without regard to safety health hazards, and aesthetic degradation. Common sites are abandoned mines and quarries where gravel and stone have been removed (sometimes by ancient civilization); natural low areas, such as swamps or flood plains; and hillside areas above or below towns. The waste is often poled as high equipment allows. In some instances, the refuse is ignited and allowed to burn. In other, the refuse is periodically levered and compacted.

As a general rule open dumps create a nuisance by being unsightly, providing breeding grounds for pests, creating a health hazard polluting the air and sometime polluting groundwater and surface water. Fortunately, open dumps are giving way to the better planned and sanitary landfills (Kiely, 2005).

2.2 Leachate

The most significant hazard from a dumpsite is pollution of groundwater or surface water. If waste buried in a dumpsite comes into contact with water percolating down from the surface or with groundwater moving laterally through the refuse, Leachate a noxious, mineralized liquid capable of transporting bacterial pollution is produced. For example two landfills dating from the 1930s and 1940s in long Island, New York, have produced subsurface Leachate trails(plumes) several hundred meters wide that have migrated kilometres from the disposal site(Jensen and Chirokisen, 2003).

The nature and strength of the Leachate produced at a disposal site depends on the composition of the waste, the amount of water that infiltrates or moves through the waste, and the length of time that the infiltrated water is in contact with the refuse.

2.3 Site Selection

The sitting of a dumpsite is very important. A number of factors must be taken to consideration. Including topography, location of the groundwater table amount of precipitation type of soil and rock, and location of disposal zone in the surface-water and groundwater flows system a favourable combination of climatic hydrologic, and geologic condition helps to ensures reasonable safety in containing the waste and it's Leachate (Corbitt, 2004).

The best sites are in arid regions, where disposal conditions are relatively safe because little Leachate is produced in a dry environment. In a humid environment some Leachate is always produced; therefore, an acceptable varies with local water use local regulation, and the ability of the natural hydrologic system to disperse, dilute, and otherwise degrade the Leachate to harmless levels.

The elements of the most desirable site in a humid climate are physically seen when viewed. The waste is buried above the water table in relatively impermeable clay and silt soils, materials through which water cannot easily move. Any Leachate produce remain in the vicinity of the site and degrades by natural filtering action and chemical reaction between the clay and the Leachate. This also holds true for the high water condition often found in humid areas provided that the impermeable materials are present (Freeman, 2007).

There are also important social considerations concerning the sitting of waste disposal facilities. Often planers of these facilities choose sites where they expect local resistance to be minimal or where they perceive the land to have little values. Waste disposal facilities are frequently located in area where residents tend to have low socioeconomic status or belong to a particular race or ethnic group. Study of the social issues of sitting waste facilities to which many people object based on potential environmental problem is an emerging field in the social sciences known as environmental justice (Davis and Cornwell, 2002).

2.4 Pollution Monitoring

Once a site is chosen for a dumpsite and before filling starts monitoring the movement of groundwater should begin. The monitoring is accomplished by periodically taking samples of water and gas from special designed monitoring wells. Monitoring the movement of Leachate and gases should be continued as long there is any possibility of pollution. This procedure is particularly important after the site is completely filled and a final, permanent cover material is in place. Continued monitoring is necessary because a certain amount of settlement always occurs after a dumpsite is completed, and if small depressions form, surface water may collect, infiltrate, and produce Leachate. Monitoring and proper maintenance of an abandoned landfill reduce its pollution potential (Jensen, 2003).

2.5 How Pollution Enter the Environment

Hazardous- waste pollutants from solid-waste disposal site may enter environment by as many as six paths:

i. Methane, Ammonia, Hydrogen Sulphide and Nitrogen gases may be produced from compound in the soil and the waste and may enter the atmosphere

ii. Heavy metals, such as Lead, Chromium and Iron may be retained in the soil

v. Soluble materials, such as Chloride Nitrate and Sulphate may readily pass through the waste and soil to the groundwater system.

vi. Overland runoff may pick up Leachate and transport it into stream and rivers.

vii. Some plants (including crops) growing in the disposal area may selectively take up heavy metals and other toxic materials to be passed up the food chain as people and animals eat them.

v. If the plant residue from crops left in the field contains toxic substances these materials will return to the soil.

Modern dumpsites are carefully engineered to include a system of multiple barriers (double lined), such as clay and plastic liners to limit the movement of Leachate; system to collect methane gas produced as the waste decomposes; and groundwater-monitoring system to detect leaks of Leachate below and adjacent to the dumpsite. A through monitoring program considers all six possible paths by which pollutants enter the environment. In practice, monitoring of all six pathways is not often done. It is particularly important to monitoring water in the vadose zone (above the water table where soil and rock pores are unsaturated) to identify potential pollution problems before they reach and contaminate groundwater resources, where correction is very expensive (Cunningham and Saigo, 2003).

2.6 Federal Legislation

New dumpsites opened in the United State after October 1993 must comply with requirements under the Resource Conservation and Recovery Act of 1980. State may choose from two options

i. The State may obtain US Environmental Protection Agency (EPA) approval of its solid waste management plan. Such approval allows greater flexibility in implementation and enforcement of the law,

ii. The State may opt not to seek approval and must rigidly comply with the Federal Standards.

The legislation is intended to strengthen and standardize the design, operation, and monitoring of dumpsites that cannot comply with the regulation face closure. Provisions of the regulations include the following:

a. Dumpsites may not be sited on floodplain, wet-land, earthquake fault zone, an unstable land or near (birds attracted to the site present a hazard to aircraft).
b. Dumpsites must have liners.
c. Dumpsites must have a Leachate collection system.
d. Dumpsites operators must monitor groundwater for many specific toxic chemicals
e. Dumpsites operators must meet financial assurance criteria through posted bonds or insurance to ensure that monitoring continues for 30 years after closure of the dumpsite.

As mention, States with EPA approval of their dumpsite program are provided more flexibility:

i. Groundwater monitoring may be suspended if the dumpsite operator can demonstrate that hazardous constituents are not migrating from the dumpsite
ii. Alternative types of daily cover over the waste may be used
iii. Alternative groundwater protection standards are allowed.

iv. Under certain circumstances expansion of dumpsites in wetland and fault zone is allowed.

v. Alternative financial assurance mechanisms are allowed.

2.7 Uncontrolled Sites

In the United States, there are 32,000-50,000 uncontrolled waste disposal sites, and of these probably 1200-2000 contain sufficient hazardous waste to be a serious threat to public health and environment. For this reason, a number of scientists believe that management of hazardous chemical materials may be the most serious environmental problem ever to face the United States. Past uncontrolled dumping of chemical waste has polluted the soil and groundwater resources in several ways:

i. Chemical wastes may be stored in barrels either in stacked on the surface of the ground or buried at a disposal site. Eventually, the barrels corrode and leak, with potentials to pollute surface water, soil and groundwater.

ii. Liquid chemical waste may be dumped in an unlined lagoon, from which the contaminated water may then percolate through the soil and rock to the groundwater table.

iii. Liquid chemical waste may be illegally dumped in deserted fields or even along roads.

2.8 Responsible Management

In the United States, the management of hazardous waste began in 1976 with the passage of the Re- source Conservation and Recovery Act, intended to provide for cradle-to-grave control. At the heart of the act is the identification of hazardous wastes and their life cycles. Regulations require that stringent record keeping and reporting be maintained to verify that wastes do not present a public nuisance or a public health problem. The act also classifies wastes considered hazardous in terms of several categories: materials that are highly toxic to people and other living things; wastes that may explode or ignite when exposed to air; wastes that are extremely corrosive and waste that are otherwise unstable.

