LECTURE NOTES

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Solid and Liquid Waste Management

For Health Extension Workers

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In collaboration with the Ethiopia Public Health Training Initiative, The Carter Center, the Ethiopia Ministry of Health, and the Ethiopia Ministry of Education

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Acknowledgments

The development of this lecture note for training Health Extension workers is an arduous assignment for Ato Esayas Alemayehu at Jimma University.

Essentially, it required the consolidation and merging of existing in depth training materials, examination of Health Extension Package manuals and the Curriculum.

Recognizing the importance of and the need for the preparation of the lecture note for the Training of Health Extension workers THE CARTER CENTER (TCC) ETHIOPIA PUBLIC HEALTH TRAINING INITIATIVE (EPHTI) facilitated the task for Jimma University to write the lecture note in consultation with the Health Extension Coordinating Office of the Federal Ministry of Health.

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Definitions of technical terms used in solid and liquid waste management

Ashes: residue from fires used for cooking and heating

Biodegradable: capable of being breakdown by biological process.

Biodegradation: metabolic process by which high energy organics are converted to low energy, CO_2, and H_2O

Biological Oxygen Demand (BOD): amount of oxygen, used by microorganisms in the biodegradation process.

Bulky Refuse: materials that are non-combustible including metals cans furniture dirt glass. etc.

Decomposition: reduction of net energy level and change in chemical composition of organic matter because of actions of aerobic or anaerobic microorganisms.

Dumping: The final disposal of all refuses by uncontrolled, indiscriminate deposition on sand areas, in pits or quarries, rivers, etc.

Effluent: out flowing liquid and broken by the action of anaerobic bacteria.

Garbage: Organic and generally biodegradable wastes from the preparation and processing of foods in homes,

restaurants, food processing and packaging plants abattoirs and other similar establishments.

Garden trash: Grass clippings, flowers, shrubbery and tree trimmings, leaves, and other tree droppings.

Influent: inflowing liquid

Municipal wastes: normal sized wastes from street cleaning and litter collections from playgrounds, schools, hospitals, parks, dead animals and public slaughtering house.

Recyclable (salvageable): Materials or items which can economically sorted out and removed from refuse for sale, refuse by private enterprise.

Residues: Solid material which is left (discharged) at the end of burning (incineration)

Rubbish: combustible wastes including paper, card board boxes, barrels, wood, tree branches yard trimmings, furniture originating from homes institutions hotels, markets, Stores, etc.

Sewage disposal: the act of disposing sewage by any means.

Sewage treatment: covers any process in which sewage is subjected in order to remove or alter its objectionable constituent to make it less dangerous or offensive.

Sewer: a pipe containing sewage or wastewater

Sewerage: a system of sewer pipes for collecting sewage or wastewater into the treatment and disposal.

Solid wastes: is all the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted.

Street Refuse: street-sweeping dirt.

Sullage: domestic dirty water not combined with excreta

Background Information

Domestic Waste is waste, which is either solid or liquid generated in residential areas, Commercial settings and institutions. Waste in general terms is defined as an unwanted as it is obviously undesirable. It is nevertheless an inevitable and inherent product of social, economic and cultural life.

The indiscriminate disposal of waste, both liquid and solid, adversely affects the immediate human environment by degrading the natural phenomena hence, exerting health risk to exposed population. Health risks may be carried through different vehicles including flies, dogs, rodent and others that scavenge on the waste.

In this lecture note, the most practical ways of managing solid and liquid waste at household and community levels are discussed in detail. However, considerable emphasis is given to solid waste management systems. The various technologies for proper disposal of solid wastes are listed.

This lecture note is basically aimed at health extension students and community promoters to provide a ready-made reference, but other primary health workers can also use it. The lecture note has three main chapters namely, solid waste management, liquid waste management and contaminated waste management.

UNIT ONE

Solid Waste Management

Learning Objectives

After completing this unit the trainee will be able to:

- Define solid Waste Management.
- Describe public health importance of Solid Waste.
- Describe the major sources and types of Solid Waste
- Demonstrate common Solid Waste disposal methods.

1.1 Introduction

Solid waste management: A systematic administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment and disposal of solid waste.

1.2 Public Health importance of solid waste

- It can be best media for the growth of microorganisms
- Attraction of arthropods such as common housefly, mosquito, etc
- Attraction of rodents and other animals e.g. rats mice dogs cats

- Open dump can contaminate water sources
- Can contaminate food supply and cause food borne disease
- Hospital and pathological wastes are potential disease carrying waste products
- Radioactive wastes are highly dangerous
- It can create fire accident
- Slum areas
- It can create nuisance:

  Bad odor, smoke, dust

  Aesthetical problem

  Discomfort: sneezing, coughing

1.3 Classifications of solid waste

Solid waste can be classified into two categories by its characteristics. These are:

- Organic solid waste
- Inorganic Solid waste

Organic solid waste: Wastes that are generally biodegradable and decompose in the process of which emits offensive and irritating smell when left unattended.

⇒ Putrescible wastes e.g. Garbage

Inorganic solid waste: Solid matter that does not decompose at any rate This category of waste matter may be combustible depending on the type of the nature of the material they constitute.

⇒ Non-putrescible wastes e.g. Rubbish

1.4 Functional Elements of solid waste management system

There are six functional elements in the activities associated with the management of solid wastes from the point of generation to final disposal site. These are:

1. Waste generation
2. On-site handling (sorting, storage and processing)
3. Collection
4. Transfer and transport
5. Processing and recovery
6. Disposal

Description of the six main functional elements of solid waste management system:

Waste generation*:* those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal.

On-site handling, storage, and processing*:* activities associated with the handling, storage, and processing of solid wastes at or near the point of generation.

Collection: those activities association with the gathering of solid wastes and the hauling of wastes to the location where the collection vehicle is emptied.

Transfer and transport: Those activities association with (1) the transfer of wastes from the smaller collection vehicle to the larger transport equipment and (2) the subsequent transport of the wastes, usually over long distance, to the disposal site.

Processing and recovery: Those techniques equipment and facilities used both to improve the efficiency of the other functional elements and to recover useable materials, conversion products, or energy from solid wastes.

Disposal: Those activities associated with ultimate disposal of solid wastes

Interrelationship of functional elements comprising a solid waste management system.

