



Baseline Study for the Pacific Hazardous Waste Management Project - Healthcare Waste

The collection, collation and review of data on the management of healthcare waste and best-practice options for its disposal in participating Pacific Island Countries

Kiribati

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**Secretariat of the Pacific Regional
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Prepared by:		Authorised by:	
Name:	Trevor Thornton	Name:	Geoff Latimer
Title:		Title:	Senior Manager
Phone:		Phone:	9606 1508
Email:		Email:	glatimer@environcorp.com
Signature:	Date:	Signature:	Date:

This document is issued in confidence to Secretariat of the Pacific Regional Environment Programme (SPREP) for the purposes of collection and collation of information on the regional management of healthcare waste and its disposal, as part of their broader strategy of improving hazardous waste management in Pacific Island countries, and specifically to assist in establishing sustainable healthcare waste management. This report presents the findings of this assessment. It should not be used for any other purpose.

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Executive Summary

Introduction

The Secretariat of the Pacific Regional Environment Programme (SPREP) is the Pacific region's major intergovernmental organisation charged with protecting and managing the environment and natural resources. SPREP works with and on behalf of its 21 member countries and territories to promote cooperation in the Pacific islands region, providing assistance to protect and improve the Pacific environment and to ensure sustainable development for present and future generations.

SPREP is implementing the Pacific Hazardous Waste Management (PacWaste) Project, a four year, €7,850,000 (2013 – 2017) project funded by the European Union and administered through SPREP. The project will provide fundamental on-ground improvement in the way priority high risk wastes are managed in Pacific Island Countries to help build a healthy, economically and environmentally sustainable Pacific for future generations. The PacWaste project is funded by the European Union under its 10th European Development Fund (EDF 10). The project focuses on three priority hazardous waste streams including asbestos, E-waste and healthcare waste.

ENVIRON was engaged by SPREP to collect and collate information on the regional management of healthcare waste and its disposal, as part of their broader strategy of improving waste management in Pacific Island Countries, and specifically to assist in establishing sustainable healthcare waste management. This report presents the findings of the assessment conducted for Kiribati.

Current Healthcare Waste Management in Kiribati

The Ministry of Health operates health care facilities in Kiribati, and there are no private clinics or hospitals. Information regarding the waste management process occurring, from ward-level waste generation through to ultimate treatment and disposal was collected during audits of the two largest hospitals as follows:

- South Tarawa Tungaru Central Hospital – 16th April 2014
- Kiritimati Island London Hospital – 17th April 2014

A minimum standards framework has been developed to set a benchmark for the sustainable management of healthcare waste in the Pacific Island region. This framework is drawn from the *Industry code of practice for the management of biohazardous waste (including clinical and related) wastes*, Waste Management Association of Australia (2014), Draft 7th edition, taking into account the Pacific Island hospital and environmental context.

Using information obtained from the audits, the hospitals were assessed against this framework. Table ES1 highlights the key areas of concern in terms of health services delivery by the hospitals, as part of this assessment.

A full description and definitions of minimum standards applicable for healthcare waste management, as well as a comprehensive assessment against each of the criteria is presented in **Appendix C**.

Target areas have been rated as follows:

	Meets minimum standards assessment criteria
	Partially meets minimum standards assessment criteria.
	Does not meet minimum standards assessment criteria.

Table ES1: HEALTHCARE WASTE – KEY ISSUES FOR KIRIBATI						
Scale	Category	Item	Minimum Standard Criterion	South Tarawa Tungaru Central Hospital	Kiritimati Island London Hospital	Kiribati overall
Healthcare Facility	Policy	Waste Management Plan	Has been developed by the hospital and is based on a review of healthcare waste management and is current (within 5 years)			
Healthcare Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types			
Healthcare Facility	Segregation		Waste are correctly segregated in all wards/departments with use of containers that are colour coded for the different waste types			
Healthcare Facility	Containers		All areas have dedicated waste containers are suitable for the types of waste generated. All waste containers are colour coded and have correct wording on them. Sharps are deposited into containers that reduce potential for needle-stick injury			
Healthcare Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.			
Healthcare Facility	Storage	Storage before treatment	Meets the standards stated in Appendix E, Recommendation 2, <i>Correct Storage</i> .			
Healthcare Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure			
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.			
Healthcare Facility	Treatment	Suitability of treatment for healthcare waste	The method for treating healthcare waste is in accord with required standards - this includes operating parameters and location of the treatment unit.			
Healthcare Facility	Healthcare waste management emergencies	Spill Prevention and Control	Spill kits are provided or all types of healthcare waste in all wards/departments, storage areas and on trolleys and vehicles. Staff are trained on the use of spill kits. All incidents of spills of healthcare waste are investigated and where appropriate remedial actions implemented.			

Key Issues

Healthcare waste management at both hospitals reviewed was at differing levels of sophistication. Part of this was that at London Hospital, there are very small quantities of waste generated and as such is relatively easily disposed of at the local landfill.

At Tungaru Central Hospital, there is a MediBurn incinerator that appears to be functioning in accord with specifications. However, there is a growing stockpile of waste that has not been incinerated as well as a volume of ash and other wastes that need to be transported to landfill for disposal. London Hospital has a small wood fired incinerator that is not functioning (with no reason able to be provided for its in-operable state), resulting in healthcare waste being burnt in the open at the local landfill.

Storage facilities for healthcare waste for both hospitals needs improvement so that standards as advocated within this report are achieved and maintained.

There needs to be a more integrated system of ensuring that wastes are clearly identified via the use of colour coded bins, signage and training, consistently across Kiribati. The larger Tungaru hospital was better performed in this area.

Analysis of Options for Sustainable Healthcare Waste Management in Kiribati

Where non-treatment waste management aspects were observed to be performing below the Minimum Standards Framework, this framework is referenced for recommended actions.

For treatment of healthcare waste, various options used around the world were considered in the Pacific Islands context, via a two stage process:

- Stage 1: High-level costs and benefits (cost, lifespan, technical feasibility and how that relates to the Pacific Island regional context); and
- Stage 2: A Kiribati-specific feasibility assessment, using an analysis of 10 criteria (**Appendix D**)

Treatment options that rated best for Kiribati were:

- **High Temperature Incineration** is the promoted disinfection practice where units are modern, maintained, have sufficient waste volumes and locked in supplier maintenance and training contracts.
- **Medium Temperature Incineration** is acceptable in the medium term to remedy current unacceptable practices at sites too small to justify costs of expensive equipment.
- **Autoclaving** is an acceptable disinfection practice where units with shredder are affordable and locked in supplier maintenance and training contracts are in place.
- **Low temperature burning** is a borderline practice which can only be acceptable in the short term, in low population density environments, to remedy current unacceptable practices.

Encapsulation ranks as an effective way to deal with the residual risk from already disinfected sharps: i.e., the risk of needle stick injury by healthcare workers or the community (waste disposal area) due to the fact that sharps are disinfected but not

physically destroyed by the low-medium temperature of open burning (or non-destruction of autoclaving). Encapsulation is never recommended as an isolated form of treatment, as it does not disinfect or otherwise treat the hazard of the waste.

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. This is occurring at Tungaru via incineration, but open burning at London Hospital is a borderline practice – it disinfects to a reasonable level but has environmental and human health impacts.

South Tarawa Tungaru Central Hospital – has a functioning relatively new MediBurn model incinerator. It is housed in a dedicated building, but this is not fully roofed and located close to hospital buildings. Even on its current 7 days per week running schedule, the incinerator appears to be not keeping pace with the volumes of waste generated, especially when Betio Hospital quantities are also considered.

Kiritimati Island London Hospital – has a non-operational wood fired incinerator. It is located in a small building some distance from the hospital. It generates relatively small quantities of healthcare waste and there is minimal pharmaceutical waste generated. Wastes are taken to the local landfill and burnt before burial.

Recommendations

Table ES2 provides a summary of the recommendations for Kiribati.

Where a recommendation is **unique** to the circumstances of a particular hospital, because of issues identified that are **unique** to that hospital, the recommendation (and associated implementation action) is appended with the annotation ^{U2H}.

Target recommendations have been rated as follows:

	Fully Applicable
	Partially applicable
	Not applicable

Table ES2: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
Recommendation 1: Develop a Waste Management Framework					
Description	<ul style="list-style-type: none"> A <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility. Appoint an <i>officer responsible</i> for the development and implementation of the Healthcare Waste Management Plan A <i>waste management committee</i>, appropriate to the scale of each facility. 				
Output	<ul style="list-style-type: none"> An agreed <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility outlining procedures and guidelines, waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures Accountability for healthcare waste management through clearly defined roles and 				

Table ES2: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
Monitoring & Evaluation Indicators	responsibilities				
	<ul style="list-style-type: none"> Plan approved by Ministry of Health (all facilities) Approved budget for implementation of Healthcare Waste Management Plan The Plan should be regularly monitored, reviewed, revised and updated. Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies. 				
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided Ongoing – Low 				
Recommendation 2: Procurement of Consumables (Segregation & Storage)					
Description	<ul style="list-style-type: none"> For London Hospital: Supply of colour-coded waste bins and plastic liners in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. Supply of signage to explain the colour-coded segregation system as well as posters to promote it. 				
Output	<ul style="list-style-type: none"> Adequate supply of consumables to bed down more rigorous segregation practices 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Wastes are segregated at their place of production. Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. Zero Needle Stick Injuries. 				
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low; Ongoing - Low, sustainably funded by country 				
Recommendation 3: Provision of a Sustainable Training Program					
Description	A structured waste management education/awareness program is developed and delivered to all stakeholders (including non-hospital employees)				
Output	<ul style="list-style-type: none"> Development and delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies) Improvement of personnel skills and competency in managing healthcare waste Promotion of the advantages of sustainable segregation and storage techniques for the different waste streams and an understanding of the health and safety risks resulting from the mismanagement risks of healthcare waste. 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Competency Assessments 				

Table ES2: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
	<ul style="list-style-type: none"> • Refresher Training • No/very little cross contamination between waste streams demonstrated by waste audits. 				
Costs (\$US)	<ul style="list-style-type: none"> • Establishment – Medium; Ongoing - Low 				
Recommendation 4: Procure new incinerators ^{U2H}					
Description	<ul style="list-style-type: none"> • Procurement of a new high temperature incinerator for Tungaru Hospital, within existing building (but upgraded), that houses the existing incinerator, with maintenance support contract. • Procurement of a new small (medium temperature) incinerator and protective structure for London Hospital, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Kiribati Ministry of Health and Medical Services) 				
Output	<ul style="list-style-type: none"> • A treatment system that reduces the potential hazard posed by health-care waste, while endeavouring to protect the environment. 				
Monitoring & Evaluation Indicators	<p>Assessment of the following should be regularly undertaken for new and existing incinerators:</p> <ul style="list-style-type: none"> • Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures above 800°C only) • Maintenance program – are maintenance issues dealt with promptly? • Ensure burn times are sufficient to reduce waste ash volumes 				
Costs (\$US)	<ul style="list-style-type: none"> • Establishment – High (approx.. \$50,000 for high temperature unit (Tungaru) and \$7,000 for the small medium-temperature unit for London Hospital (including housing and commissioning costs); • Ongoing – medium (fuel and maintenance) 				
Recommendation 5: Upgrade of Central Storage Facilities					
Description	Storage areas used for the consolidation of wastes prior to treatment/disposal are of a standard that avoids environmental and health related negative impacts from such issues as spills or access by unauthorized person.				
Output	<ul style="list-style-type: none"> • Storage areas are secure, suitably designed and isolated from patients and the public. • Storage areas have capacity to contain wastes generated under “normal” conditions as well as for contingencies 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> • Suitability of storage areas regularly assessed by ‘responsible officer’ of waste management committee. 				

