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

Samoa

Prepared for:
Secretariat of the Pacific Regional Environment Programme (SPREP)

Prepared by:
ENVIRON Australia Pty Ltd

Date:
July 2014

Project Number:
AS140211

EUROPEAN UNION

ENVIRON

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

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

This has been produced with the assistance of the European Union. Its contents are the sole responsibility of Environ and can in no way be taken to reflect the views of the European Union.

VERSION CONTROL RECORD

Document File Name	**Date Issued**	**Version**	**Author**	**Reviewer**
AS140211_SPREP_Healthcare Waste Report_Samoa_Draft rev0	6 June 2014	Draft 1	Trevor Thornton	Geoff Latimer
AS140211_SPREP_Healthcare Waste Report_Samoa_final rev0	12 July 2014	Final	Trevor Thornton	Geoff Latimer
Location correction (Table 9) pg. 29 Table number correction pg. 29	10 Sept 2014	Final 1.1	Jade Tavane (SPREP)	Nil
PacWaste_HCW_Baseline_Report_SAMOA_v1.2	10 & 23 Oct 2014	Final 1.2	J. Tavane	EU emblem & disclaimer added

Contents

List of Tables

List of Photographs

List of Appendices

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 Samoa.

Current Healthcare Waste Management in Samoa

The Ministry of Health operates health care facilities in Samoa, and there are some private clinics and private hospital facilities. Information regarding the waste management process occurring, from ward-level waste generation through to ultimate treatment and disposal was collected during audits of two Ministry Hospitals (and incineration facilities), as follows:

- Tupua Tamasese Meaole Hospital, Upolu (28th April 2014)
- Malietoa Tanumafili II Hospital, Savaii (29th April 2014)

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

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

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

Target areas have been rated as follows:

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

Table ES1: HEALTHCARE WASTE – KEY ISSUES FOR SAMOA

Scale	Category	Item	Minimum Standard Criterion	Tupua Tamasese Meaole Hospital, Upolu	Malietoa Tanumafili II Hospital, Savaii	Samoa – Overall Rating
Health care 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)			
Health care Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types			
Health care Facility	Segregation		Waste are correctly segregated in all wards/departments with use of containers that are colour coded for the different waste types			
Health care 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			
Health care Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.			
Health care Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure			
Health care 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.			
Health care Facility	Storage	Storage before treatment	Meets the standards stated in Appendix E, Recommendation 2, *Correct Storage*.			
Health care 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.			
Health care 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.			
Health care Facility	Healthcare waste management emergencies	Spill Prevention and Control	Spill kits are provided or all types of healthcare waste in all wards/departments, storage areas and on trolleys and vehicles. Staff are trained on the use of spill kits. All incidents of spills of healthcare waste are investigated and where appropriate remedial actions implemented.			

Key Issues

The basic elements of an effective healthcare waste management program were evident at both hospitals audited. However, there are some issues that do need to be addressed and not allowed to reemerge so that Samoan Hospitals do have a program that could be measured against "best-practice". These issues include:

- Segregation of wastes needs to be more effective so that only healthcare is deposited into this stream and other wastes correctly into their respective management streams. Part of the reason for the poor segregation observed was the lack of uniform, colour coded bins along with supplementary education materials such as signage. Ministry of Health personnel advised that audits are conducted of the segregation practices, but if so, the results need to be provided to all staff so corrective actions can be undertaken.
- At both hospitals there were stockpiles of healthcare waste. At Upolu, this was pharmaceutical waste (i.e., materials that were out of use-by date), and on Savaii this was a large quantity of sharps and other healthcare waste located in the clinical waste store. Part of the reason for the pharmaceutical waste being waste, was the fact that all had resulted from donations, and once these were able to be accessed by the Hospital, the use by date has passed.
- On Savaii, only one of the two incinerators was operational. It was advised that the reason for one being non-operational was related to proactive maintenance. Ministry of Health personnel advised that there was a $WST300,000 maintenance budget for the incinerators – further investigations and advice may need to be provided as to the most cost-effective manner in which to utlise this significant resource.

Analysis of Options for Sustainable Healthcare Waste Management in Samoa

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

Treatment options that rated best for Samoa were:

- ***High Temperature Incineration*** is the promoted disinfection practice where units are modern, maintained, have sufficient waste volumes and locked in supplier maintenance and training contracts.
- ***Medium Temperature Incineration*** is acceptable in the medium term to remedy current unacceptable practices at sites too small to justify costs of expensive equipment.
- ***Autoclaving*** is an acceptable disinfection practice where units with shredder are affordable and locked in supplier maintenance and training contracts are in place.

- ***Low temperature burning*** is a borderline practice which can only be acceptable in the short term, in low population density environments, to remedy current unacceptable practices.

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. This is occurring in the main, via incineration, in the two Samoan hospitals (apart from stockpiled waste in each), as described below:

Tupua Tamasese Meaole Hospital, Upolu – utilises an incinerator that burns at appropriate temperatures and is located away from the hospital and community and housed in an undercover building. This unit is sufficient in scale and effectiveness to treat all of its healthcare waste (and those provided by surrounding health care facilities). *Consequently no treatment infrastructure improvements are suggested for Upolu*.

Malietoa Tanumafili II Hospital, Savaii – utilises two relatively new MediBurn 20 model incinerators (with one only currently operational). They are located within a dedicated building away from the hospital and community. One unit alone is sufficient in scale and effectiveness to treat all of its healthcare waste (and those provided by surrounding health care facilities), but 2 workable units allows maintenance to be conducted without impacting operations. It would also provide spare capacity to eliminate the current stockpile quickly. In light of some stack issues with the working MediBurn, repairs are recommended for both incinerators.

Recommendations

Table ES2 provides a summary of the recommendations for Samoa.

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

Target recommendations have been rated as follows:

	Fully Applicable
	Partially applicable
	Not applicable

Table ES2: Recommendations for Samoa	**Applicable to**	**Tupua Tamasese Meaole Hospital**	**Malietoa Tanumafili II Hospital**
Recommendation 1: Develop a Waste Management Framework			
Description	• A *Healthcare Waste Management Plan*, specific to each healthcare facility • Appoint an *officer responsible* for the development and implementation of the Healthcare Waste Management Plan • A *waste management committee*, appropriate to the scale of each facility.		
Output	• An agreed *Healthcare Waste Management Plan*, specific to each healthcare facility outlining procedures and guidelines, waste definitions and characterisation, segregation techniques,		

Table ES2: Recommendations for Samoa		Applicable to	Tupua Tamasese Meaole Hospital	Malietoa Tanumafili II Hospital
	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	• Plan approved by Ministry of Health (all facilities) • Approved budget for implementation of Healthcare Waste Management Plan • The Plan should be regularly monitored, reviewed, revised and updated. • Annual assessment of 'Responsible Officer's' or Waste Management Committees' performance against key healthcare waste management competencies.			
Costs ($US)	• Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided • Ongoing – Low			
Recommendation 2: Procurement of Consumables (Segregation & Storage)				
Description	• Supply of colour-coded **waste bins** and **plastic liners** in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. • Supply of small number of colour-coded **wheelie bins** (where required) per hospital to act as both in-ward/department storage and internal transport trolleys. • Supply of **signage** to explain the colour-coded segregation system as well as **posters** to promote it.			
Output	• Adequate supply of consumables to bed down more rigorous segregation practices			
Monitoring & Evaluation Indicators	• Wastes are segregated at their place of production. • Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. • Zero Needle Stick Injuries.			
Costs ($US)	• Establishment – Low; Ongoing - Low, sustainably funded by country			
Recommendation 3: Expand Existing Training Program *U2H*				
Description	The existing waste management education program that is provided by the Ministry of Health is delivered to all stakeholders (including non-hospital employees)			
Output	• 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)			

