Sudan University of Science and Technology

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A study of Achievement of Standard Treatment of Municipal Solid Wastes in Khartoum State

دراسة لتحقيق معايير معالجة النفايات المحلية الصلبة في ولاية الخرطوم

(A case study of Abuwilidat landfill)

دراسة حالة مردم أبووليدات

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بسم الله الرحمن الرحيم

الآيـــــة

قال تعالى:

ٱهُوَ ٱلَّذِيٓ أَنزَلَ عَلَيۡكَ ٱلۡكِتَٰبَ مِنۡهُ ءَايَٰتٞ مُّحۡكَمَٰتٌ هُنَّ أُمُّ ٱلۡكِتَٰبِ وَأُخَرُ مُتَشَٰبِهَٰتٞۖ فَأَمَّا ٱلَّذِينَ فِي قُلُوبِهِمۡ زَيۡغٞ فَيَتَّبِعُونَ مَا تَشَٰبَهَ مِنۡهُ ٱبۡتِغَآءَ ٱلۡفِتۡنَةِ وَٱبۡتِغَآءَ تَأۡوِيلِهِۦۖ وَمَا يَعۡلَمُ تَأۡوِيلَهُۥٓ إِلَّا ٱللَّهُۗ وَٱلرَّٰسِخُونَ فِي ٱلۡعِلۡمِ يَقُولُونَ ءَامَنَّا بِهِۦ كُلّٞ مِّنۡ عِندِ رَبِّنَاۗ وَمَا يَذَّكَّرُ إِلَّآ أُوْلُواْ ٱلۡأَلۡبَٰبِ ﴿

صدق الله العظيم

سورة آل عمران، الآية (7)

Dedication

To my father, who did not spare me one day. My mother's who, gave me affection and love; you have given me life, hope and youth, to the twilight of knowledge.

To my brothers, my family and my friends.

Then to everyone who taught me a character that has become a great lady lights road.

Acknowledgements

I would really like to thank my instructor who helped and supports me to bring this research to this picture.

And many thanks to the staff and the librarians of the Sudan University of Science and Technology as well as the staff of University of Khartoum library.

Finely; thanks to all my fans and supporters in producing this research.

Abstract

This research study the Standard Treatment of Municipal Solid Wastes in Khartoum State (A case study of Abuwilidat landfill).

The objectives of this study is to examine and analyze the current situation of municipal solid wastes treatment in Khartoum state compared with the standard recommended methods and to determine the gaps and to introduce policy recommendation to achieve standard methods of treatment.

This is a descriptive analytical research which intends to analyze the current situation of municipal solid wastes treatment in Khartoum state

The researcher hypothesized that: the treatment of municipal solid waste in Khartoum state does not follow technical standard methods.

To achieve the aims of the study a questioner was used for data collection, in addition, engineering's measurements were analyzed, and then the results were critically described and discussed.

According to the results, the hypothesis were confirmed, with regard to the standard of treatment, the results of environmental management have indicated to that there is no negative impact in the environment in the water and the air in the landfill site, that is due to short life time of the landfill.

The analyzed data from the questioner of the residential area near the landfill showed that there are some effects in winter and summer due to geographical factors and wind direction, these effects are spread of smoke, nagging odors, files, rodents and insects leading to the spread of diseases, as well as some security disorders represented in theft in addition there are bacteria in the well of AL Fath area.

Regarding the achievement of the standard treatment, the study confirmed that it is not implemented as it should be, but efforts are being made in this regard.

The most important recommendation; implementation of the sanitary landfill concept, recycling and guideline for waste treatment.

مستخلص الدراسة

البحث يتمثل في دراسة وضع معايير معالجة النفايات المحلية الصلبة في ولاية الخرطوم(منطقة الدراسة مردم ابو وليدات).
اهداف الدراسة: اختبار و تحليل الوضع الحالي لمعالجة النفايات المحلية الصلبة في ولاية الخرطوم و مقارنتها مع المعايير القياسية ، تحديد الفجوات، تقديم السياسات و التوصيات.

هذا البحث تحليلي و وصفي يهدف الي تحليل الوضع الحالي لمعالجة النفايات المحلية الصلبة في ولاية الخرطوم.

قامت الدراسة علي فرضية: ان معالجة النفايات المحلية الصلبة في ولاية الخرطوم لا تتبع معايير المعالجة الفنية.
ولتحقيق اهداف الدراسة استخدم الباحث استبيان لجمع البيانات ، قياسات بيئية وتم تحليل ومناقشة النتائج.
وفقا لنتائج البحث فقد تطابقت الفرضية، وفيما يتعلق بنتائج القياسات البيئية فقد اشارت الي انه لا يوجد اى تاثيرات سالبة على البيئة بالنسبة للماء و الهواء في موقع المردم ويعذي ذلك لقصر عمر المردم.
و اوضحت البيانات الناتجة من الاستبيان للمنطقة السكنية المجاورة للمردم أنه توجد بعض التأثيرات في فصلي الصيف و الشتاء نتيجة للعوامل الجغرافية وأتجاه الرياح وتتمثل هذه التأثيرات في الانتشار الكثيف للدخان ، الروائح الكريهة، الذباب ،القوارض والحشرات مما يؤادي الي انتشار بعض الأمراض، كذلك بعض الاضطرابات الامنية ممثلة في السرقة،كما توجد بيكتريا في بئر المنطقة.
وفيما يتعلق بتحقيق معايير المعالجة، اكدت الدراسة انها غير مطبقة كما يجب ولكن هنالك جهود مبذولة في هذا الاطار.
اهم التوصيات: تطبيق مفاهيم المردم الصحي، اعادة التدوير، المبادئ التوجيهية لمعالجة النفايات.

Lists contents

Chapter one

Introduction

1. Introduction

1.1 Overview:

Waste is defined as the products it wishes to dispose of in order to avoid its health and environmental risks.

It is produced from various sources such as household waste, industrial waste and markets waste…etc.

Municipal solid waste (MSW) is solid waste from residential, commercial, institutional, and industrial sources, but it does not include such things as construction waste, automobile bodies, municipal sludge, combustion ash, and industrial process. Waste even though those wastes might also be disposal of in municipal waste landfills or incinerators (Gilbertm and Wendell, 2007).

The basic goal of treatment is treated society's waste in a manner that meets public health and environmental concerns and the public's desire to reuse and recycle waste material

The need for a text that puts the engineering and scientific details of treatment into the framework of resource treatment has grown significantly in recent years.

In each situation, engineering principles must be applied to evaluate equipment and facility options, to make operational choices, and to develop treatment system (William, 2007).

There are many negative effects resulting from these waste and the wrong methods that are done in the treatment and disposal, and these effects are harmful to human health and environment.

In Khartoum state the municipal solid waste consist of household waste, construction, demolition debris, and waste from streets.

Municipal solid waste is a real challenge in Sudan due to the increasing amount of waste.

Khartoum state suffers much from the negative impact of MSW. Collection, transportation and treatment are major steps in waste management.

Poor methods of MSW treatment is one of the most challenging problems, this has resulted in:

1- Soil, air and water pollution.
2- Land misuse.
3- Spared of vector.

The quantity of waste produced daily by the Khartoum Cleaning Corporation estimated about 1500 tan/day in Aubwilidat landfill out of 5000 tan/day and it's increasing rapidly.

The disposed of waste in Khartoum states accomplish in two stages: transport and final disposal. These processes are carried out in the intermediate stations and landfill, where the waste is transferred from the small vehicles to the tractors that transport them to landfill, to the distance from the human groups or cities.

In Khartoum state the municipal solid waste are treated in traditional ways (Khartoum, 2018).

Knowledge of the sources and type of MSW, along with data on the composition and rates of generation, is basic to the design and operation of the functional elements associated with the treatment of municipal solid waste.

In Khartoum state the quantity of waste produced depends on the growing of the population and increasing.

1.2 Statement of the problem:

In Khartoum state the municipal solid waste is treated in traditional ways without proper treatment, segregation, recycling, reuse and recovery. These wastes contain organic materials, plastic, iron, heavy metals etc. Of course this leads to contamination of soil, water, air and the spread of vectors such as insects and rodents.

Note that there is a significant and continuous increase in the amount of waste in Khartoum state.

Following those traditional methods of treatment causes a lot of problems like:

1. Consumption of land.
2. Increased pollution rate.
3. Resource waste.
4. The spread of diseases.

1.3 The study hypothesis:

The study assumes that municipal solid waste treatment in Khartoum state does not follow technical standard methods of treatment.

1.4 The study methodology:

This is a descriptive analytical research which intends to analyze the current situation of municipal solid waste treatment in Khartoum state and determines the gaps and challenges compared to the standard

methods of municipal solid waste treatment to introduce Practical solutions.

1.4.1Data collocation:

Data was collected through the following methods:

1- Primary data; library, academics, society and questioners.

2- Secondary data; government statistics, literature in the field.

3- Interview with experts and practioners in the fields.

1.5 Objectives of study:

1.5.1 Main Objective

The main objective of this study is to examine and analyze the current situation of municipal solid waste treatment in Khartoum state compared with the standard recommended methods.

1.5.2 Specific Objectives:

1. Analyze the current situation of municipal solid waste treatment in Khartoum State.
2. Determine the gaps and challenges in municipal solid waste treatment in Khartoum State.
3. Introduce proposal and solutions for proper municipal solid waste treatment in Khartoum State.

1.6 Organization of the study:

This study will include five chapters. Chapter one is an introduction, Chapter two is in Literature review, Chapter three is about the methodology of study, Chapter four on data analysis, results and discussion and Chapter five is on Conclusions and recommendation.

Chapter Two

Literature review

Chapter Two

Literature review

2. Introduction:

Basic definitions:

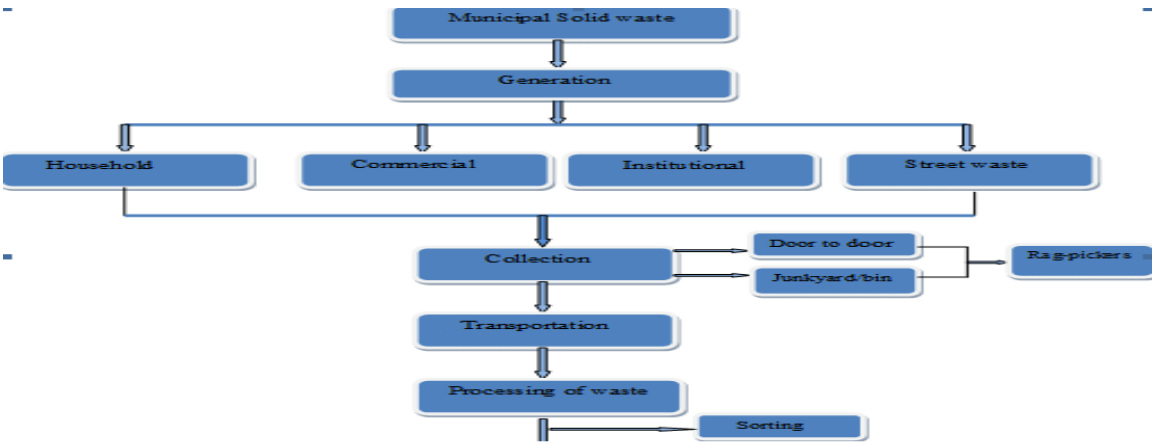
Solid waste management includes all activities that seek to minimize the hazardous of the health, environmental pollution and aesthetic impacts of solid wastes.