Table ES2: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Medium; Ongoing - Low 				
Recommendation 6: Procurement of Spill Control Kits					
Description	Supply sufficient Spill Control Kits for entire hospital operations in both hospitals.				
Output	Capacity and capability (training – see Recommendation 3) to respond to any healthcare waste spills anywhere in the waste management process.				
Monitoring & Evaluation Indicators	Staff are aware of how to protect themselves and others from, and respond to, any spills of healthcare waste				
Costs (\$US)	Establishment – Low; Ongoing - Low, sustainably funded by country				

U2H - Unique to hospital

Implementation actions are suggested for each recommendation, classified as short, medium and long-term priorities.

1 Introduction and Background

The Secretariat of the Pacific Regional Environment Programme (SPREP) is the Pacific region's major intergovernmental organisation charged with protecting and managing the environment and natural resources. SPREP works with and on behalf of its 21 member countries and territories to promote cooperation in the Pacific islands region, providing assistance to protect and improve the Pacific environment and to ensure sustainable development for present and future generations.

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1.1 Project Scope

This report covers the approach specified in the Request for Tender AP 6/5/6/2 'The collection, collation and review of data on the management of healthcare waste and best practice options for its disposal in selected Pacific Island communities' as it specifically relates to Kiribati and includes:

- Collection and collation of data on the current practice(s) used to dispose of hazardous healthcare waste in Kiribati. Data collected includes:
 - Basic background data on the operation of the hospital sites assessed (number of beds, population served, current and projected rates of hazardous healthcare waste generation);
 - Healthcare waste separation and infection control practices;
 - Adequacy of supply of hazardous healthcare waste collection equipment;
 - Hazardous healthcare waste storage;
 - Hazardous healthcare waste transportation;
 - Hazardous healthcare waste disposal practice and annual operating costs;
 - Frequency and adequacy of infection control training;
 - Frequency and adequacy of waste disposal training;
 - Adequacy of supply of personnel protective equipment.

- Consultation with national authorities to review and identify best-practice option(s) and preferences for national hazardous healthcare waste management by considering technical feasibility within the existing health infrastructure (including review of existing local institutional, policy and regulatory arrangements).
- Identification of local contractors who may have the expertise and capacity to potentially partner with regional or international expert's in future hazardous healthcare waste management including infection control training.

1.2 Report Structure

This report is structured as follows:

- an introduction to the project (**section 1**)
- discussion of current healthcare waste management in Kiribati, including the current regulatory framework and hospital details (**section 2**)
- a summary of existing waste management practices, waste streams and quantities, waste management and infection control framework, the waste management process that was reviewed, training and education programs and identified healthcare waste management issues (**section 3**)
- key healthcare waste management issues and any county-wide or regional themes that were identified (**section 4**)
- a summary of hospital and national authority consultation outcomes (**section 5**)
- an assessment of contractor roles and their capacity to sustainably manage and treat healthcare waste, including any training or education capacity (**section 6**)
- an analysis of the healthcare waste management and treatment options available, both regionally and specific to Kiribati, to address the key issues identified (**section 7**)
- recommendations and prioritization of actions necessary to enable sustainable hazardous healthcare waste management and disposal in Kiribati (**section 8**)

2 Healthcare Waste Management in Kiribati

2.1 National Regulatory Framework

Waste management is the responsibility of the Ministry of Environment, Lands and Agricultural Development, with responsibility for the Hospitals being with the Ministry of Health and Medical Services.

A summary of relevant legislation is provided in Table 1.

Legislation	Type	Summary	References to Solid/HCW	Regulator/ Agency
The Environment Act 1999 (Amended 2007)	Act	Objects of the Act: To reduce risk to human health and prevent the degradation of the environment by all practical means: Regulating transport, collection, treatment and disposal of wastes	The Act does not directly address the management of hazardous waste such as healthcare wastes	Environment and Conservation Division
Local Government Act 1984	Act	The Act empowers Local Council to make provisions for sanitary services dealing with rubbish and the prohibition of acts detrimental to the sanitary condition of the area.	Reference to solid waste management, but not HCW	
Public Health Ordinance (Cap 56)	Ord			Ministry of Health and Medical Services

2.2 Hospitals Assessed

This section summarises the hospitals that were assessed in Kiribati, key contact personnel and key hospital administrative statistics.

The Ministry of Health and Medical Services operates healthcare facilities in Kiribati via the provision of hospitals, health centres and health clinics. There are no private and/or church operated medical services within any of the islands. Public Health Inspectors are responsible for management of healthcare waste.

2.2.1 Tungaru Hospital

Tungaru Hospital has 200 beds and approximately 53 staff which includes medical/nursing staff and cleaners. Services provided include; Outpatients, X-ray, Pharmacy, Dental, Maternity, Pathology, Operating Theatre, Rehabilitation.

2.2.2 London Hospital

London Hospital has 18 beds (8 general and 10 maternity), and approximately 30 staff which includes medical/nursing staff and cleaners. Services provided include; In patient, emergency, maternity, dental, x-ray and laboratory.

2.2.3 Hospital Statistics

Detailed operational statistics for both of these hospitals are described in Table 2.

Table 2: Hospital Details – Kiribati		
Hospital/Region	South Tarawa Tungaru Central Hospital	Kiritimati Island London Hospital
Contact Name Position	Mr Tebikau Noran Acting Chief Health Inspector	Dr Teraira Officer in Charge Kiritimati Hospital
Pop Served	50,000	6,000
No. of Beds	200	8 general, 10 maternity
Annual Average Occupancy Rate (%)	110%	100%
OBD's	80,300	6,570
No. Operations	1 theatre - no numbers	1-2 per month (more when visiting doctors on island)
No. of Births	4450 per annum	240-360 per annum
Emergency Patients Attended	560	No data
Out-Patients Attended	150/daily	40-50 per month
No. of staff	53	Approximately 30
No. of staff per function		
Nursing/ Medical	23 (Partial Numbers)	18
Infection Control	1	nil
Dedicated Waste Management – Internal Management	20	nil
Dedicated Waste Management – Treatment Operation	1	nil
Administration	8	3
Other	-	9

Notes: OBDs = Occupied Bed Days (previous 12 months)

3 Existing Waste Management Practices

This section describes waste management practices observed during hospital audits carried out at both of the hospitals introduced in Section 2. Information regarding the waste management process occurring, from ward-level waste generation through to ultimate treatment and disposal, is described for each hospital in Table 3.

Audit observations are elaborated upon further for each hospital individually in sections 3.1 and 3.2 for the remaining issue headings:

- Wastestreams, Treatment Constraints and Costs
- Waste Management and Infection Control Framework and
- Training.

A comprehensive list of all data collected from the site audits of each hospital is located in **Appendix B Collected Data from Hospital Audits in Kiribati**.

The pre-audit survey that was provided to Kiribati was not completed prior to the on-site assessment of the waste systems. However, the survey for Tarawa Hospital was provided to the auditor (although not all sections were completed). During the audit, information/data that was missing was requested and where provided included into the Hospital's response.

	Hospital Name	South Tarawa Tungaru Central Hospital		Kiritimati Island London Hospital			
Generation & Segregation	Dedicated Containers/ Bags	N		N			
	Colour Coding	N		N			
	Sharps segregated & secure	N		Y			
	Signage Present	Y		N			
Internal Handling	Degree of manual handling of bags	High		High			
	Internal Transport Mode	Trolley		Trolley			
	Spill Kit Present	N		N			
Storage	Dedicated & Appropriate Area	Y		N			
	Loading/unloading acceptable	Y		N			
	Spill Kits Present	Y		N			
	Monitoring & record keeping occurs	N		N			
Treatment	Treatment per Waste Stream		Tech. Type	Volumes (kg/week)		Tech. Type	Volumes (kg/week)

Table 3: Waste Management Process - Observations

	Hospital Name	South Tarawa Tungaru Central Hospital			Kiritimati Island London Hospital		
Healthcare Waste	✓	Burn on site	260 ¹	✓	Burn at landfill	20 ²	
Sharps	✓	Burn on site		✓	Burn at landfill	2 ³	
Pharmaceutical	✓	Landfill (without treatment)	NS	✓	Landfill (without treatment)	NS	
Cytotoxic	x	NA	N/A	x	NA	N/A	
General	✓	Landfill (without treatment)	NS	✓	Landfill (without treatment)	30	
If incinerator present		Yes			Yes		
Make, Model, Year commissioned		MediBurn, March 2013			Not known – wood fired		
Operating Temp (°C)		1,000°C			Not able to be measured		
No. chambers		2			1		
Condition		Reasonable There is a second incinerator, but this is not functional.			Broken down No information as to why the incinerator is not working was provided – despite asking hospital personnel		
Operational statistics		Per week	Per year	Per week	Per year		
Waste Throughput (kg)		0.4	21	Not in use	Not in use		
Operating Hours (hr)		7 days per week (4 hours Sunday)			Not in use		
Fuel		Diesel			Wood		
Fuel use (litres)		NS	NS	N/A	N/A		
Fuel use per kg waste burnt		NS			N/A		
Technology siting and operation issues		Too much waste for loads to be burnt efficiently and located too close to the hospital			Sited away from the hospital grounds		
Offsite transport assessment		Fair			Poor		

N/A – Not applicable

NS – Not supplied

3.1 Tungaru Hospital, Tarawa

3.1.1 Wastestreams, Treatment Constraints and Costs

Tungaru Hospital generates general waste and healthcare wastes (including, infectious waste, sharps and pharmaceutical wastes) in the approximate quantities described in Table 3.

¹ Based on weighed quantities of healthcare waste and includes sharps waste.

² Not weighed as no scale at hospital – based on estimates of bag size

³ Not weighed as no scale at hospital – based on estimates of size of containers

Tungaru has a sizeable stockpile of untreated healthcare waste (estimated to be approx. 750kg on the day of the audit) and this continues to grow because waste generation is outstripping capacity (on the twice a day, 7 days per week current incineration schedule). An analysis of treatment capacity available versus actual volumes stockpiled is shown in Table 4.

Waste Treatment Parameter	Volume	
Incinerator Design Capacity (kg per batch)	20	
No. batches run per day	2	
	Per week**	Per Year
Available Incinerator Capacity (kg)	280	14,000
Actual Incinerated Waste Throughput (kg)	400	20,000
Spare Capacity (kg)	-120	-6,000
Estimated Stockpiled Volume (kg)	750	
Reducing Existing Volumes	Weeks	
Time needed to incinerate <u>current</u> healthcare waste stockpile at estimated waste throughput (of a second incinerator of same capacity)	3**	-

**Based on a 7 day week which is currently the case

**Based on stockpile estimate on day of audit. This stockpile is growing at an estimated rate of 120kg per week.

Table 4 demonstrates that the stockpile is growing at an approximate rate of 120kg per week due to insufficient current incineration capacity.