Recognizing the existence of a great number of waste disposal sites that presented hazards congress passed the Comprehensive Environment response Compensation and Liability Act (CERCLA) in 1980, which defines policy and procedures for restricting the release of hazardous substances into the environment (for example, the dumpsite regulation discussed here). CERCLA mandated the development of a national priorities list of sites where hazardous substances produce or are likely to produces the most serious environmental problems and established a revolving fund (popularly called superfund) to assist in the cleanup of the worst abandoned hazardous-waste sites, in 1984 and 1986 CERCLA was strengthened by amendments that resulted in:

i. Improving and tightening the standards for disposal and cleanup of hazardous waste (for example, requiring double liners, Leachate collection, and monitoring of dumpsites);
ii. Banning land disposal of certain hazard chemicals, including dioxins. polychlorinated biphenyls (PCBs), and most solvents;
iii. Initiating a timetable for phasing out disposal of all untreated liquid hazardous waste in dump- sites or surface impoundments; and
iv. Increasing the size of the fund. (Superfund was allocated at about $8 billion in 1993).

Although Superfund has experienced significant management problems and the cleanup efforts are way behind schedule, a small number of sites have been treated. Unfortunately, the funds available are not sufficient to pay for decontamination of all the targeted sites, which would cost many times more, perhaps as much as $100 billion. Furthermore, I here is concern that present technology is not sufficient to treat the entire abandoned waste disposal sill's; it may be necessary to simply try to confine the waste to those sites until better disposal methods are developed. It seems apparent that abandoned disposal sites are likely to persist as problems for some time to come.

Federal legislation has changed the ways in which real estate does business. For example, there are provisions by which property owners may be liable for costly dump-up of hazardous waste present on their property even if they did not directly cause the problem. As a result, banks and other lending institutions might be liable for release of hazardous materials by their tenants. The Superfund Amendment and Reauthorized Act (SARA) of 1986 provide possible defence for those who purchase real estate against such liability, provided they have completed an environmental audit prior to the purchase of property. Such an audit involves the study of past land use at the site, usually determined from analyzing old maps, aerial photographs, and reports. It may also involve drilling and sampling of ground- water and soil to determine if hazardous materials are present. Environmental audits are now standard operating procedure completed on a routine basis prior to purchase of property for development (Corbitt, 2004).
SARA Legislation also required that certain industries report all releases of hazardous materials, and a list of companies releasing hazardous substances became public. This list was known as the "Toxic 500. No property owner or industry wants his or her company to be on such a list, and the list is thought to have provided some pressure to develop safer handling of hazardous materials by industries formerly identified as polluters.

In 1990, the U.S. Congress again reauthorized the hazardous-waste control legislation; Priorities are in the areas of

i. Establishing who is responsible (liable) for existing hazardous-waste problems;

ii. When necessary, assisting in or providing funding for cleanup at sites identified as having a hazardous-waste problem;

iii. Providing measures whereby people who suffer damages from the release of hazardous materials are compensated; and

iv. Improving the required standards for disposal and cleanup of hazardous waste.

Management of hazardous chemical waste involves several options, including recycling, on-site processing to recover by-products with commercial value, microbial breakdown, chemical stabilization, high-temperature decomposition, incineration, and disposal by secure dumpsite or deep-well injection. A number of technological advances have been made in the field of toxic-waste management, and as dumpsite disposal becomes more and more expensive, the re- cent trend toward on-site treatment is likely to continue. However, on-site treatment will not eliminate all hazardous chemical waste; disposal of some waste will remain necessary. Table 27.2 compares hazardous-waste reduction technologies for treatment and disposal. Notice that all available technologies cause some environmental disruption. There is no simple or single solution for all waste management issues (Freeman, 2006).

2.9 Secure Dumpsite

A secure dumpsite for hazardous waste is designed to confine the waste to a particular location, control the Leachate that drains from the waste, collect and treat the Leachate, and detect possible leaks. This type of dumpsite is similar to the modern dumpsite; it is an extension of the dumpsite for urban waste. Because in recent years it has become apparent that urban waste contains a lot of hazardous materials, the design of dumpsites and that of secure dumpsites for hazardous waste have converged to some extent (Corbitt, 2004).

The design of a secure dumpsite is shown in Figure 27.R. A dike and liner (made of clay or other impervious material such as plastic) confines the waste, and a system of internal drains concentrates Leachate in a collection basin from which it is pumped out and transported to a wastewater treatment plant. Designs of modern facilities include multiple barriers consisting of several impermeable layers and filters. The function of impervious liners is to ensure that the Leachate does not contaminate soil and, in particular, groundwater resources. However, this type of waste disposal procedure, like the dumpsite from which it evolved, must have several monitoring wells to alert personnel if and when Leachates leak out of the system and threaten water resources.

It has recently been argued that there is no such thing as a really secure dumpsite, implying that they all leak to some extent. This is true; impervious plastic liners, filters, and clay layers can fail, even with several backups, and drains can become clogged and cause overflow. Animals, such as gophers, ground squirrels, woodchucks, and muskrats, can chew through plastic liners and some may burrow through clay liners, thus promoting or accelerating leaks. Yet careful sitting and engineering can minimize problems. As with dumpsites, preferable sites are those with good natural barriers to migration of Leachate: thick clay deposits, an arid climate, or a deep water table. Nevertheless, land disposal should be used only for specific chemicals compatible with and suitable for the method (Crawford and Smith, 2004).

2.10 Site Application

Intentional application of waste materials to the surface soil is referred to as site application, site spreading, or site farming. Site application of waste may be a desirable method of treatment for certain biodegradable industrial waste, such as oily petroleum waste and some organic chemical-plant wastes. A good indicator of the usefulness of land application of a particular waste is the bio persistence (the measure of how long a material remains in the biosphere). The greater or longer the bio persistence, the less suitable the wastes are for land application procedures. Land application is not an effective treatment or disposal method for inorganic substances such as salts and heavy metals.

Site application of biodegradable waste works because, when such materials are added to the soil, they are attacked by micro flora (bacteria, moulds. yeasts, and other organisms) that decompose the waste material. The soil thus may be thought of as a microbial farm that constantly recycles organic and inorganic miller by breaking it down into more fundamental forms useful to other living things in the soil. Because the upper soil zone contains the largest microbial populations, site application is restricted to the uppermost (15-20 cm l6-H in.) of the soil.

2.11 Surface Impoundment

Both natural topographic depressions and human made excavations have been used to hold hazardous liquid waste. These are primarily formed of soil or other surface materials but may be lined with manufactured materials such as plastic. The surface impoundment is designed to hold the waste; examples include aeration pits and lagoons at hazardous-waste facilities. Surface impoundments have been criticized because they are especially prone to seepage, resulting in pollution of soil and ground-water. Evaporation from surface impoundments can also produce an air pollution problem. This type of storage or disposal system for hazardous waste is controversial, and many sites have been closed (Danterravanich, 2004).

2.12 Deep-Well Disposal

Deep-well disposal, another controversial method of waste disposal, involves injection of waste into deep wells A deep well must preliterate to rock (not soil) that in below and completely isolated from all freshwater, aquifers, thereby assuring that injection of waste will not contaminate or pollute existing or potential water supplies. Typically, the waste is injected into a permeable rock layer several thousand meters below the surface, in geologic basins topped by relatively impervious, fracture-resistant rock such as shale or salt deposits.

Deep-well injection of oil-field brine (salt water) has been important in the control of water pollution in oil fields for many years, and huge quantities of liquid waste (brine) pumped up with oil have been injected back into the rock.

Deep-well disposal of industrial wastes should not be viewed as a quick and easy solution to industrial waste probiems.29 Even where geologic conditions are favourable for deep-well disposal, there are a limited number of suitable sites and within these sites there is limited space for disposal of waste. Finally, disposal wells must be carefully monitored by additional wells, known as monitoring wells, which are required to determine if the waste is remaining in the disposal site (Kulear, 2004).

