



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

Tonga

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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 10th European Development Fund (EDF 10). The project focuses on three priority hazardous waste streams including asbestos, E-waste and healthcare waste.

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

Current Healthcare Waste Management in Tonga

The Ministry of Health operates healthcare facilities in Tonga. Information regarding the waste management process occurring, from ward-level waste generation through to ultimate treatment and disposal was collected during audits of the four largest hospitals as follows:

- Vaiola Hospital, Tongatapu – 31/3/2014
- Prince Ngu Hospital, Vava'u – 1/4/2014
- Niu'eiki Hospital, 'Eua – 13/5/2014
- Niu'ui Hospital, Ha'apai – 15/5/2014

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

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

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

Target areas have been rated as follows:

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

Table ES1: HEALTHCARE WASTE – KEY ISSUES FOR TONGA								
Scale	Category	Item	Minimum Standard Criterion	Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga - 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 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	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	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	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 spills of healthcare waste are investigated and remedial actions implemented.					

Key Issues

The key issues observed were:

- There is no documented waste management planning system in place and limited evidence of waste management committees.
- Segregation and containment practices are generally below minimum standard in that there is virtually no signage present; (with the exception of Vaiola Hospital) the only segregation regularly practiced is for sharps, (with the exception of Vaiola Hospital) colour coded bags (liners) and bins are not present and storage is not adequate.
- There is no structured training or waste segregation auditing program in place
- The method for treatment of healthcare waste is not in accord with required standards at any of the hospitals visited.

Analysis of Options for Sustainable Healthcare Waste Management in Tonga

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

Treatment options that rated best for Tonga 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.
- **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.
- **Autoclaving** is an acceptable disinfection practice where units with shredder are affordable and locked in supplier maintenance and training contracts are in place, but borderline beyond Tongatapu due to lack of lined landfills and increased complexity of machinery.

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 Tonga.

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

Table ES2: Recommendations for Tonga		Applicable to	Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga Overall
Recommendation 1: Develop a Waste Management Framework							
Description	<ul style="list-style-type: none"> A <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility Appoint an <i>officer responsible</i> for the development and implementation of the Healthcare Waste Management Plan A <i>waste management committee</i>, appropriate to the scale of each facility. 						
Output	<ul style="list-style-type: none"> An agreed <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility outlining procedures and guidelines, waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures Accountability for healthcare waste management through clearly defined roles and responsibilities 						
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Plan approved by Department of Health (all facilities) Approved budget for implementation of Healthcare Waste Management Plan The Plan should be regularly monitored, reviewed, revised and updated. Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies. 						
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided Ongoing – Low 						
Recommendation 2: Procurement of Consumables (Segregation & Storage)							
Description	<ul style="list-style-type: none"> Supply of colour-coded waste bins and plastic liners in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. Supply of small number of colour-coded wheelie bins (where required) per hospital to act as both in-ward/department storage and internal transport trolleys. Supply of signage to explain the colour-coded segregation system as well as posters to promote it. 						
Output	Adequate supply of consumables to bed down more rigorous segregation practices						

Table ES2: Recommendations for Tonga		Applicable to	Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga Overall
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Wastes are segregated at their place of production. Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. Zero Needle Stick Injuries. 						
Costs (\$US)	Establishment – Low; Ongoing - Low, sustainably funded by country						
Recommendation 3: Provide a Sustainable Training Program							
Description	<ul style="list-style-type: none"> Development and delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies) This could be facilitated/ delivered by SPREP staff, or outside trainers, or a combination of both, as no competent healthcare waste management training capability exists in Tonga Training should be coordinated with other countries' needs in the region 						
Output	<ul style="list-style-type: none"> Improvement of personnel skills and competency in managing healthcare waste Promotion of the advantages of sustainable segregation and storage techniques for the different waste streams and an understanding of the health and safety risks resulting from the mismanagement risks of healthcare waste. 						
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Competency Assessments Refresher Training No/very little cross contamination between waste streams demonstrated by waste audits. 						
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low-medium per facility if regional synergies are utilised Ongoing – Low-medium per facility if regional synergies are utilised 						
Recommendation 4: Improved Treatment Infrastructure^{U2H}							
Description	<ul style="list-style-type: none"> Procurement of a new incinerator for Vaiola Hospital, within existing building that houses the waste treatment autoclave, with maintenance support contract Repair of existing incinerator for Prince Ngu Hospital, to replace missing transformer. Establish maintenance support contract Procurement of a new small (medium temperature) incinerator and protective structure for Niu'eiki Hospital, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Tongan MoH) Procurement of a new small (medium temperature) incinerator and protective structure for Niu'ui Hospital, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Tongan MoH) 						

Table ES2: Recommendations for Tonga		Applicable to	Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga Overall
Output	A disposal system that reduces the potential hazard posed by healthcare waste, while endeavoring to protect the environment.						
Monitoring & Evaluation Indicators	Assessment of the following should be regularly undertaken for new and existing incinerators: <ul style="list-style-type: none"> • Operations and construction (e.g. pre-heating and not overloading the incinerator and incinerating at temperatures above 800°C only) • Maintenance program – are maintenance issues dealt with promptly? • Ensure burn times are sufficient to reduce waste ash volumes 						
Costs (\$US)	<ul style="list-style-type: none"> • Establishment – High (approx.. \$50,000 for high temperature unit (Vaiola), \$5,000 for replacement of transformer (Prince Ngu) and \$7,000 each for small medium-temperature units for Niu'eiki and Niu'ui respectively) including housing and commissioning costs; • Ongoing – medium (fuel and maintenance) 						
Recommendation 5: Procurement of Consumables (PPE)							
Description	<ul style="list-style-type: none"> • Supply appropriate PPE including overalls/protective clothing, gloves and eye protection for all waste handlers. • Incinerator staff are provided with additional PPE such as face masks and noise protection. 						
Output	Adequate supply of PPE for protection of waste handlers						
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> • PPE is provided to all staff and staff are aware on how to protect themselves from injuries and infectious wastes • Zero Needle Stick Injuries. 						
Costs (\$US)	Establishment – Low; Ongoing - Low, sustainably funded by country						
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> • Plan approved by Department of Health (all facilities) • Approved budget for implementation of Healthcare Waste Management Plan • The Plan should be regularly monitored, reviewed, revised and updated. • Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies. 						
Costs (\$US)	<ul style="list-style-type: none"> • Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided • Ongoing – Low 						

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 Tonga.

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 Tonga and includes:

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

2 Healthcare Waste Management in Tonga

2.1 National Regulatory Framework

The Kingdom of Tonga is made up of 170 islands (36 inhabited) spread over 700,000 square kilometres of ocean. In 2010, the estimated population was 103,600 people. Tonga has a net emigration rate, with 100,000 Tongans living overseas, mostly in Australia, New Zealand and the United States. Seventy percent of Tonga's population lives on the main island of Tongatapu, with the remainder spread across the other four island groups.

There are three key institutions involved in solid waste management in Tonga, specifically:

- The Ministry of Lands, Environment, Climate Change, and Natural Resources (otherwise referred to as the Ministry of Environment and Climate Change), is the regulatory body;
- The Waste Authority Limited (WAL) is a public company with the mandate for solid waste collection and disposal on Tongatapu only, through the running of the new (2008) Tongatapu engineered landfill (Tapuhia Landfill); and
- The Ministry of Health has responsibility for waste management on the outer islands, and medical waste management.

A draft National Solid Waste Management Strategy has been prepared but has not been finalized.

The health sector is managed by the Ministry of Health, who provides policy advice, manages legislative requirements and operational aspects of health service delivery and monitors population health outcomes. Delivery of health services occurs through a system of one main referral hospital (Vaiola Hospital in Tongatapu), three community or district hospitals, 14 health centres and 34 reproductive and child health clinics.

The Ministry of Health does not currently have a formal Healthcare Waste Management Policy, or a Healthcare Waste Management Plan.

A summary of relevant legislation is provided in Table 1.

Table 1: National Environmental Legislation Summary				
Legislation	Type	Summary	References to Solid/HCW	Regulator/ Agency
Public Health Act 1992	Act	The Act in a general way lays the groundwork for environmental management. It cites 'Any person who creates or allows the creation of dust, smoke, fumes, effluvia, effluent or noise which is a nuisance or prejudicial to the health of the inhabitants of the neighborhood or to the health of any person is guilty of an offence'. However, there are no regulations which define what constitutes a nuisance or prejudice to health with which to enforce the Act	-	Ministry of Health
Environmental Management Act 2010	Act		-	Ministry of Environment and Climate Change
Hazardous Materials Act Waste Management Act (2005)	Act			Ministry of Environment and Climate Change
Environmental Management Plan for the Kingdom of Tonga	Plan			Ministry of Environment and Climate Change

2.2 Hospitals Assessed

The Ministry of Health operates healthcare facilities in Tonga, and there are some private clinics, but no private hospital facilities. The Public Health Inspectors are responsible for collection and disposal of healthcare 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 Tonga, key contact personnel and key hospital administrative statistics.

