Waste Management Plan

Saphe Bagar Primary Health Clinic

INDICE

OBJECTIVES

The purpose of the present plan is to develop an efficient and cost-effective strategy for the long-term management of the health-care wastes generated in the Sanfe Bagar Primary-Health Clinic (SBHC).

The waste management plan for SBHC will be developed in order to ensure:

- Protection of public health and safety.
- Staff safety during the processing of HCW
- Minimization of the impact in the environment & local population
- Reliability of the process according to the geographic position and facilities available.
- Availability of a document for the support of staff and future training.

1. INTRODUCTION

1.1. Health care waste – A risk to health

Health-care waste includes all the waste generated by health-care establishments, research facilities, and laboratories. The health care waste (HCW) generated in health care facilities (HCF) depends on the regions/district in which is located and also on the size of the hospital:[1]

- Small HCFs: <25 beds
- Medium HCFs: 25-100 beds
- Large HCFs: >25 beds

In between the health care waste (HCW) generated, 75% to 90% of it is non-risk or "general" waste, comparable to domestic waste (Table 1.1.). This waste is produced mainly by administration and housekeeping services of the establishment. The remaining 10-25% of health care waste or health care risk waste (HCRW), is considered as Hazardous (Table 1.1) and can create a variety of health risks when the generation, packaging, storage, transport, treatment and disposal of it are not performed in an appropriate way.[2, 3]
Inappropriate treatment and/or disposal of biomedical hazardous waste can lead to serious environmental and public health risks, as the spread of infectious diseases such as HIV and Hepatitis B.

Additional examples on the diseases that can be transmitted by exposure to HCRW can be assessed in Annex 2.

The risk associated with hazardous waste involved all the exposed individuals, including those individuals that generate it or that do not handle it:

- Doctors, nurses, health-care assistants and HCF maintenance personal;
- Patients in HCF establishment of receiving home care;
- Visitors to HCF establishment;
- Auxiliary workers: laundry, waste handle and transport.

- Workers in waste disposal facilities (landfill, incinerator…).[2]

Population in general can also be affected by hazards in long term period, as a consequence of inappropriate management and handle of HCW from the moment that is generated till final disposal. The deposit of hazardous HCW, especially untreated waste in open dumps can lead to the contamination of groundwater and soil. In a long term contamination can be transmitted to vegetables, animals and humans trough the food chain.

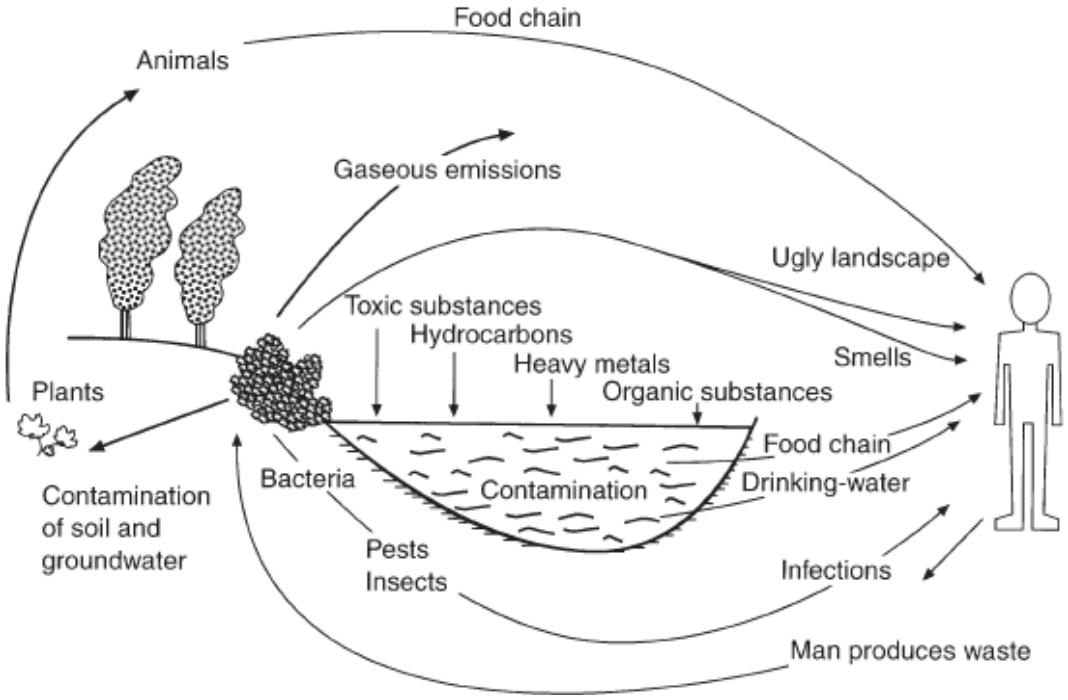

Figure 1.1 - Routes of exposure to hazards caused by incorrect waste treatment and disposal, such as open dumping. [2]

1.2. Health-care risk waste (HCRW): classification and characterization

1.2.1. According to WHO guidelines [2], HCRW can be classified into ten different sub-categories.

Here, the Radioactive Wastes were included in the Genotoxic Wastes (category 5), while the wastes with high content of Heavy Metals were included in the Chemical Wastes (category 6), while the. Consequently the HCRW classification was resumed to 7 categories which were numbered from 1 to 7 in order to facilitate their management further in this manual:

Category 1: **Infectious waste**

Has the potential to contain pathogens (bacteria, fungi and viruses) in concentration and quantity sufficient to cause disease. Incorrect handling of this waste category can lead to Tuberculosis, AIDS and Hepatitis transmission.

See examples in Table 1.2.

Categories:

1, 2, 3

Category 2: **Pathological Waste**

Tissues, organs, body parts, human fetuses, and animal carcasses (anatomical waste), blood and body fluids. This kind of waste should always be considered as infectious waste, even though it may also include healthy body parts.

Category 3: **Sharps**

Biomedical waste that can cause cuts or puncture wounds: syringe, needles, hypodermic needles, scalpel and other blades, knives, infusion sets, saws, broken glass, and nails. Even though they are not infected they should always be considered as highly hazardous waste.

Figure 1.2 – Examples of sharps waste - A, B. Appropriate container for sharps disposal (C).

Category 4: **Pharmaceutical waste**

Wastes comprising of outdated, unused, spilt, and contaminated pharmaceutical products, drugs, vaccines, and sera that are no longer required and which require appropriate disposal. Discarded items, such as bottles or boxes with residues, gloves, masks, connect tubings and drugs vials that have been used during pharmaceuticals handling.

Figure 1.3 – Disposal of pharmaceutical waste

<u>Category 5:</u> Genotoxic waste

Highly hazardous waste that can have mutagenic, teratogenic, or carcinogenic properties. It should be given special attention because it raises serious safety problems inside hospital and after disposal, and because the risk cannot be eliminated by disinfection processes as for infected waste.

Cytostatic drugs/cytotoxic waste[1] might be involved in this category, as also vomit, urine, or faeces from patients treated with cytostatic drugs, chemicals and radioactive materials. This biological waste should be considered as genotoxic for at least 48 hours and sometimes 1 week after drug administration.

Expired drugs and contaminated materials from drug preparation and administration such as needles, syringes, gauzes, vials and packaging should be also included in this group. Examples of the most common genotoxic waste can be found in Annex 1.

Category 6: Chemical waste

Discarded solid, liquid and gaseous chemicals originated from diagnostic work, cleaning, housekeeping and disinfecting procedures. The wastes included in this category can be sub-classified as hazardous or non-hazardous.

[1] Cytotoxic waste: Potential to kill or stop the growth of living cells (anaemia, cancer, foetal abnormalities). They are usually used in chemotherapy of cancer.

a. Chemicals classified and labeled as follows are considered as **Chemical hazardous waste**:

- Toxic

- Corrosive (e.g. acids pH<2; bases pH>12)

- Flammable

- Reactive (explosive, water reactive, shock sensitive)

Oxidizing

Dangerously reactive material

- Genotoxic (e.g. cytostatic drugs)

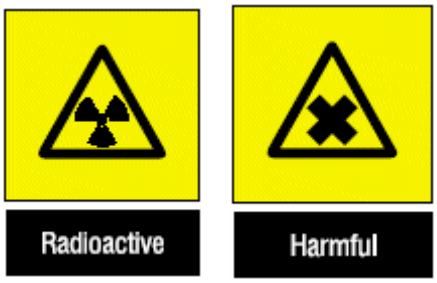

Figure 1.4 – Representation of the different chemical hazardous waste that can be generated, handle and disposed by a HCF.

b. **Non-hazardous chemicals** include Sugars, Amino acids, Certain organic and inorganic salts.

The types of chemicals used most commonly in the maintenance of HCF and most likely to be found in the waste are represented in Annex 2.

Category 7: Pressurized containers

Gas stored in pressurized cylinders, cartridges, and aerosol cans. The non-reusable must be disposed of.

Should be handled with care: containers might explode in incinerated or if accidentally punctured.

1.2.2.. According to the Indian Bio-Medical Waste Rules (1998), health-care waste is segregated into ten different categories [2, 3]:

Category 1: Human Anatomical Waste: Human tissues, organs, body parts

Category 2: Animal waste

Category 3: Microbiology and Biotechnology waste: waste from laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human/animal cell culture.

Category 4: Waste sharps (used or unused): needles, syringe, scalpels, blades, glass, etc that might cause puncture and cuts.

Category 5: Discarded Medicines and Cytotoxic drugs: outdated, contaminated, and discarded medicines.

Category 6: Soiled waste: Cotton, dressings, soiled plaster casts, linens, beddings and other materials contaminated with blood, and body fluids.

Category 7: Solid Waste: wastes generated from disposable wastes others than sharps, such as catheters, intravenous sets.

Category 8: Liquid waste: waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities.

Category 9: Incineration Ash: Ash from incineration of any biomedical waste

Category 10: Chemical waste used in production of biological, chemicals used in disinfection, as insecticides.

c. In a Nepalese context, Health-care waste were designated in 3 different classes (according to the Nepal Health Research Council(2002)).[6]

This designation is much more simplified because most of the HCF does not practice waste separation, and thus WHO and Indian classifications were considered as unnecessary classifications, Additionally, different options for the treatment of all the aforementioned specific categories are not available in Nepal.[6]

Category 1: General waste: includes paper, cardboard, metal containers, floor sweeping, and kitchen waste. It needs to be collected separately from infectious waste but does not need special treatment and storage facilities It should be placed in a suitable container lined with a black plastic bag.

Category 2: Hazardous waste: cotton, gauze, soiled bandages, cotton used for dressing, blood bags, human and animal tissue, body parts, chemicals, drugs, wastes generated by cleaning spills of hazardous waste, and any other soiled materials that has been used for treatment.

Category 3: Sharps: same description has for WHO and Indian rules.

If a combination of autoclave, incineration and deep burial are used in the treatment of infected waste, 2 additional categories can be defined:

Category 4: Autoclavable infectious waste

Category 5: Non-autoclavable (Pathological/chemical) waste for incineration and non-incinerated waste for deep burial.

1.3. Categories of HCRW with the highest potential for infection transmission in HCF.

The transmission and spread of diseases such as HIV and Hepatitis B[2] (for other examples consult Annex 2) among health-care facilities staff, is highly associated with injuries from **contaminated sharps** and **concentrated cultures of pathogens**. The existence of bacteria resistant to antibiotics and chemical disinfectants also present a potential hazard to health.

Hypodermic needles are an important part of the sharps waste category because they constitute the main reason for staff injury in HCF (Figure 1.8.A), and further contamination by the aforementioned diseases. Hypodermic needles are particularly hazardous because they are often contaminated with patients' blood and because wrong practices, such as recapping, the unnecessary opening of sharp containers and the use of non-puncture-proof containers for sharps disposal (Figure 1.8.B) constitute common practices in HCF.[2]

[2] The Japanese Association for Research on Medical Waste found that an infective dose of Hepatitis B or C virus can survive for up to one week in a blood droplet inside a hypodermic needle.[2]

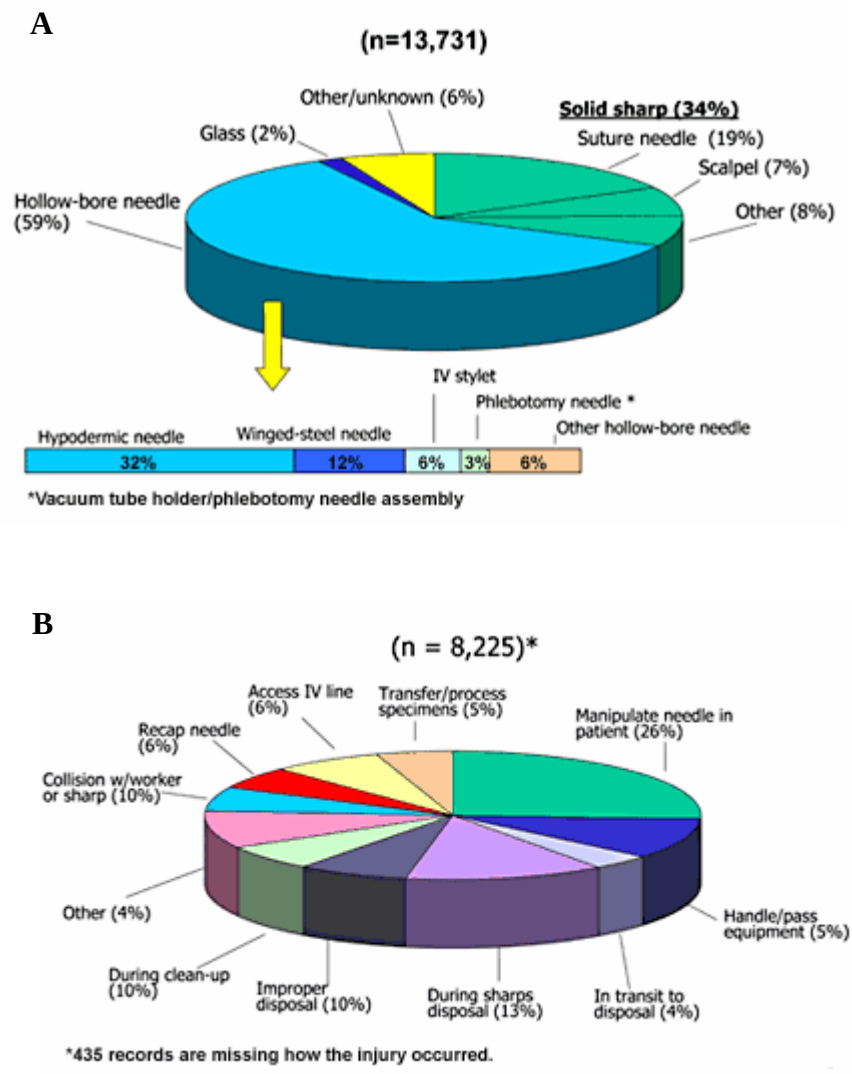

Figure 1.9. Graphic representation on the significance of different sharp devices involved in percutaneous injuries (A) and the circumstances associated with hollow-bore needles injuries (B). Data provided by the National Surveillance System for Health Care Workers (NaSH). [Adapted from [7]]

Device requiring manipulation or disassembly after use (needles attached to IV tubing, winged steel needles, and IV catheter sylets) are also associated with high rates of injury. [7]]

Health-care workers, particularly nurses are at greatest risk of being infected by these diseases trough injuries from contaminated sharps. Other health–care workers, waste-management operators that work outside the HCF are also at significant risk, as also individuals that scavenge on waste disposal sites. [2]

1.4. Estimation of Health-care wastes production in developing countries

1.4.1. Production of wastes in Health-care facilities in developing countries.

Several information concerning the typical generation of waste in Health-care facilities have been provided by many surveys. Estimations obtained about the amount of health-care wastes produced in a small HCF in developing countries in general are represented in table 1.2.[2]

Table 1.1 – Estimation for average production of health-care wastes according to WHO evaluation.[2]

Survey	Estimation
National income level Low-income countries	0.5-3.0 Kg/head/year (all health-care waste)
Source Primary Health-care center	0.05-0.2 Kg/bed/day
Region Middle-income country in Eastern Asia	1.8-2.2 Kg/bed/day

On an average, the volume of total solid waste in hospitals in India is estimated to range between 1 Kg and 3 Kg per day on a per bed basis [8]

1.4.2. Production of HCW in its different categories

It is also important to assess the production of general HCW and HCRW, which can vary in between countries according to the facilities available and also among HCF according to its size. Also the hospital specializations and waste management practices have important impact in the results of these surveys.

Estimations based on the production of general HCW and HCRW in HCF in India are represented in table 1.4.

Distribution of 'general' HCW (non-risk) and of HCRW in its different categories, have been estimated in developing countries in general by WHO [2]:

- 'General' HCW: 80%
- Infectious and Pathological waste: 15%
- Sharps waste: 1%
- Chemical and Pharmaceutical waste: 3%
- Special waste – include radioactive or cytotastic waste, pressurized containers, broken thermometers and used batteries.

Table 1.4. Estimation on the production of 'general' HCW and HCRW in India HCF. (Adapted from [4])

Health care waste (HCW)		
Health-care Risk Waste (HCRW) (10-25%)		'General', non-risk waste (75-90%)
(A) Infectious (15-18%)	(B) Miscellaneous (5-7%)	
In contact with blood and mucous membranes → Transmission of viral, parasitic or bacterial diseases. - Pathological waste - Sharps	- Pharmaceutical waste - Genotoxic waste - Chemical waste - Radioactive waste …	- Office waste - Paper - Plastic containers(1) - Glass bottles(1) - Kitchen waste

[1] Non-infected or contaminated with chemical/pharmaceutical waste.

Additionally, surveys carried out in Nepal[1] (source: Environmental & Public Health Organization (EPHO) (Figure 1.5, 1.6) and Botswana (source: NCSA) (Figure 1.7), provide estimations on the amount of hazardous waste produced by health-care facilities.

Health-care waste production in Kathmandu Valley

Category of waste	Average amount of waste for all 11 health care facilities
Health care waste (HCW)	0.54 kg/patient/day (rounded figure)
Health care risk waste (HCRW)	0.16 kg/patient/day (rounded figure)

Figure 1.5. Survey of Health care waste quantities generated in HCF in Kathmandu Valley, 1997.[Adapted from [1]]

The results represented in Figure 1.5, probably include small health care facilities. Further surveys conduced by Environmental & Public Health Organization (ENPHO) in Kathmandu Municipality (2001) show a 3x solid increase in the amount of waste generated at the HCF.

Health-care risk waste production in Nepal

Facility types	kg HCRW
Small HCFs, per day [1)]	456
Health Posts [2)], Sub HP [2)] & Outreach Clinics [3)], per day	1910
Medium HCFs, per day [1)]	1130
Large HCFs, per day [1)]	2034
Total, per day	**5 530**
Total, per year	**2 018 450**

Notes: 1) For HCF with beds: 0.5 kg/patient/day
2) For Health Post and Sub HP: 0.5 kg/HCF/day
3) For Outreach clinics: 0.1 kg/HCF/day.

Figure 1.6. Estimated total amount of HCRW generated by different size HCF in Nepal (2001).[Adapted from [1]]

Health-care waste production in Botswana

Facility	Health-care waste, excluding sharps (kg/day)	Sharps (containers[c])	Household waste (kg/day)
Referral and regional hospitals	0.75/bed	1.5/100 beds per day	3/bed
Private hospitals	1.0/bed	2/100 beds per day	4/bed
Primary hospitals	0.5/bed	1/100 beds per day	2/bed
Urban clinics with beds	20	2/30 days	40
Rural clinics with beds	10	2/30 days	20
Urban clinics	15	2/30 days	30
Rural clinics	7	2/30 days	15
Health posts	2.5	1/30 days	5
Medical and veterinary practices	2.5	1/30 days	5

[c]Sharps container capacity: 4 litres.

Figure 1.7. Estimations on the production of health-care waste in Botswana (1996).[Adapted from 2]

1.4.3. Composition of HCW

Many surveys have been developed regarding the segregation of the different HCW categories. Figure 1.8. shows data collected from a survey in India developed by National Environmental Research Institute (1997).

