# The Republic of South Sudan
# Ministry of Health

## Development of a Medical Waste Management Plan for South Sudan

**Umbrella Program for Health System Development**

# Final Report

*26th of January 2012*

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# Acronyms

| | |
|---|---|
| BSF | Basic Services Fund |
| CHD | County Health Department |
| CPA | Comprehensive Peace Agreement |
| CPD | Continuous Professional Development |
| DFID | Department for International Development (UK) |
| DG | Director General |
| HCF | Healthcare Facilities |
| INGOs | International Non-Governmental Organizations |
| MDTF | Multi Donor Trust Fund |
| MOE - RSS | Ministry of Environment – Republic of South Sudan |
| MOH - RSS | Ministry of Health - Republic of South Sudan |
| MOHE - RSS | Ministry of Higher Education |
| MWM | Medical Waste Management |
| MWO | Medical Waste Officer |
| MWT | Medical Waste Technician |
| NGO | Non-Governmental Organization |
| PHCC | Primary Health Care Centre |
| PHCU | Primary Health Care Unit |
| RSS | Republic of South Sudan |
| SMOE | State Ministry of Environment |
| SMOH | Sate Ministry of Health |
| SSP | South Sudanese Pound |
| SUHA | Sudan Health Association |
| UNDP | United Nations Development Program |

# Foreword

This is the final report of the Development of Medical Waste Management Plan for South Sudan Project, focusing on the results of the consultant's activities carried out during a 12 week period from October 2011 to January 2012. The final report summarizes the findings of the work tasks. The following documents form an integral and important part of this report and can be found in the Annex:

- The Draft Policy: National Medical Waste Management Policy
- The Draft Guidelines: Safe Management of Medical Waste in South Sudan
- The Draft National Medical Waste Management Plan with Action Plan

The project was carried out with the technical and personal support of the Ministry of Health and the financial support of the Multi Donor Trust Fund (MDTF) within the Umbrella Program for Health System Development. The report is developed considering the financial, social and physical conditions prevailing in post-conflict South Sudan but also includes general recommendations for the first time implementation of a systematic medical waste management system in the country.

Provided recommendations are mainly based on internationally accepted medical waste policies, treatment and management options, standard operating procedures and medical waste management plans provided by the World Health Organization, the Basel Convention and the Stockholm Convention. Recommendations are further based on the experience of the consultant company in other countries in eastern and western Sub-Saharan Africa as well as in other post-conflict countries.

The consultant would like to thank the Minister for Health, Hon. Dr. Michael Milly Hussein for taking part in the review of this document, Dr. Makuwe M. Kariom, Undersecretary, Ministry of Health, Dr. S. Baba, DG Planning and Coordination, Dr. Lul Riek, DG Community and Public Health, Dr. Thuou Loi, DG Medical Services for their leadership and continuous support and Dr. Pinyi Nyimol, Director for Non-Communicable Diseases and Occupational Health and Safety for accompanying and helping us during the assessment. The consultant would also like to thank all other persons who supported this study from the Ministry of Health, the Ministry of Environment, the MDTF Team, the healthcare facilities who participated in the medical waste study, WHO, UNDP, BSF and all other institutions and organizations.

This final report contains the accomplished project results and especially describes the findings of the implemented assessment and provides background information on waste treatment technologies, training & capacity building, waste management strategies, monitoring and inspection. It does not contain the medical waste management plan; for practical reasons the decision was taken to develop this as separate document. The final report can be therefore considered as a resource document for the medical waste management plan. The final report is further delivered with a DVD which contains all project reports, files, calculations and presentations which were presented during the various workshops.

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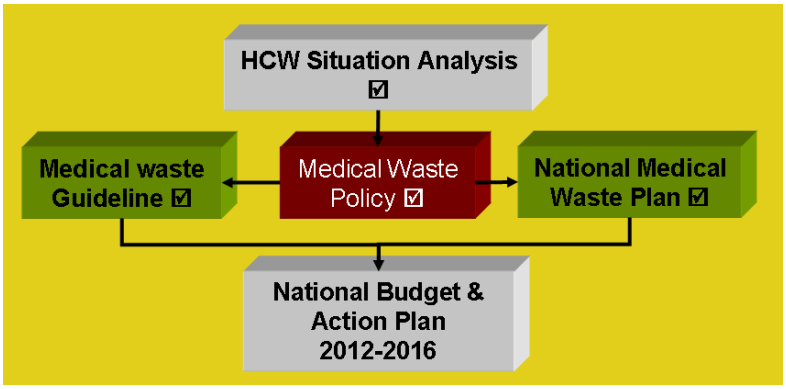
# Executive summary

The provision of healthcare services in South Sudan is unavoidably generating by-products, including different types of solid and liquid waste. As a part of this waste might be hazardous, a strategic healthcare waste management approach is to be implemented to meet the demands of environmental protection and to protect the general public and all connected persons against these hazards. The need for an appropriate segregation, collection, transport, treatment and disposal system for healthcare waste, especially medical waste, must be of high priority for safe healthcare services in South Sudan. The basis for any improvement in the medical waste sector is an assessment of the current situation and the development of a national medical waste policy, management plan and guidelines to ensure the implementation of a nation-wide, harmonized system.

Within the project "Development of Medical Waste Management Plan for South Sudan", an extensive assessment of the current medical waste situation was carried out and for the first time ever, research on waste generation rates was conducted.

The legal assessment showed that an apparent regulatory framework for medical waste management does not exist. Responsibilities for monitoring and supervision of healthcare waste activities are not clearly defined and the monitoring capacities of enforcement authorities can be regarded as low. As an immediate first intervention, it was decided to include the development of a medical waste policy and a medical waste guideline to support the later implementation of a developed national medical waste plan. To ease implementation of the plan, a 5-year action plan including cost estimation was integrated.




The assessment on the awareness and capacity of healthcare staff showed that certain awareness on problems created by medical waste exists, however general awareness on waste management issues among the public in South Sudan has to be considered as low. A concentrated and targeted awareness campaign as well as a comprehensive training system for medical waste was developed. The main task of the training program will be to establish committed staff in healthcare facilities who will be responsible initially for medical waste management and later for the complete management of healthcare facilities. The training of inspectors who will in future be able to monitor and supervise the development of the medical waste system in South Sudan was included in the comprehensive training concept.

The occupational risks to staff during medical waste management must be considered as high to very high, and dozens of serious accidents were reported to investigators. To alter this situation, an improved waste disposal logistic concept was developed, including all management steps from waste segregation, color coding, waste collection and storage. As current methods for the treatment and disposal of medical waste are unsatisfactory, alternatives were evaluated. It is recommended that non-hazardous waste should no longer be disposed of within the healthcare facility premises but collection and disposal should be organized on the nearest public dumpsite. For the treatment of hazardous waste, uncontrolled burning and use of simple incinerators should be ceased and more advanced incinerators or steam based decontamination systems (e.g. autoclaves) should be used.

Based on the assessment conducted it is expected that in the future up to 1,000 tons of infectious waste and sharps will have to be treated in South Sudan. To enable safe management of these waste streams, as well as others such as chemical waste and pharmaceutical waste, approximately 3.6 million US$ will be required to cover the capital and recurrent costs each year. Following a minimum approach and considering that investment costs may be supported and financed by development partners, a minimum of 1 million US$ will be needed to cover recurrent costs. Indicative costings were developed to enable the financial planning of medical waste management costs for different healthcare facilities.

To allow a nation-wide harmonization of medical waste management in South Sudan, a national treatment strategy for medical waste was developed. Based upon this strategy, a tool for the selection of the best and most practical waste treatment technologies for different healthcare facilities was developed. It will be one of the future tasks of the national and state level Ministry of Health to control and supervise the implementation of this system. For this, the establishment of a risk-based inspection system is recommended. This will allow limited resources to be used in a most efficient way.

The developed national medical waste management policy, the guideline on the safe management of medical waste in South Sudan and the national medical waste management plan with action plan form an integral part of this report. The documents were developed separately to allow independent usage away from this report. This report should therefore be considered as a future source of background information during the implementation of the developed policy, guideline and management plan.

# 1 Introduction

After almost 50 years of civil war, South Sudan gained independence on 9 July 2011; the result of a referendum conducted in January 2011 as provided for in the Comprehensive Peace Agreement (CPA). The Republic of South Sudan is now facing the challenge of building its health care system. Since the signing of the CPA, the process of reconstructing the healthcare sector has been one of the main challenges for the government and the health system is currently in transition from humanitarian relief towards nationally managed public health and clinical services. The following table shows the key health indicators in South Sudan in comparison with the average:

| | Southern Sudan | Sub-Sahara Africa |
|---|---|---|
| Total population | Estimations range between 8 and 12 million | |
| Government expenditure on health as % of total government expenditure | 8% | 9.07% |
| DPT3 coverage | 12% | 67% (WHO Africa Region) |
| Child mortality (per 1,000) | 250 | 151 |
| Infant mortality (per 1,000) | 150 | 93 |
| Maternal mortality ratio (per 100,000 live births) | 2,037 | 855 |
| Births assisted by skilled attendant | 6% | 51.7% |

**Source: USAID. July 2007. Building an equitable health system for Southern Sudan: Options for GAVI Health Systems Strengthening Funding**

**Table 1-1:** Overview of key health Indicators (2007)

The operation of a healthcare system will inevitably result in the generation of by-products such as medical waste. This includes not only curative activities, but also vaccination campaigns, research and dental services, all creating different waste streams.

A comprehensive medical waste management plan will have to cover all types of medical waste originating from all types of healthcare activities or related activities. During the first workshop it was decided to include priorities for action in the waste management plan. The waste management plan will be included in the final report.

**Figure 1-1: Medical Waste Disposal Site, Yei Civil Hospital**

# 2 Policy, legal and administrative framework

Article 4.1 of the Transitional Constitution of the Republic of South Sudan proclaims that every person and community has the right to a clean and healthy environment, but also cites the obligation to protect the environment for the benefit of present and future generations. The Constitution calls upon all levels of government to undertake appropriate legislative action and to develop energy policies that will ensure that the basic needs of the people are met whilst still protecting and preserving the environment.

This article forms the constitutional basis for an active National Policy on Medical Waste Management and for the preparation of national development plans that are environmentally sustainable - including plans for the future management of medical waste.

***The Environment***

*41. (1) Every person or community shall have the right to a clean and healthy environment.*
*(2) Every person shall have the obligation to protect the environment for the benefit of present and future generations.*
*(3) Every person shall have the right to have the environment protected for the benefit of present and future generations, through appropriate legislative action and other measures that:*
*(a) Prevent pollution and ecological degradation;*
*(b) Promote conservation; and*
*(c) Secure ecologically sustainable development and use of natural resources while promoting rational economic and social development so as to protect genetic stability and bio-diversity.*
*(4) All levels of government shall develop energy policies that will ensure that the basic needs of the people are met while protecting and preserving the environment.*

***Source: Transitional Constitution of the Republic of South Sudan, 2011***

This section of the report also identifies the permit requirements, explains the required public participation and procedures and describes environmental impact requirements. As environmental permit requirements do not currently exist, or only exist in draft form, recommendations based on best practices or based on experience of other countries were provided.

## 2.1 Assessment of the Policy, Regulatory (Legal) and Administrative Framework on medical waste management

A legal analysis of the medical waste situation in South Sudan was carried out within the Project. The assessment showed that no specific policies or regulations for medical waste currently exist. The legal framework for health services shows deficits and only draft documents exist for the environmental framework. Even if a sufficient framework should exist, South Sudan currently lacks resource capacity to empower regulatory bodies to effectively monitor and

inspect healthcare facilities to enforce the implementation of regulations, guidelines or standards.

For the legal assessment, documents from the health sector as well as the environmental sector were assessed, as both sectors are of equal importance for medical waste issues

**Policy, Regulatory (Legal) and Administrative Framework on medical waste management from the healthcare sector side:**

The management of medical waste is indirectly regulated by existing health policies, as for example:

- The National Ministry of Health developed an Immunization Policy (2009) which in Annex 6 provides instructions on safe injections and safe disposal of sharps waste.

The Health Policy for the Government of Southern Sudan (2006-2011) requires that:

> *6.25 Policy statement on environmental health: The Ministry of Health will raise awareness levels … health facility waste*

Also the new Draft Health Strategic Plan (2011 – 2015) includes specific instruction on medical waste and it is planned:

> *5.3.1.2 Environmental Health/Sanitation:*
>
> > *Strategic objective 3: To strengthen the capacity of public and private health care providers in medical waste management*

According to the strategic plan, priority interventions will be:

- Development of guidelines for medical waste management
- Sensitization of health workers and private health care providers in medical waste management
- Provide medical waste management facilities at all health facilities

The Basic Package of Health and Nutrition Services (Final Draft 2009) includes the community management of environmental health and hygiene (CMEH) and requires for the future: "… At work place, CMEH will develop Healthy Workplace activities to promote and protect the health and safety of people at work by preventing workplace-related fatalities…"

The legal findings of the consultant for the health sector are confirmed by a recent study conducted by the MoH to identify gaps in the health sector legal framework with view to designing a roadmap for review, and to ascertain the suitability of public-private partnerships in the health sector. The study "identifies … bills to be drafted in order for the sector to function efficiently [including the] Medical Waste Disposal Bill."

**Policy, Regulatory (Legal) and Administrative Framework on medical waste management from the Environmental sector side:**

In 2006 a National Plan for Environmental Management (2006) – NPEM for post-conflict Sudan was developed which acknowledged the pressures on the environment and the immediate human needs. The then GoSS recognized at that time the priority need for sustainable economic development, based on sound environmental management, and endorsed the preparation of a National Plan for Environmental Management in post-conflict Sudan. This National plan is currently under preparation but as yet unfinalized.

On the environmental side, two main acts exist in draft form:

- Environmental Protection Bill (2010)
- South Sudan National Environment Policy (2011)

Article 60 of the Draft Environmental Protection Bill regulates the management of hazardous waste and requests that the Ministry of Environment of the Republic South Sudan (MoE-RSS), in consultation with the respective responsible lead agency (for medical waste MoH-RSS), shall adopt standard criteria for the classification of hazardous wastes including medical waste.

It is further requested that the Ministry of Environment, in consultation with the Lead Agency, shall make regulations and issue guidelines for the management of medical waste.

The further assessment of the existing draft documents showed that several draft requirements exist for carrying out environmental impact assessments for proposed projects that may affect the environment. Although in reality these requirements are not enforced, it is recommended that for projects with a possible environmental impact (e.g. larger, centrally operated hazardous waste treatment plants), these requirements should be more stringently imposed.

### 2.1.1 Need for a medical waste policy and a medical waste guideline

Based on the outcome of this study, the requirements of the MoH-RSS to develop a medical waste bill, the requirements from the strategic plan to draft medical waste guidelines and the requirements from the draft environmental bill to set up the medical waste guidelines, it was recommended by the consultant to draft these two documents within this project.

Therefore, it was decided to draw up within the project a draft policy on medical waste and draft National Guidelines for South Sudan. This decision was supported by all stakeholders to bolster the sustainability of the project. Nearly all stakeholders interviewed referred to the lack of a robust and implementable policy as a root cause of the myriad of medical waste management problems. Additionally, the donor community confirmed a high need for these documents. As these documents would form a legal basis for a medical waste management plan, it was decided to draft these documents as core result of the legal section of the project.

### 2.1.2 The Medical Waste Management Policy

The policy document was derived from analyzing the current legal context within South Sudan (including draft guidelines).The objective is to produce a document that complements, rather than replaces existing legislation. It sets out a broad framework within which the guidelines will provide more specific practical solutions. Its goal is to minimize the negative effects of medical waste management on human health and the environment. The policy also aims to promote the sustainable use of resources and the relative reduction of costs associated with medical waste management.

The guiding principles listed in the policy underscore the importance of sustainability and adaptability within the South Sudanese context. The principles are based largely upon empowering healthcare workers to create an environment where workplace accidents are minimized and environmental hazards are avoided. In line with the World Health Organization policy paper[1] on safe healthcare waste management, the 'polluter pays' principle is also included. This calls for waste producers to be legally and financially responsible for the safe and environmentally sound disposal of the waste they produce.

To eliminate unsafe practices and improper handling of medical waste, it is imperative that healthcare workers, and more broadly the general public, are aware of the issues and their role in managing waste. This project already has a public awareness and education component, so the policy accordingly includes this element. The key to good governance is public participation, with policy provisions to heighten the awareness of healthcare workers and the general public.

Healthcare workers (both medical and janitorial/maintenance) are at the highest risk of contracting nosocomial (hospital-borne) diseases. The policy therefore sets out objectives to minimize potential risks and mitigate against potential accidents.

Personal and environmental harm will naturally decrease if waste is managed correctly. To ensure safe management, the policy makes reference to a number of relevant international conventions such as the Stockholm convention on the Persistent Organic Pollutants and the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal. Within healthcare facilities, the key objective is to ensure waste is segregated at the point of generation, and deposited, handled, treated and disposed of properly.

A monitoring and evaluation (M&E) framework is proposed to monitor the progress of the implementation of the policy and guideline, and to act as a mechanism to institute future improvement where necessary. Although medical waste management systems will be mainly implemented by private and public healthcare institutions, the Ministry of Environment will also play a key monitoring role.

To clearly delineate institutional responsibilities, the policy sets out a framework indicating which line ministries will have authority relating to medical waste. The

[1] http://www.healthcarewaste.org/fileadmin/user_upload/resources/WHO-HCWM-policy-paper-2004.pdf

MOH-RSS is placed in a prime position (Lead Agency), as it is responsible for providing healthcare services. The Ministry of Environment will also have certain responsibilities, especially in regards to environmental impact assessments. The MOH-RSS will serve as the leading body, in coordination with the appropriate sister Ministries and Agencies, and will be responsible for the implementation of the South Sudanese National Medical Waste Management Policy.

### 2.1.3 Draft Guidelines: Safe Management of Medical Waste in South Sudan

The effective management of medical waste is of vital importance to the healthcare sector and the people in South Sudan need to be assured that such waste is managed and disposed of properly.

The guidelines have been developed to support healthcare facilities in their implementation of the National Health Policy and the National Health Plan, as well as the National Policy on Medical Waste Management. As such, the guidelines aim to be a part of the Basic Package of Health Services (BPHS). Whilst the guidance set out in this document should help those responsible for the management of medical waste, it does not remove their obligation to comply with other legislation and good practices.

The guideline will serve as a tool for the long term implementation of sustainable medical waste management solutions in South Sudan. It also acts as a guide for the national government, state authorities, and international donors on how to implement a sustainable system in the context of the existing healthcare system in rural and urban areas of South Sudan.

The draft policy and the draft guidelines are provided as an Annex to this document.

## 2.2 Identification of permit requirements

Permit requirements for medical waste management projects and infrastructure are typically regulated in countries by the environmental protection laws. In South Sudan the Environmental Protection Bill, 2010 is the relevant document.

As stated in this draft bill, it will be the future task of the Ministerial Environment Committees to develop standard methodologies for Environmental Impact Assessments (EIA) and procedures for RSS development polices and private sector investments. It will be the responsibility of the Ministry of Environment to review and approve the EIA reports of proposed projects and issue EIA licenses.
According to the draft Bill, an EIA should be undertaken by a project manager when the Ministry of Environment is of the view that the project:

1. may have an impact on the Environment
2. is likely to have a significant impact on the Environment
3. will have a significant impact on the Environment

This will be the case for all medical waste projects. EIAs will be conducted by an expert retained by the project manager whose name and qualifications have

been approved by the Ministry. It is required that the EIA shall be appropriate to the scale and possible effects of the project. Three levels are planned:

I. Environmental Impact Review – if the project has a minor impact on the Environment
II. Environmental Impact Evaluation – if the project is likely to have a significant impact on the Environment or,
III. Environmental Impact Statement - if the project will have a great impact on the Environment

If the Ministry of Environment is satisfied that an environmental impact review or an environmental impact evaluation conducted does not significantly harm the Environment, it will approve the environmental aspects of the project.

Due to the lack of environmental legislation, direct environmental permit requirements do not exist. The absence of legislation, however, does not mean that informal permit requirements do not exist. It can be reasonably expected that most of the medical waste infrastructure will be financed by official development aid projects. In the Paris Declaration on Aid Effectiveness (2005), donors – including donors contributing to the MDTF - reiterated the importance of promoting a standardized approach to environmental assessments.

Specifically, they committed to “strengthen the application of EIAs and deepen common procedures for projects, including consultations with stakeholders; and develop and apply common approaches for ‘strategic environmental assessment’ at the sector and national levels” (Art. 41). EIA implementing procedures to guide future ODA-financed medical waste projects are provided in these recommendations

An EIA is an assessment of the possible positive or negative impact that a proposed project may have on the environment, including the social, economic, and environmental impacts. The purpose of the assessment is to ensure that decision-makers consider the ensuing environmental impacts when deciding whether to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as:

"The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made."

EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to be accountable for the environmental impacts of their decisions and to justify those decisions based on environmental studies and public comments.

Based on The Environmental Impact Assessment (EIA) - Global Guidelines Project, it is suggested that an EIA be required for medium to larger medical waste projects. Projects will be defined as medium if the treatment capacity is larger than 50 kg/h hazardous medical waste.

The EIA process should be based on operating principles and should be applied as follows:

- As early as possible in decision making and throughout the life cycle of the proposed activity
- To all development proposals that may cause potentially significant effects
- To biophysical impacts and relevant socio-economic factors, including health, culture, gender, lifestyle, age, and cumulative effects consistent with the concept and principles of sustainable development
- To provide for the involvement and input of communities and industries affected by a proposal, as well as the interested public
- In accordance with internationally agreed measures and activities

The structure of the generic EIA is recommended to be as follows:

1 Summary
2 Introduction
2.1 Structure
2.2 Background
2.3 Purpose and Need for Action
2.4 Proposed Action
2.5 Decision Framework
2.6 Public Involvement
2.7 Issues
3 Alternatives, including the Proposed Action
3.1 Alternatives
3.2 Mitigation Common to All Alternatives
3.3 Comparison of Alternatives
4 Environmental Consequences
5 Consultation and Coordination

It is recommended that project developers for medium or large scale medical waste projects be required to submit an application to the State Environmental Officer of the Ministry of Environment for an EIA license (permit) prior to the commencement of all projects and activities. It is also recommended that a project brief be submitted to the Ministry of Health.

Following the submission of the application for an EIA permit, the applicant shall publish a notice of intent, which shall state in a concise manner the information that may be necessary for a stakeholder or interested party to determine its interest in the proposed project or activity. The State Ministry of Environment (SMoE), in consultation with the line Ministries, shall evaluate the project brief to determine the potential environmental impact of the proposed project or activity and shall determine the following:

a) If a project may have a significant impact on the environment, the SMoE shall require the proponent or applicant to prepare an environmental review

b) If the project or activity will have or is likely to have a significant impact on the environment and the project brief discloses no sufficient mitigation measures, the SMoE shall require the proponent or applicant to prepare an environmental impact study

c) If the project or activity will not have, or is unlikely to have a significant impact on the environment or the project discloses sufficient mitigating

measures, the SMoE shall issue a finding of no significant impact (FONSI) or a certificate of approval

In addition to environmental permits, a medical waste facility will need financial registration to be financially registered. Assuming that this process is similar to the process for registering health facilities, three stages are needed:

I. Registration with the Ministry of Investment: Under the Investment Act, all potential investors are required to register. A certificate is issued.
II. Incorporation: The facility is incorporated and issued a registration certificate.
III. Operating License: After inspecting a facility and determining if it meets the set requirements, the Director of Medical Services will issue an operating license. Licenses obtained at stages 2 & 3 are renewable annually upon payment of prescribed fees.

### 2.2.1 Current practice & experience:

Interviews with different stakeholders including MoH-RSS and MoE-RSS were held. To date, no EIAs have been carried out for any health project. For the most recent MDTF/NPA project, which included five small scale medical waste incinerators in Central Equatoria, no permit procedure was followed. MDTF/NPA Office informed the consultant that the permit for the incinerators was not required as their design was based on an operational incinerator that had already been approved in Kajo-Keji in 2006. Additionally incinerator installations are considered as minor installations with limited environmental impact.

## 2.3 Required public participation or involvement and procedures

Interviews with various ministries at state and central level indicated that policies on public participation or involvement in waste management are still in the developmental stage. The RSS Ministry of Environment indicated that public participation procedures are outlined in the draft Waste Management Policy that will be released for approval to the Ministry of Justice and Council of Ministers in early 2012.

It is important to keep in mind that in the federalist system of South Sudan, the central government is responsible for issuing policies and frameworks whilst building the capacity of state ministries to implement these policies and procedures themselves.

The primary dump site for Juba is located on the outskirts of the town en route to Central Equatoria's second largest town, Yei. Interviews indicated conflicting opinions on whether there had been public participation in the selection of this particular site. As a result of the large influx of returnees, citizens and residents inhabiting the land at the time of construction may differ from those inhabiting it now.

In the future, the Ministry of Environment has noted that all waste management projects must involve an EIA. As part of this impact assessment the government in certain communities will be consulted in the selection of future waste disposal sites.

The United Nations Conference on Environment and Development in Rio de Janeiro (Rio Earth Summit) was a major step towards establishing public participation as a right. Principle 10 of the declaration deals with public participation and states that “environmental issues are best handled with participation of all concerned citizens, at the relevant level”. The Rio Declaration then emphasizes the important role of states in facilitating public participation by ensuring access to information.

The term “public participation” includes organized processes adopted by elected officials, government agencies, or other public- or private-sector organizations to engage the public in environmental assessment, planning, decision making, management, monitoring, and evaluation. These processes supplement traditional forms of public participation (voting, forming interest groups, demonstrating, lobbying) by directly involving the public in executive functions that are traditionally delegated to administrative agencies. The goal of participation is to improve the quality, legitimacy and capacity of environmental assessments and decisions.

When done well, public participation improves the quality and legitimacy of a decision and builds the capacity of all involved to engage in the policy process. It can lead to better results in terms of environmental quality and other social objectives. It also can enhance trust and understanding among parties. Achieving these results depends on using practices that account for difficulties that might arise as a result of the project.

When government agencies engage in public participation, they should do so with:

- clarity of purpose,
- a commitment to using the process to inform their actions,
- adequate funding and staff,
- appropriate timing in relation to decisions,
- a focus on implementation
- a commitment to self-assessment and learning from experience.

The agency responsible for undertaking the public participation process should consider the purpose of the process and design it to address the challenges that will arise in specific contexts. The design of the project should be guided by four principles:

I. Inclusiveness of participation
II. Collaborative problem formulation and process design
III. Transparency of the process
IV. Good-faith communication

The Protocol on Strategic Environmental Assessment (SEA Protocol) supplements EIA procedures and is a “process of evaluation of environmental effects (including health) during the preparation of policies, plans, [programs] and

legislation". The SEA protocol requires that health, social, economic and other issues be factored into strategic decisions. In order to achieve this, the SEA protocol should be conducted with public participation. If this is done, strategic decisions will be more transparent and harm to the environment and health of community members will be limited.

### 2.3.1 Current practice & experience:

So far public participation is not mandated and it is typically up to the aid provider to decide whether or not public participation is solicited.

## 2.4 Assessment of typical time demands for obtaining permits for proposed facilities, and description of necessary environmental impact requirements

Precise time demands for obtaining permits or operation licenses are currently not defined in any legal documents in South Sudan. In the draft environmental bill from the MoE-RSS however, the following guidelines for obtaining an Environmental Impact Statement are given:

> *31. Consideration of the Environmental Impact Statement by the Lead Agency; obligation of the Project Proponent*
>
> *(1) The Lead Agency which receives an Environmental Impact Statement shall, in consultation with the Ministry, study it and if it considers it to be complete shall deal with it in the manner prescribed within forty-five (45) days.*

Article 58 of the environmental bill (MoE-RSS) explains that:

> *(1) No person shall use, operate, establish, alter, enlarge or extend,*
> *(a) A Waste Management System; or*
> *(b) A Waste Disposal Site,*
>
> *unless a license has been issued by the Ministry and except in accordance with any conditions set out in such License.*

No timeline is provided on the length of time it will take to receive an operation permit or how long it will take to receive this license.

### 2.4.1 Current practice & experience:

Interviews with the MDTF/NPA Office indicated that projects with the potential to seriously impact the environment require a licensing procedure. It was estimated that this licensing procedure could take between 14 to 30 days through the SMoE. So far no project projects have been carried out that have followed a licensing procedure or obtained an EIA.

The consultant also interviewed the UNDP regarding information on the duration of obtaining permits for the proposed incinerators which will be installed in

hospitals in Torit, Wau, Malakal and Renk. According to the UNDP, the tender procedure was finalized in October 2011. As of December 9, 2011, none of the relevant government agencies or target hospitals had received any information on the proposed facilities. Therefore, no EIA or licensing procedures have been commenced. Interviews with the MoH-RSS Department for Procurement indicated that this institution had neither been consulted about this matter nor provided with information on other similar investments concerning the installation of waste treatment facilities in other locations and states.

**Figure 2-2: Old Medical Waste Incinerator, Malakal**

# 3 Project description

## 3.1 Project goals and objectives

The overall objective of the project was to conduct a comprehensive medical supplies and medical waste management assessment in South Sudan and to develop a national medical supplies and waste management strategy, including physical investments, waste management and disposal, compliance monitoring and training activities.

The main activities of the project were the assessment of existing policies and waste management practices, identification of appropriate technology and sites, analysis of training and public awareness needs and the preparation and presentations of reports.

The project period was 12 weeks and commenced mid-October 2011. The project included a break during Christmas and the final workshop and closing ceremony of the project was held on the 27.01.12.

The problems of medical waste management in South Sudan are well-known to the stakeholders and the project were supported and welcomed by all relevant institutions and organizations. The project aimed to assess existing problems and to achieve sustainability for ongoing updating of knowledge and skills.

The project was coordinated with other ongoing projects and donor organizations, including the WHO and UNICEF, the BSF, Joint Donor Project, USAID, the World Bank, UNDP, MSF and other projects.

## 3.2 Project outputs and results

The main outputs and results to be delivered by the Consultant are:

- Information on the legal situation is provided and recommendations for an update are formulated
- A baseline study of the actual medical waste generation rate is conducted
- Information on the medical waste management situation is made available
- A short report on appropriate medical waste treatment technology for South Sudan including a decision making process is completed
- A short report on the evaluation of sample disposal sites with clear recommendations for future disposal sites is completed
- A short report on financing possibilities including possibilities for private funding is provided
- A review of existing practices and public awareness systems is completed
- A training plan for the implementation of medical waste training is drafted
- Two workshops are carried out (first strategic workshop on the 02.12.11 and a final workshop on the 27.01.12)

The following formal project reports were delivered on time:

- Inception Report
- Draft Final Report
- Final Report (including all findings and recommendations)

## 3.3 Project implementation plan:

At the beginning of the project, the final work plan for the implementation of the project was developed and presented in the inception report. This project implementation plan was followed throughout the entire project.

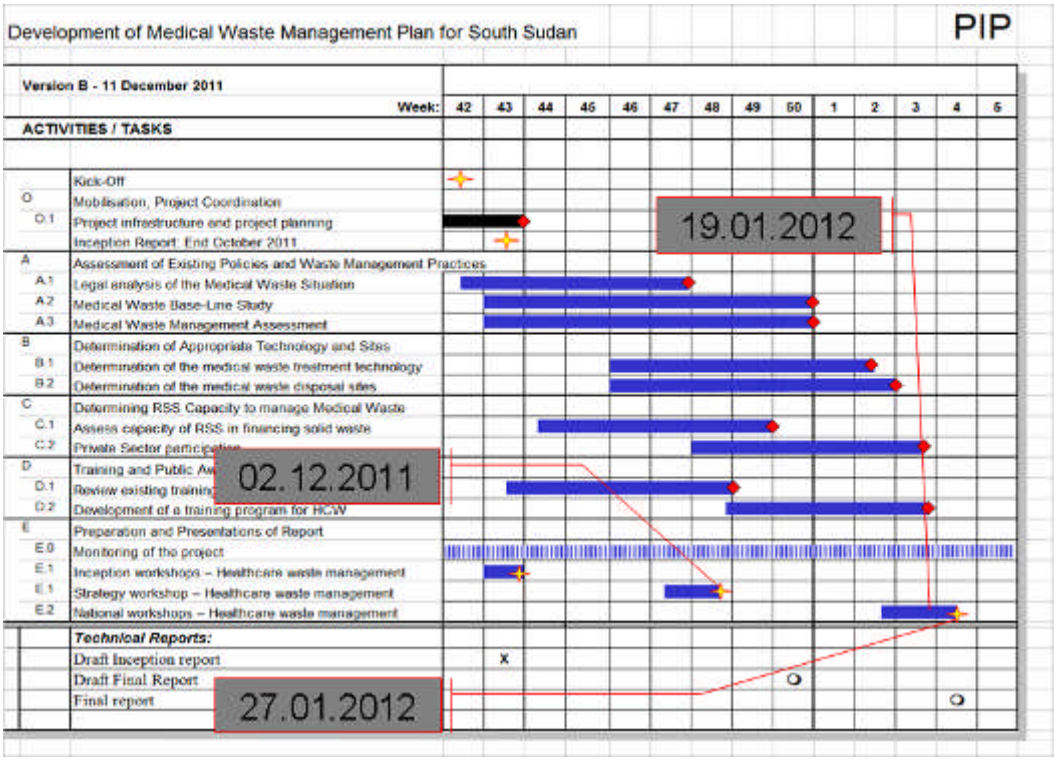



**Figure 3-3: Project implementation Plan (Jan.12)**

Certain unexpected difficulties such as missing data for healthcare facilities, no available data on bed occupation rates and delays by participating hospitals in providing data from waste assessments resulted in slight delays in the provision of the final draft report, which was provided on the 15.12.11. At the end of the project, however, all technical project reports were supplied in week 10 of the project on the 26.01.12. Instead of one, two strategy and stakeholder workshops were carried out. The second strategy workshop was carried out by invitation from the Ministry of Health and involved high level officials, including the Minister. The final workshop took place on the 27.01.12. The project itself was divided into 5 main tasks. The different tasks include the following activities:

**Task A: Assessment of Existing Policies and Waste Management Practices**

1. Legal analysis of the Medical Waste Situation
   - Assessment of the policy, regulatory (legal) and administrative framework on medical waste management

- Identification of permit requirements, including environmental building, and procedures for medical waste treatment/destruction facilities
- Description of required public participation and procedures
- Assessment of typical time demands for obtaining permits for proposed facilities and description of environmental impact requirement

2. Medical Waste Base-Line Study
- Identify all medical waste generators and collect all key data such as number of beds, occupation rates, length of stay, etc.
- Assess the medical waste generation rates in different healthcare facilities and extrapolate for the entire country
- Provide a comprehensive description of the current status of medical waste management in South Sudan, including description of the existing treatment and disposal infrastructure

3. Medical Waste Management Assessment
- Analysis of applied medical waste management including medical waste guidelines, segregation, collection, transportation, storage and disposal systems
- Assessment of medical waste management knowledge, awareness and behaviors at various levels
- Identification of financing needs, potential sources of funding, key actors and necessary budgetary allocation for waste management
- Assessment of the existing recycling system for medical waste inside health care facilities, along transportation routes and at final disposal sites

**Task B: Determination of Appropriate Technology and Sites**

1. Determination of the medical waste treatment technology
- Comprehensive assessment of alternative technologies and facility sizes for treatment and destruction considering the situation in South Sudan
- Development of a decision making process flow for the choice of environmentally sound treatment and final disposal of medical waste

2. Determination of medical waste disposal sites
- Analysis of sample existing medical waste disposal sites
- Provide recommendations for medical waste disposal sites

**Task C: Determining RSS Capacity to Manage Medical Waste**

1. Assess the capacity of the RSS to finance solid waste treatment
- Evaluation of the current capacity of the government, including municipalities, in financing effective solid waste treatment.

2. Private Sector participation
- Evaluate the possibility of including the private sector as a service provider

**Task D: Training and Public Awareness**

1. Review existing training and public awareness programs on medical waste
- Identify the strengths, weaknesses and opportunities to develop better practices
- Develop a program to raise awareness about medical waste

2. Develop a training program for medical waste
- Prepare a training program for medical waste disposal and discuss with stakeholders
- Develop a complete training program and presentation

**Task E: Preparation and Presentations of Reports**

1. Monitor the project
- Set up internal monitoring based on LFA
- Evaluate internal monitoring processes

2. Inception report meetings on medical waste management
- Prepare meeting reports
- Organize meetings to report on tasks

3. National workshops (2x) on medical waste management
- Prepare workshop
- Organize workshop

## 3.4 Designation of key and non-key experts and allocation of resources:

All key and non-key experts performed their work as planned. All external experts arrived on time and in accordance to the work plan.

The staff planning for the project was as follows:

| | | Staff input (in the form of a bar chart) | | | | | | | | | | | | | | Total staff- input | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | W41 | W42 | W43 | W44 | W45 | W46 | W47 | W48 | W49 | W50 | W1 | W2 | W3 | W4 | W5 | Home | Field | **Total** |
| Foreign Experts (1) | | | | | | | | | | | | | | | | | | | | |
| 1 | Jan-Gerd Kühling | [Home] | | | | | | | | | | | | | | | | 15 | | 15 |
| | Team Leader / Public Health Expert | [Field] | | | | | | | | | | | | | | | | | 25 | 25 |
| 2 | Dr. Ute Pieper | [Home] | | | | | | | | | | | | | | | | 8 | | 8 |
| | Waste Management Expert | [Field] | | | | | | | | | | | | | | | | | 12 | 12 |
| 3 | Pawel Gluszynski | [Home] | | | | | | | | | | | | | | | | 8 | | 8 |
| | Environmental Expert | [Field] | | | | | | | | | | | | | | | | | 52 | 52 |
| 4 | Natalie Forcier | [Home] | | | | | | | | | | | | | | | | | | 0 |
| | Sociologist | [Field] | | | | | | | | | | | | | | | | | 50 | 50 |
| | | | | | | | | | | | | | | | | | | **31** | **139** | **170** |
| Local support staff | | | | | | | | | | | | | | | | | | | | |
| 1 | Secretary / Logistic | [Field] | | | | | | | | | | | | | | | | | 50 | 50 |
| 2 | Driver | [Field] | | | | | | | | | | | | | | | | | 40 | 40 |
| | | | | | | | | | | | | | | | | | | | 90 | 90 |

(1): For Foreign experts, it is expected that they will work 6 days per week while in South Sudan and 5 days when working at the home office

Legend:
= Fulltime
= Parttime, about 2/3 working for the project
= Parttime, about 50% working for the project
= Parttime, about 1/3 working for the project

**Figure 3-4: Staff resource planning**

Due to limitations such as missing data it was decided during the project that the environmental expert should especially concentrate on the assessment to ensure the high quality of data. In order to achieve this, the waste management expert and the team leader took over other parts the environmental expert's work. The time increase for these two positions was covered by the consultant company and did not incur any additional costs for the client.

