



## **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

### **Cook Islands**

Prepared for:  
**Secretariat of the Pacific Regional  
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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 10<sup>th</sup> 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 the Cook Islands.

### *Current Healthcare Waste Management in the Cook Islands*

The Ministry of Health operates health care facilities in the Cook Islands, and there are some private clinics, but no private hospital facilities. 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:

- Rarotonga General Hospital, Rarotonga – 4/04/2014
- Aitutaki District Hospital, Aitutaki – 8/4/2014

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.

<b>Table ES1: HEALTHCARE WASTE – KEY ISSUES FOR THE COOK ISLANDS</b>						
Scale	Category	Item	Minimum Standard Criterion	Rarotonga General Hospital	Aitutaki District Hospital	Cook Islands - 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	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**

Rarotonga General Hospital is one of the best hospitals observed in the region, in terms of its approach to infection control and, to a less specific extent, waste management. It has a functioning waste management planning system in place, excellent segregation practices and appropriate containers, new and functional wheelie bin storage and internal transport systems, a structured training program in place and appropriate healthcare waste treatment systems with good use of PPE.

Aitutaki District Hospital, in contrast to Rarotonga, has a number of deficiencies with regard to healthcare waste management, although staff had previously identified this as an issue and were keen to learn what they should do to improve it.

The most significant healthcare waste management issues observed at Aitutaki District Hospital were:

- There is no signage and poor segregation – only sharps are separated into sharps containers (disposable cardboard sharps boxes) and other healthcare waste and general waste are combined in bins with black plastic bag liners.
- There are no dedicated storage or internal transport receptacles
- Aitutaki's major issue is its treatment system – this is not at the standard it should be.
  - Currently sharps (and empty glass vials from the pharmacy) are burnt on the concrete 'burning block' (**Photo #3**) located at the back of the hospital grounds and buried nearby.
  - Non-sharps healthcare waste is poorly segregated, so it is dumped into the pit (**Photo #4**) co-located with the burning block with all other waste, where it is to be burnt. However burning only occurs every Friday, weather-dependent, so quantities of healthcare waste remain untreated, out in the open, in a totally unfenced area for days on end.
- There is no documented waste management planning system in place specific to Aitutaki.
- There is no structured training or waste segregation auditing program in place and no spill kits appeared to be present anywhere throughout the facility.

## **Analysis of Options for Sustainable Healthcare Waste Management in the Cook Islands**

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 Cook Islands-specific feasibility assessment, using an analysis of 10 criteria (**Appendix D**)

Treatment options that rated best for the Cook Islands 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.

### Recommendations

Table ES2 provides a summary of the recommendations for the Cook Islands.

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 <sup>U2H</sup>.

Table ES2: Recommendations for the Cook Islands		Applicable to	Rarotonga General Hospital	Aitutaki District Hospital
<b>Recommendation 1: Develop a Waste Management Framework <u>for Aitutaki</u></b>				
Description	<ul style="list-style-type: none"> <li>• A <i>Healthcare Waste Management Plan</i>, specific to Aitutaki District Hospital (using Rarotonga's as a reference point)</li> <li>• Appoint an <i>officer responsible</i> for the development and implementation of the Healthcare Waste Management Plan</li> <li>• Establish a <i>waste management committee</i>, noting that it would be small for Aitutaki.</li> </ul>			
Output	<ul style="list-style-type: none"> <li>• An agreed <i>Healthcare Waste Management Plan</i>, specific to Aitutaki, outlining procedures and guidelines, waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures</li> <li>• Accountability for healthcare waste management through clearly defined roles and</li> </ul>			

Table ES2: Recommendations for the Cook Islands		Applicable to	Rarotonga General Hospital	Aitutaki District Hospital
	responsibilities			
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> <li>Plan approved by Department of Health</li> <li>Approved budget for implementation of Healthcare Waste Management Plan</li> <li>The Plan should be regularly monitored, reviewed, revised and updated.</li> <li>Annual assessment of ‘Responsible Officer’s’ or Waste Management Committee’s performance against key healthcare waste management competencies.</li> </ul>			
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Low, if existing systems (such as that for Rarotonga) are used as starting points and document drafting assistance is provided</li> <li>Ongoing – Low</li> </ul>			
<b>Recommendation 2: Procurement of Consumables (Segregation &amp; Storage) for Aitutaki</b>				
Description	<ul style="list-style-type: none"> <li>Supply of colour-coded <b>waste bins</b> and <b>plastic liners</b> in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process.</li> <li>Supply two colour-coded <b>wheelie bins</b> (where required) per hospital to act as both in-ward/department storage and internal transport trolleys.</li> <li>Supply of <b>signage</b> to explain the colour-coded segregation system as well as <b>posters</b> to promote it. Provision of signs only is also recommended for <b>Rarotonga General Hospital</b>.</li> </ul>			
Output	Adequate supply of consumables to bed down more rigorous segregation practices			
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> <li>Wastes are segregated at their place of production.</li> <li>Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas.</li> <li>Zero Needle Stick Injuries.</li> </ul>			
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Low;</li> <li>Ongoing - Low, sustainably funded by country</li> </ul>			
<b>Recommendation 3: Provide a Sustainable Training Program</b>				
Description	<ul style="list-style-type: none"> <li>Development and delivery of a structured healthcare waste training program, <b>prioritized for Aitutaki</b>, but inclusive of Rarotonga as well, to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies)</li> <li>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 the Cook Islands</li> <li>Training should be coordinated with other countries’ needs in the region</li> <li>Assistant should be provided to <b>Rarotonga</b> to establish a waste segregation auditing</li> </ul>			

