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 Republic of Palau

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

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Executive Summary

This report covers the Republic of Palau (hereafter referred to as Palau) 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 Palau during a field visit undertaken by John O'Grady and Claude Midgley between the 8th and 14th of June 2014. The visit was organised through the Palau Environmental Quality Protection Board (EQPB).

PacWaste (Pacific Hazardous Waste) is a four year, €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, E-waste, asbestos, and integrated atoll solid waste management.

Asbestos-containing wastes 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, 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 hazardous 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'.

Survey Methodology

The survey work undertaken in Palau included meetings with key government agencies, area-wide surveys of residential properties and targeted investigations of public and commercial buildings. The survey was limited to the islands of Koror and Babeldaob, mainly for logistical reasons.

The most recent census data for Palau indicates that there are approximately 4345 households in Palau, and 60% of these were surveyed, although the survey was skewed by the fact of confining the work to Koror and Babeldaob. As no properties were identified as having asbestos cladding or roofing, however, out of the 60% that were surveyed, then probably no houses have asbestos roofing or cladding. Statistically, applying a 95% confidence level to a sample this size, it can be said that it would be expected that there would be no more than 52 houses with asbestos cladding. The skewed nature of the survey would also, however, have to be taken into account.

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.

Two air samples were also collected from the burnt-out building at Ameliik Power Plant. These samples proved negative for asbestos in air (below the level of detection.

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 also 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 several locations in Palau. The main one was the large recently-constructed building at Malakal Power Station. The rest were asbestos-cement pipes (including in one case pipes used as a structural member) except for a gasket at the burnt-out old Ameliik Power Plant.

Based on the algorithm adopted as part of the risk assessment to prioritise asbestos management, this study has identified that there are two sites in Palau that are considered moderate risk with regard to occupant/public potential exposure to asbestos. These are the Malakal Power Station site and a stockpile of pipes at the Palau Water Treatment Plant in Airai. The remaining sites identified are considered to present a 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.

As no regulations currently exist, the remediation methods can be easily implemented without the need for permits. Asbestos cement water pipes can be collected under specialist supervision and transported to the government landfill for secure disposal. It is recommended that the EQPB and Ministry of Works are invited to assist with the collection and disposal of the materials as a capacity building initiative that will allow the departments to manage similar projects in the future (if required).

It was reassuring to discover that the old burnt-out Power Station at Ameliik was substantially asbestos-free, based on bulk and air samples that were taken. Asbestos was, however, discovered in gasket material and so care still needs to be taken with the demolition process.

The one major project that needs to be undertaken is the remediation of the recently-constructed generator building at the Malakal Power Station. The roofing and cladding is asbestos-containing material and encapsulation using a suitable paint system should be undertaken. The encapsulant needs to be carefully chosen and the project should be regarded as an asbestos project with the use of suitable relevant protocols. There are several local contractors who could undertake this work.

Management procedures should also be put in place prior to and after the Malakal encapsulation has taken place, including methods for maintaining the cladding and roofing to avoid exposure to asbestos fibres.

Suitable legislation should be enacted to prevent any further importation of asbestos into Palau.

Costings

As a result of the above, and additional considerations, the following broad basis for costings calculations has been arrived at for Palau:

Item	US$/m2
Encapsulation	
Roof if Ceiling Needs Removal	91.00
Roof if No Ceiling	50.00
Cladding (lining on inside)	18.00
Cladding (no lining on inside)	26.00
Cladding (internal wall cladding in poor condition needing removal and replacement)	66.00
Removal and Replacement (Including Local Disposal)	
Roofs	96.00
Roof Removal without Replacement	49.00
Cladding	76.00
Cladding Removal without Replacement	27.00
Floor Tiles*	80.00
Miscellaneous	
Picking up Debris, Pipes	40.00
If Mixture of Roof and Cladding - just take average figure	
If removal of broken bits and soil cleanup needed on top of removal of roofing / cladding - add 10%	

**$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.*

Recommendations and Prioritised List of Actions

A summary of the recommended actions and estimated costs are included in the table below.