The financial resources provided by the consultant company to facilitate the project were considered sufficient and enabled the experts to carry out the project as planned. Due to the security and infrastructure situation, transportation was more costly than originally expected; extra costs were covered by the consultant company. Additional funds were agreed and delivered for training and for the payment of per diems by the MDTF project.

**Figure 3-5: Incinerator of the Juba Teaching Hospital**

# 4 Baseline data on medical waste generation

The assessment revealed a deficiency in available and reliable data on healthcare infrastructure in South Sudan. The main source of information on healthcare facilities is currently a database compiled for the Health Facility Mapping Project by the RSS Ministry of Health (MoH-RSS). The data from this project, for example hospital bed numbers, will be used to calculate the waste generation rate.

Data of good quality but with a limited scope in regards to medical waste issues was compiled by the WHO on major hospitals in South Sudan. The WHO carried out an extensive assessment of 8 state and 12 county hospitals in 2010, incorporating data collected by other institutions in the four previous years.

Development partners (NGOs and UN development agencies) are very active in South Sudan. In the course of their work they collect and exchange information regarding the healthcare facilities they support. The BSF for example maintains a comprehensive database on healthcare facilities (District Health Information Software) but it does not include information on bed numbers and occupancy rates, nor on on-site waste treatment installations.

For the project database, data was collected from the aforementioned sources. In the case of missing data, State Ministries of Health in Warrap, Western Bahr El Gazal, Western Equatoria, and Upper Nile were consulted. The data was cross-checked against other sources to confirm its validity. For areas where no data was available, conclusions were drawn based on data from other locations. In summary, the final document contains the best possible data source considering the quality of locally available data.

A complete list of health care facilities in South Sudan is contained in the Annex. The list will be used to carry out the calculation of total infectious waste generated within the country.

## 4.1 Basic health information on healthcare facilities

The structure of the health care system in South Sudan is defined by the MoH-RSS's Basic Package of Health Services (January 2009) and the Health Strategic Plan 2011 – 2015 (15th September 2010). It consists of three levels of services.

The Primary Level of Care includes basic health care services delivered through Primary Health Care Units (PHCUs) and Primary Health Care Centers (PHCCs). PHCUs are small facilities with no beds, and provide basic preventive and curative care for a population of 15 000 people. Service provision at this level includes promotional health, family planning, antenatal care and normal delivery. Curative care is provided for common and uncomplicated diseases. Anyone requiring further supervised care is referred to the nearest PHCC or hospital.

The PHCCs are the first referral centers for the payam. According to the Basic Package of Health Services they are divided into two categories: The Basic Emergency Obstetric and Neonatal Care (BEmONC PHCC), and Comprehensive EmONC (CEPHCC). The first is expected to have a catchment population of

50 000, and the second 150 000 to 200 000 people. Both types of PHCCs offer a wider range of diagnostic and curative services than a PHCU, notably laboratory diagnostics, and they also have an observation ward. In addition, CEPHCCs provide full surgical obstetrics. PHCCs should have 10-30 observation beds.

There are 286 PHCCs and 792 PHCUs in the 10 states of South Sudan. The PHCCs and PHCUs are run and managed by the respective County Health Departments (CHDs) in different states.

Primary level care is also supported at village level by Home Health Promoters (HHP) and Mother and Child Health Workers (MCHW) who provide health care under the supervision of Community Midwives and Community Health Extension Workers (CHEWs). There is no physical structure but a team of trained community health workers work as a link between health facilities and the community.

The Secondary Level of Care encompasses state and county hospitals. There are 7 state hospitals and 27 county hospitals. These are run and managed by the respective states. State and county hospitals are general hospitals and provide preventive and curative in-patient health services and surgery. County hospitals are expected to cover a catchment population of 300,000 people.

The Tertiary Level of Care is the most specialized health care, administered to patients with complex diseases who may require high-risk pharmacologic regimes, surgical procedures, or high-cost, high-technology resources. There are 3 tertiary hospitals in South Sudan: Juba, Malakal and Wau. Tertiary hospitals are managed by MoH-RSS and serve as referral hospitals for a group of states (or regions). Tertiary hospitals provide specialist clinical services such as higher level surgical, medical and clinical support services: laboratory, medical imaging (X-ray, USG) and pathology. They are also involved in teaching.

According to a report of the Health Facility Mapping Project conducted by MoH-RSS between 2009 and 2011, the following number of healthcare facilities were identified in ten states of South Sudan:

| State | Teaching Hospital | State Hospital | County Hospital | Special Hospital | Other Hospital | Private Hospital | PHCC | PHCU | *Total* |
|---|---|---|---|---|---|---|---|---|---|
| **Cent.E.** | 1 | 2 | 2 | 4 | 2 | 4 | 49 | 127 | *191* |
| **East E.** | - | 1 | 3 | 1 | 2 | - | 34 | 92 | *133* |
| **Jonglei** | - | 1 | 3 | - | - | 2 | 31 | 87 | *124* |
| **Lakes** | - | 1 | 5 | 1 | - | - | 19 | 55 | *81* |
| **NBG** | - | 1 | 1 | 2 | 2 | - | 15 | 77 | *98* |
| **Unity** | - | - | - | - | - | 1 | 20 | 54 | *75* |
| **Upper Nile** | 1 | - | 4 | 4 | 2 | 2 | 36 | 72 | *121* |
| **Warrap** | - | - | 3 | 1 | - | - | 26 | 56 | *86* |
| **WBG** | 1 | - | 1 | 1 | 1 | - | 19 | 64 | *87* |
| **West E.** | - | 1 | 5 | - | 1 | 2 | 37 | 108 | *154* |
| ***Total*** | ***3*** | ***7*** | ***27*** | ***14*** | ***10*** | ***11*** | ***286*** | ***792*** | ***1150*** |

**Table 4-2:** Number and type of healthcare facilities in ten states of South Sudan.

The data provided could be further used to get a first overview on the number of beds and hospitals in the different states.

| Name of State | Facilities with beds | Total number of beds | Incinerators |
|---|---|---|---|
| Central Equatoria | 39 | 1744 | 10 |
| Eastern Equatoria | 26 | 860 | 5 |
| Jonglei | 41 | 706 | 32 |
| Lakes | 14 | 846 | 6 |
| Northern Bahr El Ghazal | 16 | 450 | 13 |
| Unity | 14 | 348 | 2 |
| Upper Nile | 38 | 1133 | 22 |
| Western Bahr El Ghazal | 17 | 1026 | 14 |
| Western Equatoria | 28 | 666 | 14 |
| Warrap | 24 | 666 | 17 |
| **Total South Sudan** | **257** | **8445** | **135** |

**Table 4-3:** Number of facilities with beds and number of hospital beds by state

A report finalized seven months earlier by WHO ascertains that there are 9 states (including 3 teaching) and 23 county hospitals for the whole of South Sudan, which was verified by the respective State Ministries.[2]


**Figure 4-6: Map of the States and Counties of South Sudan**

The consultant obtained an excerpt from MoH-RSS database on healthcare facilities on December 1, 2011. The database contains information on bed numbers and on-site incinerators. However, the database does not employ a naming convention, and it is not possible to identify and differentiate healthcare

[2] Report on the Assessment of Hospitals in Southern Sudan, WHO South Sudan, November 2010.

facilities according to their kind, level, and ownership. The following data was provided:

| Kind of information | Data reported |
|---|---|
| Total number of healthcare facilities | 1463 |
| Number of identified hospitals (public & private) | 59 |
| Total number of hospital beds | 5333 |
| Number of PHCCs reported with beds | 138 |
| Total number of beds in PHCCs | 1772 |
| Total number of beds in all healthcare facilities | 7147 |
| Number of incinerators in all healthcare facilities | 128 |

**Table 4-4:** Healthcare facilities in ten states of South Sudan.

As this information is considered to be the most accurate available, it was used for the following calculations. Based on this data it can be estimated that a PHCC contains on average about 15 beds. As the three teaching hospitals have together around 1,239 beds, the average bed rate of the remaining 56 hospitals is about 75 beds.

## 4.2 Assessment of waste generation rates

The project aimed to identify medical waste generators, assess their waste generation rates and provide a comprehensive description of the current status of medical waste management in South Sudan.

The Ministry of Health selected the following healthcare facilities for further analysis.

- Three tertiary hospitals;
- Eight state, county and special hospitals;
- Five major health centers;
- Three private hospitals

To assess medical waste generation rates, the following healthcare facilities were targeted:

| Type of facility | Name of facility |
|---|---|
| Tertiary Hospital 1 | Juba Teaching Hospital |
| Tertiary Hospital 2 | Malakal Teaching Hospital |
| Tertiary Hospital 3 | Wau Teaching Hospital |
| County Hospital 1 | El Sabbah Children Hospital |
| County Hospital 2 | Juba Military Hospital |
| County Hospital 3 | Juba Police Hospital |
| County Hospital 4 | Lainya PHCC (Hospital) * |
| County Hospital 5 | Yei Civil Hospital |
| County Hospital 6 | Terekeka PHCC (Hospital) * |
| County Hospital 7 | Torit State Hospital |
| County Hospital 8 | Rumbek State Hospital |
| Health Care Centre 1 | Kator Primary Health Care Centre (Juba) |

| | |
|---|---|
| Health Care Centre 2 | Munuki Primary Health Care Centre(Juba) |
| Health Care Centre 3 | Nyokuron Primary Health Care Centre (Juba) |
| Health Care Centre 4 | Muktah Primary Health Care Centre (Wau) |
| Health Care Centre 5 | Primary Health Care Centre (Malakal) |
| Private Hospital 1 | Juba International Hospital |
| Private Hospital 2 | Juba Medical Complex |
| Private Hospital 3 | Victorious Hospital |

**Table 4-5:** List of assessed healthcare facilities.

*Facilities marked with asterisk*:* Lainya and Terekeka are currently PHCC but were selected by the Central Equatoria State Ministry of Health to be included in the assessment as county hospitals as they will be soon upgraded.

Fourteen representatives of the selected health care facilities who are responsible for the waste management system in their establishments were provided with one day interactive training on medical waste management and assessment. A training manual and instructions on waste segregation and weighing were delivered to the trainees. Five facilities who were unable to participate in the training were instructed during on-site visits on how to weigh waste.

Upon return, it was the task of the trainees to carry out an assessment of the waste generation in their facilities for a period of 14 days. During these 14 days, they reported the following data to the consultant:

- Total number of beds,
- Number of inpatients and outpatients admitted each day,
- Quantity of medical waste generated per day (24 hours), divided into: sharps, mixed waste (infectious), body parts, chemicals, expired drugs, and domestic (solid) waste.

During the assessment period, all of the healthcare facilities participating in the research were continuously assisted and on-site visits were carried out as often as possible. Additionally the waste system in each institution was inspected at least once and stakeholders interviewed for other information on their institutional structure, services provided and the waste management system they maintain. The site visit reports from each assessment are provided in the annex.

Representatives from the MoH-RSS, relevant SMoH, and County Health Departments (CHD) supervised the assessment. The returned data was then evaluated to estimate average waste generation rates for each facility, particularly for different waste streams and for bed occupancy rates. This data was then used to draw up conclusions on the national situation.

### 4.2.1 Problems and shortcomings

Medical waste management and the assessment of medical waste management systems is a new topic for healthcare staff in South Sudan. To overcome difficulties, the consultant provided training on waste management. During the training it became obvious that participants would face problems in fulfilling their duties.

During the assessment, major issues with communication were confronted. Often it was not possible to contact the healthcare facility administration. In some

cases, the consultant was able to obtain contact information for SMoHs and healthcare facilities from the MoH-RSS but in many cases communication was not possible due to telephone failure and/or lack of communication between SMoHs and healthcare facilities.

Due to a lack of flight availability, healthcare workers from the healthcare facilities in Wau were not able to participate in the training. As a result of this, Wau healthcare facilities were delayed in starting their waste weighing program until after the consultant had visited them.

Additionally the following healthcare facilities could not participate in the training: Yei Civil Hospital, Torit State Hospital and Juba Medical Complex. Training was conducted onsite for these healthcare facilities and all necessary information was hand delivered.

The Police Hospital in Juba informed the consultant during the training that it had decided to start a renovation project and would be closed until at least the end of 2011. As no medical waste was generated during the assessment period, this hospital was excluded from the assessment.

When the consultant visited the three PHCCs in Juba it was noticed that the facilities did not start the waste weighing on time due to the lack of a scale. In case of Kator PHCC the personnel was also not informed about the project by the two PHOs who had represented the facility at the training. The scales were delivered to the PHCCs on November 28. Also a delay in implementing the waste assessment was noticed in other facilities. At the end of the project Wau Teaching Hospital, Juba Police Hospital, Yei Civil Hospital and Muktah PHCC were not able to deliver the required information. Rumbek State Hospital and Malakia did respond but did not deliver all required information. Other hospitals tried to deliver all required data but reported some difficulties.

Overall it can be said that, considering the current limitations of medical waste know-how, the collected data after corrections had been carried out was sufficient for the purpose of this study. It is recommended that this study be repeated after the introduction of a basic medical waste management system to update the data.

### 4.2.2 Main results and extrapolation

A summary of information on bed numbers and occupancy rates compiled from information collected by the consultant and delivered by healthcare facilities is summarized in the below table:

| Health care facility | Number of beds | Number of inpatients | Number of outpatients | Occupancy rate |
|---|---|---|---|---|
| Juba Teaching Hospital | 534 | 391 | 276 | **73%** |
| Malakal Teaching Hospital | 325 | 50 | 183 | **15%** |
| El Sabbah Children Hospital | 94 | 78 | 67 | **83%** |
| Lainya PHCC (Hospital) | 26 | 1 | 22 | **5%** |
| Terekeka PHCC (Hospital) | 11 | 3 | 29 | **31%** |
| Torit Hospital | 128 | 82 | 169 | **73%** |
| Rumbek State Hospital | 124 | 81 | 66 | **65%** |
| Kator PHCC | 25 | 6 | 139 | **23%** |

| | | | | |
|---|---|---|---|---|
| Munuki PHCC | 22 | 6 | 90 | **27%** |
| Nyokuron PHCC | 12 | 0 | 48 | **0%** |
| International Hospital Kampala Juba Clinic | 2 | 0 | 0 | **100%** |
| Juba Medical Complex | 22 | 9 | 28 | **41%** |
| Victorious Hospital | 14 | 5 | 17 | **32%** |
| **Average** | | | | **44%** |

**Table 4-6:** Summary of collected data from health care facilities.

The total amounts of non-hazardous and hazardous waste were estimated for each individual healthcare facility. These estimations are based on the total number of beds and reported occupancy rates. As in most hospitals a separation of hazardous and non-hazardous waste was not introduced or was of poor quality, it was agreed to compile all waste streams to identify the total amount of waste produced per occupied bed per day.

In cases like South Sudan where waste segregation is being newly introduced, it is recommended by the WHO to consider the following composition of medical waste for the calculation of the normalized waste generation rates: [3]

- 80% general medical waste, which may be dealt with by the normal domestic and urban waste management system
- 15% infectious and pathological waste
- 1% sharps waste
- 3% chemical or pharmaceutical waste
- less than 1% specialized waste, such as radioactive or cytostatic waste, pressurized containers, or broken thermometers and used batteries

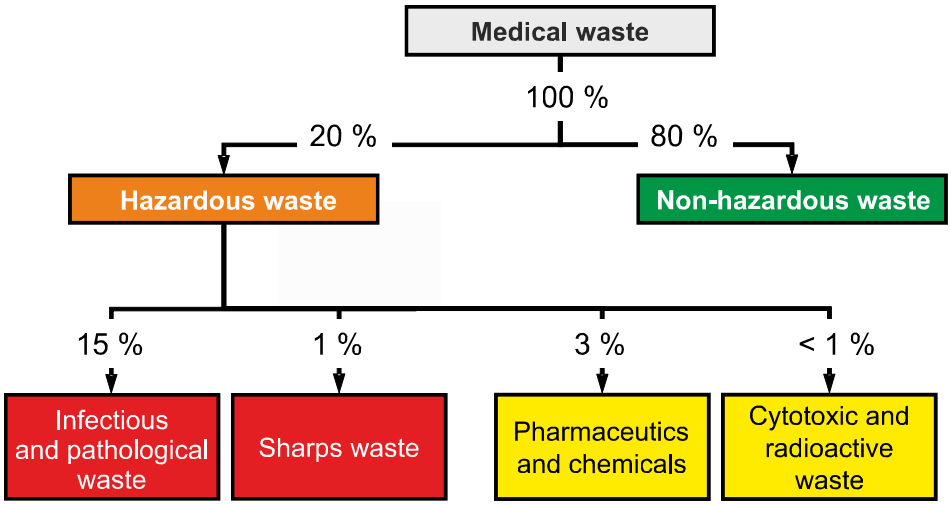



**Figure 4-7:** Composition of the medical waste stream, WHO 2011.

Based on the above rationale, normalized medical waste generation rates were estimated for the 19 health care facilities. These estimations take into account bed occupancy rates. The results are presented in the table below.

[3] WHO, Fact sheet N°253, Reviewed November 2011, Wastes from health-care activities.

| Health care facility | Total daily average (kg/bed/day) | General Waste - 80% (kg/bed/day) | Infectious Waste - 15% (kg/bed/day) | Sharps Waste - 1% (kg/bed/day) | Chemical Waste - 3% (kg/bed/day) | Special Hazardous Waste - 1% (kg/bed/day) |
|---|---|---|---|---|---|---|
| Juba Teaching Hospital | 1,40 | 1,12 | 0,21 | 0,01 | 0,04 | 0,01 |
| Malakal Teaching Hospital | 1,32 | 1,06 | 0,20 | 0,01 | 0,04 | 0,01 |
| El Sabbah Children Hospital | 0,38 | 0,31 | 0,06 | 0,00 | 0,01 | 0,00 |
| Lainya PHCC (Hospital) | 0,72 | 0,58 | 0,11 | 0,01 | 0,02 | 0,01 |
| Terekeka PHCC (Hospital) | 0,74 | 0,59 | 0,11 | 0,01 | 0,02 | 0,01 |
| Torit Hospital | 0,37 | 0,30 | 0,06 | 0,00 | 0,01 | 0,00 |
| Kator PHCC | 0,70 | 0,56 | 0,11 | 0,01 | 0,02 | 0,01 |
| Munuki PHCC | 0,67 | 0,54 | 0,10 | 0,01 | 0,02 | 0,01 |
| Nyokuron PHCC | 0,91 | 0,73 | 0,14 | 0,01 | 0,03 | 0,01 |
| International Hospital Kampala Juba C | 1,77 | 1,41 | 0,27 | 0,02 | 0,05 | 0,02 |
| Juba Medical Complex | 1,88 | 1,51 | 0,28 | 0,02 | 0,06 | 0,02 |
| Victorious Hospital | 0,41 | 0,33 | 0,06 | 0,00 | 0,01 | 0,00 |
| **Average** | **0,94** | **0,75** | **0,14** | **0,01** | **0,03** | **0,01** |

**Table 4-7:** Normalized average waste generation rates for non-hazardous and hazardous waste produced by the assessed healthcare facilities.

Research shows very typical healthcare waste generation rates for developing countries. While tertiary level hospitals and private hospitals are generating comparably high waste amounts per occupied bed, rates in other hospitals are much lower.

It is found that the average waste generation rate is approximately 0.94 kg per occupied bed per day. A correlation between the amount of waste generated and the type or size of health care facility can be identified. Considering that about 20% of this waste may be infectious medical waste, the infectious waste generation rate is around 0.2 kg at tertiary level and up to 0.3 kg in private hospitals. On average, the infectious waste rate is about 0.14 kg.

According to the WHO Fact sheet, high-income countries generate on average up to 0.5 kg of hazardous waste per bed per day; while low-income countries generate on average 0.2 kg of hazardous waste per hospital bed per day.

A similar project carried out in Liberia in 2009 showed a comparable average infectious waste generation rate of 0.14 kg/bed/day[4]. Research conducted in 2007 in Kenya showed an average rate of hazardous infectious waste of 0.175 kg per inpatient per day[5].

Due to dynamic reconstruction and improvement of the health care system in South Sudan, it can be expected that the waste generation rate will increase in near future. Studies in other countries with comparable growth showed an annual increase of waste generation rates of 10-20%. Taking this into account and based on the experience of the consultant in other similar countries, it is projected that the infectious waste generation rate will grow by 15% each year.

[4] Assessment of Medical Supplies and Medical Waste Management in Liberia, Final Report, 2010

[5] The National Health Care Waste Management Plan, 2008-2012, Kenya

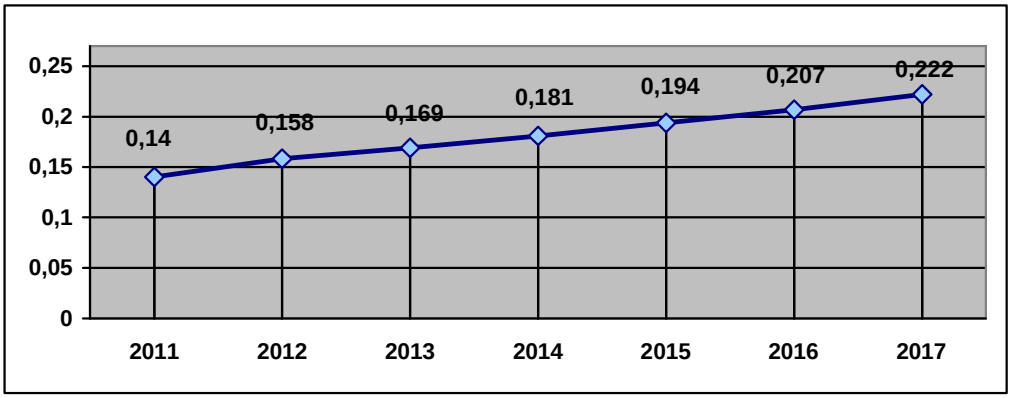



**Figure 4-8:** Expected increase of infectious waste generation rate in South Sudan

It is also expected that the implementation of an improved medical waste management system in South Sudan will lead to improvement of waste classification and segregation practices by the health care sector. Therefore, better management will further influence the system by reducing infectious waste generation rate by about 8% per year, so that the total increase is assumed to be only about 7% per year:

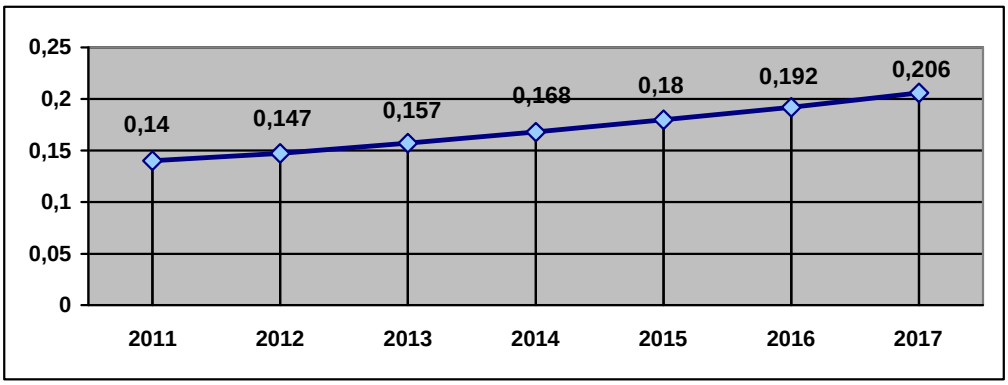



**Figure 4-9:** Expected increase of infectious waste after implementation of MWM Plan.

It is expected that the waste generation rate will increase until 2017 to >0.2 kg per bed and day. For the development of waste management plans and proposals for the procurement of necessary equipment, the adoption of infectious waste generation rate at 0.2 kg/bed/day is recommended. For small healthcare waste facilities without beds it shall be assumed that the minimum infectious waste generation rate for each facility is not less than 1 kg per day. After the implementation of the MWM Plan, the quality of data on waste generation will improve and waste generation rates will rise as they have in other countries.

Based on the assessment and the results of the study, it can be assumed that:

- Primary Health Care Units and PHCCs without beds are generating no less and no more than 1 kg per day of infectious waste. The same assumption has been made for “Other” healthcare facilities listed in MoH-RSS database.
- Number of beds in Primary Health Centers is on average 15.

- Information on the total number of hospitals and beds is based on the MoH-RSS database and research carried by the consultant.

Based on the above infectious waste generation rates, the following rates can be extrapolated for the entire country:

| Type of healthcare facility | Number of facilities | Number of beds | Infectious waste generation rate | Quantity of infectious waste (kg/day) |
|---|---|---|---|---|
| Primary Health Care Units | 1266 | 0 | 1 kg/day | 1266.0 |
| Primary Health Care Centers (average ~15 beds) | 138 | 1772 | 3 kg/day | 414.0 |
| Hospitals | 59 | 5333 | 0.2 kg/bed/day | 1066.6 |
| ***Total*** | **1 463** | **7105** | | **2746,6** |

**Table 4-8,** Extrapolation of infectious waste generation rate for all healthcare facilities in South Sudan.

The estimated annual quantity of infectious waste generated by all of the above facilities is 2.75 tons per day or about 1000 tons per year. It is advised to repeat the assessment of the medical waste management system in two years after the MWM Plan is in place to measure the improvements.

# 5 Assessment of medical waste management

## 5.1 Analysis of the applied medical waste management

### 5.1.1 Medical waste classification and segregation

Infectious medical waste, including sharps

Infectious waste and sharps are considered to be hazardous waste because of their ability to spread pathogenic micro-organisms. Sharps pose a special risk, as they are able to break the human protection mechanism (skin, mucous membranes, etc.).

In all assessed healthcare facilities, currently only sharps are recognized and treated as hazardous waste. Even though safety boxes are available in adequate quantities within the healthcare facilities, sharps are commonly mixed with other solid waste streams. Other wastes contaminated with blood and certain body liquids are not classified as hazardous and are mixed with solid waste and buried or burnt openly on facility premise. Very rarely is the hazardous waste treated in a Small Scale Incinerator (SSI).

Body parts

According to tradition in South Sudan, a placenta is collected by a patient or her relatives and buried in ground after childbirth. A few healthcare facilities reported other means of placenta disposal: toilet or mixed with other waste and open burning. Only one hospital visited had a dedicated placenta pit, albeit incorrectly maintained due to the disposal of the incinerator ash.

Other pathological waste, such as waste from surgical operations, is mixed with other kind of waste and burnt on-site.

Pharmaceutical waste

The MoH-RSS Department of Pharmaceuticals, Quality Assurance & Control Division has to be notified about any expired pharmaceuticals by their owner, whether the owner is a healthcare facility, a central medical store, a private company or an NGO. A special registration form is used. The weight of pharmaceuticals is not registered, but the type and number of items is recorded.

A Department Committee then inspects the items, performs consistency checks and determines the cost of waste disposal, including transportation. The Committee issues a letter to the owner of the medications informing her/him of the waste disposal costs and possible date of their destruction. If the quantity of waste is low, then the owner must wait and store the waste at her/his compound.

Pharmaceuticals are burnt at the Juba-Yei dumpsite, under the supervision of the Committee supported by a Public Health Officer, police and security. The Committee issues a destruction protocol. The most recent disposal included 380 large boxes (various sizes) of expired medications.

The MoH-RSS system is operational only for public healthcare facilities in Juba and surrounding towns and not for facilities operated by NGOs. NGOs operating in other towns and states are not allowed to independently destroy waste locally, but have to deliver it to Juba at an agreed time for disposal.

The Department has not as yet developed guidelines or policy document on the disposal of pharmaceutical waste. It is currently using an old Sudanese guideline, as well as incorporating documents from other countries. New guidelines are planned, based on collected information and experiences. In other parts of the country the MoH-RSS system is mirrored by the State Ministries of Health.

Chemical waste

No system exists in South Sudan for the disposal and treatment of chemical waste. Hospitals and Primary Health Care Centers who use chemicals in laboratories and surgery dispose of the waste directly to the drain. As in most facilities, septic tanks are not periodically cleaned and are dysfunctional, thus chemicals eventually leak into the ground.

### 5.1.2 Equipment used for on-site medical waste collection

Healthcare facilities in South Sudan are not familiar with international standards for waste collection equipment, such as cleaning and disinfection, safety conditions, color coding, labeling, etc. The only exceptions are standard cardboard containers (safety boxes) for sharps waste which are available at all visited healthcare facilities in appropriate quantity.

Other waste is collected in various kinds of bins and containers, including plastic, metal and cardboard boxes left from medical supplies - whatever is available. Most of the bins and containers are not equipped with a lid and only a few facilities visited used the recommended pedal operated bins. Bins and containers are rarely padded with a plastic bag due to lack of money but also due to general lack of awareness of safety and hygiene.

One of the most commonly used types of bin is a perforated one. Bearing in mind that there is no segregation of infectious waste and loose sharps are often collected with mixed waste, such bins pose a serious threat to both medical and cleaning personnel. These bins are also difficult to clean as contaminated water pours out of them and their large number of cavities mean there is no way for them to be cleaned sufficiently by standard methods. Frequent and sometimes complete lack of running water and shortage of disinfectants create additional challenges for proper equipment maintenance.

**Figure 5-10:** Commonly used perforated bins for mixed waste collection.

Logistical planning to determine which type of waste separation and collection container should be located where has not been carried out. The same issues affect the frequency of waste removal from wards and the cleaning of containers – no planning or defined timescale is applied. Bins are often overfilled and dirty.

### 5.1.3 On-site transport of medical waste

Trolleys for the internal transport of waste do not exist in the facilities visited. Hazardous waste is normally transported by hand in bags or placed directly into bins. Only one hospital visited uses wheeled-bins for on-site waste transportation.

**Figure 5-11:** Risky method for on-site transport of mixed waste.

As healthcare facilities do not operate interim storage sites or waste function areas, containers are often transported relatively long distances in small quantities. Littering of hazardous waste en route to disposal areas was noted in all facilities visited.

In general, the logistical system of on-site waste transportation must be considered as unsafe and risky and is creating an unnecessarily high workload for the cleaners.

### 5.1.4 Off-site transport of medical waste

Off-site or external transport is the transport of medical waste on public streets outside of the compound of the healthcare facility. By transporting medical waste on public streets, the general public may be affected in the event of an accident; special requirements and restrictions should be considered to prevent accidents involving other people and vehicles.

Transportation of hazardous waste should comply with international regulations like the “UN Recommendations on the Transport of Dangerous Goods”. Infectious (biomedical) and potential infectious sharp waste is classified internationally as UN 3291 waste, and should be transported in approved container (e.g. in accordance of UN agreement number 11H2/Y/S). Further requirements for the external transportation of infectious waste are:

- Special vehicle requirements,
- Labeling of the vehicle,
- Transport documentation,
- Knowledge of the transport personal and PPE

For detection, tracking and monitoring of the collected, transported and treated hazardous medical waste, a waste manifest and tracking document should be used by the healthcare facility, external transport company, disposal and/or treatment company and authority monitoring and supervising the system.

The above requirements for off-site transportation of medical waste do not exist in South Sudan. Only in Juba do some healthcare facilities hire external companies or individuals to remove mixed waste from their compound and to transport it to the Juba-Yei dumpsite. The waste transportation in Juba does not meet international standards.

### 5.1.5 Documentation on medical waste management

Waste tracing documentation and record keeping of a medical waste stream is not carried out at all.

## 5.2 Assessment of awareness on medical waste management

For the assessment of awareness/knowledge and behaviors at various levels of health facilities, a rapid assessment tool was used.

### 5.2.1 Rapid On-site Assessment (ROSA)

The objective of ROSA[6] is to ascertain the opinion of waste generators on existing waste management, to identify weak points and possible fields for action and change. ROSA is based on an easily answerable questionnaire (ticking boxes). There are three possible answers: Yes, No, Maybe/Sometimes. In order to carry out the assessment, 300 questionnaires were distributed amongst medical and auxiliary staff.

All departments participated in the activity and 195 completed questionnaires were collected. The questionnaire itself was split into two parts:

- Part A: Anonymous questions about the interviewed person: position in the hospital, gender, age, years of service spent in the institution
- Part B: Questions about the interviewees' opinion on the waste management situation in the hospital's main sectors, 6 questions per sector. Total of 24 questions randomly spread

The following target groups participated in the research:

| Position | Number | % |
|---|---|---|
| Junior Doctor | 22 | 13% |
| Doctor | 10 | 6% |
| Senior Doctor | 18 | 10% |
| Junior Nurse | 10 | 6% |
| Nurse | 39 | 23% |
| Matron | 3 | 2% |
| Midwife | 6 | 3% |
| Cleaning | 17 | 10% |
| Technician | 14 | 8% |
| Senior Techn. | 19 | 11% |
| Administrat | 15 | 9% |
| Total | 173 | 100% |

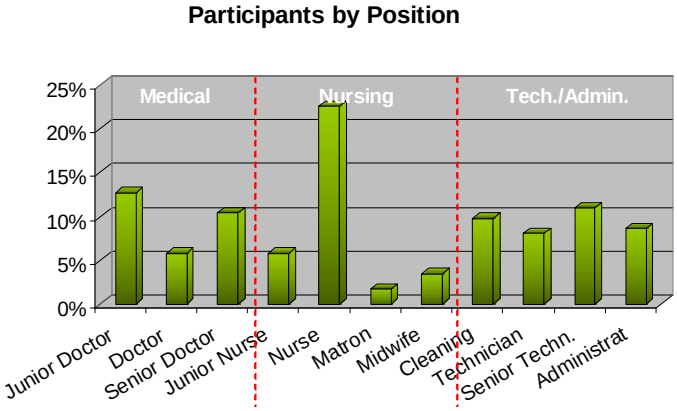



**Figure 5-12: Position of ROSA participants**

There were 46% of female participants and 54% of male participants. The age structure was as follows:

- <25 years of age - 10 persons (5%)
- 25-34 years of age - 68 persons (36%)
- 35-50 years of age - 96 persons (51%)
- >50 years of age - 16 persons (8%)

56 staff members participating in the survey have been working for more than 10 years in the respective healthcare waste institution:

- <2 Years = 39 staff (21%)
- 2-5 Years = 52 staff (28%)
- 5-10 Years = 37 staff (20%)
- >10 Years = 56 staff (30%)

[6] ROSA = Rapid On-Site Assessment, © ETLog 2010

A point-based ranking system was used to evaluate questionnaires and the results are displayed for each participant and merged together with the average (overall) rating obtained from three hospitals. Point values of 1, 3 or 5 are scored for each answer (5 being the maximum). A “traffic light” system (red, yellow, and green) is used for the evaluation of the questionnaires. Red indicates an urgent need for change. A sample of the used questionnaire can be found in the Annex. The overall results can be found below.

***Note:*** The results do not display the consultant’s findings, but they show how the users of the healthcare waste system evaluate the situation. High or low ratings of certain issues do not necessarily reflect the real situation, but they show the opinion of the user of a certain aspect and allow identification of awareness and knowledge.

### ROSA –Results for South Sudan

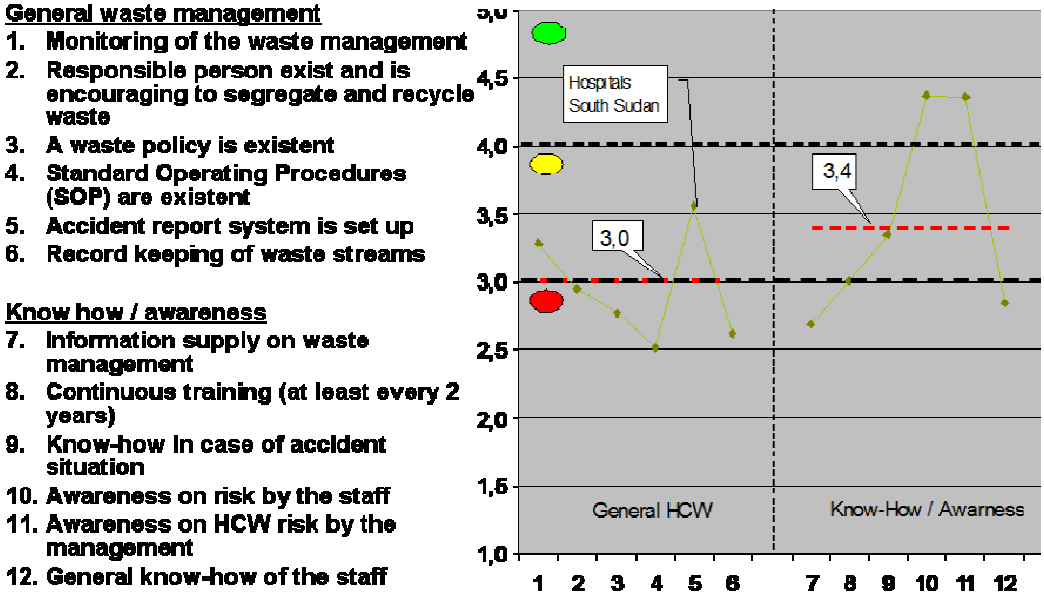



**Figure 5-13: ROSA Results - first two sections**

### *ROSA – General HCW Management*

The section “General HCW Management” showed that most of the hospital staff thinks that a policy and monitoring system are not in place. Also nearly 50% of the staff do not know the responsible person for waste management in their hospital. As expected, personnel see that Standard Operating Procedures (SOP) are not implemented.

However, an accident reporting system does seem to exist in some hospitals in one way or the other, but not all staff are informed of how to report accidents.

Comparable high ratings in monitoring and accident reporting and shortcomings in the field of structured waste management (lack of policies, responsible persons, SOPs) indicate that health care waste management is mainly introduced through the “bottom up” principle. If at all, the hospital had created

their own medical waste management system that is not based on any national standards or guidelines.

General Conclusions and Recommendations on HCWM:

The users of waste management systems state that theoretically an internal waste management system only exists in a very basic state and also lacks practical implementation. It is, therefore, recommended to:

- Strengthen practical aspects of the HCWM by improving information on the accident-at-work reporting system and develop a waste recording system to monitor progress in the healthcare waste management system;
- Standardize the waste management system in the hospital by providing support in the field of policy making, including the set up of a hospital waste management plan;
- Increase the transparency of responsibilities in the field of healthcare waste management e.g. improving the internal communication and reporting system.

***ROSA – Know-how / Awareness***

The section “Know-how / Awareness” shows a typical situation for a medical waste management system in very early development. Very few people confirmed that they had already received training in healthcare waste management, and less than 50% confirmed that they had even received information on such. Accordingly, the same low number of people responded that they have enough knowledge to handle an emergency situation (accident) or that other staff in the hospital had sufficient knowledge.

Awareness on healthcare waste problems is generally high amongst staff and only slightly lower amongst the managers of the healthcare facilities. The already high awareness level may result in the positive acceptance of any change process and is considered as important when implementing a new and sustainable system (high participation of the staff, financing by the management).