Table ES2: Recommendations for the Cook Islands		Applicable to	Rarotonga General Hospital	Aitutaki District Hospital
	program.			
Output	<ul style="list-style-type: none"> <li>Improvement of personnel skills and competency in managing healthcare waste</li> <li>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.</li> <li>An established segregation audit program for Rarotonga</li> </ul>			
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> <li>Competency Assessments</li> <li>Refresher Training</li> <li>No/very little cross contamination between waste streams demonstrated by waste audits.</li> </ul>			
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Low-medium per facility if regional synergies are utilised</li> <li>Ongoing – Low-medium per facility if regional synergies are utilised</li> </ul>			
<b>Recommendation 4: Improved Treatment Infrastructure for Aitutaki<sup>UTH</sup></b>				
Description	<ul style="list-style-type: none"> <li>Procurement of a new small (medium temperature) incinerator and protective structure for Aitutaki District Hospital, with maintenance support contract</li> <li>Urgently <u>fence</u> the existing waste disposal area</li> </ul>			
Output	A disposal system that reduces the potential hazard posed by healthcare waste, while endeavoring 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"> <li>Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures as instructed by the manufacturer)</li> <li>Maintenance program – are maintenance issues dealt with promptly?</li> <li>Ensure burn times are sufficient to reduce waste ash volumes</li> </ul>			
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Medium (approx. \$10,000 for small medium-temperature unit for Aitutaki, including housing and commissioning costs)</li> <li>Ongoing – medium (fuel and maintenance at approximately \$5,000pa)</li> </ul>			
<b>Recommendation 5: Procurement of Spill Control Kits</b>				
Description	Supply sufficient Spill Control Kits for entire hospital operations in both Rarotonga and Aitutaki.			
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			

<b>Table ES2: Recommendations for the Cook Islands</b>		<b>Applicable to</b>	<b>Rarotonga General Hospital</b>	<b>Aitutaki District Hospital</b>
<b>Costs (\$US)</b>	<ul style="list-style-type: none"> <li>Establishment – Low; Ongoing - Low, sustainably funded by country</li> </ul>			

**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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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 the Cook Islands.

## 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 the Cook Islands and includes:

- Collection and collation of data on the current practice(s) used to dispose of hazardous healthcare waste in the Cook Islands. 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 the Cook Islands, 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 the Cook Islands, to address the key issues identified (**section 7**)
- recommendations and prioritization of actions necessary to enable sustainable hazardous healthcare waste management and disposal in the Cook Islands (**section 8**)

## 2 Healthcare Waste Management in the Cook Islands

### 2.1 National Regulatory Framework

There are fifteen major islands in the Cook Islands, which are divided into two distinct groups of coral atolls: the Southern Cook Islands and the Northern Cook Islands. The population numbers of the Cook Islands continues to decline – in 2011 the resident population was 15,000 showing a decrease of 2.3% when compared to the 2006 Census. Over 50,000 Cook Islanders reside in New Zealand and approximately 30,000 in Australia.

Cook Islands are geographically and demographically dispersed. Approximately three quarters of the population live in urban settings; the majority residing on Rarotonga (72%), followed by other Southern Group islands (21%) and the Northern Group (7%). Like Rarotonga, Aitutaki is also a Southern Group island.

The geographically dispersed islands and relatively small numbers of people on isolated islands provide a challenging environment in which to plan and develop health services.

Health services in the Cook Islands are provided through a system of child welfare clinics, dental clinics, health centres/ district hospitals and one general hospital on the main island of Rarotonga.

There are three key institutions involved in solid waste management in the Cook Islands, specifically:

- The National Environment Service - environmental compliance and enforcement , waste diversion programs, best practice awareness, assess landfill monitoring data;
- The Ministry of Works (in Rarotonga, Island Councils on other islands) – manage waste disposal facilities, landfill monitoring and reporting, future waste management planning; and
- The Ministry of Health – oversight of public health compliance, environmental compliance and enforcement as it relates to public health.

The *Cook Islands National Waste Strategy 2011 -2015* has the following Strategy Objectives:

1. Develop an infection waste management policy
2. Develop standard operating procedure for incinerator operations including temperature monitoring
3. Regulate stack emissions under the permitting system established under the Environment Act
4. Assess alternative options for medical and quarantine waste disposal

A summary of relevant legislation is provided in Table 1.

<b>Table 1: National Environmental Legislation Summary</b>			
<b>Legislation, Policies &amp; Guidelines</b>	<b>Summary</b>	<b>References to Solid/HCW</b>	<b>Regulator / Agency</b>
Conservation Act 1986/87	Makes extensive provisions for the control of litter. The Act gives Conservation offices wide powers to prevent the disposal of litter in any public place or on private land	-	NES*
Environmental Act 2003	Specifically the Act prescribes measurement for the control of litter on public places including the designation or approvals of waste disposal areas, and charges the National Environment Service (NES) with ensuring environmentally safe disposal of toxic chemicals and wastes.	Yes	NES
Environment (Atiu and Takutea) Regulation 2008	Regulates the environment for Atiu and Takutea islands. It prescribes measures for environmental protection	Yes	NES
Environment (Mitiaro) Regulation 2008	These regulations apply to Mitiaro Islands and includes provisions for waste management which are identical to the Environment (Atiu and Takutea) Regulations 2008	Yes	NES
Public Health Act	Defines "solid waste" Part 6. of the Public Health Act 2004 has the stated purpose of ensuring that "wastes so safely stored, collected, treated, removed, transported, disposed of, and otherwise dealt with". It prescribes responsibilities for waste receptacle proprietors and building occupiers, and prohibits the burning of plastic waste and tyres with exception for fire fighting training. It also prescribes the fines for waste related offences.	Yes	MoH**
Public Health Regulation 1987		Yes	MoH
Cook Islands State of the Environment Report 1992	Solid waste disposal sites on all islands are unsuitably located due to lack of land. Private contractors on Rarotonga are used for cartage and the Island Councils on the outer islands undertake disposal functions using private or government vehicles.	Yes	NES
Cook Islands National Waste Strategy 2011 - 2015	Addresses solid waste management with the key outcome being the priorities Cook Islands National Waste Strategy consistent with strategies outlines in the Regional Waste Management Strategy.	Yes	NES
Draft Waste Policy 2010	Prepared by AECOM and held at the Office of the Prime Minister	Yes	Office of the Prime Minister

\* NES = National Environment Service

\*\* MoH = Ministry of Health

## **2.2 Hospitals Assessed**

The Ministry of Health operates health care facilities in the Cook Islands, and there are some private clinics, but no private hospital facilities. The Public Health Inspectors are responsible for collection and disposal of health care waste, along with other duties such as inspection of potable water well installations and private sewage disposal facilities.

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

### **2.2.1 Rarotonga General Hospital**

Rarotonga Hospital has approximately 70 beds and a total staffing of 217. The hospital services include accident and emergency; medical services; obstetrics and gynecology; pediatrics; general surgical services; ultrasound/radiology; mental health services (limited); physiotherapy and rehabilitation; eye clinic; laboratory; dental; pharmacy.

### **2.2.2 Aitutaki District Hospital**

Aitutaki District Hospital has approximately 26 beds and a total staffing of 20. The hospital services include an outpatient and NCD clinic, small pharmacy, small laboratory, emergency, general ward, antenatal care, dental and small theatre for minor operations.