2.2.1 Vaiola Hospital, Tongatapu

Vaiola Hospital has 274 beds and approximately 44 doctors and 328 nurses, with a total staffing of 680. The hospital services include general medicine, obstetrics/ gynecology, surgery, pediatrics, emergency, outpatients, radiology, pharmacy, laboratory, ENT, dentistry, X-ray facilities and health administration.

2.2.2 Prince Ngu Hospital, Vava'u

Prince Ngu Hospital has 62 beds and approximately 35 nursing and medical staff with a total staffing of 80. The hospital services include general medicine, emergency, outpatients, inpatients, reproductive health, NCD clinic, pharmacy, eye clinic, laboratory, pharmacy and dentistry.

2.2.3 Niu'eiki Hospital, 'Eua

Niu'eiki Hospital has 20 beds and approximately 15 nursing and medical staff with a total staffing of 21. The hospital services include general medicine, emergency, outpatients, inpatients (general care), pharmacy, laboratory (very basic), dental and reproductive health.

2.2.4 Niu'ui Hospital, Ha'apai

Niu'ui Hospital has 18 beds and a total staffing of 31. The hospital services include general medicine, emergency care, outpatient care, maternity and minor theatre.

2.2.5 Hospital Statistics

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

Hospital/Region	Vaiola Hospital, Tongatapu	Prince Ngu Hospital, Vava'u	Niu'eiki Hospital, 'Eua		Niu'ui Hospital, Ha'apai (Lifuka)	
Contact Name			'Amelia Vea, Health Inspector	Dr Kalo Nofo'akifolau, Officer in Charge	Dr. Tevita Vakasiuola, Officer in Charge	Mr Mosese Fifita, Public Health Inspector
Position	Isileli Fakailoatonga, Acting Public Health Supervisor	Leopino Fa'asolo, Public Health Inspector				
Pop Served	75,416	15505	5206		7570	
No. of Beds	274	62	20		18	
Annual Average Occupancy Rate (%)	58%	33%	19%		25%	
Occupied Bed Days (OBD)	58,006	7468	1387		1642	
No. Operations	2702	300	0		0	
No. of Births	2766	300	115		100	
Emergency Patients Attended	Not available	Not available	22		500	
Out-Patients Attended	52209	17298	8957		12568	
No. of staff	680	80	21		31	
No. of staff per function						
Nursing/ Medical	372	35	15		21	
Infection Control	2	2	0		0	
Dedicated Waste Management – Internal Management	2	2	4		2	
Dedicated Waste Management – Treatment Operation	3	3	1		6	
Administration	204	4	1		2	
Other	98	34	0		0	

3 Existing Waste Management Practices

This section describes waste management practices observed during hospital audits carried out at each 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 of the four hospitals in Table 3.

Audit observations are elaborated upon further for each hospital individually in sections 3.1 – 3.4 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**.

	Hospital Name	Vaiola Hospital Tongatapu		Prince Ngu Hospital Vava'u		Niu'eiki Hospital 'Eua		Niu'ui Hospital, Ha'apai					
Generation & Segregation	Dedicated Containers/ Bags	Y		N		N		N					
	Colour Coding	Y		N		N		N					
	Sharps segregated & secure	Y		Y		Y		Y					
	Signage Present	N		N		N		N					
Internal Handling	Degree of manual handling of bags	Medium		High		High		High					
	Internal Transport Mode	Wheelie Bin		Wheelie Bin		Manual		Manual					
	Spill Kit Present	N		N		N		N					
Storage	Dedicated & Appropriate Area	Y		N		N		N					
	Loading/unloading acceptable	N		N		N		N					
	Spill Kits Present	N		N		N		N					
	Monitoring & record keeping occurs	N		N		N		N					
Treatment	Treatment per Waste Stream		Tech. Type	Volumes (kg/wk)		Tech. Type	Volumes (kg/wk)		Tech. Type	Volumes (kg/wk)			
	Healthcare Waste	✓	Landfill (w/o treat) ¹	915	✓	Landfill (w/o treat)	~180	✓	Landfill (w/o treat)	~5	✓	Burn on site	~100
	Sharps	✓	Landfill (w/o treat) ¹	111	✓	Incinerate (internal)	~10	✓	Landfill (w/o treat)	~8	✓	Burn on site	~5
	Pharmaceutical	✓	Landfill (w/o treat) ¹	NM	✓	Landfill (w/o treat)	NM	✓	Landfill (w/o treat)	NM	✓	NA	NM
	Cytotoxic	×	NA	NA	×	NA	NA	×	NA	NA	×	NA	NA
	General	✓	Landfill (w/o treat) ¹	NM	✓	External	~110	✓	Landfill (w/o treat)	~22	✓	Burn on site	500 ⁶
	If incinerator present												
	Make, Model, Year commissioned	2007		2007		-		2007					
	Operating Temp (°C)	-		uncertain		-		-					
	No. chambers	1		1		-		1					

Table 3: Waste Management Process - Observations

Hospital Name	Vaiola Hospital Tongatapu		Prince Ngu Hospital Vava'u		Niu'eiki Hospital 'Eua		Niu'ui Hospital, Ha'apai	
Condition	Not operating		Temporarily broken down		-		Not operating - ruined	
Comments	Tapuhia landfill ² has an incinerator (not/ never used) donated by Rotary Japan/ JICA at same time as Vava'u		Incinerator donated by Japanese Rotary/ JICA but not operating as transformer is missing, perhaps stolen. Many wheelie bins have no/ broken wheels, some broken lids, typically no bags used for hcw.		No incinerator. Sharps are buried at dump after first burning there but we were unable to view evidence of burnt waste on inspecting at the dump.		Incinerator donated by Japanese Rotary/ JICA - same as Vava'u. Enclosure roof was blown over and damage sustained in a small cyclone about 6 months after becoming operational so couldn't use it. Now it is totally rusted and ruined.	
Operational statistics	Per week	Per year	Per week	Per year	Per week	Per year	Per week	Per year
Waste Throughput (kg)	1026	53352	190	9880	13	676	105	5460
Operating Hours (hr)	NA	NA	NA	NA	NA	NA	NA	NA
Fuel	NA		Diesel		NA		uncertain	
Fuel use (kg/litres)	NA		NA		NA		NA	
Fuel use per kg waste burnt	NA		NA		NA		NA	
Technology siting and operation issues	Good		Poor		Good		Good	
Offsite transport assessment	Fair		Poor		Poor		Fair	

Notes:

- Vaiola Hospital has a steam sterilizer for treating healthcare waste. However this unit only has capacity of approximately 3 yellow bags worth of waste per day (there are approximately 22 bags generated daily). Consequently it is likely that the sterilization unit gets limited use, if any at all. The sterilizer was manufactured and installed in 2009 by Sterilisers New Zealand Ltd and is designed to operate at 544kPa and 1620C.
- Tapuhia landfill has an incinerator (not used) donated by Rotary Japan/ JICA at same time as Vava'u in 2007 (see Photo1). It was in a locked secure structure but lack of access makes it difficult to adequately judge its condition.
- NA = Not Applicable
- NM = Not Measured
- ~ = estimation based on estimates of weekly bin loads
- It is possible that this disproportionately high figure may be influenced by waste created from the substantial damage Cyclone Ian caused the hospital in January 2014

3.2 Vaiola Hospital, Tongatapu

3.2.1 Wastestreams, Treatment Constraints and Costs

Vaiola Hospital generates general wastes, healthcare wastes (including, infectious waste, sharps and pharmaceutical wastes) in the approximate quantities described in Table 3. They do not generate cytotoxic waste. They do not have an incinerator. There is a relatively new (2009) steam sterilizer specifically located for treating healthcare waste (**Photo 3**), but this appears to have insufficient capacity to treat all healthcare waste volumes (see further discussion in Key Issues, section 4.1.1).

Note that hospital representatives indicated that pathological waste is routinely returned to the family for home burial in Tongan culture.

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 Vaiola Hospital:

- There is no waste management policy, plan or formalised waste management procedure. The Environmental Health Inspector oversees waste management and a maintenance team is responsible for waste disposal.
- There is an infection control policy but it does not include waste management procedures.
- There is no formal waste auditing or inspections, however there has recently been a waste management committee formed.