Conclusions and Recommendations: Know-how / Awareness:

Only a few training sessions have been provided on medical waste in South Sudan – but however limited these were, staff awareness levels have improved as a result. However, further training and awareness is required to improve levels to an acceptable standard. It is recommended to:

- Introduce a broader awareness raising system
- Revise existing training methods and strengthen practical, work-related aspects
- Develop and distribute an information, education and communication package (IEC) to support users regarding medical waste management
- Develop a continuous training plan and strategy to include training for all staff

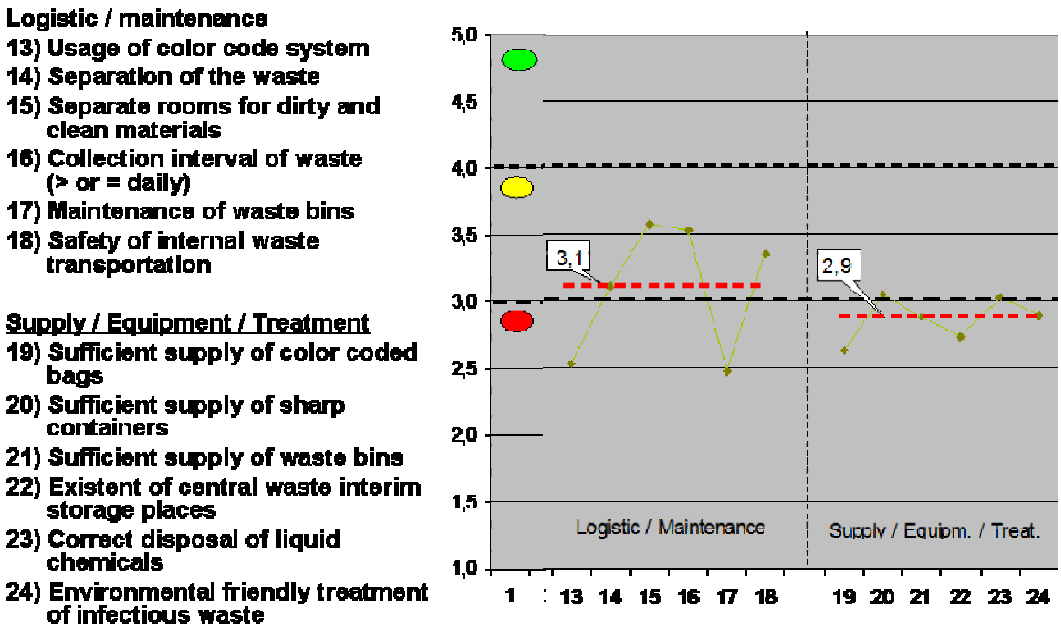



**Figure 5-14: ROSA Results - third and fourth section**

### *ROSA – Logistics / Maintenance*

The research confirmed the findings of the consultant that no color coding system is introduced. Also separation of waste only exists at a basic level. Some staff state that separate rooms for dirty materials are present and that waste is frequently removed. Strong complaints exist about the maintenance of bins, which is considered as critical. Also a lot participants state that they consider the transportation of waste within the healthcare facility as not unsafe and often dangerous.

Conclusions and Recommendations: Logistics / Maintenance:
According to staff in some hospitals, improvement of the collection frequency of waste is required and the development of a safer logistics system should be considered in the near future. It is recommended to:

- Introduce a strict color coding system
- Implement at least a basic waste segregation system (separation into hazardous and non-hazardous waste)
- Revise the existing logistics system and strengthen safety aspects in the logistics chain
- Improve maintenance of waste bins

### *ROSA – Supply / Equipment / Treatment*

According to staff there are weaknesses in all sections. The provision of sufficient numbers of bins and disposable items such as bags or sharp boxes does not take place. Even sharps containers are short in supply. The research shows that there is no solution available for liquid chemical waste (e.g. a developer solution from radiology) as this waste is disposed of in a septic tank

and most people believe that the current waste disposal system is harmful to the environment.

Conclusions and Recommendations: Supply / Equipment / Treatment:

In order to minimize supply problems, especially with consumables (plastic bags), it is necessary to have a special budget line for medical waste management. It is recommended to:

- Assess the required annual budget for medical waste management and set up a dedicated budget line
- Check usage of the budget provided for the destruction of sharp items
- Inform staff about medical waste treatment methods, as it influences waste segregation systems in the hospital (e.g. how to deal with chemical and pharmaceutical waste)

The correct treatment of liquid hazardous waste will be one of the challenges for the future; however solutions for this waste stream will require relatively high financial efforts or the set up of central solutions for liquid chemical waste.

**ROSA: Sharps Accidents**

**Background Information and Research Justification:**

Healthcare workers in South Sudan are exposed to blood and other bodily fluids in the course of their work. Consequently, they are at risk of infection with blood borne viruses including human immunodeficiency virus (HIV), hepatitis B (HBV) and hepatitis C (HCV). Occupational exposure to blood can be the result of a percutaneous injury. The most common form of occupational exposure to blood is a needle-stick injury that can result in infection.

According to the WHO[7], every year about 3 million (8.5%) healthcare workers out of 35 million healthcare workers worldwide are exposed to percutaneous injuries supported by blood borne pathogens. The risk of infection caused by a needle-stick injury while treating an infected source patient is approximately 0.3% for HIV, 3% for hepatitis C and 6-30% for hepatitis B. According to the Ministry of Health, it can be assumed that the average prevalence rate for HBV is about >7% and the rate of HCV is about >3.3%.

Within ROSA, rapid research of the actual healthcare waste management situation was carried out to identify whether staff were at high risk from percutaneous injuries and to roughly identify the number of accidents with sharp items amongst healthcare workers.

**Research Method:**

Questionnaire distributed randomly in Victoria Hospital as a part of ROSA research:

**Question to be answered:**

[7] WORLD HEALTH ORGANISATION, AIDE-MEMOIRE for a strategy to protect healthcare workers against infections caused by bloodborne viruses

In the last 12 months, I had

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ >5 (Please tick the appropriate box)

accidents with sharp items (e.g. a needle – stick accident)

### Persons included in the survey

141 persons out of 195 persons who participated in the ROSA research answered the question on sharps accidents (72%). 86 persons (61%) stated that they had had no accidents during last 12 months, and 55 (39%) answered that they had one or more accidents during last 12 months. A total of 150 accidents were reported by the research group (on average 1.06 accidents per staff per year).

### Percentage of participants with no accidents, one or more than one accident

| No. of sticks | Amount | % |
|---|---|---|
| 0 | 86 | 61% |
| 1 | 17 | 12% |
| 2 | 10 | 7% |
| 3 | 11 | 8% |
| 4 | 11 | 8% |
| 5 | 0 | 0% |
| >5 | 6 | 4% |
| Persons | 141 | |
| Total Accid. | 150 | |
| Acci/Pers. | 1,06 | |

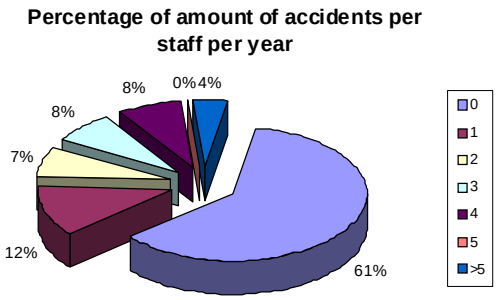



**Figure 5-15: Accident rates in the healthcare institutions included in the survey**

Most of the accidents occur among cleaners which can mainly be traced back to an inadequate logistic system. Secondly nurses and junior doctors reported accidents. Nearly 2/3 of all accidents happened among these risk groups.

### Positions of the persons who had accidents last year

| Staff | Total-Acc | % | Acc.p.Staff |
|---|---|---|---|
| Junior Doctor | 23 | 16% | 1,05 |
| Doctor | 5 | 3% | 0,50 |
| Senior Doctor | 5 | 3% | 0,28 |
| Junior Nurse | 4 | 3% | 0,40 |
| Nurse | 42 | 29% | 1,08 |
| Matron | 1 | 1% | 0,33 |
| Midwife | 4 | 3% | 0,67 |
| Cleaning | 27 | 18% | 1,59 |
| Technician | 11 | 8% | 0,79 |
| Senior Techn. | 17 | 12% | 0,89 |
| Administrat | 7 | 5% | 0,47 |

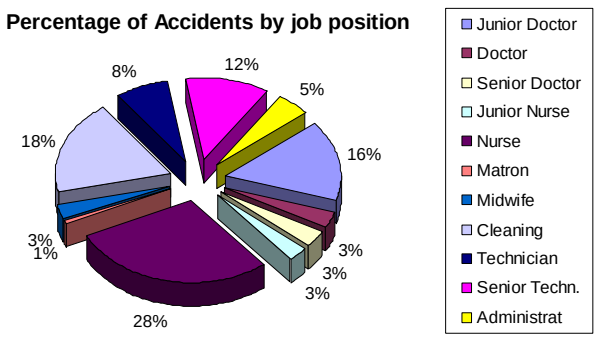



**Figure 5-16: Percentage of accidents by positions**

## 5.3 Assessment of the existing recycling processes

Recycling is the act of processing used or abandoned materials for use in creating new products. While the reusing of materials (e.g. beer bottles, etc.) is widely practiced in South Sudan, recycling systems are limited to greater Juba area.

In general, no established recycling system or waste re-processing industries exist in South Sudan. There are only minor activities carried out in Juba by a private waste disposal company called Philling Environmental. This company has set up small bins around Juba for separate collection of recyclables: paper, plastics, and metals. Individuals, mostly from Uganda, collect metal waste to export for the recycling and manufacturing of tools.

At larger city dumpsites, especially in Juba, waste-pickers recover plastic bottles, large plastic bags, metals and food that has yet to rot. Plastic waste is then used by individuals who sell their products at local markets – honey, oils, fuel, etc.

None of the assessed healthcare facilities have organized or participate in a household waste recycling scheme. Due to a lack of know-how, chemical waste such as X-ray waste that contains silver is disposed of down the drain or in the ground.

The main reason for this unusual situation is the non-existent demand for recycled raw materials. Countries with efficient recycling industries are nearly always market driven. In South Sudan no paper production or bottle production takes place to make use of recycled raw-material. The same situation exists in the plastic industry. Also, there are no established wholesalers or buyers for bulky but light raw materials such as polyethylene and polypropylene.

The only market which exists for recycled materials is for metal. This market includes scrap metal (ferrous metal) and other metals such as copper from cables, lead from batteries and other non-ferrous metals. As metals are only generated in limited amounts in the healthcare setting in South Sudan, this recycling system is of limited relevance to this project.

The practically non-existent medical waste recycling system creates advantages as well as disadvantages. There is little risk that potentially infectious materials will be recycled illegally, especially those made from plastic (IV-lines, syringes, etc.). The lack of recycling opportunities is also a drawback, as income from recycling can act as an incentive for the housekeeping department to improve waste management. Additionally it is reducing the amount of plastic waste which is non-biodegradable and does not break down in dumpsites.

Scavenging of waste in South Sudan (including for food) is widely practiced. As only a weak collection system exists in Juba and no formal collection system exists in other places, salvaging of waste is not only done at the dumpsite but more often directly after the discharge of materials in the city. From a medical waste point of view, scavengers create two public health risks:

1. Risk of acquiring transferable diseases by getting in contact with potentially infectious healthcare waste (e.g. stepping on sharps)

2. Risk of the selling of medical products for illegal reuse (e.g. selling of used syringes, expired drugs, etc.)

It can therefore be concluded that due to the nearly non-existent recycling system, no risks for the public are created by illegal or improper recycling or reusing of medical waste. This can be said for recycling inside the health care facilities, along the transportation routes and at the final disposal sites. At the same time, however, due to the missing recycling system, opportunities such as the reduction of plastic waste are missed.

## 5.4 Guidelines and other informational materials related to medical waste management

No separate and dedicated guidelines on medical waste management currently exist. As described in Chapter 2 (policy, legal and administrative framework) there are few policy documents which address issues related to medical waste, i.e. injection safety, sharps handling and disposal. The majority of those documents call for waste burning as a final method of waste treatment.

In none of the healthcare facilities that were visited were information documents on medical waste management - like worksite instructions, posters, leaflets, etc. - found. The exception was a number of laboratories in larger hospitals who had bio-safety instructions and manuals that varied in quality.

## 5.5 Identification of potential source of funding, key actors and necessary budgetary allocation for waste management

Funding of healthcare waste management systems is a general problem and typically in most developing countries, under-funding of this sector can be found. Multiple explanations exist e.g. the general under-funding of the healthcare sector, rating curative healthcare services as more important than preventive healthcare services, missing awareness about the risks from healthcare waste among stakeholders, etc.

The WHO core principles for achieving safe and sustainable management of health-care waste[8] recommends today that:

**Governments should:**

- allocate a budget to cover the costs of establishment and maintenance of sound health-care waste management systems;
- request donors, partners and other sources of external financing to include an adequate contribution towards the management of waste associated with their interventions; and
- implement and monitor sound health-care waste management systems, support capacity building, and ensure worker and community health.

**Donors and partners should:**

[8] http://www.who.int/water_sanitation_health/medicalwaste/hcwprinciples/en/index.html

- include a provision in their health program assistance to cover the costs of sound healthcare waste management systems.

These recommendations are mainly based upon the so-called “polluter-pays” principle which is today internationally accepted:

*The polluter-pays principle is the principle according to which the polluter should bear the cost of measures to reduce pollution according to the extent of either the damage done to society or the exceeding of an acceptable level (standard) of pollution.*[9]

### 5.5.1 Initial estimations on financing needs[10]

In South Sudan, so far no specific budget lines for medical waste management exist and only limited information on the cost of medical waste management exists. As a first approach, it is today internationally accepted to assume an average value of 1 USD/ kg of medical waste treatment. Based on the estimated amount of 1000 tons per year this would mean that about one Million USD would be required per year to run a basic healthcare waste system.

Another recommended initial calculation is to take the total number of hospital beds and to multiply this with US$150. For South Sudan, and based on 7147 hospital beds, this would be 1.07 Million US$.

A third accepted method to estimate financing needs is to take the total number of small health care facilities and consider 600 US$ cost per year, the total number of medium-sized health care facilities and multiply with 6'000 US$ and the total number of large healthcare facilities x 60'000 US$. Considering 1404 small health care facilities, 56 medium sized facilities and 3 large facilities, the financing needs could be estimated as about 1.36 Million US$.

Taking the average of the above three methods, it can be assumed that a yearly financing need of about 1.15 million US$ per year exists. Considering prices are on average around 50% higher for consumer and investment goods compared with neighboring countries, a yearly budget of **~1,7 Million US$** is considered to be needed for recurrent costs.

*Note: Cost does not include capital cost*

### 5.5.2 Sources for funding

Financing the healthcare Sector in South Sudan is a challenge. In 2009, the Southern Sudan Health Financing Study was carried out. The report states that the health sector is constrained by chronic under-funding, weaknesses in resource allocations, budgeting and planning leading to poor health outcomes, acute shortage of health professionals, poor infrastructural development and very low health service coverage at all levels of the health system.

[9] Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations, New York, 1997.

[10] http://www.healthcarewaste.org/resources/costing-calculations/

The total budget allocated to the health sector in US dollars (millions) was in the previous years:

- 2006: 109.5 Million US$
- 2007: 82.5 Million US$
- 2008: 70 Million US$
- 2009: 85 Million US$

Of e.g. the 2009 budget allocation, Secondary and Tertiary Health Care received the highest amount of 26.5 Million US$ as opposed to 3.3 million US$ for Primary Health Care.

Other sources of funding include the Umbrella Program for Health System Development (UPHSD), the UN agencies (including UNICEF, UNFPA, WHO, WFP, and UNHRC), bilateral agencies or donors (notably USAID), and international NGOs. The high importance of the other sources of funding becomes visible by comparing the governmental budget of 70 Million US$ with the estimated budget of these other sources of US$427.9 million for the fiscal year 2008.

Considering the estimated required budget of 1.25 Million US$, it seems unlikely that the Government or the Ministry of Health will be able to finance this in the short term. Especially the potentially high investment cost of infrastructure as well as the cost of capacity building and awareness raising, which will have to be financed from other sources, e.g. by development partners. It should however be the task of the Ministry of Health to finance annual recurrent costs from the beginning. In the long term, the government should also finance the annual capital cost to ensure the sustainability of the system.

### 5.5.3 Necessary budgetary allocation

#### A) Limitation of the budget calculation

As the assessment chapter showed, the predominant hazardous healthcare waste stream is the bio-hazardous waste stream (infectious and sharp waste). As the treatment of other waste categories (such as chemical waste, waste containing heavy metals, etc.) is strongly connected with development in other sectors (e.g. industrial sector, communal sector, etc.) the first five year action plan concentrates on the treatment of bio-hazardous waste. Accordingly, the budget calculation for the first 5-year plan should especially consider the cost of bio-hazardous waste management.

#### B) Strategic costing analysis

For the calculation of cost related to the treatment and disposal of bio-hazardous waste, hardly any information is available in South Sudan. Typically, the cost for healthcare waste management is included in the overhead cost for healthcare setting (if at all) and no further efforts are done to calculate the yearly cost.

Also on hospital level, no separate calculation about the cost of medical waste management was carried out. In the past this sector was chronically under-

funded as awareness on needs was low. Allocating insufficient financial resources to manage medical waste might result in an even greater financial impact in the medium and long term. A possible increase of nosocomial infections might result in an increase in morbidity and mortality rates. Additionally the environmental damage will in the long term impact negatively on peoples' health.

**C) Expanded Costing Analysis Tool (WHO)**

As so far no data and national experience exist, it is recommended to use the WHO medical waste Expanded - Cost Analysis Tool (E-CAT) for the first budget calculations. The ECAT allows the adjustment of data for specific situations in order to obtain basic medical waste related figures. It is a modified version of the previous medical waste Cost Analysis Tool (CAT) and provides more options and approaches than the CAT.

E-CAT was especially created to estimate costs related to medical waste management at the:

- healthcare facility (HCF)
- central healthcare waste treatment facility (cluster)
- national level

The E-CAT allows calculation for one or more HCWM treatment strategies:

1) Treatment of waste on-site at the healthcare facilities (decentralized or on-site treatment);
2) Treatment of waste by central healthcare waste treatment facilities or by large hospitals to which waste from the smaller hospitals of a dedicated area (cluster) is sent (centralized or cluster treatment); or
3) a combination of the above

In other words, treatment can take place at:

- small HCFs (PHCU and PHCC without beds),
- medium HCFs (PHCC, average 15 beds),
- large HCFs (30 to 200 beds, state or county hospitals),
- very large HCFs (200 beds or more, teaching hospitals)
- medium-size clusters (treating between 100 to 300 kg/day),
- any combination of these.

The ECAT also allows four treatment technology options for on-site treatment:

a. Autoclave and sharps pit;
b. Incinerator and lined ash pit;
c. Needle remover, autoclave and small pit; and
d. Needle remover, incinerator and lined ash pit.

For large and very large HCFs, options 1 and 3 (autoclave treatment) include a medium-size shredder.

For centralized or cluster treatment, two options are provided:

1) Transport vehicle(s), large autoclave, and shredder; and
2) Transport vehicle(s), large incinerator, and ash pit.

The ECAT version chosen uses small incinerators that do not meet international standards for small HCFs (as currently in use in South Sudan), incinerators with improved pollution control for medium and large HCFs (as will be supplied soon by UNDP), and large incinerators that meet international standards for cluster or centralized treatment.

The annual costs of HCWM include both capital (or one-time) costs as well as annual operating (or recurrent) costs. Capital costs involve equipment and technologies with different life spans. For the purposes of this tool, the capital cost is converted to an equivalent annual cost using the standard discounting formula which takes into account the equipment life span and a discount or interest rate.

**Input and assumptions for South Sudan**

Besides waste generation rates, the main parameter used in calculations is the number of beds and the number of healthcare facilities. Here it was assumed that the data which collected during the assessment was correct and shall be used. For small healthcare facilities without beds, it was assumed that the number will not be reduced until 2014.

**Specific assumptions for South Sudan**

The ECAT Tool is a general, world-wide used tool. The consultant adapted the tools according to his best knowledge to the specific situation in South Sudan (especially in regards to comparable high costs for the importation of medical equipment, the cost of construction and operational costs). Despite this, the following cost must still be considered as a pure assumption, and fluctuation in the range of +/- 50% must be expected:

**A) Capital Cost assumption**

| Item | Value | Unit | Lifespan (yrs) |
|---|---|---|---|
| 15-liter bin | **20** | $ | **2** |
| Personal protection equipment | **50** | $ | **2** |
| 24-liter autoclave | **3.000** | $ | **5** |
| Simple autoclave shelter | **1.000** | $ | **5** |
| Sharps pit | **200** | $ | **5** |
| Small pit | **200** | $ | **2** |
| Needle remover | **80** | $ | **4** |
| Small-scale incinerator (5kg/h) non-compliant with international standards | **4.000** | $ | **3** |
| Shelter for small-scale incinerator | **1.500** | $ | **5** |
| Small ash pit | **200** | $ | **5** |
| 50-liter bin | **40** | $ | **2** |
| 240-liter wheeled bin | **100** | $ | **4** |
| Storage area | **2.000** | $ | **10** |
| 51-liter autoclave | **6.000** | $ | **5** |
| Shelter for treatment system | **2.000** | $ | **10** |
| Small-scale incinerator (12kg/hr) non-compliant with international standards | **8.000** | $ | **5** |
| Medium ash pit (lined) | **500** | $ | **5** |
| Large ash pit (lined) | **1.000** | $ | **3** |

| | | | |
|---|---|---|---|
| Very large ash pit (lined) | **1.500** | $ | **2** |
| Large storage area | **4.000** | $ | **10** |
| 125-liter autoclave | **20.000** | $ | **10** |
| Reusable sharps containers | **35** | $ | **2** |
| Medium-size incinerator (50kg/h) non-compliant with international standards | **50.000** | $ | **10** |
| 340-liter autoclave | **50.000** | $ | **10** |
| Medium HCW shredder | **25.000** | $ | **5** |
| Transport vehicle (5000 liter capacity) | **40.000** | $ | **5** |
| 2300-liter autoclave | **125.000** | $ | **10** |
| Large HCW shredder | **56.000** | $ | **5** |
| Large incinerator (350 kg/hr) | **250.000** | $ | **10** |
| Air pollution control | **300.000** | $ | **10** |

**Table 5-9:** Capital Cost Assumption

### B) Recurrent cost assumptions

| Item | Value | Unit |
|---|---|---|
| Safety box | **1** | $/box |
| 15-liter plastic bag | **0,1** | $/bag |
| Electrical use (24L autoclave) | **0,7** | kWh/cycle |
| Water use (24L autoclave) | **1** | liter/cycle |
| Maintenance | **0,05** | fraction of capital cost |
| Fuel use (small-scale incinerator) | **2** | $/kg wood |
| 50-liter plastic bag | **0,2** | $/bag |
| Electrical use (51L autoclave) | **1** | kWh/cycle |
| Water use (51L autoclave) | **3** | liter/100 liters waste |
| Test indicators | **0,5** | $/indicator |
| Fuel use (medium incinerator) | **2** | $/liter diesel |
| Electrical use (125L or 340L autoclave) | **0,01** | kWh/liter of waste |
| Water use (125L autoclave) | **3** | liter/100 liters waste |
| Water use (340L autoclave) | **3** | liter/100 liters waste |
| Water use (2300L autoclave) | **3** | liter/100 liters waste |
| Electrical use (medium shredder) | **0,01** | kWh/liter of waste |
| Cost of air pollution control | **60000** | $/yr |

**Table 5-10:** Main recurrent cost assumptions

### C) Other assumptions

Other assumptions which have been made can be found in the annex: “Financial calculations – E-CAT”

Based on the calculations carried out, it could be concluded that generally the treatment strategy of “autoclave and sharps pit” has financial advantages over other options. However in most cases, these cost savings are minor and other factors, e.g. the wider treatment spectrum of incinerators, will justify the choice of other options.

Also the calculation showed that central treatment solutions may have financial advantages compared with de-centralized solutions. The central solutions

however require a comparably high density of healthcare facilities. Out of these it might only be feasible in larger cities with teaching hospitals.

### 5.5.4 Recommended Budget planning

Based on the calculation carried out and considering that the three teaching hospitals will in future operate the centralized treatment system, the following cost calculation can be carried out:

| Facility | No. | Capital Cost | Recurrent Cost | Total Cap. Cost | Total Recu. Cost |
|---|---|---|---|---|---|
| **Small Scale HCF** | 1221 | $1.000 | $600 | $1.221.000 | $732.600 |
| **PHCC with Beds** | 123 | $2.000 | $1.650 | $246.000 | $202.950 |
| **State & County hospital** | 50 | $3.600 | $13.600 | $180.000 | $680.000 |
| **Central Treatment Center** | 3 | $33.500 | $83.000 | $100.500 | $249.000 |
| | | | | $1.747.500 | $1.864.550 |

**Table 5-11:** Capital Cost Assumption

The cost calculation shows a total annual finance demand of about 3.6 million US$ if capital cost are included in calculations. The minimum budget required to cover recurrent costs (under the assumption that investment costs will be covered by development partners) would be 1.85 million US$ and is slightly higher than the estimation of 1.7 million US$.

Considering the available budget, it might seem unrealistic to fully finance the medical waste sector. In that case, at least the recurrent medical waste management cost of healthcare facilities with beds should be covered (about 1.13 million US$. The minimum budget is therefore estimated to be at least 1 million US$.

# 6 Determination of treatment technology

## 6.1 Status of existing waste treatment systems

### 6.1.1 Central waste treatment facilities

Currently there is no central waste treatment facility in South Sudan for any type of hazardous and non-hazardous waste. However, Small Scale Incinerators (SSI) are used during periodic immunization campaigns to treat infectious medical waste. Unfortunately, no list of central sites scheduled to be used for EPI campaigns exists. The EPI campaign personnel do not manage the waste itself, but provide money to State MoHs for waste disposal and treatment. Therefore it is the responsibility of a State MoH to organize the transportation and treatment of immunization waste.

The incinerator at Juba Teaching Hospital sometimes receives waste from other healthcare facilities, but it is not an established waste treatment system with a defined waste reception and disposal schedule.

### 6.1.2 On-site waste treatment facilities

Healthcare facilities in South Sudan use various types of incinerators for mixed and hazardous medical waste treatment. Health Facility Mapping of South Sudan (HFMoSS) reports 133 installations, while the MoH-RSS database lists 128 installations. However, no exact information has been compiled on their type, wear, and quality of the performance.

| State | Number of incinerators (HFMoSS) | Number of incinerators ((MoH-RSS Database) |
|---|---|---|
| Central Equatoria | 8 | 10 |
| Eastern Equatoria | 5 | 5 |
| Western Equatoria | 16 | 14 |
| Jonglei | 36 | 32 |
| Lakes | 7 | 6 |
| Northern Bahr El Gazal | 15 | 13 |
| Western Bahr El Gazal | 8 | 7 |
| Unity | 3 | 2 |
| Upper Nile | 22 | 22 |
| Warrap | 13 | 17 |
| ***Total*** | ***133*** | ***128*** |

**Table 6-12,** Number of incinerators reported by Health Facility Mapping of South Sudan, MoH-RSS 2011.

Available data and field investigation showed that most of the incinerators however are outdated or face strong maintenance problems. The majority of the incinerators can be considered as broken and the satus is beyond repair. In its report MoH states that, depending on state, only 4% to 10% of the healthcare facilities have access to an incinerator. Most of the facilities do open burning, burn waste in pits or are disposing the waste without any treatment in the bush.

**Figure 6-17: Old and broken incinerators, Malakal**

Currently some older units are being replaced by new SSIs at the following locations:

| Location | State | Type | Financed by |
|---|---|---|---|
| Malakal Teaching Hospital | UN | Advanced SSI | UNDP/Global Fund |
| Renk Hospital | UN | Advanced SSI | UNDP/Global Fund |
| Wau Teaching Hospital | WBEG | Advanced SSI | UNDP/Global Fund |
| Torit State Hospital | EE | Advanced SSI | UNDP/Global Fund |
| State MoH, Juba | CE | Grate Burner SSI | MDTF/SMoH |
| Yei Civil Hospital | CE | Grate Burner SSI | MDTF/SMoH |
| Lainya PHCC | CE | Grate Burner SSI | MDTF/SMoH |
| Terekeka County Headquarters | CE | Grate Burner SSI | MDTF/SMoH |
| **Total** | **8** | | |

**Table 6-13:** Planned medical waste incinerators (November 2011)

Additional, simple SSI have been offered to Eastern Equatoria within the MDTF project. However, the State MoH has not yet decided how many units will be installed.

Information on existing medical waste treatment installations was verified for the following sites:

Juba Teaching Hospital, CE

The incinerator was installed approximately 4 years ago but was put into operation only in 2010. It can be classified as Advanced SSI as it has a burning chamber and a secondary chamber for the post combustion of off-gasses. Further is has automatically controlled air fans and combustion temperature. However, the installation is not maintained as it should be and is not operated

automatically but manually to diminish the costs by lowering fuel consumption which is required for controlled operation. The air fans are switched off most of the time therefore self-mend burning process takes up to 6 hours instead of 70 minutes. Lack of appropriate air flow and oxygen volume in the chambers not only increases the burning time, but also increases air pollution and reduces the combustion of waste. Black smoke can be observed during the first hours of operation, and partly burnt waste can be found in the bottom ash. The amount of waste burned is not known as it is not registered, but it is relatively low due to over mentioned issues with operation the installation.

Malakal Teaching Hospital, Upper Nile

Three small brick incinerators were constructed close to each other by MSF, between 2005 and 2007. All are damaged, and not used for a long time. There are no trained personnel to operate an incinerator. One of the three incinerators could be repaired by removing mud and ash which blocks the grate and ash-pan.

The Kala Azar Department managed by MSF-Holland has its own two drum burners in a partly enclosed area – however dogs, goats, and birds were accessing the site during the assessment. The barrels were installed in November 2010. One drum is already burnt out, and the second will be corroded soon as well.

There is no separate ash pit, and ash is left at the burning site or dumped in the waste pit. Hospital DG and Administration, nor State MoH have any information on an advanced SSI incinerator to be delivered by UNDP/Global Found

Wau Teaching Hospital, WBG

A single grate SSI was installed but it has not been used for a long time. The installation lacks chamber and bottom ash doors, and grates are partly damaged. Incinerator walls, however, have no cracks, and are still in good condition. No explanation was provided why the incinerator had not been repaired.

There is no separate ash pit but a waste pit right close to the installation may serve for this purpose as it is isolated from soil and ground water.

Hospital DG and Administration, nor State MoH have any information on an advanced SSI incinerator to be delivered by UNDP/Global Found. Lack of information also concerns an EIA procedure required for the UN founded project. (The State has not yet established an Ministry of Environment).

Catholic Church Hospital (former Military Hospital), Wau, WBG

The hospital is not yet officially open but it maintains an OPD. A single grate SSI was installed at the beginning of 2011, and it has been used for mixed waste generated by the OPD. No ash pit was constructed but a placenta pit close to the incinerator. Incinerator bottom ash is faultily dumped to the pit.

Lainya PHCC (Hospital), CE

A single grate SSI was installed in November 2011. It sitting is less than 20 meters to residential area, and crops. No ash pit was specified in a tender documentation for the incinerator construction. No manual for the incinerator operation exists.

Torit State Hospital, EE

Small Scale Incinerator of De Montfort Mk2 type was installed a few years ago but was used only for a short period of time due to lack of trained operator. The chimney is corroded and broken at the outlet level. No ash pit was constructed.

Terekeka PHCC (Hospital), CE

A waste incinerator was setup near a new hospital in the beginning of December 2011. It may start operation in February 2012, when the hospital is finished. It is a standard single chamber incinerator with an ash-pan, identical like constructed in Lainya. The construction is faulty as no grate was installed nor ash pit. The consultant delivered to CHD necessary documents (incinerator manual, design for ash pit).

Rumbek State Hospital, Lakes

Large single grate brick incinerator was installed outside the TB Ward in 2007. Its walls and chimney cracked one year after installaton. Currently it serves as a chaotic dumping and burning ground for mixed waste.

Conclusion

Nearly all inspected incinerators were broken and beyond repair. Main reasons are missing know-how in the operation of incinerators, missing maintenance and low quality equipment. Without changes it must be expected that all soon to be delivered incinerators will also be out of operation after a short time.

## 6.2 Assessment on (alternative) treatment technologies

Different kinds of methods for the treatment, destruction, or disposal of hazardous medical waste are available today.

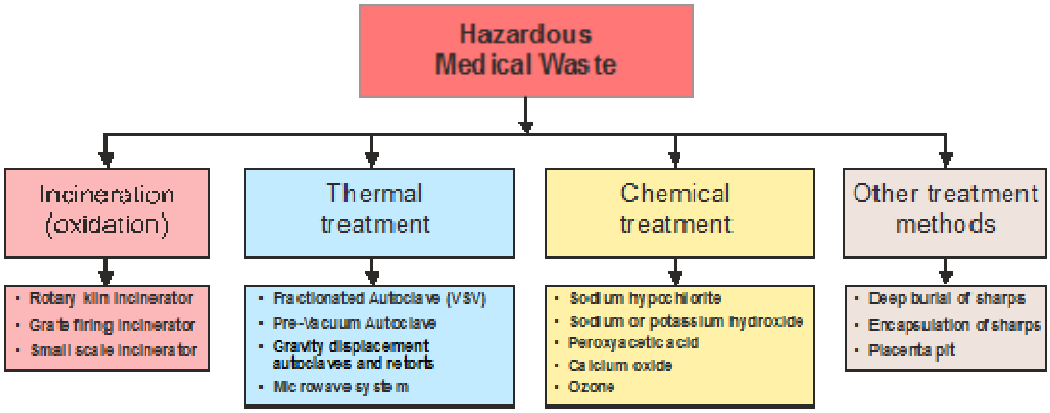



**Figure 6-18,** Overview of possible medical waste treatment methods

In the past, incineration was most common used treatment method for medical waste. in the world. Due to concerns about the environmental impacts of emissions (flue gas, bottom ash, contaminated fly ash and waste water from the flue gas treatment), and relatively high investment and operational costcosts for incinerators, companies and research institute started to develop alternative

treatment systems in the late 70´s in Europe and later in the US and other countries.

After nearly three decades of development and operation of these systems, the systems are now well proven and a wide range of different treatment systems are available. In general, alternative treatment systems can be classified in steam based, dry heat based, chemical based and irradiation based systems. Autoclaving – a steam based process – is today the most well known alternative treatment technology for infectious waste comprising 90% of treatment of waste.

### 6.2.1 Steam treatment for infectious waste

**a) Treatment levels of steam based treatment systems**
There are different steam based treatment methods for the decontamination of medical waste each which reach different treatment levels. There are four international accepted levels of treatment defined by the Centers for Disease Control and Prevention (CDC), the Robert Koch Institute (RKI) and the World Health Organization (WHO):

Level 1 – Low Level Disinfection:

Low level treatment involves inactivating most vegetative bacteria, fungi, and some viruses. This level of treatment does not inactivate mycobacteria (e.g. bacteria causing tuberculosis) and bacterial spores. This level of treatment is inadequate for MEDICAL WASTE treatment and is not recommended.

Level 2 – Intermediate Level Disinfection:

Intermediate level of disinfection involves the inactivation of mycobacteria, all viruses, fungi and vegetative bacteria. It does not include the inactivation of bacterial spores. This level is also defined as the destruction of all micro organisms except high numbers of bacterial spores. These two definitions are essentially equivalent. Tests for intermediate level disinfection must show that a 6 log (logarithm to the base 10) reduction of the micro organism most resistant to the treatment is attained. This level does not include inactivation of bacterial spores which are required in Level 3 (e.g. for Anthrax – *Bacillus anthracis*) and Level 4 (e.g. Tetanus - *Clostridium tetani*) and therefore is only suitable for the pre-treatment of waste, prior to final treatment.

Level 3 – High Level Disinfection:

High level disinfection constitutes the killing of nearly all microbial life forms present in a medical waste load (including *Bacillus anthracis)* as evidenced by the inactivation of surrogate pathogens (bacterial spores) having death curves similar to the most resistant human pathogens. Such surrogate pathogens may not be the forms most resistant to a particular treatment process but are similar in resistance to most human pathogens found in infectious waste. This level of treatment requires the inactivation of a specific quantity of a resistant surrogate pathogen, thus assuring that the waste is treated to reduce the quantity of infectious agents present in the waste stream to a level that does not present a significant risk to human health or the environment. A minimum of 4 log reduction of spores of either *B. stearothermophilus* or *B. subtilis* by thermal inactivation technologies is accepted as indicating high level and intermediate level disinfection. A 4 log 10 reduction is equivalent to a 99.99 % reduction in spores.

Level 4 – Sterilization:

The killing of all microbial life (including *Clostridium tetani*) forms as indicated by complete inactivation of specific concentrations of those organisms recognized as most resistant to the treatment process. Sterilization is evidenced by a minimum 6 log reduction in spores of *B. stearothermophilus*. A 6 log 10 reduction is equivalent to a 99.9999% reduction in spores.

***Recommendation:*** *In most countries today a level-3 treatment is considered as sufficient (e.g. USA, Germany, etc.). As the waste after treatment shall be disposed on landfills and not recycled, a high level disinfection of the infectious waste prior landfill deposit is considered as a sufficient decontamination.*

**Overview on steam-based treatment technologies**

Different kinds of steam-based treatment systems are available today. All these technologies have one thing in common which is steam as treatment media. If heat is applied to water, its temperature rises until it reaches its boiling point or saturation temperature at which point water is turned into steam. At atmospheric pressure the saturation temperature of water is 100°C. At higher pressures, the saturation temperature is higher. For example, at a pressure of 3.2 bar, water boils at 134°C. When steam is at its saturation temperature, the condition is referred to as a saturated condition and the steam is known as saturated steam. Autoclaves and other steam-based systems generally operate at saturated conditions.

Steam-based systems are inactivating micro-organism by heat (coagulation of the proteins). The inactivation process combines the effects of moisture, heat, and pressure. Compared with the usage of hot air (dry heat disinfection), a steam atmosphere has certain advantages for the treatment of medical waste:

- Steam contains more heat energy (the enthalpy energy of the steam will be set free during the condensation on the waste, and has higher specific heat capacity than air) and can therefore transfer more heat to waste than air.
- In wet conditions, germs are more heat sensitive than in a dry conditions. Due to the moisture, spores will expand and lose their usual heat resistance.
- Steam under heat and pressure works through hydrolysis.

This process has been used for disinfecting or sterilizing medical instruments in hospitals since 1876, when Charles Chamberland built the first pressure steam sterilizer. Infectious medical waste may contain many of the same pathogens that are associated with contaminated medical instruments and supplies. Therefore, it was a natural progression to utilize autoclaves to decrease or eliminate the potential bioburdenbio-burden contained in medical waste.

