

THE EFFECT OF WASTEWATER FROM CAR-WASH ON
SOIL HYDRAULIC PROPERTIES

BY

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NOVEMBER, 2008

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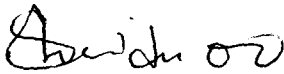
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BEING A FINAL YEAR PROJECT SUBMITTED
IN PARTIAL FULFILLMENT OF THE REQUIREMENT
FOR THE AWARD OF BACHELOR OF ENGINEERING
(B. ENG) DEGREE IN AGRICULTURAL AND
BIORESOURCES ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

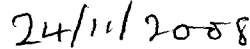
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DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or Diploma or Certificate at University or Institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.



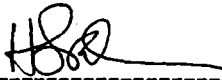
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CERTIFICATION

This is to certify that this project was carried out by Sheidu, Ojo Ozinya in the Department of Agricultural and Bioresources Engineering, Federal university of Technology, Minna.



MRS. H.I. MUSTAPHA
(SUPERVISOR)

20-11-08

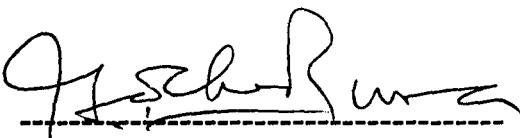
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DR. (MRS.) Z.D. OSUNDE
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EXTERNAL EXAMINER

19-11-08

DATE

CERTIFICATION

This project entitled "Effect of wastewater from Car-wash on soil hydraulic properties" by Sheidu Ojo Ozinya meets the regulations governing the award of the degree of Bachelor of Engineering (B.Eng.) of the Federal University of Technology, Minna and it is approved for contribution to scientific knowledge and literary presentation.

MRS. H.I. MUSTAPHA
(SUPERVISOR)

DATE

DR. (MRS.) Z.D. OSUNDE
(H.O.D)

DATE

EXTERNAL EXAMINER

DATE

DEDICATION

project is dedicated to my parents whose support and advice earned the success of this work

ACKNOWLEDGEMENTS

The task of doing this project was made much easier by the support and understanding of my parents Mr. and Mrs. Sheidu Ozinya. I would like to thank my supervisor, Mrs. H. Mustapha for her intellectual stimulation and encouragement. I am indebted to my lecturers who have helped me both directly and indirectly. I can only mention a few of them here H.O.D. (Mrs.) Z.D. Osunde, Dr. O. Chukwu, Dr. Ayuba audu Balam; Prof. E.S.A. Ajisegiri, Engr. Peter Idah, Mr. Peter Adeoye, Engr. Sadiq and others.

I have received a great deal of useful feedback from my family Mr. and Mrs. Abdul Malik, my step mums and Abdulummin Abdulsalam and his wife to be. I am sure this project would be much stronger if I have followed all their advice. Above all, is the Almighty Allah who spared my life and gave me strength to overcome this project work. Without His mercy upon me this project would have earned no success.

ABSTRACT

This study was to investigate the impact of wastewater from car-wash on soil hydraulic conductivity. Two Soil pits (1m x 1m x 1m) were dug, one in the car-wash site (A) and other in an adjacent area to the car-wash site (B). Core samples were collected at an interval of 20cm from each soil pH. The core samples were immediately covered with coring caps to prevent evaporation. They were then taken to the laboratory and saturated for 24 hours. After saturation period, the hydraulic conductivity of soil samples of soil A were measured and recorded using the constant head method. The same procedure was taken to measure the hydraulic conductivity of soil B, and the values obtained were also recorded. A sample of wastewater from car-wash was analysed and the result of each constituent was recorded. From the results of hydraulic conductivity it was noticed that there is a substantial decrease in the hydraulic conductivity of Soil A compared to soil B. From the results of wastewater sample analysis, it appears that sodium (Na) in car-wash detergents may play an important role in causing substantial reduction in soil hydraulic conductivity following the application of wastewater from car-wash.

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CHAPTER ONE

1.0 INTRODUCTION.

Wastewater could be defined as the graywater from bathroom sinks, laundry, carwash, washing machine and kitchen wastewater. Using wastewater is certainly a good idea but it also has its drawbacks. Wastewater from washing machine or carwash may contain bleach, which is a hazardous chemical. And when plants or crops are irrigated directly with wastewater they will be contaminated by absorbing the harmful stuff in wastewater (Attila and Walter, 2005).

Bathwater or wastewater from bathroom contains fecal matter, which may be rotten. Dish water or wastewater from kitchen contains particulate food matter, which may be rotten. And bathwater may contain fecal matter and dead skin that sloughs off while you bath. The amount of these wastes are small enough to prevent gray water from going through the treatment process that black water (wastewater from toilet) does, but it should not be used for irrigation of food plants (Josh, 2007).

Surfactants are a major ingredient in all types of detergents. The main function of surfactants is to increase the wash effectiveness of the product.

Due to limited capability of individual surfactants, a mixture of different surfactants is generally used in detergents. Surfactants can be classified as anionic, cationic and nonionic. Anionic surfactants are the most common surfactants in car wash detergents. Most anionic surfactants contain sodium in their chemical structure (Alhajjar, 1989).

As a matter of fact, irrigation for lawn and gardens is the only advisable application for using gray water. The cleaning agent found in car wash detergents like phosphorus and nitrogen are actually used in many plant fertilizers sold on the market. However, some plants like citrus and nut trees like gray water than other plants but must be sub – surface irrigated through the roots. Since gray water is alkaline – rich, it is acceptable for fruit trees if only it is applied to the roots. However, direct application to foliage can leave untreated micro organisms on surfaces. Do not surface irrigate fruits and vegetables that are eaten raw (Straw berries, lettuce, or carrots, for examples) with gray water. In addition to nitrogen and phosphate, car wash detergents also contain sodium salts. These salts can build up over time and become toxic to plants, essentially poisoning the soil. If gray water is used for edible roots plants such as carrots, or potatoes, the roots will absorb all the harmful stuff in gray water and it will be contaminated and harmful to health (Attila and Walter, 2005).

1 Objectives

The Objectives of this study are:

- i. To investigate the effect of wastewater from car-wash on soil hydraulic properties.
- ii. To compare the results of wastewater analysis with the FAO standard for irrigation water in order to know the level of contamination.

1.2 Project Justification.

This project is of utmost importance to the society and environment because it seeks to investigate the effects of untreated wastewater on agricultural land which may affect the fertility of the soil thereby reducing the quality of the produce, and results to the contamination of fruits, vegetables and roots crops. It also stops or prevents the creation of habitats for disease vectors thereby improving environmental conditions.

1.3 Statement of the Problem

Most commercial car-wash in Nigeria discharge their wastewater directly on the soil without taking it into consideration the side effects of their action. This project is undertaken to find out the effects of this wastewater on the agricultural land to ensure the improvement of soil fertility and environmental conditions.

1.4 Scope of the Study.

This study is restricted to the investigation of the effect of wastewater from car wash on soil hydraulic properties. Wastewater from other sources are not considered.

CHAPTER TWO

2.0 LITERATURE REVIEW

Most wastewater was generated from domestic sources in 1940s, but as industrial development grew significantly, increasing amounts of industrial gray water have been and continue to be discharged to municipal collection systems. The amounts of heavy metals and synthesized organic compounds generated by industrial activities have increased, and some 10,000 new organic compounds are added each year. Many of these compounds are now found in the gray water from most municipalities and communities.

As technological changes take place in manufacturing, changes also occur in the compound discharged and the resulting gray water characteristics. Numerous compounds generated from industrial processes are difficult and costly to treat by conventional gray water treatment processes. Therefore, effective industrial pretreatment becomes an essential part of an overall water quality management program. Enforcement of an industrial pretreatment program is a daunting task, and some of the regulated pollutants still escape to the municipal gray water collection system and must be treated. In the future with the objective of pollution prevention, every effort should be made by industrial discharges to assess the environmental impacts of any new compounds that may enter the gray water stream before being approved for use. If a compound cannot be treated effectively with existing technology, it should not be used (Metcalf and Eddy, 1991)

2.1 Sources of Wastewater

The sources of gray water are:

- i Domestic wastewater: - This is a wastewater generated from domestic activities such as wastewater from bathroom sink, clothe washers, and dish washing machine.
- ii Commercial wastewater: - Wastewater generated from industrial activities are referred to as industrial wastewater from laundry, car wash e.tc.
- iii Industrial wastewater: - Wastewater generated from industrial activities are referred to as industrial wastewater such as wastewater from Dunlop company vita foam, Nestle etc.