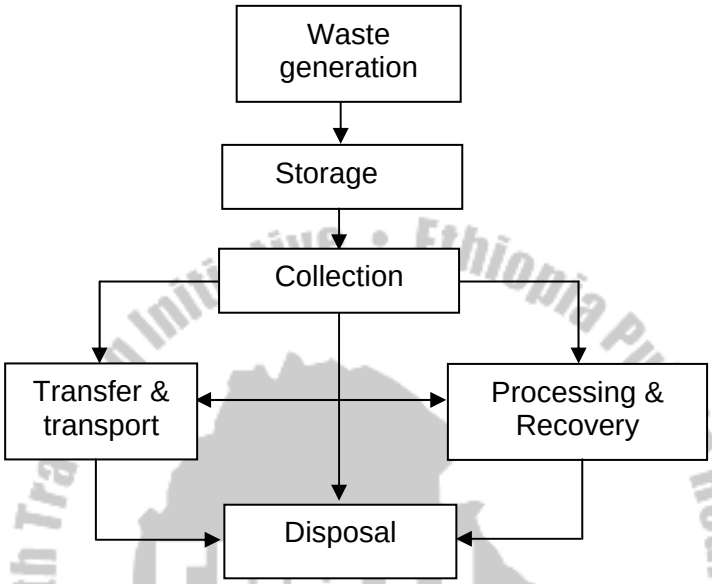

Figure 1: Interrelationship of functional elements comprising a solid waste management system

1.5 Main sources of solid waste generation

- Residential (domestic or house hold)
- Commercial
- Institutional
- Construction Demolition
- Treatment plant sites
- Industrial
- Agricultural

1.6 Waste handling and separation, storage and processing at the source

⇒ The best place to separate waste materials for reuse and recycling is at the source of generation

⇒ Home owners should be aware of separation of News paper, and cardboard, bottles, yard wastes, aluminum cans, ferrous materials and especially hazardous wastes

⇒ Waste processing is used to reduce the volume, recover usable materials, and alter the physical form of the solid wastes.

⇒ The most common on-site processing operations used are:

- Food waste grinding and release to sewer system
- Component separation
- Compaction: decrease the volume up to 70%
- Incineration, yard waste composting etc

1.7 Solid waste collection

Collection is provided under various management pattern/arrangements:

- Municipal/Rural Communities Organization- using simple and locally available technology such as Donkey Drawn Cart, see figure 2.
- Private services such as contractors
- Scavenger system: Individuals may collect and use

wastes like paper, metal, containers, clothes etc for reuse or recycling.

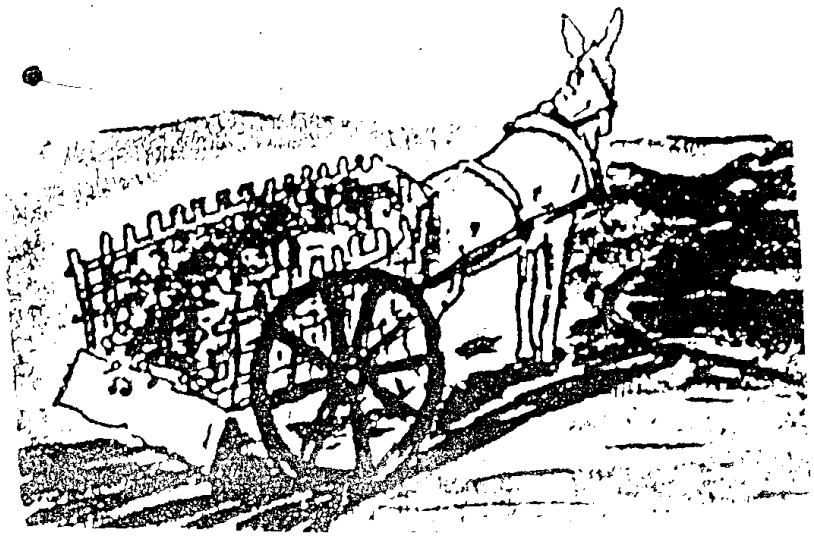

Figure 2: Collection using Donkey Drawn Cart

Frequency of collection: should be considered to avoid fly breeding and for aesthetic consideration

- **Garbage:** at least 2 times /week in residential areas
- **Rubbish:** weekly in residential areas
- **Mixed refuse:** at least 2 times/week in residential areas

N.B. All wastes should be collected daily in commercial areas.

Time of Collection:

- **Residential areas:** during the daytime, because of

noise nuisances and difficulty of locating storage containers in the dark.

- **Commercial areas:** during nighttime because of heavy traffic during day for large collection truck

Influencing factors of collection:

- Type of equipment:
  - Vehicle
  - Pushcart
- Maintenance services for equipment
  - Garage
  - Workshop
- Number and capacity of equipments
- Site and accessibility of collection situations
- Cost and routing of collection
- Number of crewmen
- Community involvements/participations
- Intermediate treatment and final disposal site distance

1.8 Recycling and reuse

Reuse and recovery/recycling of waste conserves energy and the practice is valued as it is environmental friendly. Waste products such as the non-decomposable ones, which include broken glasses, metal scraps, wires and the licke, can be recovered for further processing. Some materials can also be

recovered for reuse with out further processing. There are different ways and practices of converting wastes in to useful assets. For example:

- Human or animal urine contains the element nitrogen, which is used as fertilizers. Farmers in rural Ethiopia use manure and other waste for fertilizer.
- Animal bones can be made to be a very important animal feed after processing.
- Rural communities know and use dung for plastering of houses and as an energy source for open fire burning.
- Some people in bigger towns in Ethiopia collect bottles, old shoes, clothes, metal products, which is one form of recycling or reuse.

In general, waste recovery and reuse is economically and socially feasible and acceptable.

1.9 Common solid waste disposal methods

In rural communities the following common useful simple and practical methods of solid waste intermediate treatments/reuse and disposal methods include:

- Composting

- Controlled Tipping/Burying
- Ploughing in the Fields
- Incineration

1.9.1 Composting

Composting is one of the means of waste minimization. The mechanism implies a biological waste treatment process. The action of microorganisms breaks down complex organic compounds into simpler ones.

Composting is not final disposal method but converting waste into a useful product. Compost has been used in both the rural and semi urban areas of Ethiopia for quite a long time as a soil conditioner to grow mostly vegetables and crops but without processing it.

Composting process:

1. Sort and/or separate the compostable organic matter such as garbage, grass, dung, etc from the uncompostable ones such as plastic, leather, ceramic, clay or metal products that hamper the decomposition process.
2. Mix in equal proportion all wastes including animal manure, kitchen waste, weeds and house sweepings. It may be necessary to add and mix human and animal waste to

enhance and facilitate the biodegradation process. Adding these waste matters not only enhances the decomposition process but it also enriches the waste in nitrogen and phosphorous. Which are essential elements for plant growth. However, using human or animal waste need precautions as it may contain pathogenic organisms, which may contaminate the crops, the hand and feet of people working in the farm. This may create a perpetual communicable disease transmission condition outweighing the advantage of waste reuse.