Steam-based treatment systems today differ primarily in their ways to remove air from the treatment chamber. For good quality of a steam based disinfection (or sterilization) the process' most important parameters are:

- The complete removal of the air and replacement with steam to avoid the "Cold island problem", air pockets in the treatment chamber where air was not replaced by steam.
- The quality of the used, saturated steam (minimizing of inert gasses)

- The treatment time and temperature (measured after the waste reached the process temperature)

In the following, an overview of different treatment processes and systems is given:

Gravity displacement autoclaves and retorts

A basic autoclave consists out of a metal chamber sealed by a charging door and surrounded by a steam jacket. Steam is introduced into both the outside jacket and the inside chamber which is designed to withstand elevated pressures. Heating the outside jacket reduces condensation in the inside chamber wall. A "retort" is similar to an autoclave, except that a retort has no steam jacket. It is therefore cheaper to construct but requires a higher steam temperature than an autoclave. The high amounts of condensates generated can be problematic. Retort-type designs are found mostly in large-scale applications.

The system of gravity displacement (or downward-displacement) autoclave relies on gravity for the exchange of cool heavy air for steam (steam is lighter than air). The steam enters at the top of the device and gradually replaces the existing cooler air as it moves toward the outlet at the bottom of the chamber. The removal of all air from the chamber is essential to ensure penetration of heat into the waste. The efficiency of the system therefore depends on the method of packing and loading the waste into the autoclave to prevent the formation of air pockets where the existing air may not be displaced by steam, resulting in partly not treated waste. Problems occur if the waste is packed in bags, preventing the displacement of the air.

To minimize the problems of air pockets, systems have been developed which apply a mechanical processing (shredding) before the steam treatment for the purpose of improving the transfer of heat into the waste, achieving more uniform heating of the waste, rendering the waste unrecognizable, and/or making the treatment system a continuous (rather than a batch) process, e.g. by using oil heated auger systems (an auger is essentially a large screw that rotates inside a cylinder, thereby moving the waste forward). These new systems have sometimes been referred to as "advanced" autoclaves.

***Note:*** *Pre-shredding or pre-grinding should not be done before disinfection to protect workers from exposure to pathogens released in the air by the mechanical process. The exception would be if shredding or grinding is an integral part of a closed system designed in such a way that the air stream from the mechanical process is disinfected before being released to the surroundings. These types of systems are comparably difficult to operate and to maintain and therefore not recommended for South Sudan.*

Microwave systems

Microwave treatment is essentially a steam disinfection process since water is added to the waste and disinfection occurs through the action of moist heat and steam generated by microwave energy. Various studies show that the lethal effect of microwaves on microbial organisms is primarily due to moist heat; without water or steam, microwave energy alone does not result in significant cell inactivation.

Microwaves have wave length of several centimeters and lies in the electromagnetic spectrum between radio waves and infra red light. Microwave disinfection systems consist of a disinfection area or chamber into which microwave energy is directed from a microwave generator (magnetron). Typically, 2 to 6 magnetrons are used with an output of about 1.2 kW each. The waves of microwave energy cycle rapidly between positive and negative at very high frequency, around 2.45 billion times per second. This causes water and other molecules in the waste to vibrate swiftly as they try to align themselves to the rapidly shifting electromagnetic field. The intense vibration creates friction, which, in turn, generates heat, turning water into steam. Some systems are designed as batch processes and others are semi-continuous. Compared with typical autoclave systems, microwave systems are more complex and have a higher maintenance demand.

***Note:*** *Continuous working microwave systems normally need a pre-shredding of the waste. In that case, the same requirements on the shredding system have to be applied as mentioned before (closed system, air stream must be disinfected). It is a misconception that metals cannot be treated in the microwave disinfection system. Metals however that are too large or too hard to go through the shredder, such as steel plates or prosthetic pieces, cannot be treated in the unit, because they would damage the shredder. Under consideration of the low segregation quality found in the South Sudan hospitals and under consideration of the low maintenance capacity, microwave systems are not recommended.*

Pre-Vacuum Autoclave

An effective method to displace air with steam is the use of a vacuum pump to evacuate air before introducing steam. Pre-vacuum autoclaves remove air from the treatment chamber to create a high vacuum prior to the introduction of steam. This procedure allows the autoclave to reach operating temperatures more rapidly and allows the steam to penetrate the waste load more completely by reducing the chances for air pockets within the waste load.

***Note:*** *As an absolute vacuum from technical reasons is not possible, normally a vacuum of about 100 mbar is applied, resulting in that not all the air is removed out of the treatment chamber and the waste. Therefore, treatment time and temperature should be adjusted to this situation (Typical is 30 minutes holding time at 134°C after reaching the treatment temperature). Latest research shows however that these systems have difficulties in the treatment of larger amounts of liquids. Also they sometimes have problems in the treatment of waste packed in closed bags as the air removal is not carried out for 100%. As e.g. during avian flu cases also larger quantities of liquid waste must be treated, this type of autoclave is not recommended for South Sudan.*

Fractionated Autoclave (also called “advanced pre-vacuum autoclave” or Vacuum-Steam-Vacuum Autoclaves):

To ensure the total removal of air out of the treatment chamber and the waste load (to guarantee that the entire waste load will be penetrated by steam) certain countries and organizations (e.g. Germany – Robert Koch Institute) recommend the use of the so-called “fractionated, high vacuum-cycle”. With this treatment cycle, air is removed by several time creating high vacuums alternating with saturated steam introduction. The advantages of this treatment cycle are evidence based, of special importance is the ability of this type of treatment

plants to also safely treat waste packed in bags (due to the several times applied vacuum and steam pulses). In the medical sector, this treatment cycle is today considered as “State-of-the-Art” for steam sterilization. (See also: DIN-EN 285 – Sterilization – Steam sterilizers – Large sterilizers)

*Example of a VSV sterilization cycle:*

1. Phase: Loading of the autoclave with infectious waste
2. Phase: VSV-Cycle (e.g. 3 times vacuum of 300 mbar followed by two times steam shots of about 1900 mbar). By the steam pulses, plastic bags are weakened (e.g. the melting point of the typically in South Sudan used commercial, low-density polyethylene is typically 105 to 115 °C). In the following vacuum the bags are bursting and by the vacuum the air can be removed.
3. Sterilizing at 134°C with a holding time of 10 minutes at 3200 mbar
4. Drying and cooling down of the waste

**Figure 6-19,** Pictures of waste bags before and after treatment in a fractionated autoclave

*Note: Due to the better removal of air and the pre-heating of the waste during the VSV-Phase, sterilization time can be minimized and the treatment safety is increased. This autoclave cycle normally allows the cooling down and drying of the treated waste prior the removal from the autoclave by creating a post-vacuum.*

### 6.2.2 Chemicals based technologies for infectious waste treatment

Hospitals and other health care facilities have used chemical agents routinely for decades, in applications ranging from disinfecting reusable instruments to general cleaning of work surfaces. Chemical methods using a disinfecting liquid solution give good results in surface sterilization. When applied to medical waste treatment (heterogeneous materials – necessary treatment of inner surfaces), the main problem is how to ensure contact between the chemical and the infectious waste with a high enough concentration and sufficient exposure time.

Therefore disinfection technologies generally incorporate internal shredding and mixing to resolve the problem of contact between waste and chemical agent. Since chemical processes require shredding, the release of pathogens through aerosol formation may be a concern. Chemical-based technologies should operate as closed systems or under negative pressure passing their air exhaust through HEPA and other filters.

Chemical processes employ disinfectants such as dissolved chlorine dioxide, sodium hypochlorite, peracetic acid, or other dry inorganic chemicals. A novel system uses alkali to hydrolyze tissues in heated stainless steel tanks. To maintain the proper concentration of the chemical agents, chemical technologies must be able to replenish chemicals lost through volatilization, decomposition, adsorption on waste surfaces, and interaction with microorganisms.

Other factors such as pH, temperature, and the presence of other chemicals that may interfere with the disinfection process should also be considered. Depending

on the nature of the chemicals, occupational exposures of workers to concentrations in the air and through skin contact may be a concern. Since many chemical-based technologies release substantial quantities of liquid effluent or wastewater into the sewer, the releases must comply with limits set in effluent discharge permits. In addition, it is important to determine what the long-term environmental consequences of those releases might be. Chemical disinfectants are sometimes stored in concentrated form, thus increasing the hazards.

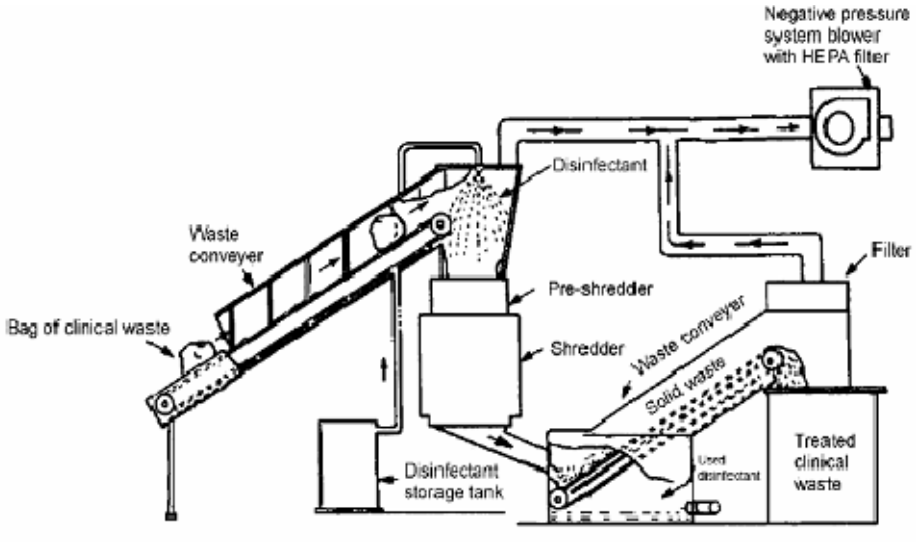



**Figure 6-20,** Sketch of a typical treatment plant using chemicals for disinfection

Micro organisms vary in their resistance to chemical treatment. The least resistant are vegetative bacteria, vegetative fungi, fungal spores, and lipophilic viruses; the more resistant organisms are hydrophilic viruses, mycobacteria, and bacterial spores such as *B. stearothermophilus*. Before using a chemical based process, it should be carefully evaluated if the agent is able to destroy all organisms.

***Note:*** *The problems combined with chemical disinfection of waste and the existing thermal alternative treatment possibilities (VSV-Autoclave) resulted in a ban of this kind of treatment plants in Germany by the RKI. Also the UNEP*[11] *recommends: "Thermal sterilization should be given preference over chemical disinfection for reasons of efficiency and environmental considerations."*

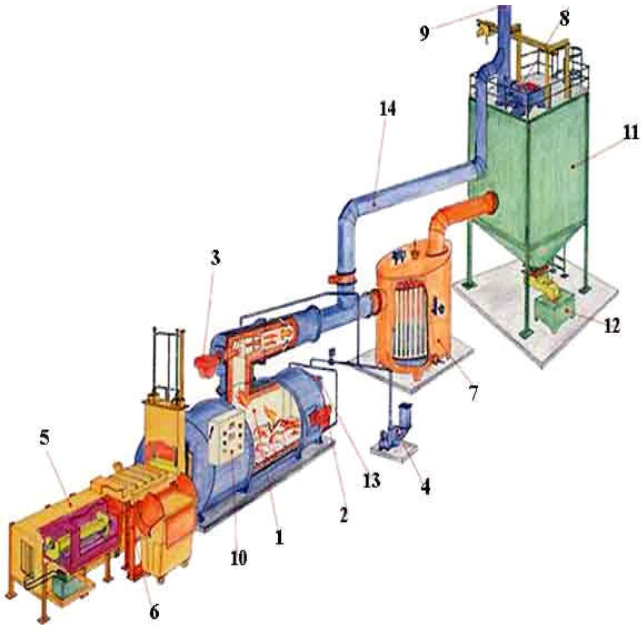
### 6.2.3 Incineration of infectious waste

Oxidation (normally called incineration) is the controlled burning of waste material, commonly in two stages, to produce minimum amounts of gas and ash. On task is the thermal oxidation, a high temperature incineration of pollutants such as VOCs and odors in gas streams. Incineration of waste materials converts the waste into incinerator bottom ash, flue gases, particulates, and heat, which can in turn be used to generate electric power. The flue gases are cleaned of pollutants before they are dispersed in the atmosphere. For the treatment of biohazard us waste especially two types of incinerators can be used:

[11] Technical guidelines on the environmentally sound management of biomedical and medical wastes, September 2003, UNEP and the Secretariat of the Basel Convention

- Rotary Kiln Incinerator
- Grate Firing Incinerators

Exemplary, in the following a typical grate firing incinerator will be described.




1. Combustion chamber
2. Combustion burner
3. Post-combustion burner
4. Primary and secondary air fan with automatic throttle
5. Hydraulic automatic loader
6. Automatic upturn of 770l bin
7. Heath exchanger
8. Gas extracting fan
9. Smoke evacuation
10. Control and regulation board
11. Neutralization and filtration of gases
12. Dust recovering tank
13. Ashes door
14. By-pass (recover +filter)

**Figure 6-21,** Principal sketch of a typical grate firing Incinerator

A grate firing incinerator is a pyrolytic type of incinerator for the treatment of solid waste, especially for waste from the healthcare sector. Capacity span is wide. In the following a plant (two line system) with a capacity of 2x250 kg/h will be described. One line is designed to treat 3.0 tons of waste per day with a lower calorific power (L.C.P) of 3,500 kcal/kg (=.14, 655 KJ/kg). To be treated waste is feed into the incinerator through the hopper. The waste is gasified in the first treatment chamber and the combustion gas is re-burned in the secondary chamber at temperature of 1100 °C with a minimum retention time of 2 seconds. The flue-gas treatment system is designed to comply with the European Emission Standard (Directive 2000/76/EC-4/12/2000).

**Automatic Feed System:**
The feed system is designed to receive waste packed in either plastic bags (packed in reusable loading container), waste packed in a combustible packing (e.g. one-way plastic bin or cartons) or waste in bales (e.g. for confidential materials). To create the necessary oxygen limited environment in the first treatment chamber, the feeding system consists out of a lift system and a hopper with incorporated airlocks (seal for the hopper and a guillotine door for the fire side). After loading the waste in the hopper, the hopper is closed and sealed to prevent the penetration of air. Than the guillotine door is opened and the waste is pushed into the furnace by a hydraulically ram. A new loading of the furnace is possible after reaching parameters set by the control panel.

**First combustion chamber:**
The incinerator follows the principle of the combustion of waste in an oxygen limited environment (pyrolytic effect), following the principles of gasification. This

gasification in a reduced atmosphere produces a gas rich in combustible CO which will be burned in the second chamber. In principle, the process runs as self-combustion and should only need additional combustibles (e.g. fuel) if the waste has a lower calorific power (L.C.P) of 2,000 kcal/kg. The plant is designed to accept waste with a calorific power of up to 7,000 kcal/kg. This amount will not risk thermal overloading of the furnace, the energy recuperation equipment and the gas treatment system. For pre-heating of the plant, two combustion burners with mono-bloc casting guiding are existent. The ash removal is automatic.

**Second combustion chamber:**
In the second chamber, the produced combustion gas with a high content of CO will be incinerated by air injection with post-combustion burners. The post-combustion takes place at a temperature of 1,200°C with a retention time of 2 seconds. From the second combustion chamber, the flue gas will go to the heat-exchanger and from there to the flue-gas treatment. In case of problems with the flue-gas system, a by-pass system for the evacuation of the gases is existent.

**Flue-gas treatment system:**
In the first step, the flue gas will be cooled down by the energy recuperation boiler from 1,100 °C to about 150°C -200 °C. In the second step, coarse dust particles are separated by a centrifugal separator. In the following reaction chamber, the flue gas is treated by neutralizing chemicals (Hydrated lime CO3Ca and activated carbon) which are injected into each reactor. While the CO3Ca will neutralize acids like HCI, S02, HF, the active carbon will absorb dioxins and furans. The chemical reaction of the hydrated lime can be generally described as follows:

$$CO3Ca + 2\ HCl \rightarrow CaCl2 + CO2 + H2O$$

$$CO3Ca + 2\ HF \rightarrow F2Ca + CO2 + H20$$

$$CO3Ca + SO4H2 \rightarrow SO4Ca + CO2 + H2O$$

The created solid particle will be removed by the usage of a ceramic filter.

As experiences showed, the typical flue gas from the medical waste combustion contains about 5 ng/$Nm^3$ dioxins and furans. According to the manufacturer about 3 ng/$Nm^3$ (in particle form) will be eliminated by the ceramic filters, the typically 2 ng/$Nm^3$ in gaseous form will be absorbed by the injected active carbon. After the filtration, the purified flue gases will be drawn out by means of I/D fan via the chimney.

To clean the filter, a compressed air jet can be injected into the inside of the elements as a counterblow pulsating cleaning system. The released dust agglomerated at the elements will fall into the dust collecting basin situated under the filter housing.

***Note:*** *Incinerator systems which are able to fulfill the EU directive 2000/76/EC-4/12/2000 require an extensive flue gas treatment system and a quite complex waste burning strategy. From the economical point of view, this type of incinerators can only be operated efficiently with to be treated waste capacities of >50 kg/h.*

### 6.2.4 Financial assessment

Based on the previous aspects, the two main treatment methods for infectious medical waste to be considered in South Sudan will be:

I. Steam based treatment systems

II. Incineration systems

Steam based treatment systems can be divided into systems where steam is externally generated by an electrical or fuel based steam generator (e.g. autoclave systems) or by using microwave energy. Some year ago, microwave systems were available at larger scale treatment plants (e.g. central solution from the company Sanitec Industries, Inc.) as well as small scale solutions (e.g. on-site treatment solutions from the companies METEKA or CMB/Sintion). During this time, more than 60 central microwave treatment plants were set up. The high start-up costs (more than US$ 300,000) make this an unrealistic waste treatment method for plants that treat less than 100 kg/h of waste. As these high quantities do not have to be treated in South Sudan, large scale microwave systems shall not be considered in the following.

Investment cost for sophisticated small scale microwave systems (as e.g. Sintion, Meteka, etc.) are typically 2-3 times more expensive than comparable sophisticated steam-based systems of the autoclave type which achieve similar treatment results. Examples are:

1. Company Meteka:
- System MEDISTER 60 HF, capacity about 40 l waste per hour: US$ 70.000
- System MEDISTER 160 HF, capacity about 80 l waste per hour: US$ 90.000
2. Company CMB:
- System Sintion 120 l waste per hour: US$ 80.000 US$
3. Autoclave system (various suppliers e.g. Tuttnauer, Cisa, TTM, Steris, etc.):
- Autoclave System, capacity about 80 l waste per hour: US$ 25.000
- Autoclave System, capacity about 250 l waste per hour: US$ 60.000

As the investment cost for microwave systems are visible higher compared with autoclave systems and as there is no difference in the operation costs, a detailed cost comparison of these two types of systems is not necessary. A sample comparison between autoclave system and incinerator system is provided.

While state of the art incinerator systems have several advantages such a broader waste treatment spectrum, high volume reduction of the waste, to ensure a sustainable solution in South Sudan especially operation cost must be considered. To identify which treatment system would be more feasible, a sample economic comparison of the two systems was carried out. For the cost calculation, the following aspects were considered:

- Investment costs and calculated interest rate on total invest
- Depreciation
- Repair and maintenance
- Personnel costs
- Variable Costs [operation cost]

- Insurance

Cost for infrastructure and land was not included, as this will be similar for both systems.

**Sample financial comparison – Autoclave vs. Incinerator**

For the economical comparison of autoclaves vs. incinerator, a treatment capacity of 100 kg/h (2 x 50 kg/h) is chosen.

The systems compared are:

1. Advanced two-chamber incineration (1,100 °C), treatment capacity 2 x 50 kg/h;

2. Sophisticated, Fractionated Vacuum-Steam-Vacuum Autoclave system, based on EN285, treatment capacity 2 x 50 kg/h.

To demonstrate this, in the following the total costs of the two different treatment systems are evaluated. The expected amount of waste to be treated would be:

2 x 50 kg/h * 6 effective operation hours per day * 260 treatment days = 156 tons p.a. For calculation, 125 -150 tons per anno are expected.

The annual operation cost calculation for the systems which could be used in cities in South Sudan showed that the treatment cost per ton of waste would be:

- Incinerator system: US$ 141,696 per anno (US$ 945 per ton)
- Autoclave system: US$ 86,531 per anno (US$ 577 per ton)

In Figure 6-22 the total treatment cost including depreciation etc. for the two methods is shown:

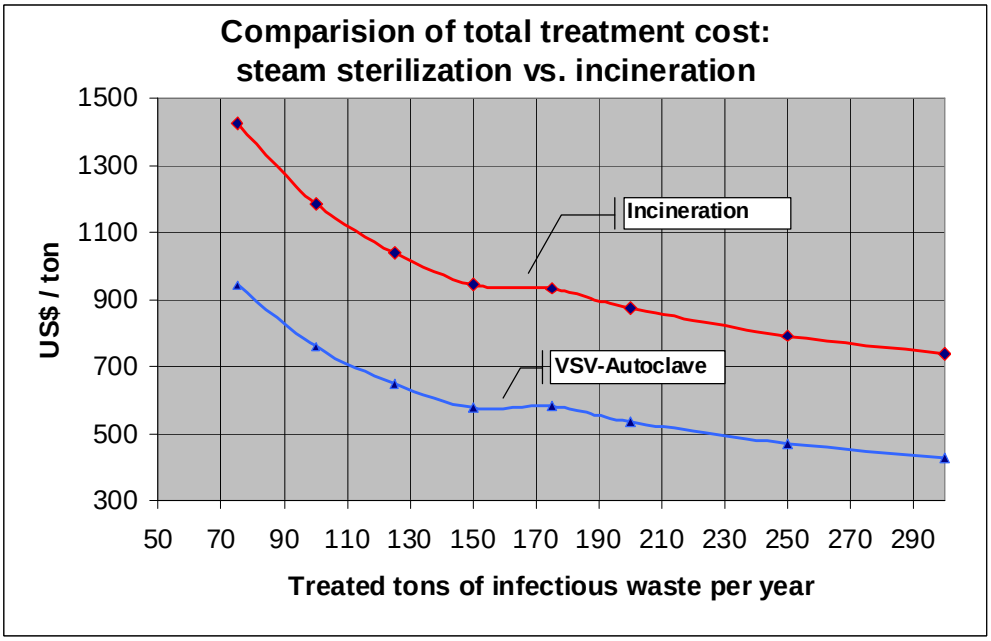



**Figure 6-22,** Comparison of total treatment cost: incinerator vs. autoclave system

In the following, the operation costs and the total treatment costs versus the waste capacity (treated amount) are displayed for the autoclave system.

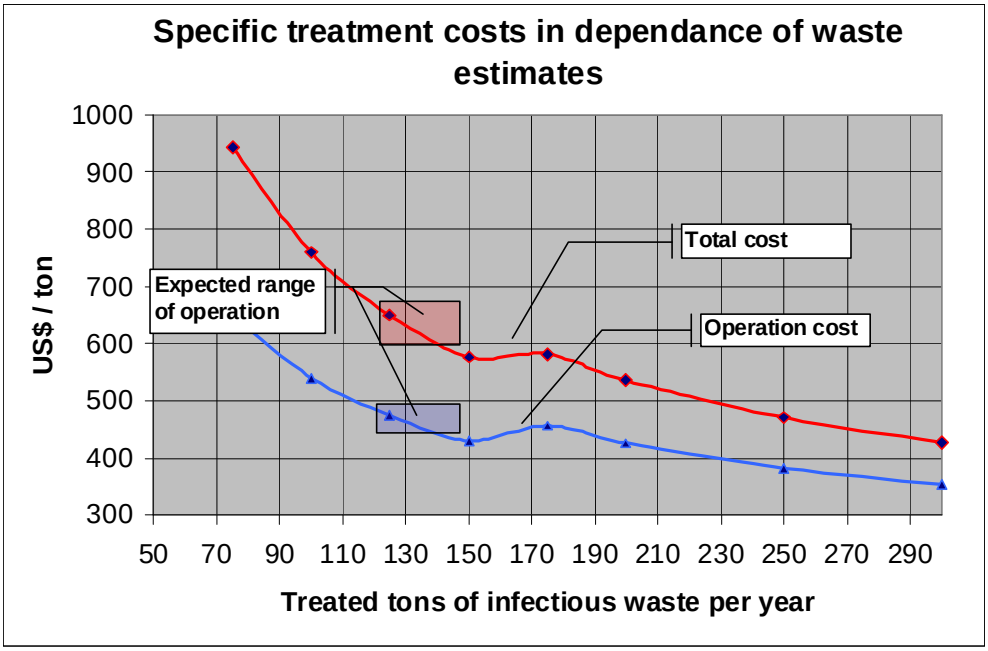



**Figure 6-23,** Operation cost and full cost analysis – 50 kg/h autoclave system

As it can be seen, the expected operation cost for a 50 kg/h autoclave system with a yearly throughput of 125 - 150 tons would be in the range of US$ 430 to 475 per ton of waste, and the total costs including depreciation and interest would be US$ 575 to 650 per ton.

### 6.2.5 Summary & Recommendation

The most common alternative for the safe decontamination of infectious medical waste is today steam treatment technology. Based on experience, other treatment systems based on waste combustion, chemicals, dry heat or irradiation are less trustable and cause unnecessary environmental pollution. Therefore these treatment methods are not recommended by certain institutions as the UNEP or the German Robert Koch Institute. In the official list for decontamination systems in Germany it is stated: “Only thermal processes are suitable for the disinfection of waste conforming to the definition in Section 10a of the Federal Epidemic Control Act (infectious waste). Processes should be given preference in which the medium is saturated steam and in which air is evacuated mechanically”.

As the treatment cost will be about 2 times higher when using an incinerator instead of an autoclave system and as the operation cost are almost 2 time higher, the usage of incineration systems for South Sudan is not recommended. Instead steam based treatment systems should be used. As the investment cost for microwave system are >2 times higher than for an autoclave, autoclave systems should be preferred.

If a steam treatment system shall be applied, fractionated autoclaving systems (VSV-Systems) should be chosen as they have a lower maintenance demand than systems which require a shredding of the waste and will ensure a higher treatment security than retort or pre-vacuum systems.

In case that an oil-fired incinerator system is chosen, it must be ensured that a budget for the fuel is available. In case that simple SSI (e.g.bio-mass incinerators) are chosen, this should be high temperature SSI (comparable to the De-Montfort Incinerator). The installation of single-grate incinerators or drum-incinerators should be avoided.

### 6.2.6 Minimum approach

Hazardous medical waste should be treated to reduce the potential for harm. At a minimum the following steps should be included in a strategy:

1) segregation and other practices to minimize the amount of waste that needs to be treated
2) safety measures during the collection, transportation and storage of the waste
3) safe disposal of the segregated, non-hazardous waste outside of the healthcare facility
4) a treatment process for hazardous waste that achieves at least the minimum required disinfection level followed by a safe disposal of the residues

Treatment can be done on the premises or at a centralized treatment facility. When treating on site, the technology should be carefully selected based on waste characteristics, technology capacity and requirements, environment and safety factors, and cost. In low-income settings, for example, this may mean modifying an old existing autoclave. Other facilities may be able to invest in small steam treatment units or use existing incinerators with air pollution control equipment. Anatomical waste can be buried in cemeteries or approved burial sites. Except for sharps waste, treated waste can be disposed with regular municipal solid waste.

In extreme circumstances where no treatment is possible, hazardous medical waste (but not non-hazardous medical waste) from small health care facilities could be buried within the premises of the facility where public access can be restricted. A safe burial pit design as shown later in the report should be used. Larger health care facilities should make arrangements with a local landfill to provide a special cell or pit, daily soil cover, and restricted access. Encapsulation, inertization and land disposal could be used for some pharmaceutical and chemical wastes as well as sharps waste. A well-designed sharps pit is another minimum option for sharps waste.

**Desirable enhancements**

Improving segregation and waste minimization are important initial steps towards enhancing existing waste treatment systems. For health care facilities that already use autoclaves, microwave units or other steam-based technologies, the addition of a shredder, grinder and/or compactor, especially for sharps waste is an option. Scheduling regular validation tests, documentation of test results, and

improve ventilation are important enhancements. The facility should also adopt good preventive maintenance procedures.

Facilities that use chemical treatment systems should take extra precautions to ensure the safety and health of their workers. It may be possible to find less hazardous but equally effective chemical disinfectants. Minimizing the environmental impact of air, liquid and solid releases of the chemical residues or by-products is also important. The facility should conduct periodic validation tests and adjust the treatment parameters using the minimum effective chemical concentrations. As with all technologies, periodic maintenance is essential.

Facilities that use incineration may be able to further minimise air emissions by adding air pollution control devices or upgrading the existing flue gas cleaning system. The facility should also adopt the primary measures outlined in the BAT/BEP guidelines of the Stockholm Convention. Another issue that is often neglected is proper handling and disposal of toxic incinerator ash. Incinerator stack tests can be expensive but are a necessary tool for improving the combustion process and ensuring compliance with emission limits. Facilities should also consider installing continuous emission monitoring systems. Periodic maintenance is a must for any incinerator. If the incinerator is reaching its end of life, priority consideration should be given to alternative technologies with lower pollutant releases.

With regards to land disposal, the health care facility could work with other stakeholders and the local municipal authorities to upgrade the existing landfill or construct a sanitary landfill if necessary for the safe disposal of waste in the area.

**Key points**

Many medical waste treatment systems are commercially available today. The choice of technology depends on the characteristics of the waste of the facility, the capabilities and requirements of the technology, environment and safety factors, and costs. The treatment technologies employ thermal, chemical, irradiative, biological or mechanical processes. The common types of treatment technologies are:

- Autoclaves
- Integrated or hybrid steam-based treatment systems
- Microwave treatment technologies
- Dry heat treatment technologies
- Chemical treatment technologies
- Incinerators

These technologies could be supplemented by post-treatment shredders, grinders and compactors. For most technologies, except incinerators, validation testing is needed to ensure that a minimum level of disinfection can be achieved. Autoclaves come in a wide range of sizes and can be classified according to the method of air removal. Integrated steam-based treatment technologies incorporate various mechanical processes to improve the treatment efficiency. Incinerators can range from small batch units to large complex treatment plants. Incinerators should have flue gas cleaning systems to minimise pollutant releases and meet national or international emission limits. Small-scale incineration is a transitional means of disposal for medical waste. When investing

in new technologies, priority consideration should be given to technologies that do not produce dioxins and furans. Regardless of the technology, the health care facility should have an annual budget for periodic maintenance and repair.

Health care facilities can work with municipal authorities and other stakeholders to gradually improve the disposal of waste in landfills. Among the desirable features of a landfill are:

- Restricted access to prevent scavenging
- Daily soil cover to prevent odours and regular compaction
- Organized deposit of wastes in small work areas
- Isolation of waste to prevent contamination of ground water and surrounding areas
- Trained staff.

In circumstances where sanitary or engineered landfills are not available, various options are possible to minimise the transmission of infections and adverse impacts on the environment from hazardous medical waste.

## 6.3 Comparison of existing treatment with alternatives

### 6.3.1 Analysis of the different systems

In the following the existing and prospective alternative treatment technologies are compared. The existing treatment procedures are described in Chapter 5 (Assessment). The following different quantitative and qualitative indicators are considered:

**Capital Costs** are costs incurred for the purchase of treatment equipment – transport, installation, infrastructure and land use and are not considered in this comparison.

**Operation Cost** is the cost acquired in completing the treatment operation - labor costs, energy costs, water costs.

**Ease of operation** is a qualitative indicator which describes the level of complexity of the use of the treatment technology for the operator. The ease of operation is distinguished in “easy, medium or complex.” The different levels are underlined by a traffic light colors system: green (easy), yellow (medium) and red (complex).

**Local availability** is a qualitative indicator which describes the availability of operational skills in the country. The availability of operation is distinguished in “easy, medium or complex.” The different levels are underlined by a traffic light colors system: green (easy), yellow (medium) and red (complex).

**Reliability** is a qualitative indicator which describes the demonstrated reliability of the treatment technology. This indicator is rated as “low, medium or high.” The different levels are underlined by a traffic light colors system: green (high reliability), yellow (medium reliability) and red (low reliability).

**Durability** is a qualitative indicator which describes the durability of the treatment technology. This indicator is rated as “low, medium or high.” The different levels are underlined by a traffic light colors system: green (high reliability), yellow (medium reliability) and red (low reliability).

**Environmental Impact** is the possible adverse effects caused by the operation of a treatment plant by the release of a hazardous substance like emissions in the environment. It is a qualitative indicator which describes the environmental impact of the treatment technology. This indicator is rated on the base that the treatment technology is operated in accordance to the operator manual. Like the ones above it is rated as “low, medium or high.” The different levels are underlined by a traffic light colors system: green (low impacts), yellow (medium impacts) and red (high impacts).

The following scheme is taken for easy comparison of the different technologies:

| | | | |
|---|---|---|---|
| Ease of operation | Easy | Medium | Complicated |
| Local availability | Available | Partly available | Not available |
| Reliability | High | Medium | Low |
| Durability | High | Medium | Low |
| Environmental Impact | Low | Medium | High |

**Existing System (compare with chapter 5)**

| | Open Burning | One chamber Small Scale Incinerator | Advanced Small Scale Incinerator |
|---|---|---|---|
| Ease of operation | Easy | Medium | Medium |
| Local availability of operational skills | Available | Partly available | Partly available |
| Reliability | Low | Low | Medium |
| Durability | Low | Low | Medium |
| Environmental Impact | High | High | High |

**Alternative Systems (technologies like outlined in this chapter)**

| | Automatic modern chemical disinfection | SSI without flue gas treatment | Modern incinerator with flue gas treatment | Vacuum Autoclave | Microwave |
|---|---|---|---|---|---|
| Ease of operation | **Low** Technology is operating automatically | **Medium** Operator has to be trained and monitored properly | **Medium** Operator has to be trained and monitored properly | **Low** Technology is operating automatically | **Low** Technology is operating automatically |
| Local availability of operational skills | **Low** Not available in SS | **Medium** Can be constructed locally | **Low** Not available in SS | **Medium** Available for CSSD | **Low** Not available in SS |
| Reliability | **Medium** Additional mechanical treatment required (shredder) | **Low** Break down likely | **High** High quality technology | **High** High quality technology | **High** High quality technology |
| Durability | **High** High quality materials | **Low** Early break down likely | **High** High quality materials | **High** High quality materials | **High** High quality materials |
| Environmental Impact | **High** Chemical waste water is generated | **High** Even if operated properly | **Medium** If operated properly | **Low** No impacts | **Low** No impacts |

### 6.3.2 Evaluation of the different systems

Existing methods for the treatment of medical waste in South Sudan include open burning, one chamber incineration, and usage of advanced small scale incinerators (SSI). The usage of the traffic light system easily highlights that open burning and “one chamber SSI” are rated in red colour for the indicators “reliability”, “durability” and “environmental impact”. For all used methods the environmental impact is very high as hazardous fume gases are emitted. Especially low temperature burning of waste from medical facilities is generating hazardous substances like dioxin and furans.

Small scale incinerators are designed to meet an immediate need for public health protection where there is no access to more sophisticated technologies. This involves a compromise between the environmental impacts from controlled combustion with an overriding need to protect public health if the only alternative is indiscriminate dumping. These circumstances exist in many developing situations and small scale incineration can be a realistic response to an immediate requirement. As far as possible, a small scale facility should avoid burning polyvinyl chloride plastics and other chlorinated waste.

WHO commissioned a screening level health risk assessment for exposure to dioxins and furans from small-scale incinerators in 2004. The study found that the expected practice with small-scale incinerators resulted in unacceptable cancer risks under medium usage (two hours per week) or higher. The report concluded that small-scale incineration should be viewed as a transitional means of disposal for medical waste (Batterman, 2004). Single chamber, drum and brick incinerators do not meet the Best Available Technology (BAT) requirements of the Stockholm Convention guidelines (UNDP, 2006).

The document “Guidelines on Best Available Techniques and Provisional Guidelines on Best Environmental Practices” under the Stockholm Convention on Persistent Organic Pollutants was released in 2007. Medical waste incinerators are specifically identified as potential sources of highly toxic dioxins and furans (Stockholm convention). The section of the guidelines on medical waste states that “priority consideration should be given to alternative processes” that do not generate dioxins and furans. The Stockholm Convention guidelines also reject “single-chamber, drum and brick incinerators” and present specific measures to reduce emissions from incinerators.

In order to provide alternatives to the currently used treatment methods the following technologies are compared:

- Automatic modern chemical disinfection,
- SSI without flue gas treatment,
- Modern incinerator with flue gas treatment,
- Vacuum autoclaves and
- Microwaving technologies.

In the comparison it is highlighted that the alternative technologies should be preferred due to their advantages in the areas “ease of operation”, “reliability”, “durability” and “environmental impact”.

The Secretariat of the Basel Convention released its “Technical Guidelines on the Environmentally Sound Management of Biomedical and Medical wastes (Y1; Y3)” in 2003. The Basel guidelines designate steam treatment as the preferred treatment method for infectious waste and stipulate conditions to minimize the environmental impact of incineration.

Also the policy paper on safe medical waste management issued by the WHO in 2004 calls for effective, scaled-up promotion of non-incineration technologies in the long term.

Also the usage of modern incinerators with flue gas treatment is rated positive except the “local availability of operational skills” as the operation of such

technology is quite complex and needs highly trained personnel. The advantage of incineration is the possibility to treat also other hazardous waste than infectious and sharp waste.

The problem with chemical disinfection in general is the generation of chemical waste water. Powerful disinfectants are often hazardous and toxic and many are harmful to skin and mucous membranes. Users should therefore be aware of their physiological effects and wear protective clothes, including gloves and protective eye glasses or goggles. Disinfectants are also aggressive to certain building materials and should be handled and stored according to manufacturers' instructions. Therefore the usage of chemical disinfection methods should be avoided if possible.

## 6.4 Decision making process for treatment and disposal

The decision on what kind of treatment / disposal technology shall be use will influence the medical waste system of a hospital or a cluster of hospitals for several years. Not only technical aspects must be considered but also economical aspects, availability of trained operators, possibilities for maintenance and the possible environmental impact.