3.2.3 Training

None of the hospitals audited in Tonga have a formal training program in place that covers infection control, waste segregation, incinerator (or other treatment infrastructure) operation or any other topic related to healthcare waste management. However, last year a one-week training program in infection control was held in Tongatapu, funded by JICA, and attended by public health and infection control officers from all four hospitals.

There were no records of historical training sessions having taken place. Anecdotally, waste management training is communicated informally upon new staff employment at a hospital, and this is restricted to basic infection control policy (provided by the infection control officer) and waste handling and disposal/ treatment practices and treatment equipment operation (provided by the environmental health inspector).

There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation. Quite the contrary in fact – staff with waste management related responsibility were keen to accommodate us because for them it was an opportunity for an outside “expert” to help them to get improvements that they otherwise felt they were not empowered enough to obtain. Also, there seemed to be a culture present that the very fact we were from “outside” of Tonga indicated we must be more knowledgeable on waste management practices than locals.

3.3 Prince Ngu Hospital, Vava'u

3.3.1 Wastestreams, Treatment Constraints and Costs

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

Note that hospital representatives indicated that pathological waste is routinely returned to the family for home burial in Tongan culture.

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

3.3.2 Waste Management and Infection Control Framework

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

- There is no waste management policy, plan or formalised waste management procedure. The Environmental Health Inspector oversees waste management and a maintenance team is responsible for waste disposal.
- There is no documented infection control policy. There is however a recently established Infection Control Committee with a quarterly work plan, so it is expected that a documented policy will be developed
- There is no formal waste auditing or inspections, however there has recently been a waste management committee formed.

3.3.3 Training

None of the hospitals audited in Tonga have a formal training program in place that covers infection control, waste segregation, incinerator (or other treatment infrastructure) operation or any other topic related to healthcare waste management. However, last year a one-week training program in infection control was held in Tongatapu, funded by JICA, and attended by public health and infection control officers from all four hospitals. This training was the catalyst for the recent establishment of an infection control committee and quarterly work plan at Prince Ngu.

There were no records of historical training sessions having taken place. Anecdotally, waste management training is communicated informally upon new staff employment at a hospital, and this is restricted to basic infection control policy (provided by the infection control officer) and waste handling and disposal/ treatment practices and treatment equipment operation (provided by the environmental health inspector).

There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation. Quite the contrary in fact – staff with waste management related responsibility were keen to accommodate us because for them it was an opportunity for an outside “expert” to help them to get improvements that they otherwise felt they were not empowered enough to obtain. Also, there seemed to be a culture present that the very fact we were from “outside” of Tonga indicated we must be more knowledgeable on waste management practices than locals.

3.4 Niu'eiki Hospital, 'Eua

3.4.1 Wastestreams and Quantities

Niu'eiki Hospital generates general wastes, healthcare wastes (including infectious waste and sharps) in the approximate quantities provided by hospital staff in Table 3 - there is no formal quantification of waste volumes undertaken.

Fuel costs are estimated at \$20^{TOP} (\$10.80USD) per week for transport of all wastes to the nearby dump and \$500^{TOP} per year (\$5.20USD per week) for proportion of dumpsite manager's time to treat hospital's waste. This equates to \$16 USD per week total.

Note that hospital representatives indicated that pathological waste is routinely returned to the family for home burial in Tongan culture.

3.4.2 Waste Management and Infection Control Framework

The following summarises the waste management and infection control framework at the Niu'eiki Hospital:

- There is no waste management policy, plan or formalised waste management procedure. The Health Inspector and Infection Control Nurse jointly oversee waste management and waste disposal.
- There is no documented infection control policy.
- There is no formal waste auditing or inspections.

3.4.3 Training

None of the hospitals audited in Tonga have a formal training program in place that covers infection control, waste segregation, incinerator (or other treatment infrastructure) operation or any other topic related to healthcare waste management. However, last year a one-week training program in infection control was held in Tongatapu, funded by JICA, and attended by public health and infection control officers from all four hospitals.

There were no records of historical training sessions having taken place. Anecdotally, waste management training is communicated informally upon new staff employment at a hospital, and this is restricted to basic infection control policy (provided by the infection control officer) and waste handling and disposal/ treatment practices and treatment equipment operation (provided by the environmental health inspector).

There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation. Quite the contrary in fact – staff with waste management related responsibility were keen to accommodate us because for them it was an opportunity for an outside “expert” to help them to get improvements that they otherwise felt they were not empowered enough to obtain. Also, there seemed to be a culture present that the very fact we were from “outside” of Tonga indicated we must be more knowledgeable on waste management practices than locals.

3.5 Niu'ui Hospital, Ha'apai

3.5.1 Wastestreams and Quantities

Niu'ui Hospital generates general wastes, healthcare wastes (including infectious waste and sharps) and recycling in the approximate quantities provided by hospital staff in Table 3 - there is no formal quantification of waste volumes undertaken.

Note that hospital representatives indicated that pathological waste is routinely returned to the family for home burial in Tongan culture.

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

3.5.2 Waste Management and Infection Control Framework

The following summarises the waste management and infection control framework at the Niu'ui Hospital:

- There is no waste management policy, plan or formalised waste management procedure. The Health Inspector oversees waste management and waste disposal on site.
- There is no documented infection control policy.
- There is no formal waste auditing or inspections.

3.5.3 Training

None of the hospitals audited in Tonga have a formal training program in place that covers infection control, waste segregation, incinerator (or other treatment infrastructure) operation or any other topic related to healthcare waste management. However, last year a one-week training program in infection control was held in Tongatapu, funded by JICA, and attended by public health and infection control officers from all four hospitals.

There were no records of historical training sessions having taken place. Anecdotally, waste management training is communicated informally upon new staff employment at a hospital, and this is restricted to basic infection control policy (provided by the infection control officer) and waste handling and disposal/ treatment practices and treatment equipment operation (provided by the environmental health inspector).

There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation. Quite the contrary in fact – staff with waste management related responsibility were keen to accommodate us because for them it was an opportunity for an outside “expert” to help them to get improvements that they otherwise felt they were not empowered enough to obtain. Also, there seemed to be a culture present that the very fact we were from “outside” of Tonga indicated we must be more knowledgeable on waste management practices than locals.

4 Key Healthcare Waste Management Issues in Tonga

This section takes the collected information from Section 3 and summarises and critically assesses it, for each hospital 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 against each of the criteria is presented in **Appendix C**. Target areas have been rated as follows:

Table 4: Assessment criteria rating system	
	Meets minimum standards assessment criteria
	Partially meets minimum standards assessment criteria.
	Does not meet minimum standards assessment criteria.

Table 5 highlights the key areas of concern, both per hospital, and in terms of health services delivery across Tongan hospitals, as part of this assessment.

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

Table 5: HEALTHCARE WASTE – KEY ISSUES FOR TONGA

Scale	Category	Item	Minimum Standard Criterion	Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga - 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 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	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	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	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 Vaiola Hospital – Key Issues

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

- Signage is rarely present, but there is good segregation at Vaiola Hospital with yellow bags and bins used throughout for non-sharps healthcare waste.
 - However, sharps are collected in yellow bags placed inside large reusable sharps containers (see **Photo 2**). While most needles observed inside these were retained with plastic caps, there were also a number of exposed needles observed which could easily puncture through the yellow bags upon handling.
- What actually occurs with disposal of healthcare waste including sharps containers is unclear. There is a relatively new (2009) steam sterilizer specifically located for treating healthcare waste (**Photo 3**), but this appears to have insufficient capacity to treat all healthcare waste volumes. The cleanliness of the unit and the building it was housed in, combined with the limitation of its capacity, suggests it is not used and all waste is taken untreated to Tapuhia landfill (an \$8M engineered facility commissioned in 2008) by health inspection staff.
 - The landfill is well-engineered and healthcare waste appeared to be segregated from other wastes, buried and covered regularly.
- There is no documented waste management planning system in place.
- There is no structured training or waste segregation auditing program in place.
- No PPE such as gloves, protective clothing, eye protection or covered footwear was observed for waste management staff and spill control kits were not observed anywhere throughout the facility.

4.1.2 Prince Ngu Hospital – Key Issues

The most significant healthcare waste management issues observed at Prince Ngu were:

- There is no signage and poor segregation – only sharps are separated into sharps containers (combination of reusable and disposable) and other healthcare waste and general waste are combined in the same bins with no plastic bag liners. The bins show evidence of blood stains indicating they are not cleaned.
- Sharps are typically incinerated onsite at Prince Ngu, but it was not operational on the day of visit due to possible theft of its transformer. Based on the large number of sharps spread all over the floor of the incineration building, it appears that the incinerator has been inoperable for some time. Once incinerated the sharps are taken to the dump site.
 - Sharps are spilling out of cardboard boxes on the floor of the incineration building (**Photo 4**) and, given the prevalence of open footwear worn by staff; these exposed non-treated needles are a potential needle stick injury risk.
- Non sharps waste is taken by hospital staff in their own truck to Kalaka Final Disposal site (dump). The truck is in a state of disrepair (**Photo 5**) and loads of untreated infectious wastes are unsecured.