Solid waste can be defined as material that no longer has any value to the person who is responsible for it, and it not intended to be discharged through a pipe (Auris, 2012).

2.1 Municipal solid waste (MSW):

Is to include commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid from excluding industrial hazardous wastes but includes treated bio-medical waste.

charter (2.1) generation of Municipal solid waste



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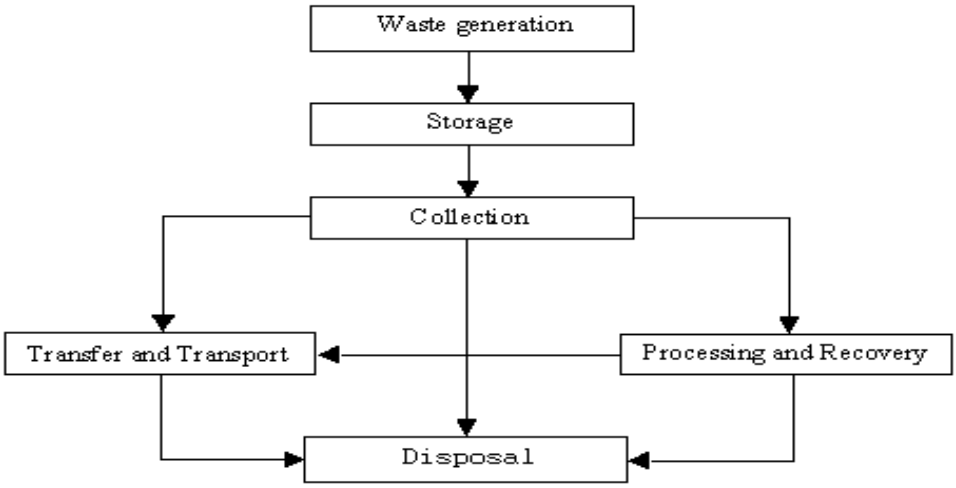
Solid wastes are all the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted. Because of their intrinsic properties, discarded waste materials are often reusable and may be considered a resource in another setting (Wiliam , 2007).

Integrated solid waste management is the term applied to all of the activities associated with the management of society's waste.

Integrated solid waste management (ISWM) knowledge of the sources and type of solid wastes, along with data on the composition and rates of generation, is basic to the design and operation of the functional elements associated with the treatment of MSW (Wiliam , 2007).

Charter (2.2): phases of waste Source:



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The method of treatment includes collection, storage, transporting and disposal (land filling).

It also requires that the municipal authority or an operator will have to seek permission for setting up waste processing and disposal facility including landfills from the state pollution board the committee constituted for the purpose.

The municipal solid waste shall be managed and handled in accordance with the compliance criteria and procedure.

Managing solid waste has become crucial for the health of urban citizens and for improving Competitiveness of localities in states.

The effective and environmentally responsible disposal of municipal solid waste is a process comprising storage, collection, transportation and land filling.

If solid wastes are not treatment properly there are many negative impacts that may result.

The relative importance of each depends very much on local conditions. Uncollected wastes often end up in drains, causing blockages which result in flooding and insanitary conditions.

Flies breed in some constituents of solid waste, and flies are very effective vectors that spread disease and emission of gases such as co2 etc.

Mosquitoes breed in blocked drains and in rain water that is retained in discarded cans, treys and other objects (Auris, 2012).

2.2 Methods of treatment:

Solid wastes treatment may be defined as that discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that also is responsive to public attitudes. In its scope, solid wastes treatment includes all administrative, financial, legal, planning, and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants (Davis-Cornwall, 2008).

2.2.1 Waste generation:

Waste generation encompasses those activities in which material are identified as on longer being of value and are either thrown away or gathered together for disposal waste generation is at present an activity that is not very controllable, it is often not considered to be a functional element (Grorge Tchobanoglous,1977).

2.2.2 Storage:

Although solid waste from urban sources may constitute only 5 percent of the nation's. Solid waste their treatment requires a large and continuous effort.

These wastes cannot be tolerated for long on individual premises because of their biodegradability, and they must be moved within a reasonable time (Grorge Tchobanoglous, 1977).

2.2.3 Collection:

The functional element of collection includes the gathering of solid wastes and the hauling of wastes after collection to the location where the collection vehicle is emptied.

The littering of municipal solid waste shall be prohibited in cities, towns etc. And organize house-to-house by using bell, singing, devise collection of waste from slums, squatter areas, horticultural and construction or generation and accessibility to users. It should not be open, aesthetically acceptable and user friendly (Grorge Tchobanoglous, 1977).

Storage facilities or (bins) shall be (easy to handle) design for handling, transfer and transportation. Bins for storage of bio-degradable waste shall of green color, for recyclable waste with white, for other waste shall be painted with black.

Manual handling of waste shall be prohibited but if is unavoidable, it shall be carried out under proper precaution and with due care for the safety of workers.

The maximum period of collection should not be greater than:

1. The normal time for the accumulation of the amount that can be placed in container of reasonable size.
2. The time it takes for fresh garbage to putrefy and emit foul odors under average storage conditions.
3. The length of the fly – breeding cycle, which during the hot summer months, is less than seven days.

Collection methods:

Curbside (pickup) – house to house – collection point or container method.

2.2.4 Waste handling and transport:

There are only two alternatives available for the long- term handling of solid wastes and residual matter: disposal on or in earth's mantle, and disposal at the bottom of the ocean.

Waste collection methods vary widely among different localities and regions. Municipal solid waste collection services are often provided by local government authorities, or by private companies in the industry.

Some areas, especially those in less developed countries, do not have a formal waste collection system (Auris, 2012).

2.2.5 Transportation of municipal solid waste

Vehicles for the use of waste shall be covered not visible to public. It shall be prevented their scattering storage facilities-bins shall be cleaned on daily basis and should not be overflowed (Auris, 2012).

2.2.6 Processing

The functional element of processing includes all the techniques, equipment, and facilities used both to improve the efficiency of the other functional elements and to recover usable material, conversion products, or energy from solid waste ((Davis-Cornwall, 2008).

Recycling:

Waste racialists and a hierarchy of recyclable dealers' plays an important role in the management of solid waste the associated activity transports nearlyb17% of the waste to the recycling units.

The benefits of recycling:

- Minimized the amount of waste that burning that perform provident the area of burning and use the cell for long period.
- Some materials from recycling which the items are made can be processed into new products(www.epch.nic.in ,2019)

2.2.7 Disposal

The final functional elements in solid waste treatment system.

Definitions of disposal of waste:

Removing and destroying or storing damaged, used or other unwanted domestic products and substances disposal includes burning, burial at landfill sites and recycling.

Disposal is the ultimate fate of all solid wastes, whether they are residential waste collected and transported directly to a landfill site (Davis-Cornwall, 2008)

A properly designed or poorly treatment landfills can create a number of adverse environmental impacts such as wind. Blown litter, attraction of vermin and generation of liquid leachate. Another common landfill includes methods to contain leachate such as clay or plastic lining material.

Deposited waste is normally compacted to increase its density and stability and also have landfill gas extraction systems (Davis-Cornwall, 2008).

2.2.8 Technologies

Traditionally the waste treatment has been slow to adopt new technologies such as Radio Frequency Identification(RFID) tags, Global positioning system(GPS) and integrated software packages which enable better quality data to be collected without the use of estimation or manual data entry(Auris, 2012).

RFID tags are now being used to collect data on presentation rates for curb-side pick-up.

Benefits of GPS tracking is particularly evident when considering the efficiency of Ad-hoc pick-up (like skip bins or dumpsters) where the collection is done on a consumer request daises.

Integrated software packages are useful in aggregating this data for use in optimization of operations for waste collection operations.

Rear vision cameras are commonly used for OH & S reasons and video recording devices are becoming more widely used, particularly concerning residential services.

2.3 Landfill:

The term sanitary landfill means an operation in which the wastes to be disposed of are compacted and covered with a layer of solid at the end of each day's operation (Grorge Tchobanoglous,1977).

A sanitary landfill is defined as land disposal site employing an engineered method of disposing of municipal solid waste on land in a manner the minimizes environmental hazards by spreading the solid waste to the smallest practical volume, and applying and compacting cover material at the end of each day (Davis-Cornwall, 2008).

Land filling or land disposal is today the most commonly used method for waste disposal by far.

Landfills are physical facilities used for the disposal of residual municipal solid waste in surface soils of the earth.

The major topics will be required in landfill is, selection of landfill site, engineering design of landfill and methods of disposal in landfill (William, 2007).

The first indication of a problem with an inactive landfill often is complaint from a community resident. If the complaint is based on visual sight of waste materials or of land movement, the inactive landfill site will have been identified.

A complaint based on odors, fire, or polluted drinking water from a well will require a legal classification and more extensive investigation to identify the exact location of landfill (Gilbertm and Wendell, 2007).

Final selection of a disposal site usually is based on the results of a detailed site survey, engineering design and cost studies, and an environmental impact assessment. It is interesting that the up-front development costs for new landfills (Grorge Tchobanoglous, 1977).

Types of landfill:

1- Municipal solid waste landfill.
2- Industrial waste landfill.
3- Hazardous waste landfill.

Factor that must be considered in evaluating potential site for the long-term disposal of solid waste include: haul distance, location restrictions, available land area, site access, soil condition and topography, climatologically conditions, surface water hydrology, geologic and hydrogeology condition, local environmental conditions, and potential ultimate uses for the completed site (Grorge Tchobanoglous, 1977).

2.3.1 Site selection:

Site location is perhaps the most difficult obstacle to overcome in the development of a sanitary landfill. Opposition by local citizens eliminates many potential sites (Hilary Theisen, 1993).

In choosing a location for a landfill, consideration should be given to the following variable:

1- Public opposition
2- Proximity of major roadways
3- Speed limits
4- Load limits on roadways
5- Bridge capacities
6- Underpass limitations

7- Traffic patterns and congestion

8- Haul distance (in time)

9- Detours

10- Zoning requirements

11- Buffer areas around the site (high trees on the site perimeter)

12- Historic buildings, end angered species

13- Wet lands and similar environmental factors

Landfill should be more than30m from streams, 160m from drinking water wells, 65m from house-schools and parks, 3000m from airport runways.