### **2.2.3 Hospital Statistics**

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

<b>Table 2: Hospital Details – Cook Islands</b>			
<b>Hospital/Region</b>	<b>Rarotonga General Hospital</b>		<b>Aitutaki District Hospital</b>
<b>Contact Name, Position</b>	Dr. Henry Tikaka, Director of Hospital Health Services	Helen Sinclair, Services Support Mgr - Hospital Health Services	Tara Tschan-Toi, Hospital Manager
<b>Pop Served</b>	17,794		3,500
<b>No. of Beds</b>	70		26
<b>Annual Average Occupancy Rate (%)</b>	Not available		7%
<b>Occupied Bed Days (OBD)</b>	Not available		696
<b>No. Operations</b>	Not available		50*
<b>No. of Births</b>	254		Not available
<b>Emergency Patients Attended</b>	Not available		Not available
<b>Out-Patients Attended</b>	37,984		Not available
<b>No. of staff</b>	217		20
<b>No. of staff per function</b>			
<b>Nursing/ Medical</b>	Not available		10
<b>Infection Control</b>	Not available		2
<b>Dedicated Waste Management – Internal Management</b>	2		6
<b>Dedicated Waste Management – Treatment Operation</b>	1		-
<b>Administration</b>	Not available		2
<b>Other</b>	Not available		-

\* Estimated number of circumcisions

### 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 the Cook Islands**.

	Hospital Name	Rarotonga General Hospital		Aitutaki District Hospital			
Generation & Segregation	Dedicated Containers/ Bags	Y		N			
	Colour Coding	Y		N			
	Sharps segregated & secure	Y		Y			
	Signage Present	N		N			
Internal Handling	Degree of manual handling of bags	Low		High			
	Internal Transport Mode	Wheelie Bin		Manual			
	Spill Kit Present	N		N			
Storage	Dedicated & Appropriate Area	N		N			
	Loading/unloading acceptable	Y		N			
	Spill Kits Present	N		N			
	Monitoring & record keeping occurs	N		N			
Treatment	Treatment per Waste Stream		Tech. Type	Volumes (kg/week)		Tech. Type	Volumes (kg/week)
	Healthcare Waste	✓	Incinerate (internal)	90	✓	Burn on site	~30 <sup>1</sup>
	Sharps	✓	Incinerate (internal)	5	✓	Burn on site	~3 <sup>1</sup>
	Pharmaceutical	✓	Incinerate (internal)	NS	✓	Burn on site	NS
	Cytotoxic	x	N/A	N/A	x	N/A	N/A
	General	✓	Landfill (w/o treatment)	NS	✓	Burn on site	NS
	If incinerator present	Yes		None present			
	Make, Model, Year commissioned	Elastec American Marine, MediBurn		N/A			
	Operating Temp (°C)	1000 °C		N/A			
	No. chambers	2		N/A			

1. estimation based on estimates of weekly bin loads

**Table 3: Waste Management Process - Observations**

Hospital Name	Rarotonga General Hospital		Aitutaki District Hospital	
Condition	Good		N/A	
Operational statistics	Per week	Per year	Per week	Per year
Waste Throughput (kg)	100	5,000	N/A	N/A
Operating Hours (hr)	18	900	N/A	N/A
Fuel	Diesel		N/A	
Fuel use (litres)	20	1,000	N/A	N/A
Fuel use per kg waste burnt	0.2		N/A	
Technology siting and operation issues	Well sited away from hospital buildings		N/A	
Offsite transport assessment	Good		Fair	

N/A – Not applicable

NS – Not supplied

### 3.1 Rarotonga Hospital

#### 3.1.1 Wastestreams, Treatment Constraints and Costs

Rarotonga Hospital generates general wastes and healthcare wastes (including infectious waste, sharps and pharmaceutical wastes (very small quantities)) in the approximate quantities described in Table 3. They do not generate cytotoxic waste. All of these wastes are incinerated.

Non-sharps health care waste generated in wards and departments is placed in proper yellow foot-operated bins (with hazard labeling signs and symbols on the bins/ bags, see **Photo #1**). Sharps are separated from syringes and placed in yellow cardboard disposable sharps boxes (hazard labeling and symbols). General waste is placed in purpose-built heavy duty brown paper bags secured on purpose-built aluminium lid and foot-pedal bin frames (the lid is labelled clearly for general waste, see **Photo #2**).

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

A critical analysis of waste treatment capacity available at Rarotonga Hospital versus actual volumes treated is shown in Table 4. This demonstrates that the incinerator has a significant excess capacity above current needs.

Table 4: Waste Treatment Capacity Analysis – Rarotonga Hospital Incinerator		
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)	200	10,400
Actual Incinerated Waste Throughput (kg)	95	4,940
Spare Capacity (kg) **	105	5,460

\* Based on a 5 day week

\*\* Theoretical spare capacity does not take into account other factors such as increased downtime maintenance that could be required under higher loads

### 3.1.2 Waste Management and Infection Control Framework

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

- There is an infection control policy which includes waste management procedures.
- There is a waste management policy and an active waste management committee
- The Hospital Services Support Manager oversees waste management and a maintenance team is responsible for waste disposal (2 groundsmen and 11 infection control cleaners)
- There are no formal waste auditing or inspections undertaken.
- All health staff are immunized

### 3.1.3 Training

- Rarotonga General Hospital has a formal training program in place that covers:
  - Infection control/ correct segregation of wastes
  - Management of sharps
  - Spill management
  - Use of personal protective equipment
  - Proper use of waste treatment equipment
- They do not appear to keep records of who has attended training sessions
- The Chief Nurse Officer and Quality Manager routinely conduct regular in-service training to nursing personnel and infection control cleaners, but there is no regular (infection control) training conducted for the two groundsmen responsible for collecting healthcare waste and other general waste that is taken to landfill.
- However, the groundsmen are routinely trained by the Biomedical Manager (and Technician) in the proper use of waste treatment equipment.
- The Chief Nurse Officer, Charge Ward Nurses and Infection Control Manager also conduct routine training in segregation, storage and disposal of waste in the wards, including infection control.
- It was not clear how often 'routine' was but it did occur on induction of new staff.
- There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation.

