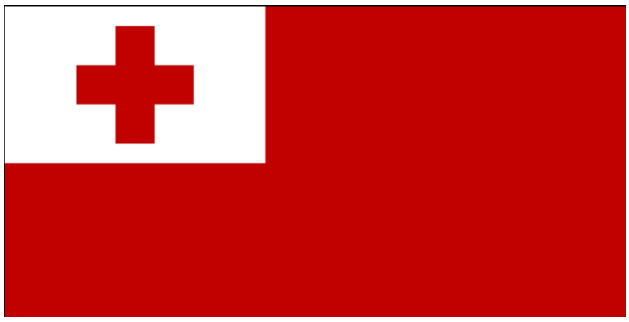
Survey of the Regional Distribution and Status of Asbestos-Contaminated Construction Material and Best Practice Options for its Management in Pacific Island Countries

Report for the Kingdom of Tonga



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

May 2015

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Executive Summary

PacWaste (Pacific Hazardous Waste) is a four year (2013-2017), €7.85 million, project funded by the European Union and implemented by Secretariat of the Pacific Regional Environment Programme (SPREP) to improve regional hazardous waste management in 14 Pacific island countries plus Timor Leste, in the priority areas of healthcare waste, asbestos, E-waste and integrated atoll solid waste management.

Asbestos-containing wastes and materials are a major issue for many Pacific Island countries with a history of use of asbestos-containing building materials in construction. All forms of asbestos are carcinogenic to humans and inhalation of asbestos fibres that have become airborne can cause serious lung disease or cancer.

SPREP's regional priorities for asbestos management include conducting an inventory of the distribution of asbestos-containing materials (ACMs) in thirteen Pacific island countries, assessing the risks posed to human health by asbestos, progressive stabilization of high-risk facilities such as schools and occupied dwellings, and final disposal of ACM wastes in suitable locations.

PacWaste has commenced with a series of baseline surveys that will collect and collate information about the current status of all three hazardous waste streams targeted (healthcare waste, asbestos, E-waste) and its management in the South Pacific region and will identify best practice options for interventions that are cost-effective, sustainable and appropriate for Pacific island communities. These remedial interventions will be implemented in priority countries identified through the baseline survey.

This report aims to meet part of the objectives of SPREP'S Pacific Regional Solid Waste Management Strategy 2010–2015 and the regional hazardous waste strategies, 'An Asbestos Free Pacific: A Regional Strategy and Action Plan 2011'.

This report covers the Tonga component of a survey of the regional distribution and status of asbestos-contaminated construction material, and best practice options for its management, in selected Pacific island communities. The objectives of the survey are summarised as follows:

- To assess the status of, and management options for, asbestos throughout the Pacific region; and
- To develop recommendations for future management interventions, including a prioritised list of target locations.

The work was carried out by a consortium led by Contract Environmental Ltd and Geoscience Consulting (NZ) Ltd, under a contract to the Secretariat of the Pacific Regional Environment Programme (SPREP), with funding provided by the European Union.

This report presents the information gathered for Tonga during a field visit undertaken by Gareth Oddy of Geoscience between 1st and 8th November 2014. The visit was organised through the Tongan Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications (MEECCDMMIC).

Survey Methodology

The survey work undertaken in Tonga included meetings with key government agencies, area-wide surveys of residential properties across the islands of Tongatapu and Vava'u, and targeted investigations of public and commercial buildings. There are 52 inhabited islands in Tonga but the survey was limited to the islands of Tongatapu and Vava'u, mainly for logistical reasons. The most recent census data for Tonga (2011) indicates that there are approximately 15,738 households on Tongatapu and Vava'u, and this represents about 86% of the total for the whole country.

A statistical method was adopted for the survey of residential properties. This involved calculating the minimum sample size required from the total population to give the required confidence level and margin of error. In this case a minimum sample size of 747 houses was required out of the 15,738 in total on Tongatapu and Vava'u to give a result with a margin of error of ± 3.5% at the 95% confidence level. The statistical approach requires that the residential properties be selected at random.

In addition to residential households, the survey sought to identify public buildings and government-owned industrial and commercial properties containing ACMs. The primary focus of this part of the survey was on public buildings that would potentially present the most prolonged and thus significant risks for public exposure. Commercial and industrial buildings were included if they were observed in close proximity to residential housing or public areas.

The basic approach taken for all property types was an initial visual assessment, usually from the roadside or property boundary, followed by closer inspection if the buildings appeared to contain potential ACMs, such as fibreboard cladding, roofing materials, or pipes. The information collected in the close-up inspections was recorded on the spot using a tablet-based application designed specifically for this project. In addition, samples of any suspect materials were collected for testing.

The collected samples were sent by courier to EMS Laboratories Incorporated in California, USA. Analysis was by Polarised Light Microscopy, which is a semi-quantitative procedure for identifying asbestos fibres, with a detection limit in the range of 0.1 to 1% on a surface area basis.

Risk Assessment

A systematic risk assessment approach was adopted in order to assess the relative risks of each building identified as containing ACMs. The method used was that given in the UK HSE guidance document '*Methods for the Determination of Hazardous Substances (MDHS100) Surveying, Sampling and Assessment of Asbestos-Containing Materials (2001)*' and UK HSE guidance document '*A Comprehensive Guide to Managing Asbestos in Premises (2002)*'. The method uses a simple scoring system to allow an assessment of the relative risks to health from ACMs. It takes into account not only the condition of the asbestos, but the likelihood of people being exposed to the fibres.

The risk assessment approach adopted presents algorithms that allow a score to be calculated for each ACM item observed or confirmed by laboratory analysis. The sites with high scores may present a higher risk to human health than those with lower scores.

Survey Outcomes

ACM has been identified by this study to be present at a number of locations in Tonga. Based on the algorithm adopted as part of the risk assessment to prioritise asbestos management, this study has identified that there are 21 sites in Tonga that are considered moderate to high risk with regards to the occupant's and/or public's potential exposure to asbestos. The remaining sites identified are considered to present a low to very low risk to human health. Management of the low risk sites will be required to ensure the risk to human health is not elevated further as the buildings deteriorate with age.

In addition, based upon a statistical approach utilising population, household and asbestos survey data adopted by this study, the number of residential properties potentially containing ACM in Tongatapu and Vava'u has been calculated based on 95% confidence level of the sample survey size to be between around 1,600 +/-2.3%. If the above results are scaled up for the whole of Tonga, the total number of houses potentially containing asbestos would be between around 295.

Cost Estimates

Pacific-wide cost estimates have been calculated for several remediation scenarios, as shown in the table below:

Summary of Costs for Various Remediation Options (Costs rounded to nearest $US)

Remediation Method	Cost per m^2 (face area) $US
Encapsulation	
Roofs:	
Encapsulate roof where there is no ceiling present below the roof	50.00
Encapsulate roof where there is an existing ceiling below the roof that needs to be removed and replaced	91.00
Cladding:	
Encapsulate wall cladding where there is no internal wall sheeting	26.00
Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated	18.00
Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/m2 (face area)	66.00
Removal and Replacement	
Roofs:	
Remove and replace roof	96.00
Cladding:	
Remove and replace cladding	76.00
Miscellaneous	
Remove and replace floor tiles*	80.00
Pick up debris, pipes	40.00

**$US80 is the lower end of the cost spectrum for removing and replacing vinyl floor tiles and the cost could easily double (or more) for difficult removal projects. To balance this out, the vinyl tile matrix is stable and there is little risk of asbestos exposure unless they are badly deteriorating. Vinyl floor asbestos projects could therefore be lower down on the priority list.*

The above removal and replacement rates assume asbestos waste disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Recommendations and Prioritised List of Actions

Remediation of sites has been prioritised based on the level of risk posed to the building occupants and public at each site according to the risk assessment methodology. The quantities of ACM observed at the sites were used to estimate costs for abatement. A summary of the recommended actions and estimated costs are included in the table below.

Site Name	ACM	Risk Score	Recommended Remedial Actions	Estimated ACM Area (m^2) and/or Volume (m^3)	Estimated Cost Range ($ USD)
Tonga Post Ltd	Fibre cement roof	27	Remove and replace ACM	1,400 m^2	$127,400
	Soffits	25			
Neiafu former market - Tonga Football Association, Vava'u	Fibre cement (roof)	24	Remove and replace ACM Roof	300 m^2	$28,800
MOI Wof Centre	Fibre cement cladding	24	Remove and replace ACM Roof and facades.	900 m^2	$86,400
			Sub-Total for High Risk Sites		$242,600
MOI Workshop	Fibre cement roof and façade cladding	23	Remove and replace ACM Roof and facades. Pick up loose ACM surface scrape of topsoil.	1,685 – 1,885 m^2	$161,760 – 180,960
Fua'amotu Domestic Airport - Residential	Fibre cement (roof)	22	Remove and replace ACM	450 m^2	$43,200
Prince Ngu Hospital, Neiafu, Vava'u	Fibre cement (loose rear car park)	21	Pick up loose ACM, assess soil.	50 m^2	$2,000
	Fibre cement roof	21	Remove and replace ACM	3,600 m^2	$345,600
St Andrews School	Fibreboard classroom 15	21	Remove and replace ACM	160 m^2	$12,160
Plumbing Shop	Fibre cement (roof and facades)	21	Encapsulate	50 – 60 m^2	$4,550 - $5,460
QTR 33-34*	Fibre cement (roof)	21	Remove and replace ACM	100 – 150 m^2	$9,600 – 14,400
QTR79 – 82*	Fibre cement (roof)	20 – 21	Remove and replace ACM	760 – 900 m^2	$75,840 – 86,400
Residential Property 01 – 13*	Fibre cement (roof)	19 – 21	Remove and replace ACM	1,300 m^2	$124,800
QTR 88 - 94 (former Government Quarters), Haveluloto.*	Fibre cement roof	21	Remove and replace ACM	1,440 – 1,700 m^2 (140 m^3)	$138,240 – 163,200
	Wall exterior panel	20	Remove and replace ACM		
Pacific International (Tonga) Limited	Fibre cement (roof)	20	Encapsulate	140 – 200 m^2 (14-20 m^3)	$13,440 – 19,200
QTR 39&40*	Fibre cement (roof)	20	Remove and replace ACM	265 m^2	$25,440

Site Name	ACM	Risk Score	Recommended Remedial Actions	Estimated ACM Area (m^2) and/or Volume (m^3)	Estimated Cost Range ($ USD)
QTR 51&52*	Fibre cement (roof)	20	Remove and replace ACM	265 m^2	$25,440
Tonga Water	Fibre cement (roof and facades)	20	Encapsulate	100 – 120 m^2 (10m^3)	$9,600 – 11,520
Industrial 02, Nuku'alofa	Fibre cement (roof)	20	Encapsulate	100 – 120 m^2 (10 m^3)	$9,600 – 11,520
Vavau'u former bulk fuel terminal	Fibre cement (loose on sports field)	18	Pick up loose ACM surface scrape of topsoil.	2,000 m^2	$80,000
	Rear building fibre cement	18	Remove	500 m^2	$24,500
Industrial 01, Nuku'alofa	Fibre cement roof	18	Encapsulate	100 – 120 m^2 (10 m^3)	$9,100 – 10,920
CAT Depot, Nuku'alofa	Loose soffit	17	Encapsulate	100 – 120 m^2 (10 m^3)	$1,800 – 2,160
Viola Hospital, Haveluloto, Tongatapu	Walkway fibre cement roof	17	Remove	20 m^2	$980
			Sub-Total for Moderate Risk Sites		**$1,117,650 - $1,189,860**

The following recommendations are made in relation to asbestos on Tonga:

A. It is recommended that the above higher priority asbestos work is carried out in Tonga. The government buildings may be eligible for inclusion in the SPREP PacWaste Project, but not the commercial or industrial buildings.
B. Numerous residential dwellings are identified in Table 13, above, as marked by an asterisk, and it has been concluded that 295 houses (+/- 2.3%) in Tongatapu and Vava'u may have asbestos roofing and/or cladding as well as potentially more in the rest of Tonga. It is recommended that all houses with PACM cladding in Tonga are tested for asbestos and that all the houses tested positive are notified and included in an awareness campaign. They should be remediated (i.e. the asbestos removed or encapsulated) where resources permit.
C. If a large number of houses are found to contain asbestos cladding then encapsulation would probably be the most cost-effective option for remediation although ongoing management procedures then would be needed and re-encapsulation (i.e. re-painting) would probably be needed 10-15 years later. If a small number of houses are found to contain asbestos cladding then removal and replacement of the cladding should be considered.
D. Any asbestos roofs found on houses in Tonga should preferably be removed rather than encapsulated as encapsulation of roofs costs only a little less than removal and removal is a permanent solution.
E. All asbestos waste should be disposed of in the Tapuhia Landfill on Tongatapu, which has been determined as suitable for the disposal of asbestos waste. The asbestos waste should be placed in special cells and covered immediately.
F. Before asbestos remediation takes place (and after if all the asbestos is not removed) it would be appropriate to set in place suitable asbestos management practices and procedures to deal with the ongoing risk posed to human health by asbestos exposure. This should be accompanied by an appropriate education and training programme.

G. Consideration should be given to Tonga passing regulations under suitable legislation to enable the above asbestos work to be carried out.

Contents

Definitions

ACM: "Asbestos Containing Material" – ie any material that contains asbestos.

Amosite: Brown or Grey Asbestos

Asbestos: The fibrous form of mineral silicates belonging to the Serpentine and Amphibole groups of rock-forming minerals, including amosite (brown asbestos), crocidolite (blue asbestos), chrysotile (white asbestos), actinolite, tremolite, anthophyllite or any mixture containing one or more of these

CEL: Contract Environmental Limited

Chrysotile: White Asbestos

Crocidolite: Blue Asbestos

EMS: EMS Laboratories Incorporated

External: Refers to the top or outside of roof sheeting or the outside of building/wall cladding

Friable: With respect to asbestos-containing material, means able to be crumbled, pulverised or reduced to powder by hand pressure when dry, and includes non-bonded asbestos fabric

GPS: Global Positioning System

Hazard: Is a potential to cause harm

IANZ: International Accreditation New Zealand

Internal: Refers to the underside of roof sheeting, or the inside of building/wall sheeting and structures therein

MDHS100: Methods for the determination of hazardous substances, surveying, sampling and assessment of asbestos-containing materials

Non-Friable: With respect to asbestos containing material means unable to be crumbled, pulverised or reduced to powder by hand pressure when dry

PACM: "Presumed Asbestos Containing Material" – ie any material presumed to contain asbestos, based on observation and knowledge of other relevant factors

PPE: Personal Protective Equipment

Practicable: Able to be done / put into practice having regard to:

- The severity of the hazard or risk in question
- The state of knowledge about the hazard or risk
- The availability and suitability of ways to remove or mitigate that hazard or risk
- The cost of removing or mitigating that hazard or risk

Risk: Is the likelihood of illness or disease arising from exposure to airborne asbestos fibres

SMF: Synthetic Mineral Fibres

SPREP: Secretariat of the Pacific Regional Environment Programme

1. Introduction

1.1 Purpose

This report covers the Tongan component of a survey of the regional distribution and status of asbestos-containing material (ACM), and best practice options for its management, in selected Pacific island communities. The objectives of the survey are summarised as follows:

- To assess the status of, and management options for, ACM throughout the Pacific region; and
- To develop recommendations for future management interventions, including a prioritised list of target locations.

The work was carried out by a consortium led by Contract Environmental Ltd and Geoscience Consulting (NZ) Ltd, under contract to the Secretariat of the Pacific Regional Environment Programme (SPREP), with funding provided by the European Union. The majority of information relating to the distribution of ACM in Tonga was obtained during a field visit undertaken by Gareth Oddy of ENGEO between Saturday 1st and Saturday 8th November 2014. The field visits were conducted with assistance from the Tongan Government and in particular the Ministry of Infrastructure (MoI) and the Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications (MEECCDMMIC).

1.2 Scope of Work

A copy of the Terms of Reference for this work is given in Appendix 1. It lists the following tasks:

1. *Collect and collate data on the location (geographic coordinates), quantity and condition of asbestos-containing building materials (including asbestos-containing waste stockpiles) in each nominated Pacific Island country;*

2. *Review, and recommend a prioritised list of local best-practice options for stabilisation, handling and final disposal of asbestos-contaminated materials in each nominated Pacific Island country (including review of existing local institutional, policy and regulatory arrangements);*

3. *Recommend and prioritise actions necessary to minimise exposure (potential and actual) of the local population to asbestos fibres for each nominated Pacific Island country. An approximate itemised national cost should be presented for each option identified;*

4. *Identify any local contractors who have the expertise and capacity to potentially partner with regional or international experts in future asbestos management work; and*

5. *Develop a schedule of rates for local equipment hire, mobilisation, labour, etc., to guide the development of detailed cost-estimates for future in-country asbestos remediation work.*

1.3 Background to Tonga

Tonga, officially the Kingdom of Tonga, is a Polynesian sovereign state and archipelago comprising 177 islands, with a total surface area of about 750 square kilometres, scattered over 700,000 square kilometres of the southern Pacific Ocean, of which 52 islands are inhabited by its 103,000 people. Seventy percent of Tongans reside on the main island of Tongatapu, on which the capital city of Nuku'alofa is located. This island covers 257 square kilometres.

Tonga stretches over approximately 800 kilometres (500 miles) in a north-south line – about a third of the way along the route from New Zealand to Hawaii. Fiji and Wallis and Futuna are to the northwest, Samoa to the northeast, Niue to the east and New Caledonia and Vanuatu further to the west.

The climate is tropical with a distinct warm period (December–April), during which the temperatures rise above 32 °C, and a cooler period (May–November), with temperatures rarely rising above 27 °C. The average wettest period is around March with on average 263 mm (10.4 in). The average daily humidity is 80%.