- Kalaka dump site does have a leachate collection system but the is an open surface dump and the facility is open to the public and, potentially, scavengers.
- There is no documented waste management planning system in place. However, Prince Ngu has recently instituted a Waste Management Committee with a quarterly workplan.
- There is no structured training or waste segregation auditing program in place.
- No PPE such as gloves, protective clothing, eye protection or covered footwear was observed for waste management staff and spill control kits were not observed anywhere throughout the facility.

4.1.3 Niu'eiki Hospital – Key Issues

The most significant healthcare waste management issues observed at Niu'eiki Hospital were:

- There is no signage and the only segregation is sharps that are separated into sharps containers (reusable). Other healthcare waste and general waste are combined in the same bins with no plastic bag liners.
- There is no incinerator. Sharps and combined other wastes are taken to the dump site (untreated) where they are supposed to be “burned and buried”. Observation at the dumpsite indicates that much of the waste is not burnt, or may be dumped for some time before burning.
 - There was an area where hospital waste is supposed to be buried (**Photo 6**), but investigation of the area did not specifically find evidence of healthcare waste or a recently dug/ covered hole.
 - The dump site is an open surface dump and the facility is open to the public and, potentially, scavengers.
- There is no documented waste management planning system in place.
- There is no structured training or waste segregation auditing program in place.
- No PPE such as gloves, protective clothing, eye protection or covered footwear was observed for waste management staff and spill control kits were not observed anywhere.

4.1.4 Niu'ui Hospital – Key Issues

The most significant healthcare waste management issues observed at Niu'ui Hospital were:

- There is no signage and the only segregation is sharps that are separated into sharps containers (reusable). Other healthcare waste and general waste are combined in the same bins with no plastic bag liners.
- There is no operating incinerator or alternative form of treatment technology. In 2007 an incinerator was donated by Japanese Rotary/ JICA – the same as that at Prince Ngu in Vava'u. However its enclosure's roof was blown over and damage sustained in a small

cyclone about 6 months after becoming operational so they stopped using it. Now it is totally rusted and ruined (see **Photo 7**).

- All wastes including sharps are dumped on hospital grounds about 70m from the main building (untreated) where they are burned.
 - Clearly unburnt sharps waste was discovered around the edge of the dump area, hidden by overgrown grass and other foliage (**Photo 8**). An unburnt full cardboard sharps container was also found amongst the rubbish (**Photo 9**)
 - The dump site is an open surface dump and the facility is relatively open to the public (but within hospital grounds). Like most parts of Tonga, pigs were evident, wandering around within 50m of the dump.
- There is no documented waste management planning system in place.
- There is no structured training or waste segregation auditing program in place.
- Spill control kits were not observed anywhere.

5 Consultation

Apart from hospital staff across all four hospitals, discussions were also held with a representative from the Ministry of Environment & Climate (Waste Management & Pollution), Ms. Mafile'o (Le'o) Masi.

She was supportive of the project and the need for sustainable healthcare management for Tonga. Le'o was extremely helpful in arranging all meetings at the four hospitals, including visits to waste disposal facilities offsite, as well as the collection of operational statistics and information from each.

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.

All hospitals audited nominated the Japanese International Cooperation Agency (JICA) as having provided either technical or material support. JICA funded and ran a centralized training workshop for key waste management and infection control staff 2-3 years ago.

7 Analysis of Options for Sustainable Healthcare Waste Management in Tonga

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

Table 6 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
A. Waste Management Framework	There is no documented waste management planning system in place and limited evidence of waste management committees.	Establish a waste management framework including: <ul style="list-style-type: none"> • Waste Management Plan • Responsible officer for implementation of waste management plan • Waste management committee, appropriate to the scale of each facility.
B. Signage, Segregation & Containers	Segregation and containment practices are generally below minimum standard in that: <ul style="list-style-type: none"> • There is virtually no signage present • With the exception of Vaiola Hospital, the only segregation regularly practiced is for sharps. • With the exception of Vaiola Hospital, colour coded bags (liners) and bins are not present and storage is not adequate. 	Improve segregation practices by: <ul style="list-style-type: none"> • Supply of colour-coded waste bins and plastic liners in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. • Supply of small number of colour-coded wheelie bins (where required) per hospital to act as both in-ward/department storage and internal transport trolleys. • Supply of signage to explain the colour-coded segregation system as well as posters to promote it.
C. Training & Audit	There is no structured training or waste segregation auditing program in place	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"> 1. SPREP staff, or 2. International technical training providers (or a combination of both), <ul style="list-style-type: none"> - as no competent healthcare waste management training capability exists in Tonga.
D. Treatment	The method for treatment of healthcare waste is typically <u>not</u> in accord with required standards.	Treatment using one (or a combination) of the following for each hospital: <ol style="list-style-type: none"> 1. Rotary kiln (highest temperature) 2. Incineration (high, medium temperature) 3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land) 4. Autoclave 5. Chemical 6. Microwave

		7. Encapsulation 8. Landfill (without disinfection) 9. Onsite burial 10. Shredding
E. Occupational Health and Safety	Waste handlers regularly do not use appropriate PPE including overalls /protective clothing, gloves and eye protection. Spill control kits were not observed anywhere.	Procurement of Consumables (PPE): <ul style="list-style-type: none"> • Supply spill kits and appropriate PPE including overalls/protective clothing, gloves and eye protection for all waste handlers. • Incinerator staff are provided with additional PPE such as face masks and noise protection.

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 6)
- The waste management process, from generation to transport up to the treatment location (B in Table 6)
- Training systems for sustainable healthcare waste management (C in Table 6)
- OHS related protection for waste handlers (E in Table 6)

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 6. 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 Tonga's Stage 2 assessment:

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

7.2.1 Waste Treatment Systems Relevant for Tonga

The Stage 2 local feasibility assessment (for Tonga) took these first 4² technologies and assessed them against the ten dot point criteria listed in 7.2. These criteria are explored qualitatively in **Appendix D**. Table 7 takes these qualitative descriptions and assigns a quantitative score from 1 – 5, to prioritise local applicability of technology options to the Tongan context, on a relative basis as follows:

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

¹ As defined in *Management of Solid Health-Care Waste at Primary Health-Care Centres - A Decision-Making Guide*, WHO (2005)

² 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.

The treatment technologies suitable for the Tongan context are ranked in order of preference in Table 7:

Stage 1-Approved Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility								Total Score out of 50	Rank
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment protected	Durability	Ease of operation		
Incineration at high temperature (>1000°C)	1	5	4	4	4	4	3	3	3	3	34	1
Incineration at med. temperature (800 - 1000°C)	4	4	3	3	2	4	4	2	2	4	32	2
Low temperature burning (<400°C)	5	3	1	2	1	3	5	1	5	5	31	3
Autoclave with shredder	2	4	4	3	5	2	2	3	2	2	29	4

Notes:

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

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.
- **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.
- **Autoclaving** is an acceptable disinfection practice where units with shredder are affordable and locked in supplier maintenance and training contracts are in place, but borderline beyond Tongatapu due to lack of lined landfills and increased complexity of machinery.

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 Tonga does not currently generate cytotoxic wastes and typically returns anatomical waste to the family of the patient for cultural reasons, limitations regarding these wastes are not particularly relevant for healthcare waste treatment choices in Tonga.

7.2.1 Treatment Investment Options for individual Tongan Hospitals

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. All four hospitals in Tonga require some investment in either replacement or maintenance of infrastructure to achieve this, as described by their respective treatment weaknesses in sections 4.1.1 – 4.1.4.

Table 8 determines ‘intervention’ options that are suggested to improve treatment of healthcare waste in each Tongan hospital visited. Shading in green indicates where investment is proposed, while orange shading shows where a technology consideration is also relevant.