2.3.2 Site preparation:

The plans specification for a sanitary landfill should require that certain steps be carried out before operations begin. These steps include grading the site area, constructing access roads and fences, and installing signs utilities and operating facilities.

On-site access roads should be of all weather construction and wide enough to permits two-way truck travel (7.3m) (Hilary Theisen, 1993).

All sanitary landfill sites should have electric, water, sanitary services, fire-fighting, dust control, telephone or radio communications are desirable operation of landfill usually require only a small building for storing hand tools and equipment parts and a shelter with sanitary facilities. A single building may serve both purposes. Building may be temporary and preferably movable (Gilbertm and Wendell, 2007).

2.3.3 Magnitude of the problem

Solid waste disposal creates a problem in highly populated areas. The greater the problem becomes various estimates have been made of the quantity of solid waste generated and collected per person per day (Davis-Cornwall, 2008)

2.3.4Environment pollution

2.3.4.1 Air pollution:

Dust generated from on-site vehicle movement, and placement of waste and materials (Auris, 2012).

2.3.4.2 Water pollution:

runoff from open dump sites containing chemicals may contaminate wells and surface water used as sources of drinking water open dumping can also impact proper drainage of runoff, making areas more susceptible to flooding when waste block ravines creeks, culverts, and drainage basins & also contamination of groundwater resources and surface water from leachate emission.

2.3.4.3 Soil pollution:

permanent or temporary loss of productive land.

2.3.4.4 Global warming and climate change:

In most of the cities and towns the municipal solid waste is being dumped and burnt in open spaces without understanding the adverse impacts on the environment. The waste in the dumping ground undergoes various anaerobic reactions produces offensive greenhouse gases such as CO2, CH4, etc. These gases are contributing potentially to global warming and climate change phenomenon

2.3.5 The impact of local conditions:

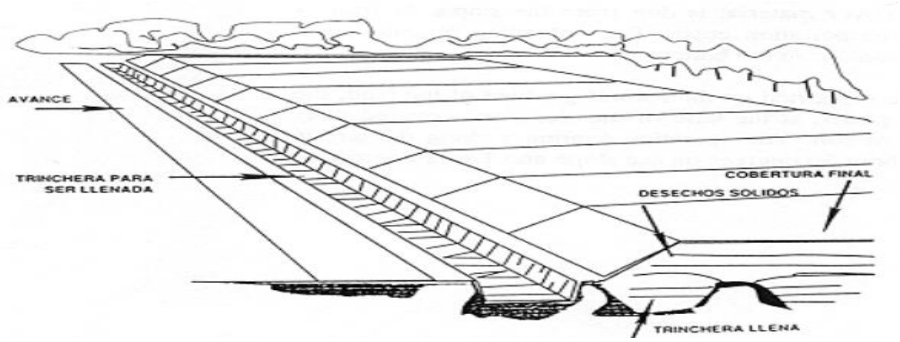
There are many factors that vary from place to place and that must be considered in the select of landfill.

Amongst them are : the waste itself-typical of municipal waste such as paper plastic, glass, metal…ect, density moisture, vehicles and system that operate well with low-density.

Abrasiveness of the sand and the corrosiveness caused by the water content can cause very rapid deterioration of equipment (Auris, 2012).

2.3.6 Design of landfills:

Fig (2.3)



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Among the important topics that must be considered in an engineering design report, though not necessarily in the order given, are the following:

1- Evaluation of seepage potential.

2- Design of drainage and seepage control facilities.

3- Development of a general operation plan.

4- Design of solid waste filling plan.

5- Land requirements.

6- Types of wastes that must be handled.

Determination of equipment requirements (Hilary Theisen, 1993).

The design of the landfill has many components including site preparation, buildings, monitoring wells, size, liners, leachate collection system, final cover and gas collection system.

2.3.6.1 Equipment:

The size, type and amount of equipment required at a sanitary landfill depend on the size and method of operation, quantities and time of municipal solid waste deliveries, and to a degree, the experience and preference of the designer and equipment operators.

The most common equipment used on sanitary landfills are: rubber, crawler tractor, tracked motor carder, scraper, drag line and steel-wheeled compactor.

2.3.6.2 Volume required:

To estimate the volume required for a landfill it is necessary to know the amount of refuse being produced and the amount of refuse being produced and the density of the in place, compacted refuse. The volume of refuse differs markedly from one city to another because of local conditions.

2.3.6.3 Liner selection:

In order to prevent groundwater contamination strict leachate control landfill measures are required. Under the 1991 subtitle D rules promulgated by EPA, new landfill must be lined in a specific manner or meet maximum contaminant levels for the groundwater at the landfill boundary.

2.3.7 Methods of disposal in landfills:

The principal methods used for the landfilling of municipal solid waste are: excavated cell/trench, area method, and canyon. The principal features of these types of landfills are described below (Grorge Tchobanoglous, 1977)

2.3.7.1 Excavated cell/ Trench method:

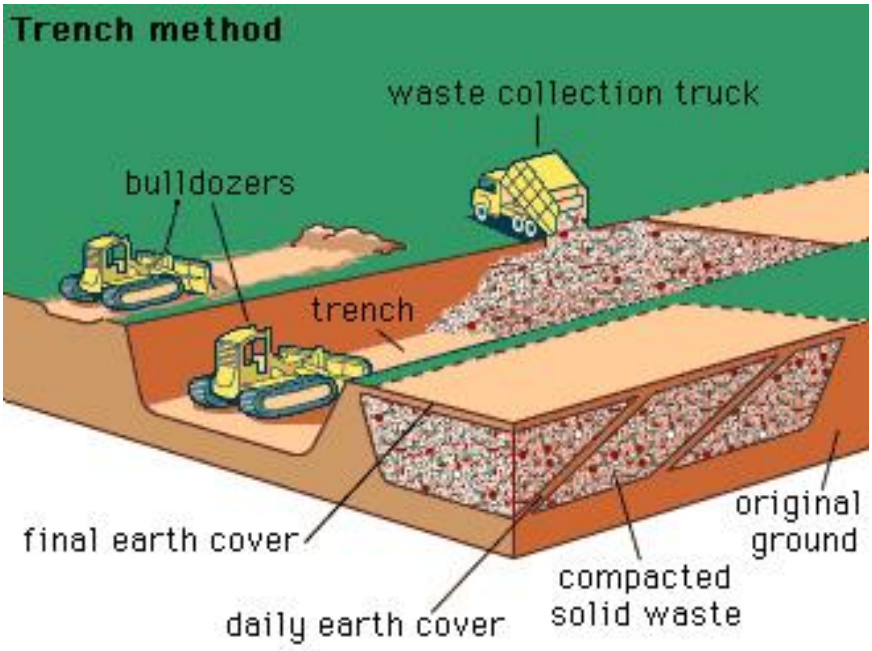
The excavated cell/trench method of landfilling is ideally suited to areas where an adequate depth of cover material is available at the site and where the water table is not near the surface (Grorge Tchobanoglous, 1977).

Typically, solid waste are placed in cells or trenches excavated in the soil. The soil excavated from the site is used for daily and final cover. The excavated cells or trenches are usually lined with synthetic membrane liners or low-permeability clay or a combination of the two to limit the movement of both landfill gases and leachate.

Excavated cells are typically square, up to 1000 ft in width and length, with side slopes of 1.5:1 to 2:1. Trenches vary from 200 to 1000 ft in length, 3 to 1o ft in depth, and 15 to 50 ft in width.

In some states, landfills constructed below the high-groundwater level are allowed if special provisions are made to prevent groundwater from entering the landfill and to contain or eliminate the movement of leachate and gases from completed cells. Usually the site is dewatered, excavated, and then lined in compliance with local regulation. The dewatering facilities are operated until the site is filled to avoid the creation of uplift pressures that could cause the liner to heave and rupture.

Fig (2.4): Trench method



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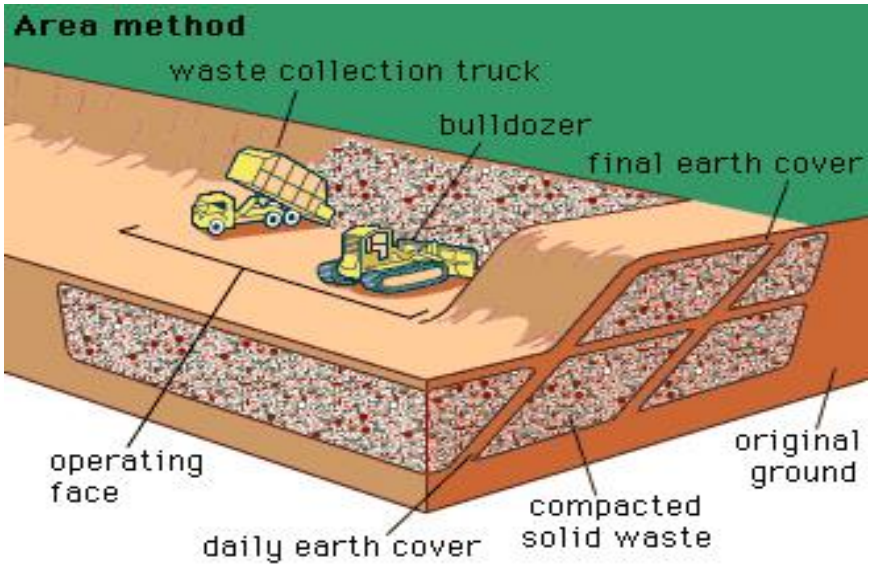
2.3.7.2 Area method:

The area method is used when the terrain is unsuitable for the excavated of cells or trenches in which to place the solid wastes. High groundwater condition, which occur in many parts of Florida and elsewhere too, necessitate the use of area-type landfills. Site preparation includes the installation of a liner and leachate control system. Cover material must be hauled in by truck or earthmoving equipment from adjacent land or from borrow-pit areas. As noted above, in location with limited availability of material that can be used as cover, compost produced from yard wastes and MSW has been used successfully as intermediate cover material. Other techniques that have been used include the use of movable temporary cover material such as soil and geo-membranes. Soil and geo-membranes, placed temporarily over a

completed cell, can be removed before the next lift is begun (Grorge Tchobanoglous, 1977).

Fig (2.5): Area method



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2.3.7.3 Canyon/Depression method:

Canyons, ravines, dry borrow pits, and quarries and compact solid wastes in canyon/depression landfills vary with the geometry of the site, the characteristics of the available cover material, the hydrology and geology of the site, the type of leachate and gas control facilities to used, and the access to the site.