The tropical cyclone season currently runs from 1 November to 30 April, though tropical cyclones can form and affect Tonga outside of the season.

The map of Tonga is shown in Figure 1.

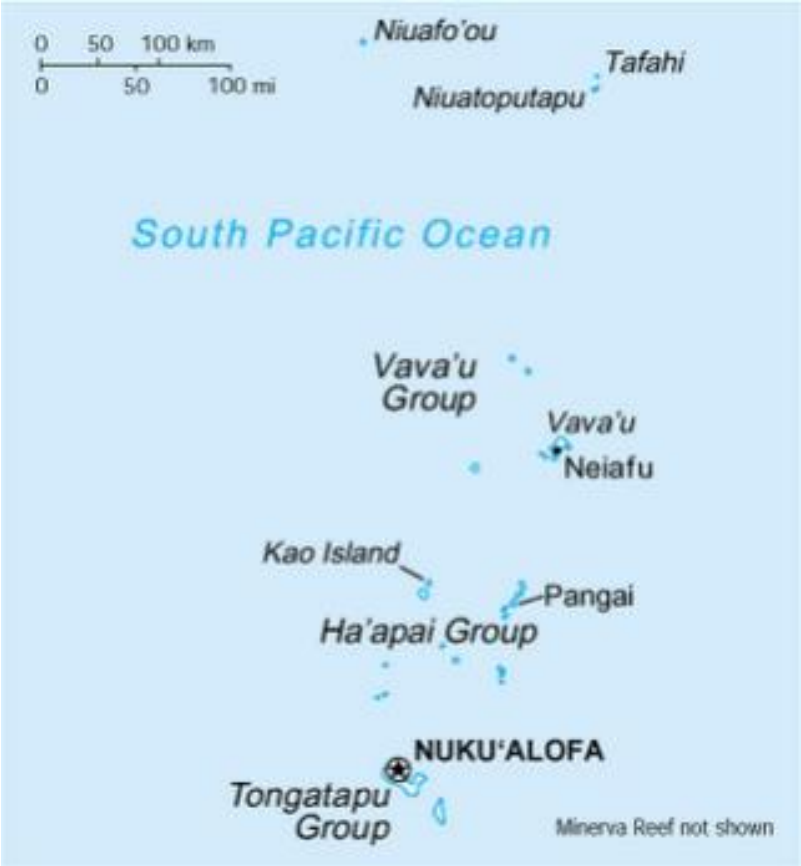

Figure 1 – Map of Tonga

1.4 Report Content and Layout

Section 2 of this report gives details of the methodology used for the study including the approach used for determining the survey coverage, the identification of specific target sites, procedures for site inspections and data capture, and sample collection and analysis. In addition, the relative importance of different sites was assessed using a risk assessment methodology, which is described in section 3.

The results of the survey are presented in section 4 of the report, with supporting information on the laboratory results given in section 5, and the risk assessment results in section 6.

Section 7 provides a generic discussion of possible management options for ACMs, and this is followed in section 8 by a specific analysis of the most appropriate options for those ACMs identified in Tonga.

Section 9 provides a review and analysis of existing national policies and legal instruments relevant to ACM management and disposal, while local contracting capabilities and costs are noted in section 10.

Section 11 of the report provides a final discussion and a list of recommended actions, including cost estimates for those sites identified as priority targets for remediation.

Additional supporting information is given in a series of appendices.

2.0 Survey Methodology

2.1 Pre-Survey Desk Study

The survey work undertaken during the visit to Tonga included meetings with key government agencies, area-wide surveys across the islands of Tongatapu and Vava'u and specific investigations of 61 individual sites.

Prior to conducting the surveys and visiting Tonga, the survey team completed a desk study to enable a more targeted assessment of buildings potentially containing ACM. The desk study included contacting relevant local Government agencies in advance of the trip to evaluate if the agencies were aware of any buildings where ACM was a concern. In addition, the consultation aimed to evaluate local regulations and practices with respect to ACM identification, removal and disposal practices.

A second objective of the desk study was to evaluate the population distribution on the survey islands in order to prioritise which population centres and if possible which individual buildings should be included in the survey. The most recent census data was sought and reviewed in order to ensure a sufficient statistically representative number of residential buildings were included in the survey.

Where population centres were identified, existing aerial photographs and geographically positioned photographs (where available) provided on Google Earth were reviewed. The review of Google Earth photographs enabled the survey team to appreciate the typical types of building construction materials in the centres, an approximate age of the buildings and in certain cases possible asbestos containing material (PACM). Conclusions on any PACM observed in the photographs were to be verified during the surveys.

2.1.1 Review of Tongan Asbestos Reports

Following the desk study, several reports detailing the presence of asbestos in Ha'apai were reviewed, as was an asbestos survey report conducted at Vaiola Hospital, Tongatapu in 2002. The reports reviewed included the following;

- Waste Authority Ltd, 2014, Cyclone Ian Reconstruction and Climate Resilience Project (CIRCRP), briefing notes on waste issues in Ha'apai;
- Ministry of Infrastructure, April 2014, Environmental Management Plan, Cyclone Ian Reconstruction and Climate Resilience Project;
- Nikau Contractors Limited, April 2014, Post Cyclone Ian Asbestos Assessments –Government of Tonga;
- Tonkin & Taylor August 2014, Safe Handling and Disposal of Waste and Debris from Cyclone Ian, Ha'apai Islands, Tonga; and
- Alfred Picardi, November 2002, Tonga Health Care Project, Asbestos Survey Report.

Summaries of the reports are provided in Appendix 4.

2.2 Survey Coverage

Due to the widespread distribution of the population of Tonga and the difficulties in accessing each island, a survey of each residential household was not feasible in the timeframes and budget of the project. For logistical reasons the survey was limited to the islands of Tongatapu and Vava'u, and a statistical approach was adopted for those two islands to ensure a sufficient number of residential properties were included in the survey.

The Tongatapu survey was concentrated on the capital city Nukualofa but also included the numerous villages located on the island. The survey of Vava'u included the settlements of Neiafu, Toula Village, Pangai, Utungake, Talihau, Makave, Mataika, Feletoa, Leimatua, Tefisi and Longomapu.

Table 1 summarises the most recent census data for Tonga with regards to the population of each region and number of households included in the asbestos survey. Although Ha'apai was not included in this survey, other recent asbestos surveys have been conducted by other contractors following the devastating Tropical Cyclone Ian (Category 5) of January 2014.

Table 1: Tonga 2011 Census – Population and Households by Region

Indicator	Tonga	Tongatapu	Vava'u	Ha'apai
Population	103,252	75,416	14,922	6,616
Households	18,156	12,904	2,834	1,266

Source: 2011 Population Census of Tonga, Samoa Bureau of Statistics.

The statistical approach adopted is a technique commonly used in household marketing surveys and political polls. For a specified total population size the required sample numbers can be calculated to give a target level of confidence and uncertainty. Further information regarding the statistical approach is provided in Section 4.1.

The statistical approach adopted required that a random method was used for selecting residential buildings to be surveyed and included in the sample size. In practice this involved selecting a cluster of properties at random when viewed from the road. The surveyor then undertook a more detailed inspection of the properties. Where possible samples of the building material were collected and tested in the field for indications of asbestos fibres.

2.3 Identification of Target Sites

In addition to residential households, the survey sought to identify public buildings and government-owned industrial and commercial properties containing ACM. The primary focus of the survey was on residential properties and public buildings that would potentially present the most prolonged and thus significant risks for public exposure. Commercial and industrial buildings were included in surveys where they were owned by the Tongan Government or were observed in close proximity to residential housing and/or public areas.

The asbestos surveys had three main objectives. Firstly, it was, as far as reasonably practicable within the time available, to record the location, extent and product type of any presumed or known ACMs. Secondly, it was to inspect and record information on the accessibility, condition and surface treatment of any presumed or known ACMs based on worst case scenarios. Thirdly, the survey aimed to determine and record the asbestos type, either by collecting representative samples of

suspect materials for laboratory identification, or by making a presumption based on the building age, product type and its appearance.

A list of the people and organisations contacted during the visit is given in Appendix 2, and the key points arising from the discussions are summarised in Appendix 3.

During the initial week of the survey, the surveyor attended meetings with representatives from the Tongan government agencies responsible for hazardous waste, waste management, planning and environmental protection. This included representatives from the Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications (MEECCDMMIC), Department of Environment and the Waste Authority. The representatives provided information regarding asbestos regulations and potential state assets containing asbestos.

Other government departments and agencies were also contacted regarding the potential for asbestos to be present in government-owned assets, including Tonga Power, Ministry of Infrastructure, Ministry of Education, and the Water Authority.

The remainder of the survey consisted of inspecting residential areas and government-owned facilities including (but not limited to) schools, hospitals and healthcare centres, power stations, water treatment facilities, research centres and government administration buildings.

A total of 61 sites were surveyed in Tonga for the presence of ACM.

2.4 Site Assessment Data Capture

Information was collected from each survey site using a tablet-based application designed specifically for this project. The software requires certain information to be recorded including location, type of facility, whether asbestos was identified, type, volumes, and most applicable remedial methodology. The software also allows for pictures to be taken of the sites and uses a Global Positioning System (GPS) to record where the pictures were taken. Information provided by owners/occupants of the building relating to its age, state of repairs, and previous ACM knowledge was also recorded in the software.

The use of the application ensures that data is collected in a uniform manner across all of the surveyed countries regardless of the survey team members. Copies of all of the individual site assessment reports for Tonga are available via SPREP.

2.5 Sample Collection Methodology

61 individual facilities / properties were identified as requiring a detailed site assessment due to their age, use, sensitive location or observations of suspected PACM. In order to assess if potential PACM contained asbestos, samples were collected and analysed by a professional accredited laboratory in accordance with international standards.

Samples of suspected PACM were only collected if the following conditions were met;

- Permission was granted by the property owner;
- The work would minimise the disruption to the owner's operations;
- The sampling would not put the health and safety of occupants at risk;
- The areas to be sampled inside buildings were as far as possible unoccupied;

- Entry of other people not wearing personal protective equipment (PPE) to the sampling area was restricted;
- Where the material to be sampled could be safely pre-wet (i.e. excludes items with a risk of electrocution or where permission to wet a surface was not received); and
- Collection of a sample would not significantly damage the building material.

Where the above conditions were met, sampling was conducted following standard CEL / Geoscience Procedure and in accordance with international guidance provided by the United Kingdom Health & Safety Executive (UK HSE) and New Zealand Demolition and Asbestos Association (NZDAA).

The samples were collected in accordance with the following procedure;

- Sampling personnel were required to wear adequate personal protective equipment (PPE), as determined by the risk assessment (disposable overalls, nitrile gloves, overshoes and a half face respirator with P3 filters);
- Airborne emissions were controlled by pre- wetting the material to be sampled, with a fine water mist;
- Damaged portions of suspected ACM were sought first where it was easier to remove a small sample. The sample size collected was approximately 5 cm^2;
- Samples were obtained using pliers or a screwdriver blade to remove a small section from an edge or corner;
- A wet-wipe tissue was used between the pliers and the sample material to prevent fibre release during the sampling;
- All samples were individually sealed in their own sealable polythene bag which was then sealed in a second polythene bag;
- After sampling, water was sprayed onto the sample area to prevent fibre release;
- Sampling points were further sealed by PVC tape where necessary;
- Samples were labelled with a unique identifier and in the survey documentation; and
- Each sample was noted on a chain of custody provided by the laboratory, and secured in a sealable container.

As with any environmental assessment, sampling of a media, in this case building material, can vary both spatially and temporally. Due to the wide scope of the survey including all residential and public buildings on the island, only a limited number of samples were collected. The collection of samples was based on the aforementioned considerations but also with the project scope in mind. Where similar building materials were encountered at numerous sites, a single sample was considered sufficient to be used to base conclusions on. Also, where a large amount of PACM was identified at a single site, one sample of each main material identified was considered sufficient for this stage of the assessment.

2.6 Sample Laboratory Analysis

The samples were sent by courier to EMS Laboratories Incorporated (EMS) located in California United States of America. Analysis of the samples was performed by EMS using Polarised Light Microscopy. According to EMS the analysis method is a semi-quantitative procedure with a detection limit between 0.1-1% by area of the bulk sample, depending on the size of the asbestos

fibres, sampling method and sample matrix. The type of asbestos fibre present was also reported with the three most common fibres types being chrysotile (white asbestos), crocidolite (blue asbestos) and amosite (brown asbestos).

The results for these samples are discussed in Section 5, and copies of the laboratory report are given in Appendix 5 of this report.

3.0 Risk Assessment Methodology

A systematic risk assessment approach was adopted in order to assess the risk that identified asbestos containing material presented to site occupants and if applicable the public. The risk assessment adopted was that provided by the UK HSE guidance document 'Methods for the Determination of Hazardous Substances (MDHS100) Surveying, Sampling and Assessment of Asbestos-Containing Materials (2001)' and UK HSE guidance document 'A Comprehensive Guide to Managing Asbestos in Premises (2002)'.

The documents present a simple scoring systems to allow an assessment of the risks to health from ACMs. It takes into account not only the condition of the asbestos, but the likelihood of people being exposed to the fibres.

The risk method used presents algorithms that allow a score for each ACM item observed or confirmed by laboratory analysis, to be calculated. The sites with high scores may present a higher risk to human health than those with lower scores.

The risk assessment approach has two elements, the first algorithm is an assessment of the type and condition of the ACMs or presumed ACMs, and their ability to release fibres if disturbed. The final score for each ACM or presumed ACM depends on the type of ACM i.e. concrete vs lagging, the condition of the ACM, if there is any surface treatment and the actual type of asbestos (i.e. chrysotile (white), amosite (brown), or crocidolite (blue).

The second algorithm considers the ACM setting, likelihood of the ACM actually being disturbed and exposure to a receptor(s). The setting assessment therefore considers the normal occupant activity in that area of the site and the likelihood of disturbance. Each ACM is scored and these scores are added to those for the material assessment to produce a total score.

3.1 ACM Assessment

The algorithm in MDHS100 considers four parameters that determine the risk from an ACM: that is the ability to release fibres if disturbed. The four parameters are:

- product type;
- extent of damage;
- surface treatment; and
- asbestos type.

Each of the parameters is scored and added to give a total score between 2 and 12:

- materials with scores of 10 or more should be regarded as high risk with a significant potential to release fibres if disturbed;
- those with a score between 7 and 9 are regarded as medium risk;
- materials with a score between 5 and 6 are low risk; and
- scores of 4 or less are very low risk.

The material assessment algorithm shown in MDHS100 is reproduced in Table 2.

Table 2: MDHS100 Material assessment algorithm

Sample variable	Score	Examples of scores
Product type (or debris from product)	1	Asbestos reinforced composites (plastics, resins, mastics,roofing felts, vinyl floor tiles, semi-rigid paints or decorative finishes, asbestos cement etc)
	2	Asbestos insulating board, mill boards, other low density insulation boards, asbestos textiles, gaskets, ropes and woven textiles, asbestos paper and felt
	3	Thermal insulation (eg pipe and boiler lagging), sprayed asbestos, loose asbestos, asbestos mattresses and packing
Extent of damage/deterioration	0	Good condition: no visible damage
	1	Low damage: a few scratches or surface marks; broken edges on boards, tiles etc
	2	Medium damage: significant breakage of materials or several small areas where material has been damaged revealing loose asbestos fibres
	3	High damage or delamination of materials, sprays and thermal insulation. Visible asbestos debris
Surface treatment	0	Composite materials containing asbestos: reinforced plastics, resins, vinyl tiles
	1	Enclosed sprays and lagging, asbestos insulating board (with exposed face painted or encapsulated), asbestos cement sheets etc.
	2	Unsealed asbestos insulating board, or encapsulated lagging and sprays
	3	Unsealed laggings and sprays
Asbestos type	1	Chrysotile
	2	Amphibole asbestos excluding crocidolite
	3	Crocidolite
Total score		Out of 12

3.2 ACM Setting Assessment

The location of the ACM is equally important as the type and condition of the ACM when considering the potential risk to human health. There are four aspects presented in MDHS1000, however this algorithm has been modified in this assessment with 'maintenance activity' not considered.

The removal of maintenance activity from the algorithm is because the level of awareness of asbestos by the building management and /or owners at the majority of surveys was considered to be low. Therefore any maintenance undertaken is likely to be 'unplanned' with little or no controls around asbestos exposure. In addition, the amount of maintenance activity was often extremely difficult to quantify through discussion with the building management contacts.

The three areas of the algorithm adopted for the ACM setting assessment are;

- Occupant activity
- Likelihood of disturbance
- Human exposure potential

Each of the above parameters are summarised below.

Occupant activity

The activities carried out in an area will have an impact on the risk assessment. When carrying out the risk assessment the main type of use of an area and the activities taking place within it was taken into account. If the use was not able to be identified, a conservative approach was adopted based on potential uses given the type of building, condition of building and surrounding land use.

Likelihood of disturbance

The two factors that will determine the likelihood of disturbance are the extent or amount of the ACM and its accessibility/vulnerability. For example, asbestos soffits outdoors are generally inaccessible without the use of ladders or scaffolding, and on a day to day basis are unlikely to be disturbed. However, if the same building had asbestos panels on the walls they would be much more likely to be disturbed by occupant movements/activities.

Human exposure potential

The human exposure potential depends on three factors:

- the number of occupants of an area,
- the frequency of use of the area, and
- the average time each area is in use.

For example, a hospital boiler which contains friable asbestos cladding in a room which is likely to be unoccupied for the majority of the day/week is a lower risk than say in a school classroom lined with an exposed asbestos cement roof, which is occupied daily for up to seven hours by 30 pupils and a teacher.