Location	Type	Recommended Action	Area (m2)	Cost/m2	Total Cost	Risk Ranking
Aimeliik Power Plant	Gaskets	Carefully Remove Gaskets as part of Demolition Process	1	LS	1000	14
Airai Water Treatment Plant	AC Pipes	Remove Pipes to Landfill and Cover	500	LS	5000	13
Public Reserve, Ngiwal	AC Pipes	Remove Pipes to Landfill and Cover	12	LS	500	12
Roadside, Imetang Village	AC Pipe	Remove Pipes to Landfill and Cover	1	LS	200	10

Location	Type	Recommended Action	Area (m2)	Cost/m2	Total Cost	Risk Ranking
Malakal Power Plant	Cladding	Cladding is 15 years old from Japan - Encapsulation is appropriate but need to do both sides	2000	50	100000	8

The following recommendations have been made as a result of the study:

a. The two main asbestos risks on Palau should be addressed - namely the new building at the Ameliik Power Plant and the old pipes stockpiled at the Palau Water Treatment Plant in Airai.
b. The remaining sites identified are considered to present a low risk to human health, but the asbestos-containing materials are treated as presenting the potential for a high risk exposure scenario because members of the public could collect and reuse the materials in a residential setting.
c. It would not be difficult to remove and landfill asbestos-cement pipes by roadsides and in village reserves and some have already been identified. Wherever such pipes are identified then they should be removed and landfilled.
d. One residence has been identified as containing concrete-filled asbestos-cement columns as roof supports (a shade house.) These columns should be encapsulated with a suitable paint system and if others are identified then they should be similarly managed.
e. The gaskets that tested positive at the old burnt-out power plant at Ameliik indicate that all gaskets should be treated carefully during the demolition process, especially where flanged pipe joints are unbolted.
f. The EQPB and Ministry of Works should be invited to assist with the collection, disposal and remediation of asbestos-containing materials as a capacity building initiative that will allow the departments to manage similar projects in the future (if required).
g. Consideration should be given to carrying out the remediation of the one major project that needs to be undertaken, namely the remediation of the recently-constructed generator building at the Malakal Power Station. The roofing and cladding is asbestos-containing material and encapsulation using a suitable paint system should be undertaken.
h. The Malakal project should be regarded as an asbestos project with the use of suitable relevant protocols, and the encapsulant should be carefully chosen. There are several local contractors who could undertake this work and it is recommended that prices be obtained from them.
i. Management procedures should also be put in place prior to and after the Malakal encapsulation has taken place, including methods for maintaining the cladding and roofing to avoid exposure to asbestos fibres.
j. There is likely to be asbestos-cement pipes present in the water reticulation system. Care needs to be given to the maintenance of this system, especially when pipes are removed. Procedures and training are therefore needed for personnel maintaining the reticulation system.
k. Suitable legislation should be enacted to prevent any further importation of asbestos into Palau.

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

AusAid: Australian Agency for International Development
CEL: Contract Environmental Limited

Chrysotile: White Asbestos

Crocidolite: Blue Asbestos

EMS: EMS Laboratories Incorporated

EQPB: Environmental Quality Protection Board

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

MOH: Ministry of Health

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 Palau 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 contract to the Secretariat of the Pacific Regional Environment Programme (SPREP), with funding provided by the European Union. Most of the information required for the Palau survey was obtained in a field visit undertaken by John O'Grady and Claude Midgley between the 8th and 14th of June 2014 and was organised through the Palau Environmental Quality Protection Board (EQPB).

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 Palau

Palau is officially called the Republic of Palau and is an island country in the Western Pacific. It is geographically part of the larger island group of Micronesia. The country's population is spread across 250 islands forming the western chain of the Caroline Islands. The most populous island is Koror. The capital Ngerulmud is located in Melekeok State on the largest island of Babeldaob.

The country was originally settled around 3,000 years ago. The islands were first visited by Europeans in the 18th century, and were made part of the Spanish East Indies in 1885. Since then it has been under German, Japanese, and American influence. In 1947 it was made part of the United States governed Trust Territory of the Pacific Islands. Having voted against joining the Federated States of Micronesia in 1979, the islands gained full sovereignty in 1994 under a Compact of Free Association with the United States.

Palau is divided into sixteen states. These are listed below with their areas (in square kilometres) and 2005 Census populations:

State	Area (km^2)	Population (Census 2012)
Aimeliik	44.0	270
Airai	59.0	2723
Angaur	8.1	320
Hatohobei	0.9	44
Kayangel	1.7	188
Koror	60.5	12676
Melekeok	26.0	391
Ngaraard	34.0	581
Ngardmau	34.0	166
Ngaremlengui	68.0	317
Ngatpang	33.0	464
Ngchesar	43.0	254
Ngerchelong	30.0	488
Ngiwai	17.0	223
Peleliu	22.3	702
Sonsorol	3.1	100
Total	**484.6**	**19907**

Palau's most populous islands are Angaur, Babeldaob, Koror and Peleliu. The latter three lie together within the same barrier reef. Angaur is an oceanic island several miles to the south. About two-thirds of the population live on Koror.