Table 8: Technology Options Applicable for Each Hospital in Tonga	
Remaining Technology Options	Technology Applicability
Vaiola Hospital	
Disinfection & Encapsulation (only sharps assessed)	Not applicable to Vaiola, as autoclaved waste goes to Tapuhia Landfill, which is the only new and functional sanitary landfill in Tonga.
Incineration at high temperature (>1000°C)	The existing autoclave/ steam sterilizer has insufficient capacity to treat all healthcare waste (and is possibly not used at all, meaning large infectious waste quantities are taken to landfill untreated). ENVIRON recommends to: <ul style="list-style-type: none"> Procure a new incinerator – a MediBurn 30 model has a manufacturer’s claimed throughput of 200 kg/day of healthcare waste. At Vaiola’s estimated rate of 1,000 kg healthcare waste per week (10% of which is sharps) this unit is theoretically large enough. However, it is likely that the existing autoclave would need to be operated in tandem to ensure these volumes (plus future growth) could be managed. Alternatively a larger incinerator may be required.
Incineration at med. temperature (800 - 1000°C)	Not applicable to Vaiola - large enough to justify a better performing larger higher temperature option.
Autoclave with shredder	The existing autoclave should be used for healthcare waste (with sharps as a priority) to its maximum capacity, ensuring sufficient temperature/ pressure/ time, followed by landfill of treated waste at Tapuhia Landfill. Using this existing infrastructure alongside a new high temperature incinerator allows for current volumes to be treated with some spare capacity. Since autoclaved waste goes to Tapuhia Landfill, which is the only new and functional sanitary landfill in Tonga, it is acceptable to autoclave in this instance without a shredder (not part of the current set up at Vaiola).
Low temp. burning (<400°C)	Not applicable to Vaiola - it has sufficient waste volumes to justify better performing disinfection technology.

Table 8: Technology Options Applicable for Each Hospital in Tonga

Remaining Technology Options	Technology Applicability
Prince Ngu	
Disinfection & Encapsulation (only sharps assessed)	Not applicable when incinerator is operating.
Incineration at high temperature (>1000°C)	Not applicable to Prince Ngu as current single chamber incinerator is sufficient for volumes handled if replacement transformer is fitted and it is made operational again.
Incineration at med. temperature (800 - 1000°C)	The existing incinerator should be supplied with a replacement transformer urgently and repaired to provide the hospital with a functional treatment option.
Autoclave with shredder	Not applicable to Prince Ngu as current single chamber incinerator handles volumes produced when it is operational.
Low temperature burning (<400°C)	Not applicable to Prince Ngu as it has sufficient waste volumes to justify a better performing disinfection technology choice.
Niu'eiki Hospital	
Disinfection & Encapsulation (only sharps assessed)	Given the small volumes of waste involved, and the small and dispersed population on 'Eua Island, a low cost alternative to incineration could be implemented, at least in the short term. For sharps this could involve concrete encapsulation of disinfected sharps in a metal drum, at the dump site. The drum could then be buried at the dump.
Incineration at high temperature (>1000°C)	Not applicable to Niu'eiki as waste volumes are insufficient to justify the investment required.
Incineration at med. temperature (800 - 1000°C)	Healthcare waste volumes at Niu'eiki appear to be underestimated by a factor of 10, when compared to Vaiola and Prince Ngu. Adjusting healthcare waste generation to approximately 50kg/ week, this would be sufficient to consider a small medium temperature incinerator. However, given Niu'eiki's lack of even the most basic investment in health care waste management (supply of bins would be a forward step) it is hard to foresee the fuel and related operating costs of approximately \$5,000 pa being sustainable.
Autoclave with shredder	Not applicable to Niu'eiki 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 'Eua Island, a low cost alternative to incineration could be implemented, at least in the short term. This could involve:</p> <ul style="list-style-type: none"> • Building a concrete floored brick burning block at the dump site • Burning sharps separately in the burning block, to disinfect, followed by concrete encapsulation and burial at the dump. • Burning healthcare waste separately in the burning block, to disinfect, followed by burial at the dump. <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 'Eua Island is small and dispersed, the air quality impact from low temperature burning of healthcare waste is not a pressing issue.</p>
Niu'ui Hospital	
Disinfection & Encapsulation (only sharps assessed)	Given the small volumes of waste involved, and the small and dispersed population on 'Lifuka Island, a low cost alternative to incineration could be implemented, at least in the short term. For sharps this could involve 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 Niu'ui as waste volumes are insufficient to justify the investment required.

Table 8: Technology Options Applicable for Each Hospital in Tonga

Remaining Technology Options	Technology Applicability
Incineration at med. temperature (800 - 1000°C)	Healthcare waste generation is reported to be approximately 100kg/ week. This appears a little high given the number of beds. Regardless, this volume would be sufficient to consider a small medium temperature incinerator, to replace the ruined onsite incinerator. However, given Niu'ui's lack of investment in health care waste management it is hard to foresee the fuel and related operating costs of approximately \$5,000 pa being sustainable.
Autoclave with shredder	Not applicable to Niu'ui 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 Lifuka Island, a low cost alternative to incineration could be implemented, at least in the short term. This could involve:</p> <ul style="list-style-type: none"> • Building a concrete floored brick burning block at the back of the hospital, by demolishing the ruined incinerator unit and utilizing the existing two bricked walls and adding a third. • Fencing the waste dump/ burning area • 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. <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 Lifuka 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 Tonga. Further details and guidance on each recommendation are provided in **Appendix E**.

Table 9 provides a summary of the recommendations for Tonga. A colour coding system is used to describe the degree of applicability of each recommendation to each hospital as follows:

	Fully Applicable
	Partially applicable
	Not applicable

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

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

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

Table 9: Recommendations for Tonga		Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga Overall
Applicable to						
Recommendation 1: Develop a Waste Management Framework						
Description	<ul style="list-style-type: none"> A <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility Appoint an <i>officer responsible</i> for the development and implementation of the Healthcare Waste Management Plan A <i>waste management committee</i>, appropriate to the scale of each facility. 					
Output	<ul style="list-style-type: none"> An agreed <i>Healthcare Waste Management Plan</i>, specific to each healthcare facility outlining procedures and guidelines, waste definitions and characterisation, segregation techniques, containment specifications and storage practices, collection and transport, treatment and disposal and emergency procedures Accountability for healthcare waste management through clearly defined roles and responsibilities 					
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Plan approved by Department of Health (all facilities) Approved budget for implementation of Healthcare Waste Management Plan The Plan should be regularly monitored, reviewed, revised and updated. Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies. 					
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided Ongoing – Low 					
Recommendation 2: Procurement of Consumables (Segregation & Storage)						
Description	<ul style="list-style-type: none"> Supply of colour-coded waste bins and plastic liners in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. Supply of small number of colour-coded wheelie bins (where required) per hospital to act as both in-ward/department storage and internal transport trolleys. Supply of signage to explain the colour-coded segregation system as well as posters to promote it. 					
Output	Adequate supply of consumables to bed down more rigorous segregation practices					
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Wastes are segregated at their place of production. Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. Zero Needle Stick Injuries. 					

Table 9: Recommendations for Tonga		Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga Overall
Applicable to						
Costs (\$US)	Establishment – Low; Ongoing - Low, sustainably funded by country					
Recommendation 3: Provide a Sustainable Training Program						
Description	<ul style="list-style-type: none"> Development and delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies) This could be facilitated/ delivered by SPREP staff, or outside trainers, or a combination of both, as no competent healthcare waste management training capability exists in Tonga Training should be coordinated with other countries' needs in the region 					
Output	<ul style="list-style-type: none"> Improvement of personnel skills and competency in managing healthcare waste Promotion of the advantages of sustainable segregation and storage techniques for the different waste streams and an understanding of the health and safety risks resulting from the mismanagement risks of healthcare waste. 					
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Competency Assessments Refresher Training No/very little cross contamination between waste streams demonstrated by waste audits. 					
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low-medium per facility if regional synergies are utilised Ongoing – Low-medium per facility if regional synergies are utilised 					
Recommendation 4: Improved Treatment Infrastructure^{U2H}						
Description	<ul style="list-style-type: none"> Procurement of a new incinerator for Vaiola Hospital, within existing building that houses the waste treatment autoclave, with maintenance support contract Repair of existing incinerator for Prince Ngu Hospital, to replace missing transformer. Establish maintenance support contract Procurement of a new small (medium temperature) incinerator and protective structure for Niu'eiki Hospital, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Tongan MoH) Procurement of a new small (medium temperature) incinerator and protective structure for Niu'ui Hospital, with maintenance support contract (only if ongoing costs of approx. \$5,000 USD per year can be met by the Tongan MoH) 					
Output	A disposal system that reduces the potential hazard posed by healthcare waste, while endeavoring to protect the environment.					
Monitoring & Evaluation	Assessment of the following should be regularly undertaken for new and existing incinerators: <ul style="list-style-type: none"> Operations and construction (e.g. pre-heating and not overloading the incinerator and 					