The algorithm adopted for ranking the ACM setting is shown in Table 3.

Table 3: HSG227 (2002) Priority Assessment Algorithm

Assessment factor	Score	Examples of score variables
Normal occupant activity		
Main type of activity in area	0	Rare disturbance activity (eg little used store room)
	1	Low disturbance activities (eg office type activity)
	2	Periodic disturbance (eg industrial or vehicular activity which may contact ACMs)
	3	High levels of disturbance, (eg fire door with asbestos insulating board sheet in constant use)
Likelihood of disturbance		
Location	0	Outdoors
	1	Large rooms or well-ventilated areas
	2	Rooms up to 100 m2
	3	Confined spaces
Accessibility	0	Usually inaccessible or unlikely to be disturbed
	1	Occasionally likely to be disturbed
	2	Easily disturbed
	3	Routinely disturbed
Extent/amount	0	Small amounts or items (eg strings, gaskets)
	1	<10 m2 or <10 m pipe run.
	2	>10 m2 to ≤50 m2 or >10 m to ≤50 m pipe run
	3	>50 m2 or >50 m pipe run
Human exposure potential		
Number of occupants	0	None
	1	1 to 3
	2	4 to 10
	3	>10
Frequency of use of area	0	Infrequent
	1	Monthly
	2	Weekly
	3	Daily
Average time area is in use	0	<1 hour
	1	>1 to <3 hours
	2	>3 to <6 hours
	3	>6 hours
Total		Out of 21

Each of the parameters is scored and added together to give a total score between 0 and 21. The setting score is then added to the ACM score to provide an overall score and risk rating in order to rank the sites in order of priority for management and/or remedial action. The scoring system is detailed in Table 4.

Table 4: Risk Ranking Scoring

ACM Score	Setting Score	Total Score	Risk Rating
10 - 12	16 – 21	24 - 33	High risk – significant potential to release fibres if disturbed and significant risk to occupants
7 – 9	11 - 15	17 - 23	Moderate risk
5 – 6	8 - 10	12 - 16	Low risk
0 – 4	0 – 7	0 – 11	Very low risk

4.0 Asbestos Survey

4.1 Residential Survey

The majority of residential dwellings observed on both Tongatapu and Vava'u were constructed of concrete blocks, bricks, weatherboard and corrugated iron. Typical residential dwellings in Tongatapu are shown in Photos 1 and 2 below.

The survey sample size was based upon a 95% confidence level and 3.5% margin of error. With 15,738 households on Tongatapu and Vava'u combined, the number of houses to be surveyed to ensure a statistically representative number of households is 747. In practice, the total number of houses examined was 1600, which means that the margin of error reduces to 2.3% at the 95% confidence level. Table 5 below provides a summary of the Tongan census data and the survey data collected during this assessment.

Photos 1 and 2 – Typical Residential Dwellings

Table 5: summary of 2011 census data

2011 Census Data			Survey Data	
	Population	**No of Households**	**No. of Households Surveyed**	**No. of Households ACM Suspected**
National Total	103,252	18,156	1,600	30
Population included in survey				
Tongatapu	75,416	12,904	1350	29
Survey % of National Total	73	71	7	0.15
Vava'u	14,922	2834	250	1
Survey % of National Total	14	15	1.3	0.005

4.2 Targeted Survey Coverage

Following consultation with the MCIL and MOI in addition to the possible ACM sites from the desk study, a number of buildings highlighted by the Ministries were shortlisted for a detailed assessment. These included buildings of sufficient age considered possible to have been constructed of ACM such as the Government owned quarters and the Ministry of Infrastructures own compound in Nuku'alofa.

The remainder of the survey consisted of visits to government buildings, including those which were likely to be frequented by large numbers of individuals and that were built or likely to be built prior to 1990. The buildings included (but were not limited to) schools, hospitals and healthcare centres, libraries, research centres, government administration buildings, power stations and waste disposal facilities. Copies of all of the individual site assessment reports for Tonga are available via SPREP. The specific sites visited are listed in Table 6.

Table 6: Specific Sites Surveyed in Tonga.

Site Name	Date of Assessment	Suspected PACM?	Samples Collected of PACM?
1. CAT Depot	02/11/2014	Yes	Yes
2. Former Government Quarters 88-94	04/11/2014	Yes	Yes
3. Fua'amotu Domestic Airport	06/11/2014	Yes	No*
4. Gov Service Station Pausa	02/11/2014	Yes	No*
5. Haveluloto School	03/11/2014	No	No
6. Hoi School	03/11/2014	No	No
7. Kanokupolu School	02/11/2014	No	No
8. Kolomotu'a School	03/11/2014	No	No
9. Kolonga School	03/11/2014	No	No
10. Ma'ufanga School	05/11/2014	No	No
11. Popua School	02/11/2014	No	No
12. Toula School	06/11/2014	No	No
13. Tu'aliku-o-pilolevu School	03/11/2104	No	No
14. Ha'amonga Primary School	03/11/2014	No	No
15. Hofoa School	02/11/2014	No	No
16. Industrial 01	02/11/2014	Yes	Yes
17. Industrial 02	02/11/2014	Yes	No*
18. Kalaka Landfill, Vava'u	07/11/2014	No	No
19. Kanokupolu Village	02/11/2014	Yes	No
20. Lyfe Tonga	03/11/2014	Yes	Yes
21. Ministry of Education	05/11/2014	Yes	Yes
22. MOI Toilet Block	04/11/2014	Yes	No*
23. MOI Wof Centre	04/11/2014	Yes	Yes
24. MOI Workshop	04/11/2014	Yes	Yes
25. Monntfort Technical Institute	02/11/2014	No	No
26. Vava'u former bulk fuel terminal	06/11/2014	Yes	Yes
27. Pacific International (Tonga) Limited	02/11/2014	Yes	No*
28. Plumbing Shop	02/11/2014	Yes	No*
29. Prince Ngu Hospital, Vava'u	06/11/2014	Yes	Yes
30. Former Government Quarters 39&40	05/11/2014	Yes	No*
31. Former Government Quarters 51&52	05/11/2014	Yes	No*
32. Former Government Quarters 33	05/11/2014	Yes	No*
33. Former Government Quarters 79	05/11/2014	Yes	No*
34. Former Government Quarters 80	05/11/2014	Yes	No*
35. Former Government Quarters 81	05/11/2014	Yes	No*
36. Former Government Quarters 82	05/11/2014	Yes	No*
37. Residential 01	02/11/2014	Yes	No*

Site Name	Date of Assessment	Suspected PACM?	Samples Collected of PACM?
38. Residential 02	02/11/2014	Yes	No*
39. Residential 03	02/11/2014	Yes	No*
40. Residential 04	02/11/2014	Yes	No*
41. Residential 05	02/11/2014	Yes	No*
42. Residential 06	02/11/2014	Yes	No*
43. Residential 07	02/11/2014	Yes	No*
44. Residential 08	02/11/2014	Yes	No*
45. Residential 09	03/11/2014	Yes	No*
46. Residential 10	03/11/2014	Yes	No*
47. Residential 11	04/11/2014	Yes	Yes
48. Residential 12	04/11/2014	Yes	No*
49. Residential 13	05/11/2014	Yes	No*
50. Small Business Centre Office	02/11/2014	Yes	Yes
51. St Andrews High School	02/11/2014	Yes	Yes
52. Tapuhia Landfill	04/11/2014	No	No
53. Tonga Forest Products Plant	03/11/2014	No	No
54. Tonga Institute of Education	02/11/2014	No	No
55. Tonga Post Ltd	02/11/2014	Yes	Yes
56. Tonga Power, Tongatapu, Nuku'alofa	03/11/2014	No	Yes
57. Tonga Water	02/11/2014	Yes	No*
58. USP Tonga	03/11/2014	No	No
59. Neiafu former market Vava'u	06/11/2014	Yes	Yes
60. Vava'u Residential 01	07/11/2014	Yes	Yes
61. Vaiola Public Hospital, Nuku'alofa	03/11/2014	Yes	Yes

** Sample collection as conditions detailed in Section 2.4 not able to be met.*

5.0 Laboratory Results and Findings

5.1 Laboratory Results

A total of 26 samples of suspected asbestos containing material were collected in the Tonga survey from 17 individual sites. Laboratory analysis confirmed asbestos present at 12 of the 17 sites.

A summary of the laboratory analytical results is provided in Table 7 while the full laboratory report is provided in Appendix 5 of this report.

Table 7: Sample Analytical Results

Site Name	Sample Name(s)	Sample Description/ Building Material Type	Asbestos Type and %
CAT Depot	TO01	Loose soffit	**Chrysotile 10%**
Industrial 01	TO02	Fibre cement façade	**Chrysotile 8%**
Small Business Centre Management Office	TO03	Exterior PACM fibre board	**Chrysotile 5%**
Tonga Post Ltd	TO04	Soffits	**Chrysotile 10%**
	TO05	Fibre cement roof	**Amosite 8%, crocidolite 6%**
Lyfe, Taufa'alau Road, Havelulota	TO06	Exterior fibreboard	None detected
Tonga Power, Power Station office, Nuku'alofa	TO07	Vinyl floor	None detected
QTR 88 (former Government Quarters), Haveluloto.	TO08	Wall exterior panel	**Chrysotile 7%**
	TO09	Fibre cement roof	**Chrysotile 7%**
Vaiola Hospital, Haveluloto, Tongatapu	TO10	Walkway fibre cement roof	**Chrysotile 10%**
	TO11	Fibreboard (loose)	None detected
	TO12	Underground pipe lagging1	None detected
	TO13	Former boiler insulation	None detected
	TO14	Underground pipe lagging2	None detected
Residential 11, Nuku'alofa	TO15	Fibreboard internal	None detected
MOI Wof Centre	TO16	Fibre cement roof (loose)	**Chrysotile 8%**
MOI Workshop	TO17	Fibre cement cladding	**Chrysotile 2%**
St Andrews School	TO18	Fibreboard classroom 15	**Chrysotile 2%**
Ministry of Education, Schools division	TO20	Vinyl floor tile	None detected
Vava'u former bulk fuel terminal	TV01	Fibre cement (loose on sports field)	**Chrysotile 5%, Amosite 2%**
	TV02	Rear building fibre cement	**Chrysotile 5%, Amosite 5%**
Ngu Hospital	TV03,	Fibre cement (loose rearcar park)	**Chrysotile 8%, Amosite 2%**
	TV05	Fibre cement roof	**Chrysotile 10%, Amosite 5%**
Neiafu former market - Tonga Football Association, Vavau'u	TV04	Fibre cement (roof)	**Chrysotile 5%, Amosite 2%**
Residential, Mavkae Village, Vava'u	TV06	Fibreboard exterior	None detected

Some of the above locations are presented in Photos 3-16 below.

Photos 3 and 4 below are of the Tonga Post complex. There are several commercial buildings with asbestos and some loose asbestos.

Photos 3 and 4 – Tonga Post

Photo 5 below shows the MOI WOF Centre with an asbestos roof and Photo 6 below shows the MOI Workshop.

Photo 5 – MOI WOF Centre **Photo 6 – MOI Workshop**

Photo 7 below shows the Industrial 01 Building cladding and Photo 8 shows cladding on the Small Business Centre Office. Both sets of cladding are damaged.

Photo 7 – Industrial 01 Building **Photo 8 – Small Business Centre Office**

Photo 9 shows the Vaiola Hospital Walkway Roof in Tongatapu and Photo 10 shows one of the Prince Ngu Hospital Roof in Vava'u. This hospital has four asbestos roofs as well as some loose asbestos. The total roof area is about 3100 m2.

Photo 11 – Vaiola Hospital

Photo 12 – Prince Ngu Hospital

Photo 13 and 14 show the Vava'u Former Bulk Fuel Depot. There is significant damage and signs of vandalism, stock grazing in areas with ACM. There is loose ACM over most of site and off-site towards school and on playing fields. The site has been derelict for at least 15 years and is not fenced. It is relatively exposed topographically, i.e. top of hill, receives wind flows directly. There is a school approximately 100m away to east. Residential areas are on two sides within 50m. Discussions with MOI indicated that there is a tender to purchase the land and they were unsure who owns land now. Pacific Energy has a sign near the site but this relates to an active fuel terminal nearby.

Photos 13 and 14 – Vava'u Former Bulk Fuel Terminal

Photos 15 and 16 show the Neiafu former market. There are damaged ACM roofs on several buildings and ACM fragments observed on ground across the road from the southern building. This former market is still widely used.


Photos 15 and 16 – Former Neiafu Market.

The areas of the locations that need to be remediated (except for the residences) are given in Table 8 below. This includes not only the locations that have tested positive but also the locations where there is little doubt that asbestos is present.

Table 8: Locations Needing Remediation.

Location	Building Material	Notes	Area
Tonga Post Ltd	Roof and Soffits		1400
Neiafu Former Market, Vava'u	Roof		300
MOI WOF Centre	Roof and Cladding		900
Fua'amotu Domestic Airport	Roof and Facades	Also pick up loose ACM and scrape topsoil	450
Prince Ngu Hospital, Neiafu, Vava'u	Roof	Also pick up loose ACM and scrape topsoil	3100
St Andrews School	Cladding		160
Plumbing Shop	Roof and Facades		60
Pacific International (Tonga) Ltd	Roof		100
Tonga Water	Roof and Facades		120
Industrial 01, Nuku'alofa	Roof		120
Industrial 02, Nuku'alofa	Roof		120
Vava'u Former Bulk Fuel Terminal	Roof	Also pick up loose ACM and scrape topsoil	500
CAT Depot, Nuku'alofa	Soffit		50
Viola Hospital, Tongatapu	Walkway Roof		20
Small Business Centre	Cladding		80
Government Service Centre, Pausa	Roof		50
MOI Toilet Block	Roof		350

5.2 Residences

Table 9: ACM Estimate for Tongatapu and Vava'u Combined

Survey	No of Households
Total of Households (2011 Census)	15,738
Households Surveyed	1600
Households PACM Suspected	30

Based on the 1,600 properties surveyed, 30 residential buildings were suspected of containing PACM in the exterior material observed. The 30 sites where PACM was suspected were all based on the roofing material and were all either formerly owned or currently owned government quarters (Refer to MOI government quarters site plans provided in Appendix 4). Given the sample size and conclusions based upon it, if this estimate is extrapolated to include the remaining residential properties in Tongatapu and Vava'u then based on a 95% confidence with a margin of error of 2.3% the total number of households potentially containing ACM would be 295.

This extrapolation could be extended to the whole of Tonga to give a figure of 340 houses, but there are doubts regarding the statistical validity of such an extension as the situation may be quite different on the other islands. For example Cyclone Ian caused extensive damage in the Ha'apai Group of Islands. Residences and other buildings with asbestos were destroyed or badly damaged and much of the resulting asbestos debris has now been collected.

5.3 General Comments on the Results

Asbestos fibres have been detected in building materials in 16 of 26 samples analysed. The percentages of fibres detected ranged from 2 – 10% with chrysotile the most commonly detected fibre being identified in 15 of the 16 samples. Amosite fibres were detected in seven of the 16 samples, while crocidolite fibres were detected in just one of the 16 samples where asbestos fibres were present.

All the samples that showed detectable asbestos fibres were from fibre cement sheeting whether it is wall cladding, soffits or roofing materials. No asbestos was detected in pipe lagging, insulation or vinyl floor materials although it is acknowledged that the sample numbers are small.

It should also be noted that a fibre board sample was collected from Pacific Timber retail outlet store for analysis. The sample was taken from fibre board recently imported to Tonga. The analytical result of the sample showed no detectable asbestos fibres. The purpose of the sample was to give some indication that ACMs were not being bought into the country.

6.0 Risk Assessment

Utilising the algorithms described in section 2 of this report and based on the laboratory analysis data of ACM samples (where available) and observations of the sites visited, the sites are listed in order of priority in Table 9.

Table 9: Risk Ranking Scores – Tonga

Site Name	Building Material Type	Asbestos Type and %	Risk Ranking Scores		
			ACM	Setting	Total Score
Tonga Post Ltd	Fibre cement roof	**Amosite 8%, crocidolite 6%**	8	19	27
	Soffits	**Chrysotile 10%**	6	19	25
Neiafu former market - Tonga Football Association, Vava'u	Fibre cement (roof)	**Chrysotile 5%, Amosite 2%**	7	17	24
MOI Wof Centre MOI Workshop	Fibre cement cladding	**Chrysotile 2%**	6	18	24
	Fibre cement roof (loose)	**Chrysotile 8%**	6	17	23
Fua'amotu Domestic Airport - Residential	Fibre cement (roof)	*Amosite**	6	16	22
Prince Ngu Hospital, Vava'u	Fibre cement (loose rearcar park)	**Chrysotile 8%, Amosite 2%**	6	15	21
	Fibre cement roof	**Chrysotile 10%, Amosite 5%**	6	15	21
St Andrews School	Fibreboard classroom 15	**Chrysotile 2%**	4	17	21
Plumbing Shop	Fibre cement (roof and facades)	*Amosite**	5	16	21
QTR 33	Fibre cement (roof)	*Amosite**	6	15	21
QTR79 - 82	Fibre cement (roof)	*Amosite**	5 – 6	15	20 – 21
Residential Property 01 – 13	Fibre cement (roof)	*Amosite**	4 – 6	14 – 15	19 – 21
QTR 88 - 94 (former Government Quarters), Haveluloto.	Fibre cement roof	**Chrysotile 7%**	6	15	21
	Wall exterior panel	**Chrysotile 7%**	5	15	20
Pacific International (Tonga) Limited	Fibre cement (roof)	*Amosite**	5	15	20
QTR 39&40	Fibre cement (roof)	*Amosite**	5	15	20
QTR 51&52	Fibre cement (roof)	*Amosite**	5	15	20
Tonga Water	Fibre cement (roof and facades)	*Amosite**	6	14	20
Industrial 02, Nuku'alofa	Fibre cement (roof)	*Amosite**	5	15	20
Vava'u former bulk fuel terminal	Fibre cement (loose on sports field)	**Chrysotile 5%, Amosite 2%**	7	11	18
	Rear building fibre cement	**Chrysotile 5%, Amosite 5%**	7	11	18
Industrial 01, Nuku'alofa	Fibre cement roof	**Chrysotile 8%**	5	13	18
CAT Depot, Nuku'alofa	Loose soffit	**Chrysotile 10%**	4	13	17
Viola Hospital, Haveluloto, Tongatapu	Walkway fibre cement roof	**Chrysotile 10%**	4	13	17
Small Business Centre Management Office	Exterior PACM fibre board	**Chrysotile 5%**	4	12	16
Gov Service Station Pausa	Fibre cement (roof)	*Amosite**	5	11	16
MOI Toilet Block	Fibre cement (roof)	*Amosite**	5	10	15

**Amosite conservatively assumed in the absence of laboratory analytical results.*

The risk assessment scoring and prioritisation presented in Table 9 above indicates that there are 25 sites assessed as presenting a moderate to high risk which would benefit from additional ACM management.