3. Compost sites may be arranged by digging a shallow hole the size of which may vary with the amount of waste intended to be composted or the waste may be place above ground. Placing it above ground is easier to work with the waste in the process of composting.
4. Pile the sorted and mixed solid waste on the ground to a height of about 0.15 meters (15 centimeters). Lay horizontally four round sticks on top of the pile as shown in figure 3. The space in between the poles could be from 75-90 cm.

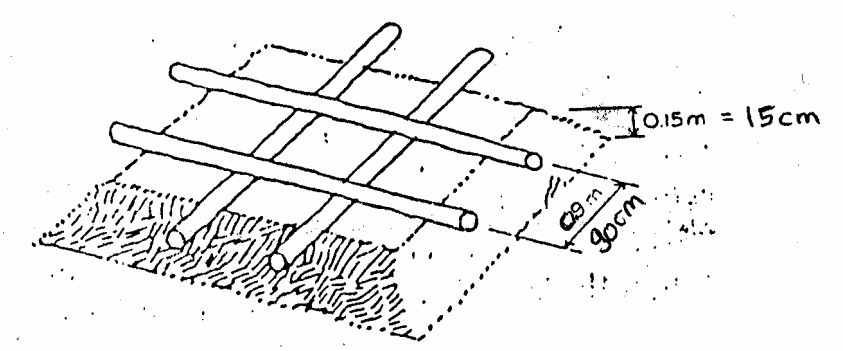

Figure 3: Piling the first layer of organic waste matter

5. On the corner of the wooden poles laid horizontally insert four poles vertically as shown in figure 4.

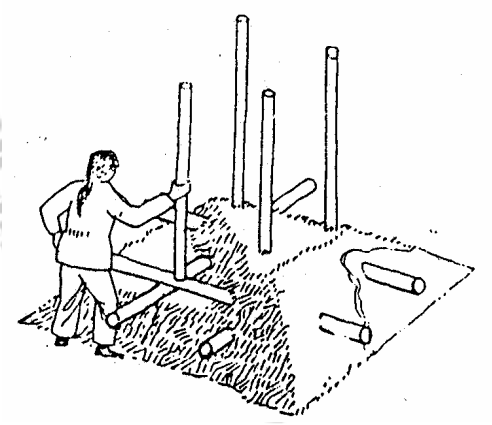

Figure 4: Place vertical poles in the pile

6. Add the rest of the sorted out waste matter on top of the wooden poles for an additional 90 cm.

7. Cover the completed pile of waste with 50 cm earth and animals manure and take out the poles from the pile as shown in figure 5.

The soil/manure cover will help in preventing rainwater from soaking into the pile. Reduce evaporation, lessen loss of nitrogen (nutrient), prevents fly breeding etc. The holes made by the poles will help in introducing oxygen into the pile hence making the composting process aerobic. Such method will not cause nuisance or smell.

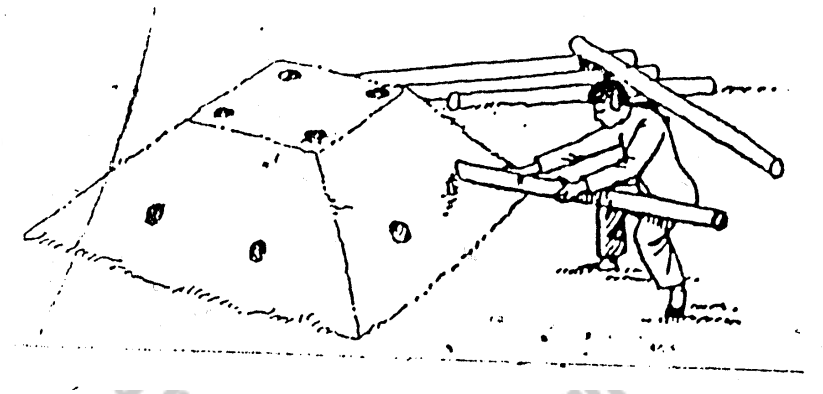

Figure 5: Final covering and taking out the poles from the pile.

- Instead of using round wooden poles the waste could be piled up as it is and aerate it once or twice a week by turning it so that aerobic bacteria can remain active and proliferate and stabilize the waste.

- Well-stabilized compost is:
  - Dark looking
  - Does not smell and
  - Stable humus

- The compost supplies the elements that plants require for growth except some deficiencies in phosphorous and nitrogen. This may be improved by adding urine together with the humus.

1.9.2 Controlled Tipping/Burying

Solid wastes that are not recycled or used should be disposed. Disposal is effected in many different ways. But the most important method is that which is able to isolate the waste for good. A method that satisfies this is known as controlled tipping. It is a way of isolating any type of waste without bothering to sort or separate.

Controlled tipping is a simple, effective and relatively cheaper method of refuse disposal. This method involves preparation of hole in the ground with a depth of 1-2 meters and width and length of 60 centimeters for a household. The method can be used as a one-time or a daily operation. If it is a daily operation the process is as follows:

1. A disposal site is identified within the compound of any residential, commercial or institutions. The site should not be:
    - Near water sources
    - Near to houses and kitchen
    - Near a road or path
2. Pile the dugout earth near the pit for future use
3. Dump the generated solid waste (garbage, refuse etc) in the pit daily
4. Cover the waste matter with the excavated soil every day

Waste generated every day is dumped into the pit and covered with earth so that flies and vermin don't get access to it. The process continues until the pit is filled after which it should be completely covered with earth and another one is dug next to the old one. With this method flies, mosquitoes, rodents, wild animals, birds and other nuisance animals will not have access to breed and feed.

The decomposable waste will still condition the soil. Crops planted on completed sites grow better and the immediate surrounding of the dwelling house looks always clean.

Figure 6: Burying solid waste in a pit

1.9.3 Incineration

Incineration is a high temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and resulting in a very significant reduction of waste volume and weight.

Characteristics of wastes suitable for incineration:

- Content of combustible matter above 60%
- Content of non-combustible solids below 5%
- Content of non-combustible fines below 20%
- Moisture content below 30%

Waste types not to be incinerated:

- Pressurized gas containers
- Large amount of reactive chemical waste
- Silver salt and photographic or radiographic wastes
- Halogenated plastics such as polyvinyl chloride (PVC)
- Waste with high mercury or cadmium content, such as broken thermometers, used batteries, and lead-lined wooden panels
- Sealed ampoules or ampoules containing heavy metals

⇒ Air pollution is undesirable characteristics of incinerator

⇒ Expensive and skill personnel is needed

⇒ May be located close to centre of waste production (advantageous)

Types of Incinerators

Incinerator can range from extremely sophisticated; high-temperature once to very basic that operate at much lower temperatures. All types of incinerators, if operated properly, eliminate microorganisms from waste and reduce the waste to ashes.