Table 9: Recommendations for Tonga		Vaiola Hospital	Prince Ngu Hospital	Niu'eiki Hospital	Niu'ui Hospital	Tonga Overall
		Applicable to				
Indicators	incinerating at temperatures above 800°C only) <ul style="list-style-type: none"> Maintenance program – are maintenance issues dealt with promptly? Ensure burn times are sufficient to reduce waste ash volumes 					
Costs (\$US)	<ul style="list-style-type: none"> Establishment – High (approx.. \$50,000 for high temperature unit (Vaiola), \$5,000 for replacement of transformer (Prince Ngu) and \$7,000 each for small medium-temperature units for Niu'eiki and Niu'ui respectively) including housing and commissioning costs; Ongoing – medium (fuel and maintenance) 					
Recommendation 5: Procurement of Consumables (PPE)						
Description	<ul style="list-style-type: none"> Supply appropriate PPE including overalls/protective clothing, gloves and eye protection for all waste handlers. Incinerator staff are provided with additional PPE such as face masks and noise protection. 					
Output	Adequate supply of PPE for protection of waste handlers					
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> PPE is provided to all staff and staff are aware on how to protect themselves from injuries and infectious wastes Zero Needle Stick Injuries. 					
Costs (\$US)	Establishment – Low; Ongoing - Low, sustainably funded by country					
Monitoring & Evaluation Indicators	<ul style="list-style-type: none"> Plan approved by Department of Health (all facilities) Approved budget for implementation of Healthcare Waste Management Plan The Plan should be regularly monitored, reviewed, revised and updated. Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies. 					
Costs (\$US)	<ul style="list-style-type: none"> Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided Ongoing – Low 					

U2H - Unique to hospital

8.1 Implementation Priorities

8.1.1 Recommendation 1: Develop a Waste Management Framework

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

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

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
- Responsible officer or healthcare waste management committee set up as part of infection control.
- Definitions of responsibilities and key accountabilities of responsible officers and Waste Management Committee developed for inclusion in Waste Management Plan.

8.1.1.2 Medium Term (6 months-1 year)

- Formulate a Draft Waste Management Plan drawing on the results of this 'Baseline Assessment' (i.e. present situation, quantities of waste generated, possibilities for waste minimization, identification of treatment options, identification and evaluation of

waste-treatment and disposal options, identification and evaluation of record keeping and documentation and estimations of costs relating to waste management)

- The draft discussion document would be prepared in consultation with hospital staff, and officials from the relevant government agencies.

8.1.1.3 Long Term (1year-3 years)

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

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

Waste should be collected in accordance with the schedules specified in the Waste Management Plan (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 (all but Vaiola)
 - Wheelie bins (Prince Ngu – 3, Niu'eiki and Niu'ui – 1 each, Vaiola – not required)
 - Classification and segregation signage as well as instructional posters to promote good healthcare waste management practices (all 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 to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies).

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

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

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

8.1.3.1 Short Term (0-6 months)

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

8.1.3.2 Medium Term (6 months-1 year)

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

8.1.3.3 Long Term (1 year-3 years)

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

8.1.4 Recommendation 4: Improved Treatment Infrastructure ^{U2H}

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. All four hospitals in Tonga require some investment in either replacement or maintenance of infrastructure:

Vaiola Hospital - Procurement of a new incinerator (high priority)

Prince Ngu Hospital - Repair of existing incinerator to replace missing transformer (high priority).

Niu'eiki Hospital - Procurement of a new small (medium-temperature) incinerator and protective structure for Niu'eiki Hospital, with maintenance support contract (*only if ongoing costs of approx. \$5,000 USD per year can be met by the Tongan MoH; shorter term alternatives are indicated below*)

Niu'ui Hospital - Procurement of a new small (medium temperature) incinerator and protective structure for Niu'ui Hospital, with maintenance support contract (*only if ongoing costs of approx. \$5,000 USD per year can be met by the Tongan MoH; shorter term alternatives are indicated below*)

^{U2H} – Unique to hospital

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

The existing autoclave/ steam sterilizer has insufficient capacity to treat all healthcare waste (and is possibly not used at all, meaning large infectious waste quantities are taken to landfill untreated). It is recommended to:

- Ensure existing autoclave is used for healthcare waste (with sharps as a priority) to its maximum capacity, ensuring sufficient temperature/ pressure/ time, followed by landfill of treated waste at Tapuhia Landfill.
- *Start the process of procurement of a new incinerator* – a MediBurn 30 model (for example) has a manufacturer's claimed throughput of 200 kg/day of healthcare waste. At Vaiola's estimated rate of 1,000 kg healthcare waste per week (10% of which is sharps) this unit is theoretically large enough. However, it is likely that the autoclave would need to be operated in tandem to ensure these volumes (plus future growth) could be managed. Alternatively a larger incinerator may be required.

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

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

(c) Long Term (1-3 years)

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

8.1.4.2 Prince Ngu Hospital

(a) Short Term (0-6 months)

- Repair existing incinerator to replace missing transformer (high priority)
- *Using appropriate PPE*, immediately gather up and treat backlog of sharps littered across the floor of the incinerator building either by:
 - Incineration or
 - (if incinerator repair is stalled) by encapsulation in concrete within drums or containers (see Section 7)

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

- Procure supplier support and maintenance contract, possibly packaged together with other incinerator purchases, even if the incinerator make and model is different to those procured elsewhere.

(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

8.1.4.3 Niu'eiki Hospital

(a) Short Term (0-6 months)

- Ensure sharps and other infectious wastes are burnt upon receipt at dump site (only 5 minutes' drive away), before burial in a separate location to other wastes
- Given the small volumes of waste involved, and the small and dispersed population on 'Eua Island, a low cost alternative to incineration could be implemented. This could involve:
 - Building a concrete floored brick burning block at the dump site
 - Burning sharps separately in the burning block, to disinfect, followed by concrete encapsulation in a metal drum. The drum could then be buried at the dump
 - Burning healthcare waste separately in the burning block, to disinfect, followed by burial at the dump (separate burning is suggested as only the sharps need to be encapsulated).
- Establish a procedure to measure all waste taken to the dump site. 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.

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

- Budget withstanding, *start the process of procurement of a new incinerator* – one that is sized according to Niu'eiki's (likely) weekly throughput of approximately 50kg/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.

- Given Niu'eiki's lack of investment in health care waste management, this procurement should only be pursued if agreement is reached with the Tongan MoH to meet the ongoing costs of approx. \$5,000 USD per year in incinerator operating expenses
- Another critical aspect to purchase of incinerators in the Tongan situation is the inclusion of a supplier support and maintenance contract.
- Procure, install and commission new incinerator, with supplier support and maintenance contract.

(c) Long Term (1-3 years)

- Incineration remains the long term preference. If one is procured, 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.

8.1.4.4 Niu'ui Hospital

An important consideration for investment in improved healthcare waste management at Niu'ui Hospital is its longevity in the medium term. Cyclone Ian devastated most buildings in the Ha'apai group of islands in January 2014, including the hospital which lost much of its roof. There is currently temporary roofing in part which is suitable in the short term. The Public Health Inspector for the hospital, Mr Mosese Fifita, indicated that there had been very preliminary talks with the World Bank about the possibility of building a new hospital to replace Niu'ui, which would probably be located elsewhere on the island. This eventuality needs to be considered in any infrastructure investment decision, but such a project if it went forward would still likely be years in the development.

(a) Short Term (0-6 months)

- Ensure sharps and other infectious wastes are burnt before burial onsite
- Fence the onsite waste disposal area
- Given the small volumes of waste involved, and the small and dispersed population on Lifuka Island, a low cost alternative to incineration could be implemented, at least in the short term. This could involve:
 - Building a concrete floored brick burning block at the back of the hospital, by demolishing the ruined incinerator unit and utilizing the existing two bricked walls and adding a third.
 - 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.

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

- Budget withstanding, *start the process of procurement of a new incinerator* – one that is sized according to Niu'ui's (likely) weekly throughput of approximately 50kg/week of healthcare waste (their report of 100kg/week is high compared to other hospitals in Tonga and likely to be unreliable due to a lack of measurement scale). 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.
- Given Niu'eiki's lack of investment in health care waste management, this procurement should only be pursued if agreement is reached with the Tongan MoH to meet the ongoing costs of approx. \$5,000 USD per year in incinerator operating expenses
- Another critical aspect to purchase of incinerators in the Tongan situation is the inclusion of a supplier support and maintenance contract.
- Procure, install and commission new incinerator, with supplier support and maintenance contract.

(c) Long Term (1-3 years)

- Incineration remains the long term preference. If one is procured, 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 Consumables (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.

8.1.5.1 Short Term (0-6 months)

- Procurement of in-hospital healthcare waste management PPE including overalls/protective clothing, gloves and eye protection
- Incinerator staff are provided with additional PPE such as face masks and noise protection
- Procurement plan developed to ensure the sustainable supply of healthcare waste management resources.

8.1.5.2 Medium Term (6 months-1 year)

- A system is set up to monitor correct use of PPE.