2.13 Summary of land Disposal Methods

Direct site disposal of hazardous waste is often not the best initial alternative. There is consensus that even with extensive safeguards and state-of-the-art designs, site disposal alternatives cannot guarantee that the waste is contained and will not cause environmental disruption in the future. This concern holds true for all land disposal facilities, including dumpsites, surface impoundments, site application, and injection wells. Pollution of air, site, surface water, and groundwater may result from failure of a site disposal site to contain hazardous waste. Pollution of groundwater is perhaps the most significant risk, because groundwater provides a convenient route for pollutants to reach humans and other living things. Figure 27.9 shows some of the paths that pollutants may take from site disposal sites to contaminate the environment. These paths include leakage and runoff to surface water or groundwater from improperly designed or maintained dumpsites; seepage, runoff, or air emissions from unlined lagoons; percolation and seepage from failure of surface site application of waste to soils; leaks in pipes or other equipment associated with deep-well injection; and leaks from buried drums, tanks, or other containers (Fortage,2002).

2.14 Alternatives to Site Disposal of Hazardous Waste

The philosophy of handling hazardous chemical waste should be multifaceted. In addition to the disposal methods just discussed, chemical waste management should include such processes as source reduction, recycling and resource recovery, treatment, and incineration. 3D Recently it has been argued that these alternatives to site disposal are not being utilized to their full potential; that is, the volume of waste could be reduced and the remaining waste could be recycled or treated in some form prior to site disposal of the residues of the treatment processes.30 Advantages to sonrce reduction, recycling, treatment, and incineration include:

i. The actual waste that must eventually he disposed of is reduced to a much smaller volume.

ii. Useful chemicals may be reclaimed and reused. Treatment of wastes may make them less toxic and therefore less likely to cause problems in dumpsites.

iii. Because a reduced volume of hazardous waste is finally disposed of, there is less stress on the dwindling capacity of waste disposal site.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 PROCEDURES

In line with the stated aim and objectives of the study, an area survey and observation was conducted, on ten major settlements in the Minna area. About 200 households were chose to the central uncontrolled dumpsite while the remainder were not.

3.2 Reconnaissance survey

Reconnaissance survey was carried out on the field to ascertain some features and practices in the study area; this enabled the researcher see things for Himself and this helped him to make informed decisions concerning related issues.

3.3 Questionnaire

Questionnaires were administered to randomly selected people in some selected areas and also most in the downstream locations. A total of 300 questionnaires each were distributed to each selected areas. The questionnaires administered was used to gather information on occupation of the residents, road network of the area, water supply, electricity supply, quality of water available, waste disposals and major environmental problems they are affected by among others. A copy of the administered questionnaire can be found in the appendix.

3.4 Collection of Samples

25g each of soil samples from the top portion of the waste, the bottom of the waste and opposite the waste in uncontrolled dumpsite were collected in clean plastic containers for analysis.

750ml each of water samples from tap water, well water (very close to uncontrolled dumpsites) were also collected in clean plastic containers in Minna Metropolis and analysed.

Isolation of organisms and microbial load percentage occurrence of each organism and identification of each organism and fungi were performed in the laboratory on water and soil samples collected from the uncontrolled dumpsites

3.5 Personal interview

Some persons were selected arbitrarily and asked questions on their own assessment of pollution potentials for the uncontrolled dumpsite located in the areas and the effect on health matters most especially as it relate to people close to the waste site in the downstream end point.

3.6 Properties of Municipal Waste

Efficient waste management now involves energy, recovery, resource recovery and Disposal waste recovery. It is relevant to know the details of the waste with regard to physical, chemical, energy and biological properties.

3.7 Physical Properties of Municipal Waste

The physical properties of Municipal include density, moisture content, particle size, size distribution, field capacity, hydraulic conductivity, shear strength. (KN/m^2).

3.7.1 Density and Moistures Content

The density of waste is estimated by dividing the mean weight (kg) of waste by the volume of waste. Density of waste varies with its composition, moistures content, degree of compaction, geographical location, and season of the year and length of time in storage. Moisture content of waste is relevant when estimating the calorific value, rector sizing etc. The moisture content (MC) of waste is expressed as mass of moisture content per unit mass of wet or dry materials. Two methods exist for moisture determination.

i. Wet weight analysis
ii. Dry weight analysis

Wet weight moisture content is expressed as a percentage of the wet weight of the materials and as follows.

$W (\%) = [a-b/a]$

Where

w- Moisture content %

a-initial weight of the sample, kg

b- Weight of the sample after drying at 10 degree Celsius / kg

To obtain the dry mass, the waste material is dried in an oven at 77 degree Celsius for 24 hours. Temperature and time is used to dehydrate the material completely and to limit the vaporization of volatile materials.

3.7.2 Determination of Biological Integrity

The presence of macro-organisms (insects, ant, etc.) dead or alive was recorded by direct observation capturing them with a net (diameter of the mesh 0.2mm), and by soaking the soil samples in water and recording the presence of macro-organisms dead or alive.

3.7.3 Determination of Soil and Water Micro-Biology

A serial dilution with distilled water was prepared, 0.02g of soil samples were added to each of the dilution plates containing nutrient agar prepared for bacterial counts: some of the plats containing Sabouraud dextrose agar (SDA) prepared for fungal counts. Water samples were also incubated for 24 hours and the growth recorded, as described by postage

.

3.7.4 Determination of Trace and Heavy Metals in Water, Soil and Foodstuff Samples.

The atomic absorption spectrophotometer (Unican Spectrophotometer Manual (UNICAM LTD., York Street Cambridge CB 12 PX, England) was used to determine trace and heavy metals. Atomic absorption spectrophotometer (AAS) is a variable analytical tool for determining trace amount of metals in biological sampled ASS depends on the absorption by atoms of a quantum of energy of characteristic wavelength, when going from ground state to an exited. It uses this fact to achieve a high specificity for many other elements and low level interference from other elements.

3.7.5 Glassware and Media Sterilization

All glassware used were thoroughly washed, rinsed with distilled water and dried. They were sterilized in the hot air oven at 160°C for 2 hours. All the media used were sterilised by autoclaving at 121°c for 15 minutes with the exception of a few that only dissolved by boiling in sterile distilled water as directed by the manufacturers.

3.7.6 Enumeration of Coli Form Bacteria

The coli form group of organisms as determined by the most probable number technique includes all of the aerobic and factitively anaerobic Gram-negative, non-spore which ferments lactose with gas formation between at $37^{o}c$.

CHAPTER FOUR

4.0 RESULTS

This chapter focuses on the laboratory analysis of the results obtained from Top and Bottom of Dumpsite Soil, Well Water, Tap Water samples collected from different sampling point in the project area which was earlier mentioned. The results of the different parameters analysed are presented below.

4.1 Waste Stream Characteristics in Minna Area, Niger State

Based on Survey Research in Minna Area, the following summary statistics were obtained for Kpakungu which indicated percentage of Residential, Business, Agricultural practise, Services, Transport and Green vegetation.

Table 4.1: Land Use (%)

Areas	Residential	Business	Agric	Services	Transport	Green
Mai Anguwa	37.7	11.6	2.2	13.8	2.0	32.5
Station	86.6	7.0	1.2	9.5	4.8	8.7
Garage	47.2	2.4	2.3	27.0	7.5	13.5
Kasuwa	61.5	9.5	2.5	20	1.55	1.66

4.2 Waste generated in houses headed by women

This shows percentage of Waste generated in houses headed by women in Kpakungu that are vital and contribute their own quarter in the development of community within the studies area.

Table 4.2: Women Headed Households in Kpakungu

Areas	Households headed by women
Mai Anguwa	5.0
Station	3.0
Garage	40
Kasuwa	5.0

4.3 Number size and number of households in Kpakungu.

This are averages population size and number of households in a particular area which confirm with numerated data which are of great significant to the actualization of project in studies area.

Table 4.3: Number and Average Size of Households in Kpakungu

Areas	Total Number of Households	Average size of Households
Mai Anguwa	95,393	8-10
Station	10,824	5-8
Garage	6,708	8-9
Kasuwa	85,000	7-8

4.4 Ranges of households in Kpakungu.

The total numbers of households ranges from lowest to highest of the study area that reflects the general size of Kpakungu and this contribute to the uncontrolled dumpsite in the studies area.