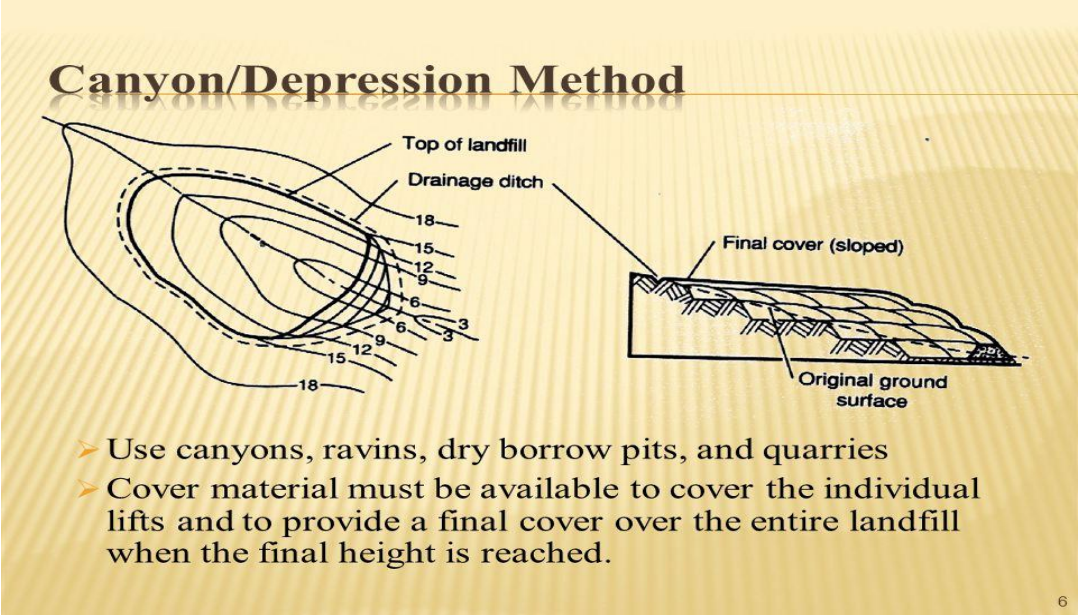
Control of surface drainage often is a critical factor in the development of canyon/depression site. Typically, filling for each lift starts at the head end of the canyon and ends at the mouth, so as to prevent the accumulation of water behind the landfill. Canyon/depression sites are filled in multiple lifts, and the method of operation is essentially the same as the area method described above. If a canyon floor is

reasonably flat, the initial landfilling may be carried out using the excavated cell/trench method.

A key to the successful use of the canyon/depression method is the availability of adequate material to cover the individual lifts as they are completed and to provide a final cover over the entire landfill when the final height is reached.

Cover material is excavated from the canyon walls or floor before the liner system is installed .borrow pits and abandoned quarries may not contain sufficient soil for intermediate cover, so that cover material may have to be imported. Compost produced from yard waste and MSW can be used for the intermediate cover layers (Grorge Tchobanoglous, 1977).

Fig (2.6): Depression method



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2.3.7.4 Incineration:

Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products.

This process reduces the volumes of solid waste 20-30% of the original volume incinerators convert waste material into heat, gas, steam and ash.

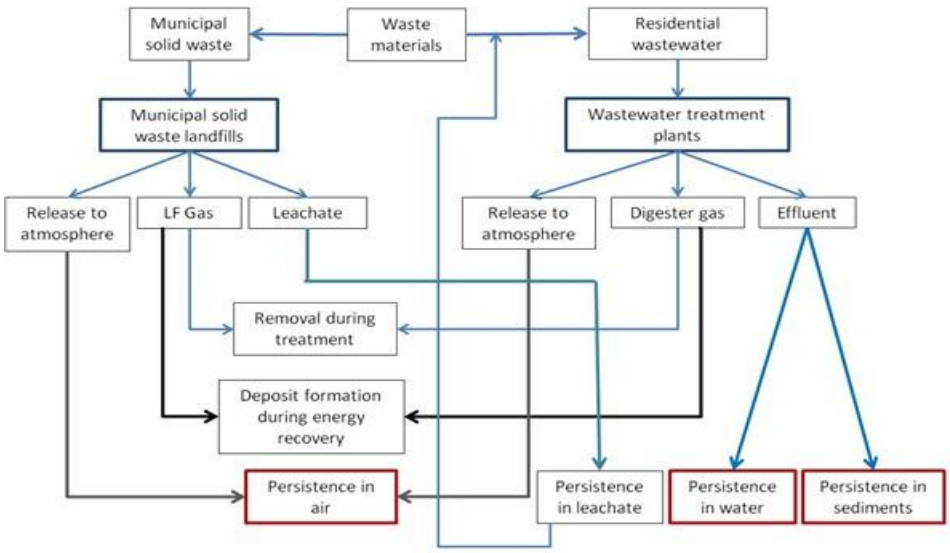
Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants.

2.3.7.5 Energy recovery:

The energy content of waste products can be harnessed directly by using them as a direct combustion fuel or indirectly by processing them into another type of fuel (Auris, 2012).

pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperature with limited oxygen availability.

Charter (2.7): Energy recovery



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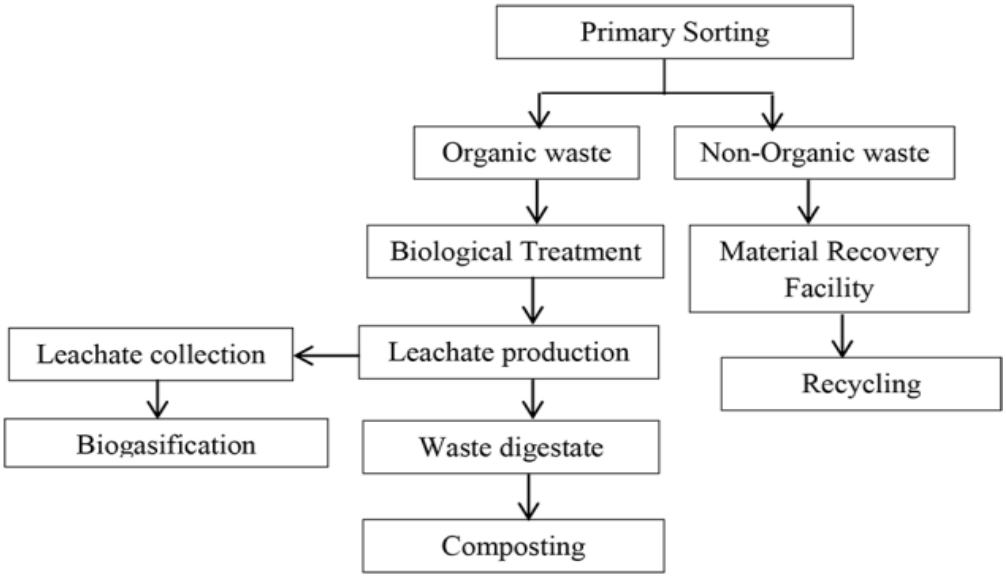
2.3.7.6 Resource recovery:

Resource recovery uses life cycle analysis (LCA) attempts. For mixed municipal solid waste a number of broad studies have indicated that administration, source separation and collection followed by reuse and recycling of the compost/fertilizer production of the organic waste fraction via anaerobic digestion to be the favored path (Auris, 2012).

Charter (2.8): Resource recovery



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2.3.7.7 Avoidance and reduction methods:

An important method of treatment is the prevention of waste material being created, also known as waste reduction. Methods of avoidance include reuse of second-hand products, repairing broken items instead of buying now, designing products to be refillable or reusable.

Encouraging consumers to avoid using disposable products, removing any food/liquid remains from cans, packaging and designing products that use less material to achieve the same purpose (Auris, 2012).

Chapter three

Literature review

(Sanitary landfill)

Chapter three

Literature review

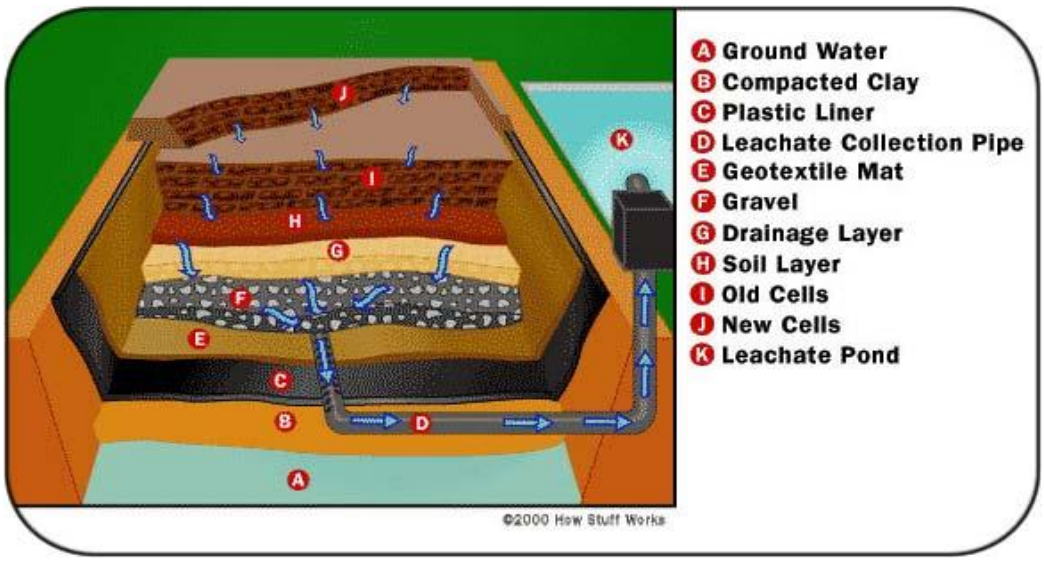
Sanitary landfill

3. Introduction:

Sanitary landfill refers to an engineered facility for the disposal of municipal solid waste designed and operated to minimize public health and environmental impacts. Landfills for the disposal of hazardous wastes are calls secure landfills. A sanitary landfill is also sometimes identified as a solid waste management unit. Landfilling is the process by which residual solid waste is placed in a landfill. Landfilling includes monitoring of the incoming waste stream, placement and compaction of the waste and installation of landfill environmental monitoring and control facilities.

The term cell is used to describe the volume of material placed in a landfill during one operating period, usually one day. A cell includes the solid waste deposited and the daily cover material surrounding it. Daily cover usually consists of 6 to 12 in of native soil or alternative materials such as compost that are applied to the working faces of the landfill at the end of each operating period. The purposes of daily cover are to control the blowing of waste material to prevent rats, flies, and other disease vectors from entering or exiting the landfill and to control the entry of water into the landfill during operation (Hilary Theisen, 1993).