HCW produced in hospitals in India

Material	Percentage (wet-weight basis)
Paper	15
Plastics	10
Rags	15
Metals (sharps, etc.)	1
Infectious waste	1.5
Glass	4.0
General waste (food waste, sweepings from hospital premises)	53.5

Figure 1.8. Average composition of hospital waste in India, obtained from 10 large hospitals during the period 1993-1996. [Adapted from 2]

According to a survey developed in Italy [5], in middle-income developing countries, wet HCRW present a typical low heating value, which corresponds to 3500 Kcal/Kg (14.65 MJ/Kg). This data are based on daily waste production of 4.0 liters or 0.44 kg per bed in use. In order to perform treatments, such as incineration in a less impact to the environment and population health philosophy, products made from polyvinyl chloride (PVC) plastic compounds should de replaced by products made from ethylene vinyl acetate copolymers. [3]

1.5. Strategy for Waste management

1.5.1 Recommendations and considerations in Waste management

Agenda 21 according to United Nations Conference on the Environment and Development (UNCED) in 1992 recommends the following measures for waste management:

- Prevent and minimize waste production.

- Reuse and Recycle the waste to the extent possible.
- Treat waste by safe and environmentally sound methods.
- Dispose on the final residues by landfill in confined and carefully designed sites.[2]

In order to implement an effective waste management program, an appropriate plan should be first developed according to the following points:

- HCF location.
- Number of HCF beds and bed occupancy rate for each health-care waste;
- Identification of different waste sources within the HCF, as also the types and quantities generated;
- Personnel involved in the management of health-care waste;
- Evaluate the current disposal options and practices, including segregation, collection, transportation, storage, and disposal methods.
- Specialty and access to disposal services.[2,3]

There are three basic options for managing the treatment of health-care waste according to the specification and access to disposal services:

1. An on-site treatment facility in each health-care establishment.
2. Regional or cooperative health-care waste treatment facilities, supplements by individual facilities for outlying hospitals.
3. Treatment of health-care waste in existing industrial or municipal treatment facilities (e.g. municipal incinerators), where this exists.

The advantages and disadvantages of each of the aforementioned options are represented on table 1.5.

Table 1.5. Advantages and disadvantages on on-site and Regional/cooperative Health-care waste treatment facilities

	Advantages	**Disadvantages**
On-site	- Convenience - Minimization of risks to public health and environment - Appropriate for isolated hospitals and when good road assesses is not present.	- High costs if there are many hospitals. - Requirement of more technical staff for operation and maintenance - Difficult monitoring by authorities → poor compliance with operating standards → Increase environmental pollution
Regional /Cooperative	- Greater cost-effectiveness. - Provide spare capacity in a more economically way. -Future modifications /expansions less expensive. - Easier to supervise/monitor. - Easier to ensure efficiency of operations. - Easier to find skilled and available staff. - Easier to reduce the environmental pollution. - Less time spend per hospital in the management of waste treatment installations.	- Provide accessibility for all centers: road, distances and transportation time. - Need for assessment on heath-care waste produced from each establishment. - Possible need of transfer stations. - Changes in the capacity/ function of each hospital. - Adequacy of the land area in a proposed site - Attitude of the population - Necessity for a detailed environmental and health impact assessment.

1.5.2. Waste management plan

An appropriate waste management should include appropriate classification and segregation of the different categories of wastes. As aforementioned the classification and consequently the segregation depends on the availability of the treatment and disposal processes.

a) *Waste minimization, recycling and reuse.*

The first step that should be considered in a waste management plan is the minimization, recycling and reuse of wastes. [1, 2, 3] The consideration of these important factors will minimize the wastes produced and consequently the costs associated with it treatment.

Significant reduction of the wastes generated can be achieved by the implementation of some of the following good practices:

- Source reduction: implementation of purchasing restrictions, **a green procurement**:
  - Purchase reusable items (the items should only be reused if this does not increase the risks to staff and patients).
  - Purchase equipment with minimum required packaging material.
  - Purchase plastic bags, containers or similar items made from polypropylene (PP) or polyethylene (PE) or any other plastic that produced minimum emissions when incinerated, etc.
  - Purchase materials that generated less hazardous waste.
- Recyclable Products: Use materials that might be recyclable.
- Good management and control practices: e.g. avoid the creation of outdated chemicals and pharmaceuticals in the HCF trough a correct stock management.
- Waste segregation: Careful separation of the wastes into different categories → minimization of the quantity of hazardous waste, facilitate the recycling process, etc. [1, 2]

b) From waste segregation to storage.

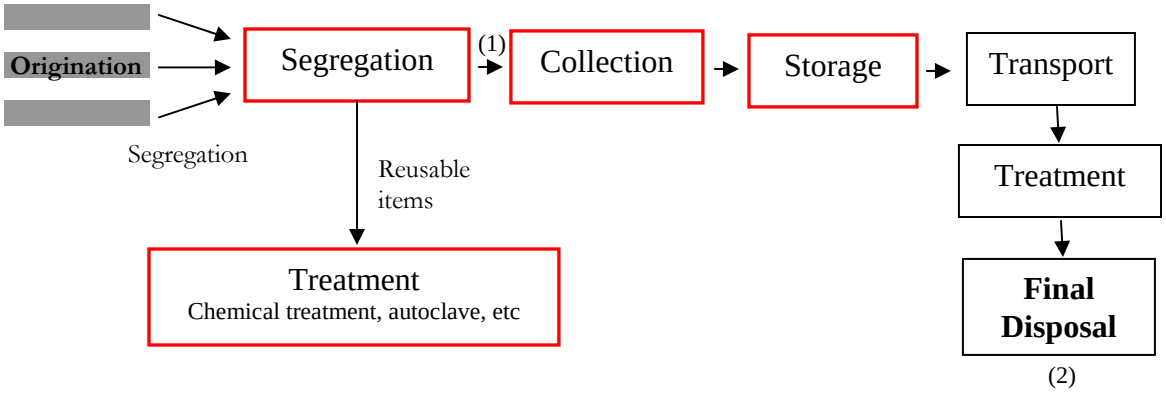

Figure 1. 9 – Flow process of HCF waste. [Adapted from [3]]

Note: every time that is possible, treatment should be taken in the place of segregation

(1) Other wastes such as highly infectious can be immediately treated by autoclaving to reduced the risk involved during further handling.

(2) After final disposal by incineration, the resultant ash must be disposed appropriately.

i. Waste segregation: good practices

Waste segregation refers to the process of separating wastes at the point of generation and keeping them apart during handling, accumulation, interim storage and transportation

Segregation is a responsibility from the waste producer and should take place in the place of generation. For easier segregation, the waste should be sorted into color-coded plastic bags or containers.

Additionally the following practices should be considered:

- General health-care waste should be segregated with domestic waste for same disposal.
- Infected or non-infected sharps must be collected always together as infectious waste.
- Whenever possible, sterilize highly infectious waste immediately by autoclaving. It must be packed in bags that are compatible to the selected treatment process (e.g. for autoclaving, specific red bags suitable for autoclave must be used).

→ **INFECTIOUS WASTE** correctly packed and labeled for autoclave disinfection

CYTOTOXIC

- Cytotoxic waste must be appropriately collected in strong, leak-proof containers labeled according to the previous picture.
- Small amount of pharmaceutical or infectious waste can be collected and disposed together with infectious waste.
- Large amount of obsolete or expired pharmaceutical waste must be returned to the supplier or manufacturer.
- Large amounts of chemical waste must be packed in chemical resistant containers, corrected labeled and sent to specialized treatment facilities. Different types of hazardous chemicals should never be mixed.
- Waste with high content of heavy metals should be collected separately.
- Low-level radioactive infectious waste (e.g. swabs, syringes, for diagnostic or therapeutic use) may be collected together with the infectious waste (yellow containers) if this is destined for incineration.
- Completely empty and non hazardous aerosol containers can be collected with general waste, in the case that this is not destined for incineration. [1, 2, 3]

ii. Waste segregation: color-coding scheme

Different recommendations about the scheme for waste sorting have been proposed. The scheme adapted by each HCF must be according to the strategy and plan defined in the respective country. However, it should also be adapted to kind of services provided in the HCF, to the kind of waste generated and facilities available for disposal.

WHO, recommends the following color-coding strategy:

Table 1.6. Color-coding scheme recommended by WHO for the segregation of HCW. [2]

Type of waste	*Color of container and markings*	*Type of container*
Highly infectious waste	Yellow Marked 'highly infectious'	Strong, leak-proof plastic bag, or container capable of being autoclaved.
Other infectious waste Pathological/anatomical waste	Yellow	Leak-proof plastic bag or container
Sharps	Yellow Marked 'sharps'	Puncture-proof container
Chemical/pharmaceutical	Brown	Plastic bag or container
Radioactive waste [(1)]	_____	Lead box, labeled with the radioactive symbol
General waste	Black	Plastic bag

(1) Only generated in major hospitals

On the other hand, the Ministry of Health of Nepal suggested the following strategy for waste segregation:

Table 1.7. Color-coding strategy defined for the Ministry of Health of Nepal for the segregation of HCW by small and medium size health care facilities in remote areas. [1]

Type of waste	*Color of container and markings*	*Type of container*
General infectious waste	Yellow 	Yellow plastic bucket with lid and liner (inside layer)
Sharps	Yellow 	Still box with lockable lid
Domestic waste	Black	Black plastic bucket with lid and liner
Chemicals		Solid plastic bin with lid/glass bottles.

iii. Waste segregation: containers

- Use puncture-resistant and disposable sharp containers for all disposable sharps.
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Figure 1.10. Example of appropriate sharp containers

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- For infectious waste, leak-proof bags and containers should be used and marked with the international infectious substance symbol (source [6]):

Figure 1.11 – Symbols that can be used for the identification of contaminated sharps (A) and Hazardous waste.

- Rigid walled lined containers (plastic or galvanized metal) should be handled mechanically.
- When plastic bags are used they are not to be reused.
- When plastic bags are not used, the containers for contaminated wastes should also have tight/fitting covers.
- All waste containers/bags must be color-coded.
- Equipment that is used to hold and transport wastes must not be used for any other proposes.

- All he contaminated containers must be washed with a disinfectant cleaning solution (0.5%/1% chlorine solution plus soap) and rinses with water regularly.
- When possible, use separate containers for combustible and noncombustible wastes prior to disposable, which prevents further handling and separation. [1, 2, 3]

iv. Waste collection:

Nurses and other clinical staff responsible for waste segregation and collection must ensure that:

- When ¾ of the bag is full, it should be removed from the container, tied tight with a plastic string and properly labeled (do not close by stapling).
- Disposable sharp containers should be sealed by tape.
- Always avoid accumulation at the point of production.
- Sealed sharp containers should be out in a labeled, yellow infectious waste bag before collection.
- Specifically colored plastic bags should be kept in its container when collected.
- The bags and containers should keep the same color-coding and labeling in between the segregation and storage room
- Waste should be so put in the bags and collected in a way that it does not spill outside
- Never mix infectious and non-infectious waste
- Collection of disposable infected items, which cannot be incinerated (e.g. catheters) or highly infectious waste should be collected only after chemical disinfection[3] or steam disinfection (autoclave), respectively.
- Bags and containers should be replaced with new ones of the same type immediately after collection.
- Containers (specially the ones without bags) should be collected carefully to avoid aerosol generation and exposure and be disinfected after every cycle of waste collection (a new bag must be placed only after disinfection).

[3] Dipping in 1% hypochlorite solution for 30 min.

- Staff involved in this operation and any waste handling action must wear protective clothing at all the times including face mask, industrisl aprons, leg protectors, industrial boots and disposable or heavy duty gloves.[2, 3, 6]

v. Waste Storage: Storage time

Storage time for health-care waste should not exceed:

Temperate climate:	- 72 hours in winter
	- 48 hours in summer
Warm climate:	- 48 hours in cool season
	- 24 hours in hot season. [2]

vi. Waste Storage: recommendations for storage infrastructures

- The storage area should have an impermeable, hard-standing floor with good drainage and should be easy to clean and disinfect.
- Should be situated in the ground floor and near the rear entrance.
- There should be a water supply for cleaning purposes.
- Located away from functional areas, drinking water tanks, chimneys, diesel generator sets, oil storage, gas storage chambers and other potential source of fire.
- The area should be isolated with barbed wire fencing to prevent access to animals and birds.
- It should be big enough to store the required number of waste bags at a time and for two days waste
- It should have good flooring, ventilation, water and light supply.
- There should be protection from the sun.
- There should be special drain to discharge the washing products which should go to the sewer.
- Unauthorized entry at the site should be strictly prohibited and avoid trough the use of lockers.

- The area should include a supply of cleaning equipment, protective clothing, and waste bags or containers. [1, 2, 3]

c) From waste transport to final disposal.

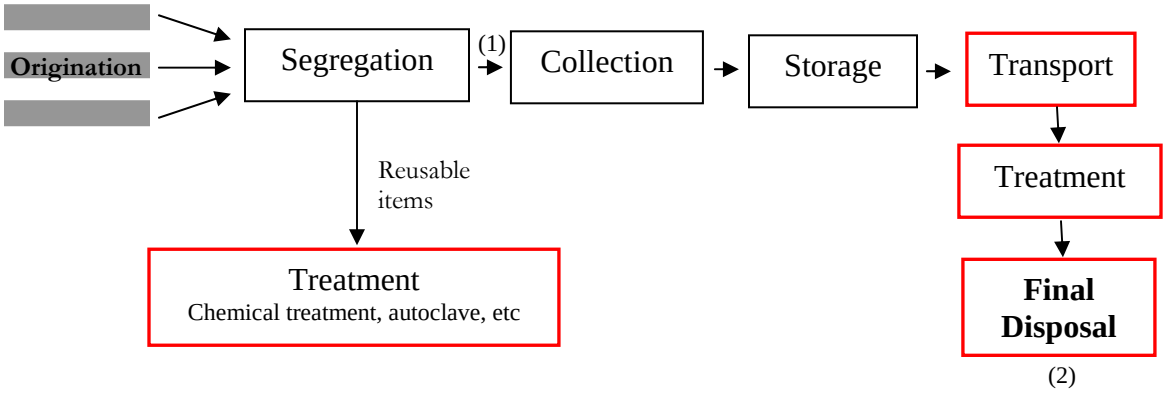


Figure 1. 12 – Flow process of HCF waste. [Adapted from [3]]

Note: every time that is possible, treatment should be taken in the place of segregation

(1) Other wastes such as highly infectious can be immediately treated by autoclaving to reduced the risk involved during further handling.

(2) After final disposal by incineration, the resultant ash must be disposed appropriately.

i. On-site transport:

It should be used trolleys/handcarts with solid base and bunding to contain spills. Additionally, they should be designed for easy load and unload, to prevent leakage, be easily cleaned and minimize manual handling. Sharp edges should be absent to avoid bag damage. Infected waste and general waste must be collected always in different trolleys.

Spill kits must be easily accessible: adsorbents, disinfectants, buckets, shovel, gloves, disposable overalls, facemask/shield, torch, disposable container, and plastic waste bags with appropriate labeling.

Vehicles must be disinfected and cleaned daily with appropriate disinfectant.[2, 3]

ii. Of-site transport

Off-transport transport it's the transport from the place of segregation or storage to a different area in order to be treated/disposed. For off-site transport the waste should be previous labeled with

- Waste category
- Appropriate warning symbols
- Date of collection
- Place of segregation
- Waste destination [2]

A record of this must be kept for future surveys, statistics and analysis of waste production versus strategy

iii. Treatment and disposal technologies

The choice of a treatment system should be made carefully and after access the following parameters:

- Quantity of waste Kg/day/category;
- Resources available: Human, budget, material;
- Availability of national legislation;
- Availability of a national plan;
- Overview of options used in the country;
- Availability of central facilities, reliable transportation and equipment;
- Power and water supply on site;
- Space available;
- Estimate of running costs and total costs.
- Public acceptability for the different treatments.
- Training requirements for operation of each method and availability of competent staff.

- Analysis of each treatment for volume and mass reduction, disinfection efficiency and infrastructures required. [2, 3]

An overview trough the some of technologies available for the treatment and disposal of HCRW id discussed in the next section.

1.5.3. Options for the treatment/disposal of HCRW

a) Incineration (Drum/brick incinerator - low temperature):

Process usually selected to treat wastes that cannot be recycled, reused, or disposed on in a landfill site. It requires no pre-treatment, provided that wastes that cannot be incinerated are not included in this process.
Incineration of wastes is only affordable if the 'heating value' of the waste reaches at least 2000 Kcal/Kg (8370 KJ/Kg). Infectious waste exceeds 4000 Kcal/Kg. In order to increase the efficiency of combustion the wastes can be loaded together with combustible: e.g. kerosene). [2]

Wastes that should not be incinerated:

- Pressurized gas containers.
- Large amounts of photographic or radioactive wastes.
- Silver salts and photographic or radiographic wastes.
- Halogenated plastics such as polyvinyl chloride (PVC), usually present in blood bags, IV tubing or disposable syringes;
- Wastes with high mercury or cadmium content, such as broken thermometers, used batteries, and lead-lined wooden panels.
- Sealed ampoules or ampoules containing heavy metals.
- Huge quantities of reactive waste. [2, 3]

Types of incinerators:

Incinerators can range from extremely sophisticated, high temperature operating plants to very basic combustion unit's that operate at much lower temperatures. All type of incinerators, if operating properly, eliminates pathogens from waste and reduces the wastes to ashes.[2] An incinerator system is preferred and widely recommended for certain categories of waste such as anatomical and pathological waste , discarded materials (swabs, bandages, cottons, dressings) contaminated with blood and body fluids and small amounts of discarded medicines.[3]

In this resume, only the drum and bricks incinerator, which meet minimum requirements and are easier to built in remote regions in developing countries, will be discussed more in detail. However, a general overview trough all the possibilities available, such pyrolytic incinerators, rotary kilns incinerators and single-chamber incinerators can be accessed in Annex 4. Also information more in detail can be accessed trough reference number 2.

Brick incinerator:

Closed area constructed with bricks or concrete walls. It should be used only as a last resort, as it is difficult to burn that waste completely without generating potentially harmful smoke.
It should be designed to allow sufficient intake of air and the addition of adequate quantities of fuel that maintain the temperature as higher as possible (for complete combustion or maximum as possible)

This kind of incinerator might achieve 80-90% efficiency and lead to a destruction of 99% of the microorganisms. If temperature inside the incinerator does not exceed 200 C, many chemicals and pharmaceuticals residues will persist. Additionally, this process will cause massive emission of black smoke, fly ash and potentially toxic gases. [1]
One example of brick incinerator designed for the incineration of HCW, and specially sharps in represented in the figure 1.13.

Figure 1.12. The Montfort Incinerator Mark8a [9]

Strengths:

- Reduction in waste volume and weight
- No need for highly trained operators
- Relative high disinfection efficiency
- No pre-treatment of waste necessary

Weaknesses:

- May require fuel, dry waste to start burning
- Incomplete combustion
- May not completely sterilize
- Potential for needle stick injuries since needle are not destroyed
- Toxic emissions (heavy metals, dioxins, furans, fly ash
- Emits heavy smoke and has potential fire hazardous
- Production of hazardous ash containing leachable metals, dioxins, and furans that may pollute soil and water
- Produces secondary waste [4, 10]

Decisive factors:

- Correct segregation of waste

- Waste moisture content
- Combustion chamber filling
- Temperature/residence time
- Maintenance and repairs. [10]

100 to 200 Kg per day or a drum 5 to 10 Kg. [10]

b) Steam autoclave:

Efficient wet thermal disinfection process that is usually used in HCF for the sterilization of medical equipment. [2] The strengths and weaknesses associated with this process are (see also annex 5):

Figure 1.13. Examples of steam autoclaves3

Strengths:

- Sterilizes many types of waste, such as used injection equipment;
- Low adverse environmental impact;
- Low skills required for operator;
- Liquid emissions are minimal;
- Facilitates plastic recycling;
- When combined with shredding reduced waste volume and can safely be handled as municipal solid
- Low operating cost.