Table 4.4 Ranges of Households in Kpakungu

Areas	Lowest	Highest	Average
Mai Anguwa	16,000	2,300,000	36,000
Station	3,600	320,000	8,000
Garage	5,000	840,000	12,000
Kasuwa	4, 5000	960,000	15,000

4.5 Waste Generated in Kpakungu.

This indicated the total volume and weight of waste generated in most area in study that is taken yearly and entailed the level of sanity in Kpakungu area.

Table 4.5: Waste Generated in Kpakungu

Areas	Volume (m^2/yr)	Weight (tonnes/yr)
Mai Anguwa	3,184,000	2,201
Station	242,075	205
Garage	1,645,820	1,851
Kasuwa	2,888,000	2,800

4.6 Characteristics and Composition of Urban Waste in Minna Area, Niger State.

This shows the characteristics and composition of Urban Waste in Minna Area, Niger State by indicating the three social classes of people residing in Kpakungu area.

Table 4.6: Characteristics and Composition of Urban Waste in Minna Area, Niger State. (*Three Social Classes indicated).*

Waste Generation Rate	GRA	Middle Class Area	Old Top Area
Paper	81.3	12.6	33.7
Leaves	2.5	13.2	11.3
Garbage	8.2	65.3	41.6
Tin	3.4	4.6	6.2
Glass	0.1	2.1	2.5
Rag	4.3	1.6	3.4
Dust	0.2	0.6	1.3
Density (km/m^3)	296	256	280
Moisture content (%)	64.8	61.4	49.7

4.7 Sources of Waste Generated.

This show where the Sources of Waste Generation are obtained from in the Kpakungu area that contributes to the uncontrolled dumpsite.

Table 4.7 Sources of Waste Generation s

Types of solid waste	General Compounds	Sources
Garage	Waste from preparation of Cooking, left over's, Markets etc.	Households, kitchen, restaurants, stores and Markets
Rubbish	Combustible paper,	Office, household etc.
Ashes and Dust	resides from fire used in Kitchen,	Market Cooking
Street trash	Leaf, litters, cans, cobs	Restaurants, and fruit peels
Abandoned vehicles	unwanted cars,	motor Road side mechanic etc

4.8 Percentages of Households enjoying regular Solid Waste Collection

This shows the Percent of Households Enjoying Regular Solid Waste Collection by the State sanitation Board.

Table 4.8: Percent of Households Enjoying Regular Solid Waste Collection

Areas	Male Headed Household (%)	Female Headed Household (%)	Total Household (%)
Mai Anguwa	36.3	18.5	27.4
Station	10.0	14.0	12.0
Garage	10.0	4.7	7.5
Kasuwa	08	5.0	13

4.9 Results of Presumptive Test for Water Samples

This show laboratory analysis of well water close to the dumpsite and far away in the study area taken for experimental studies

Table 4.9 Results of Presumptive Test for Water Samples

Water Samples	Acid and Gas									READING	MPN	GAS PRODUCTION	RENGE 95% PROBABILITY
	LB2X-10ml			LB1X-1ml			LB1X-0.1ml						
Tubes	1	2	3	4	5	6	7	8	9				
Tap water (Heart of Kpakungu)	+ve	+ve	+ve	+ve	+ve	-ve	+ve	-ve	-ve	3-2-1	150	+ve	30-440
Well water (closed pot)	+ve	+ve	+ve	+ve	+ve	-ve	+ve	-ve	-ve	3-2-1	150	+ve	30-440
Well water close to dump site at Kpakungu	+ve	+ve	+ve	+ve	+ve	-ve	+ve	-ve	-ve	3-2-1	150	+ve	30-440

Key note:

Lactose broth double strength = LB2X

Lactose broth single strength = LB1X

Most probable number = MPN

Acid and gas formation = +ve

4.10 Results of Confirmed Microbial Test for Waste Sample

This show laboratory analysis of well and Tap water close to the dumpsite and far away in the study area for confirming Microbial Test

Table 4.10 Results of Confirmed Microbial Test for Water Samples

Water Samples	Coli forms Mac Conkey Plate	Organism EMB Plate	Potable	Non -Potable
Tap water (Heart of Kpakungu)	Pinkish mucoid colonies, Pale pink colonies.	Pale mucoid colonies	E. coli	✓
Well water (closed pot)	Pinkish mixed colonies, mucoid sheen colonies.	Metallic sheen colonies, pale colonies.	E. coli	✓
Well water (close to dump site)	Pinkish colonies, pale pink, greenish colonies.	Metallic sheen colonies, greenish colonies.	E. coli	✓

Key

MCA = Mac Conkey agar

EMB = Eosin Methylene blue agar

4.11 Results of Completed Microbial Test for Waste Sample

This show the completed laboratory analysis of well and Tap water close to the dumpsite and far away in the study area for confirming Microbial Test

Table 4.11 Results of Completed Microbial Test for Water Samples

Water source	Lactose broth A/G (+) OR (-)	Gram Stain Reaction Reaction Morphology	Possible Organism	Non -portable
Tap water (Heart of Kpakungu)	A/G +	+ve rods, +ve cocci in cluster	E. coli	✓
Well water (closed pot) Kpakungu	A/G +	-ve rods, -ve short rods,	E. coli	✓
Well water (close to dump site Kpakungu)	A/G +	-ve short rods +ve cocci in cluster +ve cocci in chains, -ve rods	E. coli	✓

Key Note;

A = Acid production, G = Gas production,+ = Positive,- = Negative, A/G = Acid and gas production.

4.12 Results of Total Viable Plate Count in Waste Sample

This show the completed laboratory analysis of well and Tap water close to the dumpsite and far away in the study area for total viable count

Table 4.12 Result of Total Viable Plate Count in Water Samples

Water Sample Code	E. Coli forms (CFU)	Indicator Organisms	Results
Tap Water (Heart of Kpakungu)	10^{-4} x 50	10^{-4} x 25	Not portable
Well water (closed pot)	10^{-4} x 95	10^{-4} x 80	"
Well water (close to dumpsite Kpakungu)	10^{-4} x 165	10^{-4} x 120	"

Key;

CFU = Colony Forming Unit

4.13 Results of Total Viable Count of Microorganism (NA) in Soil Sample

This show the completed laboratory analysis of Top and Bottom Soil in the dumpsite in the study area for total viable count of Microorganism

Table 4.13 Result of Total Viable Count of Microorganism (NA) in Soil Samples

Sample Code	CFU/ml
Dumpsite (Kpakungu)	2.34×10^5
Dumpsite ,,	1.69×10^6
Bottom of dump site (Kpakungu)	1.63×10^5
Bottom of dump site ,,	1.40×10^6
Opposite dump site (Kpakungu)	1.06×10^5
Opposite dump site ,,	9.8×10^5

Key: - NA = Nutrient Agar

CFU/ml = Colony forming unit per

4.14 Results of E. Coli Count (MCA) in Soil Sample

This show the completed laboratory analysis of Top and Bottom Soil in the dumpsite in the study area for total viable count of E-coli form count

Table 4.14 Result of E.Coli form Counts (MCA) in Soil Samples

Sample Code	CFU/ml
Dump site (Kpakungu)	8.0×10^4
Dump site ,,	6.0×10^5
Bottom of dump site (Kpakungu)	9.6×10^5
Bottom of dump site ,,	7.3×10^6
Opposite dump site (Kpakungu)	5.8×10^5
Opposite dump site ,,	4.9×10^6

Key: - MCA = Mac Conkey Agar

CFU/ml = Colony forming unit per ml

4.15 Results of Total Fungi Count (SDA) in Soil Sample

This show the completed laboratory analysis of Top and Bottom Soil in the dumpsite in the study area for total Fungi count

Table 4.15 Result of Total Fungal Count (SDA) in Soil Samples

Sample Code	CFU/ml
Dump site (Kpakungu)	2.34×10^5
Dump site ,,	1.69×10^6
Bottom of dump site (Kpakungu)	1.63×10^5
Bottom of dumpsite ,,	1.40×10^6
Opposite dump site (Kpakungu)	1.06×10^5
Opposite dump site ,,	9.7×10^5

Key: - SDA = Sabouraud Dextrose Agar

CFU/ml = Colony forming unit per ml

4.16 Results of Ranges of Heavy Metals (Copper, Lead, Mercury and Cadmium) Concentration in Water Sample

This show the completed laboratory analysis of well water in the dumpsite in the study area for ranges of Heavy metals

Table 4.16 Results of Ranges of Heavy Metals (Copper, Lead, Mercury and Cadmium) Concentrations in Water Sample.

