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# PART B

Healthcare Waste Management Toolkit for  
Global Fund Practitioners and Policy Makers

## *Waste Stream Concept Development*



**Healthcare Waste Management Toolkit  
for Global Fund Practitioners and Policy Makers**

**Part B  
Waste Stream Concept Development**

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**Other parts of the Toolkit:**



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This toolkit builds on lessons learned from a series of rapid assessments of healthcare waste management components of Global Fund grants on country level. Published are so far:



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## Abbreviations

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ACT	Artemisinin-based combination therapies	LLIN	Long-lasting insecticide-treated nets
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road (Accord européen relatif au transport international des marchandises Dangereuses par Route)	MoH	Ministry of Health
ARV	Antiretroviral (medicines)	MSDS	Material Safety Data Sheets
BAT	Best available technique	NFM	New funding model (of the GF)
BREF	Best available techniques references	NSP	National Strategic Plan
CCM	Country Coordinating Mechanisms	N.O.S.	Not Otherwise Specified
EPR	Extended producer responsibility	PE	Polyethylene
GAC	Grant Approvals Committee	POPs	Persistent organic pollutants
GF	Global Fund to Fight AIDS, Tuberculosis and Malaria	PP	Polypropylene
GHG	Greenhouse gases	PPE	Personal Protection Equipment
GHS	Globally Harmonized System of Classification and Labelling of Chemicals	PR	Principal recipient
HBV	Hepatitis B virus	PSM	Procurement and supply chain management
HCV	Hepatitis C virus	PWID	People who inject drugs
HCW	Healthcare waste	QA/QI	Quality assurance/quality improvement
HIV	Human immunodeficiency virus	RID	Regulations concerning the international transport of dangerous goods by rail
HSS	Health systems strengthening	RDT	Rapid diagnostic test
iIAT-SPHS	Informal Interagency Task Team on Sustainable Procurement in the Health Sector	SOP	Standard operating procedure
IEC	Information, education, communication	SR	Sub-recipient
IPPC	Integrated Pollution Prevention and Control	SSI	Small scale incinerators
LCA	Life-cycle assessment	STI	Sexual transmitted infections
		TB	Tuberculosis
		TRP	Technical Review Panel
		UN	United Nation
		UNDP	United Nations Development Programme
		VPP	Voluntary Pooled Procurement
		WEEE	Waste Electrical and Electronic Equipment
		WHO	World Health Organization

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# 1 Introduction

## 1.1 About this document

The document *Waste Stream Concept Development* is Part B of the Healthcare Waste Management Toolkit for GF Policy Makers and Practitioners. The other two documents are:

- ▶ *Part A: Rational for Environmental Safeguard Policies and Strategies*
- ▶ *Part C: Waste Management Planning Guide*

The objective of these documents is to enable planers and implementers of GF grants to better manage HCW generated by the grants and reduce its potential negative environmental impact. The aim is the introduction of environmental safeguard policies, strategies and their implementation throughout the

whole GF grant making process in compliance with international environmental conventions and standards as well as with today's corporate environmental responsibilities of multinational, multi-billion dollar agencies and companies in the development sector and beyond.

While Part A provides the rational for environmental safeguard policies and strategies, this document (Part B) outlines the strategic concepts for managing different waste streams expected to occur during the implementation of GF HIV, TB and malaria grants. The country specific context is taken into account. Finally, the waste management guide (Part C) provides practical know-how for grant planning and procurement as well as for operations of waste management during the grant implementation.

All three parts of the HCW Management Toolkit are designed to serve as framework and tools for all GF programmes under the New Funding Model (NFM). The HCW Management Toolkit is based on international conventions, guidelines and recommendations published by different organizations including WHO. It builds on findings and recommendations from waste management assessments of UNDP administered GF HIV, TB and malaria grants carried out in Bosnia and Herzegovina, Tajikistan, Uzbekistan and Zimbabwe in 2014/2015<sup>1</sup>.

**Figure 1: The three parts of the toolkit for environmental safeguarding of GF grants**



<sup>1</sup> Kuehling, J. Rapid Assessment: Healthcare waste component of Global Fund Projects in Bosnia and Herzegovina. UNDP 2015; Pieper, U. Rapid Assessment: Healthcare waste component of Global Fund HIV, TB and malaria projects in Tajikistan. UNDP 2014; Kuehling, J. Rapid Assessment: Healthcare waste component of Global Fund HIV/AIDS projects in Uzbekistan. UNDP 2014. Kuehling, J. Rapid Assessment: Healthcare waste component of Global Fund HIV, TB and malaria projects in Zimbabwe. UNDP 2014.



## 1.2 Waste stream concepts under the GF New Funding Model

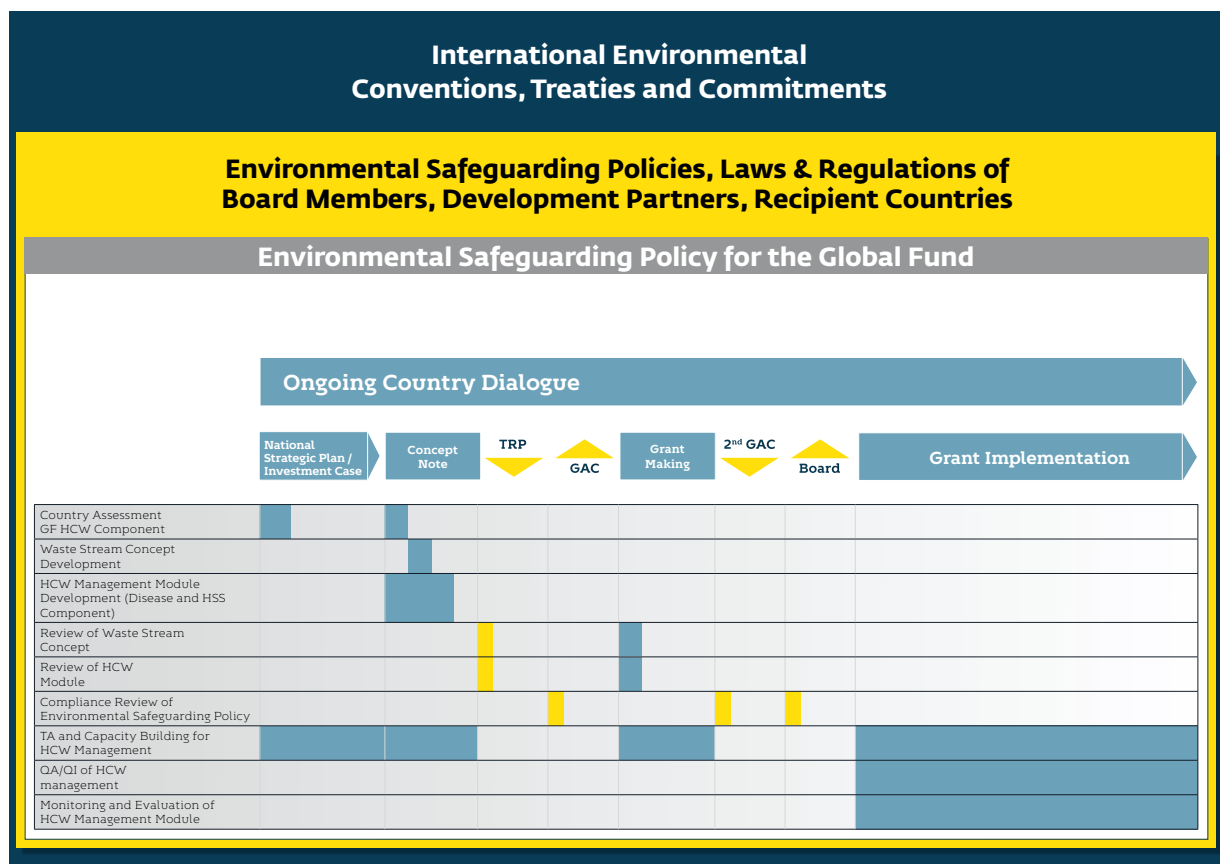
Under the NFM the country dialogue has a special relevance and environmental safeguarding should become part of this dialogue including CCM members, the government, public and private sector, and other national and international stakeholders. The waste stream concept can be used to communicate how an environmental safeguarding of the HCW produced under a GF grant should be dealt with during planning and implementation. The waste stream concept should become an integrated component of any concept note under the NFM.

## 1.3 Typical steps for developing a waste management solution

A *one size fits all* solution for waste management does unfortunately not exist as ‘waste’ can have very different characteristics. For example, the European List of Waste<sup>2</sup> identifies about 800 different kinds of waste, many of them classified as hazardous requiring special attention during production, collection, transportation, treatment and final disposal. During the operation of GF projects, several dozen types of waste are generated. This can range from non-hazardous office waste (including paper, cardboard, glass, aluminium cans and others) to more complicated waste such as WEEE (old laptops, screens, mobile phones, etc.) or hazardous

2 European Union: The European List of Waste. Accessed 03/02/2015

Figure 2: Waste stream concepts as part of the NFM



waste from maintenance activities (e.g. used car oil). It even can include construction and demolition waste from project activities. The implementation of the GF health project will create non-hazardous waste but also dozens of toxic, infectious or otherwise hazardous waste types, such as expired pharmaceuticals, contaminated packing materials, needles and syringes containing pathogens and others.

A project waste stream concept will ensure that these different types of wastes are managed in a proper way. The development of waste stream concepts is today

less driven by individual technical aspects, but by the need for integrated waste management solutions. While in the past so called *end of pipe* strategies were implemented, today a more comprehensive *cradle-to-grave* concept is used, taking into consideration the entire waste flow from production to final disposal. For future projects, circular economy aspects have to be considered which will require a *cradle-to-cradle* approach where all material inputs and outputs are seen either as technical or biological nutrients which can be reused so that projects are not just efficient but are essentially waste free.

# 2 About Waste Stream Concepts

## 2.1 What is a waste stream concept

Waste is produced in different types. The aggregated flow of the different types of waste from a defined generator can be called the total waste stream of a waste generator. This total waste stream can be divided into specific waste streams with each waste stream including different waste types having similar characteristics and similar management needs.

The total waste stream generated during the implementation of GF projects consists of several specific waste streams like the commercial waste stream, the organic waste stream, the HCW stream

and others. Health projects will generate HCW and the definitions for the HCW streams as described in the WHO handbook *Safe Management of Wastes from Health-Care Activities*<sup>3</sup> should be used:

A waste stream concept describes the recommended management of the various waste streams identified, from generation to treatment to final disposition. It takes the geographical and systems context into account. A product specific waste stream concept builds ideally on a full life-cycle assessment (LCA).

3 WHO (2014): *Safe management of wastes from health-care activities* – Second edition. Accessed 04/02/2015

**Table 1: Healthcare waste streams as defined by WHO (2014)**

Waste category	Descriptions and examples
<b>Hazardous healthcare waste</b>	
▶ Sharps waste	▶ Used or unused sharps (e.g. hypodermic, intravenous or other needles; auto-disable syringes; syringes with attached needles; infusion sets; scalpels; pipettes; knives; blades; broken glass)
▶ Infectious waste	▶ Waste suspected to contain pathogens and that poses a risk of disease transmission (e.g. waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards)
▶ Pathological waste	▶ Human tissues, organs or fluids; body parts; foetuses; unused blood products
▶ Pharmaceutical waste, cytotoxic waste	▶ Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals; cytotoxic waste containing substances with genotoxic properties
▶ Chemical waste	▶ Waste containing chemical substances (e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents; waste with high content of heavy metals, e.g. batteries; broken thermometers and blood-pressure gauges)
▶ Radioactive waste	▶ Waste containing radioactive substances (e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources)
<b>Non-hazardous or general healthcare waste</b>	Waste that does not pose any particular biological, chemical, radioactive or physical hazard

The International Organization for Standardization (ISO) defines LCA as the ‘compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle’<sup>4</sup>.

A GF grant specific waste stream concept should therefore take into account the manufacturing, transport and distribution, use and end of life of the products procured under the grant. Questions to be asked include

- ▶ **Manufacturing:** How is the product manufactured including the supply chain of rawmaterials and waste of the manufacturing process? What are the critical substances of the product and how will they influence the later treatment and disposal? Is it possible to procure items which can be reused, recycled or are less toxic and therefore easier to be disposed of?
- ▶ **Transport:** How is the product transported? Can the time and frequency of transport be influenced? What are the risks during transportation and how high are the transport emissions? How high will be the typical estimated loss during transportation and how can damaged products be disposed of? What type and which quantity of packing materials will be used? Can it be reused or recycled or has it to be disposed of?
- ▶ **Distribution:** How is the product distributed? How high are the losses during storage and distribution? Can they be influenced by better forecasting and supply management systems? What are the storage and distribution requirements?
- ▶ **Usage:** How is the product used? Does it require additional products or materials for usage which will increase the total waste stream in quantity or even alter the hazard risks?
- ▶ **Discharge:** How should the product be discharged after usage? Can it be reused or recycled? Will it become a hazardous waste which needs special treatment? Is the product compostable or biodegradable? How is the landfill or incineration behaviour of the product? How high will be the greenhouse gases (GHG) emissions from final disposal?

By answering these questions waste types from the procured products can be estimated and a risk assessment of the waste can be conducted. This document provides examples of product specific waste stream concepts for three core products categories of the Voluntary Pooled Procurement (VPP) mechanism<sup>5</sup>. The VPP is a strategic initiative established by the GF for the recipients of its grants. The detailed examples of waste stream concepts can be found in Annex of this document and include:

- ▶ Waste stream concept for antiretroviral medicines (ARVs) + artemisinin-based combination therapies (ACTs)
- ▶ Waste stream concept for rapid diagnostic test (RDT) kits for HIV and for malaria
- ▶ Waste stream concept for long lasting insecticide treated nets (LLINs)

## 2.2 How to develop a waste stream concept

A standard system for the development of a waste stream concept consists typically of seven steps:

**Figure 3: Typical steps for waste stream concept development**



4 International Organization for Standardization (2006): ISO 14040: Environmental management – Life cycle assessment. Accessed 04/02/2015

5 The Global Fund: Procurement Support Services. Accessed 04/02/2015

### Step 1: Waste identification and classification

The first step is to identify what kind of waste will be generated. After identification, certain type of waste might be managed together, e.g. all potentially infectious waste can be put together and managed as one waste stream. To identify the expected types of waste, the *input - output method* can be used:

By knowing the material *input* of a GF grant and the largely standardized processes involved during implementation, the waste *output* can be estimated. For example, the procurement of lancets for HIV testing (*input*) will result in the generation of potentially infectious sharp waste (*output*). Knowing the number of lancets to be procured or HIV tests to be done, and knowing the size and weight of the lancet, the waste can also be quantified. By assessing all planned project activities and products involved, the types and quantities of waste can be identified.