## **3.2 Aitutaki District Hospital**

### **3.2.1 Wastestreams and Quantities**

Aitutaki District Hospital generates general wastes 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 Aitutaki District Hospital:

- There is no waste management policy, plan or formalised waste management procedure. The Environmental Health Officer oversees waste management and a groundsman.
- There is no waste management committee
- There is a documented infection control policy, which is the one used by Rarotonga General Hospital.
- There are no formal waste auditing or inspections undertaken.

### **3.2.3 Training**

Aitutaki District Hospital does not have a formal training program in place that covers infection control, waste segregation, waste disposal or any other topic related to healthcare waste management.

There were no records of historical training sessions having taken place. Anecdotally, basic waste management practices are communicated informally upon new staff employment, and this is restricted to basic infection control policy (provided by the Hospital Manager) and waste handling and disposal/ treatment practices (provided by the environmental health officer if new maintenance staff are employed).

There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation.

## 4 Key Healthcare Waste Management Issues in the Cook Islands

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 Cook Islands, as part of this assessment.

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

<b>Table 6: HEALTHCARE WASTE – KEY ISSUES FOR THE COOK ISLANDS</b>						
Scale	Category	Item	Minimum Standard Criterion	Rarotonga General Hospital	Aitutaki District Hospital	Cook Islands - 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	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.			

#### 4.1.1 Rarotonga General Hospital – Key Issues

Rarotonga General Hospital is one of the best hospitals observed in the region, in terms of its approach to infection control and, to a less specific extent, waste management. It has a functioning waste management planning system in place, excellent segregation practices and appropriate containers, new and functional wheelie bin storage and internal transport systems, a structured training program in place and appropriate healthcare waste treatment systems with good use of PPE.

Of the remaining categories of healthcare waste management, the most significant issues observed at Rarotonga General Hospital were:

- Signage on walls in disposal areas is not present, although there is clear information on bin lids and bags
- There is no waste segregation auditing program in place
- There did not appear to be spill control kits located anywhere throughout the facility

#### 4.1.2 Aitutaki District Hospital – Key Issues

Aitutaki District Hospital, in contrast to Rarotonga, has a number of deficiencies with regard to healthcare waste management, although staff had previously identified this as an issue and were keen to learn what they should do to improve it.

The most significant healthcare waste management issues observed at Aitutaki District Hospital were:

- There is no signage and poor segregation – only sharps are separated into sharps containers (disposable cardboard sharps boxes) and other healthcare waste and general waste are combined in bins with black plastic bag liners.
- There are no dedicated storage or internal transport receptacles
- Aitutaki's major issue is its treatment system – this is not at the standard it should be.
  - Currently sharps (and empty glass vials from the pharmacy) are burnt on the concrete 'burning block' (**Photo #3**) located at the back of the hospital grounds and buried nearby.
  - Non-sharps healthcare waste is poorly segregated, so it is dumped into the pit (**Photo #4**) co-located with the burning block with all other waste, where it is to be burnt. However burning only occurs every Friday, weather-dependent, so quantities of healthcare waste remain untreated, out in the open, in a totally unfenced area for days on end.
- There is no documented waste management planning system in place specific to Aitutaki.
- There is no structured training or waste segregation auditing program in place and no spill kits appeared to be present anywhere throughout the facility.

## 5 Consultation

Apart from hospital staff across all four hospitals, discussions were also held with:

- Vavia Tangatataia, Manager - Advisory & Compliance Division, National Environment Service
- (Elizabeth Iro (Secretary of Health - Ministry of Health) was unable to attend a pre-arranged meeting due to pressing matters at that time but had assisted with the organisation of the hospital visits.)

## 6 Contractor Roles and Capacity

No in-country contractors were identified as providing or having the capacity to provide healthcare waste management support services. This includes training (in areas like waste management, infection control, technology operation and maintenance) and risk management.

## 7 Analysis of Options for Sustainable Healthcare Waste Management in the Cook Islands

Section 4 identifies key issues that need to be addressed in improving healthcare waste management in the Cook Islands. 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	
			Rarotonga General Hospital	Aitutaki District Hospital
A. Waste Management Framework	There is no documented <b>waste management planning</b> system in place in Aitutaki and no waste management committee.	Establish a waste management framework including: <ul style="list-style-type: none"> <li>Waste Management Plan</li> <li>Responsible officer for implementation of waste management plan</li> <li>Waste management committee, appropriate to the scale of each facility.</li> </ul>	With respect to audit procedures only	Yes
B. Signage, Segregation & Containers	<b>Segregation and containment</b> practices are below minimum standard in Aitutaki in that: <ul style="list-style-type: none"> <li>There is no signage present (Rarotonga as well)</li> <li>The only segregation regularly practiced in Aitutaki is for sharps.</li> <li>Colour coded bags (liners) and bins are not present and storage is not adequate in Aitutaki.</li> </ul>	Improve segregation practices by: <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>Supply of signage to explain the colour-coded segregation system as well as posters to promote it.</li> </ul>	Signage only	Yes
C. Training & Audit	There is no structured <b>training</b> or waste segregation <b>auditing</b> program in place in Aitutaki, while Rarotonga does not have an <b>auditing</b> 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: <ol style="list-style-type: none"> <li>SPREP staff, <b>or</b></li> <li>International technical training providers (or a combination of both), <ul style="list-style-type: none"> <li>- as no competent healthcare waste management training capability exists in the Cook Islands.</li> </ul> </li> </ol>	Auditing only	Yes
D. Treatment	The method for <b>treatment</b> of healthcare waste in Aitutaki is typically <u>not</u> in accord with required	Treatment using one (or a combination) of the following for each hospital: <ol style="list-style-type: none"> <li>Rotary kiln (highest temperature)</li> </ol>	No	Yes

Table 7: Options for Sustainable Healthcare Waste Management in the Cook Islands				
	standards.	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		
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 6. 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 7. 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 Cook Island's Stage 2 assessment:

1. Incineration (high temperature:  $>1,000^{\circ}\text{C}$  <sup>2</sup>)
2. Incineration (medium temperature:  $800 - 1,000^{\circ}\text{C}$  <sup>4</sup>)
3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land:  $<400^{\circ}\text{C}$  <sup>4</sup>)
4. Autoclave
5. Encapsulation (of sharps only, in combination with a form of disinfection).