At a small community with the limited resources and where

high-temperature incinerators are not affordable, waste may be incinerated in a drum incinerator. A drum incinerator is the simplest form of single-chamber incinerator figure 7 & 8. It can be made inexpensively and is better than open burning.

How to build and use a simple drum incinerator for waste disposal:

Step 1: where possible, select a site downwind from the health post.

Step 2: Build a simple incinerator using local materials (mud or stone) or a used oil drum (e.g., 80-100 liters drum). The size depends on the amount of daily waste collected (figure 7).

Step 3: Make sure the incinerator has:

- Sufficient air inlets underneath for good combustion
- Loosely placed fire bars to allow for the expansion
- An adequate opening for adding fresh refuse and for removal of ashes
- A long enough chimney to allow for a good draft and evacuation of smoke.

Step 4: Place the drum on hardened earth or a concrete base.

Step 5: Burn all combustible waste, such as paper and cardboard, as well as used dressings and other contaminated wastes. If the waste or refuse is wet, add kerosene so that a hot fire burns all the waste. Ash from incinerated material can be treated as non-contaminated waste.

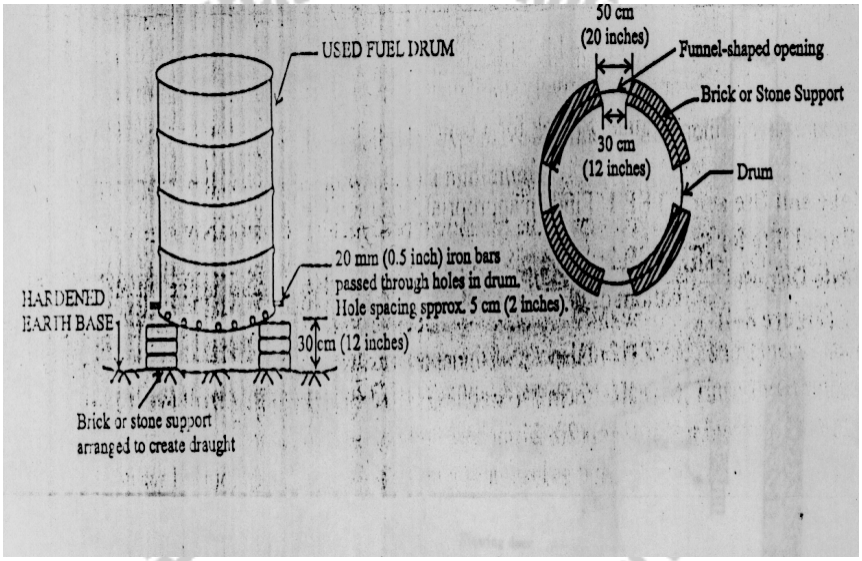

Figure 7: Design for a simple Oil Drum Incinerator (Source: SERO/WHO 1988)

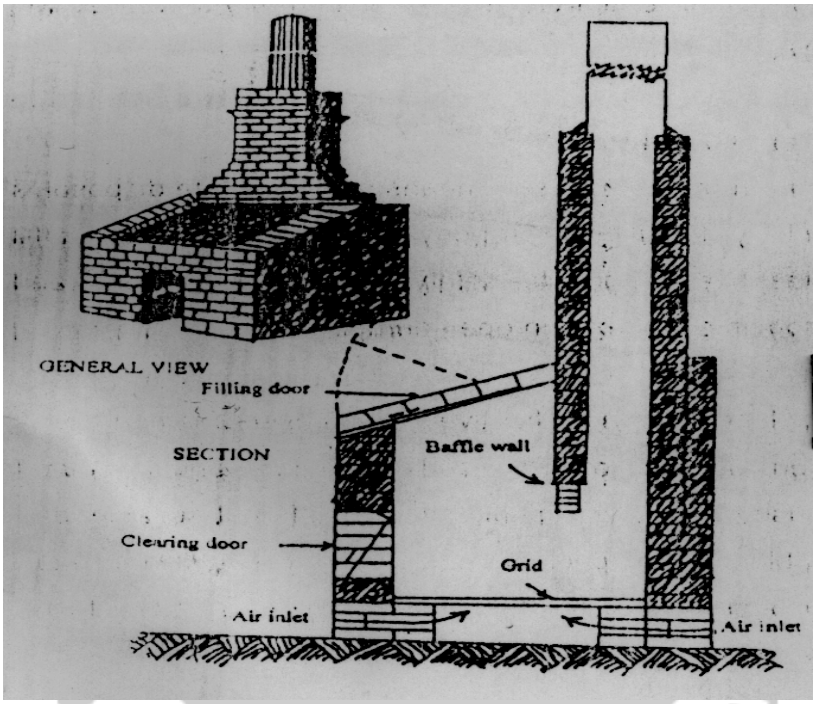

Figure 8: Single-chamber Incinerator (Source: Gebre-Emanuel Teka (1997): Solid Waste Disposal from Food Premise, in Food Hygiene).

1.8.5 Ploughing in fields

Applying waste in farm fields for soil conditioning has been practiced in Ethiopia for a long time. This is a practice with a dual purpose, it is one hand a way of waste disposal and on the other hand a means of recovering and reusing waste for soil conditioning.

Human and animal excrements, sweepings from residential premises, left over food from people and animals; vegetables, leaves etc. are some of the domestic solid wastes that are ideal for using in farms preferably after composting. However, indiscriminate disposal of waste especially in farm areas may be cause of diseases transmission and source of accidents from puncturing (nails, wire) or cutting (glass, tin) waste materials.

1.8.5 Other disposal methods

There are some other intermediate treatments or final disposal methods, which are not commonly used, in the rural communities of Ethiopia.

Sanitary landfill*:* A method of disposing a refuse on land without creating nuisances or hazards to public health or safety.

The characteristics of sanitary landfill that distinguish it from an open dump

1. The waste is placed in a suitably selected and prepared land fill site in a carefully prescribed manner
2. The waste materials is spread out and compacted with appropriate heavy machinery
3. The waste is covered each day with a layer of compacted soil

- It is effective method for permanent disposal if there is enough land and equipment
- Useless lands become usefull (hills, valleys) e.g. flat land for recreation

N.B. It may not appropriate in rural Ethiopia because of highly skilled professionals require for proper operation, planning, regulating and controlling and deposition of solid wastes on selected areas.

Dumping in to sea

- It is unsanitary since it affect aquatic ecosystem

Hog feeding for garbage

- Problem of pork tapeworm, trichinosis

Discharge to sewers

- Effective for garbage disposal only.
- It should be grinded to be disposed

Open dump

- The most unsanitary disposal option

UNIT TWO

Liquid Waste Management

Learning Objectives

After completing this unit the trainee will be able to:

- Define liquid waste management.
- Describe public health importance of liquid waste.
- Describe the major sources and types of liquid waste.
- Demonstrate common liquid waste disposal methods.