2.2 Wastewater Treatment

Gray water collected from municipalities and communities must ultimately be returned to reducing waters or to the land or reused. The complex question facing the design engineers and public health officials is what level of treatment must be achieved in given application, beyond those prescribed by discharge permits to ensure protection of public health and the environment? The answer to this question requires detailed analysis of local conditions and needs, application of scientific knowledge and engineering judgment based on past experience, and consideration of federal, state and local regulations. In some areas a detailed risk assessment may be required. The reuse and disposal of biosolids, vexing problems for some communities, are discussed here.

2.21 Treatment Method

Methods of treatment in which the application of physical forces predominate are known as unit operations. Methods of treatment in which the contaminates is brought about by chemical or biological reactions are known as unit processes. At the present time, unit operation and processes are grouped together to provide various forms or levels of treatment known as preliminary, primary, advance primary, secondary (with or without nutrient removal) treatment (table 2.1). in preliminary treatment, gross solids such as large object, rags and debris are removed that may damage equipment. In primary treatment, a physical operation, usually sedimentation is used to remove the floating and settleable materials found in wastewater for advanced primary treatments, chemicals are used or added to enhance the removal of suspended solids, and to a lesser extent, dissolved solids. In secondary treatment, biological and chemical processes are used to remove most of the organic matter. In advance treatment, additional combinations of unit operations and processes are used to remove residual suspended solids and other contaminants that are not reduced significantly

TABLE 21 LEVEL OF WASTEWATER TREATMENT.

TREATMENT LEVEL	DESCRIPTION
PRELIMINARY	Removal of gray water constituents such as rags, sticks, floatables, grit, and grease that may cause maintenance or operational problems with the treatment operations, processes, and ancillary systems.
PRIMARY	Removal of a portion of suspended solids and organic matter from wastewater.
ADVANCE PRIMARY	Enhanced removal of suspended solids and organic matter from the wastewater. Typically accomplished by chemical addition or filtration.
SECONDARY	Removal of biodegradable organic matter (in solution or suspension) and suspended solids. Disinfection is also typically included in the definition of conventional secondary treatment.
SECONDARY WITH NUTRIENT REMOVAL	Removal of biodegradable organics, suspended solids and nutrients (Nitrogen, phosphorus or both Nitrogen and phosphorus).

<p>TERITARY</p>	<p>Removal residual suspended solids (after secondary treatment) usually be granular medium filtration or micro screens. Disinfection is also typical a part of tertiary treatment. Nutrient removal is often included in the definition.</p>
<p>ADVANCE</p>	<p>Removal of dissolved and suspended materials remaining after normal biological treatment when required for various water used application.</p>

Source: (Crites and Tchobanoglous, 1998)

A list of unit operations and processes used for removal of major constituents found in wastewater is presented in table

TALBE 2.2 UNIT OPERATIONS AND PROCESSES USED TO REMOVE
 CONSTITUENTS FOUND IN WASTEWATER.

CONSTITUENTS	UNIT OPERATION OR PROCESS
SUSPENDED SOLIDS	Screening, grit removal, sedimentation. high - rate clarification, floatation. chemical precipitation, depth filtration. surface filtration.
BIODEGRADABLE ORGANICS	Aerobic suspended growth variations Aerobic attached growth variations, an aerobic suspended growth variations, lagoon variation. Physical - chemical systems, chemical oxidation, advance oxidation, membrane filtration.
NUTRIENTS	

NITROGEN	Chemical oxidation (breakpoint chlorination), suspended - growth nitrification and denitrification variations, air stripping ion exchange.
PHOSPHOROUS	Chemical treatment, biological phosphorus removal.
NITROGEN AND PHOSPHORS	Biological nutrient removal variations chlorine compounds, chlorine dioxide, ozone, ultraviolet (uv) radiation.
COLLOIDAL AND DISSOLVED SOLIDS	Membrane, chemical treatment, carbon adsorption, ion exchange.
VOLATILE ORGANIC COMPUNDS	Air stripping, carbon adsorption, advance oxidation.
ODORS.	Chemical scrubbers, carbon and sorption, Biofilters, Compostifier.

Source: crites and Tchobanglous 1998)

2.3 Wastewater Reclamation and Reuse

In many locations where the available supply of fresh water has become inadequate to meet water needs, it is clear that the once used water collected from municipalities and communities must be viewed not as waste to be disposed of but as a reuse is becoming accepted more widely as other parts of the country experience water shortages.

The use of dual water systems, such as now used in St. Petersburg in Florida and Viejo in California, is expected to increase in the future. In both locations, treated effluent is used for landscape watering and other non potable uses (U.S. NURC, 1998)

2.4 Constituents of Wastewater

Gray water is characterized in terms of its physical, chemical and biological compositions.

2.4.1 Physical characteristics: - The most important physical characteristic of wastewater is its total solid content, which is composed of floating matter, settleable matter, colloidal matter, and matter in solution. Other important physical characteristics are particle size distribution, turbidity, colour, transmittance, temperature, conductivity and density, specific gravity and specific weight.

i **Total solid content:** - This is obtained by evaporating a sample of graywater to dryness and measuring the mass of residue.

ii. **Particle size distribution:** - The measurement of particle size is undertaken and an analysis of the distribution of particle size is conducted (Tchobangolous, 1995). Information on particle size is of importance in assessing the effectiveness of the treatment process (e.g. secondary sedimentation, effluent filtration, and effluent disinfection). Because the effectiveness of both chlorine and ultraviolet disinfection depends on particle size, the determination of particle size has become more important especially with the move towards greater effluent reuse in the various countries.

iii. **Turbidity:** - This is a measure of the light – transmitting properties of water, is another test used to indicate the quality of waste discharges and natural waters with respect to colloidal and residual suspended matter. The measurement of turbidity is based on comparison of the intensity of light scattered by a sample to the light scattered by a reference suspension under the same condition. Formalin suspension are used as primary reference standard. The result of the turbidity measurements are reported as nephelometric turbidity units (NTU). Colloidal matter will scatter or absorb light and this preventing its transmission.

iv. **Temperature:** The temperature of water is a very important parameter because of its effect on chemical reactions and reaction rates, aquatic life's and the suitability of water for beneficial uses. Increase in temperature, for example can cause a change in the species of fish that can exist in the receiving water body.

v. **Colour:** - Historically, the term "condition" was used along with composition and concentration to describe gray water. Condition refers to the age of the wastewater, which is determined qualitatively by its colour and odour. Fresh graywater is usually a high brownish gray colour. However, as the travel time in the collection system increases and more anaerobic conditions develop, the colour of the wastewater changes sequentially from gray to dark gray, and ultimately to black. When the colour of the wastewater is black, the wastewater is often described as septic. In most cases the gray, dark gray and black colour of the waste water is due to formation of metallic sulfides, which forms as the sulfide produced under anaerobic conditions reacts with the metals in the wastewater.

vi. **Conductivity.:** - The electrical conductivity (EC) of a water is a measure of the ability of solution to conduct an electric current. Because the electrical current is transported by ions in solution, the conductivity increase as the concentration of ions increases. In effect, the measured EC value is used as surrogate measure of total dissolved solids (TDS) concentration. At present, the EC of water is one of the important parameters used to determine the suitability of water for irrigation. The salinity of treated waste water to be used for irrigation is estimated by measuring its electrical conductivity (EC). The electrical conductivity in SI unit is expressed as milliamperes per meter (mms./m) and in micromhos per centimeter ($\mu\text{mho/cm}$) it should be noted 1 mms./m is equivalent to 10 $\mu\text{mho/cm}$

Density, specific gravity and specific weight. - The density of wastewater is defined as its mass per unit volume expressed as g/l or kg/m^3 in SI units. Density is an important physical characteristic of wastewater because of the potential for the formation of density currents in sedimentation tanks, chlorine contact tanks, and other treatment units. In some cases the specific gravity of wastewater $S_w \geq \rho$ is used in place of density. The specific gravity is defined as.

$$S_w = \rho_w / \rho_0$$

2.1

Where ρ_w = density of wastewater.