## 7.2.1 Waste Treatment Systems Relevant for the Cook Islands

The Stage 2 local feasibility assessment (for the Cook Islands) took these first four<sup>3</sup> 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

<sup>2</sup> As defined in *Management of Solid Health-Care Waste at Primary Health-Care Centres - A Decision-Making Guide*, WHO (2005)

<sup>3</sup> 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.

assigns a quantitative score from 1 – 5, to prioritise local applicability of technology options to the Cook Islands context, on a relative basis as follows:

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

The treatment technologies suitable for the Cook Islands 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 <sup>o</sup> C)	1	5	4	4	4	4	3	3	3	3	34	1
Incineration at med. temperature (800 - 1000 <sup>o</sup> 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 <sup>o</sup> C)	5	3	1	2	1	1	3	1	5	5	27	4
Notes:												
<ul style="list-style-type: none"> <li>• Scored on a scale of 1-5, where 1= very low; 2 = low; 3= moderate; 4 = high and 5 = very high</li> <li>• Criteria given equal weighting</li> <li>• Possible maximum score: 50</li> </ul>												

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 Cook Islands do not currently generate cytotoxic waste these are not relevant for healthcare waste treatment choices in the Cook Islands.

### 7.2.1 Treatment Investment Options for individual Cook Islands Hospitals

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed.

Rarotonga General Hospital employs a relatively new MediBurn model incinerator (**Photo #5**), housed in an undercover shelter and located some distance from the hospital buildings. This unit is sufficient in scale and effectiveness to treat all of its healthcare waste. Consequently no treatment improvements are suggested for Rarotonga.

Aitutaki District Hospital requires some investment in treatment infrastructure to ensure healthcare waste infectious hazard is destroyed, as described by their treatment weaknesses in sections 4.1.2.

Table 9 determines 'intervention' options that are suggested to improve treatment of healthcare waste in Aitutaki. 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 the Cook Islands**

Remaining Technology Options	Technology Applicability
<b>Rarotonga General Hospital</b>	
Disinfection & Encapsulation (only sharps assessed)	Not applicable as sharps are destroyed in current high temperature incineration process
Incineration at high temperature (>1000°C)	Rarotonga General Hospital employs a relatively new MediBurn model incinerator, housed in an undercover shelter and located some distance from the hospital buildings. This unit is sufficient in scale and effectiveness to treat all of its healthcare waste. Consequently no incinerator improvements are suggested.
Incineration at med. temperature (800 - 1000°C)	Not applicable to Rarotonga as it is large enough to justify a better performing larger option that runs at a higher temperature.
Autoclave with shredder	Not applicable to Rarotonga.
Low temperature burning (<400°C)	Not applicable to Rarotonga as it is large enough to justify a better performing larger option that runs at a higher temperature.
<b>Aitutaki District Hospital</b>	
Disinfection & Encapsulation (only sharps assessed)	Consider concrete encapsulation of disinfected sharps in a metal drum, at the waste disposal area at the back of the hospital, and buried there.
Incineration at high temperature (>1000°C)	Not applicable to Aitutaki 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 use of the burning block. Cook Islands health authorities are likely to be able to sustainably afford the fuel and related operating costs of approximately \$5,000 pa.
Autoclave with shredder	Not applicable to Aitutaki on the grounds of waste volume justification, cost, complexity and ease of operation.
Low temperature burning (<400°C)	<p>Given the small volumes of waste involved, and the small and dispersed population on 'Aitutaki Island, a virtual NO COST alternative to incineration could be implemented, at least in the <b>short term</b>, because of the existing concrete burning block. This could involve:</p> <ul style="list-style-type: none"> <li>• <b>Fencing the waste dump/ burning area</b></li> <li>• Burning sharps separately in the burning block, to disinfect, followed by concrete encapsulation and burial onsite.</li> <li>• Burning healthcare waste separately in the burning block, to disinfect, followed by burial onsite.</li> </ul> <p>(separate burning is suggested as only the sharps need to be encapsulated).</p> <p>This could serve as a short term solution to the lack of reliable disinfection practices currently, should a low cost incinerator option be pursued, as well as build redundancy into the system should there be operational issues with a new incinerator. Because the population of Aitutaki Island is small and dispersed, the air quality impact from low temperature burning of healthcare waste is not a pressing issue.</p>

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 the Cook Islands. Further details and guidance on each recommendation are provided in **Appendix E**.

Table 10 provides a summary of the recommendations for the Cook Islands. 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 <sup>U2H</sup>.*

Table 10: Recommendations for the Cook Islands		Applicable to	Rarotonga General Hospital	Aitutaki District Hospital
<b>Recommendation 1: Develop a Waste Management Framework for Aitutaki</b>				
Description	<ul style="list-style-type: none"> <li>A <i>Healthcare Waste Management Plan</i>, specific to Aitutaki District Hospital (using Rarotonga's as a reference point)</li> <li>Appoint an <i>officer responsible</i> for the development and implementation of the Healthcare Waste Management Plan</li> <li>Establish a <i>waste management committee</i>, noting that it would be small for Aitutaki.</li> </ul>			
Output	<ul style="list-style-type: none"> <li>An agreed <i>Healthcare Waste Management Plan</i>, specific to Aitutaki, outlining procedures and guidelines, waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures</li> <li>Accountability for healthcare waste management through clearly defined roles and responsibilities</li> </ul>			
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> <li>Plan approved by Department of Health</li> <li>Approved budget for implementation of Healthcare Waste Management Plan</li> <li>The Plan should be regularly monitored, reviewed, revised and updated.</li> <li>Annual assessment of 'Responsible Officer's' or Waste Management Committee's performance against key healthcare waste management competencies.</li> </ul>			
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Low, if existing systems (such as that for Rarotonga) are used as starting points and document drafting assistance is provided</li> <li>Ongoing – Low</li> </ul>			
<b>Recommendation 2: Procurement of Consumables (Segregation &amp; Storage) for Aitutaki</b>				
Description	<ul style="list-style-type: none"> <li>Supply of colour-coded <b>waste bins</b> and <b>plastic liners</b> in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process.</li> <li>Supply two colour-coded <b>wheelie bins</b> (where required) per hospital to act as both in-ward/department storage and internal transport trolleys.</li> <li>Supply of <b>signage</b> to explain the colour-coded segregation system as well as <b>posters</b> to promote it. Provision of signs only is also recommended for <b>Rarotonga General Hospital</b>.</li> </ul>			
Output	Adequate supply of consumables to bed down more rigorous segregation practices			
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> <li>Wastes are segregated at their place of production.</li> <li>Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas.</li> <li>Zero Needle Stick Injuries.</li> </ul>			