Tungaru Hospital has some responsibility for waste management for Betio Hospital, a neighbouring but much smaller referral hospital, of similar size to London Hospital in Kiritimati Island. There has been construction of a new maternity ward at this hospital which has contributed to the volume of healthcare waste (studies internationally have shown that maternity wards can contribute between 5-10% by weight of the hospitals total healthcare waste stream. Currently this waste is transported to Tungaru Hospital for incineration.

No costs information was obtained since waste disposal costs are internally borne by the hospital it is not directly measured. General waste costs are also not quantified as no charges are made.

3.1.2 Waste Management and Infection Control Framework

The following summarises the waste management and infection control framework at Tungaru Hospital:

- There is no waste management policy, plan or formalised waste management procedure.

- The Environmental Health Inspector oversees waste management, with cleaners responsible for transporting waste to the incinerator and the incinerator operator for sorting and “burning” healthcare waste.
- Pharmaceutical waste is ground up, mixed with sand and disposed of to landfill.
- There is an infection control Policy and has a section on waste management, but the Policy was not known to the Environmental Health Inspector until this audit.
- There have been some waste audits in the past, but they no longer occur. The audits were predominantly focused on obtaining data on volumes generated.

3.1.3 Training

There is no formalised waste management training, except for some training on waste handling provided to cleaners and orderlies on commencement of their employment. The incinerator operator received training when the MediBurn incinerator was provided.

As far as could be established there is some informal training on infection control provided to staff (ie., cleaners/waste handlers) that has a focus on waste management. This training is more focused on cleaning and delivered to new staff during an induction session.

Nursing staff receive information on waste segregation by Charge Nurses during their training, with no formalised training provided. Infection control training is provided to student nurses during their training.

3.2 London Hospital, Kiritimati

3.2.1 Wastestreams, Treatment Constraints and Costs

London Hospital generates general waste and healthcare wastes (including, infectious waste, sharps and pharmaceutical wastes) in the approximate quantities described in Table 3.

No costs information was obtained since waste disposal costs are internally borne by the hospital it is not directly measured.

3.2.2 Waste Management and Infection Control Framework

The following summarises the waste management and infection control framework at London Hospital:

- There is no waste management policy, plan or formalised waste management procedure. The Environmental Health Inspector oversees waste management with cleaning/maintenance staff responsible for waste disposal – daily transport to the landfill.
- The incinerator is not working at present – but no information was provided as to the issues.
- All waste is disposed of to landfill, with healthcare waste burnt at the landfill.
- There is no documented infection control policy.
- There is no formal waste auditing or inspections.

3.2.3 Training

There is no formalised training program for any staff on waste management or infection control. Informal training on infection control takes place on a “needs basis” such as when patients with specific illnesses are admitted.

4 Key Healthcare Waste Management Issues in Kiribati

This section takes the collected information from Section 3 and summarises and critically assesses it, for both hospitals surveyed, in the context of a Minimum Standards Framework.

A key issues summary is also provided.

4.1 Minimum Standards Framework

A minimum standards framework has been developed to set a benchmark for the sustainable management of healthcare waste in the Pacific Island region. This framework is drawn from the *Industry code of practice for the management of biohazardous waste (including clinical and related) wastes*, Waste Management Association of Australia (2014), Draft 7th edition, taking into account the Pacific Island hospital and environmental context.

A full description and definitions of minimum standards applicable for healthcare waste management, as well as a comprehensive assessment of both hospitals against each of the criteria is presented in **Appendix C**. Target areas have been rated as follows:

	Meets minimum standards assessment criteria
	Partially meets minimum standards assessment criteria.
	Does not meet minimum standards assessment criteria.

Table 6 highlights the key areas of concern, both per hospital, and in terms of health services delivery across Kiribati, as part of this assessment.

The sub-sections below discuss these key areas of concern further.

Table 6: HEALTHCARE WASTE – KEY ISSUES FOR KIRIBATI

Scale	Category	Item	Minimum Standard Criterion	South Tarawa Tungaru Central Hospital	Kiritimati Island London Hospital	Kiribati overall
Healthcare Facility	Policy	Waste Management Plan	Has been developed by the hospital and is based on a review of healthcare waste management and is current (within 5 years)			
Healthcare Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types			
Healthcare Facility	Segregation		Waste are correctly segregated in all wards/departments with use of containers that are colour coded for the different waste types			
Healthcare Facility	Containers		All areas have dedicated waste containers are suitable for the types of waste generated. All waste containers are colour coded and have correct wording on them. Sharps are deposited into containers that reduce potential for needle-stick injury			
Healthcare Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.			
Healthcare Facility	Storage	Storage before treatment	Meets the standards stated in Appendix E, Recommendation 2, <i>Correct Storage</i> .			
Healthcare Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure			
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.			
Healthcare Facility	Treatment	Suitability of treatment for healthcare waste	The method for treating healthcare waste is in accord with required standards - this includes operating parameters and location of the treatment unit.			
Healthcare Facility	Healthcare waste management emergencies	Spill Prevention and Control	Spill kits are provided or all types of healthcare waste in all wards/departments, storage areas and on trolleys and vehicles. Staff are trained on the use of spill kits. All incidents of spills of healthcare waste are investigated and where appropriate remedial actions implemented.			

4.2 Tungaru Hospital – Key Issues

Below is a summary of the most significant healthcare waste management issues observed at Tungaru Hospital:

- There are dedicated bins for the various waste types, but these are not always used correctly. Sharps are deposited into dedicated cardboard sharps containers (**Photos 1 and 2**).
- Signage advising as to correct waste segregation is present, but not in all areas (**Photo 3**).
- Storage of healthcare waste is poor. There are large volumes of waste located within the incinerator area and outside on the ground. (**Photo 4**).
- There is an ad hoc collection of general waste which is transported to the landfill. This means that the general waste is not collected on a regular schedule. There is no storage area for general waste and it is located on the ground while awaiting collection (**Photo 4**).
- The incinerator appears to be operating effectively (**Photo 5**). However, the healthcare waste from the hospital and other sources means that the operator has difficulty in processing the quantities being generated. Currently the incinerator is operating 7 days per week. Ash is placed into bins and left out in the open awaiting collection for disposal to landfill.
- The incinerator is located close to the hospital buildings (**Photo 6**).
- Untreated healthcare waste and ash have been accumulating within the area where the inoperable incinerator is located (**Photo 7**), and around the current operating incinerator, and this is growing due to insufficient incinerator capacity. This stockpile was estimated to be approximately 750kg on the day of the audit and growing.
- Out of date pharmaceuticals are being disposed of to the landfill – they are ground up, mixed with sand and deposited there.
- There is “Infection Control Policy Guidelines” that has a section on waste management, but staff are not aware of this document and its requirements.
- Quarantine waste from the airport is transported to the landfill and burnt in an open pit.

4.3 London Hospital – Key Issues

Below is a summary of the most significant healthcare waste management issues observed at London Hospital:

- There is poor segregation at London Hospital – only sharps are separated into sharps containers (several different types), and other healthcare waste and general waste are combined in the same bins (some use of bin liners).
- There was no signage present advising as to correct waste segregation.
- No PPE is used by any waste handlers.
- No training on waste management occurs.

- The incinerator is not operational (**Photo 8**). It is a single chamber that uses wood as the primary fuel source. There are no gauges indicating operating temperatures and is manually loaded. If operational, it would just be utilised to burn anatomical and sharps waste – all other healthcare waste taken to the landfill. The incinerator is in an enclosed area that is securely locked.
- There are semi-regular outbreaks of gastroenteritis, but no means of incinerating the waste resulting from patient treatment.
- All general and healthcare waste is transported daily to the landfill which is essentially an open surface site. Healthcare waste is burnt in the open at this site (**Photo 9**). Scavengers do access the site.

5 Consultation

No consultation with other government jurisdictions occurred. Meetings were requested to be held while conducting the review on Tarawa, but personnel were not available.

6 Contractor Roles and Capacity

Under current arrangements the hospitals are responsible for the management of all wastes. On Tarawa, general waste from the hospitals collections are arranged by the Ministry of Environment, Lands and Agricultural Development who liaises with the Local Authority to arrange collections and subsequent transport to the landfill.

There are no private contractors or other organisations that could provide healthcare waste management support services, or any service for the management for any wastes generated by the healthcare sector, nor is there capacity for this to occur in the foreseeable future.

The only role that a contractor has had is in the provision of incinerators for both Tarawa and Kiritimati, with some operator training also provided on Tarawa.

Kiritimati also indicated that they host international medical teams on a regular basis and sometimes they bring equipment that could be used for waste management – such as sharps containers and other bins.

7 Analysis of Options for Sustainable Healthcare Waste Management in Kiribati

Section 4 identifies key issues that need to be addressed in improving healthcare waste management in Kiribati. This section evaluates the potential options that could be employed to respond to these key issues.

Table 7 categorizes these key issues (A – E) against potential options that could be adopted to tackle them, as a collated list of high-level responses.

Key Issue Category	Key Issue	Options to address the issue	Issues applicable to	
			South Tarawa Tungaru Central Hospital	Kiritimati Island London Hospital
A. Waste Management Framework	There is no documented waste management plan or system in place in Kiribati and no waste management committee for both hospitals.	Establish a waste management framework including: <ul style="list-style-type: none"> Waste Management Plan Responsible officer for implementation of waste management plan Waste management committee, appropriate to the scale of each facility. 	With respect to a waste management committee and implementation of the Plan	Yes
B. Signage, Segregation & Containers	Segregation and containment practices are below minimum standard in that: <ul style="list-style-type: none"> There is no signage present (Kiritimati) The only segregation regularly practiced is for sharps. Colour coded bags (liners) and bins are not present (Kiritimati), and storage is not adequate at both hospitals. 	Improve segregation practices by: <ul style="list-style-type: none"> Supply of colour-coded waste bins and plastic liners in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. Supply of small number of colour-coded wheelie bins (where required) per hospital to act as both in-ward/department storage and internal transport trolleys. Supply of signage to explain the colour-coded segregation system as well as posters to promote it. 	Storage upgrade required	Yes
C. Training & Audit	There is no structured training or waste segregation auditing .	Development and delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and	Yes	Yes

Table 7: Options for Sustainable Healthcare Waste Management in Kiribati				
		environment agencies). This could be facilitated/ delivered by: 1. SPREP staff, or 2. International technical training providers (or a combination of both), - as no competent healthcare waste management training capability exists in Kiribati.		
D. Treatment	The method for treatment of healthcare waste in Kiritimati is typically <u>not</u> in accord with required standards. Incinerator is suitable in Tarawa but it is stretched in its capacity	Treatment using one (or a combination) of the following for each hospital: 1. Rotary kiln (highest temperature) 2. Incineration (high, medium temperature) 3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land) 4. Autoclave 5. Chemical 6. Microwave 7. Encapsulation 8. Landfill (without disinfection) 9. Onsite burial 10. Shredding	Yes	Yes
E. Occupational Health and Safety	Spill control kits were not observed anywhere.	Procurement of: • Supply spill kits	Yes	Yes

7.1 Options for (Non-Treatment) Waste Management Aspects

Those options that do not relate directly to the waste treatment process tend to have limited alternatives that can address their respective key issue, given they typically relate to the fundamentals of hazardous waste management. These are:

- The waste management (and infection control) framework, including policies, plans, procedures, responsibility for implementation and audit of the functioning of the framework (A in Table 7)
- The waste management process, from generation to transport up to the treatment location (B in Table 7)
- Training systems for sustainable healthcare waste management (C in Table 7)
- OHS related protection for waste handlers (E in Table 7)

These areas have not been subjected to an options analysis, because the minimum standards framework has clear requirements with limited variation options.