### Step 2: Risk assessment

Following step 1, a risk assessment of the waste shall be done to identify the kind of hazards associated with the different waste materials. For the risk assessment, different strategies and supporting materials exist such as Material Safety Data Sheets<sup>6</sup> (MSDS) or the list of Environmentally Classified Pharmaceuticals<sup>7</sup>. Based on the risk assessment, final decisions on waste classification can be made and the waste can be segmented in hazardous and non-hazardous waste streams. Each waste stream however will need its own management and disposal strategy.

### Step 3: Legal assessment

A rapid legal assessment should be carried out to identify which international conventions and which national laws and regulations have to be applied during the development of the waste stream concept. Also the availability of development plans (such as HCW management development plans) should be checked.

### Step 4: Waste infrastructure and capacity assessment

All countries have some level of waste management infrastructure; however, in some countries it can be

very rudimentary and sometimes only exists of private waste haulers and some simple dumpsites. The national capacity to operate and monitor waste management systems should be reviewed and capacity strengthening measures may need to be considered.

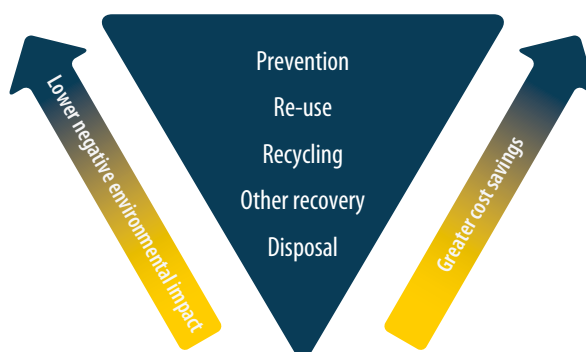
### Step 5: Assessment of downstream options

For the treatment and disposal of waste, dozens of treatment technologies and disposal options are available, ranging from traditional incineration and landfill systems to chemical-physical treatment systems and highly engineered final disposal methods. For each waste stream, the possible options have to be identified, taking country specific aspects into consideration.

### Step 6: Waste stream strategy development

Based on the findings of the previous steps, a waste stream strategy is developed taking into account each identified waste stream. The strategy should consider the results of the risk assessment, an explanation how the waste hierarchy (figure 4) will be applied and a description of the recommended waste collection, treatment, disposal and related logistic strategies. This should include a description of the main steps such as segregation, interim storage, transportation, treatment and final disposal, and the methods to be applied. The selected strategies should be technically and economical feasible under consideration of the country context, but should also include quality assurance and improvement (QA/QI) strategies in reasonable timeframes.

Figure 4: The waste management hierarchy



6 Material Safety Data Sheets: Where to find. Accessed 04/02/2015

7 Stockholm County Council (2014): Environmentally Classified Pharmaceuticals. Accessed 04/02/2015

### Step 7: Waste concept finalization and presentation

In the final step, the results of the previous steps are merged. In the final concept, country and grant specific aspects are defined, the quantity and quality of to be expected waste streams are described, an analysis of the expected risks is provided and a waste management strategy for each to be expected waste stream is recommended.

The suggested waste stream concept for a specific GF grant should be presented to the relevant stakeholders, especially to the Country Coordinating Mechanisms (CCM) and national agencies responsible for environmental and health. If the developed waste stream concept is accepted, it should be considered for inclusion in the National Strategic Plan (NSP) for HIV/AIDS, TB and malaria, respectively. The agreed waste stream concept will also inform a review process of the procurement and implementation plan of the grant and thereby trigger a continuous QA/QI cycle over the grant implementation period. Further information can be found in part C of this toolkit, the Waste Management Planning Guide.

## 2.3 Which types of waste streams to expect in Global Fund projects

This depends on the disease focus (HIV/AIDS, TB, malaria) of the GF project, on the HSS components included, on the specific project interventions and the products procured as inputs. However some types of waste will be generated in all GF grants and are for example related to office operations:

- ▶ Non-hazardous office waste such as packing materials, aluminium cans or glass
- ▶ Canteen waste including left over food
- ▶ Paper and cardboard waste
- ▶ Hazardous office waste such as printer cartridges, batteries, fluorescent lamps
- ▶ WEEE

Also all grants which include the procurement and distribution of medical and non-medical products include warehouse operations and will generate:

- ▶ Non-hazardous warehouse waste such as packing materials
- ▶ Paper and cardboard waste
- ▶ Contaminated packing materials (hazardous waste)
- ▶ Waste from spillages and accidents
- ▶ Expired products (hazardous as well as non-hazardous)

Grant specific waste types may include pesticides from the indoor spraying or old bednets (malaria grants), photo chemicals from the development of x-rays or highly infectious laboratory waste (TB grants), sharp waste from blood taking (HIV, malaria, TB grants), potentially infectious waste (HIV, malaria, TB grants), used needles from people who inject drugs (PWID), (HIV grants), infectious waste from sputum collection (TB grants).

To determine the types of waste generated by a GF grant two standard strategies exist:

- ▶ Activity based: Types and quantities of waste per units of activity-related service outputs can be estimated if they are sufficiently standardised, output targets will serve as multiplier. This will often require some observational studies.
- ▶ Procurement based: The expected type of waste are analysed based on the planned or historical PSM plan.

**Table 2: Overview – Typical waste streams to be managed**

Non-hazardous waste streams	Hazardous waste streams
Domestic (municipal) waste	Biohazardous waste
<ul style="list-style-type: none"> <li>▶ Non-recyclable packing materials</li> <li>▶ Non-hazardous pharmaceutical waste</li> <li>▶ Office waste</li> </ul>	<ul style="list-style-type: none"> <li>▶ Potentially infectious waste</li> <li>▶ Sharps waste</li> <li>▶ Highly infectious waste (laboratory)</li> </ul>
Waste for recycling	Chemical waste
<ul style="list-style-type: none"> <li>▶ Paper and cardboard waste</li> <li>▶ Glass</li> <li>▶ Plastic waste</li> <li>▶ Wood</li> </ul>	<ul style="list-style-type: none"> <li>▶ Hazardous pharmaceutical waste</li> <li>▶ Chemical waste from laboratories</li> <li>▶ Other chemical waste</li> </ul>

Especially for the development of waste stream concepts for ongoing projects, the PSM plan will be a good starting point. Table 2 summarizes the waste streams that typically will have to be managed.

## 2.4 Risks from waste management processes

It is a well-known fact today that HCW, especially hazardous HCW, creates risks for patients, staff, the public and the environment. It is however often forgotten that risks are also created during all steps of the management of the HCW streams. Hazards associated with the management of hazardous HCW can occur during all process stages: segregation, collection, storage, transport, treatment and disposal. The highest risk for infections or intoxications exists for medical staff during segregation and collection of waste and for waste management workers during the transport and the treatment of this waste. Three types of risk exposure can be identified:

- ▶ *Chronic exposure:* People come in permanent contact with small amount of hazardous materials like pathogens or chemicals. Examples are chronic exposure to pathogens at waste storage places, evaporated and inhaled chemicals or toxic gases around waste burning sites.
- ▶ *Direct, acute exposure:* Workers are exposed for a shorter period to critical levels of pathogens or toxic substances. Examples are exposures during accidents and spillages.
- ▶ *Indirect, acute exposure:* Workers are exposed to amounts of pathogens through vectors such as rodents or contaminated tools. Examples are interim waste storage places with access to vermin, rodents, cats or dogs or infections from contaminated equipment, bins or containers.

The methods chosen for waste treatment and disposal can have themselves an environmental impact. Waste treatment can contribute to global warming through GHG emissions. A recent study by UNDP on GHG emissions caused by different HCW treatment and disposal strategies for GF projects showed that the amount of emissions depends on the selected waste stream concept. In fact, all actions along the waste management hierarchy (figure 4) also influence the

amount of GHG emissions; this should always be considered as additional criteria in decision models for waste stream concepts<sup>8</sup>.

## 2.5 Awareness, responsibilities and capacity building

Critical for the introduction of sustainable waste management systems for GF projects is a high awareness about the potential environmental and health risks caused by the project implementation and an acceptance of responsibility to manage and control these risks. Saving lives by endangering health and lives of others is not a sustainable concept; healthcare without occupational and environmental health safety standards is sub-standard care.

In the best case, the CCM itself representing government and all national stakeholders should initiate and coordinate the development of waste stream concepts for GF grants, ensure continuous funding through the integration of waste management modules into the NFM concept notes and final proposals and provide oversight during the grant implementation phase. Country specific gaps in infrastructure, operational capacities as well as legal and operational frameworks should be addressed in NSPs and included in HSS components of the GF grants. A rapid country assessment using standard methodologies as recently applied for GF projects in Bosnia and Herzegovina, Uzbekistan, Tajikistan and Zimbabwe will be helpful<sup>9</sup>.

With the introduction of ceiled funding allocations to recipient countries under the NFM, the GF and its partners including PRs and SRs are challenged to pay more attention to defined quality standards and improved QA/QI systems for GF grant implementation. The current GF results-based performance framework is characterized by the dominance of quantitative output targets in the absence of strong QA/QI standards. Together with the pressure to scale-up essential health services under conditions of ceiled

<sup>8</sup> Acharya, D. Steele, K., Hamelmann, C., Dante, T. Climate change impact of waste management – A study based on Tajikistan's pharmaceutical waste management. UNDP 2014. Accessed 04/02/2015

<sup>9</sup> See footnote 1

funding allocations and overall funding gaps this provides systematic structural incentives to reduce programme unit costs by compromising on quality standards. Environmental safeguarding in compliance with international and national commitments, laws and regulations should be part of a minimum standard for service quality under GF projects. A high awareness

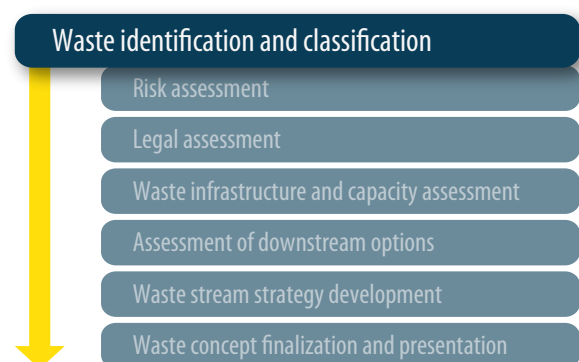
and capacity building is therefore needed within the GF and among the PRs and SRs in order to provide policy, strategy and operational frameworks for GF projects. These frameworks should adequately address the responsibilities for waste stream concept development and management of HCW created by GF projects as a mandatory component of all GF grants.



# 3 Development of Waste Stream Concepts

## 3.1 Waste identification and classification

The identification of the created waste and the classification into waste streams is always the starting point for the development of waste stream concepts.



Aside from the general waste created during office and warehouse operations, the main types of waste will be GF grant specific and mainly classified as HCW.


### Sharp waste (sharps)

Sharps are all objects and materials which pose a potential risk of physical injury (stick, cuts). Typical examples are lancets used for taking blood samples, needles, blades, broken glass and vials, infusion sets with butterflies.

### Infectious waste

Infectious waste consists of discarded materials that are contaminated with pathogens which can cause diseases in humans when transmitted. Examples are used rapid tests for malaria or and HIV, tissues (like used swabs), waste contaminated with potentially infectious excreta, body fluids and blood, infectious waste from TB

**Table 3: Overview – sharp waste**

<b>Specification</b>	All sharp items, whether contaminated with infectious material or not.
<b>Packaging</b>	Water tight, puncture proofed, sealable and strong cardboard or plastic containers. A sharps container should, once assembled, have a lid which cannot be removed, have a handle (not part of the closure device) and a lid so designed as to enable items to be dropped in by one hand. Should be resistant to penetration and leakage.
<b>Symbol / marking</b>	International biohazard symbol in black / yellow and wording: 'Danger! Contaminated Sharps'. 
<b>Recommended labelling</b>	<ul style="list-style-type: none"> <li>▶ The container should bear a horizontal line together with the words 'Warning – Do Not Fill Above The Line'.</li> <li>▶ Name of the generator (department, ward)</li> <li>▶ Waste class, date of generation</li> <li>▶ Waste volume and waste destination</li> </ul>

laboratories (as long as this waste is not considered as highly infectious waste)

### Highly infectious waste (sub-group of infectious waste)

Highly infectious waste includes all viable biological and pathological agents artificially cultivated in cultures or stocks such as cultures from TB laboratories. It also includes items used for the transfer, inoculation and mixing of cultures of infectious agents, and waste contaminated with highly infectious and pathogenic agents<sup>10</sup>. Place of origin of highly infectious waste is normally the laboratory but may also arrive from

<sup>10</sup> WHO (2004): Laboratory biosafety manual – Third edition. Accessed 04/02/2015

**Table 4: Overview – infectious waste**

Specification	HCW contaminated with pathogens which are known or clinically assessed to have the potential to cause diseases in humans or animals when transmitted.
Packaging	Strong PP or PE plastic bags of good quality and sufficient capacity. Should be placed in a container, such as a pedal bin, or suspended from a bag holder with a lid.
Symbol / marking	International biohazard symbol in black / yellow and wording: 'Danger! Biohazardous Healthcare waste.'
Recommended labelling	<ul style="list-style-type: none"> <li>▶ Name of the generator (department, ward)</li> <li>▶ Waste class, date of generation</li> <li>▶ Special remarks</li> <li>▶ Waste volume and waste destination</li> </ul>



**Table 5: Overview – highly infectious waste**

Specification	HCW contaminated with high concentrations and/or highly infectious pathogens which are known or clinically assessed to have the potential to cause diseases in humans or animals when transmitted.
Packaging	Heat resistant (e.g. made from PP), strong, leak proof bags. If bags shall be autoclaved, they should not be hermetically closed.
Symbol / marking	International biohazard symbol in black / yellow and wording: "Danger! Biohazardous Healthcare waste"
Recommended labelling	<ul style="list-style-type: none"> <li>▶ Name of the generator (department, ward)</li> <li>▶ Waste class, date of generation</li> <li>▶ Recommended is a chemical indicator which indicates if the waste was successfully sterilized</li> <li>▶ Waste volume and waste destination</li> </ul>



other places like quarantine wards. Highly infectious waste must be treated close to the place of generation (laboratory bio-safety level 1 and 2) or in the laboratory (biosafety level 3 and 4).