`

Weaknesses:

- Requires electricity;
- Treatment of limited quantities of waste;
- Medium to high capital cost;
- Requires well trained staff for operating and maintenance
- May emit volatile organics in steam during depressurization and opening of chamber;
- Not suitable for all waste types;
- Waste appearance unchanged;

- Waste weight unchanged;
- Requires further treatment to avoid reuse;
- Sterile waste needs to be disposed off. [10]

Decisive factors:

- Correct segregation of waste
- Temperature/pressure
- Requires electricity
- Steam penetration
- Waste load size
- Treatment cycle length
- Chamber air removal

Performance: 12 Kg/day to 90 Kg/hour. [10]

c) Chemical treatment:

Chemical disinfection is used routinely in health care to kill microorganisms on medical equipment, on floors and walls and also to treat-health-care waste. The strengths and weaknesses associated with this process are (see also annex 6):

Strengths:

- Simple
- Relatively inexpensive
- Disinfectants widely available
- Suitable for disinfection of liquid waste (blood, urine, stools, or hospital sewage);

Weaknesses:

- Disinfectants may be corrosive, toxic and need to handled safely

- Usually results in disinfection and not sterilization
- Difficult disinfection of solid and highly hazardous HCW
- Proper concentration must be used for specific lengths of time
- No waste volume reduction
- Environmental concerns when the disinfectants are disposed
- Uncharacterized air emissions. [2, 10]

Decisive factors:

- Correct segregation of waste
- Chemical concentration
- Temperature and pH
- Chemical contact time
- Waste/Chemical mixture
- Requires availability of disinfectants
- Requires further treatment/disposal. [10]

- Costs depend on the disinfectant selected (approximately US$ 100-120 per ton). [2]

d) Waste Burial:

In a waste burial or pit, sides are covered with a low permeability material (when for hazardous waste), covered and fenced. The pit should be sealed with cement once it is full or at least the last 50 cm should be file with compacted soil and the area identified.

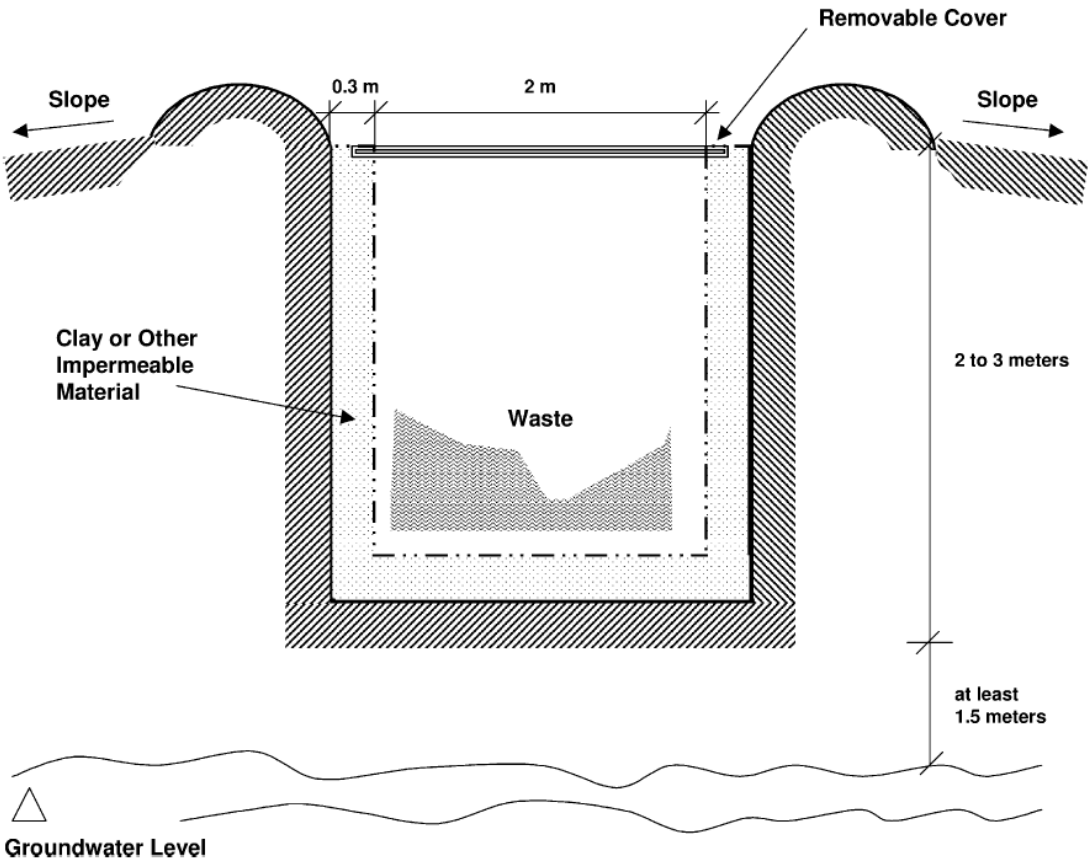


Figure 1.14 – Schematic representation of a waste burial or pit. [11]

Strengths:

- Low tech
- Simple
- Adequate for small quantities of waste
- No atmospheric pollution

Weaknesses

- Requires space available
- Does not disinfect waste
- Might be a risk to community if not properly buried
- Potentially easy access to non-authorized personnel
- No volume reduction
- May fill up quickly
- Possibility of access by animals or scavengers → Creation of vectors.

- Potential soil and waste pollution

Decisive factors:

- Correct segregation of waste
- Depth of ground water
- Size
- Lining of pit
- Impact of rainy season

Low construction cost. [10]

e) Sharp pit:

A sharp pit must be well covered with a narrow access for sharps that should be filled with cement once full.

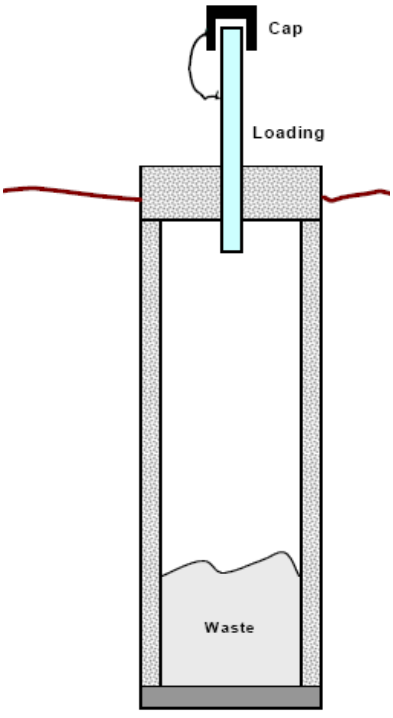


Figure 1.15. Representation of sharp pit. [10]

Strengths:

- Low cost
- Simple
- Adequate for large quantities of needles and other sharps
- No atmospheric pollution

Weaknesses:

- Space availability
- Does not disinfect waste
- No volume reduction
- Potential soil and water pollution

Capacity: Needles + syringe: 30 000 in $1m^3$, needles: 1 million in $1m^3$

Decisive factors:

- Correct segregation of waste
- Depth to ground water
- Depth, size
- Design

Construction cost: $50 for a $1m^3$ sharp pit. [10]

f) Inertization

Disposal by inertization consists of mixing the waste with cement before disposal in order to minimize the risks of leakage of toxic substances contained in the waste.

Strengths:

- Simple
- Safe
- May be used for pharmaceutical waste
- No atmospheric pollution

Weaknesses:

- Not applicable for infectious health care waste

Construction costs: Only cost of cement [10]

A resume of the advantages/strengths and disadvantages/weaknesses on the utilization of the aforementioned mechanisms for the treatment and disposal of health-care risk wastes, is represented on the following figure:

Treatment/ disposal method	Advantages	Disadvantages
Rotary kiln	Adequate for all infectious waste, most chemical waste, and pharmaceutical waste.	High investment and operating costs.
Pyrolytic incineration	Very high disinfection efficiency. Adequate for all infectious waste and most pharmaceutical and chemical waste.	Incomplete destruction of cytotoxics. Relatively high investment and operating costs.
Single-chamber incineration	Good disinfection efficiency. Drastic reduction of weight and volume of waste. The residues may be disposed of in landfills. No need for highly trained operators. Relatively low investment and operating costs.	Significant emissions of atmospheric pollutants. Need for periodic removal of slag and soot. Inefficiency in destroying thermally resistant chemicals and drugs such as cytotoxics.
Drum or brick incinerator	Drastic reduction of weight and volume of the waste. Very low investment and operating costs.	Destroys only 99% of microorganisms. No destruction of many chemicals and pharmaceuticals. Massive emission of black smoke, fly ash, toxic flue gas, and odours.
Chemical disinfection[a]	Highly efficient disinfection under good operating conditions. Some chemical disinfectants are relatively inexpensive. Drastic reduction in waste volume.	Requires highly qualified technicians for operation of the process. Uses hazardous substances that require comprehensive safety measures. Inadequate for pharmaceutical, chemical, and some types of infectious waste.
Wet thermal treatment[a]	Environmentally sound. Drastic reduction in waste volume. Relatively low investment and operating costs.	Shredders are subject to frequent breakdowns and poor functioning. Operation requires qualified technicians. Inadequate for anatomical, pharmaceutical, and chemical waste and waste that is not readily steam-permeable.
Microwave irradiation	Good disinfection efficiency under appropriate operating conditions. Drastic reduction in waste volume. Environmentally sound.	Relatively high investment and operating costs. Potential operation and maintenance problems.
Encapsulation	Simple, low-cost, and safe. May also be applied to pharmaceuticals.	Not recommended for non-sharp infectious waste.
Safe burying	Low costs. Relatively safe if access to site is restricted and where natural infiltration is limited.	Safe only if access to site is limited and certain precautions are taken.
Inertization	Relatively inexpensive.	Not applicable to infectious waste.

[a]May not apply to more sophisticated, self-contained, commercial methods.

Figure 1.15 – Advantages and disadvantages on the use of different methods of waste treatment/disposal from HCF.

Also a resume, about the applicability of the aforementioned technologies on the treatment of the different categories of waste produced within a health-care facility is represented in figure 1.16 and figure 1.17.

Waste category	Rotary kiln	Two chambers pyrolytic incineration	Single chamber incineration	Wet thermal treatment (autoclave)	Chemical disinfection	Microwave irradiation	Sanitary landfill
non-risk HCW	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Human anatomical waste	YES	YES	YES	NO	NO	NO	NO
Waste sharps	YES	YES	YES	YES	YES	YES	YES for small quantities with encapsulation
Hazardous Pharmaceutical waste	YES	Small amount only	NO	NO	NO	NO	NO
Cytotoxic pharmaceutical waste	YES	NO YES for modern ones	NO	NO	NO	NO	NO YES for small quantities with inertization
Infectious waste	YES	YES	YES	YES	YES	YES	YES
Highly infectious waste	YES	YES	YES	YES	YES	YES	NO YES only after pre-treatment
Other hazardous waste	YES	NO	NO	NO	NO	NO	NO YES if specially designed
Radioactive health-care waste	NO	NO	NO	NO	NO	NO	YES Specially designed

Figure 1.1.6 – Applicability of the different technologies for the treatment or disposal of the different categories of health-care waste. [12]

Technology or method	Infectious waste	Anatomical waste	Sharps	Pharmaceutical waste	Cytotoxic waste	Chemical waste	Radioactive waste
Rotary kiln	Yes	Yes	Yes	Yes	Yes	Yes	Low-level infectious waste
Pyrolytic incinerator	Yes	Yes	Yes	Small quantities	No	Small quantities	Low-level infectious waste
Single-chamber incinerator	Yes	Yes	Yes	No	No	No	Low-level infectious waste
Drum or brick incinerator	Yes	Yes	Yes	No	No	No	No
Chemical disinfection	Yes	No	Yes	No	No	No	No
Wet thermal treatment	Yes	No	Yes	No	No	No	No
Microwave irradiation	Yes	No	Yes	No	No	No	No
Encapsulation	No	No	Yes	Yes	Small quantities	Small quantities	No
Safe burial on hospital premises	Yes	Yes	Yes	Small quantities	No	Small quantities	No
Sanitary landfill	Yes	No	No	Small quantities	No	No	No
Discharge to sewer	No	No	No	Small quantities	No	No	Low-level liquid waste
Inertization	No	No	No	Yes	Yes	No	No
Other methods				Return expired drugs to supplier	Return expired drugs to supplier	Return unused chemicals to supplier	Decay by storage

Figure 1.17. - Applicability of the different technologies for the treatment or disposal of the different categories of west produced in a HCF. [1]

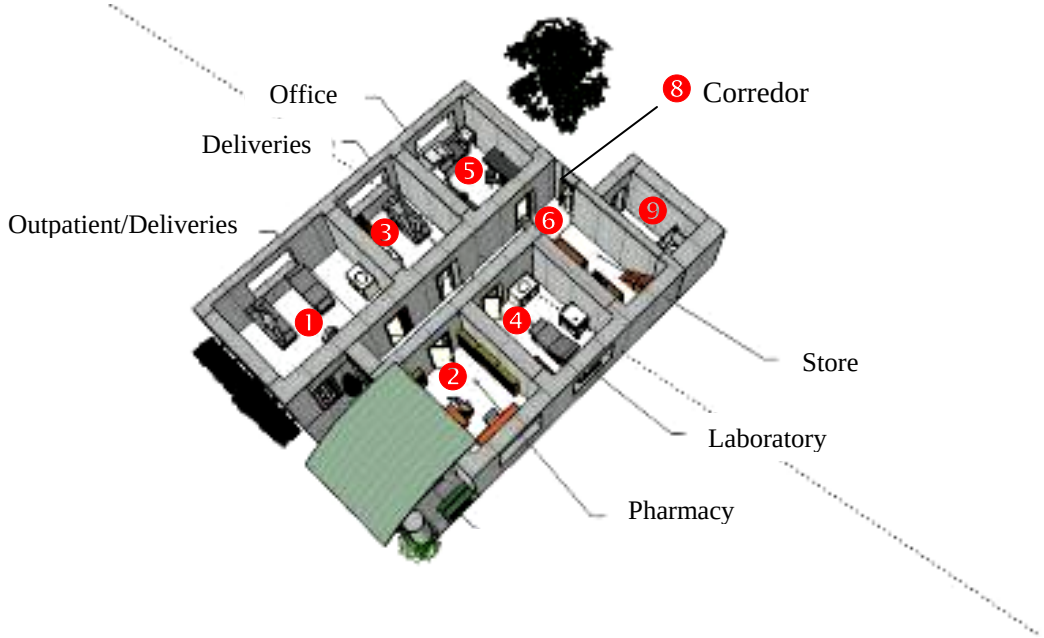
2. SAPHE BAGAR HEALTH CLINIC CHARACTERIZATION

The Sanfe Bagar Health Clinic is a primary health-care center located in the remote district of Accham. More specifically, the clinic is located in Sanfe Bagar, a central market in this district. Sanfe bagar is a important village in the district and have a central strategic position. It can be accessed by paved road from Danghadi, which takes approximately 10 hours by bus.

The clinic is situated 200 meters before achieve the Haat Bazar (market) on the right. The clinic will provide X services and infrastructures are divided in 10 regions.

1 – Outpatient/emergency room
2 – Reception/Pharmacy room
3 – Deliveries room
4 – Laboratory
5 – Office room
6 – Store room
7 – Rest room
8 – Corridor
9 – Toilettes
10 – Waste treatment station

The infrastructures of the clinic can be visualized in the following diagram, obtained with the software SketchUp:



According to the criteria presented in the 'Healthcare Waste Management in Nepal' document [1], SBHC is classified as a small HCF (see introduction), because it has 5 beds.

2.1. Context and facilities available

The following parameters have been studied according to the bibliography available and the localization of SBHC, in order to select the most appropriate strategy for waste treatment/disposal:

a) Location of the clinic:
   - 100 m from Haat Bazaar – Market in Sanfe Bagar (Achham)
   - In a rice field, surrounded by very active agriculture.
   - 250 m from the market, 150 m from the river.

b) Land available for further construction:
   - Rajan's Land 1:
     - 250 m from the clinic
     - Access trough small pathway, usually frequented by locals
     - 25 m high from the water flow
     - Stable soil for construction
     - Slightly windy
     - Dense vegetation
     - Non-densely populated (1 habitation 20 m away, 2 habitations 60 m away)
     - Area available:
   - Rajan's Land 2:

- 200 m from the clinic
- Access trough small pathway
- The land is located on the margin of the water flow (2 m from water flow - possible danger during floods)
- Unstable soil
- Slightly windy
- Not surrounded by vegetation

- Non-densely populated (7 m from 2 habitations, 80 m from other habitations)
- Area available: limited space

c) Specialty and access to disposal services:
- No availability of municipal disposal structures
- Closest hospital in the Region (Seti hospital – x H from the clinic
- Second closest hospital: Danghadi (10 hours by bus)
- Availability of septic tank in the clinic land
- Possibility of expand infrastructures (2 aforementioned lands);

d) Quantity of waste Kg/day: 13.5 Kg; general HCW: 11 Kg; HCRW: 2.5 Kg;

e) Availability of national legislation: The environmental division of the Ministry of Population and Environment (MOPE) develop the following legislation:

EIA, the Environmental Protection Act, and the Environmental Protection Regulation (1996-1997). This includes EIA (Environmental Impact Assessment) and IEE (Initial Environmental Examination).

According to this legislation, small plants and activities have to apply for IEE. However, according to the Environmental Protection Regulation the plants that develop the following activities during HCW management need to apply for EIA:

- Hazardous waste treatment plants
- Landfilling of hazardous waste
- Handling and disposal of radioactive waste.
- HCF with more than 25 beds.

EIA has to be submitted to the Ministry of Industry (MOI) that forwards to the MOPE.

f) Availability of a national plan: National Health Care Waste Guidelines (2002) [6]

'Health care waste management in Nepal: Assessment of Present State and Establishment of a Framework Strategy and Action Plan for Improvement': (Ministry of Health Nepal) [1]

'*National Health Care Waste Management Guidelines'*. (Nepal Health Research Council) [6]

There also available: 'S*afe Management of Wastes from Health-care Activities'* published by WHO - World Health Organization. [2]

g) Central facilities:

- *Equipment available in the Market:* basic equipments: Buckets (metal, plastic), bamboo in the village, paint (small cants), house/kitchen equipments, mattress, clothes, metal steel to build roof, etc.
- *Staff available:* carpenter, electricity installation, iron processor (basic), Civil Engineers (very friendly to help in the road head quarters), very easy to get staff for cleaning and to build infrastructures.
- *Limitations:* Any non-standard or more complex equipment will have to be purchase from Danghadi or ask in the market: e.g. metal, plastic pipes, cement (big quantities), metal sheets, bricks, lockers, good wood to build furniture, etc. Rajan usually says that it can be in Sanfe Bagar in the next day. Several times was taking more than a week to bring supplies from Danghadi to Sanfe in a Truck.
- Transport: It's possible to rent a truck/jeep to build equipment from Danghadi. It is also possible to ask supplies in the market and the shop will arrange for transportation. Small amounts of material can also be transported in the local bus.

h) Power supply: Available, generally off 2 hours a day
Availability of Diesel generator 5 kW

i) Water Supply: Available (non-potable)

j) No space available in clinic land for further construction
2 Land available for possible construction

k) Public acceptability for the different treatments: There is no evidence for disagreements in the construction of incinerator and landfill in the Land 1. In the

case we use land 1 or land 2 for this or any other purpose, it is extremely necessary to avoid:

- Interference with local habits: e.g. Block of the public pathways near by.
- Modification of local environment: e.g. increase of pollution.

l) There is no staff available with knowledge in waste treatment and risk associated during its handling; no staff with knowledge in health-care wastes that can be responsible for it correct collection, storage, transportation, treatment and disposal processes.

Consequently, an operator will have to be trained from one week before the beginning of the operations. Material present in this plan will be used for staff training. Some of the schemes and most important parts will be translated to Nepali. Additional schemes will be added to this document as annexes.

2.2. Estimation on the wastes produced in SBHC

Considering the criteria represented in section 1.4.1., specially the cost estimations from the Ministry of Health of Nepal [1], a small Health-care facility such as SBHC will produced an average of 0.5 Kg of HCRW per bed per day. Additionally, 11 Kg of HCW (non-risk/general) will be produced per day (Table 2.1)

Table 2.1. Estimation of general HCW and HCRW produced per day in the SBHC.

Category of waste	Average amount of waste produced (Kg/bed)	Total (Kg/day)
HCW	_____	11.0
HCRW	0.5 Kg/bed/day	2.5
	Total	13.5 Kg/day

.