### 6.4.1 General strategy on medical waste treatment and disposal

To identify the possible medical waste generators, the hospitals as described in the chapter 4 should be used. Looking at to be expected waste quantity, waste quality and the complexity of the handling of the waste streams, it can be easily understood that as more complex the provided services are (diagnostic as well as therapy), as more complex the generated waste streams will be. Also it can be easily understood that this type of more complex waste streams can be more typically found in larger facilities located at a more central political level (state or national level) than in a PHCC or an PHCU. In the following figure this correlation is displayed:

| Type of Hospital | County Level | State Level | Central Level | Quantity & Quality |
|---|---|---|---|---|
| Primary Level | | | | Low quantity, few waste streams |
| Secondary Level | | | | Higher quantity, more waste streams |
| Tertiary Level | | | | Large quantity, several waste streams |

**Figure 6-24: Medical Waste Quantity & Quality by Hospital level and location**

For the set up of a medical waste treatment strategy, it is necessary to identity the different kinds of waste generated by the healthcare sector and to cluster them in so-called "waste steams". This will enable a possible common transport and/or treatment for the main waste streams, will ease handling and will reduce cost. For certain main waste streams (as e.g. for chemical waste) out of safety or other reasons a further sub-division of the main waste stream is necessary. For

South Sudan, based on the developed policy and guideline, the following 5 main waste streams can be defined:

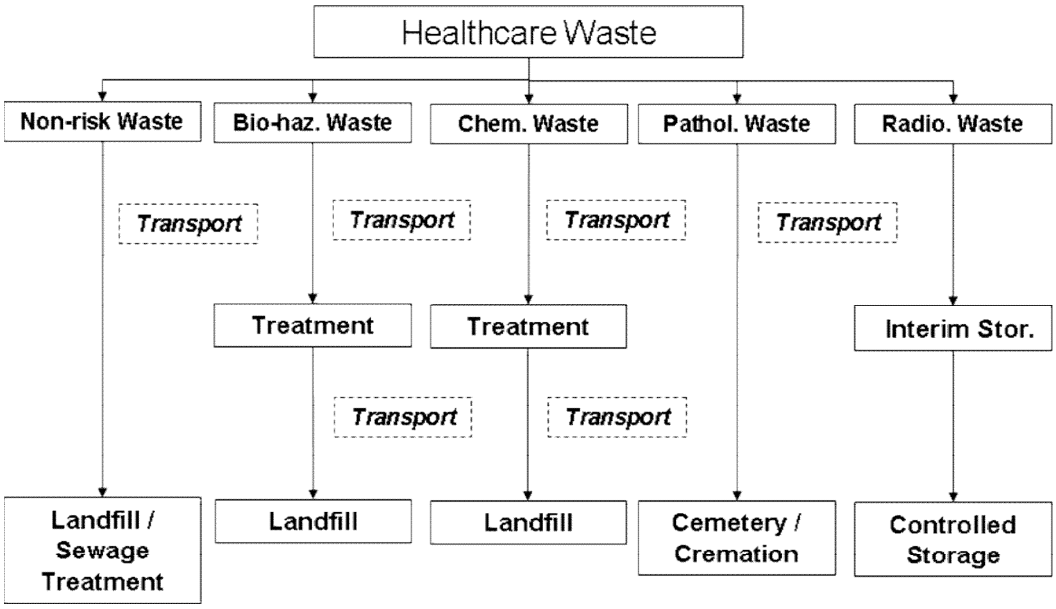



**Figure 6-25: Recommended medical waste stream strategy, South Sudan**

- A: "Non-risk, household like healthcare waste" means all solid and liquid healthcare waste generated by the healthcare sector, which creates no higher risks for humans, animals and the environment as domestic waste (waste generated by households). There are three subgroups:
    - Liquid non-risk waste: Waste water from the hospital sewage system.
    - Recyclable waste: Separately collected non-risk waste such as paper, plastics, glass, metal etc. which can be recycled.
    - Other non-risk mixed waste: waste which can be disposed of in a sanitary landfill without further treatment.

Collection of these waste streams can be carried out together with Municipal Solid Waste (MSW).

- B: "Bio-hazardous waste" means any solid or liquid waste, which is likely to be contaminated with pathogen agents. This waste stream includes the groups "infectious waste" and "sharps waste". "Sharps" waste needs to be packed in rigid and sealed containers. Also it includes group "highly infectious" waste if the waste was pre-disinfected in the hospital. It excludes any waste, which could be considered as pathological waste (human body parts). The liquid waste shall be treated in the same way as the solid waste and might need solidification. The Bio-hazardous waste stream shall either be incinerated or shall be sterilized by an accepted steam treatment system prior disposal on a landfill.

- C: "Chemical waste" means all liquid and solid chemical and pharmaceutical waste and pressurized containers, which are generated in

a hospital. Given that in hospitals up to 100 different kinds of chemical waste are generated, the waste stream must be broken down in several sub waste-streams (clustering of chemicals with similar characteristics). The strategy and way how to divide it into the sub-streams depends on the final treatment technologies available. Given the same characteristics as industrial hazardous waste, this waste stream might be treated and disposed of together with industrial hazardous waste.

- D: "Pathological waste" (Group 1d according to Decision No. 43/2007/QĐ-BYT) means any solid or liquid waste, which can be considered as human body parts. This special stream has to be handled under consideration of ethical and religious aspects. The pathological waste is to be collected and removed by special organizations.

- E: "Radioactive waste" Radioactive waste shall be managed under consideration of special regulation on radioactive materials (to be developed).

### 6.4.2 Methodology for decision making

**General aspects on decision making**

The logic behind the decision making process flow to select the most suitable choice of environmentally sound treatment and final disposal of medical waste must be based on a careful analysis. In future, decision making must include an EIA process. In addition, it is recommended that decision maker should consider the following key points to ensure that appropriate treatment and disposal methods are selected:

- suitable policies and guidelines on Medical waste management should be drafted and adopted,
- available technical documents on waste treatment methods and technologies should be considered,
- precise information on waste treatment needs to be obtained from the states and the counties,
- international guidelines and technical recommendations developed by the Basel Convention, Stockholm Convention, and World Health Organization should be adhered to,
- financial resources (project financial security/sustainability) should be made available; and
- Available technical and human resources should are required.

The general strategy for the treatment of solid healthcare waste shall be based on the healthcare waste stream strategy. "Non-risk waste" shall be handed over to the local environmental service companies for the disposal in sanitary landfills if existent.

"Bio-hazardous" waste such as infectious waste and filled sharps container can be collected together. If highly infectious waste shall be added to this waste stream it must be pre-treated prior disposal as biohazardous waste. Bio-hazardous waste is typically the largest hazardous healthcare waste stream (by volume and by weight); it has a low density (about 120 kg/m³) and the storage time is limited (biological active waste). Therefore the economical benefits of a

central solution compared with an on-site solution is often limited due to the additional transportation costs (e.g. the break-even point of the onsite treatment of biohazardous waste from an 100 bed level 1 hospital will be about 50-100 transport km - depending on to the infrastructure/road conditions).

“Chemical waste”, including pressurized containers, has a higher density and can be stored to accumulate it for efficient transport for a longer term (several months up to years if needed). An efficient transport is also for longer distances feasible, if the specific safety requirements for the different type of hazardous chemical waste are considered (See e.g. UN Orange book – Transport of dangerous goods on public streets). As the treatment and disposal of hazardous chemical waste is typically technically more demanding than the treatment of bio-hazardous waste, an on-site treatment might only be possible in large healthcare facilities for selected chemical waste types (e.g. pharmaceuticals, certain chemicals) and which are equipped with advanced, high temperature incinerators).

The challenge for the set up of a sustainable and advanced hazardous healthcare waste solution is therefore less a technical challenge but a logistical and management one. Another challenge is the financial aspects. South Sudan plans to introduce the “Polluter pays” principle for waste management. Consequently it must be expected that in future the disposal cost will have to be paid by the waste generators (the hospitals) and actually by the patients. Considering that the costs for the management & treatment of biohazardous waste are today estimated to be about 0,4 to 0,5 US$ per kg, the cost per bed might be about 0,1 US$ per day. A high burden for the poor - and actually for most not affordable. All selected strategies should take in mind to be in the long term payable without donor support.

Aspects to be considered are therefore:

- Can the selected strategy be managed by hospital?
- Can the selected strategy be operated by the hospital?
- Can the selected strategy be maintained by the hospitals?
- Can the selected strategy be financed by the hospital/patient?

In the following, a recommended strategy for the mid- to long-term for South Sudan is displayed and described. The strategy follows the following main principles:

1. Including of all generated hazardous healthcare waste streams in a hospital, not only infectious waste and sharps;
2. Chosen treatment or management solution must fulfill environmental minimum standards, even for PHCU and PHCC in more remote areas;
3. Economical based decision whether waste should be treated on-site or in a central system. However if economical acceptable, on-site solution should be preferred solutions due to lower transportation risk.
4. Following the “referral system”: if the waste treatment is more complicated, it should be done at a higher level hospital with sufficient capacity and right equipment. E.g. a county hospital might not be the right place for the treatment of halogenated solvents.

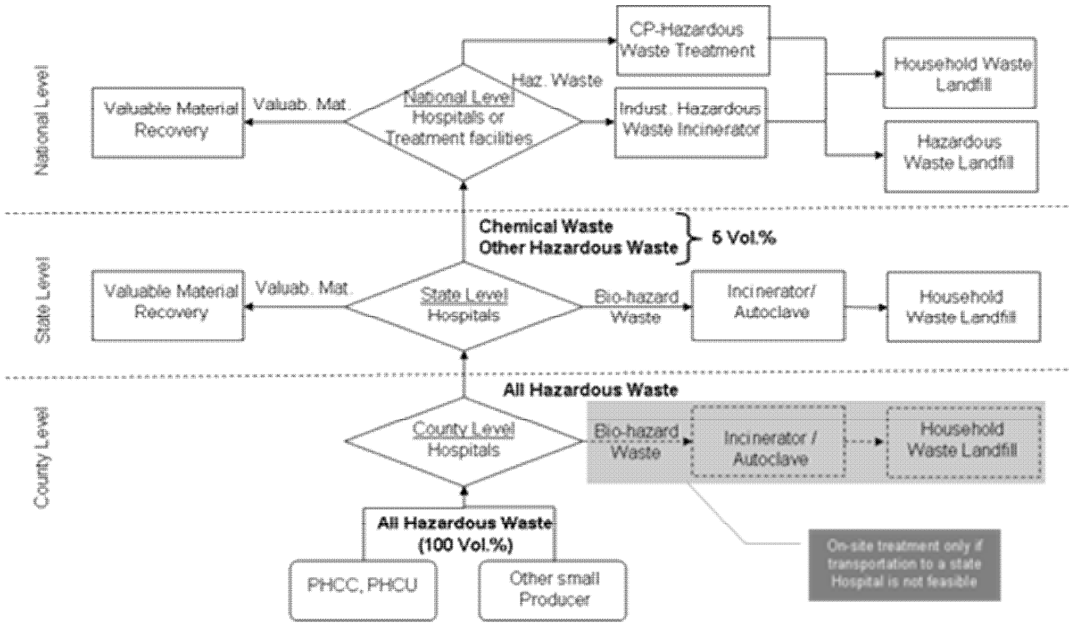



**Figure 6-26: National hazardous medical waste strategy**

### Short description of the strategy:

All hazardous waste is segregated, collected and stored as requested by the draft policy. Small healthcare settings such as PHCU and PHCC will transport all their hazardous waste to the nearest county level hospital for management or treatment if feasible.

A county level hospital will operate a storage place for the different hazardous waste streams. If a transport of biohazardous waste to the next level (state hospital) or to a centralized treatment plant is out of economical aspects not feasible, the waste might be decontaminated by using an autoclave system. In that case the decontaminated biohazardous waste will be disposed of together with the other non-risk waste. The generated hazardous chemical waste must always be interim stored and should be transported from time to time (e.g. once per month) to the next state level hospital (referral system). A treatment of hazardous chemical waste at a county level hospital should not be permitted.

A state level hospital is storing & managing its own hazardous waste and the waste received from the county level hospitals which are located in the near surrounding. If possible, all hazardous healthcare waste shall be transported to the next level (national) hospital or to the next centralized treatment plant. Only if this is not feasible (especially for bio-hazardous waste) - the hazardous waste might be decontaminated or incinerated. If an incinerator exists, easy to be treated chemical waste (such as expired pharmaceuticals) might also be treated onsite.

All waste which is not treated in the state level hospitals (mainly chemical waste but also biohazardous waste in more urban areas) shall be accumulated and periodically be transported to a state level hospital - or directly to a centralized hazardous waste treatment plant if available. As a state level Hospital is typically

a major bio-hazardous waste generator, in most cases the hospital will operate at least his own on-site autoclave system for the treatment of bio-hazardous waste. If the hospital is located outside the main cities (so outside the service areas of the central hazardous waste treatment plants) it most likely will operate his own advanced incinerator systems to treat also chemical waste (which should be equipped with an injector for the treatment of liquid hazardous chemical waste).

Only if the national level hospital cannot treat its own waste or the waste received from the state level hospital or other hospitals in the neighbourhood, the waste shall be stored in the storage place and be transported from time to time to the next national hazardous waste treatment center. This waste, which cannot be treated, will be mainly hazardous chemical healthcare waste needing sophisticated treatment systems such as heavy metal containing chemical waste.

### 6.4.3 Recommended Process flow for decision making

In the following figure, the recommended process flow for choosing the right treatment strategy for chemical waste (left) and bio-hazardous waste (right) is displayed:

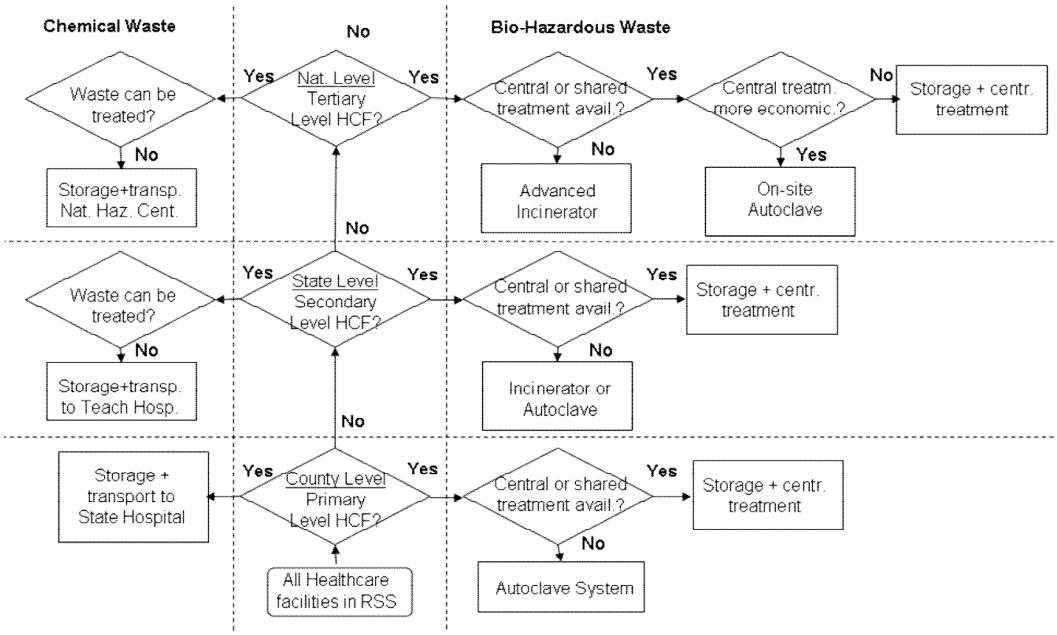



**Figure 6-27: Process flow for decision making, solid medical waste**

## 6.5 Other to be considered recommendations

To ensure an easy implementation and operation of the future treatment plants, it is necessary to improve the present waste segregation system. It should be done by:

- Providing health care personnel with information and guidelines, as well as recurrent training on waste management.

- Improving access to organized solid waste collection and disposal services, especially by constructing sanitary landfill sites.

- Implementation and strict enforcement of environment protection law which should require a permit for waste management operations, including waste treatment and disposal. Adopted national guidelines on the medical waste management should constitute a base for the permit, it monitoring and renewal.

This will not only allow to increase safety of the personnel handling the waste but also will help to substantially reduce the quantity of hazardous wastes that require specialized treatment and hence to minimize overall costs of medical waste management.

The implementation of advanced medical waste strategies has not yet started in South Sudan and only limited experience is available. In the selection of appropriate technologies, the following country specific aspects should be considered:

### 6.5.1 Usage of Small Scale Incinerators (SSI)

Simple Small Scale Incinerators, like a grate burner or single chamber burner are designed to mainly sharps waste or other easily to be burned waste. As temperatures are difficult to control, it is normally not recommended to use this type of equipment or to burn other types of waste, especially those which are moist like pathological waste, in it. Moisture in waste results in a lower calorific value of the waste and by this often lowers the combustion temperature. This is of resulting in smoldering fires and waste burns incompletely.

Burning of larger quantities of waste with high calorific value like plastics and providing sufficient oxygen may raise the temperature in this simple burning place over the acceptable level and will result in cracks of the burning chamber walls as these are typically not designed for high temperature incineration.

Today, also more advanced SSI exist which are, if properly maintained and operated, able to withstand higher burning temperatures. Normal residence time of gaseous by-products for example in the De Montfort incinerator is up to 1 second accounting for both chambers and the stack. When accounting only for the volume in the critical secondary chamber, one estimates about 0.1 second.

Based on pilot studies, World Health Organization estimated that a De Montfort unit (Mk8a) may burn 6 kg of waste per hour. This allows for the disposal of up to twelve 5 litre standard safety boxes. Maximum expected capacity of a unit is 14.4 tons per year (8 hours/day x 300 days/year).

Waste treatment costs in these more advanced incinerators depend on the used fuel. Several type of advanced SSI exist which are using biomass (wood, coconut shells, etc. as fuel. Waste treatment and burning cost than depend mainly on the local wood prices. It can be assumed that 1 – 2 kg of wood are needed for the burning of 1 kg of waste. Kerosene might be needed in small volume to fire the contents at the beginning of the process.

The bio-mass burners as the De-Montfort incinerator are a temporary solution, and the systems are designed for an operation period of no longer than 2-5 years, if well maintained. In reality life-time is about 2-3 years. After this period they should be replaced with more advanced waste treatment technologies.

*Minimum requirements for incineration of medical waste*

The Stockholm Convention is an international treaty with the goal of protecting human health and the environment from persistent organic pollutants. Under the Convention, the countries which are party to the treaty are required to use the best available techniques for new incinerators. The guidelines for best available techniques and best environmental practices limit the levels of dioxins and furans in air emissions to 0.1 ng I-TEQ/Nm3 at 11% O2. Moreover, dioxins in the waste water of treatment plants treating effluents from any gas treatment scrubber effluents should be well below 0.1 ng I-TEQ per litre.

In addition, the guidelines list primary and secondary measures to achieve the performance levels for removal of dioxins and furans. The primary measures are:

1. Introduction of the waste in the combustion chamber only at temperatures of ≥ 850 °C
2. Installation of auxiliary burners for start-up and shut-down operations
3. Avoid regular starting and stopping of the incineration process
4. Avoid combustion temperatures below 850°C and cold regions in the flue gas
5. Control of oxygen input depending on the heating value and consistency of feed material
6. Minimum residence time of 2 seconds above 850°C in the secondary chamber after the last injection of air or at 1100°C for wastes containing more than 1% halogenated organic substances (generally the case for medical waste) and 6% O2 by volume
7. High turbulence of exhaust gases and reduction of excess air by injection of secondary air or re-circulated flue gas, pre-heating of the air-streams or regulated air inflow
8. On-line monitoring for combustion control (temperature, oxygen content, CO, dust), operation and regulation of the incinerator from a central console.

The secondary measures to further reduce dioxins and furans are an appropriate combination of dust removal equipment and other techniques, such as catalytic oxidation, gas quenching and wet or (semi-) dry adsorption systems. Furthermore, fly and bottom ash, as well as wastewater, should be treated appropriately. Carbon monoxide, oxygen in the flue gas, particulate matter, hydrogen chloride, sulphur dioxide, nitrogen oxides, hydrogen fluoride, airflows and temperatures, pressure drops and pH in the flue gas should be routinely monitored according to national laws and manufacturer's guidance.

### 6.5.2 Usage of alternative treatment technologies others than incineration

Alternative treatment systems like autoclaving and microwaving are currently not used for the decontamination of infectious and sharp waste in South Sudan. These treatment technologies are in other countries often used as alternative for incineration to avoid hazardous emissions from incineration and to follow international recommendations and treaties. These treatment technologies need reliable availability of water and electricity for safe operation and are therefore often not recommended for more rural and smaller healthcare facilities. Sites for the implementation of these treatment technologies have to be identified with utmost care.

Chemical destruction is another alternative treatment technology to incineration and does not emit hazardous emissions and ash. Drawback is often the problem of the disposal of the used chemicals. Furthermore the systems are normally quite complex and require a pre-shredding of the to be treated waste. The of not local availability of spare parts for shredder and of chemicals needs to be taken into consideration. Due to these reasons the usage of chemical decontamination of infectious and sharp waste is not recommended at the moment for South Sudan.

### 6.5.3 Maintenance aspects vs. shredding

To reduce the volume of infectious waste, to avoid illegal reuse of medical products and to ease the penetration of waste by steam treatment, shredding or grinding methods are sometimes applied. Shredding and grinding systems are highly maintenance intensive and are prone to break downs. If shredding systems shall be used they must be of the industrial type with a motor power of not less than 10 kW as minimum demand to ensure a safe operation. Typical investment cost for this type of shredders are >40,000 US$ (e.g. shredders from the companies Unta, Bomatic, Erdwich, etc.).

Shredding systems which are used for the pre-shredding of infectious waste must be connected with the treatment system. For repair and maintenance it must be possible to entirely disinfect the shredding system which even more is increasing the cost of the shredding systems.

If shredding or grinding equipment shall be used, it must be expected that due to not well established waste segregation system in South Sudan these will be broken soon after the expired guarantee time. Also the final choice of the used treatment system must include the aspect of the low maintenance capacity in South Sudan. The set up of more complicated systems such as microwave systems or sophisticated incinerators should be avoided at current state.

# 7 Determination of disposal sites

The final disposal of waste is a well known problem in South Sudan. Existing disposal practices are sporadic, project based (Clean Juba) and disposal infrastructure is either non-existent or poorly functioning. Due to the absence of central operated, engineered municipally landfills, hospitals are forced to find temporary solution. Often this is resulting in the digging of simple waste pits and dumping the mixed waste in an uncontrolled and unsafe way.

The assessment of the applied disposal method showed that only uncontrolled pits for the depositing of waste into or onto land and surface impoundment methods for waste disposal exist. Both methods showed weak points in application. Considering the current situation, it cannot be expected that within the next years a nationwide system of engineered sanitary landfills will be set up. It must be expected that it might even take several years until simple dumpsites will be available in the different states and counties.

**Figure 7-1: Juba Landfill, 2011**

## 7.1 Analysis of existing medical disposal sites

### 7.1.1 Centrally operated waste disposal sites

Juba-Yei Dumpsite

The dumpsite is located approximately 25 km outside western border of Juba, near the road to Yei. The land is owned by the Government. Technical documentation for the site is not available.

The site is not an engineered landfill but just a piece of bush which is a bit higher and slightly slanting southwest, towards a flat piece of land covered by bush and trees. It is difficult to define the size of the dumpsite, as it has not any fence or defined out boundaries. The visible area covered by waste has approximately 3000 $m^2$. Farm buildings were not observed in close proximity of the dumpsite.

Various lorries, truck and some specialized back-loaded waste trucks deliver the waste. A controlled and organized landfilling does not take place. Waste is dumped everywhere on the compound, normally at the first place which look suitable for the truck driver. Waste piles are usually not higher than 2.5 meters

wide and 4 meters long. No equipment is available at the site to compact or cover dumped waste by soil. Healthcare waste, including hazardous medical waste such as syringes and needles, were found during the inspection of the site.

The dumped waste is scavenged by several waste-pickers, who recover metals, non broken plastic bottles and sacks but also scavenge for not rotten food waste. During the site visit many of the waste piles were on fire, partly due to spontaneous combustion but more often intentionally lit by the waste-pickers.

Due to relatively long distance and poor road conditions, the site may not be accessible during the wet season. Indicator for this is the existence of another but much smaller wild waste dumping ground located approximately 5 km before the main one, right along the road. Because this dumping ground is close to an inhabited area, it serves to a large group of waste-pickers.

Wau Dumpsite

The dumpsite is located approximately 5 km outside the north border of Wau, near a ballast road to (Atiedo / Bararud). Corn and fruit growing fields surround the site. The site is not an engineered landfill but an irregular trench up to 3 meters deep, and approximately 60 meters wide at maximum. A large portion of the trench is not accessible to lories transporting waste, as there is no downward slope nor a road inside. Furthermore, high grass and bushes limit access of lorries to a major portion of the trench. Therefore most of the waste is dumped at the site entrance, rather than inside the trench. Medical waste could not be found.

In general, the amount of waste deposited at the site is very little, and the site resembles a local in-town dumpsite rather than a site serving for a whole town. There is no equipment at the site to compact or cover dumped waste by soil.

**Figure 7-2: Typical central dumpsite along a road in South Sudan, 2011**

### 7.1.2 On-site waste disposal sites

Health care facilities in South Sudan generally do not have access to organized external services for waste disposal, except in some larger towns such as Juba. Therefore typically all waste is managed on-site with some sort of burn or bury process:

- Domestic and infectious waste, often including loose sharp items, are collected together and openly burned. It is rarely combusted in an incinerator. The ash afterwards is placed in simple dug-out holes or the ash is blown away by the wind;
- Sharps are treated the same as mixed waste: buried, or burned in an open fire and only rarely treated in an incinerator;
- Placentas are taken by relatives and buried in ground. Only a few healthcare facilities reported other means of placenta disposal. These included disposing of the placenta in a toilet or mixing it with other waste.
- Expired pharmaceutics are collected separately, temporary stored, and when possible sent to MoH-RSS or State MoH for disposal, which involves burning in an open fire at a town dumpsite under committee supervision. Small quantities are also burnt or disposed of into waste pits or latrines;
- Chemical waste is disposed of down a drain or buried into the ground together with domestic waste.

Due to lack of hydro-geological studies, documentation and law, for most of the inspected dumpsites their locations have been chosen based on available space rather than the locations or the distance to the ground water table. The dumpsites are not designed and maintained according to international standards. National standards do not exist.

Juba Teaching Hospital, CE

There is no placenta or waste burial pit. Part of the domestic and mixed waste is temporary deposited in a few waste skips available at the back of the hospital compound but most of the mixed waste is dumped near the incinerator. The dumping ground is not protected, and waste is often flooded by water. The waste is periodically transported off-site to Juba-Yei dumpsite by private contractors. Other waste is burnt in the on-site incinerator. The ash from the incinerator is periodically transported to Juba-Yei dumpsite like the other waste produced by the hospital.

Malakal Teaching Hospital, Upper Nile

An waste pit was constructed at the Teaching Hospital, close to the Hospital's three damaged incinerators. It is difficult to determine whether the pit was intended for the incinerator ashes or non-hazardous waste. According to the PHO, the pit is 20 meters deep, however this is considered as unlikely. The pit is 1.5 meter wide and about 3.5 meters long, covered by partly broken cement plates which have a waste inlet in the middle. The pit is almost full but mixed waste is still dumped into the pit. Larger quantities of mixed waste, including sharp items, are burnt close to the pit.

Malakia PHCC, Malakal, Upper Nile

There are two waste pits constructed by the NGO GLOBAL: one should serve for infectious waste, and the second for domestic waste. Both are cement constructions. The waste pit for infectious waste has attached a drum with a lid for the pit enclosure. Its diameter is 1.5 meter. The pit receives currently all kind of waste, including sharps boxes and is about ¾ full. The personnel stated that waste is burnt daily. The second pit for domestic waste is 1.5 meter wide and 3 meters long. It has a broken cement plate as enclosure. Although it is full of mixed medical waste, waste is still dumped into it.

A dedicated sharps pit is similar to the first waste pit, but is equipped with an attached 0.5 meter high metal inlet without an enclosure. The staff stated that the pit is still in use, and full sharps boxes are dumped into it and burnt. Sharps boxes are also present in the near waste pit, and loose in the second pit. A picture taken with a view to inside the pit shows that there is partly burnt waste, and quite number of non-burnt syringes with needles.

**Figure 7-3: Waste pits at Malakia PHCC**

Wau Teaching Hospital, WBG

There are two main waste / burning pits. One pit is located approximately 5 meters outside a surgery department. The second pit is located at the southern part of the hospital compound, close to a new mortuary and near an abandoned incinerator and about 150 meters outside to a near ward. Both pits are comparable large (approximately 2 meters wide, 6 (first) to 8 meters long (second), and over 6 meters deep). Both are dug in rocky ground and their walls are layered with bricks.

The first pit is almost full of ash and partly burnt waste but new mixed waste is continuously delivered to it. The pit burns all the time due to deep suppressed combustion. The fumes and strong odour go directly to the surgery ward. The second pit receives the largest quantity of mixed waste, sharps, and surgery

waste but it was not in fire during the site visit. It was approximately less than 20% filled with waste.

There is also a frequently used waste dumping and burning ground at the backyard of the second-2ndclass delivery ward - the fumes and strong odor are reported to enter the ward. There are several other smaller dumps and burning areas all over the hospital compound, which are used for various kind of mixed waste, including potentially infectious waste. Most placentas are taken by patients or their relatives. Placentas that are not taken are disposed of in a toilet. Other body parts are burnt on-site.

Chemical waste goes directly to the ground. X-ray uses on average 45 liters of fixer and developer per month. Liquid X-ray waste is poured out to the ground just in front of the department, at the visitors' area.

**Figure 7-4: Smoldering waste pits at Wau Teaching Hospital**

Muktah Primary Health Centre, Wau, WBG

The Centre does not have any kind of pit. Mixed waste, including safety boxes and loose sharps are dumped on-site and burned in the open every day. Three fire places were found, however the most frequently used fireplace is located close to the Centre entrance, and near a toilet. Chemicals go directly to the ground as no septic tank is installed. Placenta pits, ash pits, etc. do not exist. Created ash is mainly taken away by the wind.

El Sabbah Children Hospital, Juba, CE

There is no waste burial or placenta pit at the healthcare facility. Solid mixed waste is poured from various non-padded bins and cardboard boxes to plastic bags, which are deposited temporary at an enclosed, but not roofed, area. The

waste is periodically transported off-site to Juba-Yei dumpsite by private contractors. Sharps waste is said to be disposed of off-site by a service provided by the State MoH.

Yei Hospital, CE

Before October 2011, waste was openly burnt at a few areas of the hospital. Since then two waste pits for mixed waste were dug. Each pit is 5 meters deep, and 2 meters wide. Neither of the pits are fenced or marked, and both are close to footpaths. The level of water table is not exactly known but is said to be 5.5 meter. Waste deposited in the pits is burnt twice a week.

There is a separate placenta and surgical waste pit however it also serves for mixed waste disposal. It is approximately 4 meters deep and 2 meters wide. It is not fenced and is located approximately 50 meters away from the nearest building, and away from a footpath. The waste is burnt twice a week.

Expired chemicals are stored in a laboratory but also in a TIR container which serves also for pharmaceutical waste. Chemicals go directly to the drain and to the ground as septic tanks are not maintained at all.

**Figure 7-5: Medical waste at Yei Hospital**

Military Hospital, Juba, CE

All waste generated by the hospital is burned on the open ground.

Police Hospital, Juba, CE

Excluded from the assessment due to renovation.

Lainya PHCC (Hospital), CE

Until an incinerator will be setup, mixed waste is dumped and openly burnt. The burning area is approximately 20 meters outside the facility building, and 40 meters to nearest residential area. Placentas are taken by the patients. Chemicals go directly to the drain and into the ground as no septic tank is installed. Some chemicals are burnt with other waste. Expired drugs are registered and send to Yei Civil Hospital.

Terekeka PHCC (Hospital), CE

A small waste pit was used in the past but is now full. Although a small quantity of waste is still dumped to it from time to time most of the mixed waste is burnt close to it.

Torit State Hospital, EE

There is no waste burial pit. All kinds of solid waste is dumped near an abandoned incinerator at the back of hospital, approximately 50 meters from nearest building. The waste is then burnt once a week on Friday. During the site visits goats were feeding from medical waste.

Placentas are taken by the patient or her relatives. Other body parts are dumped with mixed waste and burnt. Chemicals go directly to the drain and to the ground as septic tanks are not maintained.

**Figure 7-6: Typical on-site dumpsite in a hospital in South Sudan, 2011**

Rumbek State Hospital, Lakes

There is no waste pit. Most of the waste is collected in large containers and drums set up in 10 areas of the hospital compound, near each ward. Collected waste is transported once a week off-site to a dumpsite located 15 miles outside the town. Part of green, and mixed waste is also dumped at three different places of the hospital compound, and burnt.

IHK Juba Clinic, Juba, CE

A waste pit was used in the past. When it was full it was covered by cement, and a power generator was installed on it. Waste is separated into “dry” (domestic), and “wet” (contaminated with blood and body liquids) waste. However, as they are collected to the same color coded bags, they are mix at the storage place, picked and dumped together. Sharps are collected separately to standard safety boxes, and burned in the open once per week.

## 7.2 Recommendations and Strategies

### 7.2.1 General medical waste disposal strategies

The disposal of hazardous medical waste, especially untreated waste on dumpsites is not recommended. Several objections exist, based on cultural or religious reasons, as well as on perceived risks about the release of pathogens to air and water and the risk of access by scavengers. The removal of the remaining medical waste, after whatever recycling or treatment of the original medical waste has been possible, will require access to land for disposal. Allowing waste to accumulate at hospitals or elsewhere constitutes a far higher risk of transmission of infection than controlled disposal at specially prepared sites or well operated municipal landfills, even if the place is not designed according to modern standards (engineered, sanitary landfill).

Indiscriminate dumping of waste is unsafe. Instead, an acceptable land disposal method, either on-site or off-site, should satisfy four general principles:

- Permanent control - The disposal location should be under some form of permanent control such as protected by a fence, equipped with a secure cover, or supervised by staff.
- Controlled waste emplacement – Waste should be deposited in a controlled way at a disposal site and not scattered around irresponsibly.
- Engineered construction – A disposal site, no matter how small or simple in design, should be constructed in a safe and properly engineered manner.
- Hydrogeological isolation - The purpose of disposal is to isolate waste from people and the environment and to allow chemical and microbiological processes to degrade the waste and its remaining pathogen content. Therefore, an acceptable disposal option is one that provides, at least, some isolation from the surrounding strata and hydrology.

In all cases it is necessary to ensure that disposal facilities are built and maintained according to future regulatory standards. This entails that the construction process should be evaluated and permitted, and State or County Environment Officers should monitor operation of the facility.

In all situations it should be ensured that waste is correctly classified and segregated so infectious waste is not mixed with other types of non-hazardous (solid waste) and hazardous waste (chemicals, pharmaceutics, etc.).

### 7.2.2 Improvement of the quality of existing dumpsites

The clear aim of every healthcare facility should be to arrange for its waste to be taken to controlled treatment and land disposal facilities off-site. In South Sudan, where the open dumping and burning of waste is a standard practice, intervention by public authorities will be required to bring about a change in the prevailing approach to medical waste management.

The uncontrolled and scattered deposit of waste at a site characterizes open dumps. Open dumps lead to acute pollution problems, vectors, higher risks of disease transmission and open access to waste-pickers, and animals. Medical waste should not be deposited on or around open dumps. The risk of either people or animals coming into contact with infectious pathogens is obvious, with the further risk of subsequent disease transmission, either directly through wounds, inhalation, and ingestion, or indirectly through the food chain or a pathogenic host.

A target, long term solution should be a sanitary landfill with appropriate engineering preparations completed before the site is ready to accept waste. A sanitary landfill is designed to provide geological isolation of waste from the environment, with organized deposit, daily coverage of waste, and staff present on site to control operations. Sanitary landfills prevent contamination of soil, surface water, and groundwater, and limits air pollution, odors, and direct contact with the public.

There are sanitary landfills for municipal non-hazardous waste and sanitary landfills for hazardous waste, which require a higher level of risk protection for the public and environment. Where sanitary landfills are available they should be preferred to other more risky disposal methods.

Constructing sophisticated sanitary landfills may be technically and financially difficult for many counties in South Sudan. It has often been found impossible to sustain such efforts from the available local resources. However, this is no reason for municipal authorities to abandon the move towards safer land disposal techniques. A possible pathway for South Sudan could be:

1. Introduction of “controlled dumping”. This involves the allocation of a site with a manageable size (2 ha for a medium-size town), covering unneeded areas of the site with soil, continuously extinguishing fires, and establishing rules with waste-pickers if they cannot be excluded completely.
2. From controlled dumping to “engineered landfill”. This involves the gradual adoption of engineering techniques to prevent surface water from coming into contact with the waste, extracting and spreading soils to cover wastes, gathering wastewater (leachate) into lagoons, spreading and compacting waste into thinner layers, prepare new parts of the landfill

with excavation equipment, and isolating the waste from the surrounding geology (e.g. with polymer sheeting under the waste).

3. From engineered landfill to “sanitary landfill”. This involves the continuing refinement, with increasing design and construction complexity, of the engineering techniques for engineered landfill. In addition, there should be landfill gas control measures, environmental monitoring points and boreholes for monitoring air and groundwater quality. In addition, a highly organized and well trained work force, detailed record-keeping by the site office and, in some circumstances, on-site treatment of leachate.

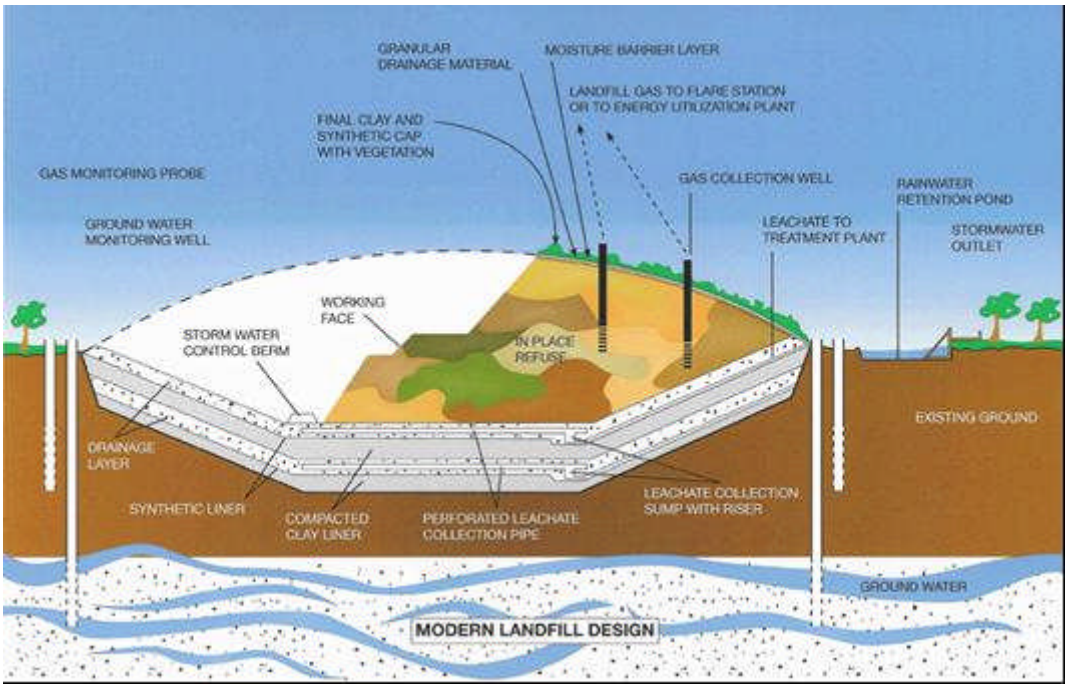



**Figure 7-7,** Modern landfill design

In the absence of access to a sanitary landfill, any site upgraded to a controlled dump or better could accept medical waste and avoid infection risks to the public. The minimal requirements to accept medical waste are:

- An established system for rational and organized deposit of wastes which could be used to dispose of medical wastes;
- Some engineering work already completed to prepare the site to retain its wastes more effectively;
- Rapid burial of the medical waste, so that as much as possible human and animal contact is avoided.