ρ_0 = density of water

Both the density and specific gravity are temperature dependant and will vary with the concentration of total solid in wastewater. Specific weight of fluid γ is its weight per unit volume. In SI units the specific weight is expressed as kN/m^3

2.4.2 CHEMICAL CHARACTERISTICS

These are quantified in terms of inorganic and organic constituents. The inorganic non – metallic constituents include pH, chlorides, Alkalinity, Nitrogen, phosphorus, sulfur, Gases etc. the inorganic metallic constituents are Arsenic, Cadmium, Calcium, Chromium, copper, iron, lead, magnesium, manganese, mercury, potassium, sodium, and zinc, etc.

The inorganic nonmetallic constituents considered in this section include pH, Nitrogen, Alkalinity, chlorides, sulfur, other inorganic constituents gases, and odours.

- i. pH: - This could be defined as the hydrogen ion concentration. And it is an important quality parameter of both natural waters and wastewaters the usual means of expressing the hydrogen ion concentration is as P_h , which is defined as the negative logarithm of hydrogen ion concentration.

$$pH = -\text{Log}_{10} [H^+] \qquad 2.2$$

The concentration range suitable for the existence of most biological life is quite narrow and critical (typically 6 to 9). Wastewater with an extreme concentration of hydrogen ion is difficult to treat by biological means and if the concentration is not altered before discharge, the wastewater effluent may alter the concentration in the natural waters. For treated effluents discharge to the environment the allowable Ph range usually varies from 6.5 to 8.5 (FAO, 2006).

ii Chlorides

Chlorides is a constituent of concern in wastewater as it can impact the final reuse applications of treated wastewater. Chlorides in natural water result from leaching of chloride – containing rocks and soils with which the water comes in contact and in coastal area from saltwater intrusion. In addition, agricultural, industrial and domestic wastewaters discharged to surface water are a source of chlorides.

iii Alkalinity

Alkalinity in wastewater results from the presence of hydroxides [HO⁻] carbonates [CO₃²⁻], and bicarbonates [HO⁻CO₃⁻] OF elements such as calcium, Magnesium, Sodium, Potassium, and Ammonia. Of these, calcium and magnesium bicarbonates are most common. Borates, silicates, phosphates can also contribute to the alkalinity. The alkalinity in wastewater helps to resist changes in Ph caused by the addition of acids. Wastewater is normally alkaline, receiving its alkalinity from the water supply, the ground water and the materials added during domestic uses. The concentration of alkalinity in wastewater is important where chemical and biological treatment is to be used.

iv. Phosphorus

Phosphorous is also essential to the growth of algae and other biological organisms. Because of noxious algae blooms that occur in surface water there is presently much interest in controlling the amount of phosphorus compounds that enter surface waters in domestic and industrial waste discharges and natural run off. The usually forms of phosphorus that are found in aqueous solutions include the orthophosphate,

polyphosphate, and organic phosphate the orthophosphate for example PO_4^{3-} , HPO_4^{2-} , H_2P^4 , H_3PO_4 are available for biological metabolism that further breakdown

v. sulfur

The sulfur ion occurs naturally in most water supplies and is present in wastewater as well. Sulfur is required for the synthesis of proteins and it released in their degradation. Sulfur is reduced biologically under anaerobic conditions to sulfide which, in turn can combine with hydrogen to form hydrogen sulfide (H_2S).

vi Gases

Gases commonly found in wastewater include Nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2) hydrogen sulfide (H_2S), ammonia (NH_3) AND METHEN (CH_4). The first three are common gases of the atmosphere and will be found in all waters exposed to air. The later three are derived from the composition of organic matter present in wastewater and are concerned with respect to worker health and safety.

2.4.3 Metallic Constituents

Trace quantities of many metals, such as Cadmium (Cd), chromium (Cr), copper (cu), iron (Fe), lead (pb), Manganese (Mn) Mercury (Hg), Nikel (Ni) and Zinc (Zn) are important constituents of most water. Many of these metals are also classified as the priority pollutants. However, most of these metals are necessary for growth of biological life, and absence of these metals in excessive quantities will interfere with many

beneficial uses of water because of their toxicity: the before it is frequently desirable to measure. And control the concentrations of these substances.

2.4.4 Importance of Metals

All living organisms required varying amounts of (Macro and micro) metallic elements, such as iron, chromium, copper, Zinc, and cobalt, for proper growth. Although macro and micro amounts of metals can be toxic when present in elevated concentrations. As more use is made of treated wastewater effluent for irrigation and landscape watering, a variety of metals must be determined to assess any adverse effects that may occur. Calcium, Magnesium and Sodium are of importance in determining the sodium adsorption ratio (SAR) which is used to assess the suitability of treated effluent for agricultural use

2.4.5 Organic Constituents

Organic compounds are normally composed of a combination of carbon, hydrogen, and oxygen, together with nitrogen in some cases. The organic matter in wastewater typically consist of proteins (40 to 60 percent), carbohydrates (25 to 50 percent) and oils and fats (8 to 12 percent) over the years, a number of different analysis have been developed to determine the organic content of wastewaters. In general, the analysis may be classified into those used to measure aggregate organic matter comprising of a number of organic constituents with similar characteristics that

can not be distinguished separately, and those analysis used to quantify individual organic compound. In general the laboratory methods commonly used to measure gross amounts of organic matter (typically greater than 1 mg/L in wastewater include: bio- chemical oxygen demand (BOD) 2. Chemical oxygen demand (COD).

i **Biochemical oxygen demand (BOD)** is the quantity of oxygen used in the biochemical oxidation of organic matter in specified time, at a specific temperature, and under specific conditions. Normally 5 days at 20°C unless otherwise stated.

ii **chemical oxygen demand (COD)** is the amount of oxygen consumed from a chemical oxidant in a specified test (Raymond CL 1984).

iii **Surfactants:** Surfactants, or surface – active agents; are large organic molecules that are slightly soluble in water and cause foaming in wastewater treatment plants and in the surface water into which the waste effluent is discharged. Surfactants are a major ingredients in all types of detergents (Alhajjar et al, 1989). The main function of surfactants is to increase the wash effectiveness of the product.

Due to limited capability of individual surfactants, a mixture of different surfactants is generally used in detergents. Surfactants can be classified as anionic, cationic and nonionic. Anionic surfactants are the most common surfactants in car – wash, laundry and other general detergents.

2.4.6 Biological characteristics of graywater

Micro organisms are commonly present in wastewater and surface water but are usually not present in ground water because of the filtering action of the aquifers. The most common microorganisms in wastewater are bacteria, algae, fungi and protozoa.

- i. Bacteria are single celled microorganisms. They possess no well defined nucleus, are devoid of chlorophyll, and reproduce by binary fission. Bacteria exhibit almost all possible variations in morphology, from the simple sphere to very elongated, branching threads. Many serious diseases of humans are caused by bacteria.
- ii. Algae unicellular, generally non motile plants. They range in size from 5 to 100µm. All use photosynthesis as their primary mode of nutrition. Algae are typically not of health concern, however, certain species may produce endo – or exotoxins, which if ingested at high enough concentrations, may be harmful.
- iii. Protozoan are unicellular, colorless, generally non motile organisms that lack a cell wall. Several protozoan are pathogenic to humans. And these are of interest in water treatment (Frederic W. Pontius, 1990).
- iv. Fungi are tiny aerobic heterotrophic, protists containing no chlorophyll. They can tolerate drier and more acid conditions than most bacteria and also are often many – celled. They live in the earth, fresh water and sea water. Often they grow so large that they can be seen with the naked eye (mushrooms). Many grow as filaments and may be seen in polluted rivers or trickling filter or activated sludge. The optimum Ph for most types is between 5 and 6 but they can exist with water at Ph values between 2 and 9 (John S. Scott, 1983)

2.5 SOIL FORMATION.

Soil formation is the differentiation of the surface volume of the landmass into horizons of soil profiles. In other words, it is the progressive organization of the system. Initially, the rocks and minerals of the landmass determine the nature of the soil (Clarence, 1982).