Fig (3.1) Design of standard landfill



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3.1Type of landfills:

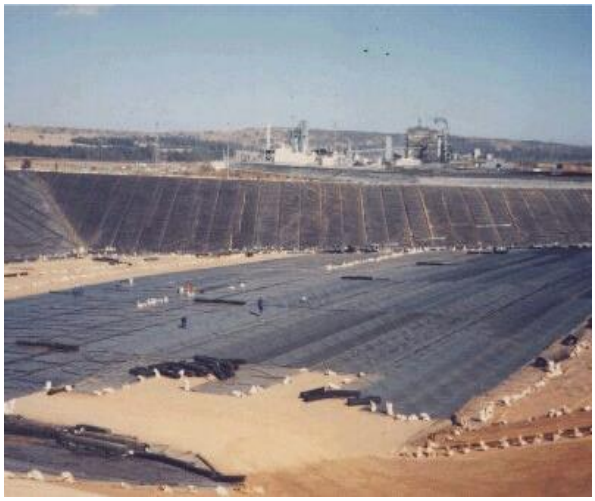
The principal type of landfills can be classified as:

1- Conventional landfill for commingled municipal solid waste.

2- Landfills for milled solid waste.

3- Mono fills for designated or specialized wastes.

Fig (3.2) Design of cell



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3.1.1 Advantages and Disadvantage of sanitary landfills:

Table (3.3)

Advantages	Disadvantages
A sanitary landfill is usually the most economical method of solid waste disposal.	In highly populated areas, suitable land may not be available within economical hauling distance.
The initial investment is low compared with other disposal methods.	Proper sanitary landfill standards must be adhered to daily or the operation may result in an open dump.
A sanitary landfills a complete or final disposal method as compared to incineration and composting which require additional treatment or disposal operations for residue, quenching water, unusable material etc.	Sanitary landfills located in residential areas can provoke extreme public opposition.
A sanitary landfill can receive all types of solid wastes, eliminating the necessity of separate collections.	A completed landfill will settle and require periodic maintenance.
A sanitary landfill is flexible; increased quantities of solid wastes can be disposed of with little additional personnel and equipment.	Special design and construction must be utilized for buildings constructed on completed landfill because of the settlement factor.
Sub marginal land may be reclaimed for use as parking lots, playgrounds, golf courses, airports etc (Grorge Tchobanoglous, 1977).	Methane, an explosive gas, and the other gases produced from the decomposition of the wastes may become a hazard or nuisance and interfere with the use of the completed landfill.

In my viewpoint the sanitary landfill is best methods of treatment of MSW if follow the standard because it economical , reclaimed of land and our Advantages if sanitary landfill does not follow the standard it make many problems in Environment society.

3.1.2 Overview of landfill planning, design, and operation:

The principal elements that must be considered in the planning, design, and operation of landfills are identified and include:

1- Landfill layout and design.

2- Landfill operation and management.

3- The reactions occurring in landfills.

4- The management of leachate.

5- The management of landfills gases.

6- Environmental monitoring.

7- Landfill closure and post closure care.

3.2 Available land Area:

In selecting potential land disposal sites, it is important to ensure that sufficient land area is available. Although there are no fixed rules concerning the area required, it is desirable to have sufficient area to operate for at least 1 yr at a given site. For shorter periods, the disposal operation becomes considerably more expensive, especially with respect to site preparation, provision of auxiliary facilities, and completion of the final cover (Grorge Tchobanoglous, 1977).

3.3 Design period of landfill:

A landfill design life will comprise of an active period and an (closures and post-closure) period. The active period shall comprise of the period for which waste filing is in progress at the landfill and typically range from 10 to 25 years depending on the availability of land area. The closure and post-closure period for which a landfill will be monitored and maintained shall be 30 years after the active period is completed (www.epa.ie,2019).

3.4 Decomposition in landfills:

The organic biodegradable components in solid wastes begin to undergo bacterial decomposition as soon as they are placed in a landfill. Initially, bacterial decomposition occurs under aerobic conditions because a certain amount of air is trapped within the landfill. However, the oxygen in the trapped air is soon exhausted, and the long-term decomposition occurs under anaerobic condition.

The principal source of both the aerobic and the anaerobic organisms responsible for the decomposition is the soil material that is used as a daily and final cover.

The overall rate at which the organic materials decompose depends on their characteristics and, to a large extent, on the moisture content. In general, the organic materials present in solid waste can be divided in to three major classifications:

1- Those that contain cellulose or derivative of cellulose.
2- Those that do not contain cellulose or cellulose derivative.
3- Plastics, rubber and leather cellulose is a major constituent of

Organic wastes, such as paper, rags, string, straw, and plant tissues. With the exception of plastics, the principal non cellulose organics are proteins, carbohydrates, and fats. Mineral salts in very limited quantities and moisture are almost always associated with these materials. Plastics that may be found in solid wastes are so many and so varied that no general list is possible in this text.

With the above wastes, the principal and products of anaerobic decomposition are partially stabilized organic material, intermediate volatile organic acids and various gases. Under normal conditions the rate of decomposition, as measured by gas production, reaches a peak within the first 2yr and then slowly tapers off, continuing in many cases for periods up to 25 yr or more. If moisture is not added to the wastes in a well. Compacted landfill, it is not uncommon to end materials in their original form years after they were buried.

Fukuoka method:

Fukuoka city environmental agency and Fukuoka University announced on July 26'2011, that their jointly developed landfill technology to "improve current landfill sites with semi-aerobic landfill structure (Fukuoka method) was accredited as a new method for clean development mechanism (CDM), as defined in the United Nations framework convention on climate change (UNFCCC). This new landfill technology is the world's first accredited method to control methane emissions at landfill sites (www.japanfs.org, 2019)

Semi-aerobic landfill structure (Fukuoka methods) refers to a mechanism whereby leachate is quickly removed from waste materials, allowing the inflow of air by installing perforated collection pipes and vertical perforated gas venting pipes at the perforated fermentation heat, air flows naturally, without need for an external energy source.

By maintaining aerobic conditions in the waste bed in terior, the Fukuoka method accelerates the decomposition of waste material, improves leachate water quality and inhibits the emission of methane gas. At present, because most of the world's landfill sites, including those of developing countries, are anaerobic landfills, the Fukuoka method will enable substantial reductions in greenhouse gas emissions (www.seoulsoution.kr, 2019).

3.5 Composition and characteristics, generation, movement, and control of landfill gases:

A solid waste landfill can be conceptualized as a biochemical reactor, with solid waste and water as the major inputs, and with landfill gas and leachate as the principal outputs. Material stored in the landfill includes partially biodegraded organic material and the other inorganic waste materials originally placed in the landfill. Landfill gas control systems are employed to prevent unwanted movement of landfill gas into the atmosphere or the lateral and vertical movement through the surrounding soil. Recovery landfill gas can be used to produce energy or can be flared under controlled conditions to eliminate the discharge of harmful constituents to the atmosphere.

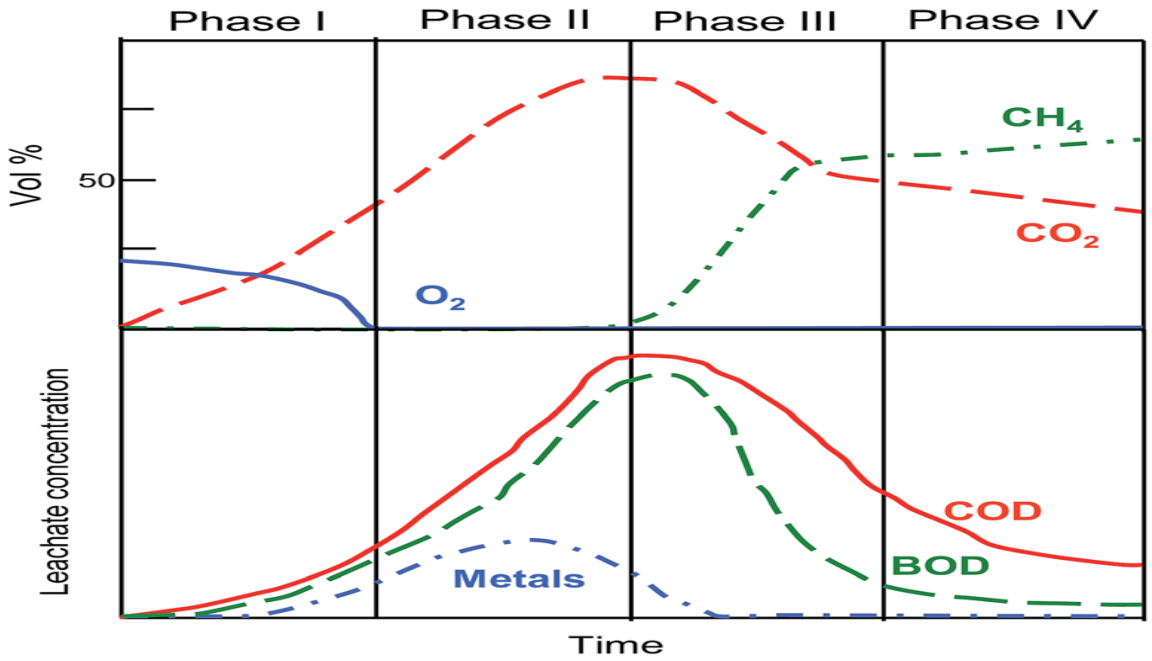
Landfill gas is composed of a number of gases that are present in large amounts (the principal gases) and a number of gases that are present in very small amounts (the trace gases). The principal gases are produced from the decomposition of the organic fraction of MSW.

Some of the trace gases, although present in small quantities, can be toxic and could present risks to public health.

Principal landfill gas includes NH3, CO2, CO, H2, H2S, CH4, N2, and O2.

Methane and carbon dioxide are the principal gases produced from the anaerobic decomposition of the biodegradable organic waste components in MSW. When methane is present in the air in concentrations between 5 to15 present, it is explosive. Because only limited amounts of oxygen are present in a landfill when methane concentrations reach this critical level, there is little danger that the landfill will explode. However, methane mixtures in the explosive range can form if landfill gas migrates off-site and mixes with air. The concentration of these gases that may be expected in the leachate will depend on their concentration in the gas phase in contact with the leachate (Hilary Theisen, 1993).

Fig (3.4): phases of concentration of gases and leachate in landfill



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Trace constituents in landfill gases have two basic sources. They may be brought to the landfill with the incoming waste or they may be produced be biotic and a biotic reactions occurring within the landfill. Of the trace compounds found in landfill gases, many are mixed into the incoming waste in liquid form, but tend to volatilize. The tendency to volatilize can be shown to be approximately proportional to the vapor pressure of the liquid, and inversely proportional to the surface area of a sphere of the volatile liquid within the landfill. The wide variation in volatilization times that are expected from some selected volatile liquids that may be found in landfills. In newer landfills where the disposal of hazardous waste has been banned, the concentrations of VOCs in the landfill gas have been reduced significantly.