Table ES2: Recommendations for Samoa		Applicable to	Tupua Tamasese Meaole Hospital	Malietoa Tanumafili II Hospital
	• 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	• Competency Assessments • Refresher Training • No/very little cross contamination between waste streams demonstrated by waste audits.			
Costs ($US)	• Establishment – Low; Ongoing - Low			
Recommendation 4: Repair and Maintenance Program for Incinerators *U2H*				
Description	Conduct **repairs** and **maintenance** on both incinerators in Savaii: 1. The broken down MediBurn 20 incinerator should have repairs carried out to get the control panel (and any other faults) fixed to make it operational. 2. The working MediBurn 20 incinerator should have maintenance carried out to replace the corroded stack. Establish maintenance support contracts (for both TTMH and MTH incinerators) and ensure allocated funds for maintenance are utilized proactively to prevent future operational issues			
Output	• Optimum and safe treatment of healthcare waste			
Monitoring & Evaluation Indicators	• All incinerators operate for required times and at optimum operating parameters as detailed by manufacturers and based on waste types processed.			
Costs ($US)	• Establishment – Medium; Ongoing - Low, sustainably funded by country			
Recommendation 5: Incinerate Existing Waste Stockpiles *U2H*				
Description	Eliminate existing waste stockpiles a follows: • TTMH (Upolu) – approx. 200kg of pharmaceutical waste: through incorporation in current incineration capacity. • MTH (Savaii) – approx. 1.5 – 2.5 tonnes of healthcare waste (predominately sharps): urgently addressed through an increase in the incineration schedule.			
Output	• Removal of existing hazards associated with these respective wastes			
Monitoring & Evaluation Indicators	• Nil stockpiled waste			
Costs ($US)	• Establishment – Nil for TTMH, low for MTH; Ongoing - Nil for TTMH, low for MTH.			

Table ES2: Recommendations for Samoa	**Applicable to**	**Tupua Tamasese Meaole Hospital**	**Malietoa Tanumafili II Hospital**
Recommendation 6: Upgrade of Central Storage Facilities			
Description	Storage areas used for the consolidation of wastes prior to treatment/disposal are of a standard that avoids environmental and health related negative impacts from such issues as spills or access by unauthorized person.		
Output	• Storage areas are secure, suitably designed and isolated from patients and the public. • Storage areas have capacity to contain wastes generated under "normal" conditions as well as for contingencies		
Monitoring & Evaluation Indicators	• Suitability of storage areas regularly assessed by 'responsible officer' of waste management committee.		
Costs ($US)	• Establishment – Medium; Ongoing - Low		
Recommendation 7: Procurement of Spill Control Kits			
Description	Supply sufficient Spill Control Kits for entire hospital operations in both hospitals.		
Output	Capacity and capability (training – see Recommendation 3) to respond to any healthcare waste spills anywhere in the waste management process.		
Monitoring & Evaluation Indicators	Staff are aware of how to protect themselves and others from, and respond to, any spills of healthcare waste		
Costs ($US)	Establishment – Low; Ongoing - Low, sustainably funded by country		

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.

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 Samoa.

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 Samoa and includes:

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

2 Healthcare Waste Management in Samoa

2.1 National Regulatory Framework

Samoa is a country encompassing the western part of the Samoan Islands in the South Pacific Ocean. It became independent from New Zealand in 1962. There are two main islands (Savaii, Upolu) and several smaller islands

The key institution involved in solid waste management in Samoa is the Ministry and Natural Resources, and Environment.

Samoa's Health Care Waste Management (HCWM) Unit was one of the core components under the Samoa Health Sector Management Project (SHSMP) in 2000 to 2005. The main aim of the HCWM component was to establish an effective, efficient and sustainable health care waste management system in Samoa. The primary roles of the Principal Health Care Waste Officer are:

- To conduct surveillance at all sources that generate health care waste in Samoa and provide technical advice accordingly.
- To conduct training and awareness programmes for health care personnel on waste segregation, containment, collections and disposal of HCW to be in line with National HCWM Plan, National HCWM Policy and WHO international standards for the management of health care waste.
- Conduct consultations and National Symposiums with sector partners to clarify the linkages of their roles and responsibilities to the National Health Sector Plan, HCWM Plan and National HCW Policy
- Ongoing monitoring visits to collect data for future planning of HCWM in Samoa and also to provide information and data for WHO website
- Monitoring of HCWM System processes and the status of resources and equipment of the HCWM infrastructure.
- Improve stakeholder partnerships through participation in the preparation and implementation of some health sector projects for the improvement of the standard of living of Samoan people which is one of the major goals stipulated in the SDS.

A summary of relevant legislation is provided in Table 1.

Table 1: National Environmental Legislation Summary			
Legislation	**Type**	**Summary**	**Regulator/ Agency**
The Lands, Survey and Environmental Act 1989	Act	The Lands, Survey and Environment Act 1989 (LSE Act) provides the basis for environmental protection and management in Samoa. It adopts an approach designed to avoid adversely affecting the beneficial used of the environment from pollution, and the improper management of wastes. Part VII of this Act through the application of Division 4 ("Management Plans") providing the legislative framework for waste management in Samoa	Department of Land Surveys and Environment; Ministry and Natural Resources, and Environment
The Health Ordinance 1959	Ord	The Health Ordinance 1959 (HO 1959) established the Ministry of Health (MOH) and defined its functions and powers to enable it to protect public health	
National Waste Management Policy (2001)		A draft document	
Health Care Waste Management Plan		The plan was developed under S 1 16(1)(h) of the LSE Act which allows management plans to be prepared for 'waste and litter disposal' and for 'any other matter relating to the environment which in the opinion of the Board will benefit from a management plan. This latter provision allows for such issues as waste classification, segregation, packaging labelling, and transport operations, and the application and performance of treatment technologies to be included in assertion to the disposal of wastes, or waste treatment residues.	Ministry of Health

2.2 Hospitals Assessed

The Ministry of Health operates public healthcare facilities in Samoa. In addition, there are a range of private providers of clinics and hospital facilities.

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

2.2.1 Tupua Tamasese Meaole Hospital, Upolu

Tupua Tamasese Meaole Hospital (TTMH) is a 300 bed hospital that provides a number of services including general surgery, orthopaedics, general medicine, intensive care, paediatrics, obstetrics, accident and emergency department radiology facilities and a pathology department.

2.2.2 Malietoa Tanumafili II Hospital, Savaii

Malietoa Tanumafili II Hospital (MTH) has 30 beds. The hospital services include general medicine, emergency, outpatients, inpatients, dialysis, maternity, NCD clinic, pharmacy, eye clinic, laboratory, pharmacy and dentistry.

2.2.3 Hospital Statistics

Detailed operational statistics for each of these hospitals are described in Table 2 overleaf. Note that information requested from the Ministry of Health on several occasions was not provided to fully complete the table.