Soil formation proceeds in stages, but these stages may grade indistinctly from one into another. The first stage is the accumulation of unconsolidated rock fragment, the parent material parent material may be accumulated by deposition of rock fragments moved by glaciers, wind, gravity of water. It may accumulate more or less in place from physical and chemical weathering of horizons. This stage may follow or go on simultaneously with the accumulation of parent material. Soil horizons are as a result of dominance of one or more process over others, producing a layer, which differs from the layers above and below.

They major processes in which promote horizon fermentation are gains, losses, transfers and trains formations of organic matter, soluble salts, carbonates, silicate clay mineral sesquioxides and silica (Smith, 1982).

Grains consist normally of additions of organic matter and oxygen and water through oxidation and hydration. Loses are mainly of material dissolved or suspended in water percolation through the profile or running off the surface.

2.5.1 The Soil Profile

The interactions within the soil system produce visible changes in the soil mass. Vertical sections of most soils reveal a succession of layers called horizons each having distinctive properties such as colour and thickness at each approximately the curvature of the land surface. The total vertical pattern including all horizons is called the soil profile horizontal variation, which may integrate very gradually are identified as kinds of soil, with each kind having similar profiles throughout its extent. Soil profiles then, are the major identifying features of kinds of soils and they reflect a particular history of natural process that has taken place at the profile site (Clarence, 1982).

Two commonly recognized major soil horizons are surface soil and subsoil. However, close inspection reveals more layers in many soils. Scientists identify them chiefly by the letters A, B, AND C from the top downward, and then often. Subdivide them as A₁ A₂ A₃ B₁ B₂ B₃ C.

THE "A" horizons are parts of the surface soil, and the B horizons are parts of the subsoil. The C horizons are made up of rock fragments called the parent material of the soil (Garrison, 1982).

2.5.2 Soil Organic Matter

All soils contain living organisms, the majority of these organisms are too small to be seen with naked eyes. It has been estimated that in every gram of soil sample there are approximately 1000 million bacteria. When plant residues are turned into the soil they are subjected to rapid bacteria attack and much of the organic matter is lost to the air as carbon dioxide (CO₂).

However a residue of dark colour less decompose losable material remains which is called "humus" or soil organic matter. The amount of organic matter in a soil depends on several factors, the most important being the supply of air. When aeration is restricted due to poor drainage, then breakdown of plants remain by bacteria and other soil organisms is inhibited, so wet soils are normally rich in organic matter and well aerated soil contain much less. The quantity of organic matter returned the soil in the form of roots, other plants remain and manures also has some effects. The actual amount of humus is the net result of input of organic material and the rate of breakdown (David Et,al, 1986).

2.5.3 Soil texture.

This refers to the size and proportions of the particles making up a particular soil. Sand, silt, and clay are the three major classes of soil particle. Soil high in sand content are said to be coarse textured because water readily infiltrates into sandy soils. The runoff and consequently the erosion potential is relatively low. Soil with high content of silt and clay are said to be fine textured or heavy clay because of its thickness, bind soil particles together and makes soil resistant to erosion. Soil that are high in silt and sand (fine sand), low in clay and organic matter are generally most erodible, well drained sandy and rocky soil are the least erodible (Goldman,1986).

Soil are commonly classified using the textural triangle fig 2.1.

2.5.4 Soil Structure.

This refers to the arrangement of particles in a soil. A granular structure is desirable because permeability and water holding capacities are increased, and clumped particles art more resistance to erosion.

2.5.5. Soil Permeability.

This refers to the ability of soil to allow air and water to move through it. Soil texture, structure and organic matter contribute to permeability. Soil with high permeability absorb more rainfall, produce less run off, are less susceptible to erosion and support plant growth more successfully (Landon, 1984).

2.5.6 Infiltration.

This is the movement of water into the soil. That is, the process by which part of precipitation (rainfall) enters the sub surface of the soil. During a rainstorm, water particles enter voids in the soil and fill them to saturation under sufficient raining conditions, and water particles move down freely to join the under ground water (reservoir).the rate at which water move from surface soil to the subsurface soil or subsoil is called the infiltration rate (Chow, 1988).

2.5.7. Percolation.

This could be defined as the movement of water though the soil. Percolation rate is synonymous to infiltration rate with the quantitative provision of saturated or near saturated condition.

2.5.8. Bulk density (D).

The dry bulk density of the soil is defined as the ratio of the mass of dry particles to the total volume of soil (including particle and pores). Considering the expression below (Micheal,1985).

$$D = M_s/V_t = M_s / (V_s + V_a + V_w) \quad 2.3$$

Where M_s = mass of dried soil (kg).

$$V_t = \text{Total volume of soil} \quad m^3$$

$$V_a = \text{Volume of air} \quad m^3$$

$$V_w = \text{Volume of water} \quad m^3$$

2.5.9. Hydraulic Conductivity

Hydraulic conductivity of a soil, K in cm/h defines the volume of water which will pass through unit cross section area of a soil of a soil in unit time given a unit difference in water potential. The measurement is being made for two purposes a. for comparison of hydraulic conductivity rates of difference soils. B. as a bases for in field drainage design (Landon, 1984.)

Saturated hydraulic conductivity referring to the flow of fluid through a saturated conducting medium, derived from empirical relationship by Darcy (1950) between the rate of flow through saturated columns of sand and the hydraulic head loss; this may be expressed as:

$$K = QL/HAT \quad 2.4$$

Where,

Q = Volume of water collected, cm³

L = Length of coring, cm

H = Combine or total height of coring, cm

A = Cross – sectional area of coring, cm²

T = time in hour.

Area, $A = \pi d^2/4$

2.5.

Where,

d = diameter of coring.

Conductivity values are related to textural and structural characteristics of the soil, (FAO 1983) classification. Soils with hydraulic conductivity value below 0.1m/day require excessive close drain and spacing and hence some artificial modification of subsoil water movement by moiling or sub soiling is essential for practical and economical field drainage system. Hydraulic conductivity of 0.1 to 1.0m/ day is the most critical for racing measuring K required in the range. Pounding changes in the hydraulic conductivity value can have serious effects on the movement of irrigation or drainage water within the profile.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Site description

The car-wash site is located about 50m away from Federal University of Technology; Minna, Bosso campus. It is under Bosso Local Government Area of Niger state. The area of the site is 17m by 15m . The soil class of the top soil (0-20)cm is loam. The site is located on the latitude of $9^{\circ}38'$ North and $6^{\circ}32'$ East. The vegetation of the site is continuously wet as a result of the car-war activities that is taking place there. The climatic condition of the area : Rain starts early March and last till early November, annually.

3.2 Experimental Procedures

3.2.1 Determination of Hydraulic Conductivity (Constant head method)

Soil profiles of 1m x 1m x 1m were dug in two different places (one on the car wash site and other one in an adjacent area to the site). Core samples were collected vertically at an interval of 20cm. Two core samples were collected at each depth and were covered immediately with the core ring cap to avoid evaporation from the soil collected. This procedure was repeated for the other soil profile pit and the core samples were taken to the laboratory and soaked for a period of 24 hours. This was done to enable the samples to saturate in order to aid the flow of water which might be disturbed by air bubbles.