**Table 6: Overview – hazardous pharmaceutical waste**

Specification	Hazardous pharmaceutical waste examples: Expired, unusable or unwanted ARVs, ACTs, TB medicines
Packaging	To be packed in specific cardboard boxes, containers or other safe packaging, depending on the specific characteristics and hazards.
Symbol / marking	Depend on the type of the waste, such as: toxic, noxious, corrosive, oxides, flammable, mixed hazards, environmental polluting materials
Recommended Labelling	<ul style="list-style-type: none"> <li>▶ Name of the generator (department, ward)</li> <li>▶ Waste class, date of generation</li> <li>▶ Special remarks</li> <li>▶ Waste volume and waste destination</li> </ul>



The wording: 'Danger! Hazardous Pharmaceutical Waste'


**Hazardous pharmaceutical waste**

Pharmaceutical waste includes expired, unused, unwanted, spilled and contaminated pharmaceutical products, medicines and vaccines. It also includes all sera and bottles, boxes and vials used to contain pharmaceuticals, which are no longer required. It does not include packaging materials for pharmaceuticals which should be disposed of as non-healthcare waste and does not include non-risk pharmaceuticals like vitamins, sugars, amino acid and certain salts.

**Hazardous chemical waste**

All discarded solid, liquid and gaseous chemicals, for example from diagnostic and experimental work, and cleaning, housekeeping and disinfecting procedures.


**Table 7: Overview – chemical waste**

Specification	Chemical waste examples: Insecticides, x-ray fixing and developing solutions, solvents, formaldehyde, chemical mixtures.
Packaging	Sealable, robust containers, appropriately for their content and for normal conditions of handling and transportation. Different types of hazardous waste should not be mixed to eliminate undesirable reactions.
Symbol / marking	Depend on the type of the waste, such as: oxides, corrosive, mixed hazards, environmental polluting materials
	
Recommended labelling	<ul style="list-style-type: none"> <li>▶ Name of the producer, if applicable: department</li> <li>▶ Waste class, date of production</li> <li>▶ Special remarks</li> <li>▶ Waste volume-waste destination</li> </ul>


There is a wide variety of dangers and different procedures within this group; it also includes for examples chemical waste from indoor spraying or contaminated primary packing materials of LLINs.

Special care must be taken during segregation and collection as these materials can be highly toxic, irritant, corrosive, ignitable, harmful, explosive or carcinogenic. Used packaging must be designed for the specific chemical waste. If no special packaging is available, the waste should be collected in the original packaging. Different kind of chemicals should only be collected together if it is ensured that they will not react with each other. If possible, chemical waste should be given back to the supplier for final disposal. Chemical waste should only be handled with Personal Protection Equipment (PPE).

**Table 8: Overview – heavy metal containing waste**

Specification	Waste with heavy metal content such as broken thermometers containing mercury, old batteries containing cadmium
Packaging	Sealable, robust containers, appropriately for their content and for normal conditions of handling and transportation. Different kind of hazardous waste should not be packed together to eliminate undesirable reactions.
Symbol / Marking	Skull and crossbones. Wording: 'Heavy Metal Waste Containing XXX.'
	
Recommended labelling	<ul style="list-style-type: none"> <li>▶ Name of the generator (department, ward)</li> <li>▶ Waste class, date of generation</li> <li>▶ Special remarks</li> <li>▶ Waste volume and waste destination</li> </ul>

**Table 9: Overview – pressurized container**

Specification	Container under pressure, examples are oxygen bottles, medical gases
Packaging	Original container, no re-packing
Symbol / marking	'Pressurized Container – handle With Care'
	
Recommended labelling	<p>Based on the content of the container – e.g. hazardous symbols for ethylene oxide</p> <ul style="list-style-type: none"> <li>▶ Name of the generator (department, ward)</li> <li>▶ Waste class, date of generation</li> <li>▶ Special remarks</li> <li>▶ Waste volume and waste destination</li> </ul>

#### Waste with high heavy metal content (sub-group of chemical waste)

Waste with high heavy-metal content is potentially highly toxic and represents a subcategory of hazardous chemical waste that needs special consideration during treatment. For example, cadmium is used in batteries and mercury in thermometers or manometers.

**Table 10: Overview – non-healthcare waste**

Specification	HCW with similar composition to household and municipal waste
Packaging	Black PP or PE plastic bags of good quality and sufficient capacity.
Symbol / Marking	Household like waste: 'Domestic Waste'. Recyclables: The international recycling sign should be placed on the bins/bags. Wording: 'Non-Contaminated XXX (kind of waste), To be Recycled'.
Recommended labelling	During normal operation not necessary, only during times of research (e.g. waste audits: Name of the producer, department, date)



**Table 11: Overview – radioactive waste**

Specification	Waste with radio-nuclides whose ionizing radiation has genotoxic effects such as Cr-51, Ga – 67, I-125, I-131, In-111, P-32, Rb-86, RD – 222, S-35, Tc-99m
Packaging:	Sealable, robust containers, appropriately for their content and for normal conditions of handling and transportation.
Symbol / marking	International radiation symbol and wording: 'Caution! Radioactive Waste'.
Required labelling	<ul style="list-style-type: none"> <li>▶ Name of the generator (department, ward)</li> <li>▶ Kind or radionuclide</li> <li>▶ Radiation on given date (start storage time)</li> <li>▶ Period of storage time required</li> <li>▶ Further safety remarks (e.g.: Danger! Contains Biohazardous materials)</li> <li>▶ Waste volume and waste destination</li> </ul>



Mercury is present also in small quantities in mercury vapour lamps. Lead is still used in radiation proofing of x-ray and diagnostic departments.

**Pressurized container (sub-group of chemical waste)**

Gases like compressed air, liquids or powdered materials are often stored in pressurized cylinders, cartridges, and aerosol cans. Filled pressurized containers must be stored in an upright position.

Most of these containers are reusable and should go back to the supplier. Whether containing inert or potential harmful materials, containers may explode if incinerated or accidentally punctured and should be collected separate and handled with care.

**Non-hazardous or general waste**

Non-medical or domestic waste is comparable to waste generated by households. This waste class is graded as non-hazardous. Examples of this kind of waste are:

- ▶ Kitchen waste, packing materials, waste from the administration, left-over food and fruit pellets,
- ▶ Other non-risk waste: Normal garden waste or construction waste

Recyclables like glass, paper, cardboard, aluminium, scrap metal or different kind of plastics are considered as a subgroup of the non-medical HCW.

**Radioactive waste**

It is unlikely that radioactive waste will be generated in GF projects. If it is generated, the responsible authorities will have to be consulted on how this waste stream has to be managed.

**Pathological Waste**

Pathological waste includes human tissue, organs or fluids, body parts, foetuses, placentas or unused blood. Like for radioactive waste, it is unlikely that in GF projects this waste will be generated. If it is generated, the responsible authorities should be consulted on how to manage this waste stream considering environmental, ethical and religious aspects.

## 3.2 Risk assessment for waste stream concepts

Ultimately, the objective of waste risk management is to minimize the risk in the short- and long-term taking into account benefits and threats for individuals and the public as well as technical feasibility and economic aspects including externalities<sup>11</sup>.

<sup>11</sup> Externality: the cost or benefit that affects a party who did not choose to incur that cost or benefit



Risk is understood here as the likelihood that the waste generated is causing an undesirable outcome of variable severity. It can be assessed by determining the likelihood of the hazard(s) occurring multiplied with the severity of undesirable consequence(s).

A risk can thus be reduced either through lowering the likelihood of the waste hazard, or through mitigating the anticipated adverse consequences. In the beginning of 2015, UNDP's Social and Environmental Standards (SES) was published<sup>12</sup>. Environmental and social screening and assessment processes are required and in 2014, UNDP issued a guidance note for the environmental and social screening procedure<sup>13</sup>. The guidance note also includes a methodology for identifying the level of significance of the potential environmental risks. Other useful reference about how to conduct risk assessments can be found under the footnote<sup>14</sup>.

### 3.2.1 Recommended tools for hazard identification

The superior principle for hazard identification is the *precautionary principle*<sup>15</sup>. This means that in case

12 UNDP (2015): Social and Environmental Standards. Accessed 03/02/2015

13 UNDP (2014): Social and Environmental Screening Procedure. Accessed 03/02/2015

14 UBC: Risk assessment. Accessed 04/02/2015; EPA: Waste and Cleanup Risk Assessment. Accessed 04/02/2015; European Commission: Guidance on risk assessment at work. Accessed 04/02/2015

15 UNEP: Rio Declaration on Environment and Development. Within the Rio Declaration it was noted that: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". Accessed 04/02/2015

of justified doubt about safety, taking preventive precautions should be the rule. There are three main tools for hazard identification which are recommended for GF projects.

#### Material safety data sheet (MSDS) / safety data sheet (SDS)

An MSDS<sup>16</sup>, also called SDS, provides workers and emergency personnel with the proper procedures for handling or working with a particular substance in a safe manner, and includes information relevant for hazard identification such as toxicity and health effects. It also includes recommendations on storage and disposal as well as the protective equipment which should be used during handling this products. MSDS / SDS formats can vary from source to source depending on national requirements. In the European Union, SDS have been made an integral part of the system of Regulation (EC) No 1907/2006 (REACH).

#### Environmentally Classified Pharmaceuticals

For pharmaceuticals used in GF projects an assessment of potential environmental hazards can be conducted by using the Persistence, Bioaccumulation and Toxicity (PBT) Index in accordance with the Environmentally Classified Pharmaceuticals 2014-2015 of the Stockholm County Council<sup>17</sup>. It shows for example that a number of the antiretroviral medicines used in GF HIV projects are very persistent (e.g. lamivudine, abacavir) and some are classified as very toxic (e.g. efavirenz). The higher the PBT index, the higher is the potential environmental impact and a disposal as hazardous HCW will be needed, or a replacement by an alternative medicine recommended by treatment guidelines.

#### The Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

In the GHS<sup>18</sup>, the term *hazard classification* is used to indicate that only the intrinsic hazardous properties of substances and mixtures are considered. It involves the following three steps:

16 MSDS sheets. Website. Accessed 16/03/2015

17 Stockholm County Council (2014): Environmentally classified pharmaceuticals. Accessed 16/03/2015

18 UNECE (2003): GHS 1st edition. Accessed 16/03/2015

- ▶ Identification of relevant data regarding the hazards of a substance or mixture.
- ▶ Subsequent review of these data to ascertain the hazards associated with the substance or mixture.
- ▶ A decision on whether the substance or mixture will be classified as a hazardous substance or mixture and the degree of hazard, where appropriate, by comparison of the data with agreed hazard classification criteria.

The GHS itself does not include requirements for testing substances or mixtures. Therefore, there is no requirement under the GHS to generate test data for any hazard class. Some parts of regulatory systems may require data to be generated.

In the annex of this document, sample hazards are identified for different products used in GF projects.

### 3.2.2 Hierarchy of hazard control

The risk assessment should include the review of hazard control options. A hierarchy of hazard controls has been proposed in order of effectiveness (figure 5).

- ▶ *Elimination* of the hazard is the most effective means of hazard control. It includes all measures to fully prevent the hazard to occur. Elimination is often the most cost intensive option. Sometimes this option is not available as the required technology to eliminate a risk does not exist.
- ▶ *Substitution* is as effective as elimination. Substitution occurs when another, non-hazardous chemical or substance is used instead of the planned

hazardous one or if the same hazardous substance is used but in a different form for example if tablets or pellets are used instead of dusty powder.

- ▶ *Isolation* restricts exposure to hazardous waste for example through encapsulation, entombing or locking hazardous substances away under strict controls.
- ▶ *Engineering controls* do not eliminate hazards from HCW, but rather reduce likelihood and severity of the hazard.
- ▶ *Administrative controls* are changes to the way people work and behave. Examples of administrative controls include the registration of contaminated sites, staff training, installation of signs and warning labels. Administrative controls mainly reduce the likelihood of the hazard.
- ▶ *Personal Protective Equipment (PPE)* is a control option particularly for those handling HCW. It can have lower effectiveness due to technical deficiencies, damage or human errors, but should be a mandatory occupational health standard.