Table 10: Recommendations for the Cook Islands		Applicable to	Rarotonga General Hospital	Aitutaki District Hospital
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Low;</li> <li>Ongoing - Low, sustainably funded by country</li> </ul>			
<b>Recommendation 3: Provide a Sustainable Training Program</b>				
Description	<ul style="list-style-type: none"> <li>Development and delivery of a structured healthcare waste training program, <b>prioritized for Aitutaki</b>, but inclusive of Rarotonga as well, to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies)</li> <li>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 the Cook Islands</li> <li>Training should be coordinated with other countries' needs in the region</li> <li>Assistant should be provided to <b>Rarotonga</b> to establish a waste segregation auditing program.</li> </ul>			
Output	<ul style="list-style-type: none"> <li>Improvement of personnel skills and competency in managing healthcare waste</li> <li>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.</li> <li>An established segregation audit program for Rarotonga</li> </ul>			
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> <li>Competency Assessments</li> <li>Refresher Training</li> <li>No/very little cross contamination between waste streams demonstrated by waste audits.</li> </ul>			
Costs (\$US)	<ul style="list-style-type: none"> <li>Establishment – Low-medium per facility if regional synergies are utilised</li> <li>Ongoing – Low-medium per facility if regional synergies are utilised</li> </ul>			
<b>Recommendation 4: Improved Treatment Infrastructure for Aitutaki<sup>UTH</sup></b>				
Description	<ul style="list-style-type: none"> <li>Procurement of a new small (medium temperature) incinerator and protective structure for Aitutaki District Hospital, with maintenance support contract</li> <li>Urgently <u>fence</u> the existing waste disposal area</li> </ul>			
Output	A disposal system that reduces the potential hazard posed by healthcare waste, while endeavoring 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"> <li>Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures as instructed by the manufacturer)</li> <li>Maintenance program – are maintenance issues dealt with promptly?</li> <li>Ensure burn times are sufficient to reduce waste ash volumes</li> </ul>			

<b>Table 10: Recommendations for the Cook Islands</b>		<b>Applicable to</b>	<b>Rarotonga General Hospital</b>	<b>Aitutaki District Hospital</b>
<b>Costs (\$US)</b>	<ul style="list-style-type: none"> <li>Establishment – Medium (approx. \$10,000 for small medium-temperature unit for Aitutaki, including housing and commissioning costs)</li> <li>Ongoing – medium (fuel and maintenance at approximately \$5,000pa)</li> </ul>			
<b>Recommendation 5: Procurement of Spill Control Kits</b>				
<b>Description</b>	Supply sufficient Spill Control Kits for entire hospital operations in both Rarotonga and Aitutaki.			
<b>Output</b>	Capacity and capability (training – see Recommendation 3) to respond to any healthcare waste spills anywhere in the waste management process.			
<b>Monitoring &amp; Evaluation Indicators</b>	Staff are aware of how to protect themselves and others from, and respond to, any spills of healthcare waste			
<b>Costs (\$US)</b>	<ul style="list-style-type: none"> <li>Establishment – Low; Ongoing - Low, sustainably funded by country</li> </ul>			

**U2H** - Unique to hospital

## 8.1 Implementation Priorities

### 8.1.1 Recommendation 1: Develop a Waste Management Framework for Aitutaki

1. Develop a **Healthcare Waste Management Plan** for Aitutaki (using Rarotonga's as a reference point) including technical guidelines and procedures relating to waste management and infection control.
2. Appoint an **officer responsible** for the development and implementation of the Healthcare Waste Management Plan in Aitutaki
3. Establish a **waste management committee**, appropriate to the scale of Aitutaki.

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.

The Management Plan should be developed in accordance with the draft *National Solid Waste Management Strategy* and representatives from the Ministry of Environment and Climate Change (MECC) and the Ministry of Health (MoH) should be consulted on the drafting of the waste management plan, to ensure policy and legislative needs are considered.

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.

A **waste management committee** 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.

#### 8.1.1.1 Short Term (0-6 months)

- Identify existing documents and systems that may have been used in the past (e.g. Rarotonga's management system)
- 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) for Aitutaki

Waste should be collected in accordance with the schedules specified in the Waste Management Plan (Recommendation One). 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. Labeling 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
  - Two wheelie bins
  - Classification and segregation signage as well as instructional posters to promote good healthcare waste management practices (**for 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: Provide a Sustainable Training Program**

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

(Rarotonga can be involved in the training program, and could contribute to it, but their focus is to use the segregation audit component of the training to establish their own program.)

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 Cook Islands.

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 (1 year-3 years)**

- Continually improve the mandatory standards of healthcare waste management
- A continuing audit program is 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: Improved Treatment Infrastructure for Aitutaki** <sup>U2H</sup>

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. Aitutaki requires some investment in improved infrastructure:

- Procurement of a new small (medium temperature) incinerator and protective structure for Aitutaki District Hospital, with maintenance support contract
- Urgently fence the existing waste disposal area

**8.1.4.1 Aitutaki District Hospital****(a) Short Term (0-6 months)**

- Ensure sharps and other infectious wastes are burnt on the existing concrete burning block before burial onsite
- Urgently fence the onsite waste disposal area
- Given the small volumes of waste involved, and the small and dispersed population on Aitutaki Island, a virtual NO COST alternative to incineration could be implemented, at least in the short term, because of the existing concrete burning block. This could involve:
  - Burning sharps separately in the burning block, to disinfect, followed by concrete encapsulation and burial onsite.
  - Burning healthcare waste separately in the burning block, to disinfect, followed by burial onsite (separate burning is suggested as only the sharps need to be encapsulated).
- Establish a procedure to measure all waste disposed. Given the lack of a measurement scale, this can be done by measuring the number of bags in the short term, once colour-coded bags and bins are supplied.
- Budget withstanding, *start the process of procurement of a new incinerator* – one that is sized according to Aitutaki's estimated weekly throughput of approximately 30kg/week of healthcare waste. 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.
  - A critical aspect to purchase of an incinerator for Aitutaki is the inclusion of a supplier support and maintenance contract.

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

- Procure, install and commission new incinerator, with supplier support and maintenance contract.

**(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.

**8.1.5 Recommendation 5: Procurement of Spill Kits for both hospitals**

Supply sufficient Spill Control Kits for entire hospital operations in both Rarotonga and Aitutaki.

**8.1.5.1 Short Term (0-6 months)**

- Procurement of sufficient Spill Control Kits for entire hospital operations in both Rarotonga and Aitutaki.