			Well Water Values (mg/l)														
S/No.	Parameters	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Copper	(mg/l)	1.7	1.7	1.6	0.8	0.7	0.6	0.5	0.7	0.6	0.6	0.7	0.8	0.6	0.7	0.6
2	Lead	(mg/l)	1.91	1.1	1.1	0.001	0.005	0.005	0.003	0.005	0.002	0.002	0.002	0.005	0.005	0.005	0.005
3	Mercury	(mg/l)	1.3	1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Cadmium	(mg/l)	1.10	1.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

4.17 Results of Ranges of Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^-) and Hydroxide (OH^-) Concentration in water Sample.

This show the completed laboratory analysis of well water in the dumpsite in the study area for Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^-) and Hydroxide (OH^-) Concentration in water Sample

Table 4.17 Results of Ranges of Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^-) and Hydroxide (OH^-) Concentration in water Sample.

			Well Water Values (mg/l)														
S/N	Parameters	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Carbonate (CO_3^{2-})	(mg/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Bicarbonate (HCO_3^-)	(mg/l)	16	11	51	37	45	15	45	58	49	57	33	32	23	27	27
3	Hydroxide (OH^-)	(mg/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4.18 Results of characterization and identification of bacteria isolated from water samples.

This show the completed laboratory analysis of Well and Tap water in the dumpsite in the study area for characterization and identification of bacteria isolated from water samples.

TABLE 4.18: RESULT OF BIOCHEMICAL ANALYSIS FOR CHARACTERIZATION AND IDENTIFICATION OF BACTERIA ISOLATED FROM WATER SAMPLES

																			CARBOHYDRATE FERMENTATION									
Table 4.18 RESULT OF BIOCHEMICAL ANALYSIS FOR	NATURE OF SAMPLE	SPECIES OF ORGANISMS	GREM REACTION	CELLS SHAPES	PRESEUCE SPORE	CATALASE	COAGULASE	MOTITITY	GELATIN HYDRO	STARCH HYDRO	NITRATE RECTION	INDOLE PRODUCTION	METHYLE RED	UREASE	CITRATE	VOGES PROSK	OXIDASE	HYDROGENE SULP	D-GLUCOSE	LACTOSE	SUCROSE	D-MANNITEL	MALTOSE	ARABINOSE	FRUCTOSE	XYLOSE	DULCITOL	SORBITOL
1	TAP WATER (HEART OF KPAKUNGU)	BACILLUS SUBSTILIS	+	RODS	-	-	-	+	+	+	+	-	-	-	+	+	-	-	+	-	-	+	-	+	-	-	-	-
	" "	STAPHYLOCCUS AUREUS	+	COCCI	-	+	+	-	+	-	+	-	-	-	-	+	-	-	+	-	+	+	+	-	+	-	-	-
2	WELL WATER (CLOSED POT)	PROTEUS VALGARIS	-	RODS	-	+	-	+	+	-	+	+	+	+	-	-	-	+	+	-	+	-	+	-	+	+	-	-
	" "	ESCHERICHIA COLI	-	RODS	-	+	-	+	-	-	+	+	+	-	-	-	-	-	+	+	+	+	+	+	+	-	-	-
	" "	SHIGELLA DYSENTERIAE	-	RODS	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	WELL WATER (CLOSE TO DUMPSITE KPAKUNGU)	ESHERICHIA COLI	-	RODS	-	+	-	+	+	-	+	+	+	-	-	-	-	-	+	+	+	+	+	+	+	-	-	-
	" "	STAPHYOLOCCUS	+	COCCI	-	+	+	-	+	-	+	-	-	-	-	+	-	-	+	-	-	+	-	+	-	-	-	-

4.19 Results of characterization and identification of bacteria isolated from Soil samples.

This show the completed laboratory analysis of Top and Bottom of Soil in the dumpsite in the study area for characterization and identification of bacteria isolated from Soil samples.

Table 4.19 RESULT OF BIOCHEMICAL ANALYSIS FOR CHARACTERIZATION AND IDETIFICATION OF BACTERIA ISOLATED FROM SOIL SAMPLES.

S/NO	NATURE OF SAMPLE	SPECIES OF ORGANISMS	GREM REACTION	CELLS SHAPES	PRESENCE OF SPORE	CATALASE	COAGULASE	MOTITITY	GELATIN HYDRO	STARCH HYDRO	NITRATE RECTION	INDOLE PRODUCTION	METHYLE RED	UREASE	CITRATE	VOGES PROSK	OXIDASE	PHOSPHATE TEST	SUCROSE	D-MANNITEL	MALTOSE	ARABINOS	FRUCTOSE	XYLOSE	DULCITOL	SORBITOL
1	SOIL SAMPLE AT DUMPSITE	PSEUDOMONAS AERUGINOSA	-	RODS	-	-	+	+	-	+	+	-	-	+	+	-	+	-	+	+	-	-	+	-	-	-
	" "	STAPHYLOCOCCUS AUREUS	+	COCCI	-	+	+	-	+	-	+	-	-	-	-	+	-	-	+	+	+	-	+	-	-	-
2	SOIL SAMPLE AT BOTTOM OF DUMPSITE	BACILLAS SUBTITIS	+	RODS	-	-	-	+	+	+	+	-	-	-	+	+	-	-	-	+	-	+	-	-	-	-
	" "	PROTEUS VULGARIS	-	RODS	-	+	-	+	+	-	+	+	+	+	-	-	-	-	+	-	+	-	+	+	-	-
3	SOIL SAMPLE AT OPPOSITE DUMPSITE	STREPTOOCCUS FAECALIS	+	COCCI	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	+	-	+	-	+	-	-
	" "	STAPHYLOCOCCUS AUREUS	+	COCCI	-	+	+	-	+	-	+	-	-	-	-	+	-	-	+	+	+	-	+	-	-	-

4.20 Results of characterization and identification of morphological characteristics and identification of mould isolated from soil samples.

This shows the completed laboratory analysis of Top and Bottom of Soil in the dumpsite in the study area for characterization and identification of morphological characteristics and identification of mould isolated from soil samples.

Table 4.20 RESULTS OF MORPHOLOGICAL CHARACTERISTICS AND IDENTIFICATION OF MOULD ISOLATED FROM SOIL.

Sample Code	Colour of Aerial Hyphae	Colour of Substate Hyphae	Nature of Hyphae	Shape and Kind of Asexual Spore	Presence of Special Structure	Appearance of Sporengiophore	Characteristics of Sporehead	Probable Organismkijilace
Dumpsite	White yellow	Blackish	Non septate	Oval	Foot cell present	Long erect and non saptate conidia long erect	Chains of brown	Aspergillus spp
Dumpsite	Gay black	Blank	Non septate	Oval	Foot cell absent	Non septate long erect	Rough walled smooth round	Rhizopus spp
Dumpsite	Yellow	Brown	Septate multi nuclear	Oval greenish	Foot cell present	Long erect	Multi nucleate	A flavus spp
Bottom of dumpsite	Orange yellow	Tamto yellowish green	Septate	Oval deep red	Foot cell absent	Long erect	Semi elliptical	Aspergillus versicolour
Bottom of dumpsite	Bluish green	Brown	Septate	Oval greenish conida	Foot cell present	Long erect	Multi nucleate	Aspergillus fumigates

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

Generally in Minna, the responsibility of waste management rests largely with municipal authorities who focus on organizational aspects such as improvement of municipal management quality, privatized collection and transportation system. The fact is that waste management, a fairly extended economic sector, comprising a range of inter-linked actors, activities, and commodities, has been neglected. Much emphasis has been on getting rid of waste at minimal cost. Despite these efforts, Figures of Uncontrolled dumpsite, Pictures, Tables of Field Work Survey results and Statistical Analysis of Questionnaires shows that there is no single Control dumpsite in Minna. That only a few proportions of households in Minna have access to regular waste collection and later end up in uncontrolled dumpsite available. Thus there are low waste collection efficiencies, varying between 7.5% and 27%. Such low collection efficiencies result in left over accumulation that are either removed on irregular basis, or burnt on site.