2.1 Introduction

Liquid waste management: A systematic administration of activities that provide for the proper handling, treatment and disposal of liquid waste/wastewater or sewage.

2.2 Public health importance of waste water/sewage

The improper disposal of waste water play a role in the contamination of surface water, ground water, and the soil

thereby posing health problems. These phenomena persist in developing countries and affect almost every one.

In Ethiopia, to day, all wastes even in large international cities like Addis Ababa are drained to the side of roads to ultimately join small streams or rivers to flow down stream causing water pollution. All the wastes drained in water ways depends on the winter rains for cleaning.

Although very high wastewater pollution may not be expected in the rural Ethiopia, there are some household sewage (liquid dung, domestic wastewater, etc.) generated from kitchens, toilets, barns, and other domestic areas.

If household, industrial, or commercial wastes are not properly disposed, then the disease problems caused by pollution will still remain to be persistent in the environment.

The disease commonly transmitted through water such, as Cholera, dysentery and typhoid are waste related. If waste was safely deposited, or treated and disposed most of the water born diseases would have not been a problem.

2.3 Classifications of liquid waste/sewage

Waste water or sewage that are generated from a home or community including toilet, bath, laundry, lavatory, and kitchen- sink wastes, and surface run off may be classified into four. These are:

- Sanitary sewage
- Industrial sewage
- Storm sewage or
- Mixed sewage (a mixture of all)

Sanitary sewage also called domestic sewage contains human wastes and wash water from homes, public buildings or commercial and industrial establishments.

N.B. *Domestic sewage/liquid waste here is meant waste from kitchen, barn, bathroom, laundry, etc., which do not contain human excreta or sewage*

Industrial sewage is the used water from manufacturing processes, usually carrying a variety of chemical compounds.

Storm sewage, or storm water, is the surface run off caused by rainfall, it carries organics, suspended and dissolved solids, and other substances picked up as it travels over the ground.

2.4 Wastewater/sewage composition

Sanitary or domestic wastewater comprises about 99.9% water and only about 0.1% impurities. In other words, if a 1-liter sample of wastewater is allowed to evaporate, only about 1gram of solids will remain behind.

Actually, sewage can contain so many different substances, both suspended and dissolved, that it is impractical to attempt to identify each specific substances or microorganism. The total amount of organic materials is related to the strength of the sewage.

This is measured by the biological oxygen demand, or BOD and the total amount of suspended solids, or TSS. On the average, untreated domestic sanitary sewage has a BOD of about 200 mg/L and a TSS of about 240 mg/L. Industrial wastewater may have BOD and TSS values much higher than those for sanitary sewage; its composition is source dependent.

Another group of impurities that is typically of major significance in wastewater is the plant nutrients. Specifically, these are compounds of nitrogen, N, and phosphorus, P. On the average, raw sanitary sewage contains about 35 mg/L of N and 10 mg/L of P.

Finally, the amount of pathogens in the wastewater is expected to be proportional to the concentration of fecal coliform bacteria. The coliform concentration in raw sanitary sewage is roughly 1 billion per liter.

2.5 Points to be consider before selecting one particular sewage disposal technique

There is no single individual sewage disposal technique that can be universally applied under all conditions. However, the selection of a particular method will depend upon the following major factors:

- The nature of soil formation and stability of the locality
- The availability of adequate land for sewage disposal
- The quantity of sewage to be disposed of
- The degree of sewage treatment to be achieved
- The presence of well water, and whether it is used as the source of the water supply
- The level of the water table of the ground water
- The proximity of the disposal site to surface water sources
- The relative cost of the disposal technology

2.6 Liquid waste/sewage disposal methods at the rural communities or households level

There are many sewage disposal methods. Some are very expensive and some need a sophisticated technology. The following disposal methods are suggested based on the type,

amount and sources of liquid waste found in most rural areas and small towns in Ethiopia. These methods are the simplest and cheapest to dispose sewage in rural communities.

A. Disposal by dilution/ "Self-purification of water bodies"

It is a common practice in some communities to discharge raw sewage into near by water bodies such as rivers, streams, etc., so that it is diluted or reduced in strength by the water.

⇒ Unsanitary:

- Nuisance (creating offensive condition)
- Water and soil pollutions (a aquatic life start to die off)
- Spread of infectious organisms greatly increases

B. Cesspool

A cesspool is a pit dug in the ground in order to receive waste water/sewages from kitchen, toilet or barns. Cesspool can be classified in to two kinds by its removal mechanisms. These are:

1. The leaching type of cesspool
2. The watertight cesspool

Leaching type of cesspool or Seepage/soakage or absorption pit

The leaching type cesspool, otherwise known as a seepage pit, soakage pit or absorption pit, is a pit dug in the ground to receive sewage from kitchen, toilet, or barns, and to allow the liquid to seep, leach or percolate into the ground.

- The liquid portion seeps or leaches off into the surrounding soil, while the solid component (sludge) is retained in the pit.
- The side of the pit is constructed with open joints in order to facilitate seepage of the liquid portion, while the top most part (60-90 cm) is plastered to make it watertight as shown in figure 9.
- A concrete slab cover with a man-hole is provide to permit access to the pit, and an outlet pipe takes the effluent into another pit or serious of pits

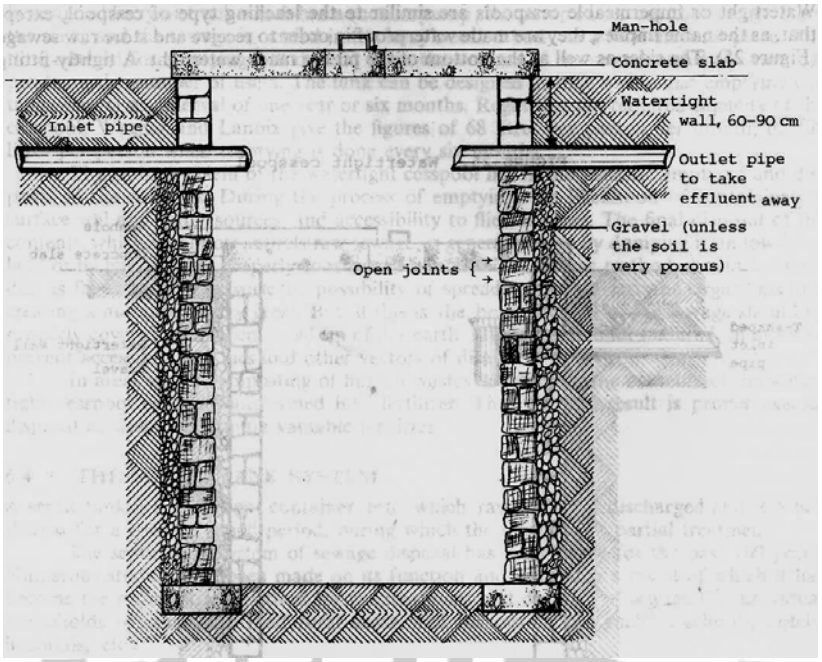

Figure 9: Leaching type of Cesspool

- A depth of 2 to 3 meters and a diameter of 90 to 120 cm will give a reasonable capacity, provided the soil is adequately porous, and can let the liquids.
- The cesspool should be sited at least 30 meters away from and on a lower level than water wells or other sources of drinking water.
- The height of the ground water table should be at least 1.2o meters below the bottom of the cesspool.