## 3.3 Legal framework assessment



Figure 5: The hierarchy of hazard control<sup>19</sup>



### 3.3.1 International conventions

A convention (or treaty) is an agreement under international law signed by governments and / or international organizations. Global health initiatives such as the GF programme should be compliant with international environmental conventions and demonstrate through progressive corporate environmental safeguarding policies, strategies and operations best practices and leadership in HCW management. In addition, many GF recipient countries are signatories of international environmental conventions. Table 12 shows sources to identify the

<sup>19</sup> Adapted from CDC: Hierarchy of controls. Accessed 04/02/2015

**Table 12: Relevant international conventions and status of ratification**

<b>Name of Convention</b>	<b>Source for identifying status of ratification</b>
<b>Basel Convention</b> on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	<a href="http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/1290/Default.aspx">http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/1290/Default.aspx</a>
<b>Rotterdam Convention</b> on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	<a href="http://www.pic.int/Countries/Statusofratifications/tabid/1072/language/en-US/Default.aspx">http://www.pic.int/Countries/Statusofratifications/tabid/1072/language/en-US/Default.aspx</a>
<b>Vienna Convention</b> for the Protection of the Ozone Layer and <b>Montreal Protocol</b> on Substances that Deplete the Ozone Layer	<a href="http://ozone.unep.org/new_site/en/treaty_ratification_status.php?treaty_id=&amp;country_id=169&amp;srchcrit=1&amp;input=Display">http://ozone.unep.org/new_site/en/treaty_ratification_status.php?treaty_id=&amp;country_id=169&amp;srchcrit=1&amp;input=Display</a>
<b>Stockholm Convention</b> on Persistent Organic Pollutants (POPs)	<a href="http://chm.pops.int/Countries/StatusofRatifications/tabid/252/Default.aspx">http://chm.pops.int/Countries/StatusofRatifications/tabid/252/Default.aspx</a>
<b>European Agreement</b> concerning the International Carriage of Dangerous Goods by Road (ADR)	<a href="http://www.unece.org/trans/danger/publi/adr/legalinst_53_tdg_adr.html">http://www.unece.org/trans/danger/publi/adr/legalinst_53_tdg_adr.html</a>
<b>Minamata Convention</b> on Mercury	<a href="http://www.mercuryconvention.org/Countries/tabid/3428/Default.aspx">http://www.mercuryconvention.org/Countries/tabid/3428/Default.aspx</a>

ratification status of international conventions relevant for the environmental safeguarding of GF projects.

Typical examples for obligatory compliance with convention for waste stream concepts under GF grants are:

- ▶ requirements under the Stockholm Convention on emitting unintentional generated persistent organic pollutants such as dioxin in the context of procurement and HCW incineration
- ▶ requirements under the Rotterdam Convention in the context of DDT procurement
- ▶ requirements under the Minamata Convention in the context of procurement and HCW management of mercury containing products
- ▶ requirements under the ADR in the context of transportation of hazardous waste
- ▶ requirements under the Basel Convention in the context of trans-boundary movements of hazardous waste

Some conventions provide detailed recommendation on how to manage certain types of waste<sup>20</sup>.

<sup>20</sup> Basel Convention (2003): Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes. Accessed 04/02/2015

### 3.3.2 National legal framework

The management of waste, particularly hazardous waste is directly or indirectly regulated in national laws and regulatory frameworks and usually involves various sectors such as environment, health, transport and others. In addition to country level consultations with governments, FAOLEX can be consulted. It is one of the world's largest electronic collections of national laws and regulations on food, agriculture, renewable natural resources and is also a good source for laws on waste and environmental management<sup>21</sup>.

During the last decade several countries have developed national HCW management plans. Waste stream concepts for GF projects should be linked to national HCW management strategies and health systems strengthening components of the grants should strengthen national plans and their implementation as necessary.

### 3.3.3 Legal aspects for waste logistics

The transport of hazardous waste by road, water or air has to be handled similarly to the transportation of other hazardous goods and countries have introduced different laws and regulations to ensure safety. Regulations for transport of hazardous goods are often based on the

<sup>21</sup> FAO: Legal Office FAOLEX. Accessed 04/02/2015

UN Model Regulations<sup>22</sup> which addresses in particular transnational transport of hazardous materials. The documents cover all types of hazardous goods, including potentially infectious, toxic, inflammable, explosive, reactive or corrosive waste stream products.

### 3.4 Existing waste management infrastructure



The next step of the development of a waste stream concept is the assessment of the existing waste management infrastructure. It should cover at least the following components:

#### Non-hazardous waste

- ▶ Collection and transport
  - ▷ Types of waste collected for recycling (e.g. scrap metal, plastics)
  - ▷ Types of waste collected for disposal (e.g. domestic waste)
  - ▷ Waste collection method (e.g. kerbside collection, transfer station)
  - ▷ Equipment available for collection (trucks, containers)
  - ▷ Informal waste sector involved in waste collection (e.g. waste pickers)
- ▶ Recycling, treatment and disposal
  - ▷ Industrial sector buying waste products for utilization (e.g. transport pallets, glass, cardboard)

- ▷ Recycling industry buying waste for reprocessing or export
- ▷ Availability and quality of the local dumpsites or landfills

#### Hazardous waste:

- ▶ Collection and transport
  - ▷ Types of hazardous waste collected for recycling (e.g. oil)
  - ▷ Types of hazardous waste collected for treatment (e.g. infectious waste)
  - ▷ Waste collection method (e.g. reusable containers)
  - ▷ Equipment available for collection (trucks, containers)
- ▶ Recycling, treatment and disposal
  - ▷ Existing hazardous waste treatment facilities (public or private owned) including incinerators, waste decontamination systems and others
  - ▷ Existing hazardous waste landfills
  - ▷ Industrial sector buying hazardous waste products for utilization (e.g. waste oil or solvents used as refuse-derived fuel)
  - ▷ Recycling industry buying waste for reprocessing or export (e.g. fixing bath from x-ray for silver recovery)
  - ▷ Industrial sector accepting hazardous waste for co-incineration (e.g. destruction of pharmaceuticals in cement kilns)

In the annex of this document, sample questionnaires for the identification of the existing infrastructure are provided.

### 3.5 Assessment of downstream options



22 UNECE: Recommendations on the Transport of Dangerous Goods – Model Regulations. Accessed 04/02/2015



**Table 13: Waste treatment and disposal methods****Hazardous waste treatment methods**

Incineration (high temperature):	Non-burning treatment technologies:
<ul style="list-style-type: none"> <li>▶ Small-Scale-Incinerator</li> <li>▶ Two-chamber incinerator</li> <li>▶ Rotary kiln incinerator</li> <li>▶ Co-Incineration (cement kiln)</li> </ul>	<ul style="list-style-type: none"> <li>▶ Thermal/steam disinfection (autoclave, microwave, hot air)</li> <li>▶ Chemical based disinfection</li> <li>▶ Physical treatment (electrolysis)</li> </ul>

**Waste Disposal Methods**

Non-Hazardous waste:	Hazardous waste:
<ul style="list-style-type: none"> <li>▶ (Sanitary) landfill</li> <li>▶ Waste pits (placenta pit)</li> </ul>	<ul style="list-style-type: none"> <li>▶ Hazardous waste landfill</li> <li>▶ Encapsulation</li> <li>▶ Inertization / stabilization</li> </ul>

In the past, main options for the disposal of generated waste included the dumping of the waste in uncontrolled pits or the burning of the waste. With the increase of the awareness on the environmental impact of these disposal methods, safer and environmentally improved strategies were developed. Some of the possible strategies are complex and might not be applicable due to missing waste infrastructure and waste management capacity. To identify strategies, an assessment of the feasibility of possible logistic, treatment and disposal solutions should be carried out. More detailed information on the set up of logistic solutions and different treatment methods (including alternative treatment methods) can be found in Part C Waste Management Planning of this toolkit<sup>23</sup>.

**3.5.1 Waste logistics options**

The two main logistic strategies include the *disposal chain logistic* (waste is collected and transported to the place for treatment and disposal) and the *reverse logistic* (waste is taken back by using existing supply logistic systems). Both systems require a safe transportation system. A disposal chain logistic system is often the more feasible option for bulky hazardous waste which requires regularly collection such as infectious waste. Reverse logistic systems might be an alternative for

<sup>23</sup> Kuehling, J., Hamelmann, C. Part C: Waste Management Planning Guide. UNDP (in publication)

hazardous waste generated in smaller quantities and which does not require regularly but only periodically collection such as pharmaceutical waste or chemical waste. Both options require an interim storage at the place of waste generation.

**3.5.2 Waste treatment and disposal options**

For waste treatment and disposal options, it has to be assessed first whether a central or de-central strategy is the more feasible solution. This will depend on the expected waste streams but also on the selected logistic system and the existing waste infrastructure. The selection of the best treatment and disposal methods for a GF project depends on several factors such as the national waste strategy, safety aspects, and environmental friendliness but also on associated investment and recurrent costs. In table 13, an overview of typical treatment and disposal options is provided and it will be the task of the downstream assessment to select the most appropriated one for to the expected waste streams.

**3.6 The waste stream strategy development**

The first step of the development of a waste stream strategy is to apply the waste hierarchy (see figure 4). For each waste stream to be managed, the following questions should be asked:

- ▶ Can the generation of the waste be avoided?
- ▶ If not – can the generated waste be reused?
- ▶ If not – can the generated waste be recycled?
- ▶ If the above is not possible – do other possibilities exist to recover energy from the waste?

Only if all strategies mentioned before cannot be applied, the waste shall be disposed of.

For the final treatment and disposal, only treatment and disposal systems with lowest possible environmental impact shall be applied. The selected system must ensure that all relevant national requirements are fulfilled and that the selected system is compliant with the international conventions. A reference point for the selection of the system can be the Directive 2010/75/EU on Integrated Pollution Prevention and Control<sup>24</sup>. This Directive brings together Directive 2008/1/EC (the 'IPPC Directive') and six other directives in a single directive on industrial emissions.

The purpose of this Directive is to achieve integrated prevention and control of pollution arising from defined activities. One of these activities is the management of hazardous waste. The Directive requires from hazardous waste treatment activities to have a permit. This permit can only be issued if defined environmental conditions are met. In order to receive a permit for a hazardous waste installation, it must comply with certain basic obligations. In particular, it must

- ▶ use all appropriate pollution-prevention measures, namely the Best Available Technique (BAT) which produces the least waste, use less hazardous substances, enable the substances generated to be recovered and recycled, etc.;
- ▶ prevent all large-scale pollution and use energy efficiently;
- ▶ prevent, recycle or dispose of waste in the least polluting way possible;
- ▶ ensure accident prevention and damage limitation, and return sites to their original state when the activity is over.

For the hazardous waste treatment sector, two of the BREF documents which have been developed for the implementation of the IPPC Directive can be of relevance:

- ▶ BREF Waste Treatments Industries<sup>25</sup>: Covering especially chemical and physical treatment plants

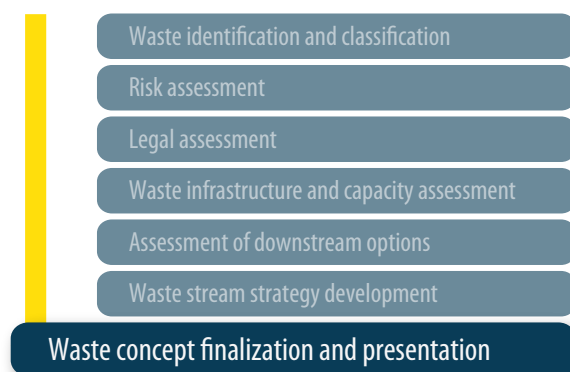
(such as steam decontamination systems for hazardous healthcare waste).

- ▶ BREF Waste Incineration<sup>26</sup>: Covering installations for the incineration of hazardous and municipal waste which includes medical hazardous waste.

In order to minimize the risks involved in the collection, storage and transport, the proximity principle should be applied. This requires that waste should be disposed of as close as possible to where it is produced. The closest possible point has to be technically and economically feasible and for certain waste types (e.g. persistent organic pollutants) the closest point might be a central, national treatment facility or even will require the export of waste to the nearest country which operates a suitable treatment plant. For other types of waste such as biohazardous waste, the treatment at the place of generation might be feasible.

In consideration of these aspects, different management strategies can be designed for the various expected waste streams. The advantages and disadvantages of the different strategies shall be analysed by taking into account potential health, safety and environmental risks, including the impact on climate change. Using the results of this analysis, the best possible and feasible strategy shall be recommended. In the Annex 3 of this document, sample strategies for different waste streams are described.

### 3.7 Waste concept finalization and presentation



24 European Union: Directive 2010/75/EU. Accessed 22.07.2014

25 European Union (2006): BREF Waste Treatments Industries. Accessed 04/02/2015

26 European Union (2006): BREF Waste Incineration. Accessed 04/02/2015

Based on the findings of the previous steps, the final waste stream concept for a GF project should be developed. It is recommended that it will include at least the following points:

- ▶ General Information
  - ▷ Basic information about the GF project and its planned activities
  - ▷ Overview of products and services which will be procured during the project period
  - ▷ Short description of the international and national legal and regulatory frameworks relevant for environmental safeguarding and waste management of the project, the existing waste infrastructure and the waste management capacity in the country and among the prospective PRs and SRs.
- ▶ Identifications of waste streams to be managed
  - ▷ Description of the types and volumes of waste expected to be generated by the project
  - ▷ Clustering of different type of waste into waste streams
  - ▷ Short description of the specific characteristics of each waste stream including potential risks
- ▶ Waste stream management (for each waste stream)
  - ▷ Description of waste generation (amount, place, time)
  - ▷ Description of the recommended logistic concept (packing, collection, transportation)
  - ▷ Description of the recommended waste treatment and disposal concept

- ▷ Description of HSS components related to the waste stream concept implementation
  - ▷ Procurement requirements for waste management
  - ▷ Financial requirements
  - ▷ Capacity building requirements
- ▶ Safety and Quality management
    - ▷ Description of applied safety and QA/QI standards
    - ▷ Description of planned safety measures
    - ▷ Description of planned monitoring and evaluation system

The final waste stream concept development should be closely linked to ongoing country processes like reviews of the NSPs and the dialogues around the GF concept note development. If a social and environmental screening procedure was carried out, the concept should make reference to this.

The waste stream concept including recommendations for the waste management strategy, key activities, waste management related procurement plan and budget shall be presented to all stakeholders of the NFM national dialogue. After acceptance, it should become one of the modules submitted to the GF as part of the NFM concept note. A practical HCW management guide for GF planners and practitioners can be found in the Part C of this toolkit.

It is recommended that the GF should issue under the NFM a guidance note for waste stream concept development and should make waste stream concepts a mandatory module for each GF concept note and final project proposal. The GF Technical Review Panel should review and ensure its inclusion and quality standard.