7.2 Options for Treatment of Healthcare Waste

Healthcare waste treatment (key issue category D) has a range of alternative approaches, as summarized in Table 7. These have strengths and weaknesses that need to be considered in the context of criteria such as performance and cost of the technology itself, the waste types and volumes it is required to process, the environment it would be operating in and a range of factors specific to the Pacific Islands region and in some cases an individual country's circumstances.

Treatment solutions may involve a single technology, more than one technology for sub-categories of healthcare waste or combination of the technologies listed in Table 8. These alternatives have been assessed using a two stage process:

Stage 1: High-level costs and benefits

- Cost (capital, operating, maintenance)*
- Lifespan
- Technical feasibility (advantages and disadvantages) and how that relates to the Pacific Island regional context

* Costs are estimated at a high level for relative comparison purposes. Detailed quotations, particularly for equipment purchase and associated operating and maintenance costs will be required as part of any future procurement process to be managed by SPREP.

Stage 2: Local feasibility assessment (per country)

- comparative cost to implement
- comparative effectiveness across all HCWs
- health and safety considerations
- sustainability
- institutional and policy fit
- cultural fit
- barriers to implementation
- environmental impact
- durability and
- ease of operator use.

The stage 1 treatment technology options assessment is generic to the Pacific region so is included in the *Whole of Project – Summary Report*, Appendix E. This analysis highlights the following technologies as worthy of consideration for the Kiribati's Stage 2 assessment:

1. Incineration (high temperature: $>1,000^{\circ}\text{C}$ ⁴)
2. Incineration (medium temperature: $800 - 1,000^{\circ}\text{C}$ ⁴)

⁴ As defined in *Management of Solid Health-Care Waste at Primary Health-Care Centres - A Decision-Making Guide*, WHO (2005)

3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land: 400°C⁴)
4. Autoclave
5. Encapsulation (of sharps only, in combination with a form of disinfection).

7.2.1 Waste Treatment Systems Relevant for Kiribati

The Stage 2 local feasibility assessment (for Kiribati) took these first four⁵ technologies and assessed them against the ten dot point criteria listed in 7.2. These criteria are explored qualitatively in **Appendix D**. Table 8 takes these qualitative descriptions and assigns a quantitative score from 1 – 5, to prioritise local applicability of technology options to Kiribati context, on a relative basis as follows:

1. Very low
2. Low
3. Moderate
4. High
5. Very High.

The treatment technologies suitable for Kiribati context are ranked in order of preference in Table 8:

Stage 1-Approved Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility								Total Score out of 50	Rank
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment protected	Durability	Ease of operation		
Incineration at high temperature (>1000°C)	1	5	4	4	4	4	3	3	3	3	34	1
Incineration at med. temperature (800 - 1000°C)	4	4	3	3	2	4	4	2	2	4	32	2
Autoclave with shredder	2	4	4	3	5	2	2	4	2	2	30	3
Low temperature burning (<400°C)	5	3	1	2	1	1	3	1	5	5	27	4

Notes:

- Scored on a scale of 1-5, where 1= very low; 2 = low; 3= moderate; 4 = high and 5 = very high
- Criteria given equal weighting
- Possible maximum score: 50

⁵ Encapsulation is assessed separately as its potential applicability is only for sharps that have already been treated to remove the infection risk, whereas all other technologies have a wider application and are fundamentally standalone options.

In support of Table 8's ranking:

- **High Temperature Incineration** is the promoted disinfection practice where units are modern, maintained, have sufficient waste volumes and locked in supplier maintenance and training contracts.
- **Medium Temperature Incineration** is acceptable in the medium term to remedy current unacceptable practices at sites too small to justify costs of expensive equipment.
- **Autoclaving** is an acceptable disinfection practice where units with shredder are affordable and locked in supplier maintenance and training contracts are in place.
- **Low temperature burning** is a borderline practice which can only be acceptable in the short term, in low population density environments, to remedy current unacceptable practices.

Based on the qualitative assessment in **Appendix D**, **encapsulation** ranks as an effective way to deal with the residual risk from already disinfected sharps: i.e., the risk of needle stick injury by healthcare workers or the community (waste disposal area) due to the fact that sharps are disinfected but not physically destroyed by the low-medium temperature of open burning (or non-destruction of autoclaving). Encapsulation is never recommended as an isolated form of treatment, as it does not disinfect or otherwise treat the hazard of the waste.

A substantial amount of data exists on the emissions generated from incinerators, but conversely, little studies have been conducted on all aspects of alternate technologies performance. While the literature is inconclusive on the requirements needed to effectively manage the blood and body fluid contaminated and infectious components of the waste streams, there does seem to be consensus that hazardous components such as pharmaceuticals and cytotoxic wastes do need to be treated prior to final disposal to ensure there is no risks to the environment or health of humans and other species. No publication from a government environmental or health agency, or any article reviewed advocated any other preferred form of treatment for pharmaceuticals and cytotoxic wastes than incineration. In most instances the preference for anatomical waste was also incineration.

Since the Kiribati hospitals reviewed do not currently generate cytotoxic waste these are not relevant for healthcare waste treatment choices in the Kiribati.

7.2.1 Treatment Investment Options for individual Kiribati Hospitals

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. This is occurring at Tungaru via incineration, but open burning at London Hospital is a borderline practice – it disinfects to a reasonable level but has environmental and human health impacts.

South Tarawa Tungaru Central Hospital – has a functioning relatively new MediBurn model incinerator. It is housed in a dedicated building, but this is not fully roofed and located close to hospital buildings. Even on its current 7 days per week running schedule, the incinerator appears to be not keeping pace with the volumes of waste generated, especially when Betio Hospital quantities are also considered.

Kiritimati Island London Hospital – has a non-operational wood fired incinerator. It is located in a small building some distance from the hospital. It generates relatively small quantities of

healthcare waste and there is minimal pharmaceutical waste generated. Wastes are taken to the local landfill and burnt before burial.

Table 9 determines 'intervention' options that are suggested to improve treatment of healthcare waste for Kiribati. Shading in green indicates where investment is proposed, while orange shading shows where a technology consideration is also relevant.

Table 9: Technology Options Applicable for Each Hospital in Kiribati	
Remaining Technology Options	Technology Applicability
South Tarawa Tungaru Central Hospital	
Disinfection & Encapsulation (only sharps assessed)	Not applicable as sharps are destroyed in current high temperature incineration process
Incineration at high temperature (>1000°C)	The relatively new MediBurn model incinerator is not keeping up with healthcare waste generation volumes, from both this hospital and Betio, as evidenced by the growing stockpile. It is expected that volumes will increase over time and current 'treatment' of pharmaceutical waste is not appropriate – but could be incinerated if spare capacity was available. An additional high temperature incinerator would allow Tungaru to meet current and future treatment needs.
Incineration at med. temperature (800 - 1000°C)	Not applicable to as quantities are large enough to justify a better performing larger option that runs at a higher temperature.
Autoclave with shredder	Feasibility of autoclaving doesn't rate as high as incineration in the Kiribati context.
Low temperature burning (<400°C)	Not applicable to South Tarawa as quantities of waste are large enough to justify a better performing larger option that runs at a higher temperature.
Kiritimati Island London Hospital	
Disinfection & Encapsulation (only sharps assessed)	Consider concrete encapsulation of <u>disinfected</u> sharps in a metal drum and burial at the landfill.
Incineration at high temperature (>1000°C)	Not applicable to Kiritimati as waste volumes are insufficient to justify the investment required.
Incineration at med. temperature (800 - 1000°C)	Healthcare waste generation is approximately 30kg/ week. This volume would be sufficient to consider a small medium temperature incinerator to replace the open burning practices at the landfill. Kiribati health authorities are likely to be able to sustainably afford the fuel and related operating costs of approximately \$5,000 pa.
Autoclave with shredder	Feasibility of autoclaving doesn't rate as high as incineration in the Kiribati context.
Low temperature burning (<400°C)	This is currently occurring. Because the population of Kiritimati is small and dispersed, the air quality impact from low temperature burning of healthcare waste is not a pressing issue.

Timing considerations for these options, in the context of other (non-treatment) options, is provided in the Section 8 (Recommendations).

8 Recommendations

The following section outlines recommendations and a proposed implementation plan for each recommendation to achieve sustainable management of healthcare waste in Kiribati. Further details and guidance on each recommendation are provided in **Appendix E**.

Table 10 provides a summary of the recommendations for Kiribati. A colour coding system is used to describe the degree of applicability of each recommendation to each hospital as follows:

	Fully Applicable
	Partially applicable
	Not applicable

In terms of relative priorities of the five recommendations, they are all high, based on the deficiencies addressed against the minimum standards framework. They are also highly inter-related, for example: segregation practices cannot be sustainably improved without the requirements and responsibility of the waste management framework; which in turn cannot be turned into active policies and procedures without the understanding and reinforcement that comes from training. Effective treatment and use of PPE cannot be sustained without the reinforcement of training, effective segregation and the procedures and monitoring spelled out in the waste management framework.

However, the staggered timing of actions required to implement the recommendations, as outlined for each hospital in section 8.1, and their different short, medium and long term approaches give an indication of priority of the recommendation actions themselves.