**8.1.5.2 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.

**8.1.5.3 Long Term (1-3 years)**

Nil.

**Appendix A**  
**Photo Log**



**Photo 6: Typical bag and bin for non-sharps infectious waste at Rarotonga General Hospital, the Cook Islands (taken 4/04/2014 by Geoff Latimer ref:DSC03971**



**Photo 7: Typical bag and bin for general waste at Rarotonga General Hospital, the Cook Islands** (taken 4/04/2014 by Geoff Latimer ref:DSC03977)



**Photo 8: Concrete 'burning block' at Aitutaki District Hospital, the Cook Islands** (taken 8/04/2014 by Geoff Latimer ref:DSC04146)



**Photo 9: Waste Disposal Pit at Aitutaki District Hospital, the Cook Islands** (taken 8/04/2014 by Geoff Latimer ref:DSC04145)



**Photo 5: MediBurn 20 incinerator at Rarotonga Hospital, the Cook Islands** (taken 04/04/2014 by Geoff Latimer ref:DSC03992)

**Appendix B**  
**Collected Data from Hospital Audits in the Cook Islands**

Table B1: Collected Data from Hospital Audits in the Cook Islands							
HOSPITAL DETAILS	Region		Rarotonga		Aitutaki		
	Facility Name & Contact Information	Hospital Name		Rarotonga General Hospital		Aitutaki District Hospital	
		Contact Name & Position		Dr. Henry Tikaka, Director of Hospital Health Services	Helen Sinclair, Services Support Manager - Hospital Health Services	Tara Tschan-Toi, Hospital Manager	
		Email		<a href="mailto:h.henry@health.gov.ck">h.henry@health.gov.ck</a>	<a href="mailto:h.sinclair@health.gov.ck">h.sinclair@health.gov.ck</a>	<a href="mailto:t.toi@health.gov.ck">t.toi@health.gov.ck</a>	
		Phone			Phone: (682) 22664	(682) 31002 ext 216, mob: (682) 56736	
	Key Services Data	Summary of Services Provided		Accident and emergency; medical services; obstetrics and gynecology; pediatrics; general surgical services; ultrasound/radiology; mental health services (limited); physiotherapy and rehabilitation; eye clinic; laboratory; dental; pharmacy		Outpatient and NCD clinic, small pharmacy, small laboratory, emergency, general ward, antenatal care, dental, minor operations	
		Pop Served		17,794		3500	
		No. of Beds		70		26	
		OBD's <sup>1</sup>				696	
		No. Operations				50	
No. of Births <sup>2</sup>		254		31			
Emergency Patients Attended <sup>2</sup>							
Out-Patients Attended <sup>2</sup>		37984					
WASTE MANAGEMENT PROCESS	Waste Streams Managed	Estimates		Volumes (kg/wk)	Cost ext. (\$US)	Volumes (kg/wk)	Cost ext. (\$US)
		Healthcare Waste		90		30	
		Sharps		5		3	
		Pharmaceutical					
		Cytotoxic					
		General					
		Recycling					
		TOTAL		95	\$ -	33	\$ -
	Generation & Segregation	Dedicated Containers/ Bags		Y		N	
		Colour Coding		Y		N	
Sharps segregated & secure		Y		Y			
Signage Present		N		N			

WASTE MANAGEMENT FRAMEWORK	Internal Handling	Degree of manual handling of bags	Low		High	
		Internal Transport Mode	Wheelie Bin		Manual	
		Spill Kit Present	N		N	
	Storage	Dedicated & Appropriate Area	N		N	
		Loading/unloading acceptable	Y		N	
		Spill Kits Present	N		N	
		Monitoring & record keeping occurs	N		N	
	Treatment	Treatment per Waste Stream	Tech. Type	Int/Ext	Tech. Type	Int/Ext
		Healthcare Waste	Incinerate (internal)	Internal	Burn on site	Internal
		Sharps	Incinerate (internal)	Internal	Burn on site	Internal
		Pharmaceutical	Incinerate (internal)	Internal	Burn on site	Internal
		Cytotoxic				
		General	Landfill (without treatment)	External	Burn on site	Internal
		If incinerator present			None	
		Make, Model, Year commissioned	Elastec American Marine, MediBurn			
		Operating Temp (°C)	1000 C			
		No. chambers	2			
		Condition	Good			
			Per week	Per year	Per week	Per year
		Waste Throughput (tonnes)	0.1	5		
		Operating Hours (hr)	18	900		
		Fuel	Diesel			
		Fuel use (kg/litres)	20	1000		
		Fuel use per kg waste burnt	0.2			
	Technology siting and operation issues	Well sited away from hospital buildings				
	Offsite transport assessment	Good		Fair		
	Waste Management Documents	Waste Management Policy	Y		N	
		Waste Management Plan	Y		N	
		Waste Management Procedure	Y		N	
		Waste Management Committee	Y		N	
	Infection Control	Infection Control Policy	Y		N	
		Infection Control Procedures	Y		N	
	Auditing and Record Keeping	Audit Program	N		N	
What is audited		Segregation	N	Segregation	N	
		Compliance P&P	N	Compliance P&P	N	

ENVIRON

PROJECTED ISSUES		Int. transport	N	Int. transport	N	
		Storage	N	Storage	N	
		Treatment/ disposal	N	Treatment/ disposal	N	
		Frequency				
	Training	Training Program	Y		N	
		Curricula	Infection Control	Y	Infection Control	N
			Waste Mgt	Y	Waste Mgt	N
			PPE	Y	PPE	N
			Treat. Tech operation	Y	Treat. Tech operation	N
	Duration / frequency of training		Monthly			
Records of who has been trained		N		N		
Monitoring or refresher courses		Y		N		
Forecasting	10 year projections for waste management					
	Barriers to change			Keen to get assistance - have identified that poor healthcare waste disposal is an infection risk but felt they didn't have the knowledge to know what to do about it.		
	Other issues			Both infectious (including sharps) and general waste are taken to an area at the back of the hospital where there is an open burial pit and a small (700mm x 700mm) concrete burning block. Sharps, infectious wastes and out of date drugs are supposed to be burnt on the concrete block then the residue buried in the pit beside.		
LOCAL CONTRACTORS	Potential in-country contractors	Who	Key Capability	Who	Key Capability	

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

**Appendix C**  
**Minimum Standards Assessment**

<b>Table C1: HEALTHCARE WASTE - MINIMUM STANDARDS FRAMEWORK &amp; ASSESSMENT FOR THE COOK ISLANDS</b>						
Scale	Category	Item	Minimum Standard Criterion	Rarotonga General Hospital	Aitutaki District Hospital	Cook Islands - overall
National Authority	National Legislation	Definitions	A clear definition of hazardous healthcare 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 healthcare 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 spill kit is provided.	N/A	N/A	N/A
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.	N/A		

\* The minimum standards 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.