# 4 Annex

## 4.1 Annex 1: General waste stream concept checklist

### The top ten waste management checks for environmental safeguarding of GF projects

	<b>Question</b>	<b>Yes</b>	<b>No</b>
<b>1</b>	Was a legal assessment on the environmental requirements in the country carried out and the results evaluated?		
<b>2</b>	Were the existent waste management system, capacities and infrastructure in the country assessed?		
<b>3</b>	Was a project specific waste stream analysis conducted based on project activities and detailed procurement plans and was a risk assessment done?		
<b>4</b>	Were recommendations for procurement provided for the selection of products that generate less waste with lower risks and easier demands on disposal logistics?		
<b>5</b>	Was a feasibility check on the application of more advanced waste management strategies such as ERP, take back duties, reverse logistic, alternative treatment systems or cooperation with the private sector carried out?		
<b>6</b>	Was a strategy for the disposal of the estimated waste streams developed and was it integrated into national systems?		
<b>7</b>	Was a needs assessment for waste management equipment, and consumables conducted and a budget developed for the project's waste management module?		
<b>8</b>	Were necessary actions for capacity building and HSS included in the project plan?		
<b>9</b>	Were responsibilities for the operational waste management including monitoring and evaluations discussed and clarified?		
<b>10</b>	Was a sustainability strategy developed for the management of project waste and the strengthened waste management for the time after the project period?		

## 4.2 Annex 2: General healthcare waste assessment guide

**Table 14: Assessment on national level**

National laws and regulations:	<ul style="list-style-type: none"> <li>▶ For the handling and disposal of non-hazardous waste</li> <li>▶ For the handling, treatment and disposal of hazardous waste</li> <li>▶ For the handling, treatment and disposal of healthcare waste</li> <li>▶ For the transport of hazardous goods on streets</li> <li>▶ For occupational safety (especially for healthcare institutions)</li> <li>▶ For getting permission for the centralized or de-centralized treatment of hazardous waste (especially for the treatment of healthcare waste)</li> <li>▶ For the storage and use of hazardous goods</li> </ul>
General information and responsibilities:	<ul style="list-style-type: none"> <li>▶ Description of the healthcare system:               <ul style="list-style-type: none"> <li>▷ Responsibilities and tasks of the relevant authority</li> <li>▷ Types of hospitals (private, governmental etc.; number and percentage)</li> <li>▷ Financing of the healthcare system (tax revenue, health insurance etc.)</li> <li>▷ Cost pressure and financial situation of the healthcare sector</li> </ul> </li> <li>▶ Description of the national environmental and hygienic situation:               <ul style="list-style-type: none"> <li>▷ Awareness and importance of environmental issues at the authorities</li> <li>▷ Awareness of environmental problems among the public and media</li> <li>▷ Awareness regarding communicable diseases (HIV, HBV, HCV)</li> <li>▷ Awareness regarding nosocomial infections</li> <li>▷ Ways of financing of the environmental sector</li> </ul> </li> <li>▶ Identification of national authorities in charge for:               <ul style="list-style-type: none"> <li>▷ Occupational health matters (of healthcare facility staff)</li> <li>▷ Management and disposal of household waste (strategic planning)</li> <li>▷ Management and disposal of hazardous waste (strategic planning)</li> <li>▷ Management and disposal of healthcare waste (strategic planning)</li> <li>▷ Permissions of centralized and de-centralized waste treatment methods</li> </ul> </li> </ul>
Information on the health situation:	<ul style="list-style-type: none"> <li>▶ Prevalence of communicable diseases               <ul style="list-style-type: none"> <li>▷ HIV, HBV, HCV, TB and malaria</li> </ul> </li> <li>▶ Which are the top ten diseases?</li> <li>▶ Life expectancy, under-five and maternal mortality</li> </ul>

**Table 15: Assessment on sub-national level**

Sub-national regulations, guidelines and directives:	<ul style="list-style-type: none"><li>▶ For the handling and disposal of non-hazardous waste</li><li>▶ For the handling, treatment and disposal of hazardous waste</li><li>▶ For the management and treatment of healthcare waste within healthcare facilities</li><li>▶ For the collection, transport, treatment and disposal of healthcare waste outside of healthcare facilities</li><li>▶ For the transport of hazardous goods on public roads</li><li>▶ For occupational safety (especially for healthcare institutions)</li><li>▶ For getting permission for the centralized or de-centralized treatment of hazardous waste (especially for the treatment of healthcare waste)</li><li>▶ For the storage and use of hazardous goods</li></ul>
General information and responsibilities:	<ul style="list-style-type: none"><li>▶ Description of the healthcare system by sub-national administrative unit:<ul style="list-style-type: none"><li>▷ Responsibilities and tasks of the relevant, regional authority</li><li>▷ Type by ownership (private, governmental etc.) and number of healthcare facilities. If available percentage of type of healthcare facility</li><li>▷ Average occupation rate (in %) and average stay of patients (in days)</li><li>▷ How many people are living in the sub-national administrative unit?</li></ul></li><li>▶ Identification of sub-national authorities in charge for:<ul style="list-style-type: none"><li>▷ Occupational health matters (of healthcare facility staff)</li><li>▷ Management and disposal of household waste (monitoring, executing)</li><li>▷ Management and disposal of hazardous waste (monitoring, executing)</li><li>▷ Management and disposal of healthcare waste (monitoring, executing)</li><li>▷ Permissions of centralized and de-centralized waste treatment methods</li></ul></li><li>▶ Description of the sub-regional waste system:<ul style="list-style-type: none"><li>▷ How is the general way of collection and disposal for non-hazardous waste? How high are the disposal costs per ton of waste?</li><li>▷ Which types of waste are recycled? What are the prices per ton of recyclable waste?</li><li>▷ Which treatment methods are available for hazardous waste, how high are the treatment costs per ton of waste?</li><li>▷ How are the different types of waste collected and transported, how high are the pick-up and transport costs?</li><li>▷ Are private companies involved in the waste system? If yes, what is their task, which kind of waste do they collect, who are the main players?</li></ul></li><li>▶ Description of the healthcare waste system:<ul style="list-style-type: none"><li>▷ Which different kinds of waste streams are defined?</li><li>▷ Which kinds of waste are recycled? How much is paid per kg?</li><li>▷ What are the costs and the treatment methods (if any) for non-hazardous waste, infectious waste, chemical waste, cytotoxic waste, radioactive waste and pathological waste</li></ul></li><li>▶ How are the above-mentioned waste streams collected and transported?</li></ul>

**Table 16: Assessment at waste generator level (e.g. healthcare facility)**

If possible, three different types of healthcare facilities should be investigated. Ideally, assessment includes the whole facility with disaggregation of GF funded services.

General Information about the healthcare facility	<ul style="list-style-type: none"> <li>▶ List of main medical and non-medical departments</li> <li>▶ List of the main existing committees (if existing) with a short description of the terms of references</li> <li>▶ Clearance of the pathways of decision making:               <ul style="list-style-type: none"> <li>▷ For personal matters</li> <li>▷ For purchasing and investments</li> <li>▷ For organisational matters</li> </ul> </li> </ul>
Input analysis of the healthcare facility	<ul style="list-style-type: none"> <li>▶ How many people are working in the healthcare facility?</li> <li>▶ What kind of hazardous goods are purchased and used?</li> <li>▶ What kind of products will be supplied by the GF grant?</li> <li>▶ How many beds does the healthcare facility have in total? How high is the occupation rate?</li> </ul>
Output analysis of the healthcare facility	<ul style="list-style-type: none"> <li>▶ Medical services:               <ul style="list-style-type: none"> <li>▷ How many patients are treated in the healthcare facility per year (in-patients, out-patients)?</li> <li>▷ How many total treatment days (duration of the stay per patient)</li> <li>▷ What are the top 10 treated diseases in the hospital?</li> </ul> </li> <li>▶ Waste production:               <ul style="list-style-type: none"> <li>▷ How much waste (separated in the different waste categories) is produced per year?</li> </ul> </li> </ul>
Analysis of waste management:	<ul style="list-style-type: none"> <li>▶ Organisation of the waste management:               <ul style="list-style-type: none"> <li>▷ Who is currently responsible for the waste management?</li> <li>▷ Which persons are strategically involved in the waste management, what are their tasks?</li> <li>▷ Which groups of persons are operationally involved in the waste management, what are their tasks?</li> <li>▷ Do waste management plans and teams exist?</li> <li>▷ Do any internal or external policies, guidelines or regulations for waste management exist?</li> <li>▷ Which different kinds of waste are generated?</li> <li>▷ Are data on waste management recorded (waste management plans, waste generation, waste manifests from the transportation of waste)?</li> <li>▷ Do awareness and training programmes for healthcare facility staff exist on waste management, occupational safety and nosocomial infections?</li> <li>▷ Does a special training programme for the waste workers exist?</li> <li>▷ Are SOPs for waste management available?</li> <li>▷ Is PPE for the waste worker available? If yes, which kind of equipment?</li> <li>▷ Are the waste workers vaccinated (hepatitis, tetanus etc.)?</li> </ul> </li> <li>▶ Current processes in waste management               <ul style="list-style-type: none"> <li>▷ How is the non-hazardous waste (household waste, disposables, plastic, paper, glass, metal) segregated, collected, transported, stored and disposed of?</li> <li>▷ How is the hazardous waste (for each waste group, e.g. infectious waste, pharmaceutical waste, chemical waste, radioactive waste, cytotoxic waste) handled during the steps: segregation, collection, transportation, storage and disposal?</li> <li>▷ What kind of equipment is available for the segregation, collection, transport, storage and disposal of the different kind of hazardous and non-hazardous waste?</li> <li>▷ How is sharps waste (needles, blades, broken glass) collected?</li> <li>▷ Do treatment plants for hazardous healthcare waste exist? If yes, for which kind of waste?</li> <li>▷ How often is the hazardous and non-hazardous waste collected at the wards, how often is the waste disposed of?</li> <li>▷ Are any data regarding the waste generation available (type of waste in kg)?</li> </ul> </li> <li>▶ Incident and accident management               <ul style="list-style-type: none"> <li>▷ Are incidents and accidents recorded and evaluated?</li> <li>▷ Are proceedings and equipment for the case of accidents available?</li> <li>▷ How is the needle stick problem solved?</li> </ul> </li> </ul>

## 4.3 Annex 3: Sample hazard identifications for products used in GF projects

### 4.3.1 Hazard identification for ARVs and ACTs

ARVs and ACTs include different pharmaceuticals and a separate hazard assessment should be carried out for each pharmaceutical product.

As example for ARVs, efavirenz was analysed using the MSDS from a randomly selected sample supplier<sup>27</sup>.

Hazard identification for Efavirenz:

- ▶ Hazard statement(s)<sup>28</sup>: H400 Very toxic to aquatic life.
- ▶ Precautionary statement(s): P273 Avoid release to the environment.

Potential health effects of efavirenz:

- ▶ Inhalation: May be harmful if inhaled. May cause respiratory tract irritation.
- ▶ Ingestion: May be harmful if swallowed.
- ▶ Skin: May be harmful if absorbed through skin. May cause skin irritation.
- ▶ Eyes: May cause eye irritation.

Waste treatment methods of efavirenz:

- ▶ Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Different is the situation for ACTs. Artemisinin is not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008 and the substance is not classified as dangerous according to Directive 67/548/EEC. The combination products however can be considered as hazardous. For example amodiaquine-

d10<sup>29</sup> is considered as a toxic material causing immediate and serious toxic effects and is considered as toxic by ingestion.

Hazard identification for amodiaquine-d10:

- ▶ Hazard statement(s): H302 Harmful if swallowed.
- ▶ Precautionary statement(s): P301/P312 if swallowed: call a poison centre or doctor/physician if you feel unwell

Potential health effects of amodiaquine-d10:

- ▶ Inhalation: May be harmful if inhaled. May cause respiratory tract irritation.
- ▶ Ingestion: Harmful if swallowed.
- ▶ Skin: May be harmful if absorbed through skin. May cause skin irritation.
- ▶ Eyes: May cause eye irritation.

Waste treatment methods of amodiaquine-d10:

- ▶ Contact a licensed professional waste disposal service to dispose of this material.

The outer and inner packing (e.g. blister) of the products are not considered as hazardous waste and can be disposed of as non-hazardous waste.

If possible, during the procurement of ARVs and ACTs medicines with a possible high negative environmental and health impact should not be selected if alternatives are provided through international or national treatment guidelines. In addition, the expertise in environmental impact of pharmaceuticals should be strengthened in international and national treatment guidelines committees.

27 Sigma-Aldrich: Material Safety Data Sheet – Efavirenz. Website. Accessed 17/03/2015

28 Hazard statements (e.g. H400) and precautionary statements (e.g. P273) form part of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). They are intended to form a set of standardized phrases about the hazards of chemical substances and mixtures that can be translated into different languages.

29 Santa Cruz Biotechnology: Material Safety Data Sheet – Amodiaquine-d10. Website. Accessed 17/03/2015



### 4.3.2 Hazard identification for RDTs

RDTs test kits generally consist of three main materials: The rapid test kit, capillary tube for specimens and assay diluent.

In addition, a lancet, alcohol swab and sterile gauze will be used for the testing. The generated waste will therefore usually consist of:

- ▶ Used rapid test kit
- ▶ Used capillary tube
- ▶ Used lancet
- ▶ Used swab and gauze

While the test itself is generally considered as non-hazardous, after usage with a potentially infectious patient the rapid test kit as well as the capillary tube has to be considered as potentially infectious waste (precautionary principle). The used lancet has to be classified as hazardous sharps waste. Additionally used swabs and gauze will become potentially infectious waste.

Hazard identification for potentially infectious waste:

- ▶ GHS does not apply, potentially infectious waste is classified as biohazardous. It should be assumed in principle that they contain pathogens of the particular infectious diseases

Potential health effects of potentially infectious waste:

- ▶ GHS does not apply, risk of transferring of contagious diseases exist.

Waste treatment methods for potentially infectious waste:

- ▶ Decontamination of the waste by using thermal or chemical methods

### 4.3.3 Hazard identification for LLIN

Risks from LLIN and the primary packing are created by deltamethrin, alpha-cypermethrin or permethrin and for each insecticide a separate risk assessment is required. The following is based on available MSDS data.