Finally an empty core ring was connected to one end of the core sample (after 24 hours of saturation) by the use of cellophane and then clothe cotton was used to cover the other end of the core samples with the aid of rubber band. It was then mounted on a

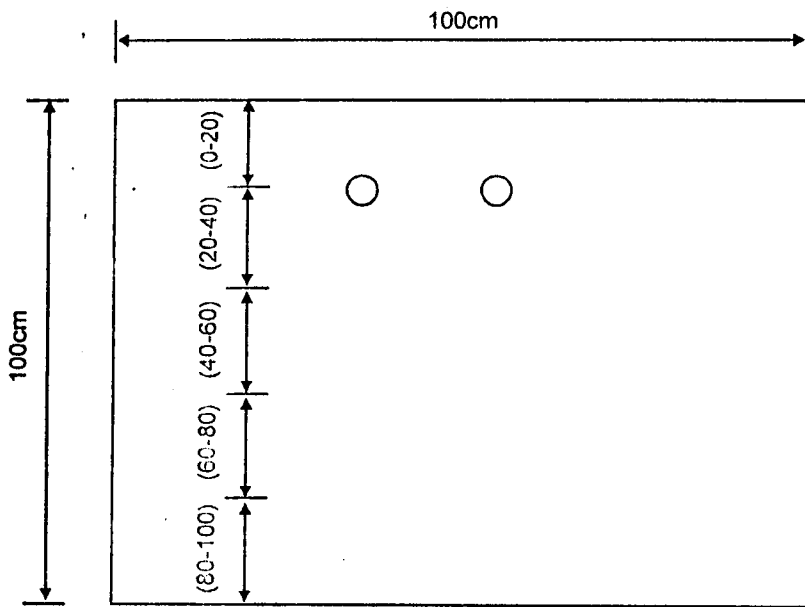


Figure 3.1 Cross Section of the Soil Pit.

tripod stand and the top empty core ring was filled with water and allowed to infiltrate into an empty can for 5 minutes. The water that passed through the core samples into the can was measured with a measuring cylinder. This process was repeated for all the core samples for the two soil profiles pits.

$$K = \frac{QL}{HA t}$$

Where

Q = Volume of water collected, cm^3

L = Length of covering, cm

H = Combined height of core ring, cm or the head causing the flow over distance L

A = Cross sectional area of covering, cm^2

t = Time, hr

$$A = \frac{\pi d^2}{4}$$

where

d = diameter of covering, cm

The combined height of coverings, $H = 9.6cm$

the diameter of core ring = $5.0cm$

$t = 5 \text{ minute} = 0.083hr$

$$\text{Volume of core ring } V_i = \frac{\pi d^2}{4} \times L \quad 3.2 \quad 3.2$$

$$V_i = \frac{3.142 \times 5^2}{4} \times 4.8 = 94.27 cm^3$$

3.1.2 Soil Particle Size Analysis (Hydrometer Method)

Apparatus

1. Multimix machine with baffled "milkshake" cups.
2. Glass cylinders of approximately one liter capacity for containing soil suspension on during settling.
3. Special hydrometers for measuring density of soil suspension.
4. Thermometer for measuring temperature of the suspension.

5. A 2mm sieve.

Reagent

Calgon (sodium hexametaphosphate) dispersing agent) 5%.

Procedure:

Weigh 51.0g of air dry soil which has been passed through a 2mm sieve and transfer to a "Milkshake" mix cup (A 51.0g of air dry sample represents approximately 50.0g of oven dry soil). If the soil is estimated to contain 75% or more sand, 101.0g of soil are used. Add 50cl of 50% sodium hexametaphosphate along with 100cc of distilled water mix with a stirring rod and let samples set for 30 minutes.

Stir the soil suspensions for 15 minutes with the multimix machine transfer the suspension from the cup to the glass cylinder with the hydrometer in the suspension. Add distilled water to the lower blue line. The volume will be 1130cc. Use upper line (1250cc) when 100 grams are used. Remove the hydrometer.

Cover top of cylinder with the hand and invert several times until all soil is in suspension. Place cylinder on flat surface and note time. Immediately place soil hydrometer into suspension. Slide slowly into suspension until hydrometer is floating. The first reading on the hydrometer is taken at 40 seconds after the cylinder is set down. Remove hydrometer and record temperature of suspension with a thermometer.

After the first hydrometer reading let the suspension stand for 3 hours and take a second reading. Also take the temperature of the suspension. The first reading measures the percentage of silt and clay in suspension. The second reading indicates the percentage of 2 micron (total) clay in the suspension.

Results are corrected to a temperature of 68° Fahrenheit for every degree over 68°f add 0.2 to hydrometer reading before computation and for under 68° subtract 0.2 from hydrometer reading. Avoid extreme such as 50° or 100°. Also subtract 2.0 from every hydrometer reading to compensate the added dispersing agent.ss

Sample Calculation

Given

- 1a. Hydrometer reading at 40 seconds, $H^1 = 18$
 - b. Temperature at 40 seconds, $T^1 = 75^{\circ}f$
- 2a. Hydrometer reading at 3 hours, $H^2 = 8$
 - b. Temperature at 3 hours, $T^2 = 63^{\circ}f$
3. Temperature correction to be added to hydrometer reading = $0.2 (T - 68)$ where T = degree Fahrenheit.
4. Salt correction to be added to hydrometer reading = - 20

Calculations:

$$A. \quad \text{SAND} = 100.0 - [H_1 + 0.2 (T_1 - 68) - 2.0] 2 \quad 3.3$$

$$B. \quad \text{CLAY} = [H_2 + 2.0 (T_2 - 68) - 2.0] 2 \quad 3.4$$

$$C. \quad \text{SILT} = 100.0 - (\% \text{ SAND} + \% \text{ CLAY}) \quad 3.5$$

3.1.3 Bulk Density

A core ring of 5cm in diameter and 4.8cm in height was placed into the soil (0 – 20) cm and pressed into the soil by tapping it gently with a machete until the core was completely filled with soil. It was then removed gently by placing the cutlass under the core samples. This was necessary so as to prevent the soil in the core from falling off. After removing, the core sample from soil, the soil was gently transferred into a moisture

can and covered immediately so as to avoid moisture loss or gain by evaporation or condensation. The moisture can was then placed in a cool place. The same procedure was then repeated for (20 – 40)cm, (40 – 60)cm, (60 – 80)cm, (80 – 100)cm, soil depth for the two profile pits.

The cans were all covered with polythene after filling them with soil. All the samples were taken gently in a container and conveyed to the laboratory where an electronic machine was used to weigh the cans and the soil. The moisture cans were clearly labeled to distinguish the sample depth and location. They were then placed in an oven at a temperature of 105°C for 24 hours after which the oven was switched off and opened for the cans to cool a little before it was then re-weighed. The initial weight, final weight and weight of empty can sampler were taken. The bulk density and then calculated.

$$r_b = \frac{M_s}{V_t} = \frac{M_s}{V_s + V_a + V_w}$$

where

M_s = mass of dried soil (g)

V_t = Total volume of soil m^3

V_a = Volume of air m^3

V_w = Volume of water m^3

$$r_b = \frac{M_s}{V_t} \text{ (Micheal (1985))}$$

Moisture content can be calculated from the formula below;

$$M.C(\%) = \frac{W_2 - W_3}{W_3 - W_1} \times 100 \quad 3.8$$

Where

W_1 = weight of empty can (g)

W_2 = weight of empty can + weight of soil (g)

W_3 = Weight of empty can + weight of dry soil (g)

3.2.0 Determination of Some Selected Properties of Wastewater from Car- Wash

3.2.1 pH

The pH was determined to know the avidity or alkalinity of the graywater samples.

Procedure: The pH was taken using oyster – 10 pH meter. The electrode of the pH meter was washed with distilled water and rinsed with water sample. It was then inserted into 250ml beaker containing the water sample. The meter was switched on and the pH reading was taken from the digital display.

3.2.2 Calcium and Magnesium

There are determined by EDTA-Titration.

Procedure: 25ml of water was measured and transferred into 250ml conical flask. It is further diluted by adding 100ml of H₂O. 20ml of ammonium buffer was then added. Then 4 drops of Erichrome black indicator was added and titrated to a blue end point with 0.02M disodium-EDTA (Ethylene diamine tetra-aceti acid(. The amount of Na₂-EDTA used was observed and recorded. This value was used to calculate the amount of Ca²⁺ and Mg²⁺ content in the water.

Determination of calcium: Pipette 25ml of water sample into a 250ml conical flask. And 100ml of distilled water was added. This is followed by the addition of 20ml of 20% KOH. A pinch of murexide power indicator was also added. And 0.02N Na₂EDTA was titrated from reddish to produce end point.

$$Ca^{2+} = \frac{S - B \times 1000 \times 0.4}{25} mgl^{-1} \quad 3.9$$

Where,

S = Volume of EDTA used by the sample

B = Blank reading (Volume of EDTA used by blank)

$$Mg^{2+} = \frac{\{(Ca^{2+} + Mg^{2+}) - B\} - (Ca^{2+} - B) \times 1000 \times 0.247}{24} \quad 3.10$$

3.2.3 Phosphorus

Procedure: (A) A standard stock solution of phosphorus approximately 100mgp/dm was prepared by dissolving 0.11g of KH_2PO_4 (This was accurately weighed) in distilled water and diluted to 250cm³ in a volumetric flask (stock solution) water. Stock B was used to prepare standards of approximately 0.20, 0.40, 0.60, 0.80, and 1.0mgp/dm³ that is, pipette 5, 10, 15, 20 and 25cm³ portions respectively to separate labeled 100cm³ portions respectively to separate 100cm³ volumetric flasks. 50cm³ of distilled water was roughly placed into 100cm³ flask as a blank solution, then all the analytical solutions for colour development was organized.