*Where a recommendation is **unique** to the circumstances of a particular hospital, because of issues identified that are **unique** to that hospital, the recommendation (and associated implementation action) is appended with the annotation ^{U2H}*

Table 10: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
Recommendation 1: Develop a Waste Management Framework					
Description	<ul style="list-style-type: none"> • A <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility. • Appoint an <i>officer responsible</i> for the development and implementation of the Healthcare Waste Management Plan • A <i>waste management committee</i>, appropriate to the scale of each facility. 				
Output	<ul style="list-style-type: none"> • An agreed <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility outlining procedures and guidelines, waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures • Accountability for healthcare waste management through clearly defined roles and responsibilities 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> • Plan approved by Ministry of Health (all facilities) • Approved budget for implementation of Healthcare Waste Management Plan • The Plan should be regularly monitored, reviewed, revised and updated. • Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies. 				
Costs (\$US)	<ul style="list-style-type: none"> • Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided • Ongoing – Low 				
Recommendation 2: Procurement of Consumables (Segregation & Storage)					
Description	<ul style="list-style-type: none"> • For London Hospital: Supply of colour-coded waste bins and plastic liners in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. • Supply of signage to explain the colour-coded segregation system as well as posters to promote it. 				
Output	<ul style="list-style-type: none"> • Adequate supply of consumables to bed down more rigorous segregation practices 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> • Wastes are segregated at their place of production. • Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. • Zero Needle Stick Injuries. 				
Costs (\$US)	<ul style="list-style-type: none"> • Establishment – Low; Ongoing - Low, sustainably funded by country 				
Recommendation 3: Provision of a Sustainable Training Program					

Table 10: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
Description	A structured waste management education/awareness program is developed and delivered to all stakeholders (including non-hospital employees)				
Output	<ul style="list-style-type: none"> Development and delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies) Improvement of personnel skills and competency in managing healthcare waste Promotion of the advantages of sustainable segregation and storage techniques for the different waste streams and an understanding of the health and safety risks resulting from the mismanagement risks of healthcare waste. 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Competency Assessments Refresher Training No/very little cross contamination between waste streams demonstrated by waste audits. 				
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Medium; Ongoing - Low 				
Recommendation 4: Procure new incinerators ^{U2H}					
Description	<ul style="list-style-type: none"> Procurement of a new high temperature incinerator for Tungaru Hospital, within existing building (but upgraded), that houses the existing incinerator, with maintenance support contract. Procurement of a new small (medium temperature) incinerator and protective structure for London Hospital, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Kiribati Ministry of Health and Medical Services) 				
Output	<ul style="list-style-type: none"> A treatment system that reduces the potential hazard posed by health-care waste, while endeavouring to protect the environment. 				
Monitoring & Evaluation Indicators	<p>Assessment of the following should be regularly undertaken for new and existing incinerators:</p> <ul style="list-style-type: none"> Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures above 800°C only) Maintenance program – are maintenance issues dealt with promptly? Ensure burn times are sufficient to reduce waste ash volumes 				
Costs (\$US)	<ul style="list-style-type: none"> Establishment – High (approx.. \$50,000 for high temperature unit (Tungaru) and \$7,000 for the small medium-temperature unit for London Hospital (including housing and commissioning costs); Ongoing – medium (fuel and maintenance) 				

Table 10: Recommendations for Kiribati		Applicable to	Tungaru Hospital	London Hospital	Kiribati Overall
Recommendation 5: Upgrade of Central Storage Facilities					
Description	Storage areas used for the consolidation of wastes prior to treatment/disposal are of a standard that avoids environmental and health related negative impacts from such issues as spills or access by unauthorized person.				
Output	<ul style="list-style-type: none"> Storage areas are secure, suitably designed and isolated from patients and the public. Storage areas have capacity to contain wastes generated under “normal” conditions as well as for contingencies 				
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Suitability of storage areas regularly assessed by ‘responsible officer’ of waste management committee. 				
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Medium; Ongoing - Low 				
Recommendation 6: Procurement of Spill Control Kits					
Description	Supply sufficient Spill Control Kits for entire hospital operations in both hospitals.				
Output	Capacity and capability (training – see Recommendation 3) to respond to any healthcare waste spills anywhere in the waste management process.				
Monitoring & Evaluation Indicators	Staff are aware of how to protect themselves and others from, and respond to, any spills of healthcare waste				
Costs (\$US)	Establishment – Low; Ongoing - Low, sustainably funded by country				

8.1 Implementation Priorities

8.1.1 Recommendation 1: Develop a Waste Management Framework

1. Develop a **Healthcare Waste Management Plan** specific to each hospital, including technical guidelines and procedures relating to waste management and if not already present, infection control.
2. Appoint an **officer responsible** for the development and implementation of the Healthcare Waste Management Plan
3. Establish a **waste management committee**, appropriate to the scale of the facility.

A **Healthcare Waste Management Plan**, specific to each healthcare facility outlining waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures should be developed as an overarching document to guide healthcare waste management processes and procedures at each healthcare facility.

A responsible officer or **waste management officer** would be responsible for the day-to-day operations and monitoring of the waste management system and is usually established as a separate post in larger hospitals (however, one appointee could be responsible for the waste management performance for a number of hospitals with a stated time fraction allocated to each hospital). It is important that the waste management officer be adequately resourced to enable them to undertake their role as well as supported by hospital management to ensure that all staff recognise the importance of adopting waste management practices that are in accord with all requirements.

8.1.1.1 Short Term (0-6 months)

- Identify existing documents and systems that may have been used in the past
- Responsible officer or healthcare waste management committee set up as part of infection control.
- Definitions of responsibilities and key accountabilities of responsible officers and Waste Management Committee developed for inclusion in Waste Management Plan.

8.1.1.2 Medium Term (6 months-1 year)

- Formulate a Draft Waste Management Plan drawing on the results of this 'Baseline Assessment' (i.e. present situation, quantities of waste generated, possibilities for waste minimization, identification of treatment options, identification and evaluation of waste-treatment and disposal options, identification and evaluation of record keeping and documentation and estimations of costs relating to waste management)
- The draft discussion document would be prepared in consultation with hospital staff, and officials from the relevant government agencies.

8.1.1.3 Long Term (1year-3 years)

- Finalise the Waste Management Framework
- Continually improve the mandatory standards of healthcare waste management

- Implement a program to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.

8.1.2 Recommendation 2: Procurement of Consumables (Segregation & Storage)

Waste should be collected in accordance with the schedules specified in the Waste Management Plan. The correct segregation of healthcare waste is the responsibility of the person who produces each waste item, whatever their position in the organisation. The healthcare facility is responsible for making sure there is a suitable segregation, transport and storage system, and that all staff adhere to the correct procedures. Labelling of waste containers is used to identify the source, record their type and quantities of waste produced in each area, and allow problems with waste segregation to be traced back to a medical area.

8.1.2.1 Short Term (0-6 months)

- Procurement of in-hospital healthcare waste management consumables including:
 - Colour coded bins and bin liners (for London Hospital only)
 - Classification and segregation signage as well as instructional posters to promote good healthcare waste management practices (both hospitals)
- Procurement plan developed to ensure the sustainable supply of healthcare waste management resources.

8.1.2.2 Medium Term (6 months-1 year)

As per short term above.

8.1.2.3 Long Term (1-3 years)

Consumables to be supplied from in-country health agency budgets.

8.1.3 Recommendation 3: Provision of a Sustainable Training Program

Development and delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies).

This could be facilitated/ delivered by SPREP staff, or outside trainers, or a combination of both, as no competent healthcare waste management training capability exists in Tonga.

Training should be coordinated with other countries' needs in the region.

All staff and contractors should attend a waste management training session. This is to be conducted during all induction programs in the first instance. For those staff and contractors currently employed on-site, they will be required to attend a dedicated training session so that they are fully aware of their roles and responsibilities in respect to waste management.

Records shall be maintained of all staff and contractors attendance at a training session to ensure that all personnel attend.

8.1.3.1 Short Term (0-6 months)

- Identify potential trainers and build training skills
- Develop a budget for long term training delivery
- Identification and prioritization of employees that need to be trained
- Defining the specific learning objectives for each target audience
- Develop a detailed curriculum specifying the training plan for each session.

8.1.3.2 Medium Term (6 months – 1 year)

- Explore incentives for training (e.g. training in collaboration with a health professional society or university that can award certificates or professional credentials)

8.1.3.3 Long Term

- Continually improve the mandatory standards of health-care waste management
- A continuing audit program be implemented to identify incorrect waste management practices and results of such audits communicated to staff in all wards/departments. Results from these audits and corrective actions to be reported to the facility waste management committee

8.1.4 Recommendation 4: Procure new incinerators ^{U2H}

- Procurement of a new **high temperature** incinerator for **Tungaru Hospital**, within existing building (but upgraded), that houses the existing incinerator, with maintenance support contract.
- Procurement of a new small **medium temperature** incinerator and protective structure for **London Hospital**, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Kiribati Ministry of Health and Medical Services)

Provision of adequate incineration capacity for Tarawa and Kiritimati is important. For Tarawa, this should focus on ensuring that there is additional capacity to process the healthcare waste that is generated from both Tungaru Central and Betio Hospitals – by providing an additional incinerator as well as a structured maintenance program.

For Kiritimati, the procurement of a new incinerator (small capacity) has been proposed as an appropriate treatment and disposal methodology.

8.1.4.1 Tungaru Hospital

(a) Short Term (0-6 months)

The existing MediBurn incinerator has insufficient capacity to treat all healthcare waste, accumulating a sizeable stockpile which continues to grow. It is recommended to:

- *Start the process of procurement of a new incinerator* – a MediBurn 30 model (for example) has a manufacturer's throughput of 30 kg/batch of healthcare waste. At

Tungaru's estimated rate of 400 kg healthcare waste per week (which includes Betio Hospital waste) this unit in combination with the existing MediBurn 20 can manage current and likely future needs. As well as provide contingency for breakdowns.

(b) Medium Term (6 months-1 year)

- Procure and commission new incinerator, with supplier support and maintenance contract.
- Dispose of ash at Landfill.

(c) Long Term (1-3 years)

- Ongoing incineration system maintenance support
- Recording of waste treatment quantities and operating conditions (e.g. burn temperatures per batch)
- Maintain training of operators as required
- Recording of waste treatment quantities and operating conditions (e.g. burn temperatures per batch)
- Maintain training of operators as required

8.1.4.2 London Hospital

(a) Short Term (0-6 months)

- Burn sharps separately at landfill to disinfect, followed by concrete encapsulation in a metal drum. The drum could then be buried at the landfill.
- Burn healthcare waste separately, followed by burial at the dump (separate burning is suggested as only the sharps need to be encapsulated).
-

(b) Medium Term (6 months-1 year)

- Budget withstanding, *start the process of procurement of a new incinerator* – a small unit is sufficient since London Hospital only generates approximately 22kg of healthcare waste per week. This is likely to be a small, single chamber, medium temperature incinerator. Key considerations with such a purchase are: capacity, purchase cost, operating costs, ease of operation, durability and life span.
- This procurement should only be pursued if agreement is reached with the Kiribati Ministry of Health and Medical Services to meet the ongoing costs of approx. \$5,000 USD per year in incinerator operating expenses.
- Another critical aspect to purchase of incinerators in the Kiribati situation is the inclusion of a supplier support and maintenance contract.
- Procure, install and commission new incinerator, with supplier support and maintenance contract.

(c) Long Term (1-3 years)

- Recording of waste treatment quantities and operating conditions (e.g. burn temperatures per batch)
- Maintain training of operators as required.

8.1.5 Recommendation 5: Upgrade of Central Storage Facilities

Storage areas for healthcare waste should be designated within the healthcare facility. Storage facilities should be labelled in accordance with the hazard level of the stored waste and should be designed to prevent the risk of infection risk and environmental harm. Spill Kits for healthcare and cytotoxic waste should also be located in the storage areas.

8.1.5.1 Short Term (0-6 months)

- Upgrade central storage areas to meet minimum standards outlined in **Appendix D** to eliminate the risk of ongoing public risk and environmental harm.

8.1.5.2 Medium Term (6 months – 1 year)

- Procure spill kits for each central storage area

8.1.5.3 Long Term

- Implement an ongoing healthcare waste facilities audit program to monitor the condition of central storage areas

8.1.6 Recommendation 7: Procurement of Spill Kits for both hospitals

Supply sufficient Spill Control Kits for entire hospital operations at both Tungaru and London.