Palau has a tropical climate with an annual mean temperature of 82 °F (28 °C). Rainfall is heavy throughout the year, averaging 150 inches (3,800 mm). The average humidity is 82% and although rain falls more frequently between July and October, there is still much sunshine.

Maps of Palau are shown below.

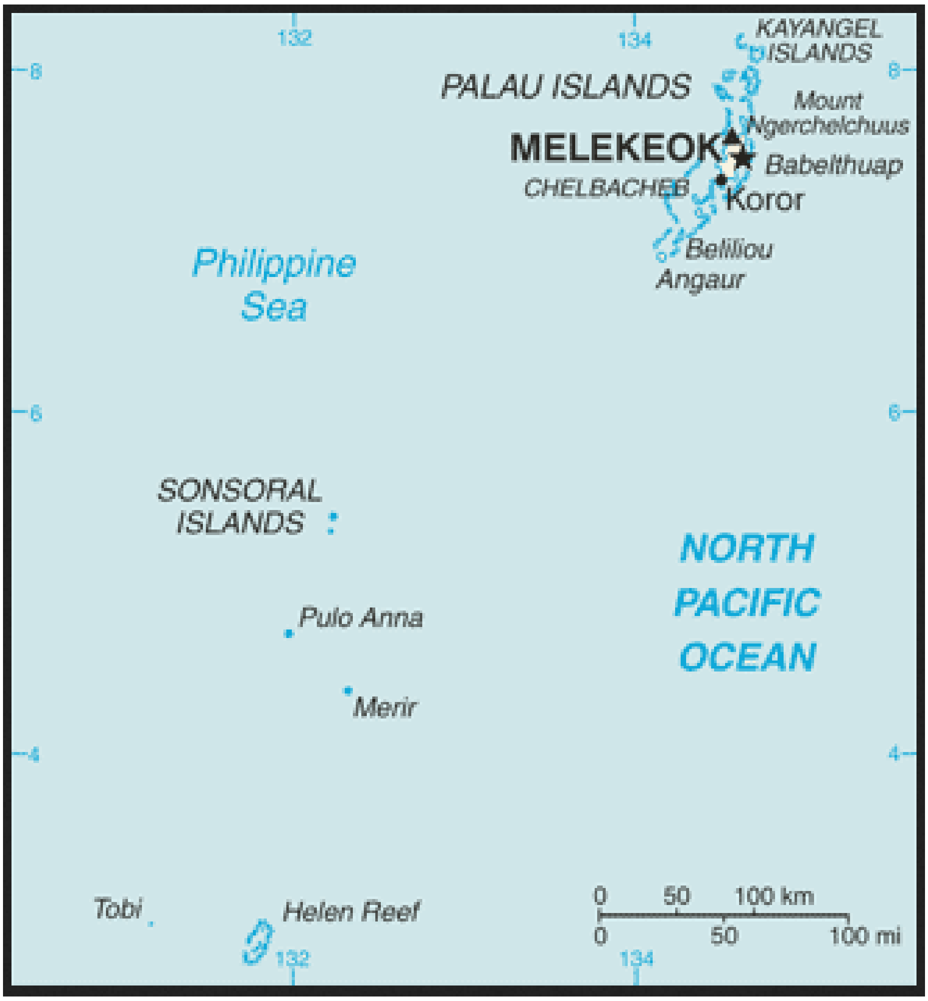

Figure 1 – Geographical Map

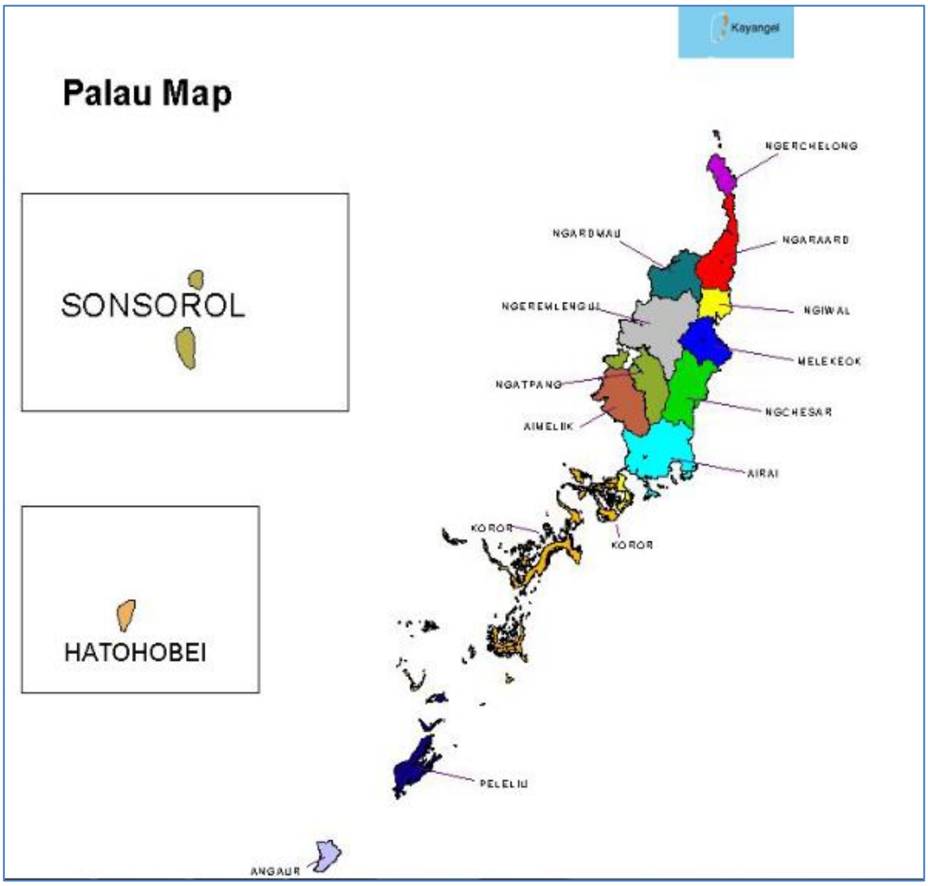

Figure 2 – Palau Map by States

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, including the laboratory results.

Section 5 discusses remedial and management options, both general and for Palau. Section 7 discusses disposal. Section 8 covers cost considerations with a focus on Palau costs, and Section 9 discusses local issues including relevant legislation, programs and policies.

Section 10 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 the appendices. Appendix 1 contains the Terms of Reference for the Study. Appendix 2 contains the organisational details and list of contacts. Appendix 3 contains in-country discussions. Appendix 4 contains the laboratory reports.

2.0 Methodology

2.1 Overview

This survey was based around a field visit to Palau between the 8th and 14th of June 2014. The work carried out during the visit included meetings with key government agencies, area-wide surveys across Koror and Babeldoab, and specific investigations of 35 sites.

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.

2.2 Identification of Target Sites

The primary focus was on residential properties and public buildings that might present the most significant potential risks for public exposures. Therefore, a general survey of common residential construction materials was undertaken during the first two days of the survey.

Thereafter, the surveyors attended meetings with representatives from various government departments, notably the EQPB, Public Works and Ministry of Health (MoH). The representatives provided information regarding asbestos regulations, known state assets containing asbestos and the development of a government policy specific to asbestos.

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

One specific site, the Aiimelik Power Plant had been damaged by fire in November 2011 and demolition work was underway during the survey period. The site was selected for air sampling to ensure that demolition workers were not being exposed to asbestos fibres.