The waste management in the centre is highly dependent on (an active informal network. This sector consists of waste pickers, internal, waste dealers and wholesalers, and small recycling, enterprises. Generally, there is poor performance of the formal sector, which is basically restricted to (a) sweeping and kerbside collection; (b) transportation by hand-carts to large or road collection points, which often than not are open dumps; and (c) transportation by vehicles to the disposal sites. As an example, waste collected by the formal and informal sectors in Minna is delivered to one major destination along a major highway. This dumping in an open field is extremely hazardous to both the environment and human health.

Like in many other parts of Northern States, waste management in Minna has focused primarily on minimizing the costs of collection. The approach has not given much attention to key economic goals of waste management such as waste reduction, source segregation, and local recycling. In a similar vein social goals such as sustainable employment generation and environmental goals such as litter avoidance, and the care for a healthy and sustainable environment are not properly reflected in the current approach. Yet, these constitute economic, social and environmental externalities that affect waste generation and management. It is now accepted that to achieve socially and environmentally sound waste management, an integrated approach is not only necessary, but also imperative. Such an integrated approach will take into account the nature of waste generated, the number of stakeholders that are essential and substantial, the environmental, economic and social impacts, Construction of Engineering Design Dumpsites, as well as the involvement and participation of the private sector operators and community members.

5.1.1The Present Institutional Framework

The Waste system currently involved in Minna management board fall into three categories: The governmental system operated at the municipal level that is dedicated to cleansing and beautification of urban centres. The scope of service includes collection of solid wastes arriving at streets from different sources. Thus collected wastes include basically conventional street wastes, swept and collected on daily basis, commercial discards and considerable fraction of household wastes.

i. Door-to-door service by individual informal actors that collect household wastes and wastes from selected commercial

ii. Door-to-door service by individual informal actors that collect household wastes and wastes from selected commercial enterprises. Wastes are collected by rudimentary means such as carts.

iii. Limited involvement of the private sector system which utilizes refined transportation systems.

The current system faces a number of problems, including:

i. Poor coordination at all levels;

ii. Insufficiency of available facilities to extend service coverage programme;

iii. Irregular follow-up of the numerous daily activities;

iv. Unreliable data on waste;

v. Poor coordination with private collectors;

vi. No or Limited Control dumpsite space and poor management of the dumpsite;

vii. Limited markets for recyclables;

viii. Sustainability risk.

Further compounding these problems are lack of the following basic elements:

i. Official policies, strategic goals, objectives and work plans that address all phases of integrated sustainable waste management at all levels of government, and private sector;

ii. An institutional infrastructure at all levels of government to plan, organize and implement an integrated system;

iii. A lack of clearly defined roles and responsibilities for the different bodies currently working in the field of municipal solid waste management;

iv. Adequate legislation, regulatory and enforcement authorities to adequately enforce acceptable integrated municipal solid waste management;

v. Funding at all levels of government to support a sustainable infrastructure;

vi. Sufficient disposal capacity with proper environmental standards and the absence of Dumpsites' spaces.

vii. Qualified and trained personnel to manage the whole system • Adequate maintenance facilities.

viii. Competent and capable waste management private sector operators.

5.2 Findings

The interview conducted on some selected persons showed that there are periods when the uncontrolled dumpsites are affected by the activities of scavengers and heavy rain fall. During the dry seasons, the amounts of moisture contents are low but sometimes so small that it affects the quantity and size of waste dump constantly. During the rainy season especially when there is flood everywhere, many rubbish and cabbage floats about on dirty water. This lead to contamination of water sources available in the area.

5.3 Conclusion

The general approach to tackling these problems is to pump in more money and equipment with little or no analysis as to their main causes. In recent time, however, there is the general consensus that proper management of municipal waste requires an integrated approach in which waste is regarded largely as a negative and as a useful material that can provide a potential source of income, this is important for public health, environmental, and socio-economic reasons.

In other words, it is now realized that most waste management problems have to do with something other than money and equipment. Some problems have to do with the attitude of the people, waste management staff, private (formal and informal) enterprises and waste pickers, as well as other problems related to managerial capacities, institutional framework, the environment and general changing social, institutional, legal and even political conditions. Integrated solid waste management has been demonstrated to provide some tools to look more in depth at the actual needs of the people and the way they can overcome the problem of waste management.

This Research Work sets out the key elements of the concept of integrated sustainable waste management, in Minna Area, Niger State.

5.4 Recommendations

The result of this study should be of particular interest and value to Minna Municipal Council, State Environmental and Sanitation board and to Federal Ministry of Environmental Protection Board. It might also be of interest to other Waste Management Works in Nigeria.

Municipal Waste Management is a complex task that requires appropriate organizational capacity cooperation among various stakeholders. Some key issues that need to be adequately addressed by Waste Management Board or there Integrated Sustainable Waste Management (ISWM) are stated below

Goals and Principles

The main goals of the Waste Management Board are to:

i. Protect environmental health of the urban population, particularly the poor who suffer most from poor waste management;

ii. Promote the quality of the urban environmental conditions by controlling pollution and ensuring the sustainability of the urban ecosystems;

iii. Support the efficiency and productivity of the urban economic development by providing demanded waste management services and ensuring the efficient use and conservation of valuable materials and resources; and

iv. Generate employment and income.

To achieve the above-mentioned goals, sustainable systems of Waste management must be established. These systems must be appropriate to the particular circumstances and problems of the city and locality, as well as involve the participation of all sectors of the society and local communities. Moreover, cross-sectional approaches are not only required, but also imperative.

The key principles of sustainable waste management strategies are to:

i. Minimize waste generation;

ii. Maximize waste recycling and reuse; and

iii. Ensure the safe and environmentally sound disposal of Waste in Controlled dumpsites.

The scope of Waste Management Board encompasses planning and management, waste generation and waste handling processes. Practical strategies for improving will focus on developing specific objectives and measures in the following areas:

Planning and Management

i. Strategic planning

ii. Legal and regulatory framework

iii. Public participation

iv. Financial management (cost recovery, budgeting, accounting etc)

v. Institutional arrangements

vi. Control Dumpsites and Disposal facility sitting

vii. Waste Generation

viii. Waste characterization (source, rates, composition etc)

ix. Waste minimization and source separation

x. Waste Handling

xi. Waste collection

xii. Waste transfer, treatment and disposal

xiii. Special wastes (medicinal, industrial etc)

xiv. Stakeholders

For sustainable management of Municipal Waste, it is important to recognize the diverse interests and roles of various actors and partners who are concerned about Waste Management as service users, service providers, intermediaries and/or regulators. They include households, community groups, NGOs, governments, organized and informal private sector enterprises.

Residential households are mainly interested in receiving effective and dependable waste collection service at affordable prices. In general, disposal is not normally a priority demand of service users, unless their quality of life is threatened by dumpsites. It is, therefore not surprising to find that where Waste Management services are not satisfactory, Waste is commonly dumped onto nearby uncontrolled dumpsites, Open sites, along main roads or railway tracks, or into drains and waterways. Thus, it is imperative to note that pressure to improve waste collection and disposal will increase when poor people become more aware of the environmental and health implications of poor waste collection service.