(B) Analysis of water sample: with the water sample that has been diluted by a factor of 10 pipette duplicate 25.0cm³ portions of the diluted sample to two separate 100cm³ volumetric flask then colour was developed as outline below;

(C) Colour development: The distilled water was added to all the analytical solutions (standards and samples) so that each flask contained 50cm³ of solution. Starting standard 1, 13cm³ of combined reagent using 1 25cm³ measuring cylinder was added. This was shake thoroughly and made up to the mark with distilled water. All the solutions were treated similarly and then allowed 30 minutes for colour development. Prior to measurement, the wave length of the instrument was set to 890n then with distilled water

in a 1cm cuvette. The absorbance of the standard was measured in order of increasing concentration followed by that of the sample solutions.

The result was recorded in the table and a graph of the corrected absorbance versus the corresponding concentration was plotted.

3.2.4 Electrical Conductivity (EC)

Electrical conductivity of water is a measure of its ability to conduct an electric current.

Procedure: The electrode of the conductivity measuring bridge of model EIL 5013 was washed and rinsed with distilled water and then dried with tissue paper and rinsed again with water sample. The electrode was inserted into the beaker containing the water sample. The meter was switched on and the conductivity reading was taken from the analog display by the movement of the hands. The meter is calibrated in micro ohms per centimeter ($\mu\text{mho/cm}$).

3.2.5 Determination of Chloride ion Concentration

The sample of graywater was titrated with $0.01\mu\text{ AgNO}_3$ (silver trioxonitrate (v)).

Reagents/Chemicals: $0.01\mu\text{ AgNO}_3$ solution, $0.1\mu\text{ HNO}_3$, 10% potassium chromate.

Procedure: 100ml of effluent sample was pipette into a 250ml conical flask and 2 drops of phenolphthalein was also added. A red colour was produced.

0.1M HNO_3 was also added until the solution becomes colorless. Then 2 drops of potassium chromate (K_2CrO_4) was added and the resulting yellow solution was titrated with $0.01\mu\text{ AgNO}_3$ solution until the colour changes from yellow to reddish brown.

$$\text{Concentration of Cl (Mg/l)} = \frac{V_1 - V_2}{V_s} \times 100 \quad 3.11$$

Where,

V_1 = volume of AgNO_3

V_2 = Blank

V_s = volume of sample.

3.2.6 Determination of Sodium and Potassium by Flame Photometric Method

Procedure: preparation of standards for sodium. A sodium standard for calibration was prepared from salt. A stock solution of 1000 Na^+ was prepared where serial dilution of Na^+ was prepared in the concentration between 0 and 100ppm from the 1000Na^+ stock solution.

The amount of light emitted from each concentration of Na^+ was taken using the flame photo-meter and the graph of % emission against concentration was plotted.

Sample: The emission from the water sample was also taken and recorded from which the actual concentration was gotten by interpolation from the graph.

Preparation of standards for potassium: Potassium K^+ standards for calibration curve were prepared from potassium dihydrogen orthophosphate. A serial dilution was prepared from the stock of concentration between 0 and 50ppm. The % emission was taken from the flame photometer and standard calibration curve was plotted.

The % emission for the photometer was also taken from the flame photometer and the concentration was gotten from the graph.

3.2.7 Nitrogen

Procedure: Digestion (Stage I)

A 2g of wet sample was weighed into 500ml Kjeldahl flask and 20ml of concentrated H_2SO_4 was added with one Kjeldahl catalyst tablet. 0.5g of dry sample was weighed into 5ml micro Kjeldahl flask and 5ml of conc. H_2SO_4 was added with one Kjeldahl catalyst tablet. Let the weight be (W_1).

The heater was heated to digest. The flask was rotated at an intervals until the digestion was clear (light green) the heating was continued for a few minutes after that to ascertain complete digestion. It was allowed to cool and then made up the digestion to 50, 100ml (vi). Compounds containing oxidized forms of nitrogen such as organic nitro compounds must be treated with a reducing agents prior to digestion in order to obtain complete conversion to ammonium, e.g. iron

Distillation (Stage II): A 5ml of 2% boric acid (H_3BO_3) was placed into 100ml conical flask (receiving flask). H_3BO_3 as an acid trapped down the ammonia vapor from the digest. Then 3 drops of mix indicator was added. H_3BO_3 and the indicator was prepared together. The receiving flask was placed so that the tip of the condenser tube was below the surface of the boric acid. A 5ml was pipette for sample high in nitrogen and 10ml from the sample low in nitrogen into distilled water. 10ml of 40% NaOH was added and then tight the joint and distilled about 50ml into the receiving flask (V_2).

Titration and calculation (Stage III)

The distillate was titrated with standard mineral acid (0.01M HCl or 0.025 H_2SO_4). The blank was also titrated with the acid as well.

Sample titer = T_1

Sample titre = T_2

Control titre = $T_1 - T_2 = T$

And morality of Acid = M

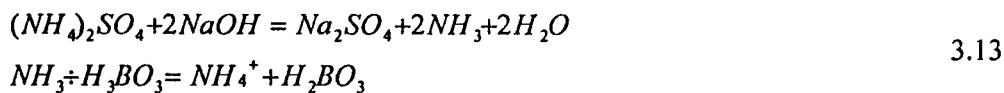
Reactions

Digestions:

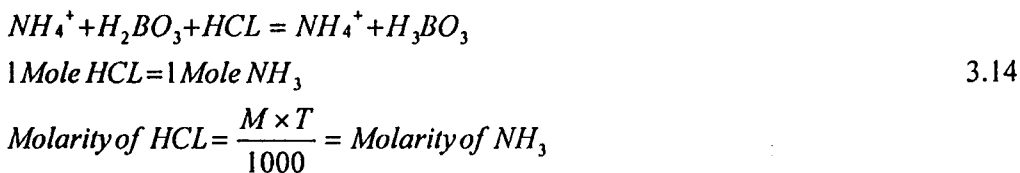


Nitrogen converted to ammonia and reacted with H_2SO_4 to form $(NH_4)_2SO_4$

Distillation



Titration



$$\text{Mass of NH}_3 = \frac{M \times T}{1000} \times 17 \text{ g}$$

$$\text{Mass of N in NH}_3 = \frac{M \times T}{1000} \times 17 \times \frac{14 \text{ g}}{17}$$
$$= M \times T \times 0.146$$

$$\%N = \frac{M \times T \times 0.014}{w} \times \frac{V_1}{V_2} \times 100$$

Where control titre = T

Morality of Acid = M

Volume of digest = V_1

Volume of digest used = V_2

Weight of sample = W

3.2.8 DETERMINATION OF SODIUM ABSORPTION RATIO (SAR)

This is calculated from the values of sodium, calcium and magnesium was obtained with the following formula.

$$SAR = \frac{Na^{2+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}} \quad 3.15$$