8.1.6.1 Short Term (0-6 months)

- Procurement of sufficient Spill Control Kits for entire hospital operations in both hospitals.

8.1.6.2 Medium Term (6 months-1 year)

- A system is set up to monitor all spills and record response actions and any learnings from these incidents.

8.1.6.3 Long Term (1-3 years)

Nil.

Appendix A

Photo Log



Photo 1: This illustrates one healthcare waste container that has a significant percentage of “non-healthcare waste” at Tungaru Hospital. This was a common theme with most healthcare waste containers.
Photo taken on the 17/04/2014 by Trevor Thornton



Photo 2: The type of sharps containers in use at Tungaru Hospital. These were observed in most wards/departments.
Photo taken on the 17/04/2014 by Trevor Thornton



Photo 3: Signage on the walls was located in most wards at Tungaru Hospital. In addition, the types of bins illustrated were also common in the wards. Photo taken on the 17/04/2014 by Trevor Thornton



Photo 4: This illustrates the area surrounding the operational incinerator building at Tungaru Hospital. Waste is located on the ground. Photo taken on the 17/04/2014 by Trevor Thornton



Photo 5: Figure 5: This is the operational incinerator at Tungaru Hospital.
Photo taken on the 17/04/2014 by Trevor Thornton



Photo 6: The brick building on the left of the photo contains the incinerator at Tungaru Hospital. Note that close proximity to the hospital buildings located on the right of the photo. Given the incinerator stack is quite small, emissions would potentially enter these buildings. Photo taken on the 17/04/2014 by Trevor Thornton



Photo 7: This illustrates both the incinerator that is not operational and the stockpile of waste and ash in the building housing it at Tungaru Hospital. Photo taken on the 17/04/2014 by Trevor Thornton



Photo 8: This is the incinerator facility located at Kiritimati.
Photo taken on the 16/04/2014 by Trevor Thornton



Photo 9: This shows the landfill at Kiritimati. Note that waste are simply deposited onto the ground and burnt (the burnt waste is visible in the background). The yellow containers in the middle of the photo are sharps containers. Photo taken on the 16/04/2014 by Trevor Thornton

Appendix B

Collected Data from Hospitals in Kiribati

HOSPITAL DETAILS	Region		Tarawa		Kiritimati	
	Facility Name & Contact Information	Hospital Name	Tungaru Central Hospital		London Hospital	
		Contact Name & Position	Tebikau Noran Acting Chief Health Inspector		Dr Teraira Officer in Charge Kiritimati Hospital	
		Email	tnoran@gmail.com			
		Phone				
	Key Services Data	Summary of Services Provided	Outpatients, X-ray, Pharmacy, Dental, Maternity, Pathology, Operating Theatre, Rehab		In patient, emergency, maternity, dental, x-ray and laboratory	
		Pop Served	50,000		6,000	
		No. of Beds	200		8 general, 10 maternity	
		OBD's ¹	110%		100%	
		No. Operations	1 theatre - no numbers		1-2 per month (more when visiting doctors on island)	
No. of Births ²		4450		240-360 per annum		
Emergency Patients Attended ²		560		No data		
Out-Patients Attended ²		150/daily		40-50 per month		
No of Staff		53		Approximately 30		
WASTE MANAGEMENT PROCESS	Waste Steams Managed	Estimates	Volumes (kg/wk)	Cost ext. (\$US)	Volumes (kg/wk)	Cost ext. (\$US)
		Healthcare Waste	260	Not calculated	20	Not calculated
		Sharps	Not measured	Not calculated	2	Not calculated
		Pharmaceutical	Not measured	Not calculated	0	Not calculated
		Cytotoxic	Not measured	Not calculated	0	Not calculated
		General	Not measured	Not calculated	30	Not calculated
		Recycling	Not measured	Not calculated	Nil recycled	Not calculated
		TOTAL		\$ -	52	\$ -
		Generation & Segregation	Dedicated Containers/ Bags	N		N
	Colour Coding		N		N	
	Sharps segregated & secure		N		Y	
	Signage Present		Y		N	
	Internal Handling	Degree of manual handling of bags	High		High	
		Internal Transport Mode	Trolley		Trolley	
		Spill Kit Present	N		N	
	Storage	Dedicated & Appropriate Area	Y		N	
		Loading/unloading acceptable	Y		N	

		Spill Kits Present	Y		N	
		Monitoring & record keeping occurs	N		N	
	Treatment	Treatment per Waste Stream	Tech. Type	Int/Ext	Tech. Type	Int/Ext
		Healthcare Waste	Burn on site	Internal	Burn off site	External
		Sharps	Burn on site	Internal	Burn on site	Internal
		Pharmaceutical	Landfill (without treatment)	External	Landfill (without treatment)	External
		Cytotoxic	Landfill (without treatment)	Internal		
		General	Landfill (without treatment)	External	Landfill (without treatment)	Internal
		If incinerator present				
		Make, Model, Year commissioned	Mediburn, March 2013		No known – wood fired	
		Operating Temp (°C)	1,000°C		not able to be measured	
		No. chambers	2		1	
		Condition	Reasonable		Broken down	
			Per week	Per year	Per week	Per year
		Waste Throughput (tonnes)	0.4	21	-	-
		Operating Hours (hr)	7 days per week (4 hours Sunday)		Not in use	
		Fuel	Diesel		Wood	
		Fuel use (kg/litres)	60 litres/3 weeks	1,040	-	-
		Fuel use per kg waste burnt	Not known		Not known	
		Technology siting and operation issues	Too much waste for loads to be burnt efficiently and located too close to the hospital		Sited away from the hospital grounds	
Offsite transport assessment	Poor		Fair			
WASTE MANAGEMENT FRAMEWORK	Waste Management Documents	Waste Management Policy	N		N	
		Waste Management Plan	N		N	
		Waste Management Procedure	N		N	
		Waste Management Committee	N		N	
Infection Control	Infection Control Policy	Y		Y		
	Infection Control Procedures	Y		Y		
Auditing and Record Keeping	Audit Program	N		N		
	What is audited	Segregation	N	Segregation	N	
		Compliance P&P	N	Compliance P&P	N	
		Int. transport	N	Int. transport	N	
		Storage	N	Storage	N	
		Treatment/ disposal	N	Treatment/ disposal	N	
Frequency						
Training	Training Program	N		N		
	Curricula	Infection Control	N	Infection Control	N	
		Waste Mgt	N	Waste Mgt	N	
		PPE	N	PPE	N	
		Treat. Tech operation	N	Treat. Tech operation	N	
Records of who has been trained	N		N			

		Monitoring or refresher courses	N		N	
PROJECTED ISSUES	Forecasting	10 year projections for waste management	None provided		Possible building a new hospital - 30 to 40 beds	
		Barriers to change	Resources for training and enforcement		Small volume of generation and resources (eg., fuel) for alternate management systems	
		Other issues				
LOCAL CONTRACTORS		Potential in-country contractors	Who	Key Capability	Who	Key Capability
			None		None	

¹ Occupied Bed Days (previous 12 months) annual average occupancy rate (as %)
² Previous 12 months

Appendix C
Minimum Standards Assessment

Scale	Category	Item	Minimum Standard Criterion	Tungaru Hospital	London Hospital
National Authority	National Legislation	Definitions	A clear definition of hazardous health-care wastes and its various categories has been developed and used by generators.		
National Authority	National Legislation	Annual Compliance Reporting	Hospitals required to annually report on waste generation and management		
	National Legislation	Technical Guidelines	Practical and directly applicable technical guidelines		
National Authority	Regulations	Annual Compliance Reporting			
National Authority	Policy	National health-care waste management plan	A national strategy for management of healthcare waste has been published and is up to date (ie., within 5 years) and hospitals required to adhere to its requirements		
Healthcare Facility	Policy	Infection Control	Infection control policy incorporates principles of waste management within it		
Healthcare Facility	Policy	Waste Management Plan	Has been developed by the hospital and is based on a review of healthcare waste management and is current (within 5 years)		
Healthcare Facility	Responsible Person		An officer has been appointed to assume responsibility for waste management within the hospital, and has been allocated sufficient time and resources - this person could have waste management as part of other duties		
Healthcare Facility	Management Committee		A waste management committee has been formed that has representatives from a broad range of departments and meets at least twice per year. A clear set of objectives has been developed for this committee. It reports to the senior management of the hospital.		
Healthcare Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types		
Healthcare Facility	Segregation		Waste are correctly segregated in all wards/departments with use of containers that are colour coded for the different waste types		

Healthcare Facility	Containers		All areas have dedicated waste containers are suitable for the types of waste generated. All waste containers are colour coded and have correct wording on them. Sharps are deposited into containers that reduce potential for needle-stick injury		
Healthcare Facility	Storage	Interim storage in healthcare facility	Storage areas at ward/department level should be secure and located away from public areas. Storage areas should be sufficient in size to allow waste to be segregated and so as to avoid waste of different classifications being stored together.		
		Storage before treatment	Meets the standards stated in Appendix E, Recommendation 2, <i>Correct Storage</i> .		
Healthcare Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.		
	Internal Handling	Routing	Healthcare waste is not transported where clean linen and/or food are transported		
Healthcare Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure		
Healthcare Facility	Training	Curricula	A structured waste management training program has been developed that targets the different roles within the hospitals.		
Healthcare Facility	Training	Follow-up & refresher courses	All staff receive waste management education during induction. All staff receive refresher training annually. Waste management training is delivered following an adverse incident to the relevant staff/ward/department.		
Healthcare Facility	Training	Training responsibility	A hospital officer has responsibility for ensuring all training occurs as required and that records are maintained of all training and attendance.		
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.		
Healthcare Facility	Transport - External		A dedicated vehicle is used to transport untreated healthcare waste. This load carrying area of the vehicle is enclosed and constructed so that any spilt material is contained within this area. A split kit is provided.		

Healthcare Facility	Treatment	Suitability of treatment for healthcare waste	The method for treating healthcare waste is in accord with required standards - this includes operating parameters and location of the treatment unit.		
Healthcare Facility	Economics	Cost Effectiveness	A process has been developed that cost all aspects of waste management and these costs are reported annually to the waste management committee.		
Healthcare Facility	Occupational Health and Safety	PPE	All waste handlers are provided with and use appropriate PPE including overalls/protective clothing, gloves and eye protection. Incinerator staff are provided with additional PPE such as face masks and noise protection. A system is in place to monitor correct use of PPE.		
Healthcare Facility	Occupational Health and Safety	Staff risk	Waste containers, locations, storage and management procedures for healthcare waste incorporate identified risks to staff in accessing the waste and/or having needle-stick injuries.		
Healthcare Facility	Occupational Health and Safety	Patient/Visitor risk	Waste containers, locations, storage and management procedures for healthcare waste incorporate identified risks to patients and visitors in accessing the waste and/or having needle-stick injuries.		
Healthcare Facility	Healthcare waste management emergencies	Spill Prevention and Control	Spill kits are provided or all types of healthcare waste in all wards/departments, storage areas and on trolleys and vehicles. Staff are trained on the use of spill kits. All incidents of spills of healthcare waste are investigated and where appropriate remedial actions implemented.		
Healthcare Facility	Future Planning	Planning for change	Hospitals have developed a process to benchmark waste generation so as to (amongst other requirements), plan of future hospital development in terms of services and numbers of patients.		
Local Council	Waste Treatment Facility	Landfill	Healthcare waste is disposed of at a dedicated location and covered immediately on arrival. Scavengers cannot access untreated healthcare waste.		