### Deltamethrin

Hazard identification for Deltamethrin<sup>30</sup>:

- ▶ Hazard statement(s)<sup>31</sup>:
  - ▷ H301 + H331 Toxic if swallowed or if inhaled.
  - ▷ H410 Very toxic to aquatic life with long lasting effects.
- ▶ Precautionary statement(s):
  - ▷ P261 Avoid breathing dust.
  - ▷ P273 Avoid release to the environment.
  - ▷ P301 + P310 If Swallowed: Immediately call a Poison Center or doctor/ physician.
  - ▷ P311 Call a Poison Center or doctor/ physician.
  - ▷ P501 Dispose of contents/ container to an approved waste disposal plant

Potential health effects of deltamethrin:

- ▶ Acute toxicity
  - ▷ LD<sub>50</sub><sup>32</sup> Oral – rat – 9,36 mg/kg
  - ▷ Remarks: Behavioral:Somnolence (general depressed activity). Behavioural: Convulsions or effect on seizure threshold. Kidney, Ureter, Bladder: Urine volume increased.
  - ▷ LC<sub>50</sub><sup>33</sup> Inhalation – rat – 2 h – 785 mg/m<sup>3</sup>
  - ▷ Remarks: Behavioural: Somnolence (general depressed activity). Behavioural: Convulsions or effect on seizure threshold. Gastrointestinal: Changes in structure or function of salivary glands.
  - ▷ LD<sub>50</sub> Dermal – rabbit – 2.000 mg/kg

Waste treatment methods of deltamethrin:

- ▶ Product: Offer surplus and non-recyclable solutions to a licensed disposal company. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

30 Sigma-Aldrich: Material Safety Data Sheet – Deltamethrin. Website. Accessed 17/03/2015

31 H = Hazard statements; P = Precautionary statements (see also footnote 28)

32 LD<sub>50</sub>: lethal dose 50 – the amount of a toxic agent that is sufficient to kill 50 percent of a population of animals usually within a certain time

33 LC<sub>50</sub>: lethal concentration 50 – toxicity of the surrounding medium that will kill half of the sample population of a specific test-animal in a specified period through exposure via inhalation

- ▶ Contaminated packaging: Dispose of as unused product;

### Alpha-Cypermethrin

Hazard identification for alpha-cypermethrin<sup>34</sup>:

- ▶ Hazard statement(s):
  - ▷ H301 Toxic if swallowed
  - ▷ H335 May cause respiratory irritation
  - ▷ H373 May cause damage to organs through prolonged or repeated exposure
  - ▷ H410 Very toxic to aquatic life with long lasting effects
- ▶ Precautionary statement(s):
  - ▷ P261 Avoid breathing dust.
  - ▷ P273 Avoid release to the environment.
  - ▷ P301 + P310 If Swallowed: Immediately call a Poison Center or doctor/ physician.
  - ▷ P501 Dispose of contents/container to an approved waste disposal plant.

Potential health effects of alpha-cypermethrin:

- ▶ Acute toxicity
  - ▷ LD<sub>50</sub> Dermal – rabbit – > 2.000 mg/kg
- ▶ Inhalation: May be harmful if inhaled. Cause respiratory tract irritation.
- ▶ Ingestion: Toxic if swallowed.
- ▶ Skin: May be harmful if absorbed through skin. May cause skin irritation.
- ▶ Eyes: May cause eye irritation

Waste treatment methods for alpha-cypermethrin:

- ▶ Product: Offer surplus and non-recyclable solutions to a licensed disposal company. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.
- ▶ Contaminated packaging: Dispose of as unused product.

### Permethrin

Hazard identification for permethrin<sup>35</sup>:

- ▶ Hazard statement(s):
  - ▷ H302 Harmful if swallowed.
  - ▷ H317 May cause an allergic skin reaction.
  - ▷ H332 Harmful if inhaled.
  - ▷ H410 Very toxic to aquatic life with long lasting effects.
- ▶ Precautionary statement(s):
  - ▷ P273 Avoid release to the environment.
  - ▷ P280 Wear protective gloves.
  - ▷ P501 Dispose of contents/ container to an approved waste disposal plant.

Potential health effects of permethrin:

- ▶ Acute toxicity
  - ▷ LD<sub>50</sub> Oral – Rat – 383 mg/kg
  - ▷ LC<sub>50</sub> Inhalation – Rat – 485 mg/m<sup>3</sup>
  - ▷ LD<sub>50</sub> Dermal – Rabbit – > 2.000 mg/kg
- ▶ Skin: Skin – Rabbit – Result: Mild skin irritation

Waste treatment methods for permethrin:

- ▶ Product: Offer surplus and non-recyclable solutions to a licensed disposal company. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.
- ▶ Contaminated packaging: Dispose of as unused product.

34 Chemical Trading Guide: Material Safety Data Sheet – alpha-Cypermethrin. Website. Accessed 17/03/2015

35 Sigma-Aldrich: Material Safety Data Sheet – Permethrin. Website. Accessed 17/03/2015

## 4.4 Annex 4: Sample application of the waste management hierarchy for products used in GF projects

**Table 17: Application of the waste hierarchy for ARVs and ACTs, RDTs, LLINs and contaminated packaging**

	<b>ARVs and ACTs</b>	<b>RDTs</b>	<b>LLIN and contaminated packaging</b>
<b>Prevention</b>	During procurement it should be considered if less hazardous products can be used (if acceptable from the medical point of view). Of special importance is the need for a good logistic system to avoid waste from transport accidents and the need for advanced storage management systems to reduce amounts of expired waste.	As after usage the test kit as well as the capillary tube will become infectious waste, products with the lowest weight and material consumption should be preferred.	During procurement of LLIN the nets with least toxic insecticide should be procured. In case of replacement of old nets, new nets should only be supplied against old nets (exchange strategy) – old nets should be packed in the packing of new nets.
<b>Re-Use</b>	A reuse of medicines and RDTs is not recommended and normally not possible, a reuse of the transport packing (tertiary packing) should be considered.		A reuse of the LLIN and the contaminated packing is not recommended <sup>36</sup> .
<b>Recycling</b>	A recycling of the primary product (medicine) is not possible. Recycling of the secondary packing (outer packing) and the primary packing (blister, box) should be done if the medicines can be safely unpacked. Contaminated packing is normally not suitable for recycling.	A recycling of the primary product (RDT) is not possible. Recycling of the secondary packing (outer packing) and the primary packing (box) should be done.	A demonstration project showed that the collection of retired LLINs from households is logistically possible <sup>37</sup> . It also showed that pesticide residue remaining in old LLINs can be quite significant. Polyethylene (PE) nets were able to be recycled but polyester (PET) nets were not. The materials should only be recycled into products with limited potential for human contact and are not likely to be recycled again.
<b>Other recovery</b>	The possibility of the disposal of unpacked expired products in a facility equipped with heat recovery (e.g. cement kiln, waste-to-energy incinerator) should be considered		The possibility of the disposal of used LLIN and primary packing in a facility equipped with heat recovery (e.g. cement kiln, waste-to-energy incinerator) should be considered.
<b>Disposal</b>	A safe way of disposal – if possible carried out by a professional disposal company – should be selected. If the product has special disposal requirements (e.g. it is toxic to aquatic life) but hazardous waste disposal facilities are not available, alternative solutions such as encapsulation or inertization <sup>38</sup> should be considered. The disposal of hazardous ARVs and ACTs via the household waste stream must be avoided.	The infectious waste and the sharp waste needs to be decontaminated prior disposal. The disposal of used RDTs and the other materials used during performing the test via the household waste stream must be avoided.	A safe way of disposal – if possible carried out by a professional disposal company – should be selected. Incinerate LLIN bags and baling material only if specified high temperature incineration conditions for pesticide-tainted plastic can be assured. The landfilling of LLINs and bags in a properly engineered landfill is an option if it exists and if the FAO/WHO Guidelines on Management Options for Empty Pesticide Containers can be followed.

<sup>36</sup> Recommendations on the Sound Management of Packaging for Long Lasting Insecticidal Nets (LLINs), WHO, November 2011

<sup>37</sup> Nelson, Michelle, and Ralph Rack. 2012. Madagascar: LLIN Recycling Pilot Project, Report on Phase III. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 7

<sup>38</sup> Inertization: The inertization process of a waste consist in binding it to an inert matrix through a chemical and/or physical process.

## 4.5 Annex 5: Sample waste stream strategies

*Disclaimer: The following sample waste stream strategies are based on assumptions and experiences from different countries but are fictional only. They are included to explain the methodology of strategy development for selected waste streams. They are not intended to replace the development of country specific waste stream strategies. Suggested strategies are exemplary only and country specific best solutions might be different.*

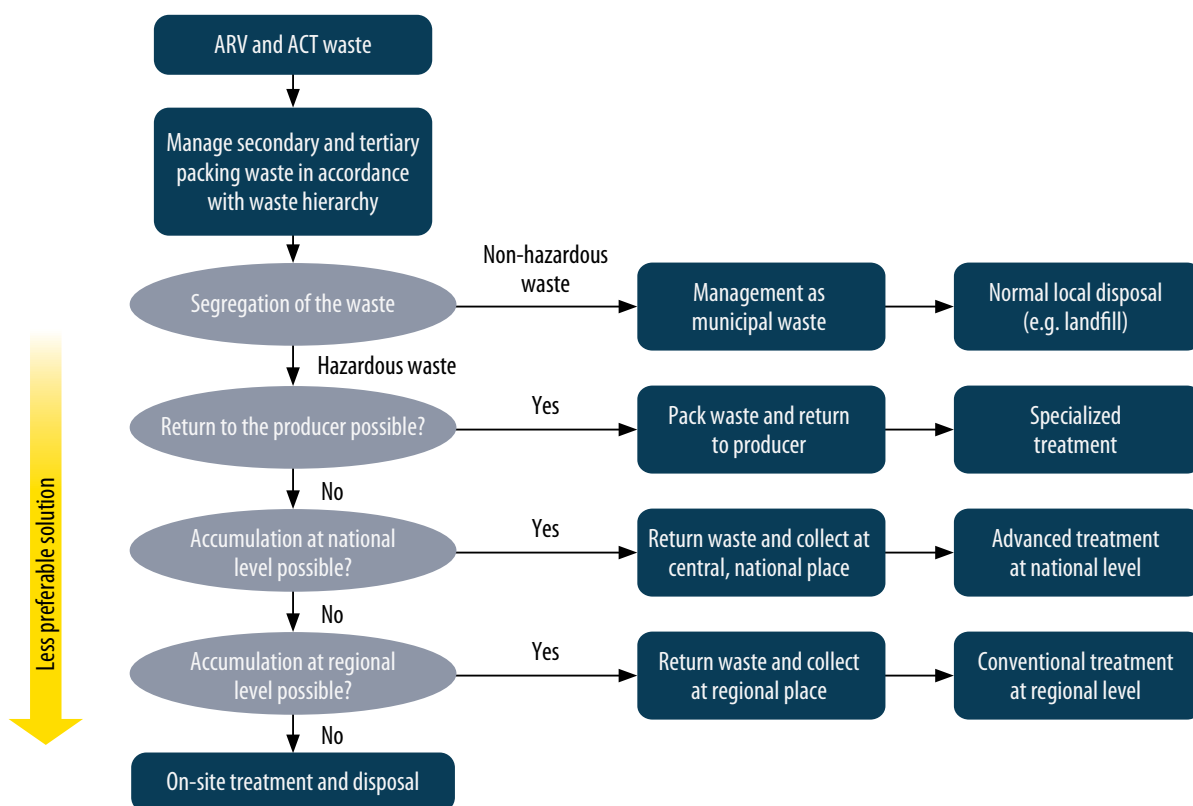
*Note: The strategies concentrate on the disposal of generated waste. It is assumed that the waste hierarchy (see annex 4) was applied and that manufacturers were influenced during the procurement process to minimize packing (secondary and tertiary) and to reduce / avoid the use of harmful substances (materials).*

### 4.5.1 Waste stream strategies for ARVs and ACTs

Most GF HIV/AIDS projects include ARV treatment components. The typical selection of ARVs procured will depend on national and international ARV treatment guidelines<sup>39</sup>. More and more products are fixed-dose combinations of two or three ARVs in one tablet, introduced to improve the adherence through less complicated treatment regimens.

Similarly, GF malaria projects are likely to include treatment components using artemisinin-based combination therapies (ACTs) as first-line treatment. ACTs combine artemisinin derivatives with another, different antimalaria medicine as fixed-dose combination, e.g with amodiaquine, mefloquine,

**Figure 6: Sample decision model for ARVs and ACTs waste stream strategies**



39 WHO (2013): Consolidated ARV guidelines. Accessed 16.07.2014

sulfadoxine–pyrimethamine, dihydroartemisinin or piperazine<sup>40</sup>.

Depending on the country specific context, different options may exist for the disposal and treatment of pharmaceutical waste generated by the project. It is assumed that the waste hierarchy was applied (figure 4) and that the waste consists only of ARVs and ACTs in their primary packing (packing that is in direct contact with the medicines), but does not include secondary packing (used to collate primary packaging so that it can be handled safely manually) and tertiary packing (used to transport products in a safe and large number). While the non-hazardous waste disposal should be integrated into the existing national system for municipal waste disposal or recycling, for hazardous waste different options are available.

#### Strategy 1: Applying EPR through a reverse logistic system

Collection of hazardous ARV and ACT waste and accumulation of the waste at a central national storage. Returning the waste to the supplier (e.g. annually).

- ▶ Reverse logistics: Transport of the hazardous waste back to the producer, packing of waste in accordance with the International Maritime Dangerous Goods (IMDG) Code<sup>41</sup> if required, transport and organization by experienced waste hauler.
- ▶ Waste treatment: Sophisticated treatment in accordance with the country legislation<sup>42</sup>, typically high temperature incineration in a rotary kiln incinerator.