However, it may not be recommend except in very special circumstances (e.g. it can be used if the soil formation is sufficiently porous; where water sources are properly protected).

Improperly used cesspool may create:

- Fly-breeding
- Objectionable odour
- Nuisances

Watertight cesspool

- Similar to leaching type except made water proof in order to receive and store sewage as shown in figure 10.
- Inside water tight tank sewage undergoes anaerobic decomposition but should not considered sewage treatment
- Problem: periodic emptying and disposal of contents

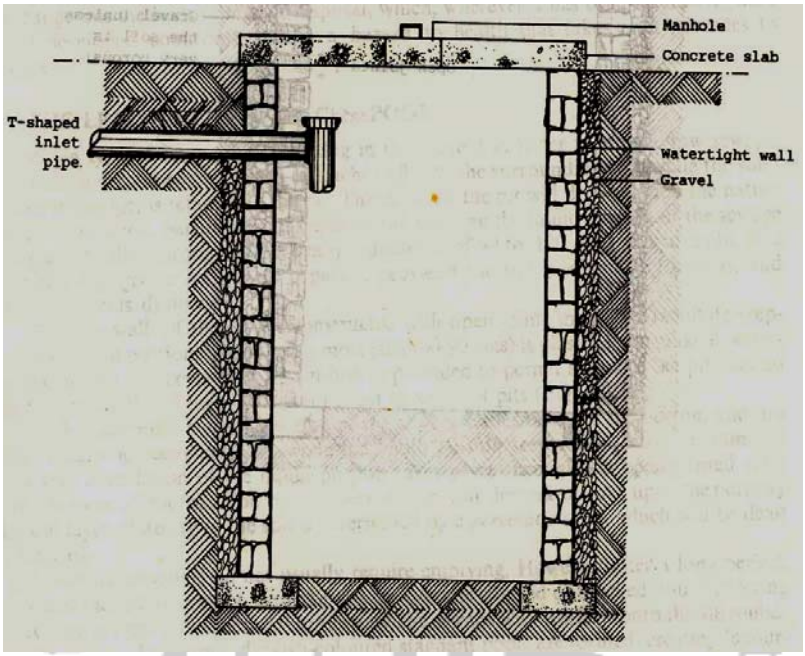

Figure 10: Watertight Cesspool

C. Septic tank

Septic tanks are commonly used for wastewater treatment for individual households in low-density residential areas, for institutional such as schools and hospitals, and for small housing estates. The wastewater may be waste from toilets only, or may also include Sullage.

The septic tank, in conjunction with its effluent disposal system, offers many of the advantages of conventional sewerage.

However, septic tanks systems are more expensive than other on-site sanitation systems and are unlikely to be affordable by the poorer people in society. They also require sufficient piped water to flush all the wastes through the drains to the tanks.

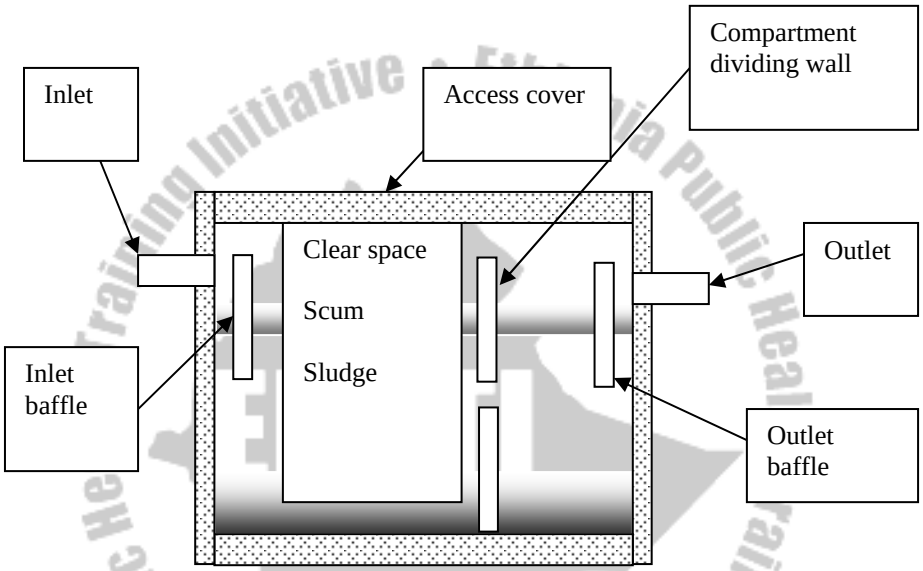

Figure 11: Schematic of septic tank

2.7 Sewage/wastewater treatment

Why treatment?

Before discharging wastewater back into the environment and the natural hydrologic cycle, it is necessary to provide some degree of treatment in order to protect public health and

environmental quality. The basic purposes of sewage treatment are:

- To destroy pathogenic microorganisms
- To remove most suspended and
- To remove dissolved biodegradable organic materials.

Sometimes it is also necessary to remove the plant nutrients – nitrogen and phosphorus. Disinfections, usually with chlorine, serves to destroy most pathogens and helps to prevent the transmission of communicable disease.

The removal of organics (BOD) and nutrients helps to protect the quality of aquatic ecosystems.

Treatment methods

Treatment methods are grouped into three general categories:

- **Primary treatment:** Screening, grit removal, and sedimentation (settling)
- **Secondary or biological treatment:** biological processes and additional settling.
- **Tertiary or advanced treatment:** not all sewage treatment plant requires tertiary (advanced) treatment.