7.0 Remedial and Management Options

7.1 General

Based on all of the country visits made by the consultants for the PacWaste asbestos surveys, it is evident that:

a. The types of asbestos problems are relatively similar from country to country although there are very significant variations in incidence and quantity of asbestos.

b. Most asbestos is non-friable, or at least was non-friable when installed. Often the asbestos has deteriorated significantly and, in part at least, could be considered friable because of the risk of release of significant amounts of fibres on a regular basis. Certainly where fibres have been involved the asbestos becomes friable.

c. There has been almost no asbestos identified anywhere that was friable when installed. Remediation of the few friable (at least friable when installed) asbestos projects in the Pacific will need specialist management as exceptions.

d. The predominant form of asbestos is Chrysotile (White) Asbestos, although incidences of Amosite (Brown) Asbestos and Crocidolite (Blue) Asbestos do occur occasionally. Chrysotile is hazardous, but not as hazardous as the other forms of asbestos.

e. Labour rates are similar from country to country.

f. There will most likely be a need to bring in specialist supervision for any remedial work, and rates for that supervision will be similar throughout the Pacific.

g. The cost of materials in most countries is similar as almost all materials need to be imported from manufacturing countries with similar pricing structures.

h. There is some level of awareness of asbestos management techniques in all countries (and certainly more in the countries where there are significant amounts of asbestos). Generally, however, there is little expertise available to perform professional asbestos removals to the standard that would be required in, for example, Europe, UK, USA or Australia.

i. The correct equipment for properly managing asbestos remediation is not available in any of the countries visited, with the exception of some PPE and the simpler tools required for removal operations.

j. Safe and acceptable remediation techniques will be the same everywhere.

A case can therefore easily be made for a universal policy and set of procedures to be developed across the whole Pacific region for addressing asbestos problems.

7.2 Management Options

Where ACM or PACM has been identified then there are some management measures that can be taken immediately as follows:

- communicate with building/property owners, employees, contractors and others of its presence, form, condition and potential health risks associated;
- monitor the condition of the ACM;
- put a safe system of work in place to prevent exposure to asbestos.

7.2.1 Communicating ACM Hazard

Although every attempt was made during the survey work to communicate the potential level of risk apparent during the site visits, further consultation with the relevant regulator, site/building owners

and occupants will be required based upon the findings and specifically the laboratory confirmation of the presence of ACM. Where an immediate significant risk to human health was apparent during the surveys, regulators were informed and actions taken to manage/remedy the situation.

All site owners and employees should be made aware of the location of any ACMs in the buildings identified. This is particularly important for maintenance workers or contractors who may directly disturb ACMs while working. A means of communicating with contractors who come on site to carry out other work must also be set up to prevent disturbance of ACMs without implementing the correct controls. The means of communication could include a site induction sheet or training session on the hazards presented by the ACM on site together with a formal contractor acknowledgement sheet.

If the location is a private residence then an information sheet could be handed out and an education / awareness programme initiated.

7.2.2 Monitor ACM

ACMs which are in good condition, sealed and/or repaired, and are unlikely to be disturbed, are of a lower risk than those which are damaged and in certain situations can be left in place. Often, encapsulation and management is a safer option than removal, which can result in the ACMs being disturbed further and potential further exposure to the building occupants. The on-going operations at the site will also factor into whether the ACM can be left on site. It should be noted, however, that effective encapsulation, especially of roofing, can be expensive.

If ACMs are left in place, the condition of the ACMs will have to be monitored regularly and the results recorded. A useful way of monitoring the condition of the ACMs is to regularly take photographs, which can be used to compare the condition over time. When the condition of the ACM starts to deteriorate, remedial action can be taken. The time period between monitoring will vary depending on the type of ACM, its location and the activities in the area concerned, but as a minimum should be at least once every 12 months.

7.2.3 ACM Safe System

Where an ACM is going to be left in place, one option would be to label or colour-code the material. This may work in an industrial environment, but may not be acceptable in a suite of offices or suitable in public areas, for example, retail premises. The decision to label or not will in part depend on confidence in the administration of the asbestos management system and whether communication with workers and contractors coming to work on site is effective.

Labelling and colour coding alone should not be relied upon solely as the only control measure. The physical labels and colour coding may deteriorate over time without sufficient maintenance.

7.3 Remedial Options

The management options of ACM outlined in Section 7.1 above are administration controls that can assist with effectively managing the risk ACM presents. However, in certain situations, administration controls may not be sufficient or the risk posed by the ACM by way of its damaged condition or setting sensitivity may present an unacceptable risk. Remedial measures for managing the ACM may include one or a combination of the following;

- protect/enclose the ACM;
- seal/encapsulate the ACM;

- repair of the ACM;
- removal of the ACM.

7.3.1 Protection / enclosure of ACMs

Protecting ACMs means the construction or placing of a physical barrier of some sort to prevent accidental disturbance of the ACM. This may mean placing a bollard in front of a wall panel of asbestos insulating board to prevent accidental damage by fork lift truck movements. Enclosing the ACM involves the erection of a barrier around it, which should be as airtight as possible to prevent the migration of asbestos fibres from the original material. Enclosing the ACM is a good option if it is in reasonable condition and in a low sensitivity environment.

If enclosure is chosen as the desired management option it is important that the existence of the ACM behind the enclosure is notified to all who may work or visit the site. Labelling on the enclosure to indicate the presence of the hidden ACM would assist with communicating the hazard. The condition of the enclosure should also be periodically monitored and the results of the inspection recorded.

7.3.2 Sealing or Encapsulation of ACM

Encapsulation of an ACM is only suitable if the ACM is in good condition and in a low sensitivity environment. The additional weight of the encapsulant is also an important consideration and this may unwittingly cause delamination and possible damage to the ACM.

According to the UKHSE (2001) there are two types of encapsulants; bridging and penetrating encapsulants. Bridging encapsulants adhere to the surface of the ACM and form a durable protective layer. Bridging encapsulants include high build elastomers, cementitious coatings and polyvinyl acetate (PVA). The different types of encapsulants available will suit different circumstances and ACMs and should therefore be selected by a specialist in asbestos management to ensure the correct encapsulant is chosen.

Of the bridging encapsulants, high-build elastomers can provide substantial impact resistance as well as elasticity, and are reported to provide up to 20 years of life if undisturbed. Cementitious coatings are generally spray-applied and are compatible with most asbestos applications. They provide a hard-set finish, but may crack over time. PVA is used for sealing of asbestos insulating board and may be spray or brush applied. PVA is not suitable for use on friable ACMs such as insulation or sprayed coatings. PVA will only provide a very thin coating and may not be suitable as a long-term encapsulant.

Penetrating encapsulants are designed to penetrate into the ACM before solidifying and locking the material together to give the ACM additional strength. Penetrative encapsulants are typically spray-applied and will penetrate non-friable and friable asbestos materials, strengthening them as well as providing an outer seal.

The selection, preparation and application of encapsulants requires skill, knowledge and experience with asbestos remedial work.

7.3.3 Repair of the ACM

To be readily repairable, the damage should be minimal, therefore repair should be restricted to patching/sealing small areas where cracks or exposed edges have become apparent. Where significant damage has occurred it may be more cost effective to remove the ACM.

The repair methodology selected will largely depend on the type of ACM to be repaired. For example, small areas of damaged pipe or boiler lagging can be filled with non-asbestos plaster and if necessary wrapped with calico (cotton cloth). Small areas of damaged sprayed asbestos can be treated with encapsulant and, if necessary, an open mesh scrim of glass fibre or calico reinforcement used. Damaged asbestos panelling or tiles can be sprayed with PVA sealant or a similar type of sealant such as an elastomeric paint. Asbestos cement products can be sealed using an alkali-resistant and water-permeable sealant or impermeable paint.

7.3.4 Removal of the ACM

Where ACMs have been identified that are not in good condition, or are in a vulnerable position and liable to damage, the remedial options described previously should be explored first. Where it is not practical to repair, enclose or encapsulate the ACMs, they will need to be removed. ACMs will also need to be removed if the area is due to undergo refurbishment which will disturb the ACM, or where a building is going to be demolished.

Rigorous safety procedures are required to be followed for the removal of ACM. Typically the following procedure should be followed for non-friable asbestos although some variations may be necessary from site to site.

a) Place warning barrier tape around the site at a minimum distance of ten metres, where practicable, and place warning signs to clearly indicate the nature of work.

b) The contractor shall wear protective disposable type overalls, gloves and at least a half face respirator with a P2 (and preferably a P3) replaceable filter.

c) Wet down the ACM to be removed and carefully remove any fasteners using hand tools. Attempt to remove the ACM intact – do not break it up, or throw it into a waste bin or skip.

d) Place asbestos material and debris in an approved asbestos waste bag and seal for disposal in accordance with local requirements. Sheets of asbestos cement product should be placed wet one on top of another into a skip lined with a heavy duty plastic liner, a portion of which remains outside the skip and is of sufficient size to cover the waste when the skip is full.

Vacuum asbestos removal area using a vacuum fitted with a high efficiency particulate air filter (HEPA filter).

Normally air monitoring is not required for the removal of non-friable asbestos containing materials, as if done correctly no excessive quantities of asbestos fibres should be generated. However, some operators prefer to undertake such monitoring to obtain evidence that no risks to health occurred during the removal exercise.

The whole project should be supervised by an experienced asbestos removalist. Certification processes are in place in several countries to make sure such removalists are suitably qualified and experienced.

In each case of an asbestos removal project a detailed **"Asbestos Removal Plan"** should be prepared that addresses the following matters:

1. Identification:

- Details of the asbestos-contaminated materials to be removed – for example, location/s, whether it is friable or non-friable, condition and quantity to be removed – include references to analyses.

2. Preparation:

- Consultation with regulators, owners and potentially affected neighbours
- Assigned responsibilities for the removal
- Programme of commencement and completion dates
- Consideration of other non-asbestos related safety issues such as safe working at heights
- Asbestos removal boundaries, including the type and extent of isolation required and the location of any signs and barriers
- Control of electrical and lighting installations
- Personal protective equipment (PPE) to be used, including respiratory protective equipment (RPE)
- Details of air monitoring programme
- Waste storage and disposal programme

3. Removal

- Methods for removing the asbestos-contaminated materials (wet or dry methods)
- Asbestos removal equipment (spray equipment, asbestos vacuum cleaners, cutting tools, etc)
- Details of required enclosures, including details on their size, shape, structure, etc, smoke-testing enclosures and the location of negative pressure exhaust units if needed
- Details of temporary buildings required for asbestos removal (eg decontamination units), including details on water, lighting and power requirements, negative air pressure exhaust units (see Section 7) and their locations
- Other control measures to be used to contain asbestos within the asbestos work area. This includes dust suppression measures for asbestos-contaminated soil.

4. Decontamination:

- Detailed procedures for the workplace decontamination, the decontamination of tools and equipment, personal decontamination of non-disposable PPE and RPE, decontamination of soil removal equipment (excavator, bobcat etc)

5. Waste Disposal:

- Methods for disposing of asbestos waste, including details on the disposal of:
  - Disposable protective clothing and equipment and
  - Structures used to enclose the removal area

8.0 Selection of Possible Remedial Options

8.1 General

The flow chart presented below in Figure 2 has been adapted from that presented in UKHSE HSG227 'A Comprehensive Guide to Managing Asbestos in Premises'. It details the decision process adopted by this study in determining the most suitable management option for the majority of sites with ACM.

Figure 2: ACM Management Flow Chart

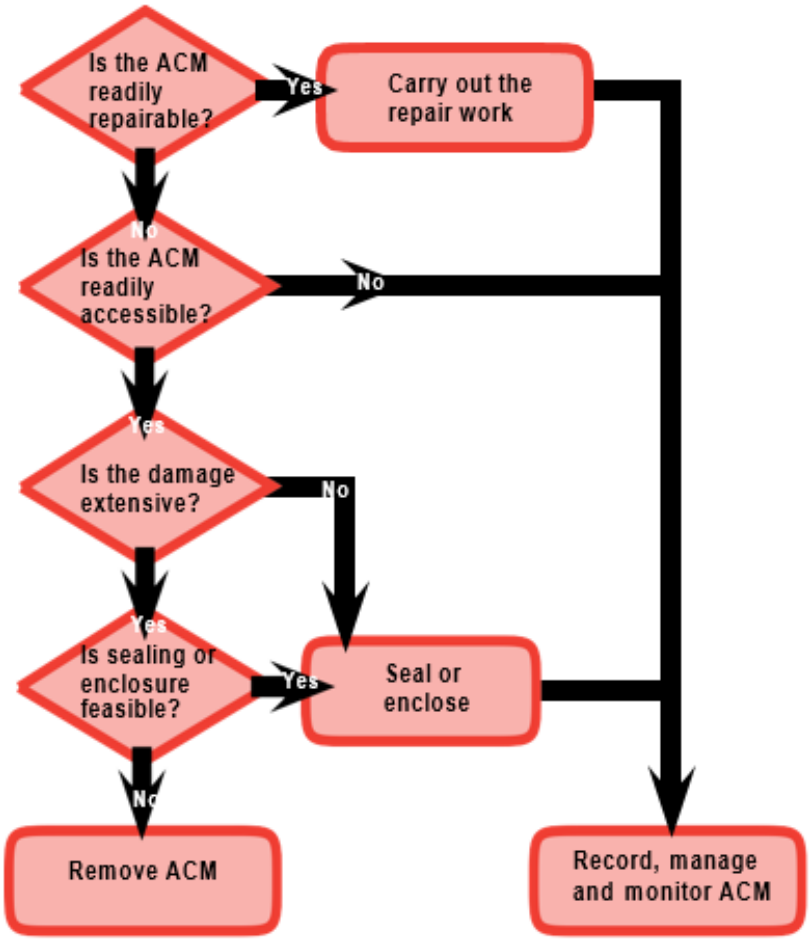

Figure adapted from; UKHSE HSG227 'A Comprehensive Guide to Managing Asbestos in Premises'.

Clearly there is a need to adopt a logical process such as above to select the correct management procedure in each case, and the flowchart above sets out such a procedure. There are some specific Pacific factors, however, that need to be considered.

8.2 Appropriate Asbestos Management for the Pacific

There are limited funds available for asbestos remediation in the Pacific and a wide range of health initiatives that may be deserving of funding besides asbestos remediation. It will therefore be necessary to prioritise which remediation projects are to be carried out, based on the risk ranking methodology and available funding. Whichever projects cannot be undertaken will need interim management until funding is available.

Management of un-remediated asbestos buildings is discussed in Section 7.2 above. The key factors in this management will be education and awareness so that minimising the generation of airborne fibres can be achieved.

Where remediation can be undertaken the first option that could be considered is encapsulation. Most asbestos roofs in the Pacific are, however, in a deteriorating condition and need to be encapsulated on the underside as well as the top surface. In most cases there is also a ceiling in place so the ceiling will need to be removed, as well as electrical and other services if they cannot be worked around. The top surface of the ceiling, as well as the services, must be treated as potentially contaminated with asbestos, especially if the asbestos roof is old, so the rooms below will need to be protected. The services and ceiling will then need to be returned or replaced as appropriate.

This process is expensive and, in fact may cause the project to be of a similar cost to removal and replacement of the roof. If there is no ceiling in place then the underside of the asbestos roof may, however, be able to be painted quite easily, although the project will still be an asbestos remediation project with all the resultant controls that must be put in place.

If an asbestos roof is encapsulated then it will still be necessary to replace any asbestos guttering and downpipes.

Asbestos cladding may be able to be satisfactorily encapsulated at a reasonable cost if it is in good condition. If there is also a wall cavity and an internal wall in good condition then there would be no need to encapsulate the inside of the asbestos cladding. Otherwise the inside would need to be encapsulated as well.

Encapsulation is discussed further in Section 8.3 below.

Removal of the asbestos roof would require all the appropriate asbestos management controls to be put in place as well as edge protection / fall arrest for safe working at heights and procedures for working on a brittle asbestos roof. Once the roof has been removed then the asbestos dust would need to be carefully vacuumed up in the ceiling space. Then a new roof would need to be put in place. With the hot conditions in the Pacific an insulating layer would also be required. Asbestos does have the merit of being cool to live under.

Removal is discussed further in Section 8.4 below.