* The minimum standard is drawn from the *Industry code of practice for the management of biohazardous waste (including clinical and related) wastes*, Waste Management Association of Australia (2014), Draft 7th edition, taking into account the Pacific Island hospital and environmental context

Appendix D

Qualitative Local Feasibility Assessment – Treatment Technology

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
Incineration at high temperature (>1000°C)	\$211,460 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Most effective – can treat all waste types and achieves complete sterilization, complete combustion and destroys waste	Some issues for operators (requires training & PPE); some potential issues for community (potential for smoke, some controlled emissions)	Equipment lifespan ~ 10 years plus; sustainability dependant on maintaining operator skills plus proper operation and maintenance	No legal barriers to incineration; loses a point for potential for smoke nuisance and the potential for minor contribution to combustion derived POPs – Kiribati is a party to Stockholm	Incinerators are currently used in hospitals there	Equipment breakdown and lack of local skills to maintain equipment – barrier can be managed through skills training & supplier support	Emissions of air pollutants and leaching from ash disposal to receiving environment are potential impacts. High temperature operation minimises pollution and proper landfilling of ash contains leaching.	Equipment lifespan ~ 10 years plus but will only last if maintained. High temperature equipment is prone to require a moderate level of maintenance	Requires skilled operators but modern equipment combined with training simplify operation
Incineration at med. temperature (800 - 1000°C)	\$69,820 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Can treat all waste types, achieves complete sterilization, incomplete combustion, may not destroy needles	Some issues for operators (requires training & PPE); potential issues for community (smoke, emissions not	Equipment lifespan ~ 5 years; sustainability dependant on maintaining operator skills plus proper operation and maintenance	No legal barriers to incineration; potential for smoke nuisance is med - high and the potential for contribution to	Incinerators are currently used in hospitals there	Equipment breakdown and lack of local skills to maintain equipment – barrier can be managed through skills training & supplier support. Simpler	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment are potential impacts. Med. temperature	Equipment lifespan typically less ~ 5 years but will only last if maintained. Equipment is prone to require a moderate	Requires less skilled operators than high temperature equipment - training simplifies operation

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
			fully controlled)		combustion derived POPs & other pollutants is high – Kiribati is a party to Stockholm		infrastructure.	operation increases risks of air pollution, but likely to only be an option in isolated small communities.	level of maintenance	
Low temperature burning (<400°C)	\$6,485 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Not applicable for all waste types, relatively high disinfection efficiency, incomplete combustion, will not destroy needles	Some issues for operators (requires training & PPE); issues for community (smoke, emissions not controlled at all)	No equipment; sustainability dependant on government & community acceptance which would be expected to decline with time	Potential for smoke nuisance is very high and the potential for contribution to combustion derived POPs & broader range of other pollutants is very high.	Landfilling waste commonly accepted. Likely community concern if healthcare waste was burned in an open situation	No equipment operation reliability barrier; however expect community/ barrier.	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment. Low temp operation provides no controls on air pollution. Risk of fire impact.	Simple, zero technology so there is nothing that can break down and no specific training is required other than health and safety.	Simple, zero technology so there is nothing that can break down
Autoclave with shredder	\$158,000 USD over 10 years (ref Whole of Project – Summary	Cannot treat all waste types, achieves complete	Some issues for operators (requires training & PPE); small	Equipment lifespan ~ 10 years; sustainability dependant on	No legal barriers; no potential for smoke nuisance;	Not familiar with use of sterilisers for waste – potential	Equipment breakdown and lack of local skills to maintain equipment –	No emissions of air pollutants/ smoke; some potential for odour impacts;	Equipment will only last if maintained. Adding shredder to	Requires skilled operators to achieve best level of

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
	Report, Appendix E)	sterilization when correctly operated, no combustion required, shredder destroys needles	potential for odours and wastewater discharge (community)	maintaining operator skills plus longevity of equipment use given technology complexity	some potential for odour nuisance; no air pollution (no combustion-POPs) and some potential for waste water management issues	community issue with waste appearance if steriliser not operated correctly or shredder not used	barrier can be managed through skills training & supplier support. Increased complexity of equipment (compared to incineration) increases barrier	still requires landfill or dump disposal of residue so some potential for leaching on burial. Some potential for waste water management issues	autoclave technology increases mechanical parts that can go wrong. May require moderate level of maintenance	disinfection.
Encapsulation (only post-disinfection sharps assessed)	Virtually zero additional cost to disinfection system costs	Not applicable to non-sharps waste. In the context of pre-sterilised sharps only: no combustion required and completely removes downstream needle injury	Encapsulation has handling issues for operators (requires training & PPE) and no community issues	No equipment; sustainability dependant burial space available. Quantities are very small in Kiribati.	No legal barriers; no smoke nuisance; no odour nuisance; no air pollution and some potential for leachate to groundwater, although limited	No particular cultural fit concerns – volumes very small in Kiribati Island	Kiritimati currently burns sharps in open pit so they are sterilised but not destroyed. May have short term value.	Encapsulation itself poses no smoke nuisance; no odour nuisance; no air pollution and some potential for leachate to groundwater, although limited inherent hazard	Highly durable due to its simplicity.	Simple procedure once operator understands and manages the risk of sharps handling and knows how to mix cement

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
		risk			inherent hazard					correctly.

Legend: Descriptions equate to the following scores:

	1. very low agreement with feasibility criteria
	2. low agreement with feasibility criteria
	3. moderate agreement with feasibility criteria
	4. high agreement with feasibility criteria
	5. very high agreement with feasibility criteria

Appendix E

Recommendations Guidelines

Recommendation 1: Develop a Waste Management Framework**Healthcare Waste Management Plan**

Hospital waste management plans should incorporate strategic objectives of the national medical waste management strategy as well as the following information:

- Location and organisation of collection and storage facilities
- Overview of the purpose of, and design specifications:
 - Drawing showing the type of waste container to be used in the wards and departments (eg., sizes, colours and wording)
 - Drawing illustrating the type of trolley or wheeled container to be used for bag collection
 - Minimum specifications of sharps containers
- Required Material and human resources
- Responsibilities:
 - Including definitions of responsibilities, duties and codes of practice for each of the different categories of personnel of the hospital who, through their daily work, will generate waste and be involved in the segregation, storage and handling of the waste.
 - Definitions of responsibilities of hospital attendants and ancillary staff in collecting and handling wastes, for each ward and department.
- Procedures and practices
- Training
 - Description of the training courses and programs to be set up and the personnel who should participate in each.
- Implementation Strategy

It is important that it also is compatible with any National Waste Management Strategies to ensure consistency of approaches such as with external transport and disposal of treated residues.

Appointment of a Responsible Officer

A responsible officer or waste management officer would be responsible for the day-to-day operations and monitoring of the waste-management system and is usually established as a separate post in larger hospitals (however, one appointee could be responsible for the waste management performance for a number of hospitals with a stated time fraction allocated to each hospital).

It is important that the waste management officer be adequately resourced to enable them to undertake their role as well as supported by Hospital management to ensure that all staff

recognise the importance of adopting waste management practices that are in accord with all requirements.

Appointment of a Waste Management Committee

A waste management committee should also be established to provide guidance and support to the waste management officer and assist in implementation of developed actions. In larger hospitals, a separate waste management committee should be formed. For smaller hospitals, such a committee could be either part of the responsibility of another related committee (eg., infection control or quality assurance), or a sub-committee reporting back to this related committee.

This Committee should not necessarily undertake all activities themselves, but by the nature of the members and the professions/departments represented will ensure that there is a balanced approach to the investigations and analysis to ensure that patient and staff safety will not be compromised.

In addition, the Committee approach will enable advocates for such factors as environmental and economic performance to be heard in a balanced manner.

Waste Management Committee Members should serve for a minimum period of 2 years, with the option of reappointment.

The Waste Management Committee will work with hospital staff, stakeholders and the wider community to develop a culture of environmentally responsible waste management through information sharing and education.

Its members will ensure that waste management issues are considered on committees that deal with product evaluation, infection control and occupational health and safety, and in user groups such as Unit/Department Managers.

The Waste Management Committee should:

- Develop a waste management policy that meets current environmental legislation “due diligence” requirements. This policy is to include strategic directions for correct waste minimisation and management.
- Ensure that the hospital is meeting due-diligence requirements as specified by the Waste Management Team.
- Develop and implement a system to document waste and recyclable quantities on a spreadsheet to evaluate these quantities and therefore the waste minimisation programs that have been implemented, ensuring the results are circulated to all Unit managers/department managers on a regular basis.
- Review and submit subsequent reporting to Unit managers/department managers of the results of all implemented programs and trials.
- Work on implementing the most appropriate waste minimisation/management recommendations as agreed with hospital management and the Waste Management Team.

- Target in order the waste items that are contributing the most significant quantities of waste being generated and in particular waste segregation methods.
- Agree on the Waste Reduction targets for the hospital and outline the key objectives of the committee
- Review current work and waste management practices and develop waste management/minimisation initiatives.
- Conduct mini audits to review progress.
- Visually inspect waste and recycling containers to ascertain if staff are depositing appropriate items into them.

Recommendation 2: Procurement of Consumables (Segregation & Storage)

The correct segregation of healthcare waste is the responsibility of the person who produces each waste item, regardless of their position in the organisation. The healthcare facility is responsible for making sure there is a suitable segregation, transport and storage system, and that all staff adheres to the correct procedures.

Ideally, the same system of segregation should be in force throughout a country, and many countries have national legislation that prescribes the waste segregation categories to be used and a system of colour coding for waste containers. Colour coding makes it easier for medical staff and hospital workers to put waste items into the correct container, and to maintain segregation of the wastes during transport, storage, treatment and disposal. Colour coding also provides visual identification of the potential risk posed by the waste in that container.

Labelling of waste containers is used to identify the source, record they type and quantities of waste produces in each area, and allow problems with waste segregation to be traced back to a medical area.

Waste containers specification and siting

Containers should have well-fitting lids, either removable by hand or preferably operated by a foot pedal. Both the containers and the bags should be of the correct colour for the waste they are intended to receive and labelled clearly.

All containers should be able to adequately contain the wastes deposited into it – to prevent the possibility of spills.

Sharps should be collected in puncture proof and impermeable containers that are difficult to open after closure.

The appropriate waste receptacle (bags, bins, sharps containers) should be available to staff in each medical and other waste-producing area in a healthcare facility. This permits staff to segregate and dispose of waste at the point of generation, and reduces the need for staff to carry waste through a medical area. Posters showing the type of waste that should be disposed of in each container should be displayed on the walls to guide staff and reinforce good habits.

Segregation success can be improved by making sure that the containers are large enough for the quantities of waste generated at the location during the period between collections, as well as a collection frequency that ensures no container is overfilled.

Setting and Maintaining Segregation Standards

Segregation requirements and methods should be clearly set out in the waste-management policy of a healthcare facility. It is important that the waste-management policy is supported and enforced by senior staff and managers. Managers and medical supervisors should know the relevant legislation and understand how to implement waste audits.