Considering the values estimated by WHO for the distribution of HCW in a HCF in developing countries (section 1.4.2.)[1], the waste generated in the SBHC will be:

- 'General' HCW: 11.0 Kg
- Infectious and Pathological waste: 2.1 Kg
- Sharps waste: 0.1 Kg
- Chemical and Pharmaceutical waste: 0.4 Kg
- Special waste – include radioactive or cytotastic waste, pressurized containers, broken thermometers and used batteries: 0.1 Kg

Assuming that the composition of the SBHC will be the same as the composition of the HCW in a hospital in India (see section 1.4.3.), the average composition of the HCW produced in the SBHC will be:

Table 2.2. Estimation of the different kind of HCW produced in the SBHC.

Kind of HCW produced	**Percentage (wet-weight)**	**Kg/day**
Paper	15 %	2.03
Plastics	10 %	1.35
Rags	15 %	2.03
Metals (sharps, etc.)	1 %	0.14
Infectious waste	1.5 %	0.20
Glass	4.0 %	0.54
General Waste (food waste, sweeping…)	53.5 %	7.22
	Total	13.5 Kg/day

3. ESTIMATION ON THE ANNUAL COSTS FOR WASTE MANAGEMENT

According to the CAT costing tools available in the WHO web-site, (http://www.healthcarewaste.org/en/715_fin_calculations.html) the total cost per kilo of health-care waste produced will be US$ 0.20 (Table 2.3). Consequently, the annual cost for the treatment of the health-care wastes produced in the SBHC will be US$ 827 (Table 2.4.)

Table 2.3. Estimations on the costs of waste treatment per year.[Calculated with CAT tool]

HCWM • Costing tool	Tool B1: calculations for small HCFs

Assumptions

unit		value	unit
1 day	average production of HCW	14	kg
small HCFs	total number in country	1	units

Calculations: annual capital costs

#	item	unit price	quantity	lifespan [years]	nnual costs [USD]
1	HCW bin, plastic	5	2	2	5
2	protective equipment	35	1	2	18
3	needle remover (mechanical)	30	1	4	8
4	waste treatment system (SSI, autoclave…)	1,500	1	5	328
5	shelter for waste treatment system (simple)	1,000	1	5	218
6	waste pit, small	25	1	2	13
				total annual capital costs per small HCF	**591**
				total annual capital costs for all small HCFs at national level	**591**

Calculations: annual recurrent costs

#	item	unit price	quantity	*info*	nnual costs [USD]
1	sharp box, cardboard, 5 liters	0.0	10	*150 AD syringes / b*	0
2	plastic bags for infectious non-sharp waste	0.1	100	*approx. 2 bags / we*	12
3	fuel used by HCW treatment system	0.5	50	*approx. 1 "burn" / w*	25
4	staff wages: HCW worker	1.0	70	*1/2 day of work / we*	70
5	maintenance (spare parts…)	129.8	1	*5% of capital costs*	130
				total annual recurrent costs per small HCF	**237**
				total annual recurrent costs for all small HCFs at national level	**237**

total annual costs per small HCF	**827**
total annual costs for all small HCFs at national level	**827**

total cost per kilo of HCW treated in small HCFs	**0.20**

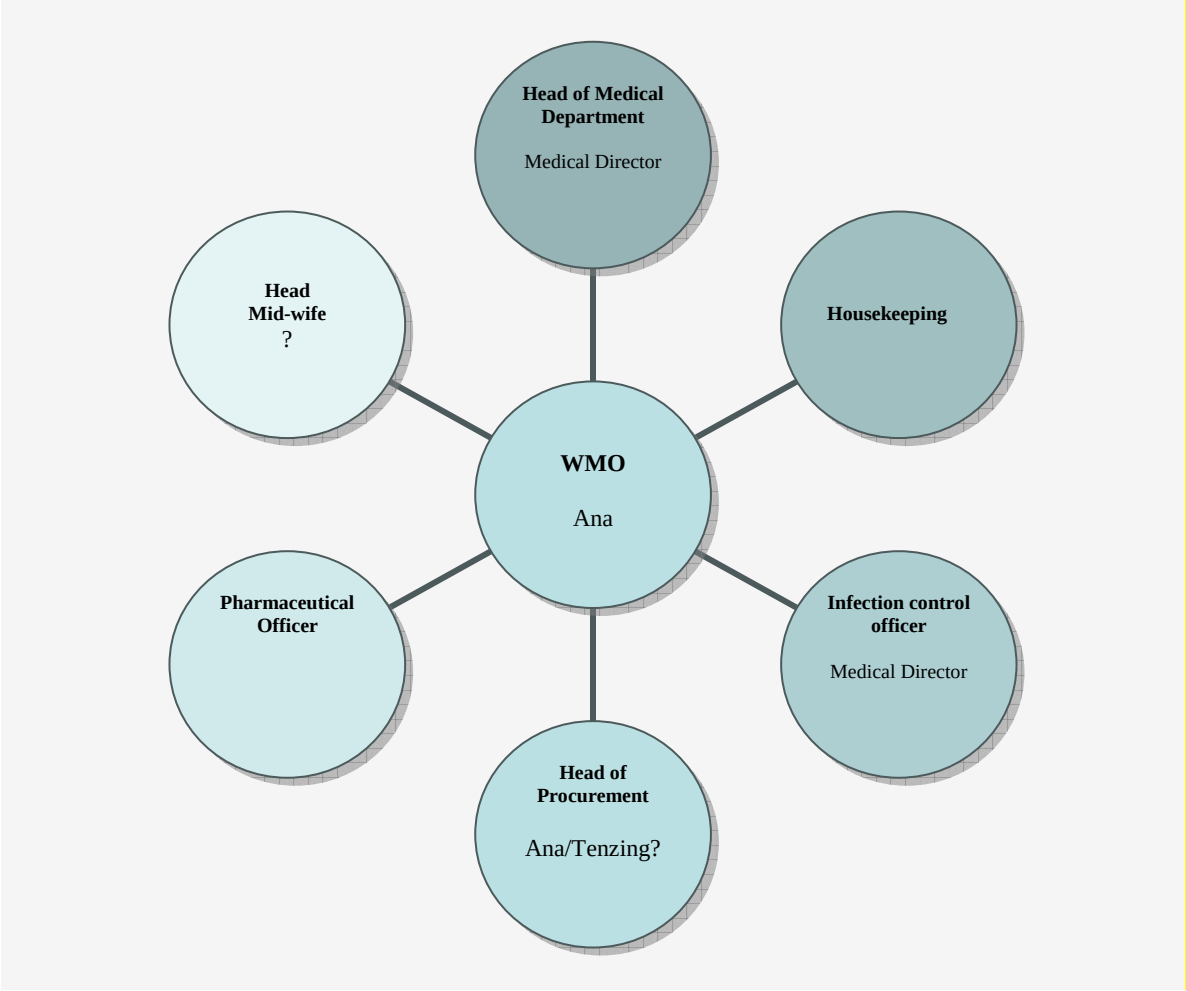
4. ORGANIZATION ISSUES

In order to ensure the necessary coordination in between the staff involved in the management of the waste produced in SBHC, from segregation to final disposal, and to ensure a current discussion of opinions to improve the strategy in different perspectives, a waste management committee, composed by the following members will be developed:

- Waste management officer: (WMO) head of the Waste Management Unit.
- Head Midwife: represent the other midwifes and Health Assistant;
- Housekeeping: Person responsible for cleanliness, waste collection and disposal.
- Infection Control officer: responsible for the infection control, closely related with the waste management;
- Head of medical department;
- Pharmaceutical Officer: Responsible for the safe disposal of pharmaceutical waste;
- Head of Procurement: responsible for procurement of equipment and materials for clinic, pharmacy and waste management.

(To complete latter with specific functions)

In the first month of operations the committee will meet once a week in order to discuss the strategy and adapt it to the circumstances and staff. After this period the committee will meet once every fifteen days.


Head of Medical Department
Medical Director
Head
Mid-wife
?
Housekeeping
WMO
Ana
Pharmaceutical Officer
Infection control officer
Medical Director
Head of Procurement
Ana/Tenzing?

5. SBHC WASTE MANAGEMENT PLAN

5.1. Waste definition and characterization

The definition of the waste produced in the SBHC was established according to the Nepal Health Research Council classification [6], and also according to the future possibilities for HCW treatment/disposal facilities that will be developed during the implementation of this plan.

CATEGORY 1: SHARPS: Biomedical wastes that can cause cuts or puncture wounds: E.g. SYRINGE, NEEDLES, HYPODERMIC NEEDLES, SCALPS, BLADES, KNIVES, INFUSION SETS, SAWS, MICROSCOPIC SLIDES, COVER SLIPS, BROKEN GLASS, NAILS, etc.

The possibility of contact with infected blood or other body fluids makes them into highly hazardous waste, because of elevated probability of diseases (e.g HIV, Hepatitis B) transmission. Handling from segregation till final disposal has to be minimized in order to avoid cuts or puncture wounds.

Any of these equipments must be handled as high hazardous waste, even when there are no evidences of infection. All the aforementioned equipments, such as glass, needles, syringe, infusion sets that are contaminated with small amounts of hazardous chemicals should also be handled, treated and disposed as sharps.

CATEGORY 2: HAZARDOUS/INFECTED WASTE

WASTE WITH POTENCIAL TO CONTAIN PATHOGENS (bacteria, fungi and viruses) that can cause disease after exposition. Incorrect handling of this waste category can lead to the transmission of diseases, such as Tuberculosis, AIDS and Hepatitis.

E.g. COTTON, GAUZE, SOILED BANDAGES, COTTON USED FOR DRESSING, BLOOD BAGS, HUMAN AND ANIMAL TISSUE, ANATOMICAL WASTE (body parts, tissues, organs, etc), WASTES GENERATED FROM CLEANING SPILLS OF HAZARDOUS/INFECTED WASTE and any other MATERIAL USED FOR TREATMENT. Even wastes are generated from a health patient are ALL considered as INFECTED.

Note: Highly infectious: AUTOCLAVABLE WASTE (blood and infectious waste that has been originated trough contact with patients infected with Hepatite B, HIV, cholera) will be segregated differently. It must be autoclaved before treatment/disposal as infectious waste. *Note:* Anatomical/Pathological waste and plastics CANNOT be autoclaved. Consequently they must be segregated as infected waste.

CATEGORY 3: Chemical waste and pharmaceutical waste: Expired drugs, liquid and solid waste generated from laboratory, medical activities and pharmacy. In this group it is included any Hazardous or non-hazardous, cytotoxic and non-cytotoxic chemical and pharmaceutical waste. Materials contaminated with any of these compounds, as a result for example, of drug preparation and administration (needles, syringes, gauzes, vials and packaging), are also included in this group.

All the process for handling of these substances highly depends on the characteristics of each chemical or pharmaceutical product. Consequently, information provided in the drugs and chemicals package must always be read and considered for a safe handling of this substances during segregation, collection, treatment and disposal.

Special attention should be given to the hazardous chemicals, labeled as:

- Toxic

- Corrosive (e.g. acids pH<2; bases pH>12)

- Flammable

- Reactive (explosive, water reactive, shock sensitive)

Oxidizing

Dangerously reactive material

- Genotoxic (e.g. cytostatic drugs)

CATEGORY 4: General waste: includes paper, cardboard, metal containers, floor sweeping, and kitchen waste. It needs to be collected separately from infectious waste but does not need special treatment and storage facilities.

CATEGORY 5: EFFLUENTS: Any liquid originated from the clinic operations, including cleaning, disinfecting activities. Particular attention should be given to liquid infectious waste originated from medical analysis and laboratory operations.

Effluents can be categorized as infectious waste (category 2), when contaminated with blood or body fluids, as chemical waste when resulting from disinfecting activities, liquid pharmaceuticals, etc, or general waste when is non-infected or non-contaminated.

Consequently, the handling of this category, from segregation till final disposal will be described in between different categories (category 2, category 3 and present category)

CATEGORY 6: Special wastes – include wastes with high contents of heavy metals such as batteries, pressurized containers, broken thermometers, blood pressure gauzes, as also radioactive waste: photographic fixing and developing solutions in X-ray processes.


A resume on the different categories of waste produced in SBHC is represented on table 5.1.

Table 5.1. Resume on the different categories of waste produced in SBHC.

Waste category	Description
Category **1** **SHARPS**	ALL SYRINGE, NEEDLES, HYPODERMIC NEEDLES, SCALPS, BLADES, KNIVES, INFUSION SETS, SAWS, BROKEN GLASS, NAILS. *Notes:* Highly hazardous waste, Elevated probability of diseases transmission. Handling should be minimized
Category **2** **Infectious Waste**	COTTON, GAUZE, SOILED BANDAGES, COTTON USED FOR DRESSING, BLOOD BAGS, HUMAN AND ANIMAL ANATOMICAL WASTE (body parts, tissues, organs, stool samples, etc), WASTES GENERATED FROM CLEANING SPILLS OF HAZARDOUS/INFECTED WASTE and any other MATERIAL USED FOR TREATMENT.(1) *Notes:* Waste generated form patients infected with cholera, HIV, Hepatitis B (HIGLY INFECTED WASTE) will be immediately pre-treated in autoclave and then segregated with infectious waste.
Category 3 **Chemical/pharmaceutical Waste**	CHEMICALS, MEDICINES, DRUS (liquid or solid; diluted or pure; Hazardous or Non-hazardous, cytotoxic or non-cytotoxic). ANY MATERIAL CONTAMINATED WITH THESE SUBSTANCES.
Category 4 **General waste**	Paper, cardboard, metal containers, floor sweeping, and kitchen waste. *Note:* Segregation and collection separately from Category 2. Does not need special treatment and storage facilities
Category 5 **Effluents**	ANY LIQUID WASTE originated in SBHC. Particular attention should be taken to liquid infectious waste, as also to chemical liquid waste, that can be very hazardous to environment and health. *Note:* Handling of hazardous/infectious liquid waste, as also chemical liquid waste will be also covered in categories 2 and 3, respectively.
Category 6 **Special waste**	CYTOTASTIC OR RADIOACTIVE waste, pressurized containers, broken thermometers and used batteries

(1) There will be no Chemical pretreatment before incineration. Chlorinated plastics should not be incinerated.

5.2. SBHC waste audit

1) Sharps waste

Sharps waste (a.1 Kg/day) will be mainly originated in the outpatient room, laboratory room, followed by delivery room. Most of the sharps segregated will be hypodermic needles (59%) and suture needles (19%) and according to data presented in section 1.4.2, two 4 liters cardboard boxes will be generated every 30 days.

2) Infectious waste

Infectious waste will be *mainly generated* in the **outpatient room and delivery room**. *Highly infectious* waste, such as big amounts of blood and pathological waste will be generated in the **delivery room**. A smaller percentage of infectious waste will be generated in the laboratory, (stool, and sputum samples).

3) Chemical/Pharmaceutical waste

Chemical waste (0.4 Kg/day) will be mainly generated in the laboratory (gram staining, routine tests, chemistry) and pharmacy (outdated medicines, drugs). A big amount of packages contaminated with chemical and medicines will also be generated in the outpatient rooms and delivery room.

4) General waste

According to estimations in section 2.3, 11 Kg of 'general' HCW will be originated per day. This majority of this waste will be produced in the **office** (paper, cardboards, organic waste, plastics, etc) and **pharmacy** room.
Small amounts of 'General' waste will be generated in the **laboratory** (packets from syringe, needle packets), **outpatient room and delivery room** (packets from syringe, needle, infusion catheters, sterilized gloves).

5) Effluents

Effluents will be *mainly generated* from the **two toilets** and **delivery room**. Effluents will be generated in small amounts in the **laboratory.** However, whenever hazardous chemicals or non-hazardous chemicals are segregated in big amounts, the disposal into the sewage will be avoided.

6). Special waste

Since X-ray facilities will not be present in the clinic, **radioactive waste** will be *almost absent.* (any medicine ?). Any low level-liquid radioactive waste generated [2] can be disposed in the sewage. Pressurized containers and broken thermometers will be also produced in *small amounts,* as also and used batteries.

A resume on the location of wastes produced within the Saphe Bagar Health clinic is represented on the table 5.2.

Table 5.2. Localization of waste production within the clinic.

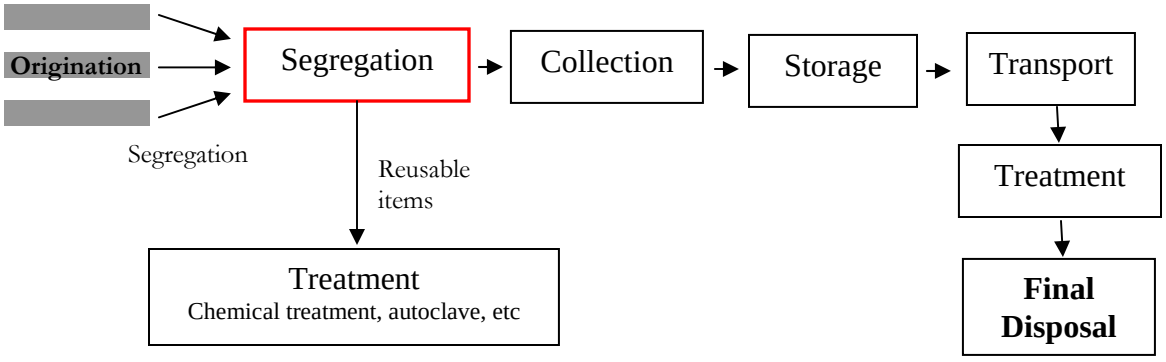
Clinic room	Sharps Cat.1	Infectious Cat.2	Chl/Pharm Cat.3	General Cat.4	Effluents Cat.5	Special Cat.6
1) Outpatient	+	+	+/_	+/_	+/_	- -
2) Recep/Pharm	No	No	+	+/_	+	_
3) Deliveries	+/_	+	+/_	+/_	_	- -
4) Lab	+	+/_	+	_	+/_	+/_
5) Office	No	No	No	+/_	+	- - (1)
6) Store	No	No	No	No	+/_	No
7) Rest area	No	No	No	No	_	No
8) Corridor	No	No	No	No	_	No
9) Toilettes	No	No	No	+	+	No

* "No" Absent, - - Almost absent, - reduced, +/– Medium, + High

(1) Toners (should be refilled in KTM)

5.3. Segregation Audit

5.3.1. The color coding-scheme.



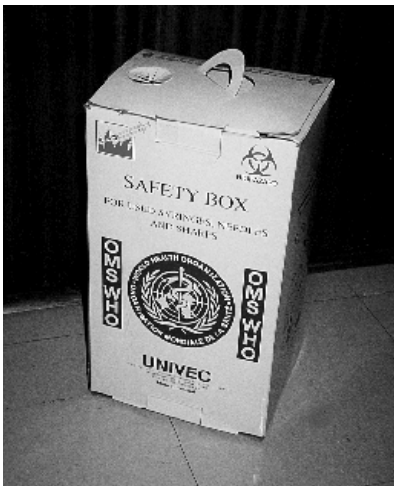
Considering the segregation scheme recommended by WHO and the Ministry of Health Nepal (see section 1.5.2.b), a color coding scheme for the segregation of waste produced in the Saphe Bagar Helath clinic was defined. However, future improvements must be done in order to make it more efficient and to adjust it to the clinic staff and to the characteristics of waste produced per day in the clinic.

The coloring code planned for the segregation of the wastes produced in the SBHC is represented on table 5.3.