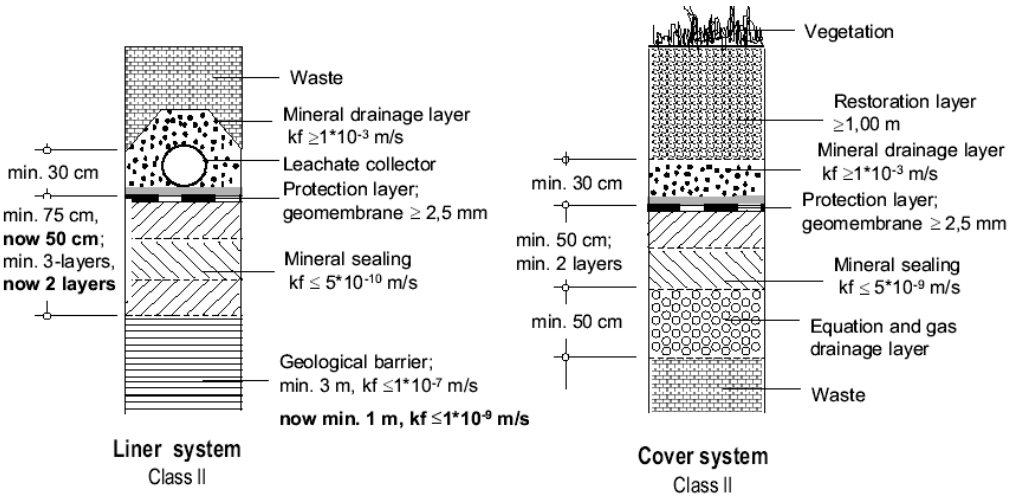



**Figure 7-8,** Modern liner and cover system for landfill design

### 7.2.3 Deep burial or encapsulation of sharp items

In the past, in some countries the deep burial of sharps at hospital premises or the encapsulation of materials, followed by landfilling, was a common practice. The hospital premise is often limited and available space is needed for future construction purposes. The burying of sharps is minimizing the available space; therefore the buried waste is often excavated after some years. To reduce negative future impact, the burying of sharps waste is not recommended.

The encapsulation of sharp items in drums filled with mortar or cement normally requires the separation of the sharp part from the non-sharp part to minimize the encapsulated amount of waste. However, the practice of separating sharps from non-sharp parts often results in needle-stick accidents. Therefore, this method is not recommended.

**Figure 7-9,** Excavation of deep buried sharps after 5 years (Tanzania, Tanga, 2009)

Isolation of untreated sharp items in boxes/containers (also sometimes referred to as encapsulation) followed by landfilling cannot be recommended as a safe burial as the landfills cannot be guaranteed due to the existing scavenging activities.

## 7.3 Determination for temporary disposal sites

### 7.3.1 Off-site disposal of hazardous medical waste

Until there are controlled municipal waste landfills in the states of South Sudan, this option might only be feasible in Juba. If landfills and transport becomes available in state towns, then off-site disposal of hazardous waste should be used. The destruction of pathogens by treatment prior to disposal further increases suitability of the residual wastes for landfill. A possible option is decontamination by steam. If pre-treatment is not possible, it might be temporarily possible for untreated medical wastes to be securely deposited in a controlled landfill.

In that case potentially infectious medical waste and sharps can be buried in trenches approximately 2m deep, excavated in partially decomposed municipal waste and preferably covered daily. At a depth of 2m, re-excavation by scavengers or animals should be prevented. The burial of potentially infectious waste and sharps is unlikely to cause additional pollution problems at a controlled landfill. Its engineered design should minimize the possibility of off-site transport of pollutants. The physical-chemical conditions within partially decomposed municipal waste would accelerate biodegradation of the organic components in the medical waste. The following points should be obtained

- Vehicle access to site and working areas for waste delivery.
- Presence of site personnel capable of effective control of daily operations.
- Division of the site into manageable phases before landfilling starts.
- Adequate sealing of the base and sides of the site to minimize the movement of wastewater (leachate) off the site.
- Adequate mechanisms for leachate collection, and treatment systems if necessary.
- Organized deposit of wastes in a small area, allowing them to be spread, compacted, and covered daily.
- Surface water collection trenches around site boundaries.
- Construction of a final cover to minimize rainwater infiltration when each phase of the landfill is completed.

### 7.3.2 Medical waste burial pit

In the absence of a central dumpsite or a sanitary landfill, a small pit for the safe burial of waste on hospital premises could be prepared to receive medical waste for a short period of time. Only hazardous medical waste should be buried because if general hospital waste were also deposited, available space would be quickly filled.

Even if the pit will be simple in design, some basic design instructions should be followed:

- The burial site should be lined with a material of low permeability, such as clay, if available, to prevent pollution of any shallow groundwater that may subsequently reach nearby wells.
- The distance to the next well or other water sources should be at least 50 meters
- The pit should be 2 to 3 meters deep, and 1 to 2 meters wide
- It should be located downhill from nearby wells
- The bottom of the pit should be at least 1.5 meters higher than the highest possible groundwater level (typical during rainy season)
- An earth mound should be built around the top of the pit to prevent surface water from running in.
- The pit should be well-marked and have a fence around it to keep animals away.

For the operation, the following basic instructions should be followed:

- The burial site should be managed as a landfill, with each layer of waste being covered with a layer of earth to prevent odors, as well as to prevent rodents and insects proliferating.
- Large quantities (>1 kg) of chemical wastes should not be buried at one time
- Burying smaller quantities avoids serious problems of environmental pollution.
- After each waste load, the waste should be covered with a soil layer 10–15 cm deep.
- In case of outbreak of an especially virulent infection, both lime and soil covers have to be added.
- Access to the disposal site should be restricted to authorized personnel only.

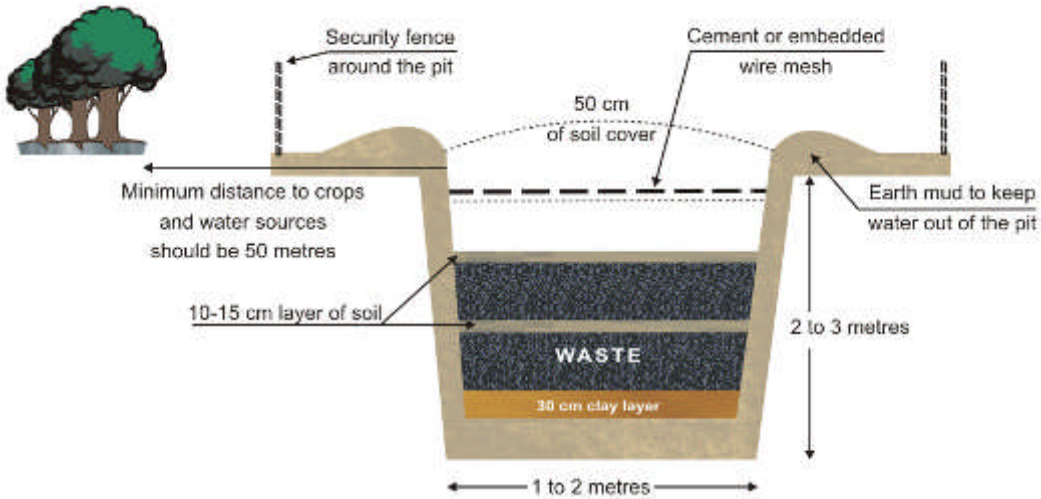



**Figure 7-10:** Recommended design for a medical waste pit as interim disposal solution

50 cm of space at the top of the contents of the pit should be left to properly seal the pit off. Cement or wire mesh should be layered before covering the pit with soil for its final closure.

The safety of waste burial depends on rational operational practices. It should be kept in mind that safe on-site burial is only practical for very limited periods of 1–

2 years, and for relatively small quantities of waste, (up to 5 or 10 tonnes in total). Where these conditions are exceeded, a longer-term solution must be found, involving disposal at a municipal solid waste landfill.

### 7.3.3 Sharps pit

A general infectious waste pit might be used for the disposal of infectious waste but not for sharps waste. If possible, sharps waste should be collected in safety boxes and transported to the next treatment unit. Smaller remote health care facilities like rural clinics, which do not generate much infectious waste and do not have the possibility to transport waste, may consider constructing a pit exclusively for needles and other small sharp objects.

An interim solution for remote areas could be to dig a subsurface sharps pit. There are several designs, for example a hand dug pit covered by a concrete slab fitted with a vertical tube. Used sharps, syringes and broken glass are dropped into the pit via the entry tube. When the pit is three quarters full concrete is poured into the entry tube to form a protective barrier restricting future access. A new sharps pit is then constructed. An alternative approach is to use oil drums fitted with an entry tube, which when three-quarters full, is sealed off with concrete.

It is difficult to place sharps into a sharps pit when sharps boxes are used at a clinic. Often the sharps boxes are too large to fit down the entry tube and their bulky shape can fill a sharps pit too quickly. In this situation, pre-treatment of sharps by incineration before land disposal of the residues may be more practical.

Alternatively, encapsulation of sharps that have been collected in puncture-proof and leak-proof containers, such as high-density polyethylene boxes, metallic drums or barrels, may be possible. When the encapsulation container is three-quarters full, material such as cement mortar, bituminous sand, plastic foam, or clay is poured into the container until it is completely filled. After this material has dried, the container is sealed and may be landfilled, stored, or buried inside the grounds of the health care institution. It is also possible to encapsulate chemical or pharmaceutical residues together with sharps.

Due to the specific usage, sharp pits may serve for many years, much longer than a waste pit. A pit of about 1 $m^3$ internal volume can hold about 1 million needles. The pit may be used for disposal of syringes with attached needles as well. However the life-span is shorter by approximately 25 times as a 1 $m^3$ internal volume approximately only can hold 35 000 syringes.

The drawback of disposing only of the needles is that the needles subsequently need to be removed from the syringe, which may cause a risk if not done correctly. Dedicated boxes with a needle removal mechanism or needle destroyers should then be used to minimize potential contact with sharps. It must be ensured that needles are not recapped, and reusable needle collection boxes are properly disinfected each time after being emptied.

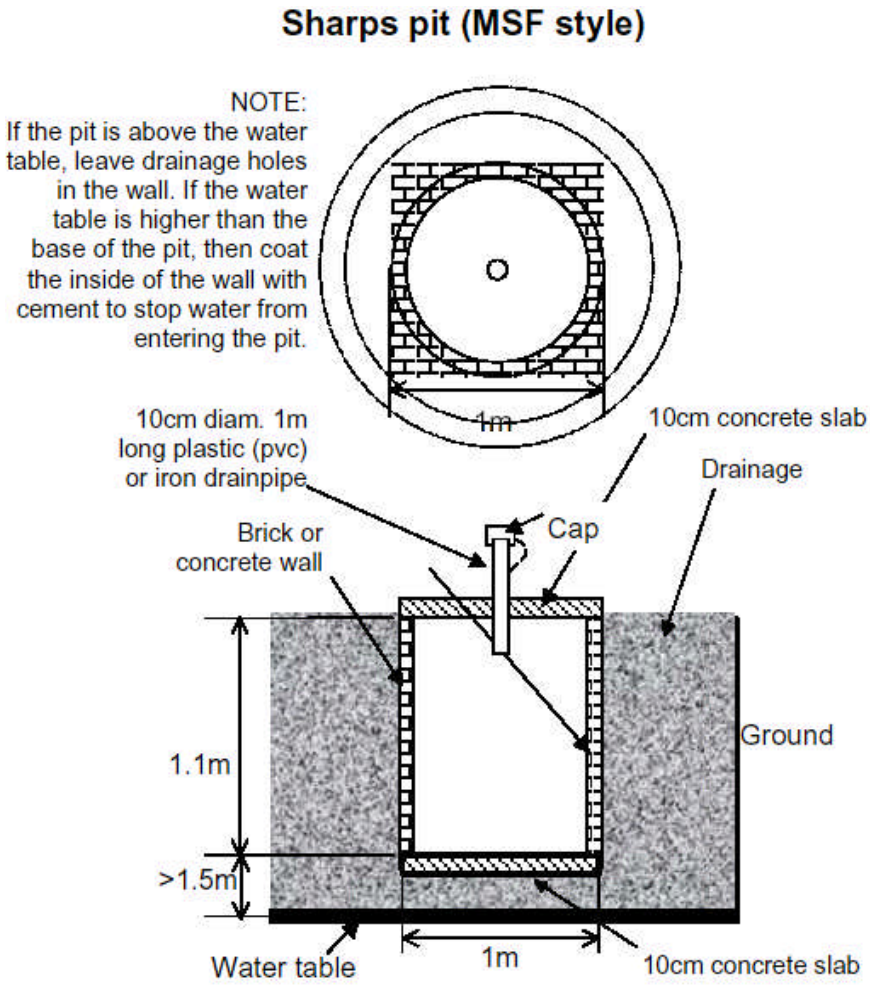



**Figure 7-11:** Examples of pit design for sharps (adapted from MSF).

A sharps pit can also be made from a standard drum (55 gallon) or from pre-fabricated concrete. In each case, it is imperative that the minimum distance to a water table is no less than 1.5 meters.

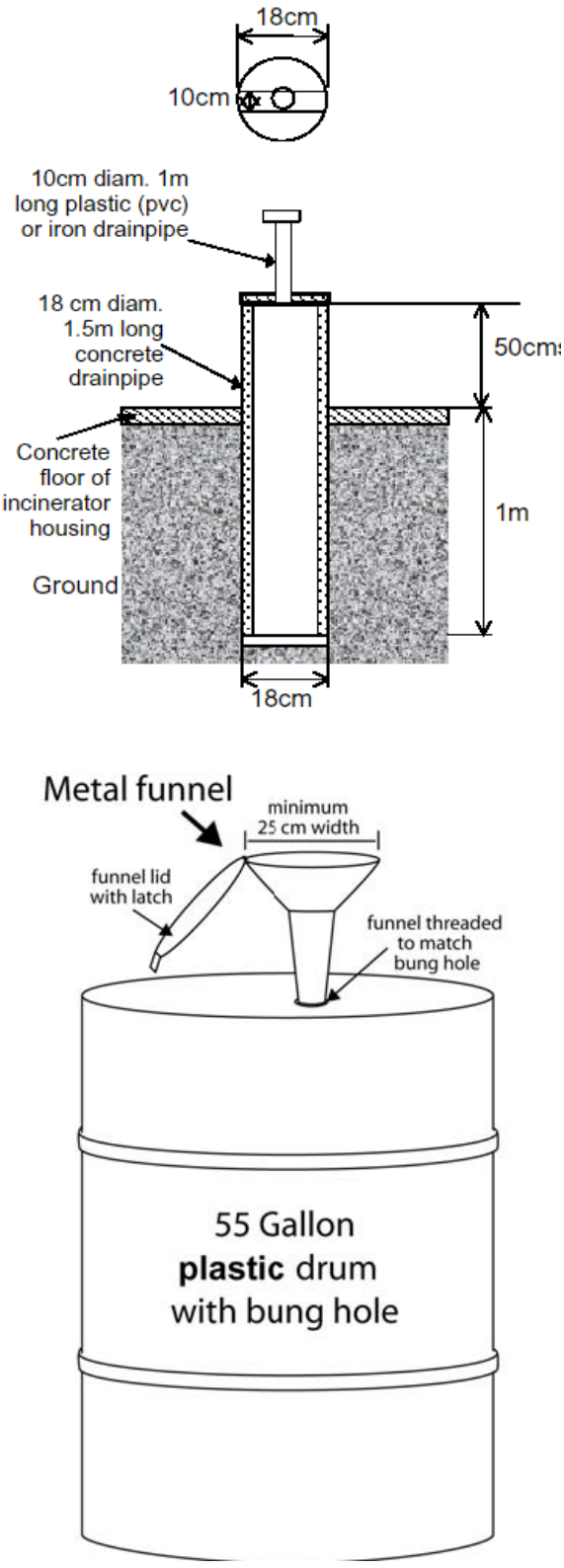



**Figure 7-12:** Examples of pit design for sharps (adapted from PATH).

### 7.3.4 Placenta pit

The main purpose of a placenta pit is to allow the controlled drying of the organic material in a mainly anaerobic environment. The organic material is placed in water and permeable layers of gravel and sand. To ensure that liquid waste, such as body fluids or blood, will be disinfected before reaching the ground water level, a distance of not less than 1.5 m between the placenta pit and the groundwater is needed. When constructing and using the placenta pit, the following guidelines should be followed:

- Distance to ground water should be about 2 m.
- Placenta pit can be made from pre-fabricated concrete rings, diameter of about 0,75-1 meter.
- The top of the pit should be about 0,3 m above ground level.
- For groundwater protection and to support drying process the open pit should be equipped with a 1st layer of gravel (about 300 mm) and a 2nd layer of sand (200 mm).
- The pit should be equipped with a hatch.
- The hatch should be easy to open, should hermitically close the tank and should be lockable.
- The placenta pit should always be locked with a padlock, only the maternity ward should have the key.
- The distance to ground water should be about 1,5 m.

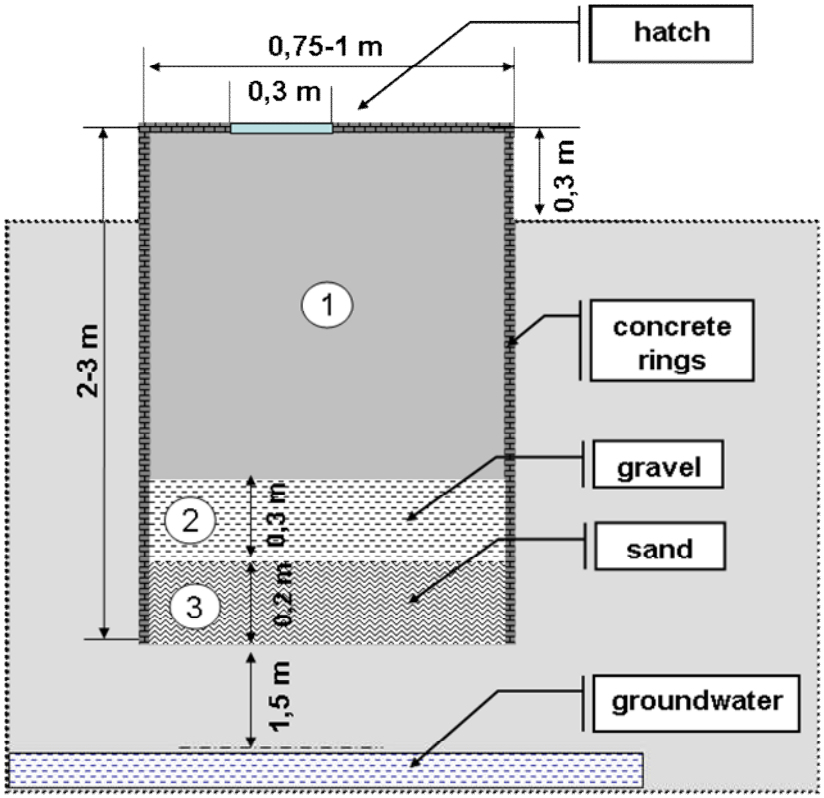



**Figure 7-13:** Recommendations for a placenta pit

# 8 Capacity Building, Training and Public Awareness

## 8.1 Capacity of the Government of South Sudan

After decades of civil war, the government of the Republic South Sudan is facing enormous challenges to set up a working administrative system for the country. Despite the short period since independence, progress is already visible in many sectors. However, the long years of war resulted in a continuous brain drain as educated and skilled people left the country. Although skilled people are slowing returning to South Sudan, there remains a significant gap of skilled and capable workers in all sectors of the government, including the health and environmental sectors.

Environmental health, in particular medical waste management, is a completely new government engagement. Therefore there is a lack of experience and capacity within the sector, with few exemptions.

### 8.1.1 Solid Waste Management

The Ministry of Environment (MoE) is responsible for the regulative framework, policies and capacity building management of solid waste. They also provide technical assistant to the state environmental departments. Currently there is a draft environmental policy available, which has gone through the first consultation but is now pending. Mr. David Batali Oliver (MoE) assumes an approval by the Ministry of Justice and Council of Ministers in the first quarter of 2012. After this approval the development of a waste policy will follow. Without approved policies the implementation of an operational system is considerably difficult.

At the central level, within the Ministry of Environment, the Directorate of Environmental Management and specifically the Deputy Director for Pollution Management is specifically tasked with addressing solid waste management control and policy. Staff within the RSS Ministry of Environment noted that the relevant departments were under-staffed, as “the ministry is new”. Additional manpower is needed in order to respond to the solid waste issues facing Juba and South Sudan as a whole.

With regards to medical waste management, the most difficult aspect of capacity is the lack of a specific “point person” for medical waste management within the Ministry of Health. This is compounded by the capacity weaknesses that are universal across all current RSS and state ministries whereby many staff lack job descriptions with clear tasks resulting in overlapping work and other issues – such as medical waste management – falling through the cracks.

The state and county level environmental departments are responsible for operational implementation and inspection procedures. There is no regulative base established or operational.

The municipalities are responsible for the collection of solid general waste from households and medical facilities, but not for the collection of hazardous waste. Currently there are three private registered companies collecting solid waste in

Juba, which receive their payment directly from the households. More information can be retrieved from the next chapter. In general, there is lack of financing by the municipality for the collection of waste and little willingness by the population to pay for regular collection of municipal general solid waste. At the moment a JICA financed project started with the task to increase capacity at the Ministry of Environment for municipal waste management and to establish a "Solid Waste Management Committee". The project will not include medical waste and information exchange between this and the new project was done.

Interviews conducted with the federal and state ministries indicated that there is a great need for capacity building. As one government official stated, "the government cannot do everything" and called upon the NGOs and donors to assist in capacity building along with government facilitation. Furthermore international organizations like BSF, MDTF, USAID, UNDP and DFID are also involved in the management and financing of the solid waste system. As these activities are time limited, a sustainable and operational system for the future is needed.

The treatment and disposal of hazardous waste generated by medical facilities is under the responsibility of the healthcare facilities. Currently there is no budget available for the management of medical waste at the national, state, or county level.

The government is aware that there is a need for safe and environmentally friendly waste management, as demonstrated in the government awareness campaigns like "Clean Southern Sudan." Clean Southern Sudan was the initiative of Human Development Council, members of the New Sudan Insurance Company, and the RSS Ministry of Rural Development in February 2011. The program dubbed "Protect and Conserve the Environment, Be responsible and Keep Southern Sudan clean" also tackled the disposal of waste by the population.

## 8.2 Private Sector participation as service provider

Several official and unofficial private waste companies exist, including dozens of illegal micro companies that are occupying the main landfills and recycling metal. There are currently three main private waste companies Juba, however the two main players are the companies Philing Environmental and Southern Express:

Southern Express was registered in 2006 and is one of the companies that was contracted in 2008 for garbage collection and disposal. In 2008 the company had 12 trucks and one waste loader but most of the equipment has broken-down.

Philing Environmental is the larger company of the two with approximately 300 employees. This company was also contracted in 2008 for garbage collection and disposal. The company started with the collection of waste in Munuki Payam, but now it is handling several other locations, as other contractors could not provide the required services.

During interviews, both companies explained that the payment morale of the government and private customers is difficult. Generally the capacity of the private sector is not much higher compared with the governmental sector. By

paying higher wages and having lower administrative barriers, the private sector might be faster in the development of new capacities, especially as they are able to attract more experienced staff from neighboring countries such as Kenya and Rwanda. A rapid assessment of these companies however showed that also they are still facing capacity problems, as e.g. in the field of maintenance.

**Figure 8-14: Truck fled, private waste disposal company, Juba**

In the capacity building and training field, the private sector (but also NGOs) could take over an important role. In the beginning of a medical waste improvement program, dozens of basic trainings on medical waste management will have to be provided which could be the task of the private sector as it is unlikely that the Government's education system will be able to provide this type of specialized vocational training in the short-term.

### 8.2.1 Options for public private partnerships (PPP)

In the last few decades, developing countries have been increasingly moving towards PPPs in an effort to improve quality and efficiency for waste management services. The alternatives to public-private partnerships are direct service provision by Government, and the utilization of Community Based Organizations (CBOs). Inherent strengths, weaknesses and opportunities exist in all approaches, mostly relating to risk sharing, transparency, accountability and 'social good'.

There are a number of categories available within the rubric of PPP, ranging from simple shorter-term service contracts to more complex arrangements requiring substantial capital investment on behalf of the contractor. Within the South Sudan context, these models can be practically categorized into 1) supply and management contracts, 2) turnkey projects (design and build), 3) leases, 4) build-operate-transfer, and 5) private ownership of assets. The risk assumed by the contractor is at a minimum with management contracts, and maximum with private ownership of capital assets.

Supply and management contracts

This is an arrangement where a public enterprise is managed by a private entity. It allows the government to focus more on monitoring and compliance while relying on the specialist expertise of the contractor to provide the service. The contract arrangement should be performance based with clear milestones and outputs. Furthermore, it is the government's responsibility to ensure that the

contractor is compliant with all related policies and legislation. These contracts are normally short term in nature, and should involve a transparent tender process prior to renewal.

The most common variant of this arrangement is the service/supply contract. This normally is where a public entity contracts out its non-core activities such as cleaning, catering, IT support, transport, or the supply of recurrently used goods. For this to work to be effective, there should be clear licensing and permit mechanisms in place. As Juba's commercial sector develops, it is likely that the competition generated from the increase in available service providers will result in higher quality service delivery.

Operational/maintenance contracts

As the name suggests, operational/maintenance contracts refer to circumstances in which a private entity either operates fully, or simply takes on the maintenance, of a publicly owned facility such as a central waste treatment plant. This is particularly relevant to South Sudan, which has a shortage of skilled local labor. These contracts can be performance based with defined targets. In this model however, the government assumes the majority of risk, as it owns the infrastructure. Furthermore the infrastructure has high start up costs and is expensive to maintain.

Turnkey projects

To reduce risk, governments may often opt for a 'turnkey' arrangement where a private contractor designs, builds and (normally) runs and maintains infrastructure and sometimes even owns (BOO – Build Operate Own). This requires substantial outlay (risk) on the private entity's behalf. The two key determinants, which normally influence a potential partner, will be political stability (or political climate) and a well-defined enabling transparent policy and legislative environment. For this reason, these kinds of projects usually have smaller budgets, and are shorter term in developing countries.

Leasehold

For longer-term arrangements, private companies can enter into a leasehold agreement with governments whereby the private entity operates and maintains a facility (or service). To be attractive to both parties, this model is usually applied in combination with other models, such as design and build. In these arrangements, the lease is awarded for a specified period, and the renewal process is by transparent tender.

Build-Operate-Transfer

The build-operate-transfer model is where a private firm undertakes to construct a facility, run it for a pre-determined period, and then transfer this asset to the government. Following the transfer, the government is at liberty to determine how it will manage the facility or service. In this model, substantial risk is borne by the private contractor given the issues associated with start up and maintenance. Again, political stability and well-defined legislation are critical to attract investors.

Private ownership of assets/services

This is a form of participation where the private sector is responsible for all stages of the project cycle, including design, construction, operations, delivery, and maintenance. It can be argued that by having one contractor responsible for all facets, a higher quality public service can be offered. In this arrangement, the

government sets out clearly defined service outputs, and payment is contingent upon the contractor maintaining a high standard of delivery.

Although the above models will have ample future possibilities in South Sudan, the current context suggests that it is too early to pragmatically move forward in the short term with any of the above models, as one of the core requirements – a high capacity of the government in the medical waste sector – does not exist. Generally it can be said that as long as an entity is not able to run a certain sector alone, it will not be able to monitor the outsourcing of this sector.

### 8.2.2 Output based aid as interim solution for PPP

At the moment, a more appropriate model for the medical waste sector in South Sudan might be Output Based Aid (OBA) models. In this arrangement, instead of financing treatment equipment or waste management infrastructure, OBA is a mechanism for providing performance-based subsidies to support the delivery of waste management services. OBA is often targeting the participation of the private sector in providing the needed service and is following the PPP approach. In the past, experiences with involving the private waste sector in South Sudan were not always positive. Often, provided services lacked quality. One driver to engage the private sector and to ensure high quality waste management services could be social franchising (SF).

SF concepts are today already used in many donor funded healthcare projects. SF is an innovative approach that applies modern, commercial franchising techniques to achieve social goals. It differs from the commercial franchising as e.g.:

- There is only a limited transfer of investment risk to the franchisee
- The franchisor is pursuing social instead of commercial interest
- Additional stakeholders (financing organization, government) are involved
- The franchisor often has only limited (local) knowledge

SF for the medical waste sector can be described as a process in which a provider (the franchisor) of a (expected) successful medical waste management concept enables others (the franchisees) to replicate his medical waste management business model, in order to scale up the coverage of a target group (hospitals and clinics) and the quality of the product (the medical waste management services). Following the OBA principle, financing agencies (donors) are not targeting the financing of hardware, but will rather subsidize HCW logistic and/or disposal services. The financial risks of the franchisee would be limited as necessary investment costs may be (partly) taken over by the financing agency. A trustable partner would guarantee the payment for the carried out service for a fixed period.

In the following, a rough example for the realization of an OBA based SF concept for the Medical waste sector in South Sudan is given:

Healthcare in South Sudan is based on a referral system. While common health services (immunizations, deliveries, etc.) are handled in primary health facilities (PHCU, PHCC), more difficult cases are referred to in the county hospital (basic secondary services). If treatment at this level is impossible, patients will be

referred to the state level hospitals (full secondary level care) or to more specialized hospitals at the national level (tertiary level).

The medical waste system in South Sudan can follow this “referral system” as it was described in the chapter “6.4.2 Methodology for decision making”

Hazardous medical waste generated by the primary healthcare level and from county hospitals will be referred to a central treatment facility at state level. This unit can be located directly at the state hospital or can be a separate facility. For the treatment of the two main hazardous waste streams (photochemical waste and infectious waste), relatively simple and robust treatment systems, such as electrolysis and steam disinfection, can be chosen. Often it will be possible to use already existent, under-utilized treatment equipment in the hospital. Only 5% of the total hazardous waste – like radioactive, heavy metal or cytotoxic waste - must be referred to the national level.

In an OBA based SF project, a management agency (MA) will be newly founded (e.g. in form of a governmental owned enterprise) and supported by experienced consultants - or the entire function is tendered by international, competitive bidding. The MA will act as the franchisor and will have to fulfill four main tasks:

1. Tendering of the franchising contract, controlling of the carried out service, subsidizing the performances.
2. Development and providing of the business concept to the franchisee; support of the franchisee during the start up period; continues improvement of the franchising concept.
3. Quality control of the provided services of the franchisee and the waste management in the hospital (best by outsourcing to an independent quality control company)
4. Carrying out of capacity and awareness building programs for hospitals, the franchisees and relevant authorities

The franchisee will have the task to fulfill his waste management services based on the standards set by the franchisor. Prices will be fixed by the franchisee and the healthcare sector and will be subsidized by the MA. For the providing of the franchising concept and the treatment facility, the franchisee will have to pay a yearly fee.

A practical example would be the future operation of the new medical waste treatment plants that will be delivered by UNDP:

UNDP / Global Fund plans to install comparable sophisticated incinerators at the Malakal Teaching Hospital, Renk Hospital, Wau Teaching Hospital and Torit State Hospital. An operation and management strategy for these incinerators is missing. One possible strategy for the four installations as well as the incinerator of the Juba Teaching hospital, would be to upgrade the incinerators to central treatment stations, responsible for the treatment of not only the medical waste of the hospitals but the treatment of the all waste from the city where they are located.

After upgrading the installation (provision of sufficient infrastructure, equipment, consumables) and the development of an operation strategy, these facilities could be operated in a pilot trial by the private sector under supervision of the

RSS MOH as Franchisor. In the following, a sample structure for the organization of a project can be found.

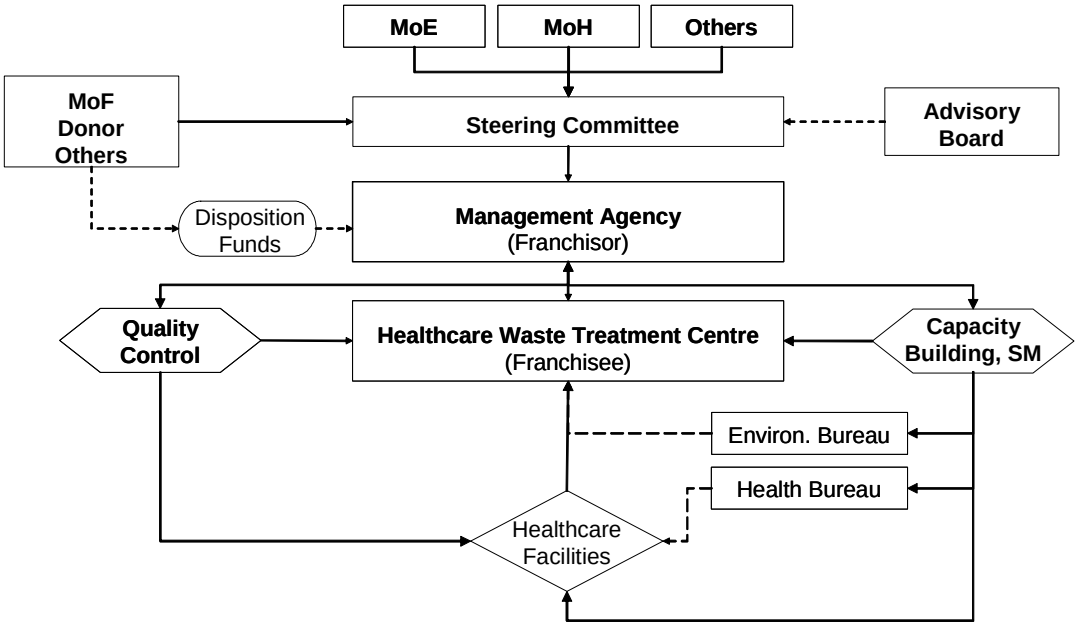



**Figure 8-15: Sample strategy for OBA based SF system for 5 cities in South Sudan**

Advantages and disadvantages of an OBA based SF system for the five cities.

- Pro:
  - Existing and soon to be delivered equipment will be better utilized and maintained
  - Fast and controlled set up of a medical waste management system under stimulation of PPP
  - High “reach” by better enforcement of laws and parallel promotion of Medical Waste Management
  - High “impact” by setting standards (franchising) and additional external quality control
  - High efficiency by included capacity building program and by profit orientation
  - User and public benefit by assured service quality levels

- Cons:
  - Pre-condition is sustained consumer demand
  - Relatively high start-up costs for development of business format, training and capacity building, cost for quality management program
  - Sustainable program will depend on the willingness and ability of users to pay for services

### 8.2.3 Recommendations – PPP South Sudan

In the context of the South Sudan medical waste management, PPP can be deemed as a workable approach with broad medium and longer term potential. However, at the present time in South Sudan, the prevailing commercial/legislative context is not conducive to immediate private sector participation. However, in the medium term, it is clear that health care facilities are better placed to focus on their core activity of providing the public with the best health care services possible, rather than on allied tasks such as medical waste management. Secondly, the government lacks the immediate short-term capacity to realistically budget for, train, and mobilize a team specifically dedicated to managing and monitoring privatized medical waste services.

Medical waste related policy and legislation is likely to be strengthened in South Sudan in the medium to long-term, as will public sector capacity to monitor and enforce compliance of private contractors. In this framework, private companies can play a key role in providing services which are economically viable, compliant and of course, very much needed.

## 8.3 Training and Public Awareness

### 8.3.1 Existing System and SWOT Analysis

Training or awareness rising on medical waste has not been conducted in South Sudan, but there is an urgent need to start improvements in this field. The MoH and other waste practitioners showed a high willingness to receive more information and training. In order to introduce new issues, like medical waste, into the South Sudan training system, an existing medical training system is outlined below.

**Training and education**
The review of the existing medical training programs for medical staff is based on the study “Off The Road: The Mapping of Health Training Facilities in Southern Sudan; Ministry of Health – Government of Southern Sudan (Mark E Beesley, RN), July 2010.” In accordance to this study there are twenty-three open health training facilities: six MOH-RSS controlled; three State MOH-owned; and fourteen run by partners, of which five train CHWs only. A further three State facilities and three partner facilities are shut down. Another six facilities have closed since 2006. Distribution of open training facilities is skewed: two states have none while one-third of all opened training facilities (and half of RSS-owned ones) are in Central Equatoria. There are three rough categories:

1. National-level facilities owned, directly funded and line-managed by the Training Department (of HR,R,P & HSD Directorate) of RSS-MOH (but sometimes part-funded by states);
2. State-owned facilities (that have a national character in that they are formally open to candidates from all states) owned, directly funded and line-managed by the HR and/or Training Department of the relevant State MOH

3. Partner-run facilities managed by, in this case, NGOs, FBOs, the Catholic Church and the Ministry of Higher Education (though the legal ownership of the infrastructure or land title may lie elsewhere).

In accordance to the "Mapping of Health Training Facilities" mentioned above, six (17%) of the thirty-six health training facilities are RSS-run, nine (25%) are State-run and twenty-one (58%) are run by partners. The ROSA research (see report on the medical waste management assessment) showed a general high awareness rate among the staff and management of the healthcare facilities. The research, however, also discovered that theoretical "know-how" as well as applied and practical "know-how" is very limited. This results in problems in the general management of the medical waste.

The South Sudan Governmental training facilities are following a four level education system, which is currently under revision:[12]

1. Degree Level (3 or 6 years)
2. Diploma Level (3 years)
3. Certificate Level (18m to 2½ year)
4. Award Level (9 to12 months)

MOH-RSS training facilities should follow the MOH-RSS designed (or at least RSS-approved) curricula. The DG Training & Professional Development of the MoH (Dr. Margaret Itto) under the Human Recourse Directorate is responsible for the development of the curriculum. The curriculum for midwifery education is currently revised in collaboration with the Juba College of Nursing and Midwifery and the UNFPA – other curricula are planned to be revised.

The post-graduate training system is only provided if money is available or international organizations are providing additional trainings on medical care. Post-graduate training on medical waste management is not provided yet.

The following is a short SWOT-Analysis of the current training and public awareness practices provided:

**Strength:**

- MoH recognizes that human resources are the most valuable asset in the health sector.
- The MoH is aware of the training and awareness lack regarding medical waste and are eager to change the situation.
- Staff at healthcare facility level is interested – staff recognized the willing to receive information and training.
- Public mobilization and awareness raising campaigns regarding waste management have been successfully implemented under the Ministry of Health (Clean Juba Campaign).)