Table 2: Hospital Details – Samoa

Hospital/Region	Tupua Tamasese Meaole Hospital, Upolu	Malietoa Tanumafili II Hospital, Savaii
Contact Name **Position**	Lameko Tesimale Principal HCW Officer Health Protection & Enforcement Division Ministry of Health	Lameko Tesimale Principal HCW Officer Health Protection & Enforcement Division Ministry of Health
Pop Served	135,000	43,000
No. of Beds	140	30
Annual Average Occupancy Rate (%)	100%	100%
OBD's	51,100	10,950
No. Operations	Not Provided	Not Provided
No. of Births	Not Provided	Not Provided
Emergency Patients Attended	Not Provided	Not Provided
Out-Patients Attended	Not Provided	Not Provided
No. of staff	Not Provided	Not Provided
No. of staff per function		
Nursing/ Medical	Not Provided	Not Provided
Infection Control	Not Provided	Not Provided
Dedicated Waste Management – Internal Management	Not Provided	Not Provided
Dedicated Waste Management – Treatment Operation	Not Provided	Not Provided
Administration	Not Provided	Not Provided
Other	Not Provided	Not Provided

Notes:

1. OBDs = Occupied Bed Days (previous 12 months)

3 Existing Waste Management Practices

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

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

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

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

The pre-audit survey that was provided to Samoa was not completed prior to the on-site assessment of the waste systems. During the audit, information/data that was missing was requested and where provided included into the Hospital's response. However, there have been multiple attempts to obtain the missing data/information and to date it has not been provided.

Table 3: Waste Management Process - Observations

	Hospital Name	Tupua Tamasese Meaole Hospital, Upolu			Malietoa Tanumafili II Hospital, Savaii		
Generation & Segregation	Dedicated Containers/ Bags	N			Y		
	Colour Coding	N			Partial		
	Sharps segregated & secure	N			Y		
	Signage Present	N			Y		
Internal Handling	Degree of manual handling of bags	High			High		
	Internal Transport Mode	Wheelie Bin/Open Bin			Wheelie Bin		
	Spill Kit Present	N			N		
Storage	Dedicated & Appropriate Area	N			Y		
	Loading/unloading acceptable	N			N		
	Spill Kits Present	N			N		
	Monitoring & record keeping occurs	N			N		
Treatment	Treatment per Waste Stream		Tech. Type	Volumes (kg/week)		Tech. Type	Volumes (kg/week)
	Healthcare Waste	✓	Incineration	~500[1]	✓	Incineration	~120[1]
	Sharps	✓	Incineration	~40	✓	Incineration	~5
	Pharmaceutical	✓	Incineration	NS	✓	Incineration	NS
	Cytotoxic	×	NA	N/A	×	NA	N/A
	General	✓	Landfill	NS	✓	Landfill	NS
	If incinerator present	Yes			None present		
	Make, Model, Year commissioned	Entech 2004			Mediburn 2011 (2 units)		
	Operating Temp (^{0}C)	~600-1,000^{0}C			Not able to be measured		
	No. chambers	2			2		
	Condition	Good			1 good, 1 not operational		
	Operational statistics	Per week	Per year		Per week	Per year	
	Waste Throughput (kg)	~600	~31,000		~135	~7,000	
	Operating Hours (hr)	5 days/week			5 days/week		
	Fuel	Diesel			Diesel		
	Fuel use (litres)	500	26,000		NS	NS	
	Fuel use (L) per kg waste burnt	0.8			NS		
	Technology siting and operation issues	Incinerator is used by this and other hospitals and is located adjacent to the landfill			Incinerator is used by this and other hospitals and is located near to the landfill. There are two MediBurn incinerators at this facility, but only one is currently operational (there is fault with the control panel for the other one)		
	Offsite transport assessment	Good			Good		

N/A – Not applicable
NS – Not supplied

1. estimation based on estimates of weekly bin loads

3.1 Tupua Tamasese Meaole Hospital, Upolu

3.1.1 Wastestreams, Treatment Constraints and Costs

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

As discussed in more detail in 4.1.1, TTMH has a small stockpile of pharmaceutical waste that could be treated within its existing incinerator capacity. An analysis of treatment capacity available versus actual volumes stockpiled is shown in Table 4.

Table 4: Waste Treatment Capacity Analysis – TTMH Incinerator Upolu

Waste Treatment Parameter	**Volume**	
Incinerator Design Capacity (kg per batch)	100*	
No. batches run per day	2	
	Per week**	**Per Year**
Available Incinerator Capacity (kg)	1000	50,000
Actual Incinerated Waste Throughput (kg)	600	30,000
Spare Capacity (kg)	400	20,000
Estimated Stockpiled Volume (kg)	200	
Reducing Existing Volumes	**Weeks**	
Time needed to incinerate stockpiled pharmaceutical waste at current estimated waste throughput	0.5	-

*Estimated capacity based on observation of the unit

**Based on a 5 day week

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

Table 4 demonstrates that because the stockpile is almost trivial it could be destroyed rapidly – 2.5 days just by augmenting current batch loads or offline in two batches done over one day (on a weekend for example).

No costs information was obtained, since waste disposal costs are internally borne by the hospital it is not directly measured. The Ministry of Health indicated that the average operating cost of the incinerator was $WST300, 000 per annum ($US132, 160).

3.1.2 Waste Management and Infection Control Framework

The following summarises the waste management and infection control framework at Tupua Tamasese Meaole Hospital:

- Waste is collected from wards/departments and transported directly to the collection vehicle for transport to the landfill or incinerator facility – there is dedicated vehicle for this purpose
- There is a National Strategy, as advised by Ministry of Health personnel, but it was not sited

- No Infection Control Policy/Procedures were provided to review if waste management was included
- The Ministry of Health indicated that they conduct regular audits, but no results were provided

3.1.3 Training

The Ministry of Health conducts regular training sessions for hospital personnel (including other hospitals), on waste management. The PowerPoint used for this training was provided for information. There were no barriers evident in discussions with onsite personnel regarding training being provided by an external organisation.

No records of attendance were kept. The training course is for one day for hospital staff, and there is a 2-3 day "train-the-trainer" course provided as well.

No details were provided as to training provided to new staff employed at the hospital – but anecdotally, it was thought that there was some informal training provided by individual hospitals.

3.1.4 Malietoa Tanumafili II Hospital, Savaii

3.1.5 Wastestreams, Treatment Constraints and Costs

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

As discussed in more detail in 4.1.2, MTH has a stockpile of healthcare waste (mainly sharps) that could be treated within its existing incinerator capacity. A critical analysis of treatment capacity available versus actual volumes stockpiled is shown in Table 5.

Table 5: Waste Treatment Capacity Analysis –MTH Incinerator Savaii

Waste Treatment Parameter	**Volume**	
Incinerator Design Capacity (kg per batch)	20	
No. batches run per day	2	
	Per week*	**Per Year**
Available Incinerator Capacity (kg)	200	10,000*
Actual Incinerated Waste Throughput (kg)	135	6,750
Spare Capacity (kg)	65	3,250
Estimated Stockpiled Volume (kg)	2,000**	
Reducing Existing Volumes	**Weeks**	
Time needed to incinerate stockpiled HCW at current incinerated waste throughput (years)	31	-
Time needed to incinerate stockpiled HCW at available incinerator capacity throughput (years)		-

*Based on a 5 day week

**midpoint of range estimate of 1.5 – 2.5 tonnes based on numbers of 240 litre bins and other containers observed

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

Table 5 demonstrates that by augmenting the current load schedule to run at maximum batch throughput, the stockpile could be fully incinerated in approximately 31 weeks of running at the current level of two burns per day.

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

3.1.6 Waste Management and Infection Control Framework

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

- Wastes are collected from wards/departments by cleaning staff and transported to a central storage area
- Wastes are then transported to the landfill and incinerator by a dedicated collection vehicle (that also collects from other hospitals on the island)
- There is no documented infection control policy
- There is no waste management policy, plan or formalised waste management procedure
- There is no formal waste auditing or inspections

3.1.7 Training

There was no 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, apart from the training provided by the Ministry of Health.

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

4 Key Healthcare Waste Management Issues in Samoa

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

A key issues summary is also provided.