Table 5.3. Color coding for the segregation of wastes in Saphe Bagar Health clinic

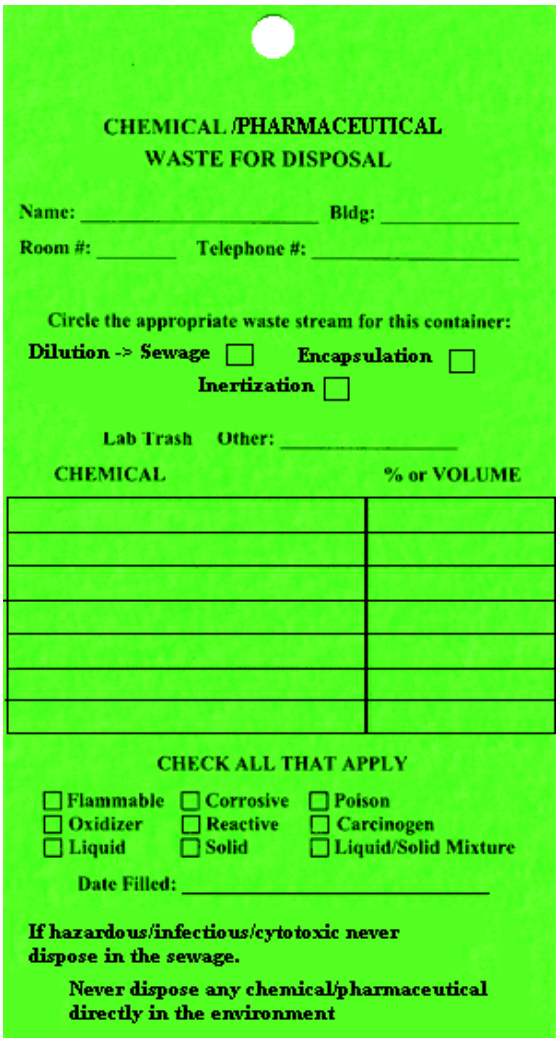
Type of waste	*Sub-types*	*Color of container and markings*	*Type of container*
1. Sharps (Infected and non-infected)	I) Disposable sharps II) Reused sharps (lab slides and tubes, scissors, etc)	I) Yellow/White II) Any color Both marked as: 	I) Cardboard Puncture-proof sharp container II) Plastic container with disinfection solution
2. Infectious waste	i) Incinerable ii) Non-incinnerable (PVC plastics) iii) Higly infectious (produced by contact with HIV, Hepatitis B, Cholera infected patients)	i) Yellow ii) Green Marked with:  iii) Red All marked as 'Hazardous waste':	i) Strong/Leak-proof container lined with resistant /incinerated (non-PVC, chlorinated plastics) plastic bag. ii) Small and strong/leak-proof plastic container lined with plastic bag. iii) Strong/leak-proof plastic container lined with plastic bag (capable of being autoclaved). *Note*: PVC plastic and anatomical/phatological waste dispose with sub-category i) after fold in plastic bag)
3. Chemical/pharmaceutics	a) *Small/Moderate quantaties* (excluding **cytotocxic**) b) Big amounts **(Pharmaceutical, cytotoxic, chemical)**	a) Segregate as infectious waste b) Brown Marked as: 	Plastic bag or container Several strong/solid/leak-proof) plastic bins with lid/glass bottles. *Note: Segregate different/reactive/ cytotoxics substances separately*
4. General waste Segregated with domestic waste	A) Reusable: (to give to local agriculture) B) Non-reusable:	Black Blue	A) Metal bucket. B) Plastic blue buckets with lid. Note: Disposed in the same way as infected waste. However, collect, store and transport separately.
5. Effluents	Notes: (no strong acids/bases, hazardous chemicals, cytotoxic)	Sewage	

SHARPS: containers that will be used in SBHC for the segregation of sharps - category 1. These cardboard containers are puncture-proof, can be directly disposed by incineration and are provided for free by the Ministry of Health Nepal (near Teku) and by the DHO.



The containers that will be used in SBHC for the segregation of infectious waste - category 2, will be plastic containers lined with yellow plastic bags. The container will be labeled according to the following figure.

Chemicals/Pharmaceuticals, if disposed in the waste treatment station must be labeled with the following green label after correctly fulfilled. On the other hand, wastes to be returned to the supplier (e.g. outdated) will be labeled with the following red label after correctly packed and sealed:



CHEMICAL /PHARMACEUTICAL WASTE FOR DISPOSAL

Name: _____ Bldg: _____

Room #: _____ Telephone #: _____

Circle the appropriate waste stream for this container:

Dilution -> Sewage ☐ Encapsulation ☐

Inertization ☐

Lab Trash Other: _____

CHEMICAL	% or VOLUME

CHECK ALL THAT APPLY

☐ Flammable ☐ Corrosive ☐ Poison
☐ Oxidizer ☐ Reactive ☐ Carcinogen
☐ Liquid ☐ Solid ☐ Liquid/Solid Mixture

Date Filled: _____

If hazardous/infectious/cytotoxic never dispose in the sewage.

Never dispose any chemical/pharmaceutical directly in the environment

RETURN TO SUPPLIER

Remarks

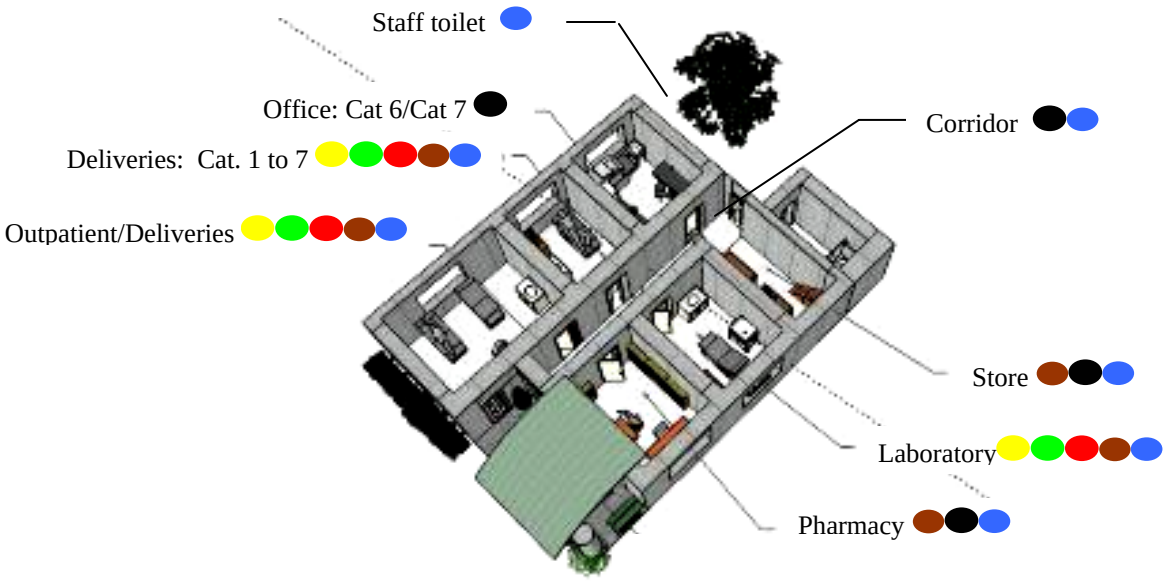
Date _____

Signed _____

It is responsibility of the staff that segregates the wastes, to label and identify it appropriately with the following criteria:

- Waste category
- Appropriate warning symbols
- Date of collection
- Place of segregation
- Waste destination

5.3.2. Distribution of color-coding containers within the clinic.



5.4. Waste minimization (based on Action Plan by Ministry of Health Nepal [1])

The reduction, reuse and recycling of waste will be considered as an important part of the SBHC Waste Management. The reduction of the wastes produced will lead to less costs associated with it treatment and also to lower impact in the environment and population.

5.4.1. Waste avoidance for waste reduction

Waste generation should avoid whenever it is possible. The reduction of wastes in the source is essential for a green management of wastes and also to avoid additional costs. However, waste generation must be reduced without compromise staff/patients and population health and safety.

The development of a green procurement, which is a responsibility from the stock manager, will be the most important strategy for waste reduction:

1. Implementation of a correct stock management in order to avoid the creation of outdated chemicals and pharmaceuticals in the clinic.
2. Purchase products with minimum required packaging.
3. Purchase reusable products (slides, slide covers…) except instruments related with a high risk of infection (syringe, infuse instruments that will be in direct contact with body fluids).
4. Disposable instruments should be non-PVC/non-chlorinated plastics (e.g. polypropylene (PP), polyethylene (PE)).
5. Avoid cardboards, plastics, paper hazardous to the environment when incinerated or disposed of (with dyes, coloring agents that contain heavy metals, chlorinated or other halogenated compounds).
6. Purchase products packed in reusable/recycled materials.
7. Avoid plastic bags during any purchase of equipment in the local market/village.

4.4.2. Reuse of waste

1. Reuse plastics, glass containers, boxes for further storage/transport of equipment. DO NOT reuse plastic bottles/flasks that where previously with hazardous chemicals/drugs.
2. Reuse packaging materials (glass bottles, cardboard, tins, plastics) for alternative purposes. E.g. In spite of buy basic equipments why not to reuse it.

3. Reuse linens (after disinfection with chlorine solution and washed properly) (only reusable).
4. Reuse of equipment in the laboratory: Slides (non-AFB), cover slips, tubes and other equipments that are not directly in contact with blood and that can be efficiently disinfected/sterilized)
5. Cardboards boxes, papers can be used to load the incinerator, and in this way avoid the use of big amounts of kerosene. Kerosene should be added whenever high temperatures are required (category 1, 2, 3).

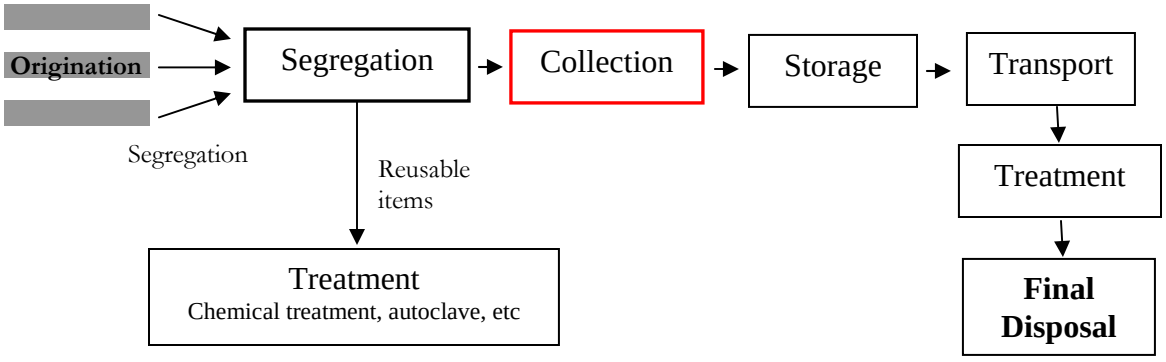
Any waste that comes into contact with HCRW can only be reused after appropriate sterilization.

5.4.3. Waste Recycling:

Recycling facilities are not available at the moment in the village or Kathmandu. Consequently, AVOIDANCE and WASTE REUSE should be performed every time that is possible.

6. WASTE HANDLING, SAFETY AND TRANSPORT

6.1 Collection



6.1.1. Good practices

For the correct collection of wastes the following criteria must the followed:

- Waste must be collected in specific days (table 6.1), or before the suggested days when **¾ full.**
- DO NOT accumulate plastic bags with waste at the point of segregation → collect to store room every time containers are ¾ full.
- The disposable sharp containers should be sealed by tape in the place of segregation.
- Sealed sharp containers should not be placed in plastic bags.
- Collect waste in the place of segregation (except general waste) → Take the store container into each room and then transport it again to the store room.
- Keep the same color-coding and labeling in between the segregation and storage room.
- Collect waste always avoiding spillage;
- Never mix infectious and non-infectious waste
- Bags and containers should be equally and immediately replaced after collection.

- Containers should be collected carefully to avoid exposure and aerosol generation and disinfected after every cycle of waste collection (place new ag only after disinfection).
- Staff that handle wastes must wear protective clothing at ALL THE TIMES, including face mask, industrial aprons, disposable or heavy duty gloves, and if available: leg protectors and industrial boots.[2, 3, 6]

6.1.2. Frequency of collection

According to the estimations performed in section 2.2. for the production of waste in the clinic, and according with recommendations from Ministry of Health Nepal [1], the frequency of waste collection will be:

- **Yellow/White sharp containers**: must be collected once a week or when ¾ full.

- **Yellow containers** must be emptied every 2 days in summer and every 3 three days in the winter. ALWAYS collected SEPARATLY from GENERAL WASTE.

- The yellow plastic bag must be always removed from the container.
- The container must be disinfected and washed after each collection.
- When additional collection is required, the yellow plastic bag must be collected into the yellow storage bucket (lined with yellow plastic bag) in the place of segregation.
-

- **RED autoclavable plastic bags** must be collected from the Red buckets immediately after segregation and disinfected by autoclaving. After this process segregate with infectious waste.

- **GREEN plastic buckets** with disinfectant solution (dettol), must be emptied with forceps into a green plastic bag, labeled as hazardous/ infectious waste.

- **Brown buckets** must be emptied when ¾ full, correctly packed and returned to the supplier.

- Different chemicals and pharmaceuticals must be segregated and collected separately. The mixture of different reagents can provoke explosion of reactions that generate hazardous substances.
- If it's to return to supplier latter on, pack, label and store appropriately in the store room.
-
    - **Blue buckets** (non-reusable) should be emptied every day into the big blue bucket in the storage room. The bucket in the storage room must be always lined with a blue plastic bag that will be disposed together with the waste.

    - **Black Metal Buckets** (reusable) must be emptied whenever necessary.
- Waste must be collected to the store room, and their separated according to the final destiny; e.g. cardboards that will be use to start the incinerator, should be stored all together and transported to the waste treatment station.

Note: Before collection, make sure that all the wastes are correctly labeled, according to criteria described in chapter 5.3.1. (DO NOT collect waste that is not identified)

The frequency and specific days for waste collection during each month is represented in the following table:

Table 6.1. Calendar for the collection of HCW produced in the SBHC.

March	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30					
Nepali calendar	23	24	25	26	27	28	29	30																						
YELLOW/WHITE Sharp containers							✓								✓								✓							
YELLOW			✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓					
RED	**Collect and sterilize immediately after segregation**																													
GREEN			✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓					
BROWN	**Collect when ¾ full and pack/fold according to disposal option**																													
BLUE		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
BLACK	**Collect when ¾ full or whenever reusable material is necessary**																													

(1) ↓ ↓ **(2)** ↓

For disposal, the **incinerator** will be working only 3 to 4 times a week. Depending on the amount of waste generated, it can be load one or more times, according to the demand.

(1) Amount of waste after collection:

General' HCW: 22.0 Kg

Infectious waste: 4.2 Kg

Total: **25 to 30 Kg**

(2) Amount of waste after collection:

General' HCW: 22.0 Kg

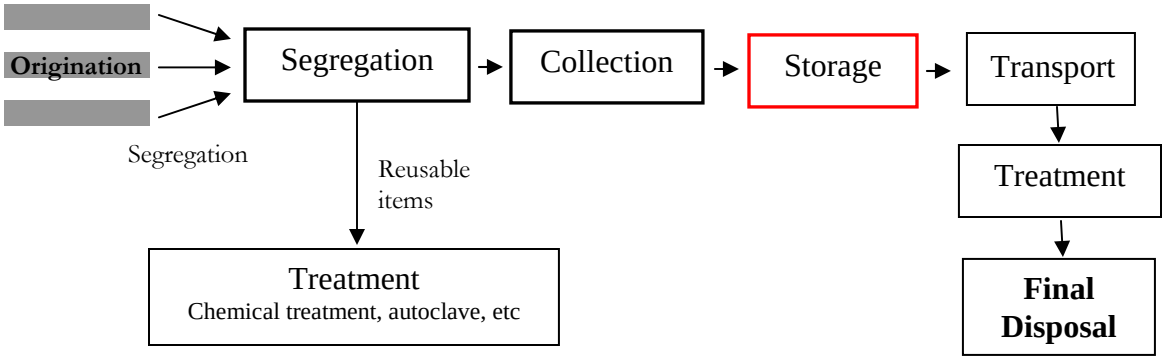
Infectious waste: 4.2 Kg

Sharps: 0.6/0.8 Kg

Total: **26 to 31 Kg**

Note: The treatment/disposal of the infectious categories will be done at the same day that it is collected for each room in the clinic. In this way storage will not happened, only if the containers in each room are overloaded (more than ¾ full)

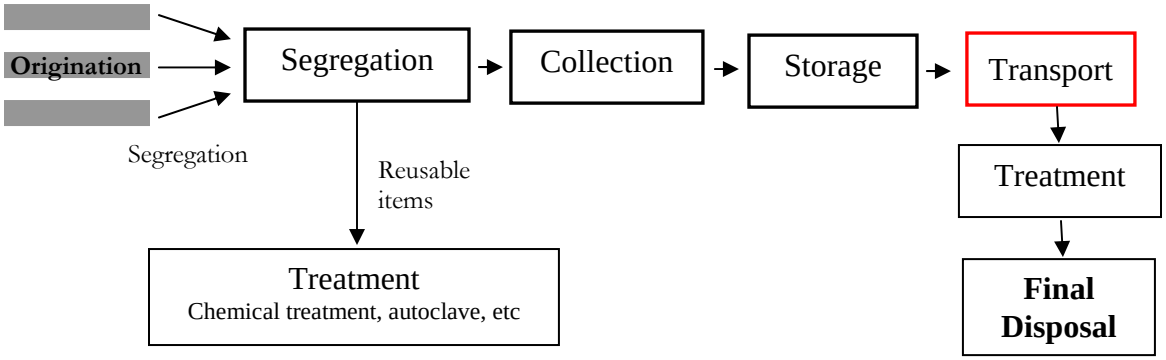
6.2. Storage



Only category 4 (general waste) will be frequently stored in the store room. Since the clinic is classified as a small HCF the amount of HCRW produced per day will be small. Consequently the wastes can remain in the different segregation room for 2 days. In the collection day, the ones from same category will be collected in a unique plastic bag (with same color and label) and transport directly to the disposal site.

In the storage room there will be two big buckets: One blue and one yellow conveniently lined with plastic bags with same colors. The yellow plastic bag must be leak-proof and resistant.

6.3. Off site-transport



Before transport the waste to the waste treatment station, make sure that:

- All the waste is correctly folded with plastic bags and that these are not leaking. If plastic bags are leaking introduce it in another plastic bag. In this case, disinfect the floor immediately.
- Plastic bags are corrected closed.
- Hazardous wastes are properly labeled with the category number and hazardous international symbol.

Danger ! Hazardous Waste
सावधान ! हानीकारक फोहर

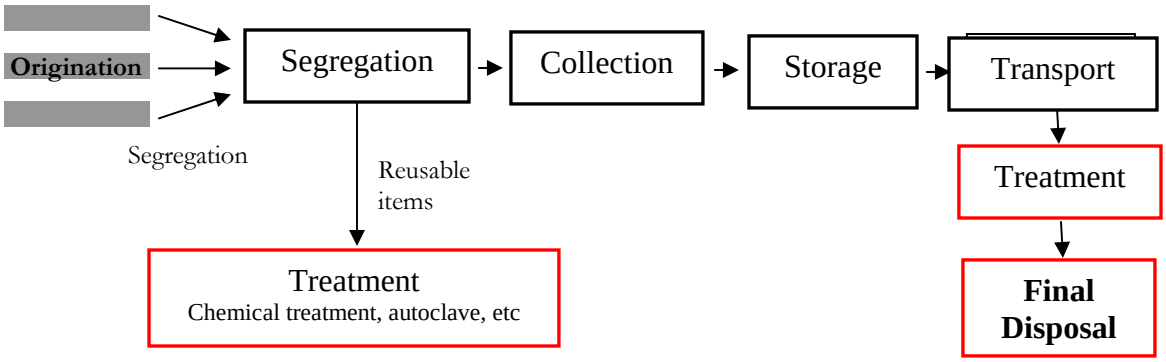
- Staff involved in this operation and any waste handling action must wear protective clothing at all the times including face mask, industrial aprons, leg protectors, industrial boots and disposable or heavy duty gloves.
- If possible, 1 month after start operations, a record with the following data must be kept for future surveys, statistics and analysis of waste production versus efficiency of strategy adapted:

    - Date of transport to waste treatment station
    - Place of segregation
    - Category of wastes
    - Waste destination

Note: To transport infectious waste (YELLOW, GREEN) or hazardous waste (BROWN) to the waste treatment station, place the bags into the black-leak proof bag. The black bag must be correctly tight and place in the basket with straps. Before transport the black bag will be fixed to the basket with a rope

In spite of trolleys/cars being recommended for the transport of hazardous waste, the aforementioned method of transport was chosen because the pathway to the waste treatment station is not suitable for cars/trolleys. Consequently, it will be more dangerous for the operator and local population to transport it in this way.