Complex biochemical pathways can exist for the production or consumption of any of the trace constituents. At present, very little can be stated definitively about the rates of biochemical transformation of the trace compounds. Half-lives varying from fraction of a year to over a thousand years have been reported for various compounds.

3.5.1 Duration of phases:

The duration of the individual phases in the production of landfill gas will vary depending on the distribution of the organic compounds in landfill, the availability of nutrients, the moisture content of waste, moisture routing through the fill, and the degree of initial compaction. The generation of landfill gas will be retarded if sufficient moisture is not available. Increasing the density of the material placed in the landfill will decrease the possibility of moisture reaching all parts of the waste and, thus, reduce the rate of bioconversion and gas production (Hilary Theisen, 1993).

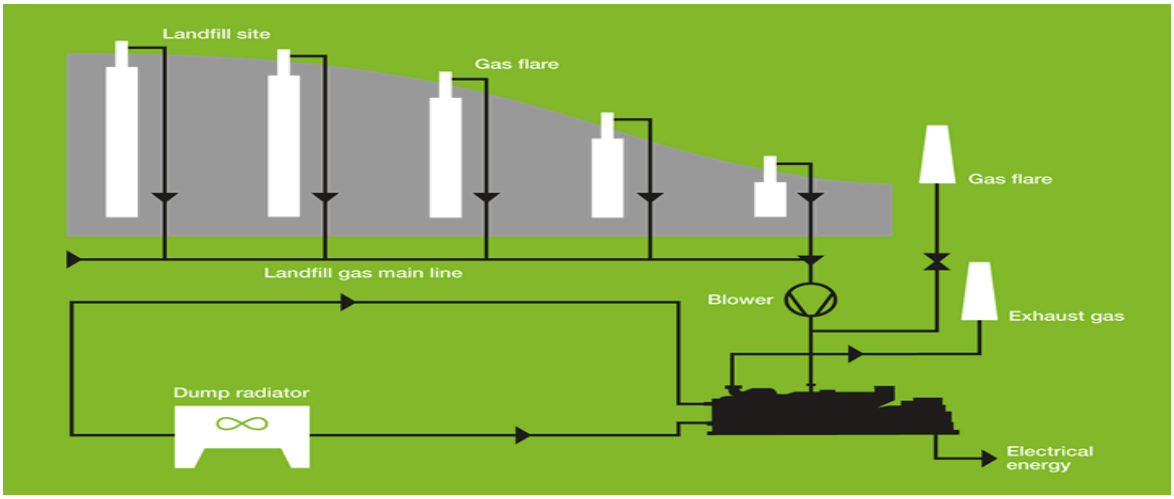
3.5.2 Volume of gas produced:

The generalized chemical reaction for the anaerobic decomposition of solid waste can be written as.

Organic material (Solid wastes) + H2O $\xrightarrow{\text{bacteria}}$ biodegraded organic material + CH4 + CO2+ other gases

3.5.3 Movement of landfill gas:

Fig (3.5)



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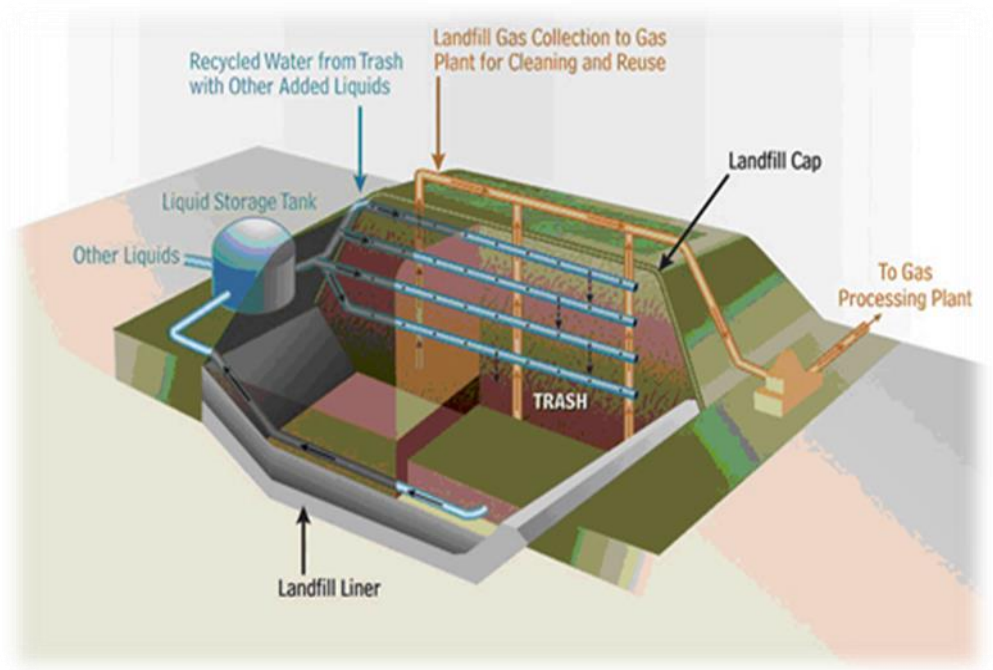
3.5.4 Control of landfill gases:

The movement of landfill gases is controlled to reduce atmospheric emissions, to minimize the release of odorous emissions, to minimize subsurface gas migration, and to allow for the recovery of energy from methane. Control system can be classified as passive or active. In passive gas control system, the pressure of the gas that is generated within the landfill serves as the driving force for the movement of gas. In active gas control systems, energy in the form of an induced vacuum is used to control the flow of gas. For both the principal and trace gases, passive

control can be achieved during times when the principal gases are being produced at a high rate by providing paths of higher permeability to guide the gas flow in the desired direction. When the production of the principal gases is limited, passive controls are not very effective because molecular diffusion will be the predominant transport mechanism. However, at this stage in the life of the landfill it may not be so important to control the residual emission of the methane in the landfill gas. Control of VOCs emissions may necessitate the use of both passive and active gas control facilities (Hilary Theisen, 1993).

Fig (3.6): control of landfill gases



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Some methods of gas controls are:

1- Cell vent.

2- Trench vent.

3- Perforated-pipe vent.

4- Barrier vent.

The cell vent, composed of gravel, is put directly above the daily cell cover. In the trench vent, a trench dug as deep as the solid wastes and filled with gravel. In perforated-pipe vent, perforated pipes are used to collect and convey the gases to riser pipe for gas venting. If gases are recovered for heating value of methane, the riser pipes may be connected to a main for pumping to a processing plant.(Arcadio and Gregoria, 1996).

Turning landfill gas to energy:

Methane was one of the major gases generated the city of Seoul installed 106 methane gas extraction wells at the internal of 120m throughout the former Nanjido landfill site. The gases are than channeled into wells using fan, which are then used to provide heating for 3 public sites including world cup stadium, 40 office buildings, and 16335 households in the surrounding residential areas.

From 2002 to 2014, energy generated from the gases provided to 43851787 m3 which is equivalent to KRW 8,770,712,570 in total (73, 089,000 KRW annually) in monetary terms. Of course this is an astonishing financial benefit is the environmental benefit of the project.

3.6 Composition, formation, movement, and control of leachate in landfills:

Leachate may be defined as liquid that has percolated through solid waste and has extracted dissolved or suspended materials. In most landfills leachate is composed of the liquid that has entered the landfill from external sources, such as surface drainage, rainfall, groundwater,

and water from underground springs and the liquid produced from the decomposition of the wastes, if any. The composition, formation, movement, and control of leachate (Hilary Theisen, 1993).

3.6.1 Composition of leachate:

When water percolates through solid wastes that are undergoing decomposition, both biological material and chemical constituents are leachate into solution. Especially for new landfill, great care should be exercised in using the typical values that are given.

3.6.2 Variations in leachate composition:

That the chemical composition of leachate will vary greatly on the age of landfill and the events preceding the time of sampling. If a leachate sample is collected during the acid phase of decomposition, the PH value will be low and the concentration of BOD5, TOC, COD, nutrients, and heavy metals will be high. If, on the other hand, a leachate sample is collected during the methane fermentation phase, the PH will be in the range from 6.5 to 7.5, and the BOD5, TOC, COD, and nutrient concentration values will be significantly lower.

Similarly the concentrations of heavy metals will be lower because most metals are less soluble at neutral PH values. The PH of the leachate will depend not only on the concentration of the acids that are present but also on the partial pressure of the CO2 in the landfill gas that is in contact with the leachate.

As a result of the variability in leachate characteristics, the design of leachate treatment systems is complicated. A treatment plant designed to treat a leachate with the characteristics reported for a new landfill would be quite different from one designed to treat the leachate from a mature landfill (Hilary Theisen, 1993).

3.6.2.1 Trace compounds:

The presence of trace compounds in leachate will depend on the concentration of these compounds in the gas phase within the landfill. As more communities and operators of landfills institute programs to limit the disposal of hazardous wastes within MSW, the quality of the leachate from new landfills is improving with respect to the presence of trace constituents.

3.6.3 Water balance and leachate generation in landfills:

The potential for the formation of leachate can be assessed by preparing a water balance of the landfill. The water balance involves summing the amounts of water entering the landfill and subtracting the amounts of water consumed in chemical reactions and the quantity leaving as water vapor. The potential leachate quantity is the quantity of water in excess of the moisture-holding capacity of the landfill material.

3.6.4 Description of water balance components for a landfill cell:

The components that make up the water balance for a landfill cell are identified. The principal sources include the water entering the landfill cell from above, the moisture in the solid waste, the moisture in the cover material, and the moisture in the sludge, if the disposal of sludge is allowed. The principal sinks are the water leaving the landfill as part of the landfill gas, as saturated water vapor in landfill gas, and as leachate (Hilary Theisen, 1993).

3.6.5 Control of leachate in landfills

Fig (3.7)

Source: www.wm.com 23/1/2019 9:42AM

As leachate percolates through the underlying strata, many of the chemical and biological constituents originally contained in it will be removed by the filtering and adsorptive action of the material composing the strata. In general, the extent of this action depends on the characteristics of the soil, especially the clay content. Because of the potential risk involved in allowing leachate to percolate to the groundwater, best practice calls for its elimination or containment.

Landfill liners are now commonly used to limit or eliminate the movement of leachate and landfill gases from landfill site. To date (1992), the use of clay as a liner material has been the favored method of reducing or eliminating the seepage (percolation) of leachate from landfill. Clay is favored for its ability to adsorb and retain many of the chemical constituents found in leachate and for its resistance to the flow of leachate. However, the use of combination composite geo-membrane and clay liners is gaining in popularity, especially because of the resistance afforded by geo-membranes to the movement of both leachate and landfill gases (Hilary Theisen, 1993).