4.1 Minimum Standards Framework

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

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

Table 6: Assessment criteria rating system	
	Meets minimum standards assessment criteria
	Partially meets minimum standards assessment criteria.
	Does not meet minimum standards assessment criteria.

Table 7 highlights the key areas of concern, both per hospital, and in terms of health services delivery across Samoa, as part of this assessment.

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

Table 7: HEALTHCARE WASTE – KEY ISSUES FOR SAMOA

Scale	Category	Item	Minimum Standard Criterion	Tupua Tamasese Meaole Hospital, Upolu	Malietoa Tanumafili II Hospital, Savaii	Samoa – Overall Rating
Health care 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)			
Health care Facility	Signage		Signs are located in all wards/department areas where waste bins are located indicating the correct container for the various waste types			
Health care Facility	Segregation		Waste are correctly segregated in all wards/departments with use of containers that are colour coded for the different waste types			
Health care 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			
Health care Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.			
Health care Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure			
Health care 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.			
Health care Facility	Storage	Storage before treatment	Meets the standards stated in Appendix E, Recommendation 2, *Correct Storage*.			
Health care 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.			
Health care 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.			
Health care 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 Tupua Tamasese Meaole Hospital, Upolu – Key Issues

The most significant healthcare waste management issues observed at Tupua Tamasese Meaole Hospital, Upolu were:

- Signage is rarely present. However, there were some examples of good signage (**Photo 1**)
- Waste segregation is poor – volumes of general waste in healthcare waste bins as well as some blood stained material in the general waste stream.
- No system for waste bins – that is use of colours and consistency in design. If bin liners are used, these are mainly black for all waste types. (**Photo 2**)
- Sharps are collected in open bins in all wards/departments except for Pathology that does have suitable sharps containers (however contents are decanted into open bins and the containers washed and reused – this then results in manual emptying of these bins into larger bins as well as when decanted into the incinerator. (**Photos 3 and 4**)
- Stockpiles of out of date pharmaceuticals (from donations and hospital supplies) – for example there was approximately 200 kilograms of pharmaceuticals that were out of date when arrived at the hospital (sourced from donations). (**Photo 5**)
- Pathology waste is not autoclaved prior to leaving the department for incineration.
- There is a dedicated vehicle for the transport of waste – this also collects healthcare waste from other hospitals on the island as well.
- The incineration facility is appropriate for the types and quantities of waste generated from Tupua Tamasese Meaole Hospital, but as the hospital is expanding as well as the amounts generated from other sources on the Island, resources should be applied to ensure that it can operate more effectively. The Ministry of Health has an allocated budget for maintenance and a technician based at the hospital services the incinerator approximately every 2 months. Logs are kept of the operating temperatures for all "burns". Currently there are two processes per day – this could be expanded to ensure there is no stockpiles of waste. (**Photo 6**)
- The pit located adjacent to the incinerator facility is appropriate for the disposal of ash, but a cover (ie., soil or similar)., could be utilised. (**Photo 7**)
- 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 Malietoa Tanumafili II Hospital, Savaii – Key Issues

The most significant healthcare waste management issues observed at Malietoa Tanumafili II Hospital were:

- Signage is rarely present. However, there were some examples of good signage
- The use of colours and consistency in design of bins is basically present, but there are some wards/departments that use different colours and bin types. If bin liners are used, there are yellow ones used for healthcare waste. Hospital personnel indicated

that he learnt of the use of yellow bin liners at a training session arranged by the Ministry of Health and simply ordered them from stores. (**Photo 8**)

- There is poor waste segregation, with general waste in healthcare waste bins and vice versa.
- Sharps are collected in open bins – this then results in manual emptying of these bins into larger bins as well as when decanted into the incinerator.
- There is a dedicated vehicle for the transport of waste – this also collects healthcare waste from other hospitals on the island as well. (**Photo 9**)
- The waste storage area has a considerable amount of stockpiled waste (predominantly sharps) in small containers and 240 litre mobile garbage bins. We estimate this to be 1,500 – 2,500kg. This storage area is also being used for storing other items. (**Photo 10**)
- 240 litre mobile garbage bins are washed at the hospital in an open area – it did not appear that disinfection of these bins was occurring.
- There are two MediBurn incinerators located in a compound some distance from the hospital – it is appropriately located being away from any residences. However, due to a fault (unknown), with the control panel of one, only one is operational. There is a need for maintenance as the operational incinerator has a stack that is corroded. Of concern is the fact that waste is manually loaded into the incinerator – with sharps from the 240 litre mobile garbage bins shovelled into the incinerator chamber. (**Photo 11**)
- 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.
- A positive process is that community nurses do bring healthcare waste back to the hospital for disposal.

5 Consultation

Apart from hospital staff across all two hospitals, no other consultations on issues associate with healthcare waste management occurred despite a request to discuss issues with other government agencies.

6 Contractor Roles and Capacity

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

7 Analysis of Options for Sustainable Healthcare Waste Management in Samoa

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

Table 8 categorizes these key issues (A – F) against potential options that could be adopted to tackle them, as a collated list of high-level responses.

Table 8: Options for Sustainable Healthcare Waste Management in Samoa

Key Issue Category	Key Issue	Options to address the issue	Issues applicable to	
			Tupua Tamasese Meaole Hospital, Upolu	**Malietoa Tanumafili II Hospital, Savaii**
A. Waste Management Framework	There is no documented **waste management plan** no waste management committee.	Establish a waste management framework including: • Waste Management Plan • Responsible officer for implementation of waste management plan • Waste management committee, appropriate to the scale of each facility.	Yes	Yes
B. Signage, Segregation & Containers	**Segregation and containment** practices are below minimum standard: • There is no signage present • The only segregation regularly practiced in is for sharps. • Colour coded bags (liners) and bins are not present and storage is not adequate in Upolu.	Improve segregation practices by: • 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.	Yes	Yes
C. Training & Audit	There is no structured **training** or waste segregation **auditing** program in place.	Review of current program 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: 1. SPREP staff, **or** 2. International technical training providers (or a combination of both), - as a basic healthcare waste management training program exists in Samoa.	Expansion of training to all staff and auditing	Expansion of training to all staff and auditing

Table 8: Options for Sustainable Healthcare Waste Management in Samoa

Key Issue Category	Key Issue	Options to address the issue	Issues applicable to	
			Tupua Tamasese Meaole Hospital, Upolu	Malietoa Tanumafili II Hospital, Savaii
D. 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): • Supply spill kits and appropriate PPE including overalls/protective clothing, gloves and eye protection for all waste handlers.	Yes	Yes
E. Storage of healthcare waste	Healthcare waste is not stored in a manner that avoids risks to personnel and the environment	• Improve the storage of healthcare waste by ensuring the storage facility meets the standards detailed in this report as well as ensuring that no waste is "littered" around the Hospital	Yes	Yes
F. Treatment	The method for **treatment** of healthcare waste in both Upolu and Savaii is in accord with required standards, but there are issues with stockpiles of infectious wastes and repair requirements for incinerators in Savaii.	Treatment using one (or a combination) of the following for each hospital: 1. Rotary kiln (highest temperature) 2. Incineration (high, medium temperature) 3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land) 4. Autoclave 5. Chemical 6. Microwave 7. Encapsulation 8. Landfill (without disinfection) 9. Onsite burial 10. Shredding	No	Yes

7.1 Options for (Non-Treatment) Waste Management Aspects

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

- The waste management (and infection control) framework, including policies, plans, procedures, responsibility for implementation and audit of the functioning of the framework (A in Table 8)
- The waste management process, from generation to transport up to the treatment location (B and E in Table 8)
- Training systems for sustainable healthcare waste management (C in Table 8)
- OHS related protection for waste handlers (D in Table 8)

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 F) has a range of alternative approaches, as summarized in Table 9. 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 9. 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 Samoa's Stage 2 assessment:

1. Incineration (high temperature: >1,000^{0}C [2])
2. Incineration (medium temperature: 800 – 1,000^{0}C [4])
3. Low temperature burning (single chamber incinerator/ pit/ drum/ brick enclosure/ land: <400^{0}C [4])
4. Autoclave
5. Encapsulation (of sharps only, in combination with a form of disinfection).