6.4. Waste treatment/disposal



Since, there is no available facilities for the disposal of the health care wastes, it is appropriated to build a Waste Treatment Station in the Rajan land 1 (see chapter 3 for detailed description. The treatment and final disposal of the wastes in this will be mentioned as off-site (out of clinic) treatment/disposal. Additionally, wastes that will be treated/disposed in the clinic are mentioned as on-site treated/disposed. A resume of the facilities available in each of this locations for waste treatment/disposal are represented on table 6.2)

Table 6.2 – Localization of waste treatment disposal and respective available facilities

Waste treatment/disposal according to localization	Facilities available
On-site (clinic)	- Chemical disinfection - Autoclave - Sewage
Off-site (waste treatment station)	- Incineration - Sharp pit - Landfill - Inertization

The selection of the facilities and infrastructures for the treatment of the HCW was performed mainly by, balancing costs, impact into the environment and population and space available to implement the strategy. Size reduction of the wastes was an important factor to select the treatment and disposal of the HCW because the size of both available lands is limited.

A resume with the most important facts involved in the selection of this infrastructures for the disposal of the HCW, is represented on table 6.3 and 6.4.

Table 6.3. – Factors involved in the selection of the methods for ON-site waste treatment/disposal.

On-site (clinic) treatment/disposal		
Treatment/Disposal facility	**Decisive factors**	**Weaknesses**
Chemical disinfection (1)	- Suitable for reusable material (lab) and for linens disinfection. - Low tech for staff - Relatively inexpensive - Disinfectants widely available - Suitable for disinfection of liquid waste (blood, urine, stools, or hospital sewage). - Cheaper than autoclave sterilization.	- Chlorinated solutions are hazardous – however, chemical disinfection will not have high demand in SBHC. - Might result in disinfection and not sterilization - Environmental concerns when the disinfectants are disposed
Autoclave (1)	- Disinfection of high contaminated waste - Reduce the waste because allows the complete sterilization and reuse of material. - Low adverse environmental impact; - Liquid emissions are minimal;	- Treatment of limit quantities of waste. - Priority for disinfection of medical equipment. - Require well trained staff for maintenance and operating. - Not suitable for anatomical/pharmaceutical/chemical treatment. - Do not reduce waste size and shape → higher chances for further reuse. - Sterile waste must be dispose off.
Sewage (2)	- Avoid the disposition of liquid waste to the environment and near the population. -	- Risk associated with waste is not reduced. - After fill up, needs to be emptied and require a secondary place for disposal.

(1) Lab, (2) outside clinic or lab?

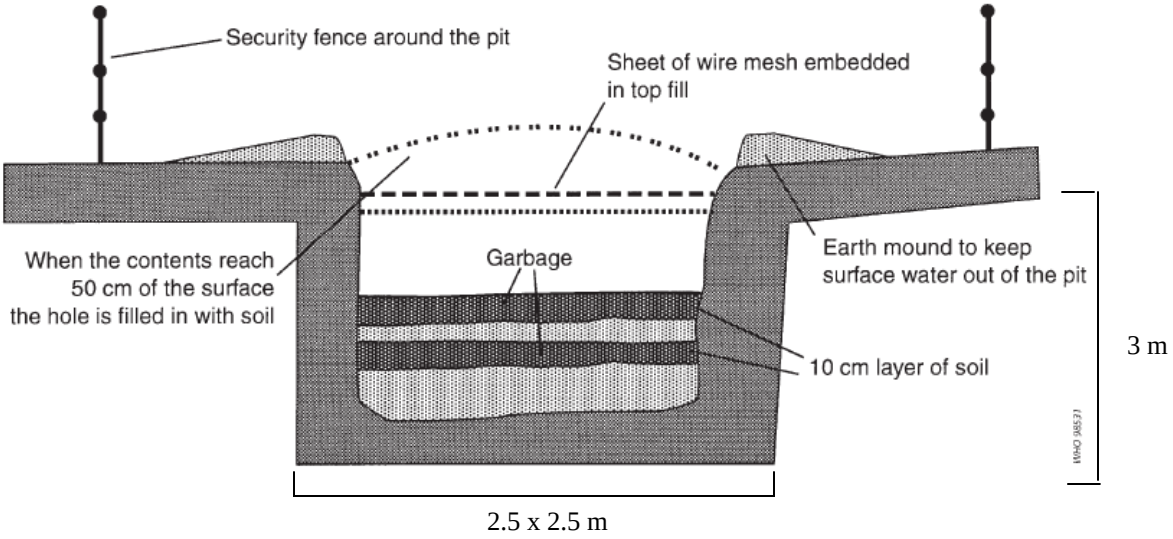
Table 6.4. - Factors involved in the selection of the methods for Off-site waste treatment/disposal.

Off-site (waste treatment station) treatment/disposal		
Treatment/Disposal facility	**Decisive factors**	**Weaknesses**
Brick incinerator	- Drastic reduction in waste volume and weight (small space available for SBHC) - High disinfection efficiency - No pre-treatment of waste necessary → Reduction of waste handling and associated risk. - Operation only 3 times a week due to the reduce amount of wastes produced. - Avoid the production of high amounts of secondary wastes trough chemical disinfection (very hazardous to environment and difficult to dispose). - Low investment and operating costs. - Suitable for anatomic waste.	- Maybe difficult for staff in the beginning - Require fuel, dry waste to start burning - Low temperature incinerator → incomplete combustion. - Heavy smoke, hazardous ash, toxic emissions (heavy metals, dioxins, furans, fly ash) - Produces secondary waste - DO not destroy many chemicals and pharmaceuticals.
Landfill	- Low cost - Low tech and simple for staff - Deposal of non-incinerable waste - Direct disposal of general waste without atmosphere pollution. - Simple - Adequate for small quantities of waste. - Land 2 appropriate – stable soil and 25 m away from water flow. - Suitable for plastic that cannot be incinerated (after chemical decontamination). - Suitable for cytotoxic and pharmaceutical waste after inertization.	- Do not reduce weight and waste volume - After close landfill 1, further space will be required. - May fill up quickly. - Potential access to non-authorized personnel and also animals → creation of vectors → preventive measures. - Lands is limited for the sustainable and log-term disposable of wastes by burying (try to reduced in source and dispose by incineration).
Sharp pit (1)	- Disposal of sharps after incineration because they are not destroyed in low temperature incinerators. - Minimize the access and reuse of sharps by scavengers. - Suitable for direct disposal of sharps in the case incinerator in non-available (e.g. broken). - Small quantities of pharmaceutical waste can be disposed.	- Do not reduce weight and waste volume - After close further space will be required. - May fill up quickly.
Inertization No infrastructures necessary	- Suitable for cytotoxic and pharmaceutical waste → landfill. - Minimize the risks of leakage of toxic substances in the landfill (final disposal). - low tech and safe - No atmospheric pollution	- Increase waste volume and weight. - Disposal of a new material (cement). - Should not be used very often because landfill may fill up quickly.

6.4.1. Off-site treatment:

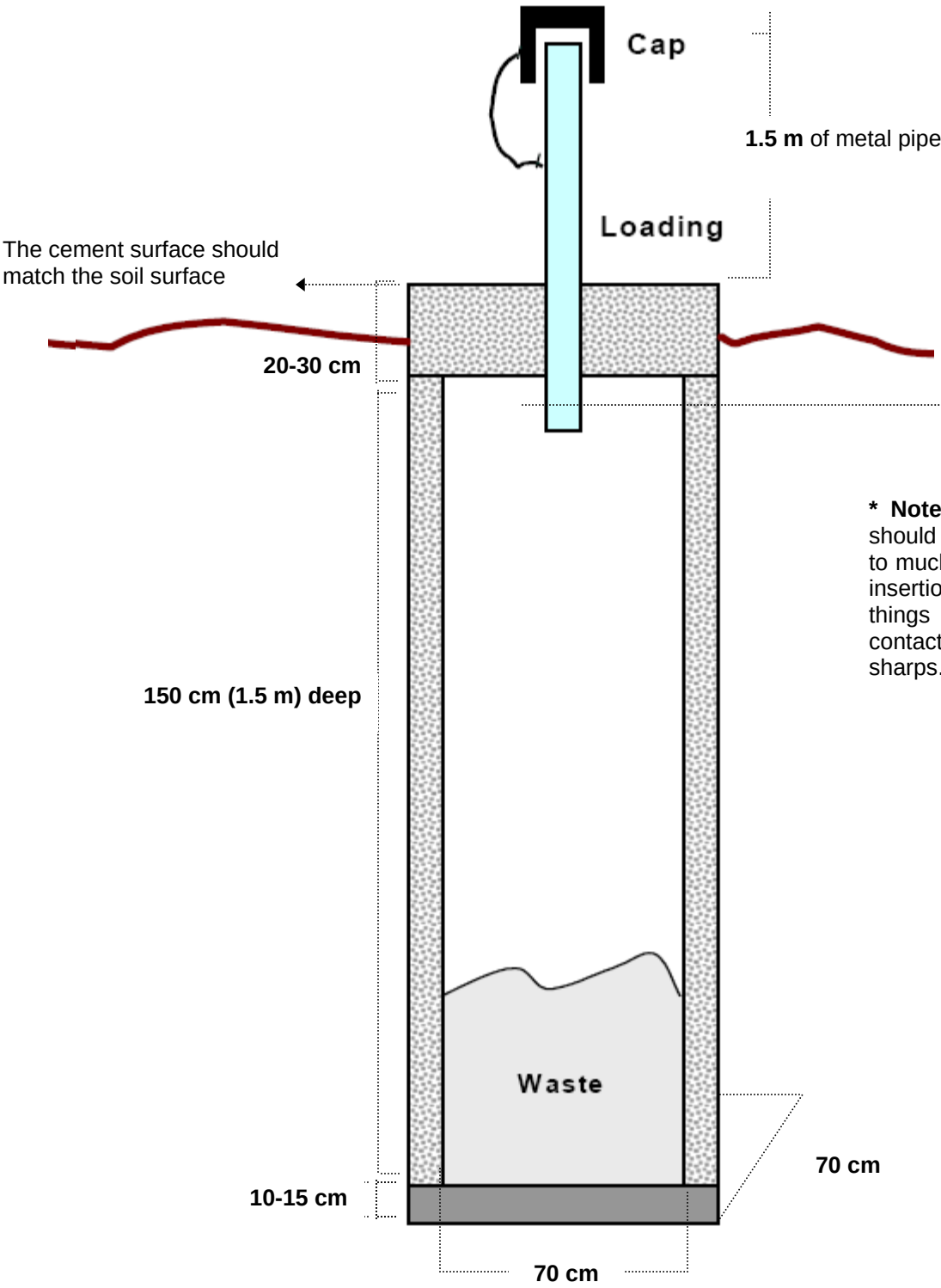
a) **Brick incinerator:** according to Montfort- Mark 8a. Detailed instructions for the construction are provided in www.mw-incinerator.info [9]. However, since the measure of the bricks available in Achham region it is different, the measurements for the construction of the brick incinerator were re-estimated (annex 8). In this annex it is also provided an explanation about the operation and maintenance of the Montfort Mark8a.

b) **Landfill** (2.5 m x 2.5 m, 3 m deep)



c) Sharp pit: it will be build in order to allow the disposal of highly infectious waste in emergency situations (incinerator damaged or over-loaded, local disagreements with population, for example because of the incinerator). The plan for the sharp pit is represented in the next page.

PLAN FOR SHARP PIT`



*** Note:** It can de adjusted but should not overtake this measure to much. The idea is to avoid the insertion of arms and other things that will allow future contact with the hazardous sharps.

In order to avoid the collapse of the burial in the future, it should be build in the presence or after get advice from the local engineer. Ensure the perpendicularity of the walls.

The waste treatment station will be properly isolated with a fence in order to avoid scavengers and animal. Animals can became vectors in the transmission of diseases, and for this reason additional measures, such as the placement of rat glue or rat traps around the landfill will be taken.

Also drainers will be built around the landfill in order to avoid water to flow into it. Soil was also left around the landfill in order to be available at any time (for the placement of soil layers after waste disposal).

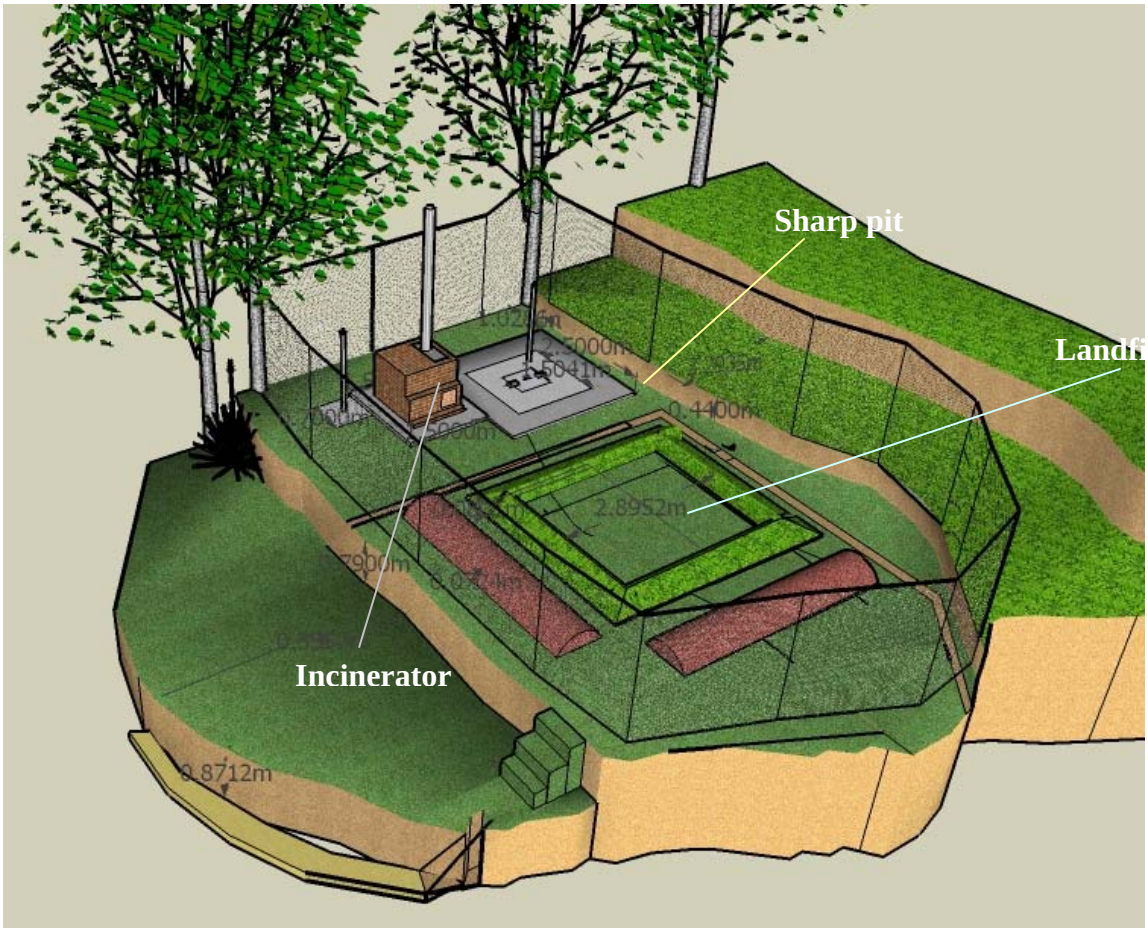


Figure 6.1. – Schematic representation of the waste treatment station plan, designed in SketchUp software.

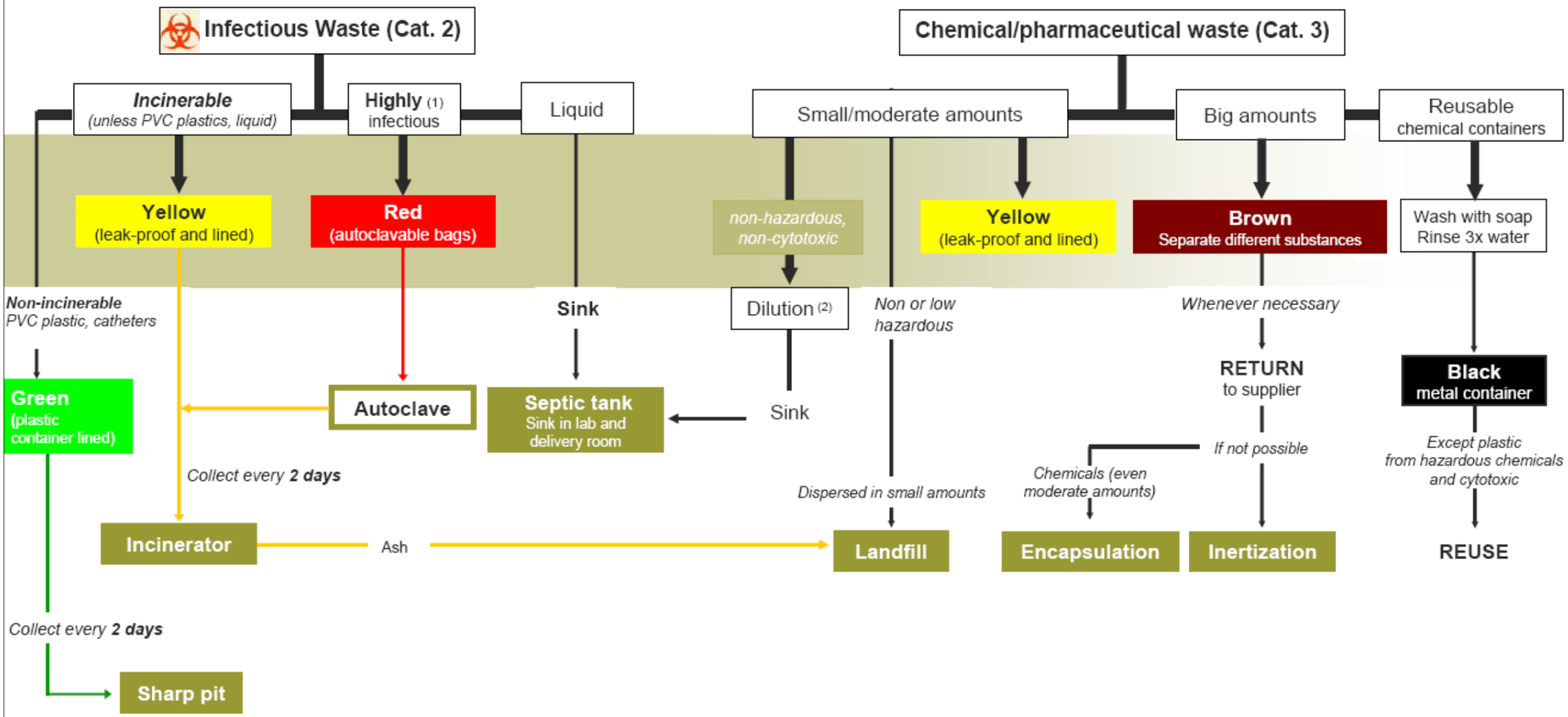
5.5. From segregation to final disposal

Table 6.5. Overview on the plan developed for waste segregation till final disposal.