8.1.5.3 Long Term (1-3 years)

Nil.

Appendix A

Photo Log



Photo 5: Incinerator at Tapuhia Landfill, Tongatapu, Tonga
(taken 31/03/2014 by Geoff Latimer ref:DSC03878)



Photo 6: Type of sharps container used at Vaiola Hospital, Tongatapu, Tonga
(taken 31/03/2014 by Geoff Latimer ref:DSC03848)



Photo 7: Autoclave (for waste treatment) at Vaiola Hospital, Tongatapu, Tonga (taken 31/03/2014 by Geoff Latimer ref:DSC03867)



Photo 8: Untreated sharps on incinerator building floor at Prince Ngu Hospital, Vava'u, Tonga (taken 01/04/2014 by Geoff Latimer ref:DSC03918)



Photo 5: Truck used for transport of all wastes to offsite dump, Prince Ngu Hospital, Vava'u, Tonga (taken 01/04/2014 by Geoff Latimer ref:DSC03909)



Photo 6: Overgrown area where healthcare waste was buried, waste dump on 'Eua Island, Tonga (taken 13/05/2014 by Geoff Latimer ref:DSC04606)



Photo 7: Old ruined incinerator at Niu'ui Hospital, Lifuka Island, Ha'apai Group, Tonga (taken 15/05/2014 by Geoff Latimer ref:DSC04662)



Photo 8: Unburnt sharps on ground at unfenced dump, hospital grounds at Niu'ui Hospital, Lifuka Island, Ha'apai Group, Tonga (taken 15/05/2014 by Geoff Latimer ref:DSC04666)



Photo 9: Unburnt full sharps box on ground at unfenced dump, hospital grounds at Niu'ui Hospital, Lifuka Island, Ha'apai Group, Tonga (taken 15/05/2014 by Geoff Latimer ref:DSC04667)

Appendix B

Collected Data from Hospital Audits in Tonga

HOSPITAL DETAILS	Region		Tongatapu (Tonga)		Vava'u (Tonga)		'Eua (Tonga)		Ha'apai (Tonga)	
	Facility Name & Contact Information	Hospital Name	Vaiola Hospital, Tofoa		Prince Ngu Hospital, Neiafu		Niu'eiki Hospital, Angaha, 'Eua		Niu'ui Hospital, Hihifo, Ha'apai	
		Contact Name & Position	Isileli Fakailoatonga, Acting Public Health Supervisor		Leopino Fa'asolo Public Health Inspector		'Amelia Vea, Helath Inspector	Dr Kalo Nofo'akifolau, Officer in Charge	Dr. Tevita Vakasiuola, Officer in Charge	Mr Mosese Fifita, Public Health Inspector
		Email	isilelif@yahoo.com.au	-	Pino_faasolo@hotmail.com		lata_vea23sept@yahoo.com	-	tidvak@gmail.com	-
Phone	23200 Ext 38				50110		60790			
Key Services Data	Summary of Services Provided	Medicine, obstetrics/ gynaecology, surgery, peditrics, emergency, radiology, laboratory, ENT, dentistry		Emergency, outpatients, inpatients, reproductive health, NCD clinic, pharmacy, eye clinic, laboratory, pharmacy, dentistry		Emergency, outpatients, inpatients (general care), pharmacy, laboratory (very basic), dental, reproductive health		Emergency care, outpatient care, maternity, minor theatre		
	Pop Served	75,416		15505		5206		7570		
	No. of Beds	274		62		20		18		
	OBD's ¹	58005.8		7467.9		1387		1642.5		
	No. Operations	2702		300		0				
	No. of Births ²	2766		300		115		100		
	Emergency Patients Attended ²					22		500		
	Out-Patients Attended ²	52209		17298		8957		12568		
	No of Staff	680		80		21		31		
WASTE MANAGEMENT PROCESS	Waste Steams Managed	Estimates	Volumes (kg/wk)	Cost ext. (\$US)	Volumes (kg/wk)	Cost ext. (\$US)	Volumes (kg/wk)	Cost ext. (\$US)	Volumes (kg/wk)	Cost ext. (\$US)
		Healthcare Waste	915		180		5	\$ 10.80	100	
		Sharps	111		10		8	\$ 5.19	5	
		Pharmaceutical	Not measured		Not measured		Not measured		N/A	
		Cytotoxic	N/A		N/A		N/A		N/A	
		General	Not measured		110		20		500	
		Recycling	N/A		N/A		2		200	
		TOTAL	1026	\$ -	300	\$ -	35	\$ 15.99	805	\$ -

	Generation & Segregation	Dedicated Containers/ Bags		Y	N	N	N			
		Colour Coding		Y	N	N	N			
		Sharps segregated & secure		Y	Y	Y	Y			
		Signage Present		N	N	N	N			
	Internal Handling	Degree of manual handling of bags		Medium	High	High	High			
		Internal Transport Mode		Wheelie Bin	Wheelie Bin	Manual	Manual			
		Spill Kit Present		N	N	N	N			
	Storage	Dedicated & Appropriate Area		Y	N	N	N			
		Loading/unloading acceptable		N	N	N	N			
		Spill Kits Present		N	N	N	N			
		Monitoring & record keeping occurs		N	N	N	N			
	Treatment	Treatment per Waste Stream		Tech. Type	Int/Ext	Tech. Type	Int/Ext	Tech. Type	Int/Ext	
		Healthcare Waste		Landfill (without treatment)	External	Landfill (without treatment)	External	Landfill (without treatment)	External	Burn on site Internal
		Sharps		Landfill (without treatment)	External	Incinerate (internal)	Internal	Landfill (without treatment)	External	Burn on site Internal
		Pharmaceutical		Landfill (without treatment)	External	Landfill (without treatment)	External	Landfill (without treatment)	External	
		Cytotoxic								
		General		Landfill (without treatment)	External	Landfill (without treatment)	External	Landfill (without treatment)	External	Burn on site Internal
		If incinerator present		Landfill has an incinerator (not/ never used) donated by Rotary Japan/ JICA at same time as Vava'u		Many Wheelie bins have no/ broken wheels, some broken lids, typically no bags used for hcw - hospital has little focus on IC		No incinerator. Sharps are buried at dump - possibly burnt also but unclear		Incinerator donated by Japanese Rotary/ JICA - same as Vava'u. Enclosure roof was blown over and damage sustained in a small cyclone about 6 months after becoming operational so couldn't use it. Now it is totally rusted and ruined.
		Make, Model, Year commissioned		2007		2007		2007		

		Operating Temp (°C)								
		No. chambers	N/A		1		N/A		N/A	
		Condition	Not operating		Broken down				Broken down	
			Per week	Per year	Per week	Per year	Per week	Per year	Per week	Per year
		Waste Throughput (tonnes)	1026	53352	190	9880	13	676	105	5460
		Operating Hours (hr)	N/A		Not available		N/A		N/A	
		Fuel	N/A		Diesel		N/A		N/A	
		Fuel use (kg/litres)	N/A	N/A	N/A	Not available	N/A	N/A	N/A	N/A
		Fuel use per kg waste burnt	N/A		N/A		N/A		N/A	
		Technology siting and operation issues	Limited capacity for autoclaving yellow bags before landfilling, although limited evidence that this occurs.		Has incinerator but not operational on day of visit due to possible 'theft' of transformer.				Waste is dumped at back of hospital property and supposed to be burned, along with all other waste. I observed syringes with needles intact loose on the ground and in cardboard sharps container - both completely unburnt. No fencing around the on-site dump.	
		Offsite transport assessment	Fair		Poor		Poor		Fair	
WASTE MANAGEMENT FRAMEWORK	Waste Management Documents	Waste Management Policy	N		N		N		N	
		Waste Management Plan	N		N		N		N	
		Waste Management Procedure	N		N		N		N	
		Waste Management Committee	Y		Y		N		N	
Infection Control	Infection Control Policy	Y		N		N		N		
	Infection Control Procedures	N		N		N		N		
Auditing and Record Keeping	Audit Program	N		N		N		N		
	What is audited	Segregation	N		N		N		N	
		Compliance P&P	N		N		N		N	
		Int. transport	N		N		N		N	
Storage		N		N		N		N		