3.6.5.1 Leachate collection systems:

The design of a leachate collection system involves:

1- The selection of the type of liner system to be used.

2- The development of the grading plan including the placement of the leachate collection and drainage channels and pipelines for the removal of leachate.

3- The layout and design of the leachate removal, collection, and holding facilities.

3.6.5.1.1 Sloped terraces:

To avoid the accumulation of leachate in the bottom of a landfill, the bottom area is graded into a series of sloped terraces. The terraces are shaped so that the leachate that accumulates on the surface of the terraces will drain to leachate collection channels. Perforated pipe placed in each leachate collection channel is used to convey the collected leachate to a central location, from which it is removed for treatment or reapplication to the surface of the landfill (Hilary Theisen, 1993).

3.6.5.1.2 Piped bottom:

An alternative plan for the collected of leachate, the bottom area is then divided into a series of rectangular strips by clay barriers placed at appropriate distances. The barrier's spacing corresponds to the width of a landfill cell. Leachate collection pipes are then placed lengthwise directly on the geomembrane. The 4in leachate collection pipes have laser-cut perforations, similar to a well screen, over one-half of the circumference.

The use of a multiple-pipe leachate collection system will ensure the rapid removal of leachate from the bottom of the landfill. Further, the use of 2ft sand layer serves to filter the leachate before it is collected for treatment.

3.6.6 Leachate Removal, Collection, and Holding Facilities:

Two methods have been used for the removal of leachate that accumulates within a landfill. The leachate collection pipe is passed through the side of the landfill. Where this method is used, great care must be taken to ensure that the seal where the pipe penetrates the landfill liner is sound. An alternative method used for the removal of leachate from landfills involves the use of an inclined collection pipe located within the landfill. Leachate collection facilities are used where the leachate is to be recycled from or treat at a control leachate. In some location, the leachate removed from the landfill is collected in a holding tank. The capacity of the holding tank will depend on the type of treatment facilities that are available and the maximum allowable discharge rate to the treatment facility (Hilary Theisen, 1993).

3.6.7 Leachate Management options:

The management of leachate, when and if it forms, is key to the elimination of the potential for a landfill to pollute underground aquifers. A number of alternatives have been used to manage the leachate collected from landfills including:

1- Leachate recycling.

2- Leachate evaporation.

3- Treatment followed by disposal.

4- Discharge to municipal wastewater collection systems (Hilary Theisen, 1993).

Chapter four

Study area and methodology

Chapter four

Study area and methodology

4. Introduction:

The disposed of waste in Khartoum states accomplish in two stages: transport and final disposal. These processes are carried out in the intermediate stations and landfill, where the waste is transferred from the small vehicles to the tractors that transport them to landfill, to the distance from the human groups or cities, Are called pressure stations or intermediate stations are includes Khartoum station which is located south of the RUMAILA tombs, operating under the pressure system and the upper head conveying sub-wastes Khartoum and the companies and part of the JABAL OLIYID to ABU-WILAIDAY landfill.

Intermediate stations Omdurman, located east of the Korean company; operates under the pressure system and the upper stage transfers sub-wastes of Omdurman, KARARY, and OMBDA to

ABU-WILAIDAY landfill.

The final disposal shall be carried out in the landfill and include the following state of Khartoum.

Al –Hashanah landfill is located south-east of the Arab company, which absorbs local waste, an upper mountain, and a part of the tree trunks that are produced from the local area of Khartoum it is 41acre receives 1200 ton/day.

Hat-tab landfill quarries located in the Hat-tab area of Bahriy where the waste is treated to two off shore and eastern Nile areas, its 6 km2 receives approximately 400ton/day (Khartoum, 2018).

Abuwilidat landfill is located north east of AlFath city in Omdurman, where waste is treated to Khartoum north, Omdurman, karre, ombada area of 6 km2, receives 1500 ton/day.

Gnaoua landfill is located west of ombada and it is 6km2 not yet used

Hazardous waste landfill located in west Omdurman, the amount of waste is not specified.

Waste disposal depends on the individual or entity responsible for the waste and often there are three stages:

- Collection and storage of waste.
- Collection and removal of disposal sites.
- Treatment and final disposal.

It is important to reduce and the production of waste from the sources (waste minimization) and then it is important to reuse the same waste either for the same or for another use without any process(reuse), and then comes the third phase, the process of recovery of some components of waste and reclassification or recycled(recycle) and these are done by the type of waste, some burn to generate heat and electricity or generate methane gas as in the process of digestion of anaerobic organic components, or converted to soil fertilization material or the rotation of papers and glass, plastic and choose the element to be retrieved and which depends on the circumstances the social, economic and environmental(Khartoum, 2018).

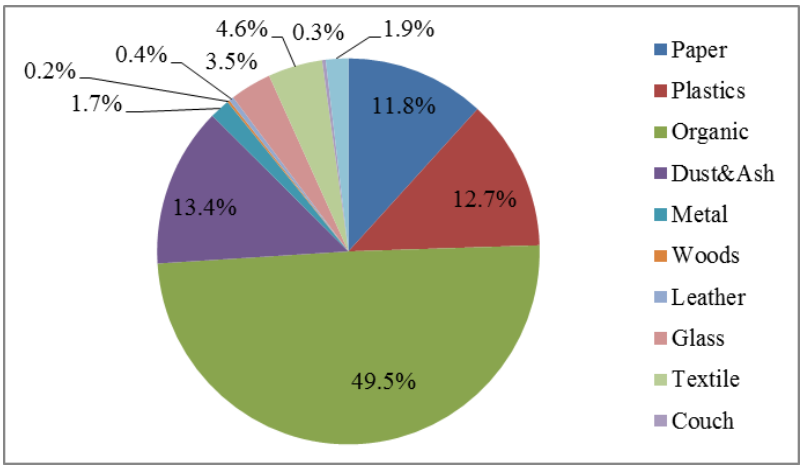
After the first sorting process of solid waste, which can be recycled and produce other things can be used as it can create jobs for small industries and disposal of a large part of the waste in positive ways and achieve economic return, and things that can be recycled:

- Papers
- Glass
- Plastics
- Cloth waste
- Bones
- Organic material
- Mineral waste

Organic wastes account for more than 50% of the waste, which may lead to rapid environmental risks.

If left untreated for its ability to produce flies and conveyors other diseases.

Fig (4.1): Percent of waste treated in the study area



Source: Khartoum Cleaning Corporation, 2018

Abu Wilidat Landfill (Our Study area):

4.1 Site location:

Abuwilidat landfill is locates in North West Omdurman the area estimated about 6Km2 and the amount of waste 1500 ton/day its fount in 2008. The landfill receives the waste from local karari, Omdurman, ombada and intermediate station.

There are medical wastes at intervals that are sterilized and then buried in a special cell (Abu Wilidat Landfill, 2018).

Fig (4.2): Aerial Photo of the study area

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Source: Khartoum Cleaning Corporation, 2018

Building and services located in landfill:

Administrative buildings, sentry services, drinking water wells and workplaces, there is no health unit.

Administrative building of the recycling plant

Administrative building of the landfill

Buffer areas

The well

4.2 site layout leveling and preparation:

The area of the project is about 6Km2, divided into two sections:

1- Landfill is composed of 32 cells.

2-recycling facilities composed of:

- Plastic recycling factory
- Natural fertilizer factory.

4.2.1 Cells construction:

This project started in 2008, the first cell is completed, the area of this cell is 315X315 m2, it's height from the surface is 20m, and it's depth 9m, the cover material 10-20cm, its design of Calcareous layer and plastic layer to prevent leakage into groundwater.

The soil type is concrete, the thickness is each meter and the cover material is 10cm and the burial is done by the bulldozer.

The landfill receives the waste from local karari, Omdurman, ombada and intermediate station.

The first stage is balance room to know the amount of waste. Weigh vehicles are full and empty to know the volume of waste.

4.2.2 Recycling plant:

The recycling plant was established with the establishment of landfill and is in partnership with TAX Company. Its task is to sort and recycle the waste.

Stop for work in 2014 by discontinuing the contract by mutual consent for reasons not mentioned.

First, the waste is removed to the conveyor belt by means of the binoculars.

The waste is then sorted process is done according to the size of the waste.

The carton is sorted first, the crystal is then the bags, then magnetized to attract the iron and then the tin.

The remaining wastes that are sorted are shipped in containers and sent to the sanitary landfill in the cell and then left from waste to the fertilizer stage.

Carrie Passable

Magnetic

Rom collection

Cutter

Compost stage:

The remaining organic materials are placed in the form of a matrix and are flipped and irrigated every 3 days and then transferred to the screening stage at this stage is sorted glass and plastic and any other materials to become compost ready.

Sieve

Compost matrix

scraper

Sieve

Manure

burial

Currently all waste is sent directly to the burial site because the recycling plant is stop of work.

4.2.3 Leachate collection system:

There are no pipes for the leachate collection constructed in the design of cells.

4.2.4 Gases collection system:

A collection system of gases in the form of a horizontal and vertical network was implemented, but the problem of breaking the assembly pipes was the idea shared with the private sector.

Currently they are no system for collection and control of gases and leachate resulting from waste decomposition.

4.3 Lanfill Management and Structure:

It consists of an administrative structure that includes the director of movement and operation, a health officer, site engineer, a mechanical team, supervisors and a 24-hour patrol.

Table (4.3): operating units

Operating units	The functions
Director	He is the general supervisor of the landfill and responsible for following and operating of the landfill
Evaluation engineering	He is responsible for developing the engineering plan for the design of the cells
Supervisors	there are responsible for implementation of engineering plan operating and engineering supervision
Services	Includes kitchen, lounge and bathrooms

4.4 Problem in the landfill:

Fires due to waste or reflection resulting from the temperature and the resulting reactions with gases and leached of decomposition, sorting workers in addition to malfunction in mechanisms.

The landfill area has odor, flies and scavengers dominated the scène, the closes cell dissipated smokes. The location is near by the residential areas, about 3-5 Km far, the wind during the winter will blow, odors and smokes to the residential area, if the landfill is not properly manage.

Abu wilidat landfill site is not an engineered control landfill, not according to the standard of the landfill and not according to the initial design proposed by Professional Engineering Consultants (PECS).

4.5 Equipment in landfill: Equipment used in the landfill

Table (4.4): function of equipment

Machine-tool	Function
Bulldozer	Works to subtract in cell subsurface and flatten the area receiving waste.
Loader	Works on dirt loading in the tippers and operation over 12 hours.
Compacter	Works on compressing waste to reduce its size and facilitate burial.
Tipper	Works to migrate cover material to the burial cells.
Bucklin (digger, Excavator Tanker)	Its digs the cells and send the bulldozers to the earthworks to help with the burial.