8.3 Encapsulation

If encapsulation is to be used then several factors need to be considered as follows:

- Durability – the encapsulating system applied should last for a long time.
- There should be minimal (or preferably no) surface preparation involved as the high pressure washing and abrasive techniques normal for surface preparation for painting will generate a large amount of asbestos fibres.
- The encapsulant product should be simple to apply.
- Preferably the solar reflection should be enhanced by the use of light colours.

Normal priming type paints (especially oil or mineral turps based paints) generally do not bind well to asbestos cement roofs and cladding and special high quality alkali resistant primers are recommended

prior to using a typical high quality 100% acrylic based exterior undercoat and exterior top coat system.

Alternatively, a semi-gloss, two-component epoxy paint suitable for metal, concrete, asbestos, cement and heavy machinery can be used. Such epoxy resin based paints exhibit long lasting durability under harsh conditions, such as acid, alkaline, salt and very humid conditions. Such paint can as used as a primer coat as well.

Another alternative is to use a special asbestos encapsulating system such as that offered by Global Encasement Inc (www.encasement.com). Global Encasement recommends for the Pacific a primer called "MPE" (Multi-Purpose Encapsulant) and a top coat called "Asbestosafe". MPE is promoted as not requiring any surface preparation and is described as a penetrating encapsulant. It does, however, require surfaces to be "clean and dry, and free of mould, mildew, chalking, dirt, grease and oil. In most cases old roofs in the Pacific would still therefore require surface preparation.

Based on coverage and cost per litre the Global Encasement paint systems are probably about 20-30% more expensive than high quality exterior acrylic paint systems and the cost of the paint (encapsulant) would in turn be about 40-50% of the overall cost of an encapsulating project, depending on labour costs. The additional cost of using a specialist coating like the Global Encasement systems may not therefore be that significant. Global Encasement do say that a 20 year life is expected while a high quality acrylic system is unlikely to last longer than 10-15 years. Global Encasement offer a guarantee for the 20 year life but it is a very limited and conditional guarantee.

The following steps would be typical for a roof asbestos encapsulation project:

a) Prepare asbestos removal plan, set up asbestos boundaries and signage, prepare PPE and decontamination area.
b) Set up scaffolding to both sides of building for access to roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems.
c) Spray with a particle capture technology such as Foamshield (www.foamshield.com.au) to the inside of the ceiling space before removal of the ceiling. This will control any asbestos dust in the ceiling space before removal of the ceiling. Alternatively the ceiling space could be vacuumed thoroughly if safe access is possible to all the ceiling space.
d) Lay down black plastic sheeting to the floor of each room, remove all ceiling linings and place all rubbish into suitable containers for disposal (plastic lined bins or fabric bags such as "Asbags" – see Photos 17 and 18 below) for correct removal & disposal. All ceiling material will need to be treated as asbestos-contaminated as debris and fibres fall from the roofing with roof movement and wear.
e) Disconnect & remove all electrical items, ceiling fans, lights, extractor fans. Vacuum thoroughly and store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work.
f) Vacuum the underside of the existing roof sheeting and all timber roof framing. After removal of ceiling materials and plastic, vacuum all the inside of the premises.
g) Spray 3 coats of protective paint system (pre-coat, undercoat and top coat) to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated.
h) Supply & fix appropriate ceiling sheeting to ceilings of all rooms. Supply & fix timber battens to all sheet joints & to perimeter of each room.

i) Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets & perimeter battens.
j) Reposition all wiring for lights & fans and connect up all fittings as previously set out.
k) Spray 3 coats of specialist paint finish (pre-coat, undercoat and top coat) to all the exterior roof area according to painting specifications.
l) Remove, and contain for disposal, asbestos gutters and downpipes from both sides of the building and supply & install new suitable box gutters (e.g. Colourbond) with down pipe each side leading to water tank.
m) Remove asbestos boundaries and signage and decontamination area and decommission from site.

NB: All vacuuming will need to be done with a specialist vacuum cleaner fitted with a high efficiency (HEPA) filter.

Asbags are fabric bags in various sizes with lifting strops – see photos below. There are special ones for roofing sizes.


Photos 17 and 18: Asbags in use

8.4 Removal

Removal of friable asbestos will need to be carried out with specialist asbestos contractors who will not normally be available in Pacific countries.

Removal of non-friable asbestos roofs and cladding will need to be done according to appropriate protocols and will again need specialist supervision and training.

The following steps would be typical for a roof asbestos removal project:

a) Prepare asbestos removal plan, set up asbestos boundaries and signage, prepare PPE and decontamination area.
b) Set up scaffolding to both sides of building to assist in removal of roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems.
c) Spray the entire roof with a water based PVA solution.
d) Carefully remove the roof sheeting by unscrewing, (not breaking) the roof sheets. All roof sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic & taped shut. Roof sheeting and all materials, (ridging, barge flashing, gutters etc) to be loaded into suitable containers for disposal (plastic lined bins or fabric bags such as “Asbags”) for correct removal & disposal.
e) Vacuum clean the existing ceiling & roof space, (rafters, purlins, ceiling joists) with a suitable vacuum cleaner fitted with a HEPA filter.

f) Supply & fit heavy duty tarpaulins to keep the roof waterproof before installation of new roofing.

The new roof sheeting, insulation, guttering and downpipes should be durable (long life and resistant to corrosion from marine environments. Suitable insulation will also need to be installed to keep the building cool.

One option where a large amount of roofing is to be installed is to use a roof roll forming machine and form the roofs locally. Roofing materials could then be cut to suit and purchase of the sheet metal rolls would be cheaper than the finished roofing sheets. Of course the capital cost of the roll forming machine would need to be included in the cost calculations. It may also be appropriate to use aluminium rolls which would be corrosion resistant in marine environments.

Alternatively suitable roofing materials can just be imported such as Colourbond Ultra Grade, which is suitable for corrosive marine environments.

The following steps would be typical for a roof replacement project:

a) Supply & fit suitable roof netting over existing purlins & fix in place ready to support suitable insulation such as 50mm thick, foil coated, fiberglass insulation.
b) Supply & lay a top layer of sisalation foil over the fibreglass insulation blanket as a dust and moisture barrier.
c) Supply & screw fix suitable roofing material such as Colourbond Ultra Grade corrugated roofing, including for ridging & barge flashings.
d) Supply & fix suitable guttering such as Colourbond box guttering to both sides of the roof & include for one downpipe each side, feeding to a tank.

8.5 Options Specific to Tonga

Table 11 below shows the sites on Tonga that returned a positive result for ACM and the most suitable, cost effective remedial options based on the flow chart process described above.

Table 11: Possible Remedial Options – Tonga

Site Name	Building Material Type	Asbestos Type and %	Risk Score	Applicable Remedial Options			
				Repair	Isolate	Encapsulate	Remove
Tonga Post Ltd	Fibre cement roof	**Amosite 8%, crocidolite 6%**	27	×	×	×	✓
	Soffits	**Chrysotile 10%**	25	×	×	×	✓
Neiafu former market - Tonga Football Association, Vavau'u	Fibre cement (roof)	**Chrysotile 5%, Amosite 2%**	24	×	×	×	✓
MOI Wof Centre MOI Workshop	Fibre cement cladding	**Chrysotile 2%**	24	×	×	×	✓
	Fibre cement roof (loose)	**Chrysotile 8%**	23	×	×	×	✓
Fua'amotu Domestic Airport - Residential	Fibre cement (roof)	*Amosite**	22	×	×	✓	✓

Ngu Hospital	Fibre cement (loose rearcar park)	**Chrysotile 8%, Amosite 2%**	21	×	×	✓	✓
	Fibre cement roof	**Chrysotile 10%, Amosite 5%**	21	×	×	✓	✓
St Andrews School	Fibreboard classroom 15	**Chrysotile 2%**	21	×	×	×	✓
Plumbing Shop	Fibre cement (roof and facades)	*Amosite**	21	×	×	✓	✓
QTR 33	Fibre cement (roof)	*Amosite**	21	×	×	×	✓
QTR79 - 82	Fibre cement (roof)	*Amosite**	20 – 21	×	×	×	✓
Residential Property 01 - 13	Fibre cement (roof)	*Amosite**	19 – 21	×	×	×	✓
QTR 88 - 94 (former Government Quarters), Haveluloto.	Fibre cement roof	**Chrysotile 7%**	21	×	×	×	✓
	Wall exterior panel	**Chrysotile 7%**	20	×	×	×	✓
Pacific International (Tonga) Limited	Fibre cement (roof)	*Amosite**	20	×	×	✓	✓
QTR 39&40	Fibre cement (roof)	*Amosite**	20	×	×	×	✓
QTR 51&52	Fibre cement (roof)	*Amosite**	20	×	×	×	✓
Tonga Water	Fibre cement (roof and facades)	*Amosite**	20	×	×	✓	✓
Industrial 02, Nuku'alofa	Fibre cement (roof)	*Amosite**	20	×	×	✓	✓
Vavau'u former bulk fuel terminal	Fibre cement (loose on sports field)	**Chrysotile 5%, Amosite 2%**	18	×	×	×	✓
	Rear building fibre cement	**Chrysotile 5%, Amosite 5%**	18	×	×	×	✓
Industrial 01, Nuku'alofa	Fibre cement roof	**Chrysotile 8%**	18	×	×	✓	✓
CAT Depot, Nuku'alofa	Loose soffit	**Chrysotile 10%**	17	×	×	✓	✓
Vaiola Hospital, Haveluloto, Tongatapu	Walkway fibre cement roof	**Chrysotile 10%**	17	×	×	×	✓

**Note that it is not intended that residential houses clad or roofed with asbestos containing materials be remediated as part of the PacWaste project.*

In order to assist with ensuring the most suitable and remedial approach is taken, a review of the National and International regulations governing asbestos has been undertaken.

9.0 Disposal

9.1 Relevant International Conventions

The three options for disposal of ACM and asbestos-contaminated wastes are as follows:

a) Local burial in a suitable landfill
b) Disposal at sea
c) Export to another country with suitable disposal

These three alternatives are discussed below.

Several International Conventions may be relevant to sea disposal and export of asbestos. These conventions and their status as at 2011 are set out in Table 12 below.

Table 12: Related International Conventions

Country	Rotterdam Convention	Basel Convention	London Convention & Protocol*	Waigani Convention	Noumea Convention
Australia	Y	Y	Y*	Y	Y
Cook Islands	Y	Y		Y	Y
FSM		Y		Y	Y
Fiji				Y	Y
Kiribati		Y	Y	Y	
Marshall Is	Y	Y	*		Y
Nauru		Y	Y		Y
New Zealand	Y	Y	Y*	Y	Y
Niue				Y	
Palau				Not ratified	
PNG		Y	Y	Y	Y
Samoa	Y	Y		Y	Y
Solomon Is			Y	Y	Y
Tonga	Y	Y	Y*	Y	
Tuvalu			Y	Y	
Vanuatu			Y*	Y	

Source; SPREP (2011) 'An Asbestos-Free Pacific: A Regional Strategy and Action Plan'

Later in 2011 Palau also became a party to the Basel Convention.

The Rotterdam Convention (formally, the *Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade*) is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that producers within their jurisdiction comply.

The Convention covers asbestos as one of its listed chemicals but not Chrysotile asbestos. The Convention, however, is for the purpose of managing imports of products and not wastes.

The London Convention and Protocol, and the Noumea Convention and associated Dumping Protocol are both relevant to the issue of dumping at sea and hence are discussed in Section 9.3 below.

The Basel and Waigani Conventions are relevant to the issue of export of waste to another country and are hence discussed in Section 9.4 below.

9.2 Local Burial

In order for local burial of ACM and asbestos-contaminated wastes to occur in a local landfill that takes general refuse, there must be a suitable landfill available as follows:

a) The landfill must be manned and secure so that no looting of asbestos materials can occur.

b) The landfill must have proper procedures for receiving and covering asbestos waste. A suitable hole must be excavated, the asbestos waste placed in the hole, and the asbestos waste covered with at least one metre of cover material. The asbestos waste should be buried immediately on receipt at the landfill.

c) Machinery must be available to enable the excavation and covering to occur.

d) The location of the asbestos should be logged or an asbestos burial area designated.

e) Records of dates and quantities should be kept.

The alternative to burial in a local landfill is to construct a special monofill for asbestos waste. This landfill could be lined and sealed once it is full. This process is expensive, however, and would only be justified where there is a large amount of asbestos for disposal.

The other factor to consider in relation to local disposal is whether such a practice is acceptable to the local people. A programme of consultation is necessary to determine if this is the case.

9.3 Disposal at Sea

The international convention governing sea disposal is the *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*, (the London Convention), which has the objective to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter (International Maritime Organization (IMO)). The *1996 "London Protocol"* to the Convention which came into force in March 2006 updates the convention to prohibit the dumping of any waste or other matter that is not listed in Annex 1 to the Protocol.

Annex 1 to the Protocol covers the following wastes

1. Dredged material
2. Sewage sludge
3. Fish waste, or material resulting from industrial fish processing operations
4. Vessels and platforms or other man-made structures at sea.
5. Inert, inorganic geological material
6. Organic material of natural origin
7. Various bulky inert items – iron, steel, concrete etc.
8. Carbon dioxide streams form carbon dioxide capture processes for sequestration

Probably asbestos would come under the category of inert inorganic geological material.

Any dumping of such Annex 1 wastes requires a permit from the country of origin and is limited to those circumstances where such wastes are generated at locations with no land disposal (or other disposal) alternatives. The 1996 protocol also prohibits the exports of wastes or other matter to non-Parties for the purpose of dumping at sea.

The decision to issue a permit is to be made only if all impact evaluations are completed and the monitoring requirements are determined. The provisions of the permit are to ensure that, as far as practicable, any environmental disturbance and detriment are minimised and the benefits maximised. Any permit issued is to contain data and information specifying:

1. The types and sources of materials to be dumped
2. The location of the dumpsite(s)
3. The method of dumping
4. Monitoring and reporting requirements.

It should be noted that the overall thrust of the Convention (as amended by the Protocol), as set out at the start of the Protocol is to eliminate pollution of the sea caused by dumping and to protect and preserve the marine environment. The Protocol also recognises the particular interests of Small Island Developing States. It would be fair to say, therefore, that even if the dumping of asbestos met the requirements of the Convention and Protocol, it would probably be contrary to the overall thrust of the Convention and Protocol, particularly if such dumping was initiated by Small Island Developing States.

If asbestos was dumped at sea, the following information would be needed (in terms of Annex 2 of the Protocol), in order for a permit to be issued:

1. Full consideration of alternatives
2. Full assessment of human health risks, environmental costs, hazards (including accidents), economics, and exclusion of future uses.

The other relevant convention is the *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region* (1986), known also as the SPREP Convention or Noumea Convention. This Convention, along with its two Protocols, is a comprehensive umbrella agreement for the protection, management and development of the marine and costal environment of the South Pacific Region. It is the Pacific region component of UNEP's Regional Seas Programme which aims to address the accelerating degradation of the world's oceans and coastal areas through the sustainable management and use of the marine and coastal environment. In order to protect the environment in the Pacific region, through the Noumea Convention the Parties agree to take all appropriate measures in conformity with international law to prevent, reduce and control pollution in the Convention Area from any source, and to ensure sound environmental management and development of natural resources.

One of two associated protocols is the Dumping Protocol which aims to prevent, reduce and control pollution by dumping of wastes and other matter in the South Pacific. Annexes associated with the protocol would permit the dumping of asbestos provided such dumping did not present a serious obstacle to fishing or navigation. A General Permit would be needed, however, that covers a number of matters including impacts on the marine environment and human health and whether sufficient

scientific knowledge exists to determine such impacts properly. Parties are required to designate an appropriate authority to issue permits.

Again the overall thrust of the Noumea Convention and its associated Dumping Protocol is to eliminate pollution of the sea caused by dumping and to protect and preserve the marine environment. Again it would be fair to say, therefore, that even if the dumping of asbestos met the requirements of the Convention and Dumping Protocol, it would probably be contrary to the overall thrust of the Convention and Dumping Protocol.

Given all the above, it may still possibly be the best option to dump the asbestos at sea. In order to successfully carry out such dumping several operating requirements would need to be met as follows:

1. The asbestos waste would need to be sealed completely and packed so that it could be loaded and unloaded satisfactorily. Probably it would best be wrapped in plastic and then placed in fabric bags fitted with loading strops. “Asbags” would meet these criteria and have a maximum 3 tonne capacity.
2. There must be a way of loading the asbestos waste satisfactorily. A shore-based crane could load asbestos in Asbags.
3. There must be a means of sea transport. A barge that towed a raft would be suitable, or a vessel with sufficient deck space.
4. There must be a safe way to unload the waste asbestos at sea. If a vessel was available with a crane with at least 3 tonne capacity at a reasonable reach then that would meet this requirement. Otherwise a shore-based crane or crane truck (Hiab) could be tied to a raft. The raft would need to have side protection around its perimeter and operating personnel would need life jackets.
5. A suitable dumping location would need to be found that a) was deep enough to ensure that no asbestos would ever return to shore; and b) had no environmental sensitivity. It is likely that such a location would be some distance from shore.

It is evident that an operation that was able to meet the permit requirements of Annex 2 of the London Protocol and the operating requirements listed above would be an expensive one. Dumping at sea would, aside from any other considerations, therefore only be considered if there was a large enough amount of asbestos waste to justify it.

9.4 Export to Another Country

The final disposal option that should be considered is export to another country. Asbestos waste is a hazardous waste in terms of both the Basel Convention and the Waigani Convention.

The *Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal*, (the Basel Convention), is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous wastes from developed to less developed countries. The Convention is also intended to minimise the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation. The Basel Convention states clearly that the trans-

boundary movement of hazardous wastes and other wastes should be permitted only when the transport and the ultimate disposal of such wastes is environmentally sound.