ENVIRON

	Training	Treatment/ disposal	N	Treatment/ disposal	N	Treatment/ disposal	N	Treatment/ disposal	Y	
		Frequency	N/A		N/A		N/A		N/A	
		Training Program	N		N		N		N	
		Curricula	Infection Control	N	Infection Control	N	Infection Control	N	Infection Control	N
			Waste Mgt	N	Waste Mgt	N	Waste Mgt	N	Waste Mgt	N
			PPE	N	PPE	N	PPE	N	PPE	N
			Treat. Tech operation	N	Treat. Tech operation	N	Treat. Tech operation	N	Treat. Tech operation	N
		Duration / frequency of training	JiCA funded one-off training event for whole of Tonga IC key staff							
		Records of who has been trained	N		N		N		N	
Monitoring or refresher courses	N		N		N		N			
PROJECTED ISSUES	Forecasting	10 year projections for waste management	New hospital - no further expansion plans		No expansion plans		No expansion plans		The hospital and staff quarters' roofs and structures were severely damaged in Cyclone Jan 2014. Temporary roofing/ covering in place for now. Suggestion of World Bank funding for new hospital but this is unlikely to come to fruition in short term (or perhaps at all)	
		Barriers to change	Knowledge, resources, awareness, commitment		Knowledge, resources, awareness, commitment, motivation		Knowledge, resources, awareness, commitment, motivation		Knowledge, resources, awareness, commitment, motivation	
		Other issues								
LOCAL CONTRACTORS	Potential in-country contractors	Who	Key Capability	Who	Key Capability	Who	Key Capability	Who	Key Capability	
		None	N/A	None	N/A	None		None	N/A	

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

Appendix C
Minimum Standards Assessment

Table C1: HEALTHCARE WASTE - MINIMUM STANDARDS FRAMEWORK & ASSESSMENT FOR TONGA								
Scale	Category	Item	Minimum Standard Criterion	Vaiola	Prince Ngu	Niu'eiki	Niu'ui	Tonga - 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 split kit is provided.				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.					

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

Appendix D

Qualitative Local Feasibility Assessment – Treatment Technology

Remaining Technology Options	Comparatively low cost to implement	Comparative effectiveness across all HCWs	Local Feasibility							
			Health & safety to workers & community	Sustainability of solution	Institutional and policy fit	Cultural fit	Implementation barriers can be overcome?	Receiving environment not impacted	Durability	Ease of operation
Incineration at high temperature (>1000°C)	\$211,460 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Most effective – can treat all waste types and achieves complete sterilization, complete combustion and destroys waste	Some issues for operators (requires training & PPE); some potential issues for community (potential for smoke, some controlled emissions)	Equipment lifespan ~ 10 years plus; sustainability dependant on maintaining operator skills plus proper operation and maintenance	No legal barriers to incineration; loses a point for potential for smoke nuisance and the potential for minor contribution to combustion derived POPs – Tonga is a party to Stockholm	Burning of rubbish is historically accepted & widely practised in Tonga. Incinerators are/ have been previously used in hospitals	Equipment breakdown and lack of local skills to maintain equipment – real barrier but can be managed through skills training & supplier support	Emissions of air pollutants and leaching from ash disposal to receiving environment are potential impacts. High temp operation minimises pollution & proper landfilling of ash restricts 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	Burning of rubbish is historically accepted & widely practised in Tonga. Incinerators are/ have been	Equipment breakdown and lack of local skills to maintain equipment – real barrier but can be managed through skills training & supplier support. Simpler	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment are potential impacts. Med. temperature 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: <u>QUALITATIVE</u> Treatment Technology Options Assessment - Local Feasibility (Tonga)										
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 – Tonga is a party to Stockholm	previously used in hospitals	infrastructure.	air pollution, but not likely to be an issue 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 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 – Tonga is a party to Stockholm	Burning of rubbish is historically accepted & widely practised in Tonga.	No equipment operation reliability barrier; burning rubbish common practice in Tonga	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment are potential impacts. Low temperature operation provides no controls on air pollution. Risk of fire impact.	Simple, zero technology so there is nothing that can break down	Simple, zero technology so there is nothing that can break down and no specific training is required other than health and safety.
Autoclave with shredder	\$158,000 USD over 10 years (ref Whole of Project –	Cannot treat all waste types, achieves complete	Some issues for operators (requires training &	Equipment lifespan ~ 10 years; sustainability	No legal barriers; no potential for smoke	Not familiar with use of sterilisers for waste –	Equipment breakdown and lack of local skills to maintain	No emissions of air pollutants/ smoke; some potential for	Equipment will only last if maintained. Adding	Requires skilled operators to achieve best

Table D1: <u>QUALITATIVE</u> Treatment Technology Options Assessment - Local Feasibility (Tonga)										
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
	Summary Report, Appendix E)	sterilization when correctly operated, no combustion required, shredder destroys needles	PPE); small potential for odours and wastewater discharge (community)	dependant on maintaining operator skills plus longevity of equipment use given technology complexity	nuisance; some potential for odour nuisance; no air pollution (no combustion-POPs) and some potential for waste water management issues	potential community issue with waste appearance if steriliser not operated correctly or shredder not used	equipment – real barrier but can be managed through skills training & supplier support. Increased complexity of equipment (compared to incineration) increases barrier	odour impacts; still requires landfill or dump disposal so some potential for leaching on burial; some potential for waste water management issues. Larger residual waste compared to burning – only engineered landfill is in Tongatapu.	shredder to autoclave technology increases mechanical parts that can go wrong. May require moderate level of maintenance	level of disinfection.
Encapsulation (only post-disinfection sharps assessed)	Virtually zero additional cost to disinfection system costs	Not applicable to non-sharps waste. In the context of pre-sterilised sharps only: no combustion required and	Encapsulation has handling issues for operators (requires training & PPE) and no community	No equipment; sustainability dependant burial space available. Only engineered landfill is in Tongatapu so	No legal barriers; no smoke nuisance; no odour nuisance; no air pollution and some	No particular cultural fit concerns	New practice proposed – may face some inertia barrier. Lack of new ‘shiny’ machinery may imply the change is not that important.	Encapsulation itself poses no smoke nuisance; no odour nuisance; no air pollution and some potential for leachate to	Highly durable due to its simplicity.	Simple procedure once operator understands and manages the risk of sharps handling and

Table D1: <u>QUALITATIVE</u> Treatment Technology Options Assessment - Local Feasibility (Tonga)										
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
		completely removes downstream needle injury risk	issues	increases waste volume that requires burial.	potential for leachate to groundwater, although limited inherent hazard			groundwater, although limited inherent hazard.		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 4: Develop a Waste Management Framework**Healthcare Waste Management Plan**

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

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

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

Appointment of a Responsible Officer

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

It is important that the waste management officer be adequately resourced to enable them to undertake their role as well as supported by Hospital management to ensure that all staff recognise the importance of adopting waste management practices that are in accord with all requirements.

Appointment of a Waste Management Committee

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

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

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

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

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

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

The Waste Management Committee should:

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

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

Recommendation 2: Procurement of Consumables (Segregation & Storage)

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

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

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

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^{3, 4}, incineration is the preferred method for treating pharmaceutical and cytotoxic wastes. This is further supported by the United Nations^{5, 6} 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^{7, 8}.

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

³ World Health Organization Regional Office for Europe, EURO Reports and Studies 97, Management of Wastes from Hospitals and other Health Care Establishments, 1983.

⁴ World Health Organization, Safe management of Wastes from healthcare Facilities, Geneva, 1999.

⁵ United Nations Environment Programme – Technical Working Group on the Basel Convention, Draft Technical Guidelines on Biomedical and Health Care Wastes, 1999.

⁶ Environment Australia, Basel Convention – Draft Technical Guidelines on Hazardous Waste: Clinical and Related Waste (Y1), March 1998.

⁷ Health care Without Harm, Non-Incineration Treatment Technologies, August 2001.

⁸ London Waste Regulation Authority, Guidelines for the Segregation, Handling, Transport and Disposal of Clinical Waste, 2nd Edition, 1994.

other than incineration for anatomical waste, pharmaceuticals and cytotoxic wastes^{9, 10, 11, 12, 13, 14}. 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 option¹⁵.

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.

Recommendation 5: Procurement of Consumables (PPE)

Personnel Protective Equipment

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

Other aspects of this program are:

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

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

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

⁹ National Health & Medical Research Council, National Guidelines for Waste Management in the Health Industry, Commonwealth of Australia, 1999.

¹⁰ EPA Victoria, Draft Guidelines for the Management of Clinical and Related Waste, July 2003.

¹¹ NSW Department of Health, Waste Management Guidelines for Health care Facilities, August 1998.

¹² Queensland Government, Environmental Protection (Waste Management) Regulation, 2000.

¹³ Australian/New Zealand Standard 3816:1998, Management of Clinical and Related Wastes.

¹⁴ Australian and New Zealand Clinical Waste Management Industry Group, Industry Code of Practice for the Management of Clinical and Related Wastes, 3rd edition July 2000.

¹⁵ Provincial Government of Gauteng (South Africa), Draft Health Care Waste Regulations, 11 September 2003.