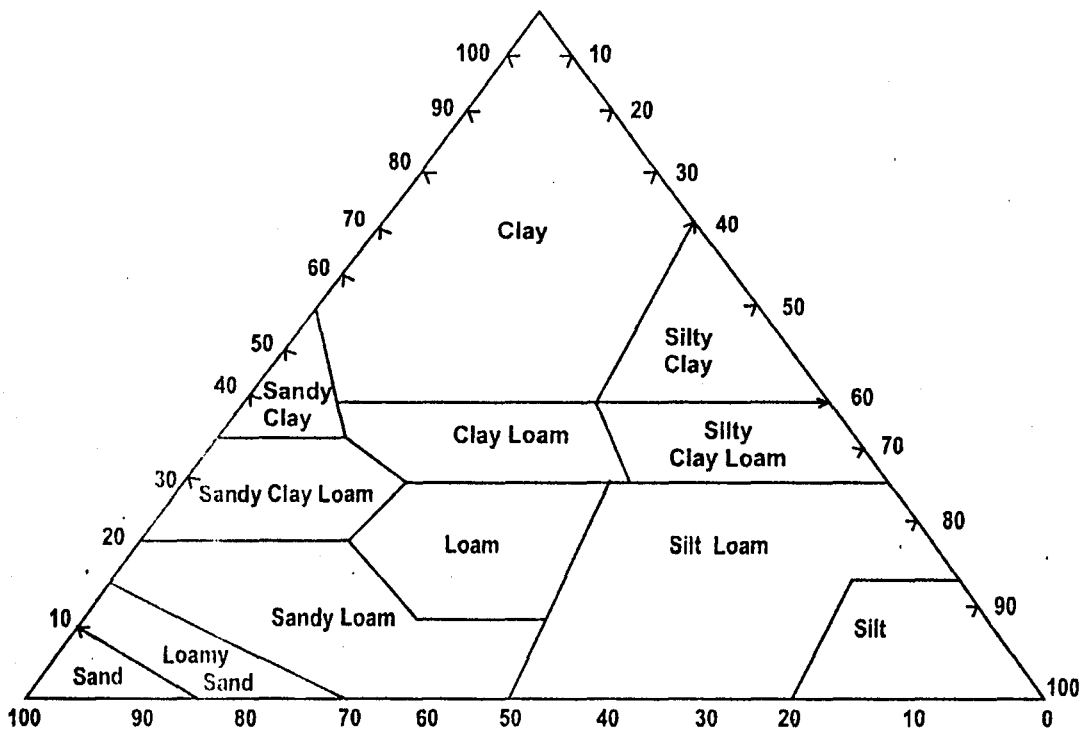


Figure 4.1 Soil may be assigned to a texture class based on the particle size distribution using the soil textural triangle.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Results

The results of the analysis are given in the tables below;

Table 4.1 Particle size analysis of soil A [Car Wash Site]

Soil Depth	Soil particle	% composition	Soil classes
0 – 20	Sand	36.00	
	Silt	40.60	Loam
	Clay	23.40	
20 – 40	Sand	34.06	
	Silt	30.04	Clay loam
	Clay	35.90	
40 – 60	Sand	19.00	
	Silt	28.30	Clay
	Clay	52.70	
60 – 80	Sand	11.50	
	Silt	30.00	Clay
	Clay	58.50	
80 – 100	Sand	6.50	
	Silt	15.00	Clay
	Clay	80.50	

Table 4.2 Particle Size analysis of soil B

Soil Depth	Soil particle	% composition	Soil classes
0 – 20	Sand	73.79	
	Silt	11.21	Sandy Loam
	Clay	15.00	
20 – 40	Sand	69.01	
	Silt	8.89	Sandy Loam
	Clay	22.10	
40 – 60	Sand	72.00	
	Silt	12.50	Loamy sand
	Clay	78.00	
60 – 80	Sand	11.90	
	Silt	10.10	Loamy sand
	Clay	75.10	
80 – 100	Sand	17.00	Loamy sand
	Silt	7.90	
	Clay		

B = An adjacent area to the car wash site

Table 4.3 Results of moisture content and bulk density of soil A

Soil depth (cm)	Weight of wet soil (g)	Weight of dry soil (g)	Moisture content	Bulk density (g/cm ³)
0 – 20	166.15	139.85	18.8	1.48
20 – 40	168.03	139.98	20.2	1.49
40 – 60	162.38	137.50	18.1	1.46
60 – 80	199.16	162.54	22.5	1.72
80 – 100	209.5	167.90	24.8	1.78

Table 4.4 Results of moisture content and bulk density of soil B

Soil depth (cm)	Weight of wet soil (g)	Weight of dry soil (g)	Moisture content	Bulk density (g/cm ³)
0 – 20	165.35	146.15	13.1	1.55
20 – 40	170.14	148.09	14.9	1.57
40 – 60	173.25	150.03	15.5	1.59
60 – 80	205.41	179.60	14.4	1.91
80 – 100	199.31	165.35	20.5	1.75

Table 4.5 Results of some selected properties of waste water (car wash)

Constituent	Waste water (car wash0
pH	8.72
EC	513 x 10 ⁻⁶
SAR	28.52
Ca	12.8mg/l
Mg	6.72 mg/l
K	0.6mg/l
Na	63mg/l
Cl	20 mg/l
PO ₄ P	0.181ppm
NH ₄ N	0.042%

Table 4.6 comparison of the results of waste water (car Wash) analysis with that of FAO standard for irrigation

Constituents	Waste water (car wash)	FAO Standard
pH	8.72	6.5 – 8.5
EC	513 x 10 ⁻⁶	< 260 x 10 ⁻⁶
SAR	28.52	< 3
Ca	12.8	1.41
Mg	6.72	0.44
K	0.6	-
Na	63	0.89
Cl	20	250
	0.181	-
	0.042	-

Table 4.7 Results of hydraulic conductivities of soil A

Soil description	Volume of water collected (cm ³)	Hydraulic conductivity (cm/m)	Time (hr)
0 – 20	8.5	2.61	0.083
20 – 40	7.0	2.15	0.083
40 – 60	3.3	1.01	0.083
60 – 80	8.1	2.49	0.083
80 – 100	29.9	9.17	0.083

Table 4.8 results of hydraulic conductivity of soil B

Soil depth (cm)	Volume of water collected (cm ³)	Hydraulic conductivity (cm/hr)	Time (hr)
0 – 20	69	21.16	0.083
20 – 40	72	22.10	0.083
40 – 60	78	23.95	0.083
60 – 80	70	21.47	0.083
80 – 100	76	23.93	0.083

Table 4.9 Comparison of hydraulic conductivities of soil A with soil B

Soil depth (cm)	Hydraulic conductivities (cm/hr) of soil		
	A	B	
0 – 20	2.61	21.16	0.083
20 – 40	2.15	22.10	0.083
40 – 60	1.01	23.95	0.083
60 – 80	2.49	21.47	0.083
80 – 100	9.17	23.93	0.083

4.2 Discussion of Results

4.2.1 Particle Size Analysis

Table 4.1 shows the results of the particle size analysis of soil "A". The percentage composition of the soil particles at depth (0 – 20) cm are as follows: 36% sand, 40.60% silt and 23.40% clay. This falls into the soil textural triangle (figure 4.2). At depth (20 – 40)cm, the proportion of soil particles are 34.06% sand, 30.04% silt and 35.90% clay. The corresponding soil textural class is clay loam. AT depth (40 – 60)cm, the proportion of soil particles are 19% sand, 28.3% silt and 53.70% clay. The corresponding soil class is clay. At depth (60 – 80)cm, the proportion of soil particles are 11.50% sand, 30.00% silt and 58.50% clay. The corresponding soil class is also clay. AT depth 90 – 100)cm, the proportion of soil particles are 6.50% sand, 15% silt and 80.50% clay. The soil textural class at this depth is clay.

Table 2.4 shows the results of the particle size analysis of soil "B". the percentage composition of soil particles at each depth is expressed as follows; At depth (0 – 20)cm, the proportion of particles sizes are 73.79% sand, 11.21% silt and 15% clay. The corresponding textural class is sandy-loam. At depth (20 – 40)cm, the proportion of soil particles are 69.01% sand, 8.89% silt and 22.10% clay. This also falls within the textural class sandy-loam.

AT depth (40 – 60)cm, the proportion of soil particles are 72% sand, 12.50% silt and 15.50% clay. The corresponding soil texture is loamy-sand. At depth (60 – 80)cm, the proportion of soil particles are 78% sand, 11.90% silt and 10.10% clay. This also falls within textural class of loamy sad.

At depth (80 – 1000cm, the proportion of soil particles are 75.10% sand, 17% silt and 7.90% clay. This also falls within the textural class of loamy sand.

Comparing table 4.1 with 4.2, it was discovered that the percentage of sand at each depth in the table 4.1 is very low compare to that in table 4.2. On the other hand, the percentage of clay at each depth in table 4.1 is higher than the percentage of clay in table 4.2. As a result of high sand fraction of soil “B”, it will transmit water rapidly than soil “A”. And due to high clay fraction in soil “A”, it will hold water more than soil “B”.