7.2.1 Waste Treatment Systems Relevant for Samoa

The Stage 2 local feasibility assessment took these first four[3] technologies and assessed them against the ten dot point criteria listed in 7.2. These criteria are explored qualitatively in **Appendix D**. Table 9 takes these qualitative descriptions and assigns a quantitative score from 1 – 5, to prioritise local applicability of technology options to the Samoan context, on a relative basis as follows:

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

The treatment technologies suitable for the Samoa context are ranked in order of preference in Table 9:

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

[3] 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.

Table 9: QUANTITATIVE **Treatment Technology Options Assessment - Local Feasibility (Samoa)**

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^{0}C)	1	5	4	4	4	4	3	3	3	3	34	1
Incineration at med. temperature (800 - 1000^{0}C)	4	4	3	3	2	4	4	2	2	4	32	2
Autoclave with shredder	2	4	4	3	5	2	2	4	2	2	30	3
Low temperature burning (<400^{0}C)	5	3	1	2	1	1	3	1	5	5	27	4

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

In support of Table 9's ranking:

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

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

A substantial amount of data exists on the emissions generated from incinerators, but conversely, little studies have been conducted on all aspects of alternate technologies performance. While the literature is inconclusive on the requirements needed to effectively manage the blood and body fluid contaminated and infectious components of the waste streams, there does seem to be consensus that hazardous components such as pharmaceuticals and cytotoxic wastes do need to be treated prior to final disposal to ensure

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

Since Samoa do not currently generate cytotoxic waste these are not relevant for healthcare waste treatment choices in Samoa.

7.2.1 Treatment Investment Options for individual Samoan Hospitals

Wastes should be treated and disposed of accordingly to ensure the infectious hazard is destroyed. This is occurring in the main, via incineration, in the two Samoan hospitals (apart from stockpiled waste in each), as described below:

Tupua Tamasese Meaole Hospital, Upolu – utilises an incinerator that burns at appropriate temperatures and is located away from the hospital and community and housed in an undercover building. This unit is sufficient in scale and effectiveness to treat all of its healthcare waste (and those provided by surrounding health care facilities). *Consequently no treatment infrastructure improvements are suggested for Upolu*.

Malietoa Tanumafili II Hospital, Savaii – utilises two relatively new MediBurn 20 model incinerators (with one only currently operational). They are located within a dedicated building away from the hospital and community. One unit alone is sufficient in scale and effectiveness to treat all of its healthcare waste (and those provided by surrounding health care facilities), but 2 workable units allows maintenance to be conducted without impacting operations. It would also provide spare capacity to eliminate the current stockpile quickly. In light of some stack issues with the working MediBurn, repairs are recommended for both incinerators.

7.2.2 Waste Stockpiles

TTMH has a small stockpile (approximately 200kg) of out of date pharmaceuticals. It is unclear what barrier is preventing this from being incinerated along with other healthcare waste, since section 3.1.1 shows it could be eliminated through incorporation in current incineration capacity in less than 3 days.

MTH on the other hand has a significant infectious healthcare waste stockpile. Section 3.1.1 shows that by augmenting the current load schedule to run at maximum batch throughput, the stockpile could be fully incinerated in approximately 31 weeks of running at the current level of two burns per day. However, given the inherent infection risks, this could be sped up through:

- Use of the second incinerator (if it was operational)
- Doing more batches per day (3 should be achievable in an 8 hour shift)
- A short term increase in operating schedule (for example additional shifts or weekends).

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 Samoa. Further details and guidance on each recommendation are provided in **Appendix E**.

Table 10 provides a summary of the recommendations for Samoa. 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 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.

Table 10: Recommendations for Samoa	**Applicable to**	**Tupua Tamasese Meaole Hospital**	**Malietoa Tanumafili II Hospital**
Recommendation 1: Develop a Waste Management Framework			
Description	• A *Healthcare Waste Management Plan*, specific to each healthcare facility • Appoint an *officer responsible* for the development and implementation of the Healthcare Waste Management Plan • A *waste management committee*, appropriate to the scale of each facility.		
Output	• An agreed *Healthcare Waste Management Plan*, 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	• Plan approved by Ministry of Health (all facilities)		

Table 10: Recommendations for Samoa	**Applicable to**	**Tupua Tamasese Meaole Hospital**	**Malietoa Tanumafili II Hospital**
& Evaluation Indicators	• 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 ($US)	• Establishment – Low, if existing systems (such as those for Fiji) are used as a starting points and document drafting assistance is provided • Ongoing – Low		
Recommendation 2: Procurement of Consumables (Segregation & Storage)			
Description	• Supply of colour-coded **waste bins** and **plastic liners** in quantities sufficient to serve all wards/departments for a period of time sufficient to allow bedding down of the segregation process. • Supply of small number of colour-coded **wheelie bins** (where required) per hospital to act as both in-ward/department storage and internal transport trolleys. • Supply of **signage** to explain the colour-coded segregation system as well as **posters** to promote it.		
Output	• Adequate supply of consumables to bed down more rigorous segregation practices		
Monitoring & Evaluation Indicators	• Wastes are segregated at their place of production. • Infection wastes, general wastes and used sharps are stored in separate colour coded containers and locations within medical areas. • Zero Needle Stick Injuries.		
Costs ($US)	• Establishment – Low; Ongoing - Low, sustainably funded by country		
Recommendation 3: Expand Existing Training Program *U2H*			
Description	The existing waste management education program that is provided by the Ministry of Health is delivered to all stakeholders (including non-hospital employees)		
Output	• Delivery of a structured healthcare waste training program to all hospital personnel as well as personnel from other stakeholders (e.g., government health and environment agencies) • Improvement of personnel skills and competency in managing healthcare waste • Promotion of the advantages of sustainable segregation and storage techniques for the different waste streams and an understanding of the health and safety risks resulting from the mismanagement risks of healthcare waste.		

Table 10: Recommendations for Samoa	**Applicable to**	**Tupua Tamasese Meaole Hospital**	**Malietoa Tanumafili II Hospital**
Monitoring & Evaluation Indicators	• Competency Assessments • Refresher Training • No/very little cross contamination between waste streams demonstrated by waste audits.		
Costs ($US)	• Establishment – Low; Ongoing - Low		
Recommendation 4: Repair and Maintenance Program for Incinerators *U2H*			
Description	Conduct **repairs** and **maintenance** on both incinerators in Savaii: 3. The broken down MediBurn 20 incinerator should have repairs carried out to get the control panel (and any other faults) fixed to make it operational. 4. The working MediBurn 20 incinerator should have maintenance carried out to replace the corroded stack. Establish maintenance support contracts (for both TTMH and MTH incinerators) and ensure allocated funds for maintenance are utilized proactively to prevent future operational issues		
Output	• Optimum and safe treatment of healthcare waste		
Monitoring & Evaluation Indicators	• All incinerators operate for required times and at optimum operating parameters as detailed by manufacturers and based on waste types processed.		
Costs ($US)	• Establishment – Medium; Ongoing - Low, sustainably funded by country		
Recommendation 5: Incinerate Existing Waste Stockpiles *U2H*			
Description	Eliminate existing waste stockpiles a follows: • TTMH (Upolu) – approx. 200kg of pharmaceutical waste: through incorporation in current incineration capacity. • MTH (Savaii) – approx. 1.5 – 2.5 tonnes of healthcare waste (predominately sharps): urgently addressed through an increase in the incineration schedule.		
Output	• Removal of existing hazards associated with these respective wastes		
Monitoring & Evaluation Indicators	• Nil stockpiled waste		
Costs ($US)	• Establishment – Nil for TTMH, low for MTH; Ongoing - Nil for TTMH, low for MTH.		
Recommendation 6: Upgrade of Central Storage Facilities			
Description	Storage areas used for the consolidation of wastes prior to treatment/disposal are of a standard that avoids environmental and health related negative impacts from such issues as spills or access by		