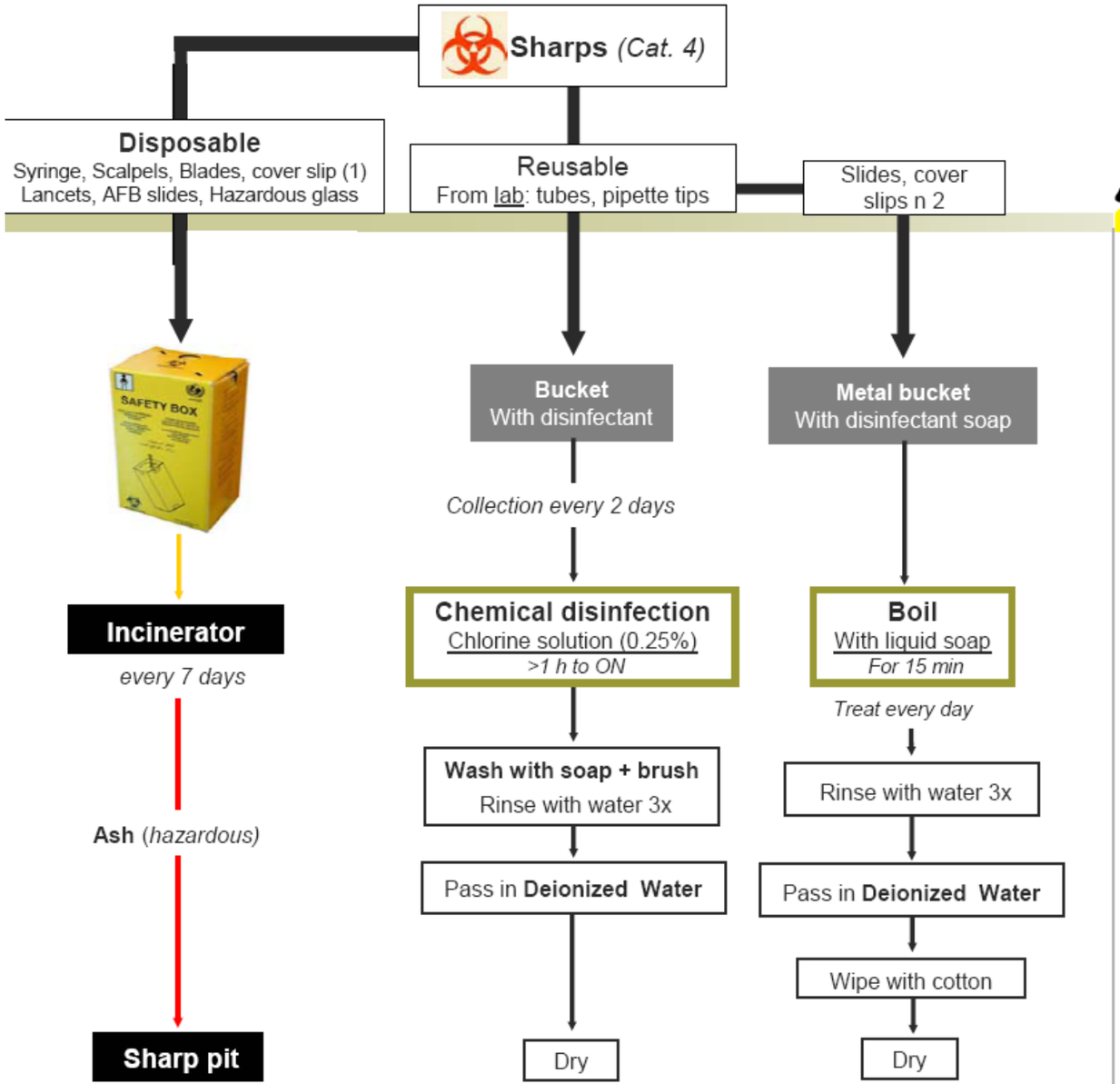
Waste category	Sub category	Segregation color	On-site treatment/disposal	Off-site treatment/disposal
Category **1**	I) Disposable		_____	**Incinerator** → Ash to sharp pit
	II) Reusable	Bucket with disinfectant	Chlorine disinfection/boiling → Reuse	
Category **2**	i) Incinerable		_____	Incinerator → Ash to landfill
	ii) Non-incinerable		_____	landfill
	iii) Highly infectious		Autoclave →	Incinerator → Ash to landfill
Category **3**	a) Moderate quantities (non-cytotoxic)		_____ Dilution	**Incinerator** → Ash to Landfill Non-hazardous → Dispose to **sewage** (with category 5)
	b) Big quantities		Segregate different substances separately → **Return to supplier**	If not possible → **Inertization**
Category **4**	A) Organic		Give to animals	Dispose for animals
	B) Non-organic		**Wash and reuse** (priority)	**Incinerator** → Ash to landfill Non-incinerable → **Landfill**
Category **5**	Effluents		Sewage	
Category **6**	Radioactive			

This procedure must also be optimized in the future according to the volume generated per day/month and in order to minimize the impact in the population and environment. Special improvements in the segregation and treatment of the liquid wastes must be done. Maybe in the future, bio-systems for the treatment of wastewater can be implemented in order to allow a safe disposal to the river.

FROM WASTE SEGREGATION TO DISPOSAL



(1) Non-contaminated with hazardous chemicals or pharmaceuticals. Reusable gloves must be segregated with linens in order to be desinfected and washed.
(2) Water soluble, relatively mild pharmaceutical mixtures (vitamins, cough syrups, intravenous solutions, eye drops may be diluted with large amounts of water and disposed in the septic tank).



ATTENTION!!!

- Discard **ALL** sharps in puncture-proof **CONTAINERS**
- **DO NOT reuse** needles and syringe
- **Use** utility hard gloves during sharps processing
- **DO NOT** recap, bend or mutilate needles/sharps manually.
- **DO NOT** overfill the sharps container (till ¾)
- **Use** goggles, plastic apron, and utility gloves during chemical disinfection
- **Before** transport sharp boxes to incinerator place the box in a puncture proof bag.
- **DO NOT** empty sharp containers.
- **Prepare** chlorine solutions daily and protected from sunlight and excessive heat.

General Waste (Cat. 4)

Liquid

Reusable

Non-reusable

Black
metal container

Blue
(lined metal container)

Plastics, glass, paper

Non-incinerable
PVC plastic

Sink
outpatient room or outside

REUSE

Incinerator

Landfill

*Only if **highly enriched with phosphates** (detergents)*

Septic tank
Toilet

Protocols

Treatment/disposal of SBHC waste

Protocols were written based on references [2, 3, 6, 10, 13, and 14]

Category 1: Sharps, sub-category: Disposable

Needles+syringe, scalpels, cover slips number 1, broken glass, lancets, AFB slides.

Treatment and Disposal

Material:

- Yellow/white combustible cardboard box. (vailable for free from DHO or from Health office (near Teku).
- Puncture-proof bag (black) for sharp boxes collection and transport to waste treatment station.
- Heavy duty gloves.
- Basket for off-site transport
- Incinerator
- Metal sheet (kind of tray to collect hazardous ash and place in sharp pit)
- Fuel (kerosene)
- Funnel
- Sharp pit
- Hand soap/water-less alcohol-based antiseptic hand rub.
- Towel (or air dry soap).
- Protective cloths, eye wear and face masks with dust filters. (to handle the ash)
- Forceps (to dispose the sharps in the sharp pit if necessary).

Procedure:

1: Do not recap needle or disassemble needle and syringe.

2: Place the assembled needles and syringe in the yellow/white puncture-resistant sharps container.

3. Register the amount of waste, type and date of collection on the paper sheet available near the segregation site.

4: Wear heavy-duty gloves, eye protection, aprons and face mask.

5: Once every 7 days (check timetable on section 6.1.) or every time the container is ¾ full, carefully collect the cardboard boxes (in the place of segregation) and place it into the puncture-proof black bag.

6: Seal the black bag with a plastic tape and place it into the transportation basket. With a rope tight the basket bag in order to fix the black bag inside of it.

7. Transport the basket to the waste treatment station.

8. Remove the basket and place it on the floor near the incinerator.

9. Fill the bottom of the incinerator with combustible materials, cardboards previously wasted and other combustible material (kerosene).
Note: Leave for approximately 30 min to achieve higher temperatures. This preheating is very important for proper combustion.

10. If a reasonable fire is produced (if not place more combustible material), place one cardboard at each time inside the incinerator.

11. After load, there will be a brief delay follow by an increase in smoke. When the smoke starts to reduce introduce the second yellow/white cardboard and repeat the operation. Make sure that the fire is still burning until all the wastes has been burnt. Repeat the operations for the 3rd, 4th cardboard boxes.

12. During combustion of last box, unlock the sharp pit and place the metal funnel into the sharp pit pipe.

13. After combustion of all the sharp wastes, carefully collect the ash and place it into the .funnel
Note: 1: Ash that results from sharp incineration still classified as hazardous. Consequently, protective equipment must be used during its handling..

Note 2: If the funnel is blocked, carefully help the sharps to go into the funnel hole with a wood stick/forceps.

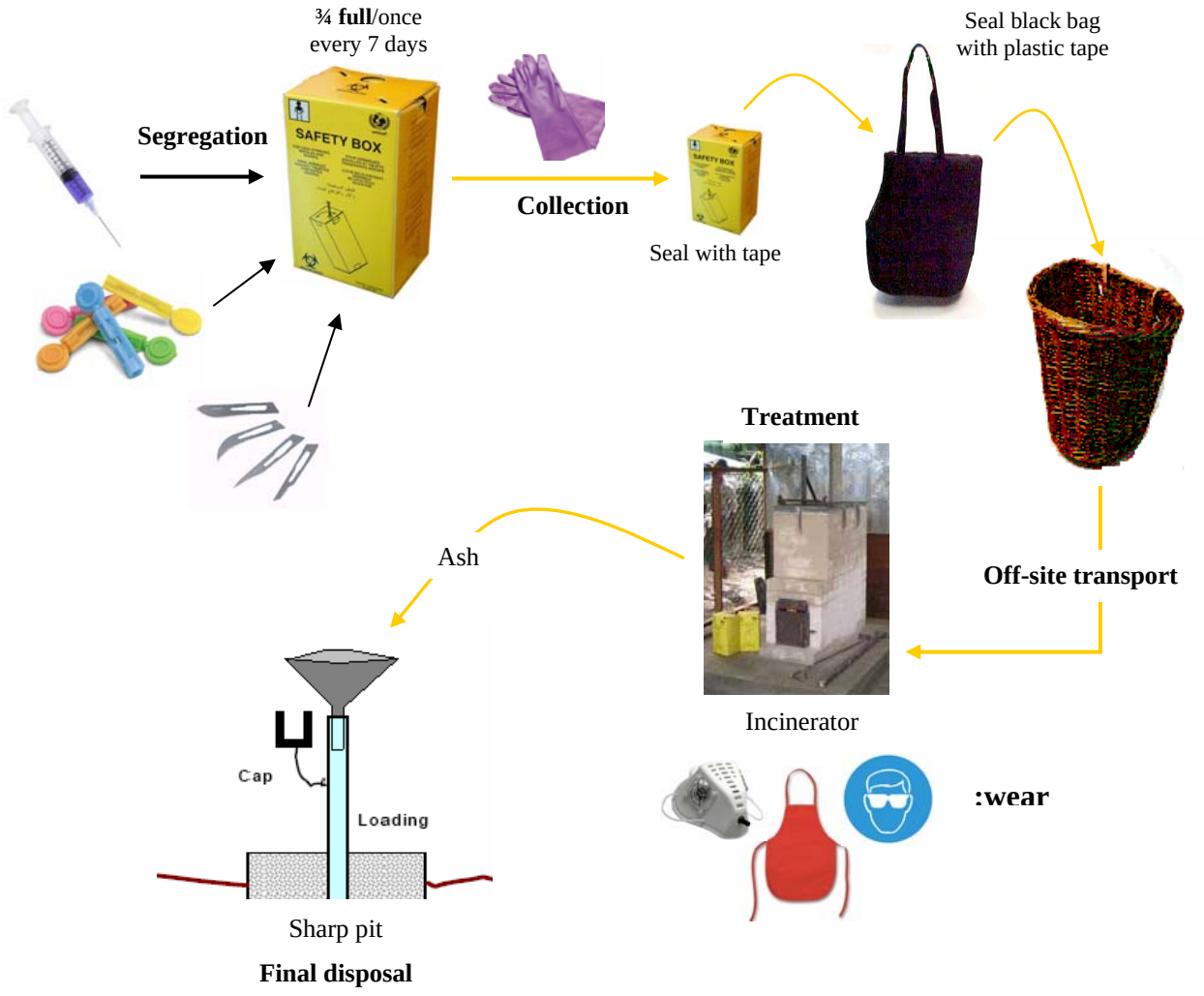
14. Make sure that the funnel is empty and that all the ash was disposed in the sharp pit. Only after this, remove the contaminated funnel from the iron pipe and place it near the incinerator.

15. LOCK the sharp pit and return to the clinic with the basket and black bag. Remove the utility gloves, face mask and eye protection.

16. Disinfect/wash protective equipment and black bag in the 0.5% chlorine (see annex 9).

17. Wash hands with antiseptic soap and dry them with a clean cloth, a towel or air dry.

Notes: All personal handling the cardboards and resultant ash should wear face masks fitted with dust filters, heavy gloves and eye protection. If available, protective clothing should also be used.



- Light the incinerator with paper and wood. After approx. half an hour, the chamber should be hot enough to start loading. This preheating is very important for proper combustion
- insert waste by small loads at regular intervals (wet loads should be separated with drier material and sharp boxes inserted one at a time
- for safety, load from the side and always wear heavy duty gloves as well as an apron and glasses

Category 1: Sharps, sub-category: Non- Disposable

Chemical treatment: tubes, pipette tips, flasks.

Thermal treatment: slides, cover slip number 2.

Chemical treatment

Tubes, pipette tips, flasks

Material:

- 2 small plastic containers with disinfectant soap (for segregation)
- 1 big plastic bucket with o.25% sodium hypochlorite solution (for collection)
- 1 big plastic bucket with water and soap
- 1 big plastic bucket with water
- Heavy duty gloves, apron, eye protection
- Metal net for pipettes
- Hypochlorite powder
- Water
- Liquid Soap
- Analytical scale
- Brush to wash tubes
- Hand soap/water-less alcohol-based antiseptic handrub
- Towel (or air dry soap)
- Heavy duty utility gloves
- Timer

Procedure:

1. SEGREGATION: Place the **contaminated flasks** and **tubes** in the small plastic bucket with water and disinfectant soap.
   Note: *pipette tips must be placed in separately plastic containers.*

2. Wear laboratory gloves.

3. Prepare 0.25% (2.5 g/L) hypochlorite solution (fresh everyday) by dissolving 2.5 g of this powder (approx, 2 sponsfuls) in 1 liter of water.
Note: Prepare the solution with deionized water, or with boiled water. Tap water contains microscopic organic matter that inactivates chlorine. If this is not possible, use 0.5% chlorine solution in tap water.

4. Wear PPE (utility gloves, protective eyewear, fecemask and plastic apron).

5. Place the chlorine solution into a big plastic bucket, with a plastic net inside, and carefully place the equipment into it (after discard the soap solution in to the sink).
Note: make sure that all the equipment is fully immersed with air bubbles expelled and do not overload the container. [livro vermelho, Hopkins manual]

6. Leave the material immersed for 1.5 hour.
Note: avoid exposition of chlorine solution to direct light.

7. After 1.5 hour, remove the net with the material inside and place it in a new plastic bucket with water and soap.
Note: keep the chlorine solution for the next disinfectant operation (if in the same day and not very soiled).

8. Carefully wash the equipment using a test tube brush
Note: To prevent splashing keep the equipments being washed under the surface of the water.

9. After wash, remove the net with the material and place in a new plastic bucket with cold water. Rinse well and carefully in deionized water 3 x.
Note: keep the soap solution for next operation if reasonable clean.

10. Remove the net from the bucket and dry the tubes facing downwards.

11. Remove the utility gloves, aprons, face mask and eye protection.

12. Disinfect/wash protective equipment and black bag in the 0.5% chlorine (see annex 9).

13. Wash hands with antiseptic soap and dry them with a clean cloth, a towel or air dry.

14. When the slides are dry store them in slide boxes (use laboratory gloves during this operation).

- Disinfect the plastic bucket by placing it in 1% hypochlorine solution for 30 min to 1 hour, and wash it with water.

Thermal treatment

Slides excluding AFB, cover slip number 2

Material:

- 2 small plastic containers (1 with a plastic sieve for cover slips) with disinfectant soap (for segregation)
- 1 big metal bucket with metal sieve (for collection)
- 1 big plastic bucket
- Heavy duty gloves, apron, eye protection
- Water
- Liquid soap
- Soft brush to wash slides
- Slides box
- Cotton
- Hand soap/water-less alcohol-based antiseptic handrub
- Towel (or air dry soap)
- Timer

1. SEGREGATION: Place the **contaminated slides** in a small plastic bucket with 0.25% of chlorine solution.

Note: *cover slips (number 2) must be segregated in a separate plastic container with a plastic sieve inside*, because the cover slips are very fragile.

2. Wear PPE (utility gloves, protective eyewear and plastic apron).

3. Place the water, liquid soap and a metal net into the big metal bucket. Place the bucket on the stove and let heat in maximum power.

4. When the water is boiling place the slides into it and swirl it frequently. (This should be done after discard the chlorine solution that is inside the small bucket, carefully into the sink). The cover slips should be placed very carefully and swirled gently.

Note: make sure that all the equipment is fully immersed with air bubbles expelled and do not overload the container. [livro vermelho, Hopkins manual]

5. Leave the material boiling for 20 minutes.

6. After 20 minutes, remove the net with the material inside and place it in a new plastic bucket with deionized water (rinse three times in water) and liquid soap.

Note: keep the both solutions for the next disinfectant operations (till get visible dirty).

7. Carefully wash the slides using a soft brush.

Note 1: the cover slips should not be washed. The detergent must be removed by putting running water on the cover slips till remove all the soap.

Note 2: To prevent splashing keep the equipments being washed under the surface of the water.

8. After wash, remove the net with the slides and place it in a new plastic bucket with deionized water. Rinse well and carefully 3 x.

9. Again remove the net and dry the slides in between cotton cloths, or wipe with cotton before store in the slide boxes. Cover-slips should be dried in between cotton cloths, which can be reused for next operation.

Note: discard any broken glass with disposable sharps infectious (yellow/white cardboard boxes)

10. Remove the utility gloves, aprons, face mask and eye protection.

11. Disinfect/wash protective equipment and black bag in the 0.5% chlorine (see annex 9).

12. Wash hands with antiseptic soap and dry with a clean cloth, a towel or air dry.

13. When the slides are dry store them in slide boxes (use laboratory gloves during this operation).

- Disinfect the plastic bucket by placing it in 1% hypochlorine solution for 30 min to 1 hour, and wash it with water.

Category 1: Infectious waste, sub-category: Incinerable

All infectious waste unless PVC plastics: human anatomical waste, laboratory cultures or sample containers (stool plastic containers), any items contaminated with body fluids: cotton, dressings, soiled plaster casts, bandages, intravenous sets, tubing's, catheters (non-PVC), disposable gloves.

Material:

- 1 strong/leak-proof yellow container per room (segregation).
- Big yellow, resistant and incinerated (non-PVC) plastic bag (segregation).
- Heavy duty gloves, apron, eye protection, face mask
- Black puncture-proof black bag (for transport)
- Basket
- Incinerator
- Fuel or combustible material
- Hand soap/water-less alcohol-based antiseptic hand rub
- Towel (or air dry soap)
- Timer

Procedure:

1. SEGREGATION: Place the infected/hazardous waste into the yellow bags/yellow container (the gloves if disposable should also be placed into it).

2. Wear PPE (heavy-duty utility gloves, protective eyewear, plastic apron, face-mask and closed protective shoes).

3. Every 2 days, or when the container is 3/4 full seal the yellow plastic bag with tape. Remove it from the plastic container and place it into the big, yellow plastic bag. Sealed the plastic bag with tape after collect the infectious waste from the different rooms.
Note: All the process must be done in the place of segregation.

4. Place the sealed yellow bag into the black puncture-proof bag and then place it carefully into the basket for off-site transport.

5. Seal the black bag with a plastic tape and place it into the transportation basket. With a rope tight the basket bag in order to fix the black bag inside of it.

6. Carefully, transport the basket to the waste treatment station.

7. Always with utility gloves, remove the basket and place it on the floor near the incinerator.

8. Remove the utility gloves, and fill the bottom of the incinerator with combustible materials, cardboards previously wasted and other combustible material (kerosene).

9. When a reasonable fire is produced, place the utility gloves, open the top door of the incinerator and dispose the yellow plastic bag into the incinerator.

10. After load, make sure that the fire is still burning until all the wastes has been burnt. If the waste was not all disposed at once, repeat the operation.

11. After combustion of all the waste, carefully collect the ash with a XXXX and place it into the landfill.

Note: 1: Ash that results from incineration still classified as hazardous. Consequently, keep the protective equipment during its handling.

12. Take the black plastic bag and the basket back to the clinic.

13. In the clinic, remove the protective equipment and disinfect/wash gloves, aprons, protective eye wear and black bag in 0.5% chlorine (see annex 9).

14. in the same solution as the linens.