4.2.2 Moisture content

Table 4.3 shows the result of moisture content and bulk density of soil “A”. The moisture content increases from depth (0 – 20) cm to (20 – 40)cm and then decreased at depth (60 – 80)cm to (80 – 100)cm as a result of capillary rise of water. The bulk density also follows the same pattern.

Table 4.4 shows the result of moisture content and bulk density of soil “B”. The moisture content increases from depth (0 – 20)cm to (20 – 40)cm and then to (40 – 60)cm before it decreased at depth (60 – 80)cm and increased at (80 – 100)cm as a result of water capillary. The bulk density increases from depth (0 – 20)cm up to depth (60 – 100)cm and slightly decreased at depth (80 – 100)cm.

4.2.3 Results of Some Selected Wastewater (Car Wash) Constituents Analysis

Table 4.5 shows the results of the waste water analysis/ from this table it was observed that the concentration of sodium (Na), the pH, the electrical conductivity (EC), and the sodium absorption ratio (SAR) of the waste water sample are too high, and these would have a negative impact on the hydraulic conductivity of the soil.

4.2.3. Results of the Analysis of Some Selected Car-Wash Wastewater Constituents.

Table 4.5. shows the results of the wastewater analysis. The values for the concentration of Sodium (Na) was 63 Mg/L, the pH was 8.72, the electrical conductivity (EC) was $513 \times 10^{-6} \mu\text{S}/\text{cm}$ and the sodium adsorption ration (SAR) was 28.52. Comparing these values with the FAD standards, it was discovered that they are above the limit of the FAO. And these would have a negative impact on the hydraulic conductivity of the soil (crites and Techobanoglous, 1998).

These higher values of sodium concentration, pH, electrical conductivity (EC) and the sodium adsorption ratio may be related to the use of car-wash detergents.

Table 4.6 shows the comparison of the results of wastewater analysis with the FAO standards. The pH of the wastewater is 8.72 which is slightly higher than the FAO standard of 6.5-8.5 for irrigation water. The electrical conductivity and the sodium (Na) content of the wastewater are $513 \times 10^{-6} \mu\text{S}/\text{CM}$ and 63mg/L respectively. They are also above the FAO standards of $>260 \times 10^{-6} \mu\text{S}/\text{cm}$ and 0.89mg/L respectively. And these higher values may lead to the salinity and alkalinity of the soil (Amoozear and Niewochner, 1998). The sodium adsorption ratio (SAR) of the wastewater is 28.52. This value is too high and could lead to permeability hazard because the value of SAR is greater than 3 (Biggar and Nielson 1982).

4.2.4 Results of Hydraulic conductivity

Table 4.7. and 4.8 shows the volume of water collected and the hydraulic conductivity of soil depth for sample A and B. The volume of water collected at each soil depth in soil sample B is higher than that collected from soils ample A This

may be related to the application of wastewater from car-wash with a high concentration of sodium in soil (Amoozegar and Peterson, 1997).

Table 4.9 shows that there is a substantial decrease in the hydraulic conductivity of soil sample A compared to soil sample B as a result of high sodium content, higher pH value, high E-C and high SAR on the soil sodium is a primary factor in soil destruction (Amoozegar (1998), and this resulted in a substantial reduction of hydraulic conductivity of the soil sample A. permeability hazard is very high when the SAR is greater than 8 (Biggar and Nielsen 1982). Since the SAR of the wastewater is 2852, this resulted to the higher permeability hazard of the soil sample A.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The objectives of this project were achieved. Application of waste water from car wash to agricultural land decreases the hydraulic conductivity of that soil. Therefore, it should never be used to irrigate agricultural land because it has high sodium content, high EC which would lead to alkalinity and salinity of the soil. Apart from this, waste water from car wash also has a higher value of SAR which could lead to permeability hazard.

Since the analysis of the constituents of waste water sample does not fall within the limits of the FAO standards for irrigation, it therefore implies that waste water from car wash is not suitable for irrigation agricultural land.

5.2 Recommendations

For future work on this project the following should be put into consideration

- i. The biochemical oxygen demand (BOD), chemical oxygen demand (COD) and Boron (B) should be determined to know the level of contamination of the water sample.
- ii. The detergents used for car-wash should be selected and analyzed in order to know more about its constituents.

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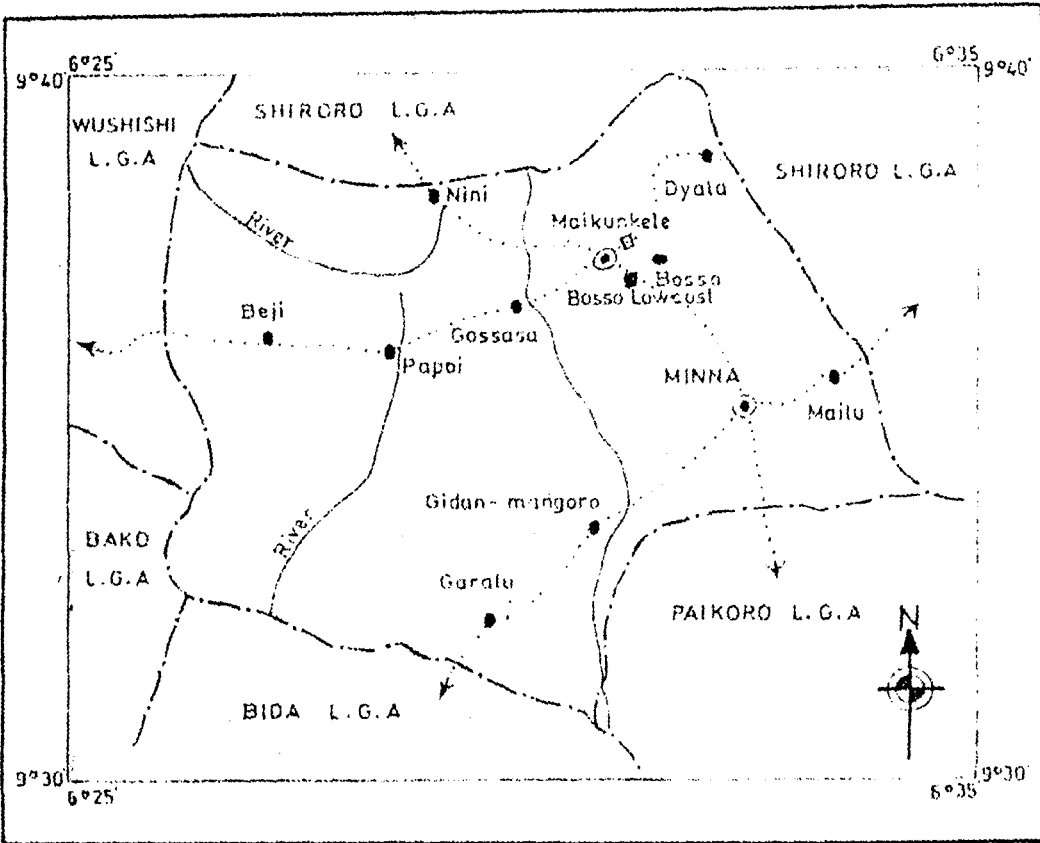
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SOURCE: Niger State Survey Division
 Drawn by: Martin S.C.

SCALE 1:175,000

0 5 10 15 20 Km

- Study Area
- Local Government Boundary
- Local Government Headquarters
- Towns and Villages
- Rivers

FIG. 3: MAP OF BOSSO L.G.A

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
DEPARTMENT OF AGRICULTURAL ENGINEERING

FINAL YEAR PROJECT INTERNAL DEFENCE GRADING SHEET

o	Reg. No	Name	Presentation (25)	Oral interview (20)	Appearance (5)	Total (50)
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	03114886FA	EMMON I AKKEGA	21	14	4	39
	03114890	SANI M. TODURAMA	20	15	4	39
	03114889	SAMARI M. ZAKARI	20	15	4	39
	03114891	HEIDUO. OZOMA			4	
	0111379FA	DAUDA BELLO HASUNA			5	
	03114902	TOLA VALENTINE			4	
	03114908	YUSUF A RAKULI			5	
	03114910	ZAKARI I. SALITU			5	
	03114898	UGU R. T.T			5	

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