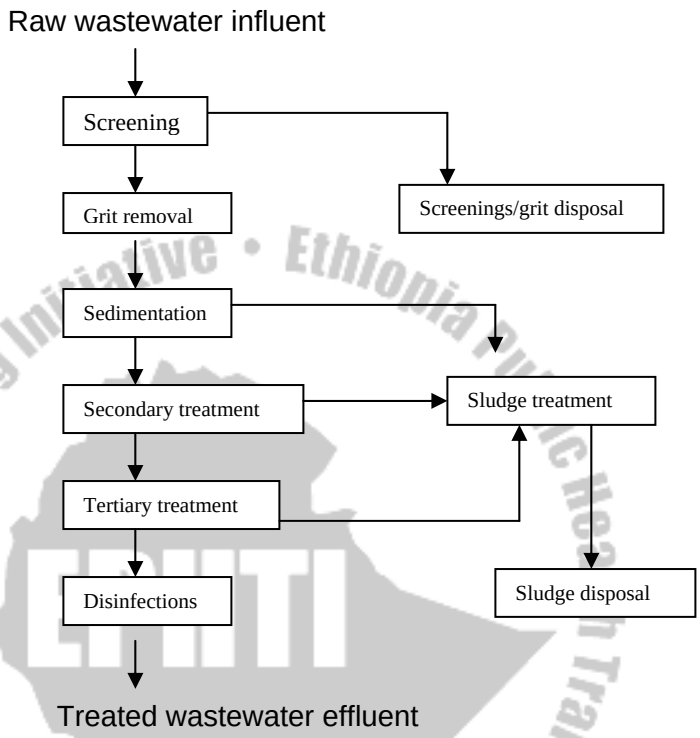

Figure 12: Schematic overview of a conventional wastewater treatment system.

UNIT THREE

Contaminated Waste Management

Learning Objectives

After completing this unit the trainee will be able to:

- Define contaminated waste.
- Demonstrate the purpose of contaminated waste.
- Demonstrate methods of collection and disposal of contaminated waste

3.1 Introduction

Wastes from hospitals and healthcare facilities may be contaminated (potentially infectious) or non-contaminated. Approximately 85% of the general waste produced by health institutions is **non-contaminated waste** and poses no infectious risk to persons who handle it.

Examples of non-contaminated waste include paper, trash, boxes, bottles, plastic containers and food. They can be disposed of by the common methods as discussed in chapter two and three.

Some waste from healthcare facilities, however, is contaminated. If not disposed of properly, **contaminated**

wastes may carry microorganisms that can infect the people who come in contact with the waste as well as the community at large.

Contaminated wastes include blood, pus, urine, stool and other body fluids, as well as items that come in contact with them, such as used dressings. Wastes from operating rooms (human tissue, blood or blood soaked sponges, gauze or cotton) and laboratories (blood, feces, sputum, urine specimens and microbiological cultures) should be considered contaminated. Soiled medical devices or items that can inflict injury (e.g., used needles and scalpel blades) are capable of spreading blood borne diseases such as hepatitis B, hepatitis C and AIDS, and are also considered contaminated waste.

Definitions:

- **Contaminated.** State of having been actually or potentially in contact with microorganism. As used in healthcare, the term generally refers to the presence of microorganisms that could be capable of producing disease or infection.
- **Container**. Vessel in which waste is placed for handling, transportation, storage and/or eventual disposal.
- **Disposal**. Intentional burial, deposit, discharge, dumping, placing or release of any waste material into or on air,

land or water. Disposal is undertaken without the intention of retrieval.

- **Encapsulation.** Filling a sharps container that is three-quarters full with cement or clay, which, after hardening, can be disposed of safely in a landfill,
- **Hazard.** Intrinsic potential property or ability of any agent, equipment, material or process that can cause harm.
- **Infectious waste.** The part of medical waste that is capable of causing infectious diseases.
- **Scavenging.** Manual sorting of solid waste at landfills and removal of usable materials.
- **Segregation**. Systematic separation of solid waste into designated categories.
- **Sharps.** Hypodermic needles, suture needles, scalpel blades, scissors, wire sutures, broken glass or any object that can cause a puncture or cut.

3.2 Purpose of contaminated waste management

The purpose of contaminated waste management is to:

- Protect people who handle waste items from accidental injury,
- Prevent the spread of infection to healthcare workers who handle the waste,
- Prevent the spread of infection to the local community, &

- Safely dispose of hazardous materials (toxic chemicals and radioactive compounds).

Open piles of contaminated waste should be avoided because they:

- Are a risk to those who scavenge and unknowingly reuse contaminated items,
- Allow persons to accidentally step on sharp items and injure themselves,
- Produce foul odors, and
- Attract insects and animals.

3.3 Collection and disposal of contaminated waste

Proper disposal of contaminated waste may include:

- Pouring liquids or wet waste directly into a safe sewerage system.
- Incinerating (burning) items to destroy the item as well as any microorganisms. (This is the best method for disposal of contaminated waste. Burning also reduces the bulk volume of waste and ensures that the items are not scavenged and reused.)
- Burying all contaminated wastes to prevent further handling.

Proper handling of contaminated waste minimizes the spread of infection to healthcare personnel and to the local community. Whenever possible, contaminated waste should be collected and transported to disposal sites in leakproof, covered waste containers.

- Use plastic or galvanized metal containers with tight-fitting covers for contaminated wastes. Many facilities now use colored plastic bags to alert handlers to the contents and to keep the general (non contaminated) waste separate from contaminated waste.
- Use puncture-resistant sharps containers for all disposable sharps (sharps that will not be reused).
- Place waste containers close to where the waste is generated and where convenient for users (carrying waste from place to place increases the risk of infection for handlers). This is especially important for sharps, which carry the highest risk of injury for health workers and staff.
- Equipment that is used to hold and transport wastes must not be used for any other purpose in the clinic or hospital. (Contaminated waste containers should be marked as such.)
- Wash all waste containers with a disinfectant cleaning solution (0.5% chlorine solution plus soap) and rinse with water regularly.

- When possible, use separate containers for combustible and noncombustible wastes prior to disposal. This step prevents workers from having to handle and separate wastes by hand later.

- ***Combustible (burnable) wastes*** include paper, cardboard and contaminated wastes such as used dressings and gauze.
- ***Noncombustible (non burnable)*** wastes include glass and metals.

- Use personal protective equipment (PPE) when handling wastes (e.g., heavy-duty utility gloves and closed protective shoes).
- Wash hands or use a waterless, alcohol-based antiseptic hand rub after removing gloves when handling wastes.

It is important to train all community health workers and healthcare workers, including physicians, to keep contaminated and non-contaminated waste separate. For example, throwing a hypodermic needle into a wastebasket in a patient's room automatically makes that container hazardous for housekeeping staff to handle. And, if discovered, that wastebasket now needs to be handled and disposed of as contaminated waste.