#### Strategy 2: National solution

Collection of hazardous ARV and ACT waste and return to the national central distribution centre

(warehouse). The waste is accumulated and periodically (e.g. bi-annually) treated.

- ▶ Reverse logistics: Transport of the hazardous waste back to the national distribution centre, in accordance with the UN recommendations<sup>43</sup> for transport of hazardous waste on public streets.
- ▶ Waste treatment:
  - ▷ Option A: Treatment in existing advanced incinerators (e.g. high temperature two-chamber system with basic flue-gas treatment); if no such treatment facility is available, installation of a fuel fired incinerator at the national warehouse could be considered.
  - ▷ Option B: Co-incineration (e.g. in a cement kiln, tar incinerator)

#### Strategy 3: Regional/provincial solution

Collection of hazardous ARV and ACT waste and return to the regional / provincial distribution centre (warehouse). The waste is accumulated and periodically (e.g. quarterly) treated.

- ▶ Reverse logistics: Transport of the hazardous waste back to the regional distribution centre (transport distance normally less than 150 km). Typically the waste is taken back using the supply system (combined supply and disposal logistic).
- ▶ Waste treatment:
  - ▷ Option A: Treatment in conventional, two chamber incinerator, normally located at the main healthcare facility in the region or operated as regional HCW incinerator. If an incinerator does not exist on regional level, the installation at the main healthcare facility could be considered.
  - ▷ Option B: Inertization or encapsulation of the ARV and ACT waste and disposal on the municipal waste landfill.

40 WHO: Overview of malaria treatment. Accessed 16.07.2014

41 IMDG Code: The International Maritime Dangerous Goods (IMDG) Code was developed as a uniform international code for the transport of dangerous goods by sea covering such matters as packing, container traffic and stowage, with particular reference to the segregation of incompatible substances.

42 For EC countries: Directive 2000/76/EC on the incineration of waste. Accessed 17/03/2015

43 UNECE: Recommendations on the Transport of Dangerous Goods – Model Regulations. Accessed 04/02/2015

**Table 18: Comparison of ARVs and ACTs waste stream strategies\* , \*\***

Selected option	Health and safety	Eco-toxic impact	Climate impact
Strategy 1	O	++	-
Strategy 2A	O	+	-
Strategy 2B	+	+	O
Strategy 3A	+	-	-
Strategy 3B	-	O	+
Strategy 4A	-	--	O
Strategy 4B	--	--	O

\* Indicative value only

\*\* ++: very good; +: good; O: acceptable; -: problematic; --: very problematic

**Strategy 4: Local/district solution (least preferred option for hazardous pharmaceutical waste – only in emergencies)**

Collection of hazardous ARV and ACT waste and disposal close to the place of generation. The waste is accumulated and e.g. disposed of monthly.

- ▶ Reverse logistics: None (disposal logistic to be applied)
- ▶ Waste treatment: Using existing waste infrastructure, treatment in existing basic incinerators, typically small scale incinerators

For a comparison of the different strategies (table 18), three categories are analysed in a rapid assessment:

- (1) Health and safety: Occupational risks during the handling and treatment of waste, transport risk, public health risk.
- (2) Eco-toxic impact: Impact on soil, water and air during treatment and disposal (flue gas emission, risk from final disposal).
- (3) Climate impact: Greenhouse gas emissions generated during transportation, treatment and disposal of the waste.

**4.5.2 Sample waste stream strategies for RDTs (HIV and malaria)**

Diagnostic testing for HIV and malaria is a core component in GF HIV/AIDS and malaria projects. The WHO recommends the use of quality RDTs because

of their high sensitivity and specificity, simplicity, cost and rapid turn-around time<sup>44</sup>. RDTs can be performed with capillary blood collected by a simple finger stick procedure and do not require venepuncture specimen collection<sup>45</sup>.

The typical testing procedure is summarized in table 19.

In accordance with the UN Model Regulations<sup>46</sup>, the used RDTs and the other materials used for the testing would be classified as infectious waste of category B and would be assigned as Class 6.2 UN 3291 substance, namely:

CLINICAL WASTE, UNSPECIFIED, N.O.S. or (BIO) MEDICAL WASTE, N.O.S or REGULATED MEDICAL WASTE, N.O.S

The collection, transport, treatment and disposal will have to be planned in compliance with these specifications.

As interim storage times for this type of waste should be short, transportation for treatment should be organized daily or every second day and coordinated

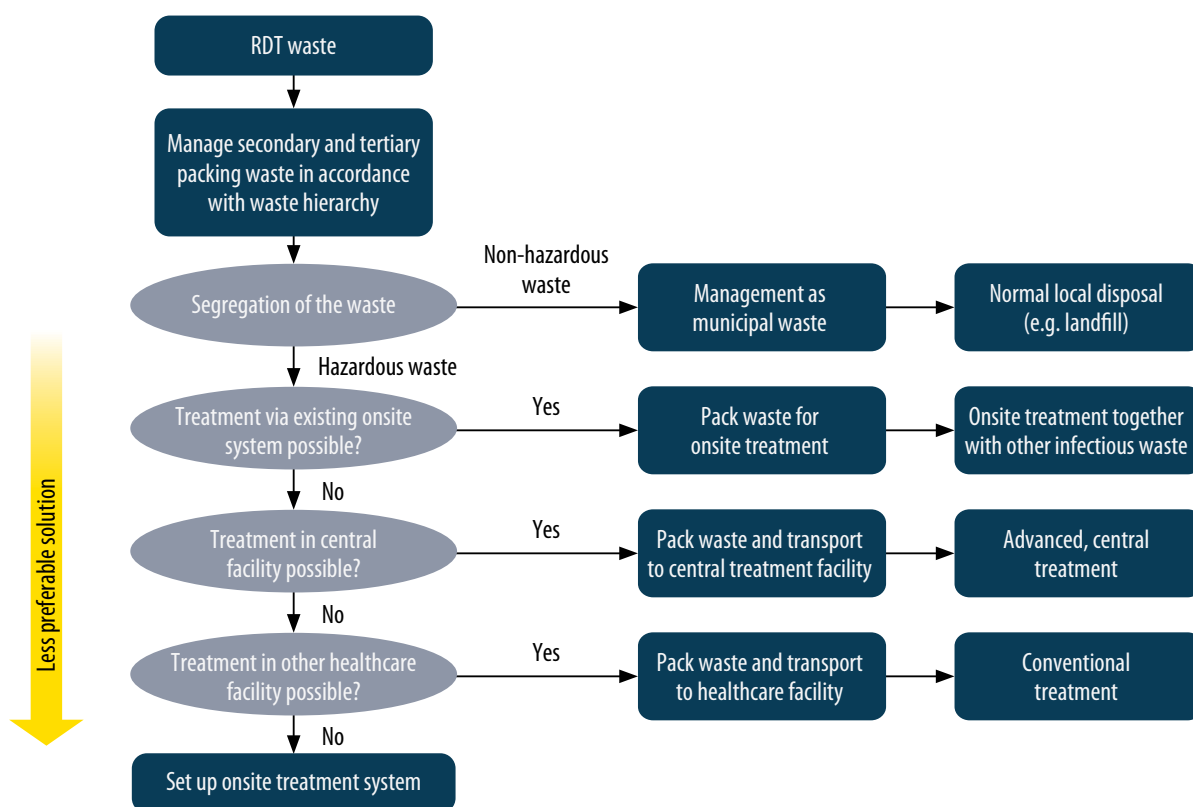
44 WHO (2013): HIV assays operational characteristics: HIV rapid diagnostic tests. Accessed 04/02/2015

45 WHO (2014): Malaria rapid diagnostic test performance (Round 4). Accessed 04/02/2015

46 UNECE: Recommendations on the Transport of Dangerous Goods – Model Regulations. Accessed 04/02/2015

**Table 19: Waste generation during the usage of RDTs (sample malaria)**

Medical procedure:	Generated waste
Opening of package and arranging of materials for procedure.	Non-hazardous, municipal waste / waste for recycling
Skin disinfection with alcohol swab.	Non-hazardous, municipal waste
The fingertip is pierced with a sterile lancet.	Sharps waste (lancet)
A capillary tube is squeezed and then the pressure released to draw blood into the capillary tube.	None
The first drop of blood is wiped away with sterile gauze or cotton.	Potentially infectious waste (contaminated cotton)
5 µl of drawn blood is added into the sample well using a capillary tube	Potentially infectious waste (used capillary tube)
Assay diluents are added into the assay diluent well.	Potentially infectious waste (used test)

**Figure 7: Sample decision model for RDT waste stream strategies**

with the existing infectious waste disposal strategies of the health facility. The facility should be provided with a sufficient amount of bins, and plastic bags for the collection of infectious waste and sharp containers for the collection of the lancets. The healthcare facility

should receive financial support to cover the costs for the disposal of the generated waste.

If no possibility for the safe on-site decontamination (steam decontamination, incineration) of the waste

in the healthcare facility is available, it should be investigated if the waste could be treated in a central waste disposal facility or, if not existent, if it could be treated in the next level healthcare facility which operates a treatment plant. If both strategies are not possible, the set-up of onsite treatment facilities should be considered. In that case it should be checked if the set-up of more environmentally friendly decontamination methods such as steam decontamination is possible.

### Strategy 1: Treatment in the healthcare facility

Following the proximity principle, the waste is treated onsite at the healthcare facility where the tests are performed.

- ▶ Logistics: Only internal collection required. The infectious waste and sharps are collected together with other, similar waste streams of the healthcare facility.
- ▶ Waste treatment: It is carried out with the other infectious waste generated by the healthcare facility. It is assumed that the existing treatment facility (steam decontamination, incineration) fulfils all required environmental and safety standards.

### Strategy 2: Central solution

The generated RDT waste is collected and regularly transported to a central operated treatment plant (incinerator, steam decontamination) for infectious waste.

- ▶ Reverse logistics not applicable, instead disposal logistics: Packing and transport of the generated infectious waste to the central treatment facility (transport distance depending on the country but should normally be less than 100 km). Transport in accordance with the UN model recommendations for the transport of hazardous waste on public streets<sup>47</sup>.
- ▶ Waste treatment: Treatment in existing central facility e.g. advanced incinerators such as a high temperature two-chamber system with basic flue-gas treatment or steam decontamination system.

47 UNECE: Recommendations on the Transport of Dangerous Goods – Model Regulations. Accessed 04/02/2015

### Strategy 3: Cooperative solution

Cooperation with the next healthcare facility with existing treatment facility is established. It is assumed that the treatment facility fulfils all environmental and safety requirements. The generated hazardous RDT is collected and regularly transported to this facility.

- ▶ Reverse logistics not applicable, instead disposal logistics: Packing and transport of the generated infectious waste to the healthcare facility. (transport distance normally less than twenty km). Transport in accordance with the UN recommendations<sup>48</sup> (UN 3291 - small quantities requirements under 333 kg).
- ▶ Waste treatment: Treatment in the existing systems of the healthcare facility (incineration, steam decontamination).

### Strategy 4: Set-up of onsite treatment

*(Note: the set-up of an onsite solution will not only require the supply of a treatment facility but the implementation of a complete system for hazardous waste management, treatment and disposal. Therefore, the feasibility of setting up an onsite treatment system must be carefully considered)*

Set up of a full on-site treatment system, preferably using steam decontamination systems.

- ▶ Logistics: Only internal collection required. Other infectious waste and sharps generated by the healthcare facility should be collected together with the RDT waste.
- ▶ Waste treatment: Treatment in a steam decontamination system to be preferred which fulfils all safety and environmental requirements. Other infectious waste generated by the healthcare facility should also be treated in the treatment plant.

Table 20 summarizes the comparison of the different strategies; see text to table 18 for further explanation of the assessment categories.

48 see footnote above



**Table 20: Comparison of RDT waste stream strategies\*, \*\***

Selected option	Health and safety	Eco-toxic impact	Climate impact
Strategy 1***	+	+	+
Strategy 2	O	+	-
Strategy 3	-	O	O
Strategy 4****	+	++	++

\* Indicative value only

\*\* ++: very good; +: good; O: acceptable; -: problematic; --: very problematic

\*\*\* It is assumed that the existing on-site treatment will fulfil all required environmental and safety standards

\*\*\*\* It is assumed that the waste will be treated by using a steam decontamination method

### 4.5.3 Sample waste stream strategies for LLINs

One of the most efficient methods to prevent malaria is the use of nets as protection against mosquitos. To increase their effectiveness, they can be dip-treated using a synthetic pyrethroid insecticide. Long-lasting insecticide-treated nets (LLINs) are produced by binding the insecticide to the fibres resulting in an estimated lifespan of three to five years or twenty washes<sup>49</sup>.

There are two methods used for binding the insecticide (normally deltamethrin, alpha-cypermethrin or permethrin) to the yarn or net:

- ▶ For polyethylene nets the insecticide is mixed with the polymer used to create the yarn. The insecticide is therefore incorporated into the polyethylene yarn as it is made. As the net is washed, insecticide on the surface that may wear off is replaced by fresh insecticide emerging from the yarn.
- ▶ For polyester nets the insecticide is bound to the manufactured netting with a chemical binder. The insecticide and binder can be applied at several stages in the process of net manufacturing, including post-manufacturing in the form of long-lasting treatment kits.

According to the WHO more than 88 million LLINs were delivered in 2009 and 145 million in 2010. Over 339 million LLINs have been distributed alone to

sub-Saharan Africa between January 2008 and July 2011<sup>50</sup>. LLINs are used in the GF malaria projects; the GF estimates its future demand at 90 million LLINs annually.