**Weakness:**

- Hardware and infrastructure of the medical training facilities are often in terrible disrepair.

[12] Mark E Beesley; "Off The Road: The Mapping of Health Training Facilities in Southern Sudan; Ministry of Health" Government of Southern Sudan, July 2010

- Awareness for safe and environmental friendly management of medical waste is weak.
- Lecturers at medical training facilities are lacking knowledge in the medical waste field.
- Training curriculum is currently under revision but needs input regarding environmental health aspects like medical waste management.
- Most textbooks and teaching aids are out-dated and information technology has not been introduced.
- South Sudan is a big country with weak infrastructure. Therefore, to train people nation-wide requires a great deal of travel expenses and logistics.
- Nation-wide campaigns onsite (in the cities / counties) also require a great deal of travel expenses and logistics.
- Several key waste handlers at the facilities level may be illiterate with little educational background, therefore requiring training and awareness training to occur at multiple levels using multiple mediums.

**Opportunities:**

- High interest - major influx of applicants into the paramedical training programs.
- Approval of draft policy and guidelines under modern and state of the art perspectives.
- Set up and implementation of a training system (on different levels).
- Set up and implementation of awareness raising program.
- Modern approaches such as CPD (Continuing Professional Development) can be introduced.
- A chance of strengthening preventive health, public heath and infection control among the new generation.
- As the training curricula of the medical institutions are currently under revision, the insertion of environmental health aspects like medical waste might be still possible and in time.
- Several partner organizations (NGOs, CBOs) have staff seconded to facilities at the state and county level that can act as advocates and trainers to promote messages and practices of medical waste management.

**Threats:**

- Implementation is pending due to lack of capacity.
- Policy and guidelines not approved.
- Financial resources for awareness building and education on medical waste not sufficient.

### 8.3.2 Capacity Development

The following is an overview of the recommended capacity building system for South Sudan. It is recommended that an international training expert aiming to build basis knowledge and to enable different stakeholders of the system to carry on the trainings in the future conduct the first training on medical waste. The system is aiming to develop a sustainable structure in South Sudan, which is developing a permanent structure within the MoH. The relevant stakeholder and decision maker are enabled to manage and advise the system aiming to provide

legal background and supervision of the medical waste system. Furthermore, trainers are educated to provide training to different levels of medical waste handlers and managers.

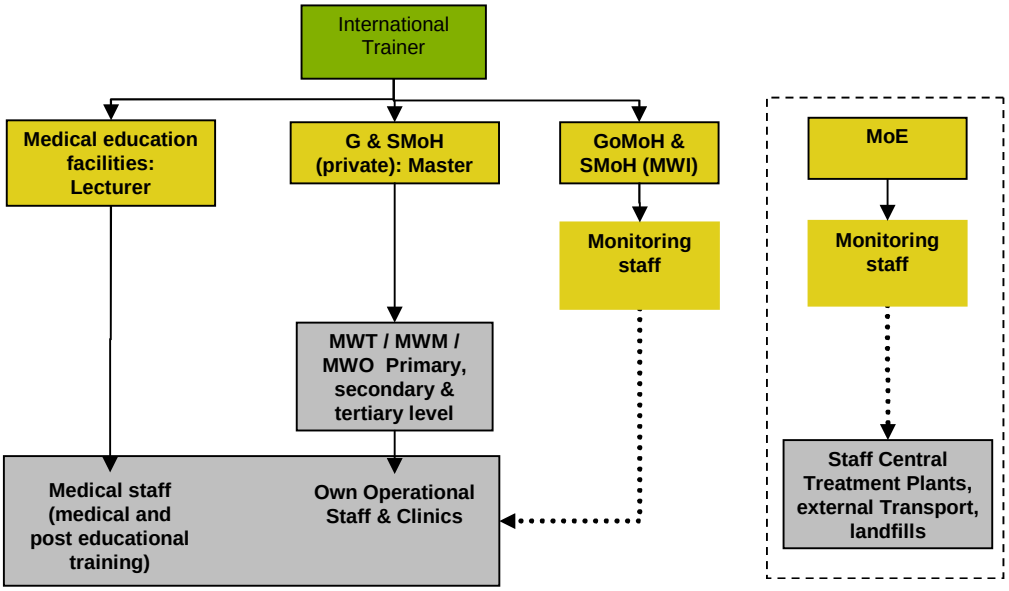



**Figure 8-16: Responsibilities and tasks within the national training system**

A system is established which appoints a position in each healthcare facility that is responsible for medical waste management. This person is either the public health officer or the infection control nurse. A certification system is established which is maintained at MoH and controls the education system including refreshing trainings. Additional medical waste modules should be inserted directly into the medical education system of the training facilities in order to educate the medical staff already within their basic and refreshing education. Also an inspector system should be established in order to establish a sustainable monitoring and penalty system for continuous improvement.

## 8.4 Awareness rising and Training plan

### 8.4.1 Awareness rising program

Although the Ministry of Health has successfully implemented awareness campaigns related to waste management in the past, the current perception by the government is that awareness campaigns are the responsibility (financially and programmatically) of the NGOs and donors, while the government should play a supporting and facilitating role. Several UN agencies and NGOs are currently implementing awareness raising campaigns on littering, hygiene, and water & sanitation practices. However, to date, medical waste management awareness has not been a priority for the government or development partners.

There is a need to conduct an extensive awareness-raising program with four broad target groups: (1) stakeholders & policymakers; (2) healthcare workers at the county and managerial levels; (3) staff and waste handlers at the facility

level; and (4) the general public. With the exception of the awareness raising agenda with stakeholder and policymakers, the remainder of the awareness campaigns will implement a cascading knowledge model.


**Figure 8-17: Awareness raising campaign – knowledge model**

This will allow the program to have the maximum effects by mobilizing individuals at the state and county levels to ensure grassroots mobilization and community support. It also assists in reducing costs of campaigns as trainings on awareness and key messages can be conducted once per state while coinciding with medical waste management training discussed below.

As different groups require different levels of increased awareness, as well as different messages, the need, purpose, content and methodology of these awareness-raising activities will be discussed herein.

### Awareness Raising Among Stakeholders & Policymakers

Currently no single individual is tasked with the responsibility of managing, implementing, or monitoring the disposal and handling of medical waste within the Ministry of Health or key line ministries. As a result, there is a need to advocate even *within* the Ministries for the need for medical waste management policies, budgets, activities and monitoring before any policy or guideline can be successful. Only after full buy-in of the stakeholders can the medical waste management policy be successfully implemented at all levels of government. Such activities will also ensure the swift and quick approval of the medical waste management policy and corresponding guidelines and budgets by the Ministry of Justice and Council of Ministers. By including donors and development partners, the policy and guidelines are further bolstered by creating a donor-driven demand for inclusion of proper medical waste management in program implementation.

<u>Target Groups</u>

The following specific target groups have been identified to receive awareness raising on this level:

- Undersecretary, Ministry of Health
- Director Generals & Deputy Directors for departments related to public health, waste management, and/or hygiene within the Ministry of Health
- Director Generals & Deputy Directors for departments related to health education, environment, pollution, waste management and/or hygiene within key line ministries, specifically the Ministry of General Education, the Ministry of Higher Education, Ministry of Environment, and Ministry of Planning.

- Representatives from key donors, specifically BSF, USAID, MDTF, DFID and the EC.
- Representatives of key UN partner agencies, specifically UNDP, UNEP, WHO.
- Representatives of key development partners, specifically those utilizing BSF and MDTF health-related funds.

Content – information and skills

The primary purpose of raising awareness among stakeholders and policy makers will be to garner widespread support for medical waste management policies, program and funding. As a result, it is anticipated that the awareness component will consist of the following key messages and activities:

- Site visit to Juba Teaching Hospital to view current medical waste management situations, guided by an expert to identify key critical areas where the policy is not being implemented currently and the corresponding dangers and risks of these activities.
- The importance and key elements required for County Medical waste Management Plans.
- Principles of waste segregation and “reduce, reuse, recover” methods for medical waste.
- The importance and need for regular and accurate reporting of waste quantities.
- The need for further awareness raising with other target groups and training on medical waste management (as discussed below).
- The importance of funding and requiring the aforementioned activities and policies in all health-related work.

Program Schedule & Requirements

It is anticipated that the above objectives could be met through a one-day awareness workshop held in Juba (including the site visit). Since a majority (if not all) of the aforementioned target groups are based in Juba, facilitating this workshop would not be difficult. It is possible that this workshop could be coupled with training activities described in the following section. It would be important that such a workshop be planned in advance (3+ weeks) in order to allow for the participation of high-level officials. Similarly, the workshop should not coincide with other regular events that may prevent government or other stakeholders from attending (cluster meetings, coordination meetings, weekly Council of Ministers meetings).

A qualified trainer should facilitate the workshop with experience in medical waste and/or advocacy and communications to ensure that activities are enjoyable and participatory. It should be noted that this training, specifically the onsite visit, could coincide with the Medical Waste Management Training discussed later in this section. A proposed schedule for the training is outlined here:

| Schedule | Day 1 |
|---|---|
| 8:30 – 9:00 | Welcome Participants |
| 9:00 – 9:45 | General Environmental and Waste Information |
| 9:45 – 10:30 | Discussion on key principles of MWMP |
| 10:30 – 11:00 | Break |
| 11:00 – 11:45 | Importance & Facilitation of County Medical Waste Plans |
| 11:45 – 12:30 | Discussion on methods of improving waste measurement & recording |
| 12:30 – 13:30 | Lunch |
| 13:30 – 15:00 | Onsite Visit to Juba Teaching Hospital |
| 15:00 – 15:15 | Break |
| 15:00 – 16:00 | Onsite Visit to Juba Teaching Hospital |
| 16:00 – 17:00 | Wrap up discussion on sharing information learned, advocacy & importance of MWM |

In order to maximize the benefits and impact of this awareness raising workshop, it is suggested that television, radio, and newspaper be mobilized to interview attendees and document the Juba Teaching Hospital site visit to kick-off and publicize the awareness raising campaign, linking this activity closely with the general public campaign to be discussed in detail below.

**Awareness Raising Among County & State Level Healthcare Workers & Management Staff**

As both the waste generators and primary handlers of medical waste, there is a need for sensitization and increased awareness on the importance of medical waste management and proper handling and disposal techniques. There are several deeply rooted customs that will be difficult to overcome in this process (specifically burning of trash and treatment of medical waste beyond incineration). As described earlier, this awareness raising will also serve as a training of “awareness raisers” for staff and the general public.

Target Groups

The following specific target groups have been identified to receive awareness raising on this level:

- Hospital Managers
- Head Nurses & Supervisors
- Administrators
- Clinic Officers
- Public Health Inspectors
- NGO/CBO Staff seconded to health facilities

Content – information and skills

The primary purpose of raising awareness among healthcare workers & management staff is to ensure that those individuals who both generate and handle waste understand the importance of following medical waste

management policies and procedures. Whereas the training component discussed in the following section details the *knowledge and practices* necessary to manage medical waste, this awareness program ensures that these knowledge and practices are bolstered with the proper *attitudes* to ensure that procedures are valued and followed. It is also important that individuals who receive awareness training during this phase are also trained to carry out awareness activities are part of the general awareness campaign.

This training also is imperative to ensuring that the awareness training campaign implemented with the general public will be implemented at the county and payam level reaching as many individuals as possible.

In particular, the following key messages will be conveyed as part of the raising awareness program:

- "Reduce, reuse, recover" messages on the importance of reducing overall waste, reusing equipment and materials when it is economically and hygienically feasible, and recovering material from waste that cannot be reused.
    - These messages will be conveyed using a series of slogans and posters as well as a practical exercise where participants are encouraged to take frequently used items and identify possible alternate uses for them.
- Segregation of wastes and the different types of medical waste will be key to raising awareness with both the primary and secondary target group. These activities will be tailored to the color and segregation scheme adapted as part of the Medical Waste Management Policy. The importance of *regularly and accurately* reporting quantities of various categories of waste will be emphasized. This will be coupled with training on the proper methodologies of weighing and reporting waste levels.
- The importance of reporting accidents, particularly involving sharps, and the proper protocols for responding to these accidents.
- The importance of proper disposal of different types of medical waste *and* the potential short-term and long-term effects of being exposed to types of medical waste improperly.
- Dangers of exposure to smoke from burning waste.
- Community mobilization techniques.

Program Schedule & Requirements

It is recommended that the training take place in the state capitals, with the full program not exceeding one day and incorporated as part of the training program detailed in the following section. Below is a proposed schedule for the raising awareness component. It is recommended that the same trainer for the previously mentioned workshop in Juba with officials be employed to conduct the training in the states for continuity of message and quality control purposes.

| **Schedule** | **Day 1** |
|---|---|
| 8:30 – 9:00 | Welcome participants |
| 9:00 – 9:45 | General environmental and waste information |

| | |
|---|---|
| 9:45 – 10:30 | Key Principles of the MWMP |
| 10:30 – 11:00 | Break |
| 11:00 – 11:45 | Key Messages for Awareness Raising I |
| 11:45 – 12:30 | Key Messages for Awareness Raising II |
| 12:30 – 13:30 | Lunch |
| 13:30 – 14:15 | Awareness raising training with co-workers in the health facility I |
| 14:15 – 15:00 | Awareness raising training with co-workers in the health facility II |
| 15:00 – 15:15 | Break |
| 15:15 – 16:00 | Development of awareness raising action plans |
| 16:00 – 16:45 | Presentation of action plans |
| 16:45 – 17:00 | Wrap up and evaluation |

In addition to the trainer and associated materials, each trainee should be provided with the following:

- One (1) t-shirt containing one of the following messages (in English and Arabic or ideally the most relevant tribal language):
  - "Smoke from burning waste is poison"
  - "Help up make our health facility safer! Separate waste!"
  - "Waste is everyone's responsibility"
- One (1) cap or hat with an alternate message
- A packet of minimum 2-3 self adhesive posters to distribution within health care facilities with the following messages:
  - "Help us to make our health facility safer! Separate waste!"
  - "Help us to make our health facility safer! Wear gloves!"
  - "Help us to make our health facility safer! Wash your hands!
  - "Do you know the color code? Be 100% Put infectious waste into the right bin!" (appropriate color TBD; replicate for different colors)
  - "Expired drugs are dangerous! Bring them to your nearest health facility!"
  - "Know your waste!" (Segregation poster with different types and disposal methods)
  - "Never recap sharps!"
  - "Use sharps containers!"
  - "Stop before it's too full! Sharps containers are only used to 75%!"
  - "Stay focused! Avoid needle sticks!"
- Representatives of facilities located in the county headquarters should also receive a megaphone for mobilization activities.

As with the awareness raising activities with stakeholder and policy makers, it is suggested that various media be invited to one of these trainings (most likely in Juba) in order to increase coverage of the overall program and build anticipation and public interest in the general campaign.

**Raising Awareness Among Facility Level Staff & Community Health Workers**

Facility level staff members are often the primary generators of waste (i.e. laboratory technicians) and primary handlers (i.e. cleaners & maintenance staff).

Training of community health workers is key to ensure that the awareness raising messages are eventually able to reach the general public.

Target Groups

The following specific target groups have been identified to receive awareness training on this level:

- Community Health Workers
- Waste Managers
- Laboratory Staff & Technicians
- Cleaners & Maintenance Staff

Content – information and skills

The training will cover the same content of the awareness raising activities with county and state level healthcare workers. However, the key difference will be the methods by which information is conveyed and promoted, as the education (and potentially literacy) level of these individuals will most likely be relatively lower.

Nevertheless, the key content of the campaign will remain the same, with more relevant topics receiving the most emphasis.

- "Reduce, reuse, recover" messages on the importance of reducing overall waste, reusing equipment and materials when it is economically and hygienically feasible, and recovering material from waste that cannot be reused.
- Different types of medical waste and the different risks and harms of exposure to each.
- The importance of reporting accidents, particularly involving sharps, and the proper protocols for responding to these accidents.
- Dangers of exposure to smoke from burning waste.
- Basic community mobilization techniques.

Program Schedule & Requirements

Training will take place within the health care facility in which the trainee is associated. For example, training with laboratory technicians will take place within the Primary Health Care Unit and be facilitated by the Clinical Officer, nurse, or other staff member who attended the training and awareness session in the state capital.

The program should not take more than one day, but should also include brief refresher meetings. Awareness on this level will be best measured by *day to day implementation of knowledge learned* and therefore clinical officers, nurses, and other management staff should be prepared to carry out awareness raising activities whenever necessary.

As part of the initial awareness raising, trainees should receive:

- One (1) t-shirt containing one of the following messages (in English and Arabic or ideally the most relevant tribal language):
    - o "Smoke from burning waste is poison"
    - o "Help up make our health facility safer! Separate waste!"
    - o "Waste is everyone's responsibility"
- One (1) cap or hat with an alternate message

The specific training schedule for the facilities will be developed in conjunction with the action plans developed by trainees in the previous section.

### Awareness Raising Among the General Public

As medical waste is often times generated outside of the health care setting, there is a need to ensure that individuals are aware of proper disposal techniques to protect themselves and the environment. Furthermore, by creating a public demand for proper medical waste management, education of the general public will assist in ensuring that health care facilities implement proper procedures for waste handling and disposal.

Building on the media attention gathered from the awareness raising among stakeholders and state & county-level healthcare workers, the general public will gradually be exposed to key messages and issues of medical waste management even before the general public awareness raising campaign begins.

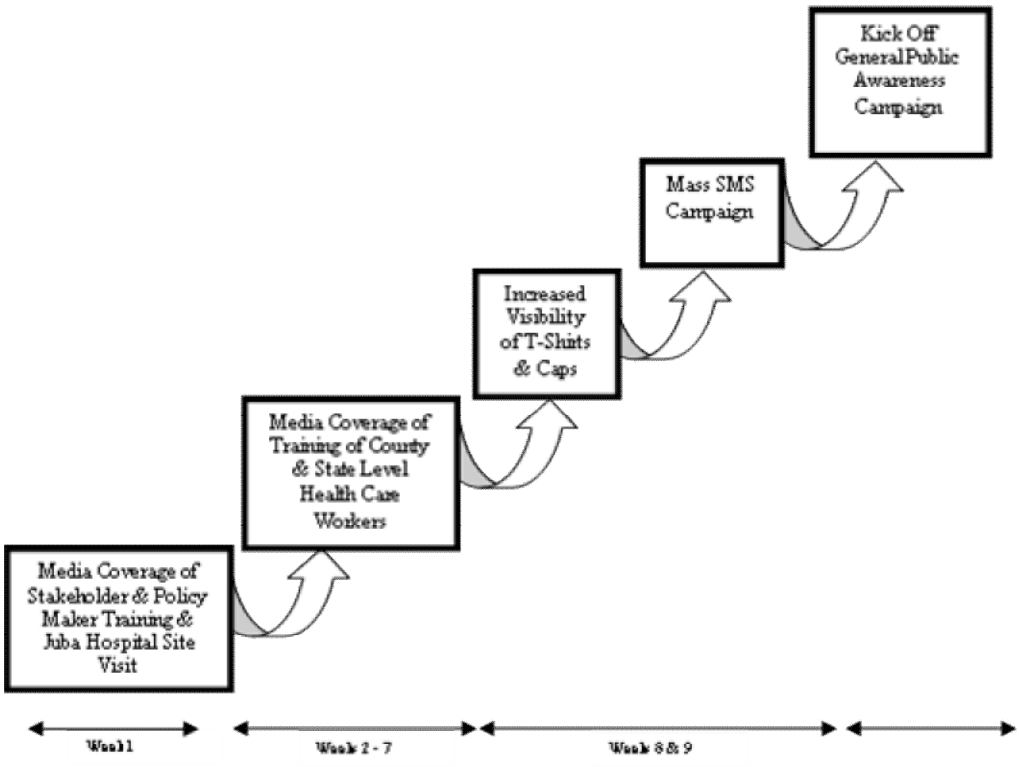



**Figure 8-18: Implementing awareness raising campaign**

Target Groups

The target group for this phase is the general public.

Content – information and skills

Whereas the previous awareness sessions targeted those specifically involved with medical service provision directly, the general public sessions will draw out the most important messages with regards to medical waste and also convey key messages regarding general hygiene and sanitation practices.

Key medical waste related messages will include:

- "Reduce, reuse, recover" messages on the importance of reducing overall waste, reusing materials when it is economically and hygienically feasible, and recovering material from waste that cannot be reused.
- The importance of preventing contact with unsterile needles. Dangers of exposure to smoke from burning waste.

In addition, the awareness raising program will also target key needs as identified in the 2010 UNICEF KAP report on water, sanitation, hygiene & nutrition. Specifically the program will include the following messages:

- Keep the toilets the cleanest part of the home and school compound.
- Defecation in the bushes forces other people to ingest (drink) feaces after it is swept into the rivers by rain water.
- Hand-washing can save lives.
- Always wash hands with soap or ash after handling garbage.
- Keep the compound clean.
- Have and use a garbage pit.
- Stay healthy by keeping your environment clean and safe.
- Dispose of your waste safely to keep your environment clean.

Program Schedule & Requirements

The program described above will be implemented using the following mediums:

- TV stations
- Radio stations, in the form of public service announcements and interviews with public health officers.
- Mass SMS to Vivacell, MTN & Zain subscribers.
- Banners, fliers, & t-shirt distribution.
- Megaphone announcements in county headquarters.

The primary promoters of this phase will be those at the county & state level who received awareness training as part of the aforementioned strategies.

### 8.4.2 Awareness Raising Costs

Workshop Costs

Before the actual workshop, content messages and supplemental materials must be prepared. Training manuals, training materials as well as promotional materials listed above (t-shirts, caps, etc.) must also be developed.

- Preparation of materials/presentation for training in Juba (MoH/Management/trainer) (ppt, manual, etc.)
    - International training expert
- Preparation of materials/presentation for training in state capitals (MoH/Management/trainer)
    - International training expert
- Development of promotional materials to be given to participants (MoH/Management/trainer/graphic design team) (posters, t-shirts, caps)
    - International training expert
    - Graphic design team

The training cost calculation includes:

1. One-day awareness raising workshop in Juba with stakeholders
2. One-day awareness raising training in each state capital with facilities staff
3. Subsequent training materials for training to take place within facilities and within the community
4. Community outreach and awareness raising activities

The time spent training co-workers and facilities staff within each PHCC/U on the various medical waste messages is not included as this is part of the regular workload of the established structure. As indicated above, it is expected that at least one representative from each PHCC and each PHCU can attend the training in the state capital, as well as three or four Community Health Worker from each county.

The above outlined assumptions result in the following basic cost calculation of trainings:

Development of training materials by an international training expert for:

- Stakeholder meeting in Juba
- Facilities training in each state capital
- Messages for distribution at the county and community levels

| | |
|---|---|
| International training expert 1 MM (without travel) | $17,500 USD |
| International trainer (incl. flight, hotel, etc) – 12 days | $12,000 USD |
| Local training expert 1 MM | $ 3,000 USD |
| Working group meetings | $ 1,000 USD |
| Printing and handouts per person | $ 100 USD |

Awareness training for stakeholders in Juba:

- 1 day
- Max 15 participants from various stakeholder organizations identified by the MoH

- Assumes that costs associated with trainer travel and days can be pegged to the development of training materials mentioned above

| | |
|---|---|
| Costs handouts of manual and guidelines and other materials per person | $ 40 USD |
| Cost for food, venue, transportation to hospital, etc. | $ 1,400 USD |

Training of health facility staff in raising awareness in the 10 state capitals

- 1 day training in each capital x 10 capitals = 10 days
- Training to be conducted with 1 staff from each PHCC and PHCU in addition to CHWs from each county
- Each workshop should not exceed 20 individuals, multiple workshops may need to be planned in one capital if more than 20 individuals will participate

Cost Calculation of one training in ONE state capital

| | |
|---|---|
| International trainer (incl. flight, hotel, etc.) – 3 days | $ 3,000 USD |
| Costs handouts (manual & guidelines) and supplementary materials per participant | $ 40 USD |
| Cost for training day (food, venue, etc.) | $ 1,400 USD |
| Promotional materials (1 t-shirt, 1 cap, 4 posters) per person | $ 55 USD |
| Additional costs for participants (transportation, lodging, food, sitting allowances) per person | $ 200 USD |

Raising awareness within health care facilities by those trained in state capitals

- 1 day training with refresher meetings within the health care facility
- Time and venue considered as part of regular running activities of the facility
- Should be conducted with health care staff, approximately 5-7 individuals per location

| | |
|---|---|
| Supplementary printed materials per participant | $ 10 USD |
| Promotional materials (1 t-shirt, 1 cap) | $ 50 USD |

Community level awareness raising and promotion

| | |
|---|---|
| TV advertisements (SSTV) | $ 2,000 USD |
| Radio advertisements (Juba & state stations) | $ 3,000 USD |
| Mass SMS campaign (Zain, Vivacell & MTN) | |
| Banners (3 in Juba + 1 per remaining 85 counties) | $ 8,800 USD |
| Posters (75 in Juba + 25 per remaining 85 counties) | $ 3,300 USD |
| T-Shirts (distributed by CHWs, 10 per county) | $ 10,200 USD |
| Megaphone announcements (1 round in each county HQ) | $ 10,320 USD |

**Cost Summary for awareness raising activities**

| No. | Item. | Unit | Price (USD) | Total (USD) |
|---|---|---|---|---|
| **Part 0: Development of awareness raising program and materials** | | | | |
| 1 | International awareness raising expert 1 MM (without travel) | 1 | $17,500 | $17,500 |
| 2 | International awareness raising expert (incl. flight, hotel, etc) – 12 days | 1 | $12,000 | $12,000 |
| 3 | Local training expert 1 MM | 1 | $ 3,000 | $3,000 |
| 4 | Working group meetings | 2 | $ 1,000 | $1,000 |
| 5 | Printing and handouts per person | 15 | $ 100 | $1,500 |
| **Part 1: Awareness raising workshop with Juba stakeholders** | | | | |
| 6 | Costs handouts of manual and guidelines and other materials per person | 20 | $40 | $800 |
| 7 | Cost for food, venue, transportation to hospital, etc. | 1 | $1,400 | $1,400 |
| **Part 2: Awareness raising workshops in each state capital** | | | | |
| 8 | International trainer (incl. flight, hotel, etc.) – 3 days | 10 | $3,000 | $30,000 |
| 9 | Costs handouts (manual & guidelines) and supplementary materials per participant | 250 | $40 | $10,000 |
| 10 | Cost for training day (food, venue, etc.) | 10 | $1,400 | $14,000 |
| 11 | Promotional materials (1 t-shirt, 1 cap, 4 posters) per person | 250 | $55 | $13,750 |
| 12 | Additional costs for participants (transportation, lodging, food, sitting allowances) per person | 250 | $200 | $50,000 |
| **Part 3: Awareness raising within healthcare facilities** | | | | |
| 13 | Supplementary printed materials per participant (1404 health care facilities @ 3 per facility) | 4212 | $10 | $42,120 |
| 14 | Promotional materials (1 t-shirt, 1 cap) (1404 health care facilities @ 3 per facility) | 4212 | $50 | $210,600 |
| **Part 4: Awareness raising at the community level** | | | | |
| 15 | TV advertisements | 2 | $ 2,000 | $ 4,000 |
| 16 | Radio advertisements | 100 | $ 30 | $ 3,000 |
| 17 | Mass SMS campaign | 3 | $ 9,000 | $27,000 |
| 18 | Banners | 88 | $ 100 | $8,800 |
| 19 | Posters | 2200 | $ 1.50 | $3,300 |
| 20 | T-Shirts | 850 | $ 12 | $10,200 |
| 21 | Megaphone announcements | 86 | $ 120 | $10,320 |
| | | | **Total Cost (USD)** | **$474,290** |

**Table 8-14: Cost Calculation of the awareness raising campaign**

### 8.4.3 Medical Waste Training Program

First of all a basic training is needed in order to build up a baseline for improvements on medical waste management. This basic training should include the decision makers from MoH, relevant stakeholder and additional training of local trainers. It is recommended to embed the training into an “Environmental Health” training curriculum in order to ensure a broad and comprehensive approach. Different level of healthcare facilities should receive adopted training in accordance to their needs. Comprehensive approach by identifying medical waste as an integrative part of infection control and environmental health:

1. Medical waste management
2. CSSD / reprocessing of instruments
3. Housekeeping / Cleaning
4. Injection Safety
5. Water & Sanitation

In order to ensure the sustainability of the activities medical waste (as part of Environmental Health) training modules should be integrated into the curriculum of medical universities and other training facilities like the Juba College Nursing & Midwifery. Accordingly medical waste training modules should be part of the post- graduate system, in order to ensure regular refresher courses for all levels of waste handlers.

The overall goal of these training courses is to train relevant stakeholders in the core principles of proper medical waste management and to introduce advanced management processes.

Like the waste spectrum, the complexity of the disposal logistic systems differs between the service levels of the health facilities. It is recommended to adjust the training on the demands and qualifications of the target groups. It is proposed to set up a training system that can serve different levels of authorities, training provider and healthcare facilities (primary, secondary and tertiary level). Depending on the target group and aims of the training, the training length and contents should be adjusted.

**Proposed Training Program on medical waste**

The proposed education plan will be based on 5 pillars:

1. Medical Waste Management Training for decision maker and relevant stakeholder.
2. Basic training of trainers (TOT) of medical education facilities / MoH and Medical Waste Inspection (MWI) of medical waste management for state and county health departments.
3. Trained trainers conduct basic trainer for responsible persons at different healthcare facility level
4. Onsite Training in healthcare facilities on implementation of the guideline
5. Inserting of waste (environmental health) modules into the medical education program of the MoH – Training of lecturers on the new modules (University, Nursing Schools etc.)

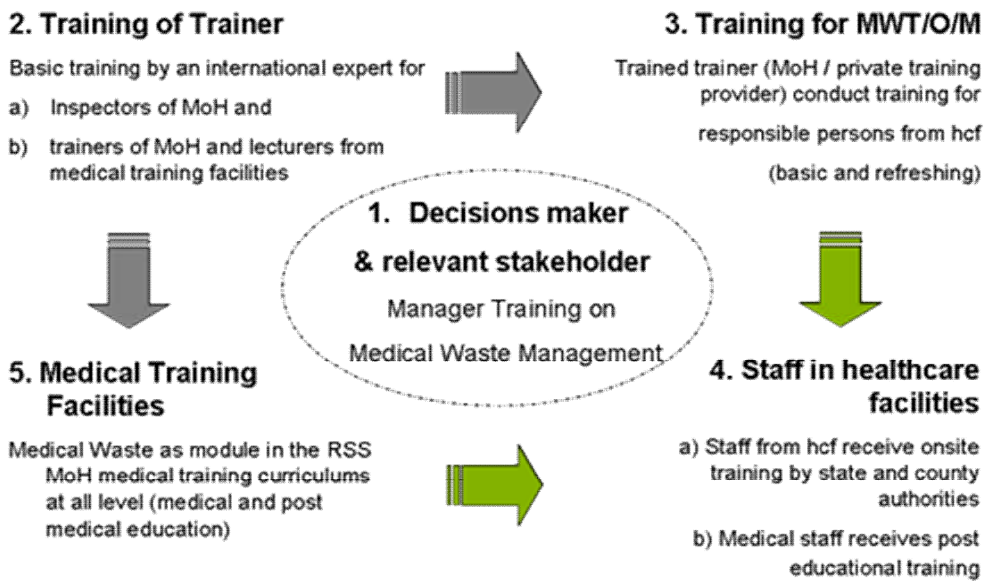



**Figure 8-19: Overview of the training plan (5 pillars)**

The first two pillars are conducted by an international medical waste training expert and are conducted once in order to build up capacity within the country. The third, fourth, and fifth pillars are meant to become a part of the permanent medical education system in order to build up a sustainable training system.

The proposed trainings should be:

- Based on up-to-date information (national regulations, international recommendations and latest information about medical waste)
- Oriented towards the needs of the participants;
- Interactive;
- Praxis orientated to include workshops, discussions and role-play.

All types of training should start with a basic training in waste types, risk prevention, classification, labeling, etc. During the training sessions, it is necessary to visit a healthcare facility (snap shot analysis) to provide the participants with an opportunity to practice and disseminate the know-how they obtained.

Large-scale training should only start in some hospitals after the working medical waste management systems exist (e.g. by the set up of demonstration projects), as the medical waste training should include the visit to and analysis of the demonstration projects. Thus, the logistic system, the operation and maintenance of treatment equipment can be shown as they are, and they will ease the implementation of medical waste management systems in hospitals. Prior to the commencement of the training program, raising awareness of the healthcare facility managers shall be carried out.

**Tutorial Design and teaching method**

The training courses should be a mix of informative theoretical lessons and interactive workshops (lectures/presentations). The lessons are based on simulations, questions, exercises, and practical demonstrations undertaken by qualified trainers to make learning enjoyable and to encourage a high level of knowledge retention. Included in the training will be onsite visits in an existent facility to allow the participants to transfer theoretical knowledge in a practical situation. Following the training, participants' performance will be evaluated.

**1) Medical Waste Management Training (Decision Makers and relevant stakeholder)**

Three days of training for decision makers and relevant stakeholder. The training will take place in the scope of a study tour described in the awareness section and should be conducted by an experienced international trainer on medical waste management. In the following an exemplary training plan is outlined:

| Schedule | Day 1 |
|---|---|
| 08:30-09:00 | Welcome of Participants |
| 09:00-09:45 | General Environmental and Waste Information |
| 09:45-10:30 | Definition, classification and generation |
| 10:30-11:00 | Break |
| 11:00-11:45 | Risks of Medical waste for Human Beings – Workshop: Risk Assessment |
| 11:45-12:30 | |
| 12:30-13:30 | Lunch |
| 13:30-14:15 | Waste Segregation - The Key for Waste Management – MEDICAL WASTE Segregation Quiz (Workshop) |
| 14:15-15:00 | |
| 15:00-15:15 | Break |
| 15:15-16:00 | The Medical waste Executive |
| 16:00-16:45 | International and National Regulations, Guidelines, Policies: Medical waste |
| 16:45-17:00 | Wrap up and Evaluation |

| Schedule | Day 2 |
|---|---|
| 08:30-09:00 | Review of Day 1 |
| 09:00-09:45 | Transport and Storage of Medical waste I (+workshop) |
| 09:45-10:30 | |
| 10:30-11:00 | Break |
| 11:00-11:45 | Sharps: Handling and Mitigation Measures Workshop Needle-stick (Report) |
| 11:45-12:30 | |
| 12:30-13:30 | Lunch |
| 13:30-14:15 | On-Site treatment of infectious waste |
| 14:15-15:00 | |
| 15:00-15:15 | Break |
| 15:15-16:00 | Onsite Visit to a medical waste treatment plant |
| 16:00-16:45 | |
| 16:45-17:00 | |

| Schedule | Day 3 |
|---|---|
| 08:30-09:00 | Review of Day 2 |
| 09:00-09:45 | General Chemical Waste Management |
| 09:45-10:30 | Working Safety- Prevention of Occupational Injuries |
| 10:30-11:00 | Break |
| 11:00-11:45 | Management of Photochemical Waste |
| 11:45-12:30 | Workshop – Photo chemicals |
| 12:30-13:30 | Lunch |
| 13:30-14:15 | Onsite Visit to a hospital |
| 14:15-15:00 | |
| 15:00-15:15 | Break |
| 15:15-16:00 | Onsite Visit to a hospital |
| 16:00-16:45 | |
| 16:45-17:00 | Wrap up and Evaluation |

**Table 8-15: Exemplary training content on medical waste management for MoH**

**2) Basic training of training (Inspectors of MoH and Medial education facilities) – see also the chapter on inspection**

a) Five days basic training for national, state and county authorities which are responsible for implementation and inspection of medical waste activities and for lecturers of medical facilities (presentations & workshops / discussions):

| Content | Structure & Duration |
|---|---|
| **Day 1-3: Medical Waste Management** | |
| 1. Risks of medical waste | Presentation + Workshop |
| 2. Legal background | Presentation |
| 3. Logistic: Segregation, Labeling, Transport, Storage | Presentations + Workshops |
| 4. Management of special waste streams (sharps, chemicals, recycling waste) | Presentation + Workshop |
| 5. Treatment and disposal of medical waste | Presentation & Onsite visit |
| 6. Reporting and Documentation | Presentation + Workshop |
| **Day 4 + 5: Inspection and monitoring** | |
| 1. Monitoring and Inspection procedures<br>2. Development of a risk based inspection system<br>3. Development of checklists<br>4. Evaluation and documentation of inspections<br>5. Reporting | Presentations + Workshops + Trial test |

**Table 8-16: Training Content for basic training for inspectors (MWI)**

The training will be conducted by an international expert on medical waste. The title of a “Medical Waste Inspector” will be certified.

b) Five days basic training for national, state and county authorities which are responsible for the training of responsible staff from healthcare facilities and for lecturers of medical education facilities (presentations & workshops / discussionsDiscussions):

| Content | Structure & Duration |
|---|---|
| **Day 1-3: Medical Waste Management** | |
| 1. Risks of medical waste | Presentation + Workshop |
| 2. Legal background | Presentation |
| 3. Logistic: Segregation, Labeling, Transport, Storage | Presentations + Workshops |
| 4. Management of special waste streams (sharps, chemicals, recycling waste) | Presentation + Workshop |
| 5. Treatment and disposal of medical waste | Presentation |
| 6. Onsite audits and monitoring | Presentation and onsite visit |
| 7. Reporting and Documentation | Presentation + Workshop |
| **Day 4 + 5: Conduction of training** | |
| 1. Planning of trainings<br>2. Development of training materials<br>3. Conducing trainings (presentation techniques, body talk, interactive presentations....)<br>4. Evaluation of trainings | Presentations + Workshops + Video evaluation |

**Table 8-17: Training Content for basic training (ToT)**

The training will be supported by an international consultant and handed over to local trained facilitator (MoH or private companies).

**3) Basic training of responsible persons in healthcare facilities**

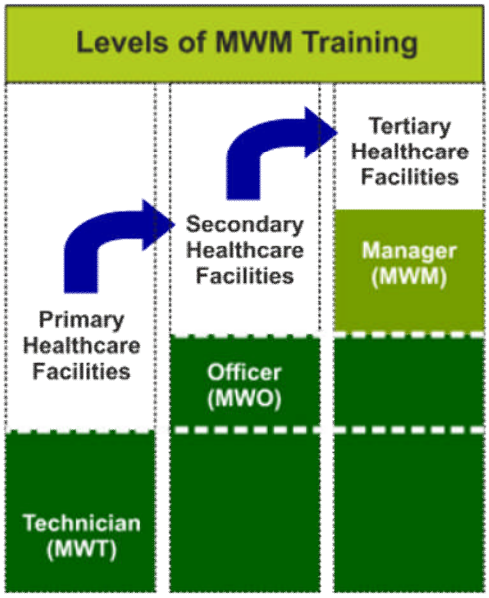
Followed by the ToT training, the trained facilitators will take over the training at the different levels of healthcare facilities. The training modules and times have to be adapted to the level of healthcare facility:

Within the healthcare facilities at least one person has to be appointed as the responsible person on medical waste management in each facility. These designated persons should be either public health officers or infection control nurses. They have to be trained in accordance to their needs and receive a respective certificate:

- Primary Health Care Centres and private hospitals with up to 30 beds (primary healthcare level)
- County hospitals and larger private hospitals (secondary healthcare level)
- State and tertiary level hospitals and hospitals with more than 300 beds.