Flow diagram for the separate collection and disposal of wet and dry contaminated waste:

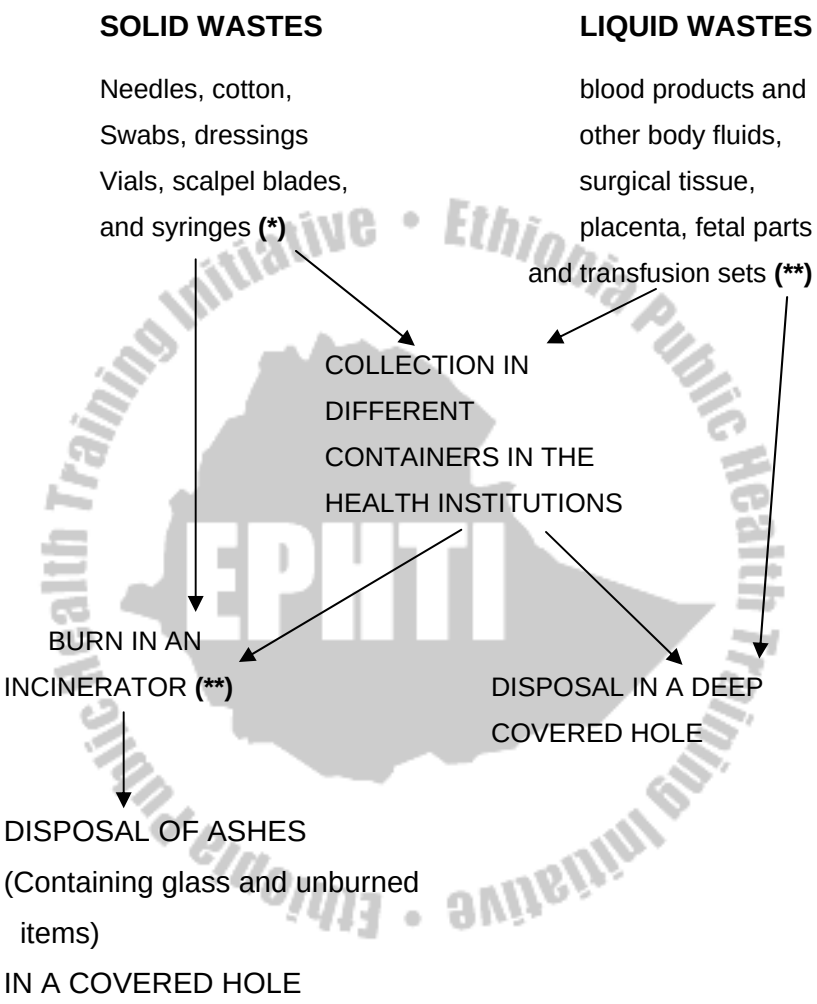

Figure 13: Flow diagram-Collection and Disposal of contaminated waste

(*) = Small quantities of syringes made of polyethylene or polypropylene cane incinerated outside without producing any environmental health hazard.

(**) = Transfusion sets or syringes made of polyvinyl chloride (PVC) should not be incinerated because they release hazardous chemicals.

(***) = Build with local material (e.g. drum or clay single-chamber incinerator as explain in chapter two).

3.4 How to dispose of solid contaminated wastes

Solid contaminated waste (e.g., surgical specimens, used dressings and other items contaminated with blood and organic materials) may carry microorganisms.

STEP 1: Wear heavy-duty or utility gloves when handling and transporting contaminated solid wastes.

STEP 2: Dispose of contaminated solid wastes by placing them in a plastic or galvanized metal container with a tight-fitting cover.

STEP 3: Collect the waste container on a regular basis and transport the burnable ones to the incinerator or area for burning.

STEP 4: Remove utility gloves (wash daily or when visibly soiled and dry).

STEP 5: Wash and dry hands.

Special Situations

If a patient or family member wants to take home the placenta or body parts for burial, first place them in a plastic bag and then into a rigid container (clay bowl, metal or plastic container) for transport.

3.5 How to dispose of liquid contaminated wastes

Liquid contaminated waste (e.g., human tissue, blood, feces, urine and other body fluids) requires special handling, because it may pose an infectious risk to community healthcare workers who contact or handle the waste.

STEP 1: Wear PPE (utility gloves, protective eyewear and plastic apron) when handling and transporting liquid contaminated wastes.

STEP 2: Carefully pour wastes down in a utility sink drain or into a flushable toilet and rinse the toilet or sink carefully and thoroughly with water to remove residual wastes. ***Avoid splashing***.

STEP 3: If a sewage system doesn't exist, dispose of liquids in a deep, covered hole, not into open drains.

STEP 4: Decontaminate specimen containers by placing them in a 0.5% chlorine solution for 10 minutes before washing them.

STEP 5: Remove utility gloves (wash daily or when visibly soiled and dry).

STEP 6: Wash and dry hands.

Special Situations

In case of a cholera epidemic, hospital sewage must also be treated and disinfected. *Vibrio cholerae*, the causative agent of cholera, is easily killed and does not require use of strong disinfectants. Buckets containing stools from patients with acute diarrhea may be disinfected by the addition of chlorine oxide powder or liquid (*berakina*).

3.6 How to dispose of contaminated sharps

Disposable sharp items (hypodermic needles, suture needles, razors and scalpel blades) require special handling because they are the items most likely to injure the community healthcare workers who handle them as well as people in the community if these items go to the landfill.

STEP 1: Wear heavy-duty utility gloves.

STEP 2: When the sharps container is three-quarters full it should be capped, plugged or taped tightly closed. Be sure that no sharp items are sticking out of the container.

STEP 3: Dispose of the sharps container by burning, **encapsulating** or burying.

STEP 4: Remove utility gloves (wash daily or when visibly soiled, and dry).

STEP 5: Wash hands and dry them with a clean cloth or towel or air dry.

Encapsulation

Encapsulation is recommended as the easiest way to safely dispose of sharps. Sharps are collected in puncture-resistant and leak proof containers. When the container is three-quarters full, a material such as cement (mortar), plastic foam or clay is poured into the container until completely filled. After the material has hardened, the container is sealed and may be stored or buried.

Review Questions

1. What are the common major classifications of solid and liquid wastes?
2. How can you determine the composition of solid and liquid waste?
3. What are factors that determine the generation rate of solid and liquid waste?
4. What factors should be consider before selecting one particular methods of liquid and solid waste disposal?
5. What are the primary risks to human health associated with solid and liquid waste dumping?
6. What are the common solid waste disposal methods that are practiced in your community, college or university?
7. What is the difference between single and double chamber incinerators?
8. What is the public health importance of wastewater?
9. What are the advantages of treating waste water/ sewages ?
10. What types of wastewater disposal methods do you recommend for rural and semi-urban areas?
11. What methods are used to handle contaminated solid and liquid waste?
12. How simple, inexpensive incinerators and burial sits are built an used?
13. What some of the problems of waste removal are?

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