The *Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Trans-boundary Movement of Hazardous wastes within the South Pacific Region*, known also as the Waigani Convention, entered into force on the 21st October 2001. It represents the regional implementation of the international regime for controlling the trans-boundary movement of hazardous wastes. The objective of the Convention is to reduce and eliminate trans-boundary movements of hazardous and radioactive waste, to minimise the production of hazardous and toxic wastes in the Pacific region and to ensure that disposal of wastes in the Convention area is completed in an environmentally sound manner.

The two countries that border the Pacific and are able to receive asbestos waste are Australia and New Zealand. Both countries are parties to both the Basel Convention and the Waigani Convention. All Pacific countries that are part of the asbestos project are party to either the Basel or the Waigani Conventions or both. In terms of trans-boundary movement, therefore, asbestos wastes could be moved from these Pacific countries to Australia or New Zealand.

Australia is not known to have ever received asbestos waste but discussions with the Hazardous Waste Section of the Australian Department of the Environment confirmed that, in terms of the Basel and Waigani Consent requirements, there would be no problem importing asbestos waste into Australia if it was done properly and safely and met other legislative requirements such as Customs and Biosecurity.

Permits are currently held to import asbestos waste into New Zealand from New Caledonia, French Polynesia and Niue. The New Zealand Government is currently funding a project to import a large amount of waste asbestos from Niue into New Zealand for disposal. This is being done under the Waigani Convention.

Potentially also, Fiji could accept waste asbestos from other Pacific countries as it has a well-run landfill at Naboro near Suva with all the controls necessary to receive asbestos. It does receive asbestos waste from within Fiji in a properly managed way. At present, however, Fiji is a party to the Waigani Convention but not the Basel Convention so it would only be able to receive asbestos waste from Waigani Convention parties.

A suitable landfill must be found in the importing country, a suitable ship and shipping route is needed, and biosecurity concerns need to be addressed. Asbestos is regarded as a Class 9 Dangerous Good for shipment purposes.

9.5 Disposal Suitable for Tonga

In the majority of sites where ACM was identified in Tonga, the asbestos is either friable or is damaged asbestos concrete material beyond repair. Encapsulation or isolation of these types of asbestos is not considered a suitable long term strategy, therefore removal of the ACM is the preferred remedial method. An objective of SPREP is that asbestos is disposed of in the most environmentally acceptable manner and as close to the source as possible.

The main landfill, Tapuhia Landfill, on Tongatapu and the Kalaka Landfill in Vava'u, were visited by the Survey team in November 2014. According to the MoI, both landfills accept hazardous waste including asbestos although the volumes of such waste was thought to be very small.

During the site visit, the Tapuhia Landfill was observed to be a relatively modern design with appropriate environmental protection measures (liner, gas and leachate collection systems) in place. Waste appeared to be being handled and disposed of appropriately. According to the Waste Strategy Team, hazardous waste is disposed of within the operating cell and is simply placed within a deeper excavation within the municipal waste. For the purposes of disposing of ACM, the Tapuhia Landfill hazardous waste handling procedures would be adequate.

The Kalaka Landfill in Vava'u, in the opinion of the survey team, was not appropriate for the handling and disposal of ACM. Waste was being burnt at the time of the survey and was uncovered; both practices are not suitable for handling asbestos waste. ACM located within Vava'u would need to be disposed of to an alternative location or the procedures and design of the Kalaka Landfill would need to be improved.

The alternative to burial in a local landfill is to construct a special monofill for asbestos waste. This landfill could be lined and sealed once it is full. This process is expensive, however, and would only be justified where there is a large amount of asbestos for disposal.

The other factor to consider in relation to local disposal is whether such a practice is acceptable to the local people. A programme of consultation is necessary to determine if this is the case.

10.0 Cost Considerations

A typical example of local Pacific costs has been obtained from Central Meridian Inc in Nauru, which is a contracting company that has worked for 14 years in Nauru and employs about 60 staff (see Appendix 6). Costs will likely vary according to local conditions but rates have been cross checked against established rates in New Zealand, and also informally with contractors in other Pacific countries, and it is believed that the figures put forward are reasonable for preliminary budgeting purposes.

10.1 Encapsulation

For the encapsulation option, cost build ups have been prepared for roofs and wall cladding based on the Central Meridian estimate. The Central Meridian costs have been changed from AUD to USD at an exchange rate of 0.8, and the figures have been reduced by 10% based on the assumption that cheaper prices could be obtained by competitive tendering, and also based on reconciliation with established rates in New Zealand.

The full cost build ups are presented in Appendix 6 and a summary is presented as follows:

Roof Encapsulation

Costs:

- Encapsulate roof where there is no ceiling present below the roof: USD49.64/^{m2} of roof (face area)
- Encapsulate roof where there is an existing ceiling below the roof that needs to be removed and replaced: USD90.79/^{m2} of roof (face area)

Assumptions:

- Rates have been built up based on a roof of a single storey building with a floor area of 14m x 12m with a roof pitch of 30 degrees. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.

Cladding Encapsulation

Costs:

- Encapsulate wall cladding where there is no internal wall sheeting: USD25.92/^{m2} (face area)

- Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated: USD17.92/^{m2} (face area)
- Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/^{m2} (face area)

Assumptions:

- Rates have been built up based on a single storey building with a floor area of 14m x 12m and walls 2.4m high. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.

10.2 Removal and Replacement

For the removal and replacement option cost build ups have been prepared for roofs and wall cladding based on the Central Meridian estimate. As for the encasement option, the Central Meridian costs have been changed from AUD to USD at an exchange rate of 0.8, and the figures have been reduced by 10% based on the assumption that cheaper prices could be obtained by competitive tendering, and also based on reconciliation with established rates in New Zealand.

The full cost build ups are presented in Appendix 6 and a summary is presented as follows:

Roof Removal and Replacement

Cost:

- Remove and replace roof: USD96.31/^{m2} (face area)

Assumptions:

- Rates assume that the existing roofs are replaced with Colourbond Ultra grade roof sheeting (for sea spray environments) with 50mm of foil coated fibreglass insulation (to address heat issues).
- Rates have been built up based on a roof of a single storey building with a floor area of 14m x 12m with a roof pitch of 30 degrees. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.

- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- A 10% contingency has been allowed for tidying up any damaged or inadequate rafters purlins and barge boards.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.
- Rates assume asbestos waste secure wrapping and disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Cladding Removal and Replacement

Costs:

- Remove and replace cladding: USD76.04/^{m2} (face area)

Assumptions:

- Rates assume that the existing cladding is replaced with a cement fibre board with treated timber battens to make water tight. An allowance has also been made to wrap the building in foil and to apply two coats of paint to complete the works.
- Rates have been built up based on a single storey building with a floor area of 14m x 12m and walls 2.4m high. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- A 10% contingency has been allowed for tidying up any damaged or inadequate framing.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.
- Rates assume asbestos waste secure wrapping and disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Table 12: Summary of Costs for Various Remediation Options (Costs rounded to nearest $US)

Remediation Method	Cost per m² (face area) $US
Encapsulation	
Roofs:	
Encapsulate roof where there is no ceiling present below the roof	50.00
Encapsulate roof where there is an existing ceiling below the roof that needs to be removed and replaced	91.00
Cladding:	
Encapsulate wall cladding where there is no internal wall sheeting	26.00
Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated	18.00
Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/m2 (face area)	66.00
Removal and Replacement	
Roofs:	
Remove and replace roof	96.00
Cladding:	
Remove and replace cladding	76.00
Miscellaneous	
Remove and replace floor tiles*	80.00
Pick up debris, pipes	40.00

**$US80 is the lower end of the cost spectrum for removing and replacing vinyl floor tiles and the cost could easily double (or more) for difficult removal projects. To balance this out, the vinyl tile matrix is stable and there is little risk of asbestos exposure unless they are badly deteriorating. Vinyl floor asbestos projects could therefore be lower down on the priority list.*

The above rates assume asbestos waste disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

10.3 Local Contractors

An objective of the study was to identify any local contractors who may have the expertise and capacity to potentially partner with regional or international experts in future asbestos management work. Attempts were made to identify and contact potentially suitable contractors prior to the visits in order to schedule meetings when the survey team was in the country. In addition key government officials were also requested to provide the details of potentially suitable contractors.

Cabella Construction are a well-regarded contractor that has expressed an interest in undertaking asbestos related work. There are other general contractors who may also be suitable.

11.0 Review of Tonga Policies and Legal Instruments

11.1 National Laws and Regulations

The primary pieces of Tongan legislation that apply to the removal, handling and disposal of ACM are the Waste Management Act 2005 and the Hazardous Wastes and Chemicals Act 2010. There is no known legislation or guidance document in Tonga regarding occupational health and asbestos.

The Hazardous Wastes and Chemicals Act 2010 aims to harmonise the legislative arrangements required to comply with the international and regional management regimes for hazardous wastes and chemicals. The Act states controls that must be adopted during imports, exports, transit within country and handling of hazardous waste. The Act is administered by the Ministry of Environment and Climate Change.

The Waste Management Act 2005 covers the collection and disposal of solid wastes and the management of all wastes in Tonga, especially hazardous waste. The Act provides for registration and licensing of waste operators, permits for dumping and incinerating wastes, and environmental standards for the management of waste. The Ministry of Health are the approved Authority for all areas of Tonga other than the island of Tongatapu, where the Waste Authority Ltd is the approved Authority.

11.2 National Strategies and Policies

There are currently no national strategies or policies in Tonga related to asbestos.

12.0 Recommended Actions for Minimising Asbestos Exposures

12.1 Discussion

ACM has been identified by this study to be present at several locations in Tonga. Based on an algorithm adopted as part of the risk assessment to prioritise asbestos management, this study has identified that there are 20 sites in Tonga that are considered moderate to high risk with regards to the occupant's and/or publics potential exposure to asbestos. The remaining sites identified are considered to present a low to very low risk to human health. Management of the low risk sites will be required to ensure the risk to human health is not elevated further as the buildings' condition deteriorates with age.

In addition, based upon a statistical approach utilising population, household and asbestos survey data adopted by this study, the number of properties potentially containing ACM in Tonga has been calculated based on 95% confidence level of the sample survey size to be 340 +/-2.3%.

Remediation of sites has been prioritised based on the level of risk posed to the building occupants and public at each site according to the methodology described in Section 3.

A summary of the recommended actions, estimated time and materials and estimated costs are included in Table 13.

Table 13: Remedial Cost Estimates for Tonga

Site Name	ACM	Risk Score	Recommended Remedial Actions	Estimated ACM Area (m^2) and/or Volume (m^3)	Estimated Cost Range ($ USD)
Tonga Post Ltd	Fibre cement roof	27	Remove and replace ACM	1,400 m^2	$127,400
	Soffits	25			
Neiafu former market - Tonga Football Association, Vavau'u	Fibre cement (roof)	24	Remove and replace ACM Roof	300 m^2	$28,800
MOI Wof Centre	Fibre cement cladding	24	Remove and replace ACM Roof and facades.	900 m^2	$86,400
			Sub-Total for High Risk Sites		$242,600
MOI Workshop	Fibre cement roof and façade cladding	23	Remove and replace ACM Roof and facades. Pick up loose ACM surface scrape of topsoil.	1,685 – 1,885 m^2	$161,760 – 180,960
Fua'amotu Domestic Airport - Residential	Fibre cement (roof)	22	Remove and replace ACM	450 m^2	$43,200
Prince Ngu Hospital, Neiafu, Vava'u	Fibre cement (loose rear car park)	21	Pick up loose ACM, assess soil.	50 m^2	$2,000
	Fibre cement roof	21	Remove and replace ACM	3,600 m^2	$345,600
St Andrews School	Fibreboard classroom 15	21	Remove and replace ACM	160 m^2	$12,160
Plumbing Shop	Fibre cement (roof and facades)	21	Encapsulate	50 – 60 m^2	$4,550 - $5,460
QTR 33-34*	Fibre cement (roof)	21	Remove and replace ACM	100 – 150 m^2	$9,600 – 14,400
QTR79 – 82*	Fibre cement (roof)	20 – 21	Remove and replace ACM	760 – 900 m^2	$75,840 – 86,400

Site Name	ACM	Risk Score	Recommended Remedial Actions	Estimated ACM Area (m^2) and/or Volume (m^3)	Estimated Cost Range ($ USD)
Residential Property 01 – 13*	Fibre cement (roof)	19 – 21	Remove and replace ACM	1,300 m^2	$124,800
QTR 88 - 94 (former Government Quarters), Haveluloto.*	Fibre cement roof	21	Remove and replace ACM	1,440 – 1,700 m^2 (140 m^3)	$138,240 – 163,200
	Wall exterior panel	20	Remove and replace ACM		
Pacific International (Tonga) Limited	Fibre cement (roof)	20	Encapsulate	140 – 200 m^2 (14-20 m^3)	$13,440 – 19,200
QTR 39&40*	Fibre cement (roof)	20	Remove and replace ACM	265 m^2	$25,440
QTR 51&52*	Fibre cement (roof)	20	Remove and replace ACM	265 m^2	$25,440
Tonga Water	Fibre cement (roof and facades)	20	Encapsulate	100 – 120 m^2 (10m^3)	$9,600 – 11,520
Industrial 02, Nuku'alofa	Fibre cement (roof)	20	Encapsulate	100 – 120 m^2 (10 m^3)	$9,600 – 11,520
Vavau'u former bulk fuel terminal	Fibre cement (loose on sports field)	18	Pick up loose ACM surface scrape of topsoil.	2,000 m^2	$80,000
	Rear building fibre cement	18	Remove	500 m^2	$24,500
Industrial 01, Nuku'alofa	Fibre cement roof	18	Encapsulate	100 – 120 m^2 (10 m^3)	$9,100 – 10,920
CAT Depot, Nuku'alofa	Loose soffit	17	Encapsulate	100 – 120 m^2 (10 m^3)	$1,800 – 2,160
Viola Hospital, Haveluloto, Tongatapu	Walkway fibre cement roof	17	Remove	20 m^2	$980
			Sub-Total for Moderate Risk Sites		**$1,117,650 - $1,189,860**

**Note that it is not intended that residential houses clad or roofed with asbestos containing materials be remediated as part of the PacWaste Project.*

12.2 Recommendations

The following recommendations are therefore made in relation to asbestos on Tonga:

A. It is recommended that the above higher priority asbestos work is carried out in Tonga. The government buildings may be eligible for inclusion in the SPREP PacWaste Project, but not the commercial or industrial buildings.
B. Numerous residential dwellings are identified in Table 13 above as marked by an asterisk, and it has been concluded that 295 houses (+/- 2.3%) in Tongatapu and Vava'u may have asbestos roofing and/or cladding as well as potentially more in the rest of Tonga. It is recommended that all houses with PACM cladding in Tonga are tested for asbestos and that all the houses tested positive are notified and included in an awareness campaign. They should be remediated (i.e. the asbestos removed or encapsulated) where resources permit.
C. If a large number of houses are found to contain asbestos cladding then encapsulation would probably be the most cost-effective option for remediation although ongoing management procedures then would be needed and re-encapsulation (i.e. re-painting) would probably be

needed 10-15 years later. If a small number of houses are found to contain asbestos cladding then removal and replacement of the cladding should be considered.

D. Any asbestos roofs found on houses in Tonga should preferably be removed rather than encapsulated as encapsulation of roofs costs only a little less than removal and removal is a permanent solution.
E. All asbestos waste should be disposed of in the Tapuhia Landfill on Tongatapu, which has been determined as suitable for the disposal of asbestos waste. The asbestos waste should be placed in special cells and covered immediately.
F. Before asbestos remediation takes place (and after if all the asbestos is not removed) it would be appropriate to set in place suitable asbestos management practices and procedures to deal with the ongoing risk posed to human health by asbestos exposure. This should be accompanied by an appropriate education and training programme.
G. Consideration should be given to Tonga passing regulations under suitable legislation to enable the above asbestos work to be carried out.

Appendix 1: Edited Copy of the Terms of Reference

Background

Asbestos-containing materials were in wide use in the past in Pacific Island countries for housing and building construction. The region is subject to periodic catastrophic weather and geological events such as tsunamis and cyclones which are highly destructive to built infrastructure, and as a consequence, asbestos has become a significant waste and human health issue in many Pacific countries. However, quantitative data on the location, quantity and condition of asbestos is not available for the region. This data is needed to define the problem and plan for future actions. This project will contribute to improved management of regional asbestos waste through collection, collation and review of such data on the location, quantity and status of asbestos-containing building materials in priority Pacific Island countries.

SPREP has received funding from the European Union under the EDF10 programme to improve the management of asbestos waste in priority Pacific Island countries.

The work for this consultancy is located in the following Sub-regions and countries;

- Sub-region A, (Nauru):
  Nauru
- Sub-region B, (Micronesia):
  FSM, Kiribati, Marshall Islands, Kiribati
- Sub-region C, (Melanesia):
  Fiji, Solomon Islands, Vanuatu
- Sub-region D, (Polynesia):
  Cook Islands, Niue, Samoa, Tonga, Tuvalu

Objective

Pacific asbestos status and management options are assessed and future intervention recommendations presented on a regional basis to identify prioritised areas for future intervention.

Scope of Work

The scope of work for this consultancy covers the following tasks:

Tasks
For each of the sub-regions and countries above, the Consultant will:

1. Collect and collate data on the location (geographic coordinates), quantity and condition of asbestos-containing building materials (including asbestos-containing waste stockpiles) in each nominated Pacific Island country.

2. Review, and recommend a prioritised list of local best-practice options for stabilisation, handling and final disposal of asbestos contaminated materials in each nominated Pacific Island country (including review of existing local institutional, policy and regulatory arrangements).