Poorly served residents can also form community-based organizations (CBOs) that when sufficiently organized has considerable potential for managing and financing local collection services and operating waste recovery and corn posting activities.

Commercial and industrial establishments are interested in effective waste collection and, in many cases, waste minimization.

Because of their usually keen interest in reducing waste generation, industrial enterprises, in particular, could play an active role in managing waste collection, treatment and disposal in collaboration with governments and/or specialized private enterprises.

Non-governmental organizations (NGOs) may help to increase the capacity of communities for sustainable waste management by contributing to:

i. people's awareness of waste management problems;

ii. organizational capacity and formation of community-based organizations (CBOs);

iii. liaison between CBOs and government authorities;

iv. People's voice in planning and implementation processes for waste management; and

V. technical know-how of locally active CBOs

In addition, NGOs may provide important support to informal sector waste workers and enterprises, assisting then to organize themselves, to improve their working conditions and facilities, increase their earnings and extend their access to essential services.

Organized private sector enterprises are primarily interested in earning a return on their investment by selling waste collection, transfer treatment, recycling and/or disposal services. They are in position to provide capital, management and organizational capacity, labour and/or technical skills, and can, provide Waste Management services more effectively and at lower cost that the public sectors. To decide whether to have private sector participation in municipal solid waste services, many factors need to be analyzed, such as cost recovery, efficiency, public accountability, management, finance, economies of scale, legislation, institutions and cost. Methods of private sector participation most common to solid waste management are contracting, concession, franchise, and open competition. This makes the involvement of the private sector in waste disposal and management imperative.

The basic motivation of the informal private sector actors is self-organized revenue generation. This sector is made up of unregistered, unregulated activities carried out by individuals, families, groups or small enterprises. Informal sector workers are often driven by poverty to work as waste collectors.

Governments, by their nature and constitutional disposition are generally responsible for the provision of Waste collection and disposal' services. This is due to the fact that they become legal owners of Waste once it .is collected or put out for collection. Responsibility for waste management is usually specified by laws and regulations that are often derived from environment policy goals, by the 1999 Nigeria Constitution the authority to enforce bylaws and regulations, and to mobilize the resources required for solid waste management is in principle, conferred upon local governments. On the other hand, Federal and State governments are responsible for the waste management institutional and legal framework. In this regard, problems can arise when local government's authority is not commensurate with its Waste management responsibilities.

The Determinants for Sustainable Waste Management

The effectiveness and sustainability of solid waste management system depend on a number of factors that need to be adapted to the prevailing context of the local conditions in which they operate. Some of these are outlined below, and they concern political, socio-cultural, economic and environmental aspects of waste management.

1. Political Context

Administrative decentralization affects the character of local governance and Waste management systems. The existing relationship between governments at all levels (local, state national), the form and extent of people's participation in the public processes of policy making and the role of party politics in local government administration would all affect the character of management,' governance and type of Waste Management system which is feasible and appropriate.

2. Socio-Cultural Context

What have cultural values got to do with Waste Management?

Values are integral to determining the criteria, options, objectives, outcomes and technological solutions for waste management systems. Values also determine and maintain the management structures and processes by which those decisions are made. Thus in general, it needs to be recognized that the people's attitude·and patterns of Waste handling influence the functioning of Waste Management. The functioning, effectiveness and sustainability of waste management will therefore depend on people's identification with the Waste Management system. It is therefore imperative that people are involved from the outset in the planning of the local segments of the intended system. Community involvement is particularly important regarding the sitting of facilities for waste management. Programmes to disseminate knowledge and skills, or to improve behaviour patterns and attitudes regarding waste management, must be based on people's social and cultural values. This will enhance people's ownership of the system.

3. Economic Development

The level of economic development is a determinant of waste generation and the demand for Waste Management services. It determines the volume and composition of wastes generated by residential and other users.

4. Environmental factor

The design of Waste Management systems must be adapted to the environmental conditions of the local area. For example, the level of the built environment would have an important influence on the character and waste management needs, just as the suitability of waste disposal site depend upon any environmental conditions.

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APPENDIX I

POST GRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

RESEARCH QUESTIONNAIRE

Dear Sir/Madam,

I am a Postgraduate student of Federal University of Technology, Minna. I am conducting a Survey Research Work on An Assessment of Pollution Effects of Uncontrolled dumpsite in Minna Area, Niger State. I solicit your kind assistance to give answer to the following scheduled interview questions in your candid opinion. By so doing you would be helping in providing valid information for this Survey Research which is partial fulfilment for the award of Master Degree in Environmental Management

Any information given shall be treated with utmost confidentiality and respect for this research work only.

Fill in the blank spaces or tick were necessary please and to be completed by a Head of the family only. Do not write your name please.

QUESTIONNAIRE ON RESIDENTAILS OCCUPANTS

1. L.G.A...

2. Village/Town..

3. Age:15-25years..

   45-55years: ....

4. Marital status: Single.........................Married: ....

   Divorced: .... Window.....................

5. Family size: (1),(2),(3),(4),(5),(6),(7),(8),(9),(10),(11) and above.

6. Educational Status: Adult Education: ....
   Primary Education:...............
   Secondary / teachers Education: ....
   Post Secondary Education: ....

7. Occupation: (Civil servant), (Business/trade), (Farmer), (Self Employed).

8. Have you a dustbin in or outside your compounds? Yes:... No:......

9. What type of dustbin did you possess in your house?

   (a) Metal Container (b) Basket (c) Carton

   (d) Plastic Container (e) Others.

10. Do your dustbin have a lid pre cover? Yes: ..... No:

11. Where do you keep your dustbin in the compound?
    (a) On a slab (b) On a bare ground.

12. Where do you usually empty your dustbin when filled?
    (a) Along the road (b) On a farming land
    (c) In an uncompleted building

    (d) In a good dumping site provided by government

    (e) Other places not mentioned.

13. Which of the following methods of refuse disposal do you practice?

(a) Uncontrolled (b) Open dumping (c) Burning

(d) Controlled tipping (e) Burying.

14. If your method of refuse disposal is by dumping on the road, does it create any unpleasant situation to you and your neighbours?

    (a) Yes (b) No (c) Don't know

15. How regularly do you empty your dustbin at your house?

    (a) Daily (b) Once a week (c) Twice every week

    (d) Once monthly.

16. Who is responsible for disposing of refuse in your families?

    (a) Husband (b) Wife (c) Male child

    (d) Female child (e) Relative

17. Indicate any type of illness recently suffered by you or members of your family. (a) Diarrhoea (b) Dysentery (c) Malaria fever

    (d) Typhoid fever (e) Others.

18. Do you know what the above disease can occur due to indiscriminate disposal of refuse?

    (a) Yes (b) No (c) Don't know.

19. Do you know that some of the solid waste materials can be picked up and refused once again i.e. bottles for necklaces and bangles?

20. Are you aware that insects like house flies, mosquitoes and cockroaches spread disease like diarrhoea, dysentery, cholera, typhoid fever and worms?

    (a) Yes(b) No (c) Don't know

21. Did any Health official enlighten you or any member of your family in your house, clinic in the publicly town on the consequences of improper disposal of refuse?

    (a) Yes (b) No (c) Yes Once (d) More than 2 Times a month

22. If yes so you think you are well informed? (a) Yes (b) No

23. How regularly do the Health personnel come to collect refuse stored in front of your house or in the dumping site provided by health authority in your areas?

(a) Daily (b) Once Weekly (c) Twice Weekly

(d) Every Two weeks (e) monthly.

24. Any vehicle collecting refuse in your area?

(a) Yes (b) No.

25. How did you feel or assess the attitude of Health officials who are responsible for the collection and final disposal of refuse in your Town?

(a) Excellent work (b) Averagely done (c) Lackadaisically done

(d) Poorly Done.

Thank you.