15. Wash hands with antiseptic soap and dry them with a clean cloth, a towel or air dry.

Notes: All personal handling the infectious waste and resultant ash should wear face masks fitted with dust filters, heavy gloves, eye protection and aprons. If available, protective clothing should also be used.

Category 2: Infectious waste, sub-category: Non-incinerable

All infected PVC plastics, which have been in contact with body fluids or used during any treatment.

Material:

- 1 small leak-proof green container per room lined with plastic bag (segregation).
- Green leak-proof plastic bag (collection).
- Heavy duty gloves, apron, eye protection, face mask
- Black puncture-proof black bag (for transport)
- Basket
- Sharp pit
- Hand soap/water-less alcohol-based antiseptic hand rub
- Towel (or air dry soap)
- Timer

Procedure:

1. SEGREGATION: after use place the **contaminated PVC waste** in the green container plastic container lined with plastic bag.

2. Wear PPE (utility gloves, protective eyewear, plastic apron and face mask) for handling and transporting the wastes and containers.

3. Every 2 days or when ¾ full seal the green plastic bags with tape and collect them into the black puncture-proof bag.

Note: If the green plastic bag is leaking, fold it with a new plastic bag.

4. Seal the black bag and place it into the transportation basket. With a rope tight the basket bag in order to fix the black bag inside of it.

   Note: It can be transported together with the incinerable infectious waste

5. Carefully, transport the basket to the waste treatment station.

6. Always with utility gloves, remove the basket and place it on the floor near the sharp pit.

7. Unlock the sharp pit door, remove the green plastic beg from the basket and place it into the sharp pit.

8. LOCK the sharp pit and return to the clinic with the basket and black bag. Remove the utility gloves, face mask, eye protection and aprons.

9. Disinfect/wash gloves, aprons, eye protection and black bag in 0.5% chlorine solution.

10. Wash hands with antiseptic soap and dry them with a clean cloth, a towel or air dry.

Notes: All personal handling the non-incinerable infectious waste should wear face masks fitted with dust filters, heavy gloves, eye protection and aprons. If available, protective clothing should also be used.

Category 2: Infectious waste, sub-category: Highly infectious

Any infectious waste generated from contact or treatment of patients infected with HIV, Hepatitis B, Cholera or other highly infectious disease: cotton, gauze, bandages,

Note: Items made from glass, metal, and plastic such as nylon, copolymer, or polypropylene can be autoclaved. Unwrapped instruments, glassware, and wrapped packs may be autoclaved.

Note: Highly infected plastics and anatomical/pathological cannot follow the same treatment → segregate directly with infectious waste.

Material:

- Autoclavable red plastic bags and appropriate support. (segregation)
- Autoclave
- Heavy duty gloves, apron, eye protection, face mask

Rest of material described for infectious waste (category 2) from sub-category incinerable.

Procedure:

1. SEGREGATION: Place the highly infected/hazardous waste into the red autoclavable red plastic bag (the gloves if disposable should also be placed into it).

2. Wear PPE (heavy-duty utility gloves, protective eyewear, plastic apron, face-mask and closed protective shoes).
3. Immediately after segregation, disinfect the waste by autoclaving: seal the red plastic bag and place it into a tin/metal container into the autoclave (additional information about autoclave loading and handling can be accessed in the laboratory manual)

Note: The metal container inside the autoclave avoids leakage or spill.

4. Autoclave the waste from 15-20 min at 121 C (the time should be considered only after achieve the recommended temperature), 10 min at 126 C and 3 min at 134 C.

5. After disinfection by autoclaving dispose the waste with incinerable infectious waste (category 1).

Note: even after autoclaving, the waste must be handled as infectious waste.

6. Follow the same protocol used for incinerable infectious waste.

- Disinfect the plastic bucket by placing it in 1% hypochlorine solution for 30 min to 1 hour, and wash it with water.

Category 3: Chemical/Pharmaceutical waste, Sub-category: Moderate amounts (non-chemicals)

Moderate amounts of water-soluble, relatively mild pharmaceutical mixtures: vitamin solutions, cough syrups, intravenous solutions, eye drops. Small amounts of pharmaceutical, such as outdated drugs/medicines.

a) **Soluble: Disposal to septic tank**

Note: **Cytotoxic waste/drugs**, antibiotics and chemicals should never be disposed in this way (see option *b)*)

Material:

- Laboratory/delivery room sinks
- Septic tank
- Funnel
- Same material used to treat infectious waste (sub-category incinerated)

Procedure:

1. Dilute non-hazardous pharmaceuticals, drugs or chemicals in high amounts of water.

2. Dispose to the sewage, trough the sink available in the laboratory or delivery room (both connected to the septic tank).
Note: Use a funnel to dispose it into the sink. After that rinse the funnel in water to remove residues
Note 2: Materials contaminated with these substances must be reused after washed with soap and rinsed with water.

b) Non-soluble: Dispose with infectious waste (sub-category incinerable). Very SMALL amounts of chemicals can also treated in this way.

Moderate amounts of chemical waste → Return supplier. If not possible dispose by **encapsulation trough the following protocol:**

Material:

- Brown plastic/metal/glass containers correctly labeled (chemical stored and final disposal)
- Cubic boxes made of high-density polyethylene or metallic drums.
- Plastic foam, bituminous sand, cement mortar, or clay material.
- Basket (off-site transportation)
- Landfill
- Heavy duty gloves, apron, eye protection, face mask
- Hand soap/water-less alcohol-based antiseptic hand rub
- Towel (or air dry soap)

Procedure:

1. Wear heavy duty gloves, apron, eye protection, face mask

2. SEGREGATION: segregate chemicals separately into strong plastic, metal containers or glass bottles.

   Note: Label the container with drugs name, properties (hazardous:reactive,….) and final disposal.

3. Collect into the cubic box (high-density polyethylene or metallic drum) till ¾ full.

4. Filled up with plastic foam, bituminous sand, cement mortar, or clay material.

5. After dried, seal the container and place it the basket.

6. Transport it to the waste treatment station.

7. Dispose it into the landfill.
8. Return to the clinic and remove the protective equipment. Wash the protective equipment with water and soap (except the face mask)

CONTAINERS: Reuse chemical/pharmaceutical containers after wash with soap and rinse with water. Do not reuse plastics that were in contact with cytotoxic and hazardous chemicals → disposed by incineration together with incinerable infectious waste (category 2).

For any **cytotoxic waste** see inertization (option *b)* of following sub-category)

Category 3: Chemical/Pharmaceutical waste, Sub-category: Large amounts

Big amounts medicines, drugs (liquid or solid; diluted or pure; hazardous or Non-hazardous).

Procedure:

a) Every time that is possible this substances must be returned to the supplier, after correctly packed and labeled for transportation.

b) **Pharmaceutical, cytotoxic waste (even small amounts), ashes with high content of heavy metals** → disposed by inertization:

Material:

- Brown plastic/metal/glass containers correctly labeled (finally destiny).
- Cubic boxes made of high-density polyethylene or metallic drums.
- Plastic foam, bituminous sand, cement mortar, or clay material.
- Basket (off-site transportation)
- Landfill
- Funnel
- Heavy duty gloves, apron, eye protection, face mask
- Hand soap/water-less alcohol-based antiseptic hand rub
- Towel (or air dry soap)

Procedure:

1. SEGREGATION: segregate pharmaceuticals into brown and strong plastic, metal containers or glass bottles.

Note: always segregate cytotoxic waste/drugs into separate containers.

Note: Label the container with drugs name, properties (hazardous, cytotoxic…) and final disposal.

2. Wear heavy duty gloves, apron, eye protection, face mask

3. IF possible shred the waste pharmaceutical waste and prepare the following mixture:
   - 65%pharmaceutical waste
   - 15% Lime
   - 15% cement
   - 5% water

4. Using a funnel, place the mixture into the cubic box (high-density polyethylene or metallic drum).
4. After dried, seal the container and place it the basket.
5. Transport it to the waste treatment station.
6. Dispose it into the landfill.
7. Return to the clinic and remove the protective equipment.
8. Wash the protective equipment with water and soap (except the face mask)

Category 4: General waste, Sub-category: Reusable

Plastic bottles, glass bottles, cants and carton boxes (black metal container).

Metal tins: can be used to inertization and encapsulation (as metal containers). Also to store medicines/outdated pharmaceuticals before return them to the supplier. To place metal instruments/pens every time that is required.

Paper, cardboard: can be reused to repack material to return to suppliers or other equipment that need to be sent to KTM. Also use as combustible material to start the incinerator.

Bottles: If non-PVC, plastic bottles can be reused to start the incinerator. Glass bottles can be used to store medicines before return it to the supplier.

Wash the following materials:

- Rinse glass containers thoroughly with water. Glass containers may be washed with soap, rinsed and reused.

- For plastic containers that contained toxic substances (glutaraldehyde, formaldehyde, etc) rinse three times with water and dispose it with infectious waste, by burning in the incinerator. Do not reuse.

Category 4: General waste, Sub-category: Non-reusable

Includes PVC plastics, domestic waste, organic waste and all the non-reusable and non-contaminated waste.

Material:

- Blue metal container (segregation)
- Big bucket in store room lined with big blue plastic bag.
- Basket
- Incinerator
- Landfill

Protocol:

1. Segregation into blue metal container (don't need bag).

2. When the container is almost full, collect the metal container and place it into the big bucket in the store room.

3. When it's full, remove it from the container and place it into the basket.

Note: Never mix with infectious/hazardous waste.

5. Transport to the waste treatment station and dispose by incineration.

6. After all the waste had been complete burn collect the ash and dispose it into the landfill.

Notes:

All personal handling the ash should wear face masks fitted with dust filters, heavy gloves and protective clothing as a safety precaution.

Category 5: **Effluents**

Note: any liquid contaminated with chemicals, drugs should be treated according to category 3.

<u>All the other liquid waste will be disposed into two different ways:</u>

Infectious waste, waste generated from gram-staining, hand washing with disinfectants, disinfection/cleaning of contaminated material (enriched with chlorine) etc. will be disposed to the septic tank (trough lab and delivery room sinks). Also effluents with high concentration of phosphates (detergents) originated from cleaning activities should be disposed into the septic tank, in order to don't contaminate the soil used for agriculture around the clinic.

Normal effluents, such as water from hand wash, housekeeping activities (Since not very enriched with phosphates), and water used to rinse slides and tubes, can be disposed into the sink outside or in the outpatient room or also into the shower drains. This outputs discharge the effluents directly to outside and thus careful must be taken to don't discharge infectious, hazardous or other liquid waste that can interfere in the agriculture and food chain.

Category 6: Special waste

Waste with high content in Heavy Metals:

Batteries, thermometers and other items that might have mercury or cadmium.

- Do not dispose by incineration (emission of toxic vapors)
- Do not dispose in landfill (groundwater pollution).

Dispose by:

- **Encapsulation:** encapsulated waste rich in heavy metals should be disposed in impermeable landfills → sharp pit.

Pressurized/aerosol containers:

- Undamaged and recyclable gas containers can be returned to the supplier to refill (reuse)
- Halogenated agents in liquid form supplied in gas bottles will be disposed as hazardous chemicals (encapsulation)
- Do not dispose by incineration (risk of explosion)

Aerosol cans:

1. Segregate into black plastic bags.

2. Released any residual pressure before buried any aerosol containers

3. Dispose in burial.

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Annex 1 - Most common genotoxic products used in health care[a]

Classified as carcinogenic

Chemicals:
benzene

Cytotoxic and other drugs:
azathioprine, chlorambucil, chlornaphazine, ciclosporin, cyclophosphamide, melphalan, semustine, tamoxifen, thiotepa, treosulfan

Radioactive substances:
(radioactive substances are treated as a separate category in this handbook)

Classified as possibly or probably carcinogenic

Cytotoxic and other drugs:
azacitidine, bleomycin, carmustine, chloramphenicol, chlorozotocin, cisplatin, dacarbazine, daunorubicin, dihydroxymethylfuratrizine (e.g. Panfuran S—no longer in use), doxorubicin, lomustine, methylthiouracil, metronidazole, mitomycin, nafenopin, niridazole, oxazepam, phenacetin, phenobarbital, phenytoin, procarbazine hydrochloride, progesterone, sarcolysin, streptozocin, trichlormethine

[a]Classified by working groups of the International Agency for Research on Cancer (IARC).

Annex 2

Table 1.1 - Hazardous chemicals most commonly used in the maintenance of HCF.[2]

Chemical <u>Hazardous</u> waste	→ **Formaldehyde**	- Clean and disinfect equipment (e.g. surgical equipment) - Preserve specimens - Disinfect liquid infectious waste. - Pathology, nursing units…
	→ **Organic chemicals**	- Disinfectants and cleaning solutions (phenol-based chemicals and perchlorethylene) - Insecticides, rodenticides.
	→ **Inorganic Chemicals**	- Mainly acids and alkaline (e.g. sulfuric, hydrochloric, nitric, and chromic acids, sodium hydroxide and ammonia solutions). - Oxidants (e.g. potassium permanganate (KMnO4), potassium dichromate (K2CrO7)) - Reducing (e.g. sodium bisulfite (NaHSO3), sodium sulfite (Na2SO3))
	→ **Solvents**	- Halogenated compounds (e.g. methylene chloride, chloroform, refrigerants) - Non-halogenated compounds (e.g. xylene, methanol, acetone, isopropanol, toluene, ethyl acetate and acetonitrile)
	→ High content of **<u>Heavy Metals</u>**	Highly toxic wastes: - Mercury wastes: typically generated by spillage from broken of clinical equipment (e.g. thermometers). - Discarded batteries: highly hazardous due to their cadmium content. Special care must be taken with heavy metals because they get absorbed by plants and can enter the food chain. - *Nitrates* and *phosphates* present in leachates from land-fills are also pollutants.
<u>Non-Hazardous chemicals</u>	Sugars, Amino acids, Certain organic and inorganic salts.	

Annex 3

Type of infection	Examples of causative organisms	Transmission vehicles
Gastroenteric infections	Enterobacteria, e.g. *Salmonella*, *Shigella* spp.; *Vibrio cholerae*; helminths	Faeces and/or vomit
Respiratory infections	*Mycobacterium tuberculosis*; measles virus; *Streptococcus pneumoniae*	Inhaled secretions; saliva
Ocular infection	Herpesvirus	Eye secretions
Genital infections	*Neisseria gonorrhoeae*; herpesvirus	Genital secretions
Skin infections	*Streptococcus* spp.	Pus
Anthrax	*Bacillus anthracis*	Skin secretions
Meningitis	*Neisseria meningitidis*	Cerebrospinal fluid
Acquired immunodeficiency syndrome (AIDS)	Human immunodeficiency virus (HIV)	Blood, sexual secretions
Haemorrhagic fevers	Junin, Lassa, Ebola, and Marburg viruses	All bloody products and secretions
Septicaemia	*Staphylococcus* spp.	Blood
Bacteraemia	Coagulase-negative *Staphylococcus* spp.; *Staphylococcus aureus*; *Enterobacter*, *Enterococcus*, *Klebsiella*, and *Streptococcus* spp.	
Candidaemia	*Candida albicans*	Blood
Viral hepatitis A	Hepatitis A virus	Faeces
Viral hepatitis B and C	Hepatitis B and C viruses	Blood and body fluids

Annex 4

Incineration / Burning	Advantages	Drawbacks
Pyrolytic or double chamber incinerators (incineration at 800–900°C) **Rotary kiln** (incineration at 1200°C and higher)	• Elimination of health risks due to the complete destruction of the waste • The waste is non-recognizable • Fully destroys micro-organisms and sharps • Reduces significantly volume and weight of the waste • Destroys all types of organic waste (liquids, pharmaceuticals, and other solids) • Important quantities of waste can be treated (except for batch incinerators)	• High investment costs • Requires skilled staff to operate • Continuous monitoring required • High maintenance, especially for rotary kilns • Relatively high operation costs; costs rise with the level of sophistication of the emission control systems • For batch incinerators: limited capacity • Emits toxic flue gases (including dioxins and furans) • Generates residues that need safe land-filling
Single chamber "incinerators" (burning at low temperatures 300-400°C)	• Good disinfection efficiency • Reduces significantly volume and weight of the waste • No need for highly trained operators	• Significant emission of atmospheric pollutants • Need for periodic removal of slag and soot • Inefficiency in destroying thermally resistant chemicals and drugs • No destruction of sharps

Annex 5

Steam Disinfection / Autoclave	Advantages	Drawbacks
	• Relatively simple to operate (a known technology at health-care facilities) • Environmentally sound technology	• Relatively expensive to install and operate • Requires boiler with stack emissions controls • Relatively high maintenance costs • Cannot be used to treat some special wastes • Generates contaminated wastewater that needs special treatment

Annex 6

Chemical treatment	Advantages	Drawbacks
	• When applied, the shredding process reduces the volume of the waste	• Can't be used to treat some special wastes such as pharmaceuticals, and cytotoxic waste • Highly skilled operators required; Chemicals used are themselves also hazardous and require special precautions/equipment when used; Final disposal must be same as for untreated special HCW; Generates hazardous waste water that needs treatment

Annex 7

Technique	Advantages	Drawbacks
Safe land filling **Trench method** (HCW is buried in a trench excavated in other waste)	• Simple and inexpensive to operate • No specific construction costs required • Operates within readily available landfill system • Waste pickers are unable to access the health-care waste	• Special health-care waste is not treated and remains hazardous • High demand for coordination between collector and landfill operator; Reduces awareness amongst health-care workers of the need to segregate waste categories • Potentially long/costly transportation to landfill
Safe land filling **Separate disposal cells** (HCW is deposited in specifically designed cells)	• Simple and relatively inexpensive to manage if operated in connection with existing landfill for other waste	• Special health-care waste is not treated and remains hazardous • Requires a safe landfill with fencing • Requires control of scavenging and animals • Needs conscientious operation according to manual
Encapsulation (Filling containers with waste adding an immobilising material and sealing the container)	• Simple, low-cost and safe • May be used for sharps • Efficient way of reducing the risk of scavengers gaining access to the waste	• Not recommended for non-sharp waste • Must be considered as an temporary solution
Inertization (Mixing waste with cement before disposal in order to minimise the risk of leakage of toxic substances contained in the waste)	• Simple, low-cost and safe • May be used for pharmaceutical waste	• Not applicable to infectious HCW

Annex 9

Table 13-3. Guidelines for Processing Linens and Personal Protective Equipment (PPE)

ITEM	DECONTAMINATION	CLEANING	HIGH-LEVEL DISINFECTION	STERILIZATION
Protective eyewear (plastic goggles and face shields)	Wipe with 0.5% chlorine solution. Rinse with clean water. After each procedure or when is visibly soiled.	Wash with liquid soap and water. Rinse with clean water, then air or towel dry.[2] After each procedure or when visibly soiled.	Not necessary	Not necessary
Linens (caps, masks, scrubsuits or covergowns)	Not necessary. (Laundry staff should wear plastic aprons, gloves, and protective foot and eyewear when handling soiled items.)	Wash with liquid soap and water, removing all dirt particles. Rinse with clean water, air or machine dry.[2] Air-dried attire can be ironed before use.	Not necessary	Not necessary
Aprons (heavy plastic or rubber)	Wipe with 0.5% chlorine solution. Rinse with clean water. Between each procedure or each time they are taken off.	Wash with liquid soap and water. Rinse with clean water, air or towel dry at the end of the day or when visibly soiled.[2]	Not necessary	Not necessary
Footwear (rubber shoes or boots)	Wipe with 0.5% chlorine solution. Rinse with clean water. At the end of the day or when visibly soiled.	Wash with liquid soap and water. Rinse with clean water, air or towel dry at the end of the day or when visibly soiled.[2]	Not necessary	Not necessary
Surgical gowns, linen drapes and wrappers	Not necessary. (Laundry staff should wear plastic aprons, gloves and protective foot and eyewear when handling soiled items.)	Wash with liquid soap and water, removing all particles. Rinse with clean water, air or machine dry.[2]	Not practical	Preferred
Paper or disposable plastic items	Place in plastic bag or leakproof, covered waste container for disposal.			

[2] If tap water is contaminated, use water that has been boiled for 10 minutes and filtered to remove particulate matter (if necessary), or use chlorinated water—water treated with a dilute bleach solution (sodium hypochlorite) to make the final concentration 0.001% (see **Chapter 26**).

Incinerator maintenance