In order to encourage healthcare facilities to employ at least one trained person (full or part-time) or to send their employees to training sessions to obtain this qualification, healthcare institutions should have a clear duty to employ at least one qualified and registered person to be responsible for medical waste. Typically the public health officer or infectious control nurse shall be responsible for medical waste management.

As mentioned above, the training duration, content, as well as the implemented responsibilities should be adjusted depending on the level of the hospital. It is recommended to inform and train persons on the following responsibilities depending on the service level:




Primary level healthcare facilities:
- Medical Waste Technician (MWT)

Secondary level healthcare facilities:
- Medical Waste Officer (MWO)

Tertiary level healthcare facilities:
- Medical Waste Manager (MWM)

It is expected that especially MWO and MWM will act as in-house trainer and also as support trainer / supervisor for PHCUs and PHCCs.

**Figure 8-20: Level based training system**

In the following the proposed training content and the duration are summarized:

*Medical waste Technician:*

- Education level: Basic know-how in medical waste management
- Duration of the training: 2 days
- Content:
  - Classification and definition of basic terms,
  - Risks from medical waste,
  - Segregation according to national guidelines and regulations,
  - Internal waste management,
  - Record keeping and documentation,
  - Working safety,
  - Basic requirements on on-site waste treatment.

*Medical waste Officer:*

- Education level: General know-how in medical waste management
- Duration of the training: 3 days
- Training content like MWT training plus:
  - Waste tracking system,
  - Occupational health and safety,
  - Requirements of on-site waste treatment,
  - Management procedures and methods for different waste categories (incl. chemical waste, etc.),
  - Waste minimization and recycling,
  - Basic know-how on waste auditing,
  - Usage of waste management plans,
  - Training of own medical staff

*Medical waste Manager:*

- Education level: Advanced knowledge of medical waste management
- Duration of the training: 4 days
- Training content of MWO plus:
  - Advanced know how in development and implementation of central waste treatment concepts,
  - Management procedures and methods for different waste categories (incl. cytotoxic waste, radioactive waste etc.),
  - Advanced know-how on waste auditing,
  - Development and implementation of waste management plans and policies,
  - Management of housekeeping staff,
  - Tendering and contracting out of service duties,
  - Training of trainer.

Successful participants will be registered by the MoH and will receive an official certificate, which will allow them to work as waste manager for two years. After this time, the trainee will have to participate in a refresher course (1 day for waste technicians, 2 days for medical waste officer / manager). After attending this course, the enrolment will be automatically prolonged for another two years.

It is the duty of each healthcare facility to send staff to trainings to receive qualifications. Furthermore, it is a clear duty for healthcare institutions to have employed at least one qualified and registered responsible person for medical waste.

**4) Onsite Training**

Onsite training (implemented by trained state and county health department staff):

a) Hands on training on occupational safety, correct segregation, transport, storage, treatment and disposal
b) Usage of poster, label etc. (see awareness building plan)
c) Providing support and recommendations on improvements

Content for waste generator and logistic staff (cleaners, porters)

- Risks of medical waste (poster)
- Occupational safety: demonstration of PPE
- Introduction of segregation scheme (poster)
- Practical demonstration of usage of bins (pedal bins and sharp bins / needle cutter)
- Practical demonstration of insertion of bags
- Demonstration of cleaning procedures of bins
- Demonstration of transport of waste
- Demonstration of storage procedures, cleaning and documentation within the storage premises
- Providing information on procedures in case of accidents (PEP and documentation)

Content for Treatment Plant Operator:

- Risks of medical waste (poster)
- Occupational safety: demonstration of PPE
- Introduction of segregation scheme (poster)
- Demonstration of transport of waste
- Demonstration of storage procedures, cleaning and documentation within the storage premises
- Demonstration / monitoring of medical waste treatment and disposal procedure including documentation
- Providing information on procedures in case of accidents (PEP and documentation)

The duration of the onsite training is dependent on the size of the healthcare facility and the availability of treatment and disposal facilities, which takes between one hour (primary facilities without treatment / disposal) and one day at bigger facilities with treatment facility.

The trainer from State or county MoH should collect participation lists of trained staff (name of trainee, name of facility, position, date and signature). The training lists are kept and handed over to the monitoring authority on request but the number of trained persons on the different facility level should be handed over yearly for statistical evaluation.

**5) Insertion into the standard medical training**

Insertion of waste management modules into the existing medical education system:

a) Development of adapted training modules for doctors, nurses, clinical officers etc.
b) Training of lecturers of the education facilities on the new modules in accordance with the basic training outlined in point two.

The topics within the curriculum should cover the following:

- Risk of medical waste,
- Waste classification – waste stream management,
- Segregation, color coding and packing of the different waste schemes,
- Occupational safety,
- Safe transport and storage of different waste streams,
- Safe Treatment and disposal of medical waste.

In the future, other areas of Environmental Health besides Medical Waste Management should be part of the curriculum for relevant target groups:

1) Central Sterilization Procedures / reprocessing of instruments,
2) Housekeeping / Cleaning,
3) Injection Safety,
4) Water & Sanitation.

The insertion and detailed content of environmental health aspects in the standard medical training curriculum needs to be developed by the MoH (Training & Professional Development) in collaboration with training institutes and international experts.

### 8.4.4 Medical Waste Training Costs

Before the physical training can take place the trainings, training manuals and modules for the inclusion into the medical education curriculums have to be developed, discussed and approved:

- Preparation of medical waste training curriculum / presentations (Management / MWI / ToT) :
  - international medical waste training expert
- Development of training material (ppt, manual etc) for local trainer (development of material, Working Group meetings, trial testing, support of international consultant etc):
  - MoH, Medical education facilities, international exerts
- Development of training material for medical training curriculum – inserting of modules in the different curricula (development of material, Working Group meetings, trial testing, support of international consultant etc):
  - MoH, Medical education facilities, international exerts

**The training cost calculation includes:**

1. Medical Waste Management Training for decision maker of MoH

- Management Training within study tour
- Training on medical waste management - 3 days

2. Basic training

- Training of MoH trainers from and lecturers from medical training facilities - 5 days
- Training for inspectors (HWI) – 5 days

3. Training of Healthcare facilities by MoH

- Primary level healthcare facilities:
  - Medical Waste Technician (MWT) – 2 day
- Secondary level healthcare facilities:
  - Medical Waste Officer (MWO) – 3 days
- Tertiary level healthcare facilities:
  - Medical Waste Manager (MWM) – 4 days

The onsite training and the training on medical waste at the medical facilities will not be calculated, as this is part of the regular workload of the established structure. The public health units receive onsite training conducted by the trained public health officer of the country health department.

Two people should be trained from each of the 72 secondary and tertiary level hospitals and one person should be trained from each of the primary public health centers. Furthermore the responsible public health officer of the state and county health department shall be trained as inspector plus a sufficient amount of persons from the MoH. Twenty-five people should be trained to become a trainer. These future trainers on medical waste management should be from the medical education facilities and MoH. A private training provider could also be included.

**The above outlined assumptions result in the following basic cost calculation of trainings:**

Development of training materials by an international medical waste training expert for:

- Decision making / stakeholder training
- ToT training
- MWI training

| | |
|---|---|
| International training expert 1 MM (Including travelcost) | 25000 US$ |
| International trainer (incl. flight, hotel etc.) – 12 days | 12000 US$ |
| Local training expert 1 MM | 3000 US$ |
| Working Group meetings | 1000 US$ |
| Prints and handouts per person | 100 US$ |

Management Training within study tour (decision maker & relevant stakeholder)

- Medical waste management training:
  - 3 days
  - Max 15 trainees from MoH/private training provider and medical education facilities

Cost calculation of one training (study tour):

| | |
|---|---|
| Costs handouts 70 page Training Manual and 50 page Guideline (printing, binding) | 35 US$ |
| International trainer (incl. flight, hotel etc.) – 7 days | 8000 US$ |
| Cost per training day (includes food, venue, etc.) | 1400 US$ |

Training of trainer education by an international trainer in Juba:

- ToT training:
  - 5 days
  - 1x25 trainees from MoH/private training provider and medical education facilities
- MWI training:
  - 5 days
  - 1x25 trainees from government and state MoH
  - 3x25 trainees from county health department

Cost calculation of 1 training in Juba:

| | |
|---|---|
| International trainer (incl. flight, hotel etc.) – 12 days | 12000 US$ |
| 5 day MWI / ToT training per participant (incl. hotel, food, sitting allowances + average costs for transportation): | 1100 US$ |
| Costs handouts 70 page Training Manual and 50 page Guideline (printing, binding) | 35 US$ |
| Cost per training day (includes food, venue, etc.) | 1400 US$ |

It is further expected that for the first ToT and MWI training, an international trainer will be available to train the future master trainer “on the Job”. Also it shall be the task of the International Trainer to develop and finalize the training program with the MoH.

Trainings of MoH trainers or private training provider:

- MWT training: 286 trainees – 11 training course (286 PHC)
- MWO training: 118 trainees - 5 training courses (59 hospitals)

  - 2 participants from each county hospitals, private, special and other hospitals)
- MWM training: 26 trainees – 1 training course (13 hospitals)
  - 2 participants from each tertiary hospitals and state hospitals, big private or special hospitals > 300 beds)

Cost calculation of one training conducted by local trainers in the states:

| | |
|---|---|
| International trainer (incl. flight, hotel etc.) – 12 days | 12000 US$ |
| 2 day training per participant (incl. hotel, food, sitting allowances + average costs for transportation | 650 US$ |
| 3 days training per participant (incl. hotel, food, sitting allowances + average costs for transportation | 800 US$ |
| 4 day training per participant (incl. hotel, sitting allowances + average costs for transportation | 950 US$ |
| Cost per training day (includes food, venue, etc.) | 1400 US$ |
| Costs handouts 70 page Training Manual and 50 page Guideline (printing, binding) | 35 US$ |
| Local training expert per day | 150 US$ |
| Costs for training hardware (computer, beamer, flipchart, etc.) | 1500 US$ |

**Cost Summary for training activities:**

| No. | Item | Unit | Price (US$) | Total Price (US$) |
|---|---|---|---|---|
| **Part 0: Development of Training** | | | | |
| 1 | International consultant cost preparation of training 2 MM | 2 | $25.000,00 | $50.000,00 |
| | International consultant cost (incl. flight, hotel etc.) – 12 days onsite | 1 | $12.000,00 | $12.000,00 |
| 2 | Local expert (3 MM) | 3 | $3.000,00 | $9.000,00 |
| 3 | Working Group Meetings / Stakeholder Meetings | 2 | $1.000,00 | $2.000,00 |
| 4 | Cost for printing, binding of training curriculum (80 pages) | 50 | $100,00 | $5.000,00 |
| **SUM** | | | | **$78.000,00** |
| **Part 1: Management Training decision maker** | | | | |
| 1 | Cost for handouts: 70 page Training Manual and 50 page Guideline (printing, binding) | 15 | $35,00 | $525,00 |
| 2 | Cost per training session (3 days) | 1 | $4.200,00 | $4.200,00 |
| 3 | Internatonal Trainer cost (incl. flight, hotel etc.) – 7 days | 1 | $8.000,00 | $8.000,00 |
| **SUM** | | | | **$12.725,00** |
| **Part 2: MWI and ToT** | | | | |
| 1 | Cost for MWI Trainees (5 days) | 100 | $1.100,00 | $110.000,00 |
| 2 | Cost for ToT Trainees (5 days) | 25 | $1.100,00 | $27.500,00 |
| 3 | Cost for Training Sessions ( 5 days) | 2 | $7.000,00 | $14.000,00 |
| 4 | Cost for handouts: 70 page Training Manual and 50 page Guideline (printing, binding) | 50 | $35,00 | $1.750,00 |
| 5 | InternationalInt. Trainer cost (incl. flight, hotel etc.) – 12 days | 1 | $12.000,00 | $12.000,00 |
| 6 | Costs for training hardware (computer, beamer, flipchart, etc.) | 50 | $1.500,00 | $75.000,00 |
| **SUM** | | | | **$240.250,00** |

| No. | Item | Unit | Price (US$) | Total Price (US$) |
|---|---|---|---|---|
| **Part 3: Training of responsible persons at healthcare facilities** | | | | |
| 1 | Cost for MWT Trainees (2 days) | 286 | $650,00 | $185.900,00 |
| 2 | Cost for MWO Trainees (3 days) | 118 | $800,00 | $94.400,00 |
| 3 | Cost for MWM Trainees (4 days) | 25 | $950,00 | $23.750,00 |
| 4 | Cost for Training Sessions 2 days | 11 | $2.800,00 | $30.800,00 |
| 5 | Cost for Training Sessions 3 days | 5 | $4.200,00 | $21.000,00 |
| 6 | Cost for Training Sessions 4 days | 1 | $5.600,00 | $5.600,00 |
| 7 | Cost for handouts: 70 page Training Manual and 50 page Guideline (printing, binding) | 450 | $35,00 | $15.750,00 |
| 8 | Hardware for local trainer from MoH (computer, beamer, flipchart, etc.) | 10 | $1.500,00 | $15.000,00 |
| 9 | Costs for local trainer | 2 | $3.000,00 | $6.000,00 |
| 10 | International Trainer cost for “on the job” supervising (incl. flight, hotel etc.) – 12 days | 1 | $12.000,00 | $12.000,00 |
| **SUM** | | | | **$410.200,00** |
| | | | **Total** | **$741.175,00** |

**Table 8-18: Cost Calculation of the implementation of the training plan**

# 9 Inspection system for medical waste

Currently, an official inspection system for medical waste does not exist. The target of a new system should include an efficient use of available resources for inspections, including the resources from the National and State level MoH. Resources should be especially used to inspect objects that pose the greatest public health risks. A risk-based inspection system is recommended. The assessment methodology for medical waste risks and risk assessment criteria should enable:

- the review, analyze and classify inspected entities depending on the risk factor;
- the development of a database including private healthcare facilities which would make it possible to classify entities according to risks;
- the introduction of an effective targeted inspection mechanism.

## 9.1 Principles for medical waste inspections

To introduce inspections on medical waste for the healthcare sector, the introduction of the following principles for the inspection of healthcare facilities is recommended:

### 9.1.1 Risk-based inspection system for the healthcare sector

Only risk-based inspection (RBI) shall be carried out in future. The risk posed by the activities of the healthcare facility is the likelihood to harm life or health of humans, the environment or of property. Risk based inspections are defined as a set of measures implemented to plan inspections of healthcare facilities by Medical Waste to ensure that inspections target the healthcare facilities that pose maximum risk. For this the following principles / steps will be followed when implementing the RBI system:

1) Creation of a set of criteria to allow assessing the risk posed by:
    a. The type of healthcare facility
    b. The specific healthcare facility

2) Setting up and maintaining a database of all healthcare facilities to be covered by medical waste inspections, along with the criteria determining the degree of assessed risks for the type of healthcare facility as well as the specific healthcare facility.

3) Assigning of all economic operators on one of the following risk categories according to the degree of the assessed risk
    a. High risk
    b. Medium risk
    c. Low risk.

4) The high risk category of the healthcare facilities shall include not more than 20% of the total healthcare facilities

5) An annual inspection plan shall be developed which shall include the full name of the healthcare facility, the date of completion of the latest inspection, the ground for conduction the last inspection and the timeframe of the last inspection.

6) The inspection plan shall maintain the following inspections proportions:
    a. >70% of the available financial and staff resources for inspections by Medical Waste shall be used for the inspection of “high risk” healthcare facilities

    b. <5% of the available resources financial and staff resources for inspections by Medical Waste shall be used for the inspection of “low risk” healthcare facilities

### 9.1.2 Checklist based inspections

Medical waste inspections shall be carried out based on checklists, which are to be developed, adopted and published by the RSS-MoH in consultation with other line ministries as e.g. MoE. The checklist shall cover the entire array whose breach may result in harm to life or health of persons or the environment. Legislative and regulatory acts such as the medical waste policy, guidelines, or other that served as a basis for the question shall be indicated in a separate column next to the question. Checklists shall be subject to mandatory publication of websites of the Ministry of Health.

### 9.1.3 Frequency of inspections

The inspection frequency is depending on the risks by the type of healthcare facility as assessed by the inspecting body and the specific risk of the individual health facility. The RSS-MoH shall maintain a database of all healthcare facilities, along with the criteria adopted by the inspecting body and shall inspect the healthcare with the following frequency:

1) High-risk healthcare facilities: once a year or less frequently;
2) Medium-risk healthcare facilities: once in 3 years or less frequently;
3) Low-risk healthcare facilities: once in 5 years or less frequently.

### 9.1.4 Inspection Report

Within three working days after the completion of the inspection of the healthcare facility, the person responsible for the inspection shall aggregate the inspection findings and submit the inspection report and conclusions to the Medical Director of the healthcare facility. The report shall include the date and venue of its compilation, names of the inspectors and the healthcare facility, the inspection purpose, the timeframe, and the results.

In the event that breaches have been revealed, the report shall be accompanied by an act that shall indicate:

1) the date, time and venue of its compilation;
2) the name of the inspecting body:
3) the date and reference number of the inspection assignment;

4) the first and last names of the inspecting official(s);
5) the name of the economic operator and the first and last names of its chief executive officer or the officer-in-charge;
6) the date, place and timeframe of the inspection;
7) in the case of an expert assessment as part of the inspection, an expert conclusion;
8) the title, adoption date and reference number of the checklist used for the inspection, as well as the questions that served as the basis for the protocol breaches, save for inspections conducted by tax and customs bodies;
9) the breaches revealed and the breached norms;
10) the legal basis for the application of relevant sanctions.

The act shall contain an annex where the inspector shall provide recommendations or instructions for the healthcare facility concerning the rectification of the revealed breaches and omissions.

## 9.2 Risk based assessment for the healthcare sector

### 9.2.1 General aspects of risk assessment

Risk is the potential that a chosen action or activity will lead to an undesirable outcome. Almost any human endeavor carries some risk, but some are much more risky than others. Risk can be assessed by determining the likelihood of the hazard occurring and multiplying it with the likely consequences

Also in the healthcare sector risk can be defined as the probability of adverse effect (hereinafter referred to as “medical waste hazard”) on sanitary situation at the inspected entity or on public health, multiplied by the anticipated adverse consequences.

*Risk = likelihood of medical waste hazard X anticipated adverse consequences*

A decrease in risk can thus be achieved either through lowering the likelihood of a medical waste hazard, or through mitigating the anticipated adverse consequences. In practice, it is not always possible to decrease potential risks and in some cases risks are acceptable if contained within acceptable limits.

### 9.2.2 Assessment methodology for risks from medical waste

The likelihood & consequences of a risk can be expressed in a quantitative (numerical) or a qualitative (descriptive) manner. Medical waste risk assessment is the determination of quantitative and qualitative value of a medical waste hazard in a specific situation and a known threat (including an “epidemic threat”).

To determine the medical waste risks of a healthcare facility the following factors shall be considered:

1. Probability of an adverse medical waste situation;
2. Expansion of the medical waste hazard and the probability thereof;

3. Potential adverse consequences of the Medical Waste hazard.

For the assessment of the risk of a healthcare facility two risk assessments will have to be carried out:

A) Risk assessment of the type of healthcare facility

B) Risk assessment of the specific risk of an healthcare facility

### 9.2.3 Assessment of risk by type of healthcare facility

The assessment of the risk by the type of healthcare facility shall be based on the following 4 factors:

A) Type of healthcare facility (e.g. primary, secondary, tertiary level, with/without beds)
B) Number of staff
C) Quantity of service provided in the last year (Number of inpatient treatment days and/or number of outpatients)
D) Quality of offered services (type of services offered).

The classification of the healthcare facility shall be done by using a scoring system with a scale from 1 to 10, with 10 identifying the highest risk. To take into consideration the importance of the different factors, a weighing system for each factor shall be introduced:

A) Type of healthcare facility: weighing factor 2
B) Number of staff: weighing factor 1
C) Quantity of service provided: weighing factor 2
D) Quality of offered services: weighing factor 5

The risk points shall be multiplied with the weighing factor and the results of the four factors shall be added. The maximum risk point will be 100. The total sum shall represent the specific risk of the type of healthcare facility:

71 to 100 risk points: High risk
46 to 70 risk points: Medium risk
Up to 45 risk points: Low risk

### 9.2.4 Assessment of the individual risks of a healthcare facility

Individual risk shall be assessed using standardized checklist, which also serves as the basis for inspections. The checklists shall be developed by the inspecting body in accordance with the existent legal and regulatory framework, and are lists of questions subject to clarification in the course of the inspection.

The individual risk shall be calculated based on the checklist answered. In case that no filled checklist is available, the precautionary principle shall be followed and it has to be assumed that the individual risk is high.

The checklist shall be divided into two sectors:

1. Checklists for units offering medical services for patients (e.g. maternity, pediatric, orthopedic, etc.)
2. Checklists for units offering supporting services (e.g. housekeeping, sterilization, laboratory, laundry, kitchen, etc.)

For each unit, a separate checklist shall be available. During the inspection the inspector can decide if he will inspect all units or only selected units. As a minimum 20% of units offering medical services or supporting services must be inspected.

In the checklist questions with “knock-out” criteria shall be included. In the case that the knock-out criteria is fulfilled (e.g. no waste segregation, no sharps container), this will result in the highest risk rating for the entire unit. If one unit is rated with the highest risk, this will result in the entire sector being rated as highest risk. For the evaluation of the individual risk, the risks created by each department shall be scored on a 1 to 6 level from 1 = Excellent to 6 = absent control. To include the different risks from different units a weighing system shall be used with

Weighing factor 3 – High risk units
Weighing factor 2 – Medium risk units
Weighing factor 1 – Low risk units

For the evaluation the risk scoring of each unit shall be multiplied with the weighing factor. Afterwards the results shall be added and divided through the sum of the weighing factors.

For the final scoring the risk results from the medical sector and the supporting sector shall be added and the result shall be multiplied with a factor of 8.33. The final result will the individual risk rating of the healthcare facility and will be in a range of 0-100 with

71 to 100 risk points: High risk
46 to 70 risk points: Medium risk
Up to 45 risk points: Low risk

### 9.2.5 Identification of the inspection frequency

The healthcare facility risk score must be reassessed two years after the introduction of the risk-based inspection system, based on the individual risks and the risks created by the type of facility. The inspection frequency shall depend on the total risk score of a healthcare facility. The total risk score shall be calculated by the following formula:

(Facility type risk score) * 0,4 + (Individual risk score) * 0,6 = Total risk score

Based on the total risk score the inspection frequency can be determined by:

| Total Risk Score | Frequency |
|---|---|
| 71 or higher | Annually or less frequently |
| 46-70 | Once in 3 years or less frequently |
| Under 45 | Once in 5 years or less frequently |

Scores given in the table are provisional and may be revised depending on the status. Scores and frequencies will be finalized after the methodology has been adopted, based on tests.

## 9.3 Implementation of medical waste inspections

### 9.3.1 Implementation - approach

The implementation of a risk based inspection system is a complex task that will require different resources. The main task will be:

- Collection of relevant data for the database
- Development of a database and inputting of data
- Finalization of all needed checklist
- Carrying out of the first round of risk based assessment

For the implementation, the following sequence is recommended, however tasks can be carried out in parallel

***Step 1: Software development***

Development of a Database. The Database shall enable a combination with the national database on healthcare facilities. Set up of at least one working station for future inputting of data.

***Step 2: Type based risk assessment***

Inputting of all needed data to carry out the type based risk assessment of the healthcare facilities. It has to be expected several facilities do not have all the required data. In that case a re-check (telephone, etc.) has to be carried out.

***Step 3: Finalization of checklist based inspections***

It is recommended to set up a guideline for the carrying out of checklist-based inspections. The guideline should include a description of the risk based inspection system, the inspection procedure and the standards and norms used as basis for the inspection. Before the first inspection round, norms and standards should be updated and reviewed as much as possible. Based on this, the final checklist shall be developed. Checklists shall follow a modular system and should be limited to about 50 questions.

***Step 4: 1st Risk Based Inspection round***

For the first risk based inspection round, only the results from the type based risk assessment are available as specific risk assessments have not been all carried out. Following the precautionary principle the individual risk of all healthcare facilities shall be rated as “high risk”.

Based on the results of the first calculation of the inspection frequency, the first checklist based inspections shall be carried out.

***Step 5: Regular Risk Based Inspection round***

After the end of the first round, the collected experience shall be evaluated and the developed inspection tools shall be reviewed. Based on the results of the first risk based inspection round the individual inspection frequency for each facility shall be determined.

### 9.3.2 Implementation - Cost

| No. | Item | Unit | Price (US$) | Total Price (US$) |
|---|---|---|---|---|
| **Part 1: Development of the Monitoring System** | | | | |
| 1 | International consultant cost preparation of Medical Waste Inspection system (MM) | 1 | $17.500,00 | $17.500,00 |
| 2 | Int. Consult - travel cost, per diem, accommodation | 1 | $8.000,00 | $8.000,00 |
| 3 | Local Software expert – Database | 0,5 | $4.000,00 | $2.000,00 |
| 4 | Local expert – Data input | 1 | $3.000,00 | $3.000,00 |
| 5 | Computer Working station incl. Software + Furniture | 1 | $5.000,00 | $5.000,00 |
| 6 | Working Group Meetings / Stakeholder Meetings | 2 | $1.000,00 | $2.000,00 |
| 7 | Cost for printing, binding of inspection guideline, copies of checklist, etc. (200 pages) | 30 | $100,00 | $3.000,00 |
| 8 | Cost for trial inspection round (one week), incl. Transport + allowance for 2 RSS-MoH worker | 1 | $2.500,00 | $2.500,00 |
| 9 | Other and unforeseeable | 1 | $2.000,00 | $2.000,00 |
| **SUM** | | | | **$45.000,00** |
| **Part 2: Annual operation cost of the monitoring system** | | | | |
| 1 | National Inspectors | 2 | $15.000,00 | $30.000,00 |
| | Traveling & Allowances for 2 Nat. Inspectors | 1 | $30.000,00 | $30.000,00 |
| 2 | Cost on State level | 10 | $2.000,00 | $20.000,00 |
| **SUM** | | | | **$80.000,00** |
| **Cost 1st Year** | | | **Total** | **$125.000,00** |

**Table 9-19: Cost calculation – implementation monitoring**

# 10 Appendices

- Terms of Reference for this study
- Estimated equipment and materials required to implement MWMP
- List of people consulted
- References
- Record of inter-agency forum and consultation meetings carried out

# Terms of Reference for this study

I. Background

Country and sector issues. On January 9, 2005, a Comprehensive Peace Agreement (CPA) was signed between the Government of Sudan and the Sudan People's Liberation Movement (SPLM), bringing nearly 50 years of civil strife in Southern Sudan to a halt. The civil war had a devastating toll on South Sudan, in terms of loss of human life, displacement, and destruction of infrastructure and social fabric. The people were yearning for better lives and had high expectations of benefiting from the peace dividends. The CPA provided a historic opportunity to address the devastation and the neglect of human development, funded by the expected substantial domestically generated oil revenues as well as increased donor flows and international support.

Poor Health Status and Limited Access to Services. Southern Sudan continues to suffer from grim health indicators and access to health services remains limited. The estimate for maternal mortality (2,054 per 100,000 live births) is the highest in the world and the coverage of preventive services such as immunization remain among the lowest. Malnutrition is widespread and tropical diseases, largely controlled in other countries, account for a large proportion of the total burden of disease. Infectious disease epidemics are common and HIV prevalence estimates from location-specific surveys range from 0 to 8% among adults. The annual incidence of tuberculosis in Southern Sudan is estimated at 325 per 100,000, among the highest rates in the world.

Uncoordinated and Inequitable Delivery of Health Services: Like in many post-conflict settings, the organization of health services in Southern Sudan is a patchwork of efforts that may not be having a substantial effect on the population as a whole. Recent work by the Ministry of Finance and Economic Planning (MoFEP) and Ministry of Health (MoH) indicates that there are 21 counties (27% of the total) that currently receive no external financing for primary health care (PHC), although there are a few counties who receive funding from multiple sources. Even those counties receiving external support may lack sufficient funds for improving the delivery of PHC as a whole either because assistance is focused on only a few of the payams or because it is concentrated on supporting vertical programs. There are, as well, significant inequities in the funds available for PHC in different states. The amount of money available for PHC varies 10-fold, from $0.94 to $9.02 per capita per year.

Progress on Strategy Formulation in the Health Sector: The MoH has made progress in formulating a strategy for the sector and establishing a consensus for moving forward. The accomplishments include: (i) "Health Policy for the Government of Southern Sudan 2007-2011" which was officially launched in December 2007, building on the cumulative policies and strategies since 1997; (ii) building partnerships with their international (mostly NGOs) and local (mostly faith-based) implementing partners after the signing of the CPA; (iii) strong government willingness to adopt implementation mechanisms, particularly in the area of contracting, which were designed to bypass existing capacity constraints; and (iv) developing a consensus on the need for decentralizing governmental responsibilities and health services management.

Consensus on the Centrality of PHC: Another important accomplishment of the RSS-MoH has been maintaining the focus on developing PHC as the cornerstone of its new health policy. It has successfully built a consensus among all stakeholders on the need for delivering basic health services to all the people of Southern Sudan. The policy instrument underlying this consensus is the basic package of health services (BPHS). As elsewhere, the BPHS in Southern Sudan has become more comprehensive with each revision, but the underlying message, that there are high impact interventions that must be widely implemented on priority basis, remains critically important and widely accepted.

Current Support to the Health Sector. Health services are fragmented among many actors, including over 100 NGOs which are supported by multilateral and bilateral agencies. Many disease control ("vertical") programs add to the complexity. In the next three years, in addition to the RSS budget, three principal financing channels will support the health sector: (i) the RSS/MDTF US$37 million Umbrella Program for Health Systems Development (UPHSD); (ii) the UN and its partners' Work Plan; and (iii) bilateral donor mechanisms, including humanitarian programs. Some donors contribute through more than one channel. Among bilateral agencies, USAID is supporting an Integrated Health Sector Development Project, building parts of the health system in 12 (of a reported 79) counties.

II. Objectives of the Assignment

The MoH, in collaboration with relevant line ministries and agencies, desires to fully address issues relating to the disposal and management of medical supplies/products and medical waste. In view of this, the current assignment will aim at the following:

Conducting a comprehensive medical supplies and medical waste management assessment in Southern Sudan; and
Developing a national medical supplies and medical waste management strategy and plan, including physical investments, waste management and disposal, compliance monitoring, and training activities.

III. Scope of Services

The work shall be carried out according to the following tasks:

**Task 1: Assessment of Existing Policies and Waste Management Practices in Southern Sudan**

- Assess the policy, regulatory (legal) and administrative frameworks on medical waste management.

- Identify permitting requirements, including environmental building, and other permits and procedures that medical waste treatment/destruction facilities would need to address.

- Outline any public participation or involvement and procedures used in medical waste management. The consultant will list the key stakeholders and how best these could be contacted.

- Assess the typical time demands for proposed facilities to obtain permits for medical waste management and address environmental impact requirement.

- Provide basic information on health facilities such as the number of bed, bed occupancy rates and specialists, divided into the following categories: tertiary hospitals, county/payam hospitals, health centres and clinics, and private health institutions throughout Southern Sudan.

- Assess the medical waste generation and management at, at least, (i) one tertiary hospital; (ii) ten county/payam hospitals; (iii) five major health centres; and (v) three private hospitals. The details should include the minimum weight of the total waste generated at each health care facility per week. The composition of the waste should be determined through segregation at the waste end point, and the results should be extrapolated to cover the entire country.

- Examine the current status of medical waste management in Southern Sudan, including available technology; quantity and type of medical waste facilities.

- Identify the potential source of funding, key actors, and necessary budgetary allocation for waste management in Sudan at the various administrative levels.

- Assess the level of scavenging, if any, or recycling taking place inside the health care facilities; along the transportation routes and at the final deposition sites. Determine and advise on safeguard and social issues in relation to scavenging taking place at the moment and anticipated at the medium- to long-term.

- Review and analyse existing medical waste guidelines, segregation (i.e., posters and color-coded facilities such as dumpsites and deposition bins), collection and disposal systems at the facilities with due regard for the level of separation, storage, the frequency of collection, and environmental and health impact for existing treatment.

- Assess medical waste management awareness/knowledge and behaviors at various levels of health facilities. For example, existence of medical waste management procedures/guidelines, evidence of used syringes and/or loose sharps in or around health sites).

- Identify possible existing Institutional weakness in terms of Structure, reporting arrangement and human resource capabilities which have an impact medical waste management. Identify cultural and general economic and political situation that have an impact on the capacity to manage medical waste.

Task 2: Determination of Appropriate Heath Care Waste Management Technology and Sites

i) Determination of the Technology

- Assess existing and alternative technologies and facility sizes for treatment and destruction. The assessment shall compare the existing and prospective alternatives on the basis of capital cost, operating cost, ease of operation, local availability of spare parts, the local availability of operational skills, demonstrated reliability, durability and environmental impacts. The technologies to be considered include: safe land filling/dumpsites, incineration, sterilization (autoclave and microwave) and chemical disinfection, etc.

- Recommend a process flow for the economically and environmentally sound treatment and final disposal of health/medical care waste leading to the selection of appropriate technologies (The government and/or the facility would make the final decision on choice of technologies).

ii) Determination of Medical Waste Disposal Sites by taking into account the following:

(a) Accessibility to the site,
(b) Distance from health care facility to the site
(c) Distance to ecologically sensitive and fragile areas
(d) Analysis of the site including information to determine whether there is sufficient appropriate material on the site for daily and final cover, the site soil, hydrological and geological conditions would ensure adequate protection of any ground and surface water used for drinking and/or irrigation.
(e) Future development plans of the area
(f) Possibility to acquire the area without incurring any significant issue related to land take and compensation
(g) Cultural & historical relevance of the site
(h) Public opinions
(i) Noise and impact to nearby areas
(j) Topography of the site.
It is important that public consultations/hearings are held as part of the final assessment of sites for the treatment facility.

Task 3: Determining RSS Capacity to manage Medical Waste

a) Assess the current capacity of the government including municipality in financing effective solid waste treatment and disposal with emphasis on medical waste management.

b) Assess private sector participation as service provider including options for public-private partnerships and cost recovery at all levels, based on possibilities of polluter pays principle, where each health care facility pays according to the volume of waste generated.

Task 4: Training and Public Awareness

- Review existing training and public awareness programmes on medical waste management at hospitals and other health care establishments and identify the strengthens, weaknesses and opportunities of the current practices.

- Working in conjunction with the relevant government institutions and municipal councils, prepare costed training programme and well targeted capacity building campaign programme including the general public, and more specifically health workers, municipal, dump site managers, incinerator operators (if that is the choice of the technology), nurses, scavengers/pickers families and street children. The design of the material required for the awareness building programmes should be discussed with the relevant authorities and general public to ensure that their concerns that are deemed appropriate are incorporated in the design of the programme layouts, mitigation measures and community communication programmes. The training and awareness building and the management programme shall be appropriately costed and the plan shall be presented in a national workshop.

Task 5: Preparation and Presentations of Reports

- The Consultant is expected to prepare and present for discussion at joint meetings of the National Health (Waste) Management Steering Committee and other stakeholders a full draft report of the assessment, focusing on the significant environmental, social and human health issues.

**IV. Output/Deliverables:**

- Inception report — End of week 2 from Commencement
- Draft Final report — End of week 8 from commencement
- Final report — End of week 12 from commencement

1. The Consultant is expected to provide 3 (three) spiral bound **final** reports with diagrams, photos/pictures and maps where necessary to the MoH, as well as 1 (One) Flash Disks containing electronic copies of the report and data collected during the assessment/study period.

2. The final report will contain the following:

An Executive summary

Section I: Introduction

Section II: Policy, legal and administrative framework

Section III: Project description

Section IV: Baseline data on medical waste generation

Section V: Assessment of medical waste management

Section VI: Determination of technology

Section VII: Determination of disposal sites

Section VIII: Medical supplies and medical waste management plan (MWMP), including estimated costs and timeline

- Medical waste management infrastructure and systems
- Management and training for institutions and agencies

Section IX: Appendices

- Terms of Reference for this study
- Estimated equipment and materials required to implement MWMP
- List of people consulted
- References
- Record of inter-agency forum and consultation meetings carried out

**V: Study supervision and time schedule**

3. Oversight of this assignment is the responsibility of the Moh. The consultant shall begin work not later than 7 days after the effective date of the contract (ie **the date when the client signs the contract and sends copy to the Consultant advising him to commence**). It is anticipated that the consultant would complete the outputs of the work over a maximum duration 12 weeks in the field for data collection and collation and of report writing and finalization of the document after the review has been carried out by the MoH. It is anticipated however, that the consultant will propose a clear schedule with critical milestones, and make all possible efforts to complete the work at the appointed time of **3** months.

**VI: Required Competencies/Profile of the Consultant**

4. The table below shows the qualification and experience for the consultant firm's team membership.

| Position | Qty | Qualification | Experience |
|---|---|---|---|
| Team Leader | 1 | S/he should be either:<br>- Public Health Specialist<br>- Waste Management Specialist<br>- Sanitary Engineer<br>- Environmental Management Specialist | Over 10 years experience in safeguard assessment especially in medical waste management and waste management assessment |
| Waste Management Specialist | 1 | - MSc Engineering or in any relevant fields<br>- Specialization in waste management or related fields | 5 to10 years of experience in waste management or related fields.<br>Candidate should have good interpersonal skills including experience in leading teams and experience in waste management training |

| | | | |
|---|---|---|---|
| Environment Management Specialist | 1 | - BSc in Environmental Science<br>- Specialization in environmental health management | 5 to10 years of experience in environmental waste management and waste management training |
| Public Health Specialist | 1 | - MPH or related health science field<br>- Specialization in public health with additional training in environmental health or health education | 5 to10 years in environmental health, health education or related field and public health and environmental training |

**Qualification and Experience of the Consulting Firm**

- Technical competency in scientific, health, environment and engineering fields in particular sanitary engineering
- Competency in the private- partnership on medical waste management
- Experience on medical waste management in Africa would be an advantage
- Experience of working in and /or consultancies in post conflict states
- Skills in training and institutional strengthening

# List of people consulted

| No. | Name | Organization | Telephone |
|---|---|---|---|
| 1. | HE Juma Saeed Worju | CE Minister for Environment | 0912 983 896 |
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| 46. | Dr Thuou Loi | MoH / RSS | |
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| 65. | Bedilu Amare Reta | World Bank | 0955 626 362 |
| 66. | Dr Mohamed Ali Kamil | World Bank | 0910 99 867 |
| 67. | Dr Kennedy | Yei Hospital | 0915 182 291 |

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