3. Recommend and prioritise actions necessary to minimise exposure (potential and actual) of the local population to asbestos fibres for each nominated Pacific Island country. An approximate itemised national cost should be presented for each option identified.

4. Identify any local contractors who have the expertise and capacity to potentially partner with regional or international experts in future asbestos management work.

5. Develop a schedule of rates for local equipment hire, mobilization, labour, etc., to guide the development of detailed cost estimates for future in-country asbestos remediation work.

Project Deliverables

1. Final report detailing the location, quantity and status of asbestos-containing building materials (including asbestos-contaminated waste stockpiles) for each Pacific Island country identified in the work region(s).

2. Final report providing recommendations for local best-practice options including local institutional and policy arrangements for national asbestos management for each Pacific Island country identified in the work region(s).

3. Final report identifying local labor and equipment hire rates and availability of in-country asbestos management expertise for each Pacific Island country identified in the work region(s).

4. Final report presenting costed priority actions necessary to minimise the exposure of the local population to asbestos fibres for each Pacific Island country identified in the work region(s).

Project Timeframe

All final reports completed and submitted to SPREP within twenty (20) weeks from signature of the contract.

Appendix 2: Organisational Details and List of Contacts

A2.1 Organisational Details

The visit to Tonga took place from between Saturday 1st and Saturday 8th November 2014. The consultant conducting the survey was Gareth Oddy of Geoscience Consulting. Mr Oddy was based in Tongatapu but also visited the island of Vava'u from the 6th to 8th November 2014.

The primary agency for liaison was the Department for Environment, and the following personnel were involved:

- Mafileo Masi, Waste Management and Pollution Control, Department of Environment and Climate Change.

In addition, correspondence with the following other key government Departments and Authority's was undertaken in order to identify other potential ACM sites;

- Ministry of Infrastructure;
- Water Authority;
- Planning Urban Management Agency;
- Ministry of Education; and,
- Tonga Power.

Full contact details are given below for all those who assisted during the survey and subsequent reporting.

A2.2. List of Contacts

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Appendix 3: Summaries of in-Country Discussions

Mrs Lupoe Matoto, Director, Ministry of Environment and Climate Change.

Mrs Matoto provided extremely important information with regards to the legislative background and asbestos in Tonga. Mrs Matoto stated that there were a number of buildings in Tonga that were known to contain asbestos. These included the old government quarters, Tonga Post and potentially Vaiola Hospital in Nuku'alofa.

Mrs Matoto described how ACM was removed from Vaiola Hospital during 2010/2011. According to the Ministry some reports of building demolition having been deposited in the lagoon were received.

Mrs Matoto also indicated which of the other agencies would be most likely to hold useful information on asbestos in buildings. She recommended contacting the Waste Authority, Planning and Urban Management Agency (PUMA), Ministry of Infrastructure (MOI) and Ministry of Education (MOE).

At the time of the survey according to Mrs Matoto there were no occupational health and safety regulations relating to asbestos. The most relevant legislation would be the Hazardous Waste and Chemicals Act 2010.

Mr Fotu Veikune, Ministry of Infrastructure.

Mr Veikune provided invaluable information on a number of government owned buildings and other privately held properties where asbestos was either suspected or known. This included the MOI own buildings in Nuku'alofa. Plans of the Government Quarters Locations dated September 2014 were provided by the MOI and these were used to locate and survey additional properties. In addition Mr Veikune suggested contacting the Ministry of Education (MOE) as he knew of a MOE survey in 2008/2009 of schools with ACM. He thought most schools had now had the ACM removed but did indicate that the GPS Maufanga School may still contain some ACM.

Mrs Talita M Helu, Waste Authority Limited.

Mrs Helu described her role at the Authority as being responsible for the Tapuhia Landfill on Tongatapu. She described how the landfill, which opened in 2007 does receive asbestos waste. In September the landfill received ACM from a primary school. The ACM was wrapped in HDPE and buried within the current disposal cell. The Authority charges $10 per m3 to dispose of ACM.

According to Mrs Helu, the Authority provided asbestos awareness training to other agencies at the beginning of the year.

Mr Michael Lani 'Ahokava, Tonga Power.

Mr Ahokava, the power generation manager, described how the government owned plant was built in Tongatapu in 1974 and upgraded and extended in 1995. Mr Ahokava stated that initially the roof of the plant was ACM and was replaced with aluminium during the upgrade in 1995. The exhaust lagging of the diesel generators was also replaced approximately 5 years ago when the older generators were replaced. The old generators and asbestos lagging were sold to a New Zealand scrap metal dealer who removed them from site.

Mr Atunaisa Fetokai, Planning & Urban Management Agency.

Mr Fetokai reiterated previous locations of possible ACM and also that he had heard of reports of waste from Vaiola Hospital had been disposed of in the lagoon.

Mr Claude Tupou, Ministry of Education.

Mr Tupou provided a list of the Kingdoms schools and also confirmed that although the majority of the older schools previously did have ACM that a programme to remove it all had been completed recently. Further information on the removal volumes, clearance procedures or validation of removal was not available.

Mr Quddus Fieleg, Water Authority.

Mr Fieleg described the volumes of AC pipe in Tonga. According to records held by the Authority, there is still over 5 km of AC pipe still in the ground and in use and approximately 19.7 km worth of disused AC pipe present in the ground. Mr Fieleg stated that the majority of this disused pipe is in Nuku'alofa following a major upgrade of the water network in 2001. The majority of the active pipe was thought to be in the rural villages in production systems such as from and to reservoirs.

According to Mr Fieleg the Authority has procedures for projects that involve AC pipe and these include minimising disturbance, leaving in ground if possible, wetting pipe during removal and PPE for workers.

Mr Leo Pino Fa'asolo, Public Health Inspector.

Mr Fa'asolo described the situation at the Vaiola Hospital with regards to its ACM roof and history of the buildings construction. He described that the roof is not water tight and is a risk to public health.

Appendix 4: Reviewed Asbestos Reports

Waste Authority Ltd, 2014, Briefing notes on waste issues in Ha'apai (CIRCRP)

Bruce's Comment

This summary (and the other "missing" ones for cyclone Ian may not be needed if they don't contain any additional (relevant) detail to that given below. You would simply note (in the appendix) that the other cyclone reports contained similar info.

Ministry of Infrastructure, April 2014, Environmental Management Plan (CIRCRP)

This report details the recovery strategy to be employed in Ha'apai following Cyclone Ian. Staff from New Zealand based Nikau Contractors Limited (Nikau) visited Ha'apai and confirmed the presence of asbestos in residences, hospital and schools. According to the MoI approximately 250-300 tons of ACM and asbestos contaminated debris was identified on Ha'apai.

According to the report an asbestos handling strategy was in production at the time of this report and had not yet been finalized or approved by Government of Tonga. The MoI report did indicate that the strategy may involve the Nikau team returning to Ha'apai to train selected local people on the safe handling of asbestos and implement the asbestos strategy to safely remove and secure the ACM. The likely handling strategy discussed in the MoI report (page 8) included '*The plastic wrapped asbestos will be stored in a safe and secure location (likely in 20 ft. containers) awaiting final disposal (after safe transport) to the Tapuhia landfill site in Nuku'alofa*'. The ACM removal and disposal work was to be carried out in accordance with the New Zealand Guidelines for the Management and Removal of Asbestos (2011, 3rd Edition) produced by the New Zealand Demolition and Asbestos Association (NZDAA).

Tonkin & Taylor August 2014, Safe Handling and Disposal of Waste and Debris from Cyclone Ian, Ha'apai Islands (Draft)

The T&T report summarises the first stage of a strategy for dealing with the waste produced from Cyclone Ian at the Ha'apai Group of islands. The report included an inventory of the debris and recommendations for the recycling, re-use and safe disposal of debris.

Asbestos containing material was identified during the T&T surveys at two locations on Ha'apai. Approximately 0.5-1.0 m^3 of corrugated asbestos sheeting was identified at the Foa large dump site. The second location of a similar volume of corrugated asbestos sheeting was identified at a property on the eastern outskirts of Pangai with the sheeting being used as a boundary fence.

Alfred Picardi, November 2002, Tonga Health Care Project, Asbestos Survey Report.

This report documents the proposed upgrade of Vaiola Hospital in Nukualofa and the results of an asbestos survey conducted at the site. PACM was identified by the report authors at the hospital in the form of vinyl floor tiles, cement roofing materials on a covered walkway and window shades and also the steam pipe insulation from the steam boiler to the wards. Samples of all three materials were collected and analysed with asbestos found in both the vinyl floor and cement walkway roofing. The report recommended its removal prior to the Hospital upgrade.

During the pre-survey discussions for the current work Mr Fetokai, the deputy physical planner at the Planning and Urban Agency of the MLECCNR, indicated that some reports of demolition rubble having been disposed of in the lagoon opposite the Hospital were received. The Hospital and surrounding area was re-visited during the current survey to evaluate if that asbestos had been removed.

Appendix 5: Laboratory Reports

EMS LABORATORIES INC.
117 W. Bellevue Drive, Pasadena, CA 91105-2548 626-568-4065

National Institute of Standards and Technology (NIST) NVLAP Lab Code 101218-0
California Department of Health Services Environmental Testing Laboratory ELAP 1119
County Sanitation Districts of Los Angeles County ID No. 10120
AIHA Laboratory Accreditation Programs, LLC 101634

CUSTOMER:	Contract Environmental	PAGE #:	1 of 4
	119 Johnson Rd. West Melton	REPORT #:	0163566
	Christchurch NZ	PROJECT:	PLM ANALYSIS
CONTACT:	John O'Grady	DATE COLLECTED:	07/11/2014
REFERENCE:	11178 Tonga	COLLECTED BY:	
METHOD:	EPA 600/R-93/116	DATE RECEIVED:	11/14/2014
		ANALYSIS DATE:	11/21/2014

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type	(%)	Non-Asbestos Components	(%)
0163566-001						
T001	Beige, Homogeneous, Hard, crush, non-friable Note: 25°C, 1.550	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0163566-002						
T002	Beige, Homogeneous, Hard, crush, non-friable Note: 25°C, 1.550	LAYER 1 100%	Chrysotile	8%	Non-Fibrous Material	92%
0163566-003						
T003	White/ Beige, Non-homogeneous, Paint/Fibrous, ash/tease, non-friable Note: 25°C, acid	LAYER 1 100%	Chrysotile	5%	Cellulose Fiber Non-Fibrous Material	30% 65%
0163566-004						
T004	Beige, Homogeneous, Hard, crush, non-friable Note: 25°C, 1.550	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0163566-005						
T005	White, Homogeneous, Chalky, crush, non-friable Note: 25°C, 1.680	LAYER 1 100%	Amosite Crocidolite	8% 6%	Cellulose Fiber Synthetic Fiber Non-Fibrous Material	5% 5% 76%
0163566-006						
T006	Blue/Gray, Non-homogeneous, Paint/Fibrous, ash/tease Note: 25°C, acid	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	25% 75%

CUSTOMER:	Contract Environmental	PAGE #:	2 of 4
	119 Johnson Rd. West Melton	REPORT #:	0163566
	Christchurch NZ	PROJECT:	PLM ANALYSIS

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type	(%)	Non-Asbestos Components	(%)
0163566-007						
T007	LAYER 1 Tan, Homogeneous, Hard, melt, non-friable Note: 25°C, 1.550	LAYER 1 95%	None Detected		Non-Fibrous Material	100%
	LAYER 2 Yellow, Homogeneous, sticky, melt, non-friable Note: 25°C, 1.550	LAYER 2 5%	None Detected		Cellulose Fiber Non-Fibrous Material	2% 98%
0163566-008						
T008	Beige, Homogeneous, Hard, tease, non-friable Note: 25°C, 1.550	LAYER 1 100%	Chrysotile	7%	Non-Fibrous Material	93%
0163566-009						
T009	Beige, Homogeneous, Hard, tease, non-friable Note: 25°C, 1.550	LAYER 1 100%	Chrysotile	7%	Cellulose Fiber Non-Fibrous Material	5% 88%
0163566-010						
T010	Black/Gray, Non-homogeneous, Paint/Fibrous, tease, non-friable Note: 25°C,acid	LAYER 1 100%	Chrysotile	10%	Cellulose Fiber Non-Fibrous Material	5% 85%
0163566-011						
T011	White/Beige, Non-homogeneous, Paint/Hard, ash/tease, non-friable Note: 25°C, acid	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	5% 95%
0163566-012						
T012	Beige/Brown, Non-homogeneous, Fibrous/Chalky, acid/crush, friable Note: 25°C	LAYER 1 100%	None Detected		Fibrous Glass Non-Fibrous Material	90% 10%
0163566-013						
T013	Brown/Yellow, Non-homogeneous, Chalky, crush, non-friable Note: 26°C, acid	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	60% 15% 25%
0163566-014						
T014	Yellow/Brown, Non-homogeneous, Fibrous/Resinous, tease/melt, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	70% 5% 25%

CUSTOMER:	Contract Environmental	PAGE #:	3 of 4
	119 Johnson Rd. West Melton	REPORT #:	0163566
	Christchurch NZ	PROJECT:	PLM ANALYSIS

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type	(%)	Non-Asbestos Components	(%)
0163566-015						
T015	Gray, Non-homogeneous, Paint/Chalky, ash/acid, non-friable Note: 26°C	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	20% 80%
0163566-016						
T016	Gray, Homogeneous, Chalky, acid, non-friable Note: 26°C	LAYER 1 100%	Chrysotile	8%	Cellulose Fiber Non-Fibrous Material	2% 90%
0163566-017						
T017	Gray, Homogeneous, Chalky, acid, non-friable Note: 26°C	LAYER 1 100%	Chrysotile	2%	Cellulose Fiber Non-Fibrous Material	2% 96%
0163566-018						
T018	Black/Gray, Non-homogeneous, Paint/Fibrous, ash/tease, non-friable Note: 26°C, acid	LAYER 1 100%	Chrysotile	2%	Cellulose Fiber Non-Fibrous Material	5% 93%
0163566-019						
T019	Gray, Homogeneous, Fibrous, tease, friable Note: 26°C, acid	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	20% 80%
0163566-020						
T020	LAYER 1 White, Homogeneous, Hard, melt, non-friable Note: 26°C, 1.550	LAYER 1 98%	None Detected		Non-Fibrous Material	100%
	LAYER 2 Yellow, Homogeneous, Resinous, melt, non-friable Note: 26°C, 1.550	LAYER 2 2%	None Detected		Cellulose Fiber Non-Fibrous Material	50% 50%
0163566-021						
TV01	Beige, Homogeneous, Chalky, crush, non-friable Note: 26°C, 1.550	LAYER 1 100%	Chrysotile Amosite	5% 2%	Cellulose Fiber Non-Fibrous Material	2% 91%
0163566-022						
TV02	Beige, Homogeneous, Chalky, crush, non-friable Note: 26°C, 1.680	LAYER 1 100%	Chrysotile Amosite	5% 5%	Cellulose Fiber Non-Fibrous Material	5% 85%

CUSTOMER:	Contract Environmental	PAGE #:	4 of 4
	119 Johnson Rd. West Melton	REPORT #:	0163566
	Christchurch NZ	PROJECT:	PLM ANALYSIS

BULK SAMPLE ANALYSIS FOR ASBESTOS CONTENT BY POLARIZED LIGHT MICROSCOPY

Laboratory ID - Sample No.	Sample Location Description	Layer No. Layer %	Asbestos Type	(%)	Non-Asbestos Components	(%)
0163566-023						
TV03	Beige, Homogeneous, Fibrous, tease, non-friable Note: 26°C, 1.550	LAYER 1 100%	Chrysotile Amosite	8% 2%	Cellulose Fiber Non-Fibrous Material	2% 88%
0163566-024						
TV04	Beige, Homogeneous, Hard, acid, non-friable Note: 26°C	LAYER 1 100%	Chrysotile Amosite	5% 2%	Cellulose Fiber Non-Fibrous Material	2% 91%
0163566-025						
TV05	Gray, Homogeneous, Fibrous, tease, friable Note: 26°C, acid	LAYER 1 100%	Chrysotile Amosite	10% 5%	Cellulose Fiber Non-Fibrous Material	5% 80%
0163566-026						
TV06	Green/Beige, Non-homogeneous, Paint/Chalky, ash/acid, non-friable Note: 26°C	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	2% 98%

Analyst - MEGHAN SWEENEY **Approved Signatory** Laboratory Director

The EPA method is a semi-quantitative procedure. The detection limit is between 0.1-1% by area and dependent upon the size of the asbestos fibers, the means of sampling and the matrix of the sampled material. The test results reported are for the sample(s) delivered to us and may not represent the entire material from which the sample was taken. The EPA recommends three samples or more be taken from a "homogeneous sampling area" before friable material is considered non-asbestos-containing. Negative floor tile samples may contain significant amounts (>1%) of very thin fibers which cannot be detected by PLM. Confirmation by TEM is recommended by the EPA (Federal Register Vol.59, No.146). Asbestos fibers bound in a non-friable organic matrix may not be detected by PLM. Alternative preparation methods are recommended. This report, from a NIST-accredited laboratory through NVLAP, must not be used by the client to claim product endorsement by NVLAP or any agencyof the U.S. government. This report shall not be reproduced, except in full, without the written approval of EMS Laboratories, Inc. Samples were received in good condition unless otherwise noted.

NVLAP Lab Code: 101298-0

Appendix 6: Build Up to Costs for Remediation Options

Four scenarios have been costed:

1. Encapsulate asbestos roofing
2. Encapsulate asbestos exterior wall cladding
3. Remove and replace asbestos roofing
4. Remove and replace asbestos exterior wall cladding

Build ups are mostly based on costs provided by Central Meridian Inc based in Nauru, cross checked against costs in New Zealand.