The 'Responsible Person' or Waste Management Committee should be responsible for seeing that segregation rules are enforced and waste audits are carried out to quantify the amount of waste produced.

Correct Signage

Signage indicating correct waste segregation practices is a valuable tool to provide ongoing guidance to staff. The success of the waste/recycling system will depend on having a clearly identified container for each type of material. This is achieved by the use of colour coded containers, symbols and wording. In addition, signage must be placed so that those wanting to dispose of materials can clearly and readily identify which container to deposit such materials into.

Once designed, signs should be located on walls above all waste containers as well as on the container itself.

Correct Storage

The storage area should be signposted with the bio-hazard symbol and other labelling appropriate to the types of waste stored in the area (eg healthcare) and includes the following:

- The base should be an impervious surface (eg. concrete) surrounded by a bund appropriate to contain any spill.
- All loading/ unloading takes place within the bunded area in such a manner to ensure any spills are appropriately managed.
- The base and walls of bunded areas are free of gaps or cracks.
- No liquid waste, wash down waters or stormwater contaminated with biohazardous wastes are disposed of via the stormwater drainage system; and
- The bunded area drains to a sump or sewer to collect spills and wash waters. Cut-off drains, which drain to a sump, should be used instead of bunds if approved by the relevant authority.
- Loading/ unloading of waste is carried out in accordance with designated safe procedures, and relevant records are completed and maintained.
- Containers in which biohazardous waste are stored secured when loading/unloading is not taking place.

- Spill Kits for biohazardous waste located in the storage areas.

Storage for larger generators may involve a dedicated room that is constructed specifically for waste management, or could be via the use of appropriately sized mobile garbage bins (eg., 240 or 660 litre).

Conditions related to security of healthcare waste include the following:

- (a) The operator shall ensure that loading/ unloading of waste is carried out in accordance with designated safe procedures, and relevant records are completed and maintained.
- (b) Containers in which healthcare waste are stored shall be secured when loading/unloading is not taking place.

Spill Kits for healthcare and cytotoxic waste shall be located in the storage areas.

Personnel Protective Equipment

The use of Personal Protective Equipment (PPE) should be a condition of employment for employees with waste management responsibilities. PPE is one aspect of a multifaceted program, designed to protect employees from injuries and unnecessary exposure to hazardous substances.

Other aspects of this program are:

- employee training
- engineering controls to reduce or eliminate known hazards
- administrative controls

The following is a list of the personal protective equipment that should as a minimum to be supplied for all waste handlers:

- Gloves
- Masks
- Safety glasses/eye shields
- Overalls/aprons
- Safety boots

Recommendation 3: Provide a Sustainable Training Program

All waste management strategies (particularly resource management programs), rely on all staff to participate and co-operate in order to ensure that objectives are met. Staff therefore should receive appropriate training/education to understand the inherent hazard and risks posed of healthcare waste, and the importance of its management from generation to final treatment and disposal.

The Waste Management Committee (apart from ensuring staff education programs are developed and implemented), should also address other methodologies in order to ensure that staff receive information on waste reduction programs (eg., signage, information sheets and flow charts).

One of the initial steps for developing a structured training program is to gain management support from hospital administration. The development of a training program can be facilitated by establishing core competencies related to healthcare waste management.

In the development of a training program, the following should be considered:

- Conduct of a training needs analysis
- Identification and prioritisation of employees that need to be trained.
- Defining the specific learning objectives for each target audience.
- Develop a detailed curriculum specifying the training plan for each session.
- Incorporate pre-evaluation and post evaluation of learners, evaluation of trainers, follow-up activities, and documentation into the training program.
- Develop training content or adapt available training materials, tailor training content to specific target audiences.
- Identify potential trainers and build training skills
- Develop a budget and secure funding
- Explore incentives for training (e.g. training in collaboration with a health professional society or university that can award certificates or professional credentials)

The following is an outline of a Staff Waste Management Education Program that could be developed:

- Introduction to the session
- Importance of good waste/environment management/ infection control
- Waste management hierarchy
- Waste minimisation principles
- Brief overview of legislation pertaining to waste management
- Hospital policies on environment/waste management/ infection control/ needle stick injuries

- Overview of waste types
- Issues relating to waste reduction
- Management responsibilities
- Identification of, and hazards associated with the different types of wastes generated
Importance of effective waste segregation
- Infection control and sharps management
- Waste, handling, packaging and disposal routes for the different types of wastes generated
- Questions

All staff and contractors should attend a waste management training session. This should be conducted during all induction programs in the first instance.

For those staff and contractors currently employed on-site, they should attend a dedicated training session so that they are fully aware of their roles and responsibilities in respect to waste management. Records should be maintained of all staff and contractors attendance at a training session to ensure that all personnel attend.

At a national and regional level, training programs could be in the form of train the trainer. The training of trainers approach allows rapid capacity building and widespread training outreach.

Training of Waste Disposal Treatment Operators

Incinerator/ healthcare waste treatment system operators should receive training in the following:

- Overview of healthcare waste management including risks and management approaches
- General functioning of the incinerator, including basic maintenance and repair training.
- Health, safety and environmental implications of treatment operations
- PPE, its correct use and removal and cleaning (if appropriate)
- Technical procedures for operation of the plant.
- Recognition of abnormal or unusual conditions
- Emergency response, in case of equipment failures.
- Maintenance of the facility and record keeping
- Surveillance of the quality of ash and emissions.
- Disposal of residues

Recommendation 4: Improved Treatment Infrastructure

The healthcare waste stream is diverse in that it contains a variety of chemical substances, organic materials, plastics, metals and materials that are potentially contaminated with

pathogenic substances. The primary aim of treating this waste stream is to ensure that there is no potential negative impact to human health or the environment as a consequence of the components of this waste not being treated adequately.

This means that the treatment process should render the waste material so that there are no pathogens likely to cause harm as well as be conducted in a manner that reduces any environmental consequences.

There are a number of treatment processes for healthcare waste. However, not all of these are able to treat all types of healthcare wastes. Materials such as pharmaceuticals, cytotoxic and anatomical wastes can only currently be treated by incineration. Therefore, when selecting a process to treat healthcare wastes, the generator must be aware of the capabilities and limitations of each of the various treatment processes and ensure that only those wastes that can be thus treated are actually sent to such a facility, and the remainder sent to an incineration facility. This is part of any facilities due diligence process.

There are a number of means of treating healthcare waste that are in commercial use around the globe. The question arises as to what type of technology is best suited to meet the various waste categories/quantities generated, environmental requirements and that treatment is done safely and in a cost-effective manner. Treatment of healthcare wastes should achieve a change in the wastes biological or chemical hazard so as to reduce or eliminate its potential to cause disease or other adverse consequences, by meeting acceptable biological standards and to ensure that there is minimal adverse environmental impact in respect to water, soil, air and noise.

Management of wastes should be based on the **precautionary principle** in that a lack of data should not mean that options be undertaken when there is still a perceivable risk of damage (to human health or the environment). The literature and other sources of information have clearly demonstrated a need for maintaining incineration as the most preferred option for at least the treatment of pharmaceutical and cytotoxic wastes – if not other components such as microbiological specimens and body parts. Only one technology has been demonstrated to be able to effectively treat all categories of healthcare waste. This technology is incineration (at high temperature, with sufficient residence time and appropriate air pollution control equipment).

A substantial amount of data exists on the emission generated from incinerators, but conversely, little studies have been conducted on all aspects of alternate technologies performance. While the literature is inconclusive on the requirements needed to effectively manage the blood and body fluid contaminated and infectious components of the waste streams, there does seem to be consensus that these hazardous components such as pharmaceuticals and cytotoxic wastes do need to be treated prior to final disposal to ensure there is no risks to the environment or health of humans and other species.

It is also very clear that there is little work been undertaken on the consequences of landfilling untreated healthcare waste, and in particular pharmaceuticals and cytotoxic wastes. The literature does relate to impacts resulting from untreated pharmaceuticals being discharged into the environment from hospital sewers and wastewater treatment plants and

does indicate that there are potential negative environmental and health consequences. The implications of these studies could legitimately be applied to discharge of waters such as leachate or surface water runoff from landfills should these wastes be deposited untreated. According to the World Health Organization^{6, 7}, incineration is the preferred method for treating pharmaceutical and cytotoxic wastes. This is further supported by the United Nations^{8, 9} in that they have also recommended incineration as the preferred method for treatment prior to disposal of pharmaceuticals and cytotoxic wastes. These recommendations are generally standard throughout the world in relation to these two specific waste types^{10, 11}.

There are other studies that have been conducted on what is referred to as “alternate treatment technologies”, and these have demonstrated that all of these technologies cannot effectively treat pharmaceutical and cytotoxic waste, with many also unable to treat anatomical waste. Some jurisdictions do allow alternative means of treating anatomical waste prior to disposal to landfill, but these are by far in the minority and mostly related to ethical or religious rationales.

In Australia as an example where there is allowed a variety of treatment technologies for the range of clinical and related wastes, without exception, jurisdictions do not allow treatment other than incineration for anatomical waste, pharmaceuticals and cytotoxic wastes^{12, 13, 14, 15, 16, 17}. This is also quite evident in a review of Australian State/Territory environmental agency licence conditions for approved clinical and related waste treatment technologies. In countries that do allow landfilling of clinical and related wastes, often these two specific waste categories are specifically excluded from this option¹⁸.

In summary, no publication from a government environmental or health agency, or any article reviewed advocated any other preferred form of treatment for pharmaceuticals and cytotoxic wastes than incineration. In most instances the preference for anatomical waste was also incineration.

⁶ World Health Organization Regional Office for Europe, EURO Reports and Studies 97, Management of Wastes from Hospitals and other Health Care Establishments, 1983.

⁷ World Health Organization, Safe management of Wastes from healthcare Facilities, Geneva, 1999.

⁸ United Nations Environment Programme – Technical Working Group on the Basel Convention, Draft Technical Guidelines on Biomedical and Health Care Wastes, 1999.

⁹ Environment Australia, Basel Convention – Draft Technical Guidelines on Hazardous Waste: Clinical and Related Waste (Y1), March 1998.

¹⁰ Health care Without Harm, Non-Incineration Treatment Technologies, August 2001.

¹¹ London Waste Regulation Authority, Guidelines for the Segregation, Handling, Transport and Disposal of Clinical Waste, 2nd Edition, 1994.

¹² National Health & Medical Research Council, National Guidelines for Waste Management in the Health Industry, Commonwealth of Australia, 1999.

¹³ EPA Victoria, Draft Guidelines for the Management of Clinical and Related Waste, July 2003.

¹⁴ NSW Department of Health, Waste Management Guidelines for Health care Facilities, August 1998.

¹⁵ Queensland Government, Environmental Protection (Waste Management) Regulation, 2000.

¹⁶ Australian/New Zealand Standard 3816:1998, Management of Clinical and Related Wastes.

¹⁷ Australian and New Zealand Clinical Waste Management Industry Group, Industry Code of Practice for the Management of Clinical and Related Wastes, 3rd edition July 2000.

¹⁸ Provincial Government of Gauteng (South Africa), Draft Health Care Waste Regulations, 11 September 2003.