Table 10: Recommendations for Samoa	**Applicable to**	**Tupua Tamasese Meaole Hospital**	**Malietoa Tanumafili II Hospital**
	unauthorized person.		
Output	• Storage areas are secure, suitably designed and isolated from patients and the public. • Storage areas have capacity to contain wastes generated under "normal" conditions as well as for contingencies		
Monitoring & Evaluation Indicators	• Suitability of storage areas regularly assessed by 'responsible officer' of waste management committee.		
Costs ($US)	• Establishment – Medium; Ongoing - Low		
Recommendation 7: Procurement of Spill Control Kits			
Description	Supply sufficient Spill Control Kits for entire hospital operations in both hospitals.		
Output	Capacity and capability (training – see Recommendation 3) to respond to any healthcare waste spills anywhere in the waste management process.		
Monitoring & Evaluation Indicators	Staff are aware of how to protect themselves and others from, and respond to, any spills of healthcare waste		
Costs ($US)	Establishment – Low; Ongoing - Low, sustainably funded by country		

8.1 Implementation Priorities

8.1.1 Recommendation 1: Develop a Waste Management Framework

1. Develop a **Healthcare Waste Management Plan** specific to each hospital, including technical guidelines and procedures relating to waste management and if not already present, infection control.

2. Appoint an **officer responsible** for the development and implementation of the Healthcare Waste Management Plan

3. Establish a **waste management committee**, appropriate to the scale of the facility.

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

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

8.1.1.1 Short Term (0-6 months)

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

8.1.1.2 Medium Term (6 months-1 year)

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

8.1.1.3 Long Term (1year-3 years)

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

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

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

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

8.1.2.1 Short Term (0-6 months)

- Procurement of in-hospital healthcare waste management consumables including:
    - Colour coded bins and bin liners
    - 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: Expand Existing Training Program *U2H*

The existing waste management education program that is provided by the Ministry of Health is expanded to be delivered to all stakeholders (including non-hospital employees)

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: Repair and Maintenance Program for Incinerators *U2H*

Conduct repairs and maintenance on both incinerators in Savaii:

1. The broken down MediBurn 20 incinerator should have repairs carried out to get the control panel (and any other faults) fixed to make it operational.
2. The working MediBurn 20 incinerator should have maintenance carried out to replace the corroded stack.

8.1.4.1 Short Term (0-6 months)

The broken down incinerator in Savaii should have repairs carried out to get the control panel (and any other faults) fixed to make it operational.

8.1.4.2 Medium Term (6 months-1 year)

- Once the broken down MediBurn is functional, take the other one offline and carry out repairs to the corroded stack.
- Establish maintenance support contracts (for both TTMH and MTH incinerators) and ensure allocated funds for maintenance are utilized proactively to prevent future operational issues.

8.1.4.3 Long Term (1-3 years)

- Establish maintenance support contracts (for both TTMH and MTH incinerators) and ensure allocated funds for maintenance are utilized proactively to prevent future operational issues.
- Maintain training of operators as required.

8.1.5 Recommendation 5: Incinerate Existing Waste Stockpiles *U2H*

Eliminate existing waste stockpiles a follows:

1. TTMH (Upolu) – approx. 200kg of pharmaceutical waste: through incorporation in current incineration capacity.

2. MTH (Savaii) – approx. 1.5 – 2.5 tonnes of healthcare waste (predominately sharps): urgently addressed through an increase in the incineration schedule.

No wastes should be stored for longer than one month. The actual time for this will depend on the type of wastes (e.g. is it organic in nature and can become odorous), and ambient weather conditions. In addition, consideration must be given to health &safety issues to waste handlers and any other person who may come in contact with the waste.

8.1.5.1 Short Term (0-6 months)

TTMH (Upolu): incinerate pharmaceutical waste stockpile through incorporation in current incineration schedule of two batches per day.

MTH (Savaii): Given the inherent infection risks posed by the large stockpile of healthcare wastes, reduction of this stockpile should begin immediately, through:

- incorporation of small amounts of stockpiled waste into existing incineration runs to maximise existing batch capacity and
- doing more batches per day (3 should be achievable in an 8 hour shift)
- Consideration should be given to a short term increase in operating schedule (for example additional shifts or weekends).

8.1.5.2 Medium Term (6 months-1 year)

After the broken-down MediBurn incinerator is made operational through repairs described in Recommendation 4, use this exclusively to eliminate the remaining stockpile.

8.1.5.3 Long Term (1-3 years)

Not required.

8.1.6 Recommendation 6: Upgrade of Central Storage Facilities

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

8.1.6.1 Short Term (0-6 months)

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

8.1.6.2 Medium Term (6 months – 1 year)

- Procure spill kits for each central storage area

8.1.6.3 Long Term

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

8.1.7 Recommendation 7: Procurement of Spill Kits for both hospitals

Supply sufficient Spill Control Kits for entire hospital operations at both TTMH and MTH.

8.1.7.1 Short Term (0-6 months)

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

8.1.7.2 Medium Term (6 months-1 year)

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

8.1.7.3 Long Term (1-3 years)

Nil.

Appendix A

Photo Log

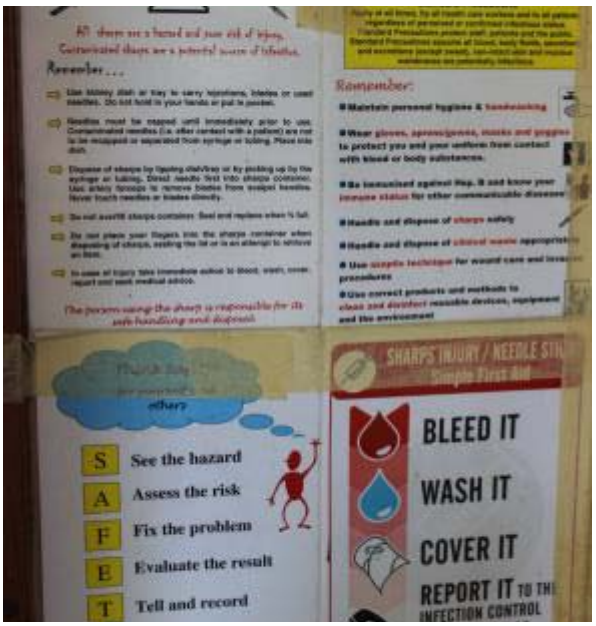

Photo 5: Signage in one ward at Tupua Tamasese Meaole Hospital (taken 31/03/2014 by Trevor Thornton)

Photo 6: Examples of the waste bins, with both using black bin liners at Tupua Tamasese Meaole Hospital (taken 31/03/2014 by Trevor Thornton)

Photo 7: Sharps deposited into one waste bin at Tupua Tamasese Meaole Hospital
(taken 31/03/2014 by Trevor Thornton)

Photo 8: Sharps deposited into another waste bin at Tupua Tamasese Meaole Hospital
(taken 01/04/2014 by Trevor Thornton)