It is noted that the costs prepared are for preliminary budgeting purposes only. Costs may vary according to local requirements, but we anticipate that the amounts allowed will be adequate to get the work done.

For the cost build ups prepared we have taken the Central Meridian rates, priced in Australian dollars, and converted them to United States dollars at an exchange rate of 0.8. We have then deducted 10% for savings that we anticipate would be achievable through competitive tendering of the work.

Provision has also been made for the works to be overseen by a SPREP appointed asbestos expert. The actual cost for this item will depend on the programme of works achievable and it is noted that this expert could also complete any contract administration and act as engineer to the contract ensuring safety, quality and commercial requirements are achieved.

Central Meridian Quote

02.12.14

PO Box 106
Republic of Nauru
Central Pacific
T 674 557 3731
AH 674 557 3813
E pfcmnauru@gmail.com
paulfinch1954@gmail.com

Quotation: 6814

Mr John O'Grady
Contract Environmental Ltd.

Cost estimates to undertake various asbestos removal work.

Dear John,

As requested I have detailed below costs to undertake various items of work involved in the removal of asbestos roof sheeting and replacement with colourbond corrugated roofing.

A full schedule of work to be undertaken during the removal and replacement process is detailed to - provide a clear build-up of costs and the relevant stages of work involved.

All work will be undertaken to the relevant NZ & Australian standards for asbestos removal & disposal.

REMOVAL OF EXISTING ASBESTOS ROOF SHEETING.
The costings detailed below are based on a roof area of 165m2. This is a standard size of many of the houses on Nauru with asbestos roof sheeting.
The cost of set up & removal of existing roofing is based on our historical costs for undertaking a number of similar roof removals on the island.
There are additional costs included as detailed:
(a) purchase of a 60 Litre Foamer unit at a price of $5,000.00 (including ocean freight & 10% import duty.) The cost of this is spread over the removal of 20 roofs.
(b) purchase of specialist vacuum cleaner with HEPA filter at a price of $2,000.00 (including freight & 10% import duty.)
(c) delivery to a central staging point for removal off island.

Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective clothing, (PPE) for staff & disposal.
$1,400.00

Set up scaffolding to both sides of building to assist in removal of roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems
$2,200.00

Coat the roof with a sprayed on water based PVA solution.
$1,250.00

Carefully remove the roof sheeting by unscrewing, (not breaking) the roof sheets. All roof sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic & taped shut. Roof sheeting and all materials, (ridging, barge flashing, gutters etc) to be loaded into 'Asbags' for safe removal.
All removed materials will be taken and stored at a suitable staging point ready to be loaded into containers for removal from Nauru.
$4,465.00

Vacuum clean the existing ceiling & roof space, (rafters, purlins, ceiling joists) with a specific vacuum cleaner with a HEPA filter. (dispose of contents of cleaner into an 'Asbag' for correct disposal $325.00

Supply & fit heavy duty tarpaulins to keep the roof waterproof before installation of new roofing. $300.00

TOTAL COST FOR REMOVAL OF EXISTING ROOFING & GUTTERS $9,940.00

INSTALLATION OF NEW ROOF SHEETING, INSULATION, GUTTERING, DOWNPIPES.
We have quoted for Ultra grade of colourbond roof sheeting. This has a greater protective coating & is better for an oceanside environment. (Long life heavy duty).
The sq metre costs & grade of materials for this work are the same as that for the TVET school project in Yaren we have recently completed to AusAID Standard.

Supply & fit 'Kiwisafe' roof netting over existing purlins & fix in place ready to support the 50mm thick, foil coated, fiberglass insulation. Supply & lay a top layer of sisalation foil over the fibreglass insulation blanket. $2,541.00

Supply & screw fix Colourbond Ultra grade corrugated roofing, including for ridging & barge flashings. $7,722.00

Supply & fix Colourbond box guttering to both sides of the roof & include for one downpipe each side, feeding to a tank. $1,060.00

TOTAL COST FOR SUPPLY & FIXING OF NEW ROOF, ROOF INSULATION & GUTTERS & DOWN PIPES. $11,323.00

NB A contingency of 10% may need to be added as necessary for repairs to roof purlins and rafters.

RETENTION OF EXISTING ASBESTOS ROOF SHEETING AND FULL ENCAPSULATION WITH CORRECT PAINT SYSTEM. INCLUDING REMOVAL & REPLACEMENT OF EXISTING CEILINGS.
The square area of ceiling to be replaced & painting to be undertaken is based on a house size of 14m x 12m in size. (168 m2)
Work involved in this process is as follows and detailed below:

Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective clothing, (PPE) for staff & disposal.
$1,400.00

Set up scaffolding to both sides of building to assist in removal of roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems
$2,200.00

Spray with Foamshield to the inside of the ceiling space before removal of the sheeting.
$475.00

Disconnect & remove all electrical items, ceiling fans, lights, extractor fans. Allow to store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work. $350.00

Lay down black plastic sheeting to floor of each room, remove all ceiling linings and place all rubbish into Asbags for correct removal & disposal. $1,850.00

Vacuum with specialist cleaner the underside of the existing roof sheeting and all timber roof framing. After removal of ceiling materials vacuum clean all the inside of the premises with vacuum cleaner with specialist HEPA filter. $350.00

Prepare correct paint product to seal & spray 2 coats of protective paint system to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated. A total of 3 coats to be applied. $2,050.00

Supply & fix 4.8mm Masonite sheeting to ceiling of all rooms. Supply & fix 40x10mm timber batten to all sheet joints & to perimeter of each room. $6,370.00 (Standard Ceiling liner)

Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets & perimeter battens. $1,425.00

Reposition all wiring for lights & fans and connect up all fittings as previously set out. $450.00

Prepare to apply 3 coats of specialist paint finish to all the exterior roof area according to painting specifications. $2,250.00

Remove and dispose of correctly asbestos gutters to both sides of the building and supply & install new colourbond box gutters with down pipe each side leading to water tank. $1,760.00

TOTAL COST FOR FULL PAINT ENCAPSULATION OF EXISTING ROOF SHEETING, INCLUDING FOR REMOVAL & REPLACEMENT OF EXISTING CEILINGS & ALL ASSOCIATED WORK. $20,930.00

Thank you for the opportunity to provide a quotation & I await your instructions.

Yours truly,

Paul Finch
Central Meridian Inc.

Build up to Encapsulation of Asbestos Roofing

BUILD UP TO RETENTION OF EXISTING ASBESTOS ROOF SHEETING AND FULL ENCAPSULATION WITH CORRECT PAINT SYSTEM, INCLUDING REMOVAL AND REPLACEMENT OF EXISTING CEILINGS.

The costing detailed below are based on building area of 168m2 (14m x 12m). For roof area multiply by 1.15 to account for the pitch, which gives an area of 193m2.

This estimate assumes that there is an existing ceiling in place within the building, which would need to be treated as asbestos contaminated and removed. Once the ceiling was removed the building would need to be cleaned of asbestos fibres, the existing roof encapsulated, and the ceiling then reinstated. The items relating to the ceiling removal are shaded in blue, and if there was no ceiling then these items could be deducted from the budgeted costs.

The estimate does not include any costs related to removing items from within the building prior to starting works, or putting them back, or any costs relating to the disruption of normal activities in the affected building.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE) for staff.	1,400.00	1,120.00	1,018.18
Set up scaffolding to both sides of building to remove asbestos guttering from building and provide safe access to the roof. Set up anchor point for fall arrest systems.	2,200.00	1,760.00	1,600.00
Spray ceiling with Foamshield, or similar particle capture system, to the inside of the ceiling space before removal of the sheeting.	475.00	380.00	345.45
Disconnect and remove all electrical items, ceiling fans, lights, extractor fans. Allow to store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work.	350.00	280.00	254.55
Lay down black plastic sheeting to floor of each room, remove all ceiling linings and place all rubbish into Asbags for correct removal and disposal.	1,850.00	1,480.00	1,345.45
After removal of ceiling materials vacuum clean all the inside of the premises with a vacuum cleaner with HEPA filter. Then vacuum the	350.00	280.00	254.55

underside of the existing roof sheeting and all timber roof framing.			
Prepare correct paint product to seal and spray 3 coats of protective paint system to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated.	2,050.00	1,640.00	1,490.91
Supply and fix 4.8mm Masonite sheeting to ceiling of all rooms. Supply and fix 40x10mm timber batten to all sheet joints and to perimeter of each room. (Standard ceiling liner)	6,370.00	5,096.00	4,632.73
Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets and perimeter battens.	1,425.00	1,140.00	1,036.36
Reposition all wiring for lights and fans and connect up all fittings as previously set out.	450.00	360.00	327.27
Apply 3 coats of specialist paint finish to all the exterior roof area according to painting specifications.	2,250.00	1,800.00	1,636.36
Remove gutters to both sides of the building and supply and install new colourbond box gutters with down pipe each side leading to water tank. Transport asbestos contaminated materials to central collection point for disposal (cost of disposal not included).	1,760.00	1,408.00	1,280.00
Oversight by SPREP appointed asbestos management expert	2,875.00	2,300.00	2,300.00
Total	**23,805.00**	**19,044.00**	**17,521.82**

Work back in to a m2 rate for encapsulating asbestos roofs where there is a ceiling present (per area of roof assuming the roof has a 30 degree pitch)	/ 193m2	90.79
Work our alternate rate for where there is no ceiling		
Deduct ceiling related costs shaded in blue		-7,941.82
Adjusted cost for a 168m2 building		9,580.00
Adjusted m2 rate for encapsulating an asbestos roof where there is no ceiling present (per area of roof assuming the roof has a 30 degree pitch)	/ 193m2	49.64

Build Up to Encapsulating Asbestos Cladding

BUILD UP TO RETENTION OF EXISTING ASBESTOS WALL CLADDING AND FULL ENCAPSULATION (INSIDE AND OUT) WITH CORRECT PAINT SYSTEM.

The estimate assumes work is completed in a building 14m x 12m in size = 168m2 (single storey - 2.4m high). Assuming windows and doors account for 10% of building exterior, the total cladding area would be approximately 360m2.

This estimate assumes that there is no internal wall sheeting (eg plaster board) and that the asbestos containing material is exposed. For a scenario where there is internal wall sheeting in good condition within the building, only the exterior would need to be treated. Items where savings could be made in this scenario are shaded in blue.

In a situation where there is internal wall sheeting in poor condition that would need to be removed and replaced, an extra $40/m2 would need to be allowed for as an extra over cost.

The estimate does not include any costs related to removing items from within the building prior to starting works, or putting them back, or any costs relating to the disruption of normal activities in the affected building.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE) for staff.	1,400.00	1,120.00	1,018.18
Vacuum clean all the inside of the premises with Vacuum cleaner with specialist HEPA filter. Then vacuum the inside of the existing cladding and all timber framing.	350.00	280.00	254.55
Prepare correct paint product to seal and spray 3 coats of protective paint system to the **outside** of all the cladding. Ensuring that all surface areas are correctly coated. A total of 3 coats to be applied.	3,960.00	3,168.00	2,880.00
Prepare correct paint product to seal and spray 3 coats of protective paint system to the **inside** of all the cladding. Ensuring that all surface areas are correctly coated.	3,960.00	3,168.00	2,880.00
Oversight by SPREP appointed asbestos management expert	2,875.00	2,300.00	2,300.00
Total	**12,545.00**	**10,036.00**	**9,332.73**

Work back in to a m2 rate for encapsulating wall cladding inside and out (per face area of cladding)	/ 360m2	25.92
Work out alternate rate for where there is adequate internal wall sheeting which would mean that the interior of the asbestos cladding would not need to be encapsulated.		
Deduct interior encapsulation costs		-2,880.00
Adjusted cost		6,452.73
Adjusted m2 rate for encapsulating asbestos cladding where there is adequate internal wall sheeting (per face area of cladding)	/ 360m2	17.92
Work out alternate rate for where the internal wall sheeting is in poor condition and would need to be stripped out and replaced.		
Add in cost of removing the existing interior walls and replacing after encapsulation		14,400.00
Adjusted cost (360m2 of cladding)		23,732.73
Adjusted m2 rate for scenario where internal wall sheeting is in poor condition and also needs to be stripped out and replaced.	/ 360m2	65.92

Build Up to Removing and Replacing Asbestos Roofing

BUILD UP TO REMOVAL OF EXISTING ASBESTOS ROOF SHEETING.

The costing detailed below are based on building area of 168m2 (14m x 12m). For roof area multiply by 1.15 to account for the pitch, which gives an area of 193m2.

The costs are as worked out with Central Meridian, who are an experienced contractor based in Nauru.

Transport and packaging costs are allowed for bring asbestos containing materials to a central point but disposal costs are excluded and treated separate.

Purchase of a 60 Litre FoamShield unit at a price of $5,000.00 (including ocean freight and 10% import duty) is allowed for and the cost of this is spread over the removal of 20 roofs.

Purchase of specialist vacuum cleaner with HEPA filter at a price of $2,000.00 (including freight and 10% import duty) is allowed for and the cost of this is spread over the removal of 20 roofs.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE) for staff.	1,400.00	1,120.00	1,018.18
Set up scaffolding to both sides of building to assist in removal of roof sheeting and to remove asbestos contaminated guttering from building. Set up anchor point for fall arrest systems.	2,200.00	1,760.00	1,600.00
Coat the roof with a sprayed on water based PVA solution.	1,250.00	1,000.00	909.09
Carefully remove the roof sheeting by unscrewing, (not breaking) the roof sheets. All roof sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic and taped shut. All removed materials will be taken and stored at a suitable staging point ready to be disposed of.	4,465.00	3,572.00	3,247.27
Vacuum clean the existing ceiling and roof space, (rafters, purlins, ceiling joists) with a specialised vacuum cleaner with a HEPA filter. Dispose of contents of cleaner into an 'Asbag' for correct disposal	325.00	260.00	236.36
Supply and fit heavy duty tarpaulins to keep the roof waterproof ready for installation of new roofing.	300.00	240.00	218.18

Oversight by SPREP appointed asbestos management expert.	2,875.00	2,300.00	2,300.00
Total	12,815.00	10,252.00	9,529.09
Work back in to a m2 rate		/ 193m2	49.37

BUILD UP TO INSTALLATION OF NEW ROOF SHEETING, INSULATION, GUTTERING, DOWNPIPES.

The cost estimate allows for Colourbond Ultra grade roof sheeting and 50mm of foil coated fibreglass insulation. This has a greater protective coating and is better for an oceanside environment. (Long life heavy duty.)

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Supply and fit 'Kiwisafe' roof netting over existing purlins and fix in place ready to support the 50mm thick, foil coated, fiberglass insulation. Supply and lay a top layer of sisalation foil over the fibreglass insulation blanket.	2,541.00	2,032.80	1,848.00
Supply and screw fix Colourbond Ultra grade corrugated roofing, including for ridging and barge flashings.	7,722.00	6,177.60	5,616.00
Supply and fix Colourbond box guttering to both sides of the roof and include for one downpipe each side, feeding to a tank.	1,060.00	848.00	770.91
NB A contingency of 10% may need to be added as necessary for repairs to roof purlins and rafters.	1,132.30	905.84	823.49
Total	**12,455.30**	**9,964.24**	**9,058.40**
Work back in to a m2 rate		/ 193m2	46.93

SUMMARY OF COSTS TO REMOVE ROOF AND REPLACE WITH NEW ROOF

Cost to remove old roof	49.37
Cost to install new roof	46.93
Total cost to remove and replace asbestos roofing (per m2 of roof area)	**96.31**

Remove and Replace Asbestos Cladding

BUILD UP TO REMOVAL AND REPLACEMENT OF ASBESTOS WALL CLADDING.

The estimate assumes work is completed on a building 14m x 12m in size = 168m2 (single storey - 2.4m high). (Assume windows and doors account for 10% of building exterior, the total cladding area would be approximately 360m2).

If a building was two stories it is recommended that USD12.00 is added per m2 for scaffolding. This figure is a rough estimate only but should provide adequate coverage.

Item	AUD estimate (based on Central Meridian costings)	Convert to USD (0.8 exchange rate)	Reduce by 10% to account for competitive tendering
Establish asbestos boundaries, mark out the property, set up relevant warning signage around the property, decontamination entry points, personal protective equipment (PPE).	1,400.00	1,120.00	1,018.18
Coat the walls with a sprayed on water based PVA solution.	1,875.00	1,500.00	1,363.64
Carefully remove the existing cladding. All wall sheets to be stacked onto plastic sheeting sitting on bearers for ease of removal. Sheeting to be fully wrapped in plastic and taped shut. All misc asbestos contaminated material to be loaded into 'Asbags' for safe removal. All removed materials will be taken and stored at a suitable staging point ready to be disposed of.	6,697.50	5,358.00	4,870.91
Vacuum clean the existing wall cavities with a vacuum cleaner with a HEPA filter. (Dispose of contents of cleaner into an 'Asbag' for correct disposal	325.00	260.00	236.36
Wrap the building in building foil, supply and fix composite cement board sheeting to exterior of buildings. Supply and fix treated 40mmx10mm timber batten to all sheet joints.	18,000.00	14,400.00	13,090.91
Paint with 2 coats of acrylic paint to all new wall cladding sheets and perimeter battens.	3,060.00	2,448.00	2,225.45
NB A contingency of 10% may need to be added as necessary for repairs to framing.	3,135.75	2,508.60	2,280.55
Oversight by SPREP appointed asbestos management expert.	2,875.00	2,300.00	2,300.00
Total	**37,368.25**	**29,894.60**	**27,386.00**

Work back in to a m2 rate for removing and replacing asbestos cladding (per face area of cladding)	/ 360m2	76.07