## Appendix D

### Qualitative Local Feasibility Assessment – Treatment Technology

Table D1: <b>QUALITATIVE</b> Treatment Technology Options Assessment - Local Feasibility (the Cook Islands)										
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 – Cook Islands 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 fully controlled)	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 combustion	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 infrastructure.	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment are potential impacts. Med. temperature operation increases risks of	Equipment lifespan typically less ~ 5 years but will only last if maintained. Equipment is prone to require a moderate level	Requires less skilled operators than high temperature equipment - training simplifies operation

Table D1: <b>QUALITATIVE</b> Treatment Technology Options Assessment - Local Feasibility (the Cook Islands)										
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
					derived POPs & other pollutants is high – Cook Islands is a party to Stockholm				air pollution, but likely to only be an option in isolated small communities.	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. Public Health Act and Regs specifically prohibit burning of plastic waste.	Burning of rubbish not as prevalent in Rarotonga as Aitutaki & other Pacific Islands. Landfilling waste commonly accepted. Likely community concern if healthcare waste was burned in an open situation	No equipment operation reliability barrier; however expect community/ Dept Env barrier in Rarotonga – probably not enforced in Aitutaki given this is current practice	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.	

Table D1: <b>QUALITATIVE</b> Treatment Technology Options Assessment - Local Feasibility (the Cook Islands)											
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	
Autoclave with shredder	\$158,000 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Cannot treat all waste types, achieves complete sterilization when correctly operated, no combustion required, shredder destroys needles	Some issues for operators (requires training & PPE); small potential for odours and wastewater discharge (community)	Equipment lifespan ~ 10 years; sustainability dependant on maintaining operator skills plus longevity of equipment use given technology complexity	No legal barriers; no potential for smoke nuisance; some potential for odour nuisance; no air pollution (no combustion-POPs) and some potential for waste water management issues		Not familiar with use of sterilisers for waste – potential community issue with waste appearance if steriliser not operated correctly or shredder not used	Equipment breakdown and lack of local skills to maintain equipment – barrier can be managed through skills training & supplier support. Increased complexity of equipment (compared to incineration) increases barrier	No emissions of air pollutants/ smoke; some potential for odour impacts; still requires landfill or dump disposal of residue so some potential for leaching on burial. Landfill volume higher than incineration but landfill facilities in Cooks are of reasonable standard. Some potential for waste water management issues	Equipment will only last if maintained. Adding shredder to autoclave technology increases mechanical parts that can go wrong. May require moderate level of maintenance	Requires skilled operators to achieve best level of disinfection.
Encapsulation (only post-disinfection)	Virtually zero additional cost to disinfection	Not applicable to non-sharps waste.	Encapsulation has handling issues for	No equipment; sustainability dependant	No legal barriers; no smoke		No particular cultural fit concerns –	Aitutaki currently burns sharps in open pit so they	Encapsulation itself poses no smoke nuisance;	Highly durable due to its simplicity.	Simple procedure once

Table D1: <b>QUALITATIVE</b> Treatment Technology Options Assessment - Local Feasibility (the Cook Islands)										
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
sharps assessed)	system costs	In the context of pre-sterilised sharps only: no combustion required and completely removes downstream needle injury risk	operators (requires training & PPE) and no community issues	burial space available. Quantities are very small in Aitutaki.	nuisance; no odour nuisance; no air pollution and some potential for leachate to groundwater, although limited inherent hazard	volumes very small in Niue	are sterilised but not destroyed. May have short term value.	no odour nuisance; no air pollution and some potential for leachate to groundwater, although limited inherent hazard		operator understands and manages the risk of sharps handling and knows how to mix cement 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**

### **Recommendation Guidelines**

**Recommendation 1: Develop a Waste Management Framework for Aitutaki****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) for Aitutaki**

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.

Labeling 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 labeled 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 labeling 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.

### **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 for Aitutaki**

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<sup>4, 5</sup>, incineration is the preferred method for treating pharmaceutical and cytotoxic wastes. This is further supported by the United Nations<sup>6, 7</sup> 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<sup>8, 9</sup>.

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

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<sup>4</sup> World Health Organization Regional Office for Europe, EURO Reports and Studies 97, Management of Wastes from Hospitals and other Health Care Establishments, 1983.

<sup>5</sup> World Health Organization, Safe management of Wastes from healthcare Facilities, Geneva, 1999.

<sup>6</sup> United Nations Environment Programme – Technical Working Group on the Basel Convention, Draft Technical Guidelines on Biomedical and Health Care Wastes, 1999.

<sup>7</sup> Environment Australia, Basel Convention – Draft Technical Guidelines on Hazardous Waste: Clinical and Related Waste (Y1), March 1998.

<sup>8</sup> Health care Without Harm, Non-Incineration Treatment Technologies, August 2001.

<sup>9</sup> London Waste Regulation Authority, Guidelines for the Segregation, Handling, Transport and Disposal of Clinical Waste, 2<sup>nd</sup> Edition, 1994.

other than incineration for anatomical waste, pharmaceuticals and cytotoxic wastes<sup>10, 11, 12, 13, 14, 15</sup>. 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 option<sup>16</sup>.

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.

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<sup>10</sup> National Health & Medical Research Council, National Guidelines for Waste Management in the Health Industry, Commonwealth of Australia, 1999.

<sup>11</sup> EPA Victoria, Draft Guidelines for the Management of Clinical and Related Waste, July 2003.

<sup>12</sup> NSW Department of Health, Waste Management Guidelines for Health care Facilities, August 1998.

<sup>13</sup> Queensland Government, Environmental Protection (Waste Management) Regulation, 2000.

<sup>14</sup> Australian/New Zealand Standard 3816:1998, Management of Clinical and Related Wastes.

<sup>15</sup> Australian and New Zealand Clinical Waste Management Industry Group, Industry Code of Practice for the Management of Clinical and Related Wastes, 3<sup>rd</sup> edition July 2000.

<sup>16</sup> Provincial Government of Gauteng (South Africa), Draft Health Care Waste Regulations, 11 September 2003.