Bucklin

Tipper

Bulldozer

Compacter

Some environmental measurements of the air were carried out in the landfill, in addition to water tests in well of the landfill and Alfath. The results are as follows:

4.6 Results and discussion:

4.6.1 Environmental monitoring in Abu wilidat landfill:

No	Location	SO2	NH3	TVOCs	CO2	H2S	CO
		ppm	Ppm	ppm	Ppm	ppm	ppm
		5 OSHA	50 OSHA	<1 OSHA	5000 OSHA	20 OSHA	50 OSHA
1	Open cell	0	0	0.129	556.9	0	1.19
2	Closed cell	0	0	0.099	523.9	0	0.714

OSHA: Occupational Safety and Health Administration

4.6.2 Water testing of landfill and Alfath:

Test condition: Temperature: 21.5ºC Relative Humidity: 41%

Test / **Location**	**Alfath**	**Landfill**
PH	7.35	6.95
Conductivity	191µs	408 µs
Total hardness	40 ppm	150 ppm
Total alkalinity	80 ppm	175 ppm
Sulfate	ND ppm	ND ppm
Zinc	ND ppm	ND ppm
Lead	ND ppm	ND ppm
BOD	95 ppm	35 ppm
COD	ND ppm	ND ppm
Total coli form	75 (MPN/100ml)	0.0 (MPN/100ml)

The results show that there are no negative impacts on the environment due to improper treatment of the wastes because the gases from the cells within the permissible limits as well as the water within the limits allowed except the BOD in not as limits due to other reasons.

However the consequences of not following the treatment criteria on the city of conquest include the following:

The spread of bags and odors due to the transfer and migration of waste in addition to spread of flies significantly and the spread of smoke resulting from burning cell closed and effects throughout the year in the summer spread flies and in the fall spread smells unpleasant and annoying and frequent at night and in winter, there are bacteria in the water well for unspecified reasons because the water has not been examined from either side. The diseases related to the location of the landfill are mostly caused by smoke and the children are heavily affected

As for security effects resulting from the sham screening workers, there are very few cases of theft.

The table bellow explains articulating of Abu wilidat landfill when implementing of the technical standard methods of treatment of MSW from design of the landfill to clasp and reused of the landfill.

4.6.3 Comparative between the standard and current situation

Standard of site selection:

Standard of landfill	Abu wilidat landfill
Public opposition	No public opposition
Proximity of major roadways	Proximity of major roadways
Speed and Load limits	Ungraded
Bridge capacities and Underpass limitations	Absent
Traffic patterns and congestion	Absent
Haul distance (in time)	Vibrated
Buffer areas around the site	In one side
Zoning requirements	Unstructured
Historic buildings, end angered species	Absent
Wet lands and similar environmental factors	Absent
Landfill should be more than	
160m from drinking water wells	300m from drinking water wells
30m from streams	200m from streams
65m from house-schools and parks	5Km of residential houses
3000m from airport runways	No airport near

Standard of site preparation:

Standard of landfill	Abu wilidat landfill
Grading the site area	Concrete soil
Constructing access roads and fences	constructing access roads but there fence in one side
Installing signs utilities	No installing signs utilities
operating facilities	Limited operating facilities
Landfill sites should have	
Electric, water and sanitary services	Electric, water and sanitary services
Fire-fighting	Fire-fighting
Dust control	No dust control
Telephone or radio communications	No Telephone or radio communications
Small building for storing hand tools and equipment parts	No Small building for storing hand tools and equipment parts
Sanitary facilities	No sanitary facilities
Types of wastes that must be handled	All types of wastes
Land, size, liners, equipment and Final cover requirements	Land, size, liners equipment and Final cover requirements

Standard of site design:

Standard of landfill	Abu wilidat landfill
Shape of the cell	Hierarchy
Leachate collection system	No leachate collection system
Gas collection system	No gas collection system
Design of drainage and seepage control facilities	No design of drainage and seepage control facilities
Design of solid waste filling plan	No design of solid waste filling plan
Landfill closure and post closure care	No care of closure and post-closure
Design period	Ungraded

Standard of operation and monitoring

Standard of landfill	Abu wilidat landfill
Operation and management	Not as standards
Decomposition	Ungraded
The reactions occurring in landfills	There are not control of reaction occurring in landfill
Environmental monitoring	No environmental monitoring

The standard	Abu wileidat landfill Current practices
Site selection	Site selection has many problems: smokes and nagging odor
Planning and database setup	No planning and database setup
Method of disposal of waste through the adoption burial	The method of burial is not conforming to the standard
Increasing investment Opportunities	Currently there are no investment opportunities to stop the recycling plant
Upgrading operation and maintenance efficiency	The landfill only works to burial of all the waste
Achieve minimum environmental requirements in reducing air, water and soil pollution	Environmental requirements are not set out in the operational plan
Preparing and training the technical personnel required to work in the management and operation in the landfill	There is a severe shortage of working cadres
Reclaimed of landfill	Will be Reclaimed of landfill

After analysis, testing and study the current situation of the landfill and compare with standard demonstrate the following:

- Site selection it as standard.
- Site preparation does not match the standard in the following:
  - No health services.
  - No communication device.
  - No buildings to store the equipment.
- Site design it's as engineering design but environmental design is not considered.

Chapter five

Conclusion and recommendation

Chapter five

5. Conclusion and recommendation

5.1 Conclusions of the study:

After examining and analyzing the current situation of treatment of municipal solid waste in Khartoum state (Abu wilidat landfill) the study found that:

1- The situation of treatment of municipal solid waste in Khartoum state does not follow the standard recommended methods of MSW treatment.
2- The design of Abu wilidat landfill does not follow the standard of engineering methods.
3- The operation of the landfill dose not following the standard recommended methods of MSW treatment.
4- The landfill has evident odor.
5- The closes cell dissipated smokes in wide range up to neighboring residential area.
6- After measurement of the environmental parameters, results show that there are no negative impacts to the environment this is due to the short life of landfill, but there are negative impacts in the environmental threat to the surrounding area including residential sector.
7- There is no monitoring or measurement of the environmental parameters.

8- Findings in Abu wilidat landfill :

- ❖ There are no internal roads.
- ❖ Problems with scavengers.
- ❖ There is no water drainage.
- ❖ There is no light in the landfill cells.
- ❖ There are no guidelines of waste treatment.
- ❖ There is no system of gas collection.
- ❖ There is no system collection of leachate.

5.2 Recommendations:

In the light of the findings of this study, the researcher suggests the following recommendations to achieve the standard treatment of municipal solid waste in Khartoum state (Abu wilidat landfill):

1- Implementation of the sanitary landfill concepts

2- Installation of proper system of leachate and gas collection, before wastes burning, as well as the implementation of adequate daily operation program.

3-Installation monitoring and measurement of the environmental parameters.

4- The landfill should be a functioning planned and data information to operate the landfill.

5- Guidelines for waste treatments.

6- Recycling plans.

7- Strategic planning to achieve zero waste standards.

8- Implementation of a clear closure and pos-closure plan for the landfill.

9- Special training or experience for the cadres.

10- Landfill authorities should make efforts to involve Abu wilidat landfill in the international carbon market.

11- Cooperation with local community, NGOs and academic to development Abu wilidate landfill.

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Appendixes

The questionnaire

Abu wilidat landfill:

1- Location of landfill, Area, Type of soil and design periods?

2- Design of cell and thickness of cover material?

3-What the methods of treatment and disposal are used?

4-What wastes are reused and recycled?

5- Is there a collection system of gases and leachate?

6-Are there buildings and services in the landfill?

7- What equipment is used in the landfill?

8-What are the problems in the landfill?

9-Are there any problems affecting of the Environmental?

10-Are there measurements and monitoring of Environmental impact?

11- How to playback and follow-up of the landfill?

12-What are the solutions and alternatives to address existing problems?

13-What are the benefits of the treatment of wastes?

14-Are there possibility to improve and develop of the landfill?

Alfath area:

1- Are there any effects on waste transportation?
2- Are there flies or rodents or any type of insects continuously and what they are?
3- Is there a trace of fire or smoke?
4- Water used to drink from the well?
5- Has the water been checked by a person or any one?
6- What kinds of diseases are prevalent in the village?
7- Are there any effects of landfill site?
8- Are there security effects resulting from screening worker?

Table: Population for Khartoum state and its locations

year	Unit	Khartoum State	Khartoum LA	JabalAuliya LA	Omdurman LA	Karary LA	umbadda LA	Bahriy LA	Sharg En Nile LA
2016	Capita	7385158	891389	1324343	714145	994227	1392841	846524	1221689
2017	Capita	7687548	927311	1379194	742809	1034216	1451025	880464	1272529
2018	Capita	7993851	963659	1435796	771806	1074674	1510039	914796	1524081
2019	Capita	8312360	1001432	1492640	801935	1116714	1571452	950466	1377721
2020	Capita	8643559	1040685	1552815	833239	1160398	1635361	987527	1433534
2021	Capita	8987953	1081476	1615416	865764	1205790	1701869	1026031	1491607
2022	Capita	9346071	1123865	1680540	899559	1252958	1771081	1066036	1552032
2023	Capita	9718460	1167916	1748290	934673	1301970	1843106	1107601	1614904
2024	Capita	10105335	1213693	1818770	971156	1352898	1918059	1150785	1680322
2025	Capita	10508335	1261263	1892091	1009063	1405818	1996058	1195652	1748390
2026	Capita	10927032	1310697	1968368	1048449	1460808	2077229	1242267	1819214
2027	Capita	11362410	1362069	2047719	1089371	1517947	2161699	1290699	1892906
2028	Capita	11815136	1415453	2130269	1131890	1577321	2249602	1341018	1969583

Table: Forecast Municipal Solid Waste (MSW) Amounts:

item	Unit	Khartoum state	Khartoum LA	JabalAulia LA	Omdurman LA	Karary LA	Umbabdda LA	Bahri LA	Sharg En Nile LA
Year2016									
UGR	Kg/c/d	0.76	1.53	0.71	1.12	0.61	0.51	0.82	0.52
MSW	Ton/day	5752	1.364	946	801	609	712	691	629
Year2020									
UGR	Kg/c/d	0.82	1.62	0.75	1.19	0.64	0.53	0.87	0.54
MSW	Ton/day	7094	1690	1163	992	745	873	855	775
Year2025									
UGR	Kg/c/d	0.88	1.75	0.79	1.28	0.68	0.56	0.93	0.59
MSW	Ton/day	9208	2207	1504	1295	958	1126	1116	1003

UGR: unit generation rate in kilograms per capita per day