Photo 5: One sample of the accumulated pharmaceutical waste at Tupua Tamasese Meaole Hospital (taken 01/04/2014 by Trevor Thornton)

Photo 6: The incinerator located on Upolu (taken 13/05/2014 by Trevor Thornton)

Photo 7: Pit where ash from the Upolu incinerator is "dumped" (taken 15/05/2014 by Trevor Thornton)

Photo 8: Example of the waste containers (different types) at Malietoa Tanumafili II Hospital (taken 15/05/2014 by Trevor Thornton)

Photo 9: The dedicated waste transport vehicle at Malietoa Tanumafili II Hospital (taken 15/05/2014 by Trevor Thornton)

Photo 10: The accumulation of waste in the storage facility at Malietoa Tanumafili II Hospital (taken 15/05/2014 by Trevor Thornton)

Photo 11: The MediBurn incinerators located on Savaii (taken 15/05/2014 by Trevor Thornton)

Appendix B

Collected Data from Hospital Audits in Samoa

Table B1: Collected Data from Hospital Audits in Samoa

HOSPITAL DETAILS	Region		Upolu (Samoa)		Savaii (Samoa)
	Facility Name & Contact Information	Hospital Name	Tupua Tamasese Meaole Hospital,		Malietoa Tanumafili II Hospital
		Contact Name & Position	Lameko Tesimale Principal HCW Officer Health Protection & Enforcement Division Ministry of Health		Lameko Tesimale Principal HCW Officer Health Protection & Enforcement Division Ministry of Health
		Email	LamekoT@health.gov.ws		LamekoT@health.gov.ws
		Phone	0685 68100		0685 68100
	Key Services Data	Summary of Services Provided	General surgery, orthopaedics, general medicine, intensive care, paediatrics, obstetrics, accident and emergency department radiology facilities and a pathology department		General medicine, emergency, outpatients, inpatients, dialysis, maternity, NCD clinic, pharmacy, eye clinic, laboratory, pharmacy and dentistry.
		Pop Served	135,000		43,000
		No. of Beds	140		30
		OBD's [1]	100%		100%
		No. Operations	Not Provided		10,950
		No. of Births[2]	Not Provided		300
		Emergency Patients Attended	Not Provided		Not Provided
		Out-Patients Attended	Not Provided		Not Provided
		No of Staff	Not Provided		Not Provided
WASTE MANAGEMENT PROCESS	Waste Steams Managed	Estimates	Volumes (kg/wk)	Cost ext. ($US)	Volumes (kg/wk)
		Healthcare Waste	500		120
		Sharps	40		5
		Pharmaceutical	Not provided		Not provided
		Cytotoxic	Nil		Nil
		General	Not provided		Not provided
		Recycling	Nil		Nil
		TOTAL		$ -	
	Generation & Segregation	Dedicated Containers/ Bags	N		Y
		Colour Coding	N		Partial
		Sharps segregated & secure	N		Y
		Signage Present	N		Y
	Internal Handling	Degree of manual handling of bags	High		High
		Internal Transport Mode	Wheelie Bin/Open Bin		Wheelie Bin
		Spill Kit Present	N		N
	Storage	Dedicated & Appropriate Area	N		Y
		Loading/unloading acceptable	N		N
		Spill Kits Present	N		N
		Monitoring & record keeping occurs	N		N

	Treatment	Treatment per Waste Stream	Tech. Type	Int/Ext	Tech. Type	Int/Ext
		Healthcare Waste	Incineration	External	Incineration	External
		Sharps	Incineration	External	Incineration	Internal
		Pharmaceutical	Incineration	External	Incineration	External
		Cytotoxic	NA		NA	
		General	Landfill (without treatment)	External	Landfill (without treatment)	External
		If incinerator present	Incinerator is used by this and other hospitals and is located adjacent to the landfill		Incinerator is used by this and other hospitals and is located near to the landfill. There are two MediBurn incinerators at this facility, but only one is currently operational (there is fault with the control panel for the other one)	
		Make, Model, Year commissioned	Entech 2004		Mediburn 2011 (2 units)	
		Operating Temp (^{0}C)	~600-1,000^{0}C		Not able to be measured	
		No. chambers	2		1	
		Condition	Good		1 good, 1 not operational	
			Per week	Per year	Per week	Per year
		Waste Throughput (tonnes)	0.5	26	0.2	10.5
		Operating Hours (hr)	5 days/week		5 days/week	
		Fuel	Diesel		Diesel	
		Fuel use (kg/litres)	1,000 litres per fortnight		Not available	
		Fuel use per kg waste burnt	N/A		N/A	
		Technology siting and operation issues				
		Offsite transport assessment	Good		Good	
WASTE MANAGEMENT FRAMEWORK	Waste Management Documents	Waste Management Policy	N		N	
		Waste Management Plan	N		N	
		Waste Management Procedure	N		N	
		Waste Management Committee	N		N	
	Infection Control	Infection Control Policy	Y		N	
		Infection Control Procedures	Not sited		Not sited	
	Auditing and Record Keeping	Audit Program	Y		N	
		What is audited	Segregation	Y	Segregation	N
			Compliance P&P	N	Compliance P&P	N
			Int. transport	N	Int. transport	N
			Storage	N	Storage	N
			Treatment/ disposal	N	Treatment/ disposal	N
		Frequency	Yearly		N/A	
	Training	Training Program	Y		Y	
		Curricula	Infection Control	N	Infection Control	N
			Waste Mgt	Y	Waste Mgt	Y

			PPE	N	PPE	N
			Treat. Tech operation	N	Treat. Tech operation	N
		Records of who has been trained	N		N	
		Monitoring or refresher courses	N		N	
PROJECTED ISSUES	Forecasting	10 year projections for waste management	Building program that will add approximately 60 beds		No expansion plans	
		Barriers to change	Resources, commitment		Resources, commitment	
		Other issues				
LOCAL CONTRACTORS		Potential in-country contractors	Who	Key Capability	Who	Key Capability
			None	N/A	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 SAMOA

Scale	Category	Item	Minimum Standard Criterion	Tupua Tamasese Meaole Hospital	Malietoa Tanumafili II Hospital	Samoa - 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, *Correct Storage*.			
Healthcare Facility	Internal Handling	Transport Trolley	A dedicated trolley is used for waste transport. The trolley is designed so that any spills are contained.			
	Internal Handling	Routing	Healthcare waste is not transported where clean linen and/or food are transported			
Healthcare Facility	Training	Planning and implementation	A structured waste management education program has been developed with a clear delivery structure			
Healthcare Facility	Training	Curricula	A structured waste management training program has been developed that targets the different roles within the hospitals.			
Healthcare Facility	Training	Follow-up & refresher courses	All staff receive waste management education during induction. All staff receive refresher training annually. Waste management training is delivered following an adverse incident to the relevant staff/ward/department.			
Healthcare Facility	Training	Training responsibility	A hospital officer has responsibility for ensuring all training occurs as required and that records are maintained of all training and attendance.			
Healthcare Facility	Waste Audits		A program has been implemented to ensure waste audits are conducted of all waste materials/systems in all wards/departments on an annual basis and reports are provided to the waste management committee. Effective systems are in place to ensure that any non-conformances (with the hospital waste management strategy) are remedied.			
Healthcare Facility	Transport - External		A dedicated vehicle is used to transport untreated healthcare waste. This load carrying area of the vehicle is enclosed and constructed so that any spilt material is contained within this area. A split kit is provided.			
Healthcare Facility	Treatment	Suitability of treatment for healthcare waste	The method for treating healthcare waste is in accord with required standards - this includes operating parameters			