APPENDIX II

POST GRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

RESEARCH QUESTIONNAIRE

Dear Sir/Madam,

I am a Postgraduate student of Federal University of Technology, Minna. I am conducting a Survey Research Work on An Assessment of Pollution Effects of Uncontrolled dumpsite in Minna Area, Niger State. I solicit your kind assistance to give answer to the following scheduled interview questions in your candid opinion. By so doing you would be helping in providing valid information for this research work which is partial fulfilment for the award of Master Degree in Environmental Management

Every information's provided will be treated in confidence as they will be Employed solely for academic purpose

1. Stall/Shop No: ....
2. Where is your shop/stall located -------------------------------?
3. What types of products do you sell in your stall / shop?

   (a) Provisions (b) Food stuff (c) Meat fish

   (d) Vegetables (c) Cloths (f) Others
4. Have you a dustbin in fort of your stall / shop?

   (a) Yes (b) No.
5. If yes, what types of dustbin have you?

   (a) Metal container (b) Basket / Plastic Container

   (c) Carton (d) Others.
6. Has it a cover? (a) Yes (b) No.
7. How regularly do you empty your dustbin?

   (a) Daily (b) Twice a week (c) Once a week

   (d) Every two days (e) When necessary.
8. Where do you empty it when filled? (a) Along the road,

   (b) Place provided by Health Dept. (c) Other place not mentioned.
9. Who is responsible for the disposal of refuse in your stall / shop?

(a) Self (b) Servant / Attendant (c) Health Officials.

10. Are you aware that improper disposal of refuse leads to breeding of insects and rodents like fillies and rats which can affect health?

(a) Yes (b) No.

11. Do you think that some of the refuse generated in your shop and town or market can be picked up and be re-used?

(a) Yes (b) No (c) Don't know.

12. Has health worker even given you or your shop / stall Health Education on the importance of storage, collection and disposal of refuse? (a) Yes (b) No.

13. If yes, do you think that you are well informed? (a) Yes (b) No.

14. What is your assessment of the attitude of Health workers who are responsible for the collection and final disposal of refuse in the market or your shop?

(a) Excellent work (b) Averagely done

(c) Lackadaisically done (d) Poorly done.

15. Suggest ways by which refuse can be handled and disposed:

(a) ....

....

(b)..

....

(c)..

....

(d)..

Thank you.

APPENDIX III

POST GRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

RESEARCH QUESTIONNAIRE

(FOR ENVIRONMENTALIST ONLY)

Dear Sir/Madam,

I am a Postgraduate student of Federal University of Technology, Minna. I am conducting a Survey Research Work on An Assessment of Pollution Effects of Uncontrolled dumpsite in Minna Area, Niger State. I solicit your kind assistance to give answer to the following scheduled interview questions in your candid opinion. By so doing you would be helping in providing valid information for this research work which is in partial fulfilment for the award of Master Degree in Environmental Management

Every information provided will be treated in confidence as they will be employed solely for academic purpose

1. Do you know or have knowledge about dumpsite? (a) Yes (b) No
2. Have you seen one before or recently checked one? (a) Yes (b) No
3. How are the dumpsite you have seen? (a) Well sanitized
   (b) Partially sanitized (c) Not sanitized at all
4. Do you know any dumpsite around or within your areas?
   (a) Yes (b) No
5. How far is the distance of the dumpsite from residential areas?
   (a) About 10km (b) About 20 km (c) Just Within (d) About 5km
6. Have you knowledge about the dumpsite by-products like Leachate? (a)Yes (b) No
7. How secure is the Leachate leakages dripping from contaminating groundwater or even treated tap water? (a) Not secure (b) partially secure (c) very secure
8. Are dumpsite in your area well designed and constructed with engineering standards (a) Yes (b) No
9. Are the dumpsites in layers? (a) Yes (b) No
10. Are dumpsite networked with pipes for Leachate leakages and connected to a suck away tank? (a) Yes (b) No

11. Are the dumpsite well compacted? (a) Yes (b) No

12. How big/large are the dumpsite? (a) Very Big/Large
(b) Small/ Tiny?

13. Do dumpsites contain most of the waste generated in the area?
(a) Yes (b) No

14. Are the dumpsites located down where water level flows?
(a) No (b) Yes

15. Are the dumpsite safe guarded against all forms of intruders (Man, Animals and Insects)? (a) Yes (b) No

16. Have you noticed any sanitary Landfill team checking the dumpsite regularly? (a) Yes (b) No

17. Do state Environmental board place monitoring devices on dumpsite for assessment? (a) Yes (b) No

18. Who built the Landfills? (a) State Government (b) Community Efforts (c) Non Governmental Organizations (d) Individual

19. Are you satisfied with ways and manners the dumpsite are being handled? (a) Yes (b) No

20. Have you ever lodged any complains on situation of dumpsite in your area? (a) Yes (b) No

21. Suggest ways to improve the situation

Thank you

APPENDIX IV

Calculation Formulae

Chi-Square Test ($\aleph$^2) = $\sum$(Oi –Ei)/ Ei = 4.947

Degree of Freedom N-1 = 15 – 1 = 14

Significant Level = 5% = 0.05

At this degree of freedom and 5% significant level

$\aleph$^2 = Critical value = 23.7

Decision: since the calculated value is less than the table of value, Null hypothesis (Ho) is Retain and Alternative Hypothesis (Hi) is Rejected.

$\aleph$^2 is Chi-Square Test

Oi is Observant

Ei is Expectant

$\sum$ is Summation

N is number of Sample Points

Ei = (total number of Observant)/(total number area counted) ≡ (261/15) =17.4

Weight of Waste = [(a-b)/a] 100

Where W is moisture Content %

a- is initial weight of the sample, kg

b- is weight of the sample after drying at 105 degree Celsius kg.

Density = weight/ volume

Volume – a measuring Cylinder m^3/yr

APPENDIX V

Calculation Formulae

Chi-Square Test ($\aleph^2$) = $\sum(Oi - Ei)/Ei = 4.947$

Degree of Freedom N-1 = $15 - 1 = 14$

Significant Level = 5% = 0.05

At this degree of freedom and 5% significant level

$\aleph^2$ = Critical value = 23.7

Decision: since the calculated value is less than the table of value, Null hypothesis (Ho) is Retain and Alternative Hypothesis (Hi) is Rejected.

$\aleph^2$ is Chi-Square Test

Oi is Observant

Ei is Expectant

$\sum$ is Summation

N is number of Sample Points

Ei = (total number of Observant)/(total number area counted) $\equiv$ (261/15) =17.4

Weight of Waste = [(a-b)/a] 100

Where W is moisture Content %

a- is initial weight of the sample, kg

b- is weight of the sample after drying at 105 degree Celsius kg.

Density = weight/ volume

Volume – a measuring Cylinder m^3/yr

APPENDIX V

Results of Values for Statistical Analysis of Data obtained from Survey Research Questionnaires Administered on Minna Residents in selected Areas mention in the Survey Research Work.

S/No.	Name of Area	No. of Yes	No. of No	Observed O_i	Expected E_i	$(O_i - E_I)$	$(O_i - E_I)^2$	$((O_i - E_I)^2 / E_i)$
1	KPAKUNKU AREA	17	3	20	19.2	0.8	0.64	0.033333
2	MAIKUKELE AREA	15	5	20	19.2	0.8	0.64	0.033333
3	MAITUNBI AREA	19	1	20	19.2	0.8	0.64	0.033333
4	BOSSO ESTATE AREA	17	2	19	19.2	-0.2	0.04	0.002083
5	AREA COURT	17	1	18	19.2	-1.2	1.44	0.007500
6	F-LAYOUT AREA	17	2	19	19.2	-0.2	0.64	0.033333
7	TUNGA LOW COST	17	3	20	19.2	0.8	0.64	0.033333
8	PAIDA AREA	18	2	20	19.2	0.8	0.64	0.033333
9	BARIKIN SALE AREA	14	3	17	19.2	-2.2	4.84	0.250800
10	DUSTE KURA AREA	18	1	19	19.2	-0.2	0.04	0.002083
	SUMMATION (Σ)	169	23	192	192			0.462464