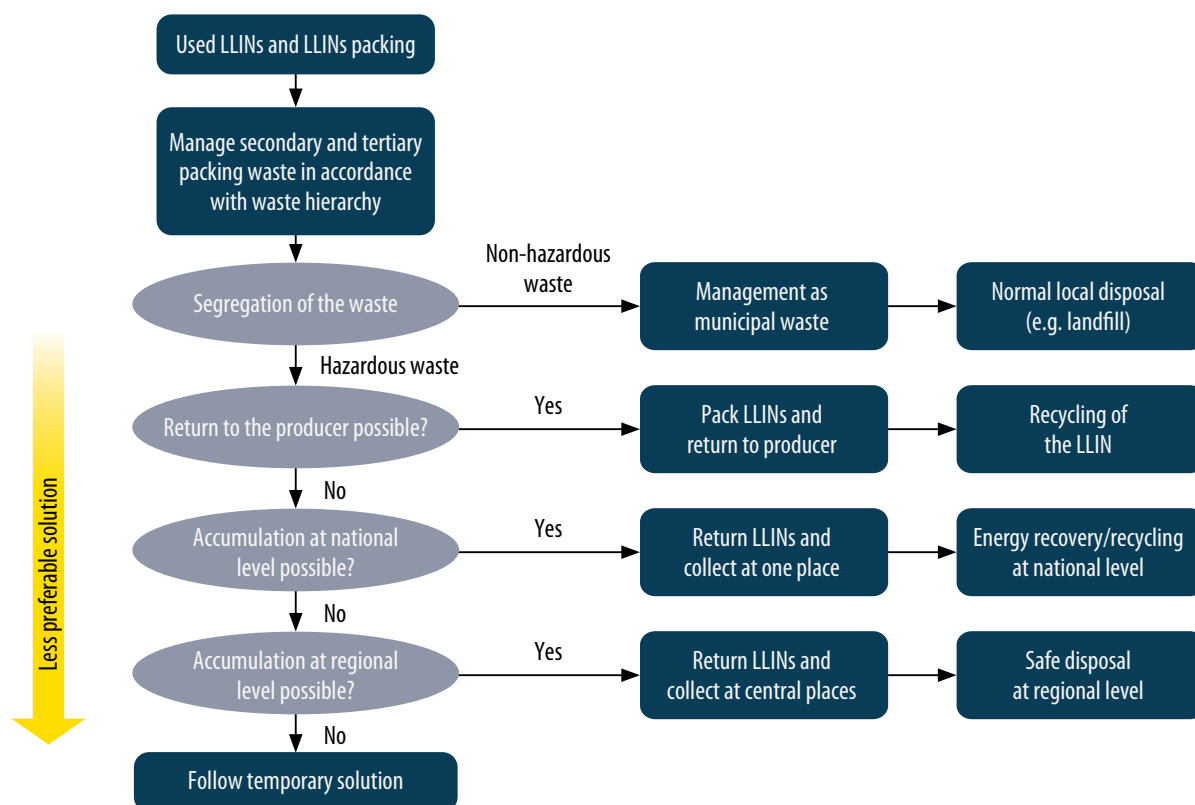
The distribution and usage of LLINs which weigh on average about 0.5 kg will result in three main waste streams, two for the packing materials and one for the LLIN:

- ▶ The transport (tertiary) and outer packing (secondary) materials used to wrap bales of nets consist normally of low density polyethylene (LDPE), paper bags and various strapping bands and the pallet.
- ▶ The product (primary) packing material for individual nets is typically made from LDPE, linear low density polyethylene (LLDPE), polyvinylchloride (PVC), or from biaxially oriented polypropylene (BOPP) or oxodegradable plastic bags. As the primary packing was in contact with the pesticides, these bags are classified as *empty pesticide container* and need special treatment as hazardous waste.
- ▶ The LLIN generally consists of three materials: the net (made from polyester, polyethylene or polypropylene), the insecticide and the binding substance by which the insecticide is affixed to the net.

49 WHO (2007): Long-lasting insecticidal nets for malaria prevention. A manual for malaria programme managers. Accessed 17.07.2014

50 WHO (2011): Recommendations on the Sound Management of Packaging for Long Lasting Insecticidal Nets (LLINs). Accessed 17.07.2014

**Figure 8: Sample decision model for LLIN waste stream strategies**



While the waste from the tertiary and secondary packing can easily be included in existing recycling and waste management programmes for warehouses, returned LLINs and potentially contaminated primary packing might create hazards and need special attention. As the experience from previous years has shown, the inclusion of environmental procurement criteria will be key to any successful disposal and logistics strategy for LLINs and their primary packing material. Key recommendations for LLINs procurement include:

- ▶ Use of the least toxic insecticide.
- ▶ Use of best recyclable LLIN and the primary packing material, preferably polyethylene.

Oxodegradable primary packing will only have limited environmental benefit as the main problem is the remaining insecticide. Fast degrading might be problematic in case primary packing is planned

to be used for long-term storage of used LLIN. A pilot project showed that after usage polyethylene terephthalate (PET) nets were 25% dirtier than the polyethylene (PE) nets; PE therefore should be preferred<sup>51</sup>.

For all of the suggested strategies it is assumed that generally the waste hierarchy is applied, tertiary and secondary packing materials are reused and/or recycled and that used LLINs are collected, e.g. through incentivised exchange strategies. The strategies are concentrating on the primary packing and the used LLINs. The WHO is also providing recommendations on the management of used LLINs<sup>52</sup>.

51 Nelson, Michelle, and Ralph Rack. 2012. Madagascar: LLIN Recycling Pilot Project, Report on Phase III. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 7

52 WHO (2014): WHO recommendations on the sound management of old long-lasting insecticidal nets. Accessed 17.07.2014

### Strategy 1: Applying EPR

Collection and accumulation of the LLINs at a central national storage point and returning the waste e.g. annually to the supplier.

- ▶ Reverse logistics: Packing of used LLINs in used primary packing, transport of the LLINs and primary packing back to the country of origin or another facility for utilization, packing of the LLINs for transportation in accordance with the International Maritime Dangerous Goods (IMDG) Code<sup>53</sup> (if required), transport and organization by experienced logistic company.
- ▶ Waste treatment:
  - ▷ Option A: If possible feedstock recycling<sup>54</sup> of the LLINs
  - ▷ Option B: Usage as refuse-derived fuel<sup>55</sup>.

### Strategy 2: National solution

The used LLINs are collected and returned to the national central distribution centre (warehouse), preferably in the primary packing of new LLINs. The waste is accumulated and periodically (e.g. bi-annually) treated. The limitations drawn up by WHO must be considered<sup>56</sup>.

- ▶ Reverse logistics: Transport of the used LLINs back to the national distribution centre by the supplier.
- ▶ Waste treatment:
  - ▷ Option A: Feedstock recycling (national or export) usage of the raw-material for products with limited potential for human contact.
  - ▷ Option B: Co-incineration of the waste in existing facilities (e.g. in a cement kiln, tar incinerator).
  - ▷ Option C: Treatment in existing, advanced incinerators (e.g. high temperature two-chamber

system with basic flue-gas treatment); if no treatment facility is available, installation of a fuel fired incinerator at the national warehouse could be considered.

### Strategy 3: Subnational / provincial solution

Used LLINs and primary packing is collected and returned to the regional / provincial distribution centre (warehouse). The waste is accumulated and periodically treated.

- ▶ Reverse logistics: Transport by combined supply / reverse logistics of the used LLINs back to the regional distribution centre (transport distance normally less than 150 km).
- ▶ Waste treatment:
  - ▷ Option A: Treatment in conventional, two chamber incinerator, normally located at the main healthcare facility in the region or operated as regional healthcare waste incinerator. If an incinerator does not exist, installation of a system at the main healthcare facility could be considered.
  - ▷ Option B: Disposal in a properly engineered and managed landfill (only if existing)

### Strategy 4: Local solution

A local solution will be in most cases not possible, however it might be needed that due to missing alternatives a temporary solution must be created. In that case the used LLINs and the primary packing is accumulated and e.g. monthly disposed of by burying. Burning is not recommended.

- ▶ Reverse logistics: Not applicable. The waste is stored at a central place in the community and from time to time disposed of.
- ▶ Waste treatment: Usage of existing waste infrastructure (landfilling) by ensuring the required standards for temporary solutions.

Table 21 summarizes the comparison of the different strategies, see text to table 18 for further explanation of the assessment categories.

According to the WHO, the following options are considered as temporarily acceptable while countries

53 IMO: IMDG Code, 2012 Edition. Accessed 17.07.2014

54 Feedstock recycling means the conversion to monomers or production of new raw materials by changing the chemical structure of plastics waste through cracking, gasification or depolymerization, excluding energy recovery and incineration.

55 Refuse-derived fuel is the product of processing solid waste to separate the non-combustible from the combustible portion, and preparing the combustible portion into a form that can be effectively fired in a boiler.

56 WHO (2014): WHO recommendations on the sound management of old long-lasting insecticidal nets. Accessed 17.07.2014

**Table 21: Comparison of LLIN waste stream strategies\*,\*\***

Selected option	Health and safety	Eco-toxic impact	Climate impact
Strategy 1A	+	++	-
Strategy 1B	+	++	-
Strategy 2A	+	++	++
Strategy 2B	++	+	+
Strategy 2C	+	O	O
Strategy 3A	+	O	O
Strategy 3B	O	-	+
Strategy 4A	-	--	O

\* Indicative value only

\*\* ++: very good; +: good; O: acceptable; -: problematic; --: very problematic

are building capacity for the sound management of primary LLIN packaging<sup>57</sup>:

- ▶ Empty primary LLIN packages should be made impossible to be reused by the end user of the LLIN, e.g. by cutting, puncturing or the equivalent and should be not left with end user.

- ▶ Bury primary LLIN packaging. At the moment, there is no consensus about the exact conditions for burial and this point needs to be further assessed. In the meantime, until further evidence has been collected, WHO recommends the following: bury in soils with low permeability, away from any residences, at least 100 metres away from any wells or surface water source and at least 1.5 metres above the water table. Sloped or domed compacted soil should cover the buried plastic to a depth of one metre or more.

57 WHO (2011): Recommendations on the Sound Management of Packaging for Long Lasting Insecticidal Nets (LLINs). Accessed 17.07.2014

## 4.6 Annex 6: Properties of waste which render it hazardous<sup>58</sup>

**Carcinogenic:** Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

**Corrosive:** Substances and preparations which may destroy living tissue on contact.

**Ecotoxic:** Waste which presents or may present immediate or delayed risks for one or more sectors of the environment.

**Explosive:** Substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

**Flammable:** Liquid substances and preparations having a flash point equal to or greater than 21 °C and less than or equal to 55 °C.

**Gas releasing:** Waste which releases toxic or very toxic gases in contact with water, air or an acid.

**Harmful:** Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.

**Highly flammable:** liquid substances and preparations having a flash point below 21 °C (including extremely flammable liquids), or

- substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or
- solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or
- gaseous substances and preparations which are flammable in air at normal pressure, or
- substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities

**Infectious:** Substances and preparations containing viable microorganisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.

**Irritant:** Non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

**Mutagenic:** Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

**Other:** Waste capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.

**Oxidizing:** Substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

**Sensitizing:** Substances and preparations which, if they are inhaled or if they penetrate the skin, are capable of eliciting a reaction of hyper-sensitization such that on further exposure to the substance or preparation, characteristic adverse effects are produced.

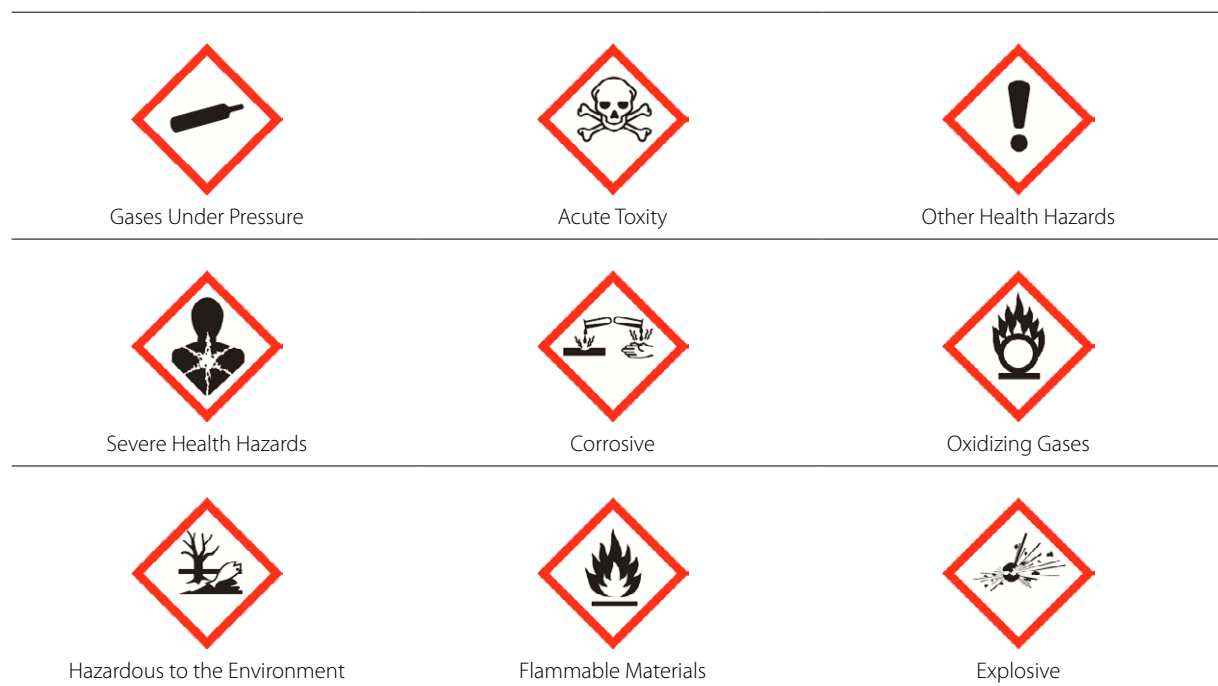
**Toxic:** Substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

**Toxic for reproduction:** Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

<sup>58</sup> Based on the European Waste Directive 2008/98/EC. Accessed 17/03/2015

## 4.7 Annex 7: Hazard Symbols – Globally Harmonized System<sup>59</sup>

**Figure 9: Hazard symbols**



<sup>59</sup> The GHS was proposed by the United Nations in an effort to internationally standardize classification and labelling of chemicals through the use of pictograms, signal words, and hazard warnings.



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