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

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

Appendix D

Qualitative Local Feasibility Assessment – Treatment Technology

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Samoa)

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^{0}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 – Samoa is a party to Stockholm	Incinerators are currently used in hospitals there	Equipment breakdown and lack of local skills to maintain equipment – barrier can be managed through skills training & supplier support	Emissions of air pollutants and leaching from ash disposal to receiving environment are potential impacts. High temperature operation minimises pollution and proper landfilling of ash contains leaching.	Equipment lifespan ~ 10 years plus but will only last if maintained. High temperature equipment is prone to require a moderate level of maintenance	Requires skilled operators but modern equipment combined with training simplify operation
Incineration at med. temperature (800 - 1000^{0}C)	$69,820 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Can treat all waste types, achieves complete sterilization, incomplete combustion, may not destroy needles	Some issues for operators (requires training & PPE); potential issues for community (smoke, emissions not	Equipment lifespan ~ 5 years; sustainability dependant on maintaining operator skills plus proper operation and maintenance	No legal barriers to incineration; potential for smoke nuisance is med - high and the potential for contribution to	Incinerators are currently used in hospitals there	Equipment breakdown and lack of local skills to maintain equipment – barrier can be managed through skills training & supplier support. Simpler	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment are potential impacts. Med. temperature	Equipment lifespan typically less ~ 5 years but will only last if maintained. Equipment is prone to require a moderate	Requires less skilled operators than high temperature equipment - training simplifies operation

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Samoa)										
Remaining Technology Options	**Comparatively low cost to implement**	**Comparative effectiveness across all HCWs**	**Local Feasibility**							
			Health & safety to workers & community	**Sustainability of solution**	**Institutional and policy fit**	**Cultural fit**	**Implementation barriers can be overcome?**	**Receiving environment not impacted**	**Durability**	**Ease of operation**
			fully controlled)		combustion derived POPs & other pollutants is high – Samoa is a party to Stockholm		infrastructure.	operation increases risks of air pollution, but likely to only be an option in isolated small communities.	level of maintenance	
Low temperature burning (<400^{0}C)	$6,485 USD over 10 years (ref Whole of Project – Summary Report, Appendix E)	Not applicable for all waste types, relatively high disinfection efficiency, incomplete combustion, will not destroy needles	Some issues for operators (requires training & PPE); issues for community (smoke, emissions not controlled at all)	No equipment; sustainability dependant on government & community acceptance which would be expected to decline with time	Potential for smoke nuisance is very high and the potential for contribution to combustion derived POPs & broader range of other pollutants is very high.	Likely community concern if healthcare waste was burned in an open situation	No equipment operation reliability barrier.	Emissions of air pollutants/ smoke and leaching from ash disposal to receiving environment. Low temp operation provides no controls on air pollution. Risk of fire impact.	Simple, zero technology so there is nothing that can break down	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 – Summary	Cannot treat all waste types, achieves complete	Some issues for operators (requires training & PPE); small	Equipment lifespan ~ 10 years; sustainability dependant on	No legal barriers; no potential for smoke nuisance;	Not familiar with use of sterilisers for waste – potential	Equipment breakdown and lack of local skills to maintain equipment –	No emissions of air pollutants/ smoke; some potential for odour impacts;	Equipment will only last if maintained. Adding shredder to	Requires skilled operators to achieve best level of

Table D1: QUALITATIVE Treatment Technology Options Assessment - Local Feasibility (Samoa)										
Remaining Technology Options	**Comparatively low cost to implement**	**Comparative effectiveness across all HCWs**	**Local Feasibility**							
			Health & safety to workers & community	**Sustainability of solution**	**Institutional and policy fit**	**Cultural fit**	**Implementation barriers can be overcome?**	**Receiving environment not impacted**	**Durability**	**Ease of operation**
	Report, Appendix E)	sterilization when correctly operated, no combustion required, shredder destroys needles	potential for odours and wastewater discharge (community)	maintaining operator skills plus longevity of equipment use given technology complexity	some potential for odour nuisance; no air pollution (no combustion-POPs) and some potential for waste water management issues	community issue with waste appearance if steriliser not operated correctly or shredder not used	barrier can be managed through skills training & supplier support. Increased complexity of equipment (compared to incineration) increases barrier	still requires landfill or dump disposal of residue so some potential for leaching on burial. Landfill volume higher than incineration but landfill facilities in Samoa are of reasonable standard. Some potential for waste water management issues	autoclave technology increases mechanical parts that can go wrong. May require moderate level of maintenance	disinfection.
Encapsulation (only post-disinfection sharps assessed)	Virtually zero additional cost to disinfection system costs	Not applicable to non-sharps waste. In the context of pre-sterilised sharps only:	Encapsulation has handling issues for operators (requires training & PPE) and no	No equipment; sustainability dependant burial space available.	No legal barriers; no smoke nuisance; no odour nuisance; no air pollution	No particular cultural fit concerns.	Shapes currently burnt in an incinerator.	Encapsulation itself poses no smoke nuisance; no odour nuisance; no air pollution and some potential	Highly durable due to its simplicity.	Simple procedure once operator understands and manages the

Table D1: QUALITATIVE **Treatment Technology Options Assessment - Local Feasibility (Samoa)**										
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**
		no combustion required and completely removes downstream needle injury risk	community issues		and some potential for leachate to groundwater, although limited inherent hazard			for leachate to groundwater, although limited inherent hazard		risk of sharps handling and knows how to mix cement correctly.

Legend: Descriptions equate to the following scores:

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

Appendix E

Recommendation Guidelines

Recommendation 1: Develop a Waste Management Framework

Healthcare Waste Management Plan

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

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

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

Appointment of a Responsible Officer

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

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

Appointment of a Waste Management Committee

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

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

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

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

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

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

The Waste Management Committee should:

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

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

Recommendation 2: Procurement of Consumables (Segregation & Storage)

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

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

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

Waste containers specification and siting

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

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

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

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

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

Setting and Maintaining Segregation Standards

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

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

Correct Signage

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

Correct Storage

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

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

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

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

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

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

Personnel Protective Equipment

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

Other aspects of this program are:

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

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

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

Recommendation 3: Provide a Sustainable Training Program

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

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

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

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

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

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

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

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

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

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

Training of Waste Disposal Treatment Operators

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

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

Recommendation 4: Improved Treatment Infrastructure

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

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

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

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

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

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

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

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

does indicate that there are potential negative environmental and health consequences. The implications of these studies could legitimately be applied to discharge of waters such as leachate or surface water runoff from landfills should these wastes be deposited untreated. According to the World Health Organization[4, 5], incineration is the preferred method for treating pharmaceutical and cytotoxic wastes. This is further supported by the United Nations[6, 7] 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[8, 9].

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

In Australia as an example where there is allowed a variety of treatment technologies for the range of clinical and related wastes, without exception, jurisdictions do not allow treatment other than incineration for anatomical waste, pharmaceuticals and cytotoxic wastes[10, 11, 12, 13, 14, 15]. This is also quite evident in a review of Australian State/Territory environmental agency licence conditions for approved clinical and related waste treatment technologies. In countries that do allow landfilling of clinical and related wastes, often these two specific waste categories are specifically excluded from this option[16].

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.

---

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

[5] World Health Organization, Safe management of Wastes from healthcare Facilities, Geneva, 1999.

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

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

[8] Health care Without Harm, Non-Incineration Treatment Technologies, August 2001.

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

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

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

[12] NSW Department of Health, Waste Management Guidelines for Health care Facilities, August 1998.

[13] Queensland Government, Environmental Protection (Waste Management) Regulation, 2000.

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

[15] 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.

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