Based on discussions with local government representatives, it is estimated that approximately 70% to 80% of the nation’s government facilities were included in this process and the results are expected to be applicable to the remaining government buildings. Based on aerial photos showing residential settlement patterns, it is estimated that approximately 60% of the residential areas were visited and a clear understanding of the common building materials was reached.

2.3 Site Assessments

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, 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.

2.4 Sample Collection and Analysis

Thirty nine individual facilities / properties were identified as requiring a detailed site assessment due to their age, use, sensitive location or observations of Potentially Asbestos-containing Materials (PACMs). In order to assess if PACM contained asbestos, samples were collected and analysed by a professional accredited laboratory in accordance with international standards.

Samples of 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).

Twenty-four sites contained building materials which could not be confirmed to be asbestos free without further laboratory testing. Samples of the Potentially Asbestos-containing Materials (PACMs) were collected from those 24 sites. The samples were collected in accordance with the following procedures:

- Sampling personnel must 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 PACM were sought first where it will be 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 polythene bag which was then sealed in a second polythene bag.
- Water was sprayed onto the sample area to prevent fibre release after sampling;
- Sampling points were further sealed with masking and PVC tape where necessary;
- Samples were labelled with a unique identifier and in the survey documentation;
- Each sample was noted on a laboratory-provided chain of custody form and secured in a sealable container.

As with any environmental assessment, sampling of a medium, 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 islands, 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.

Air samples were collected from the burnt-out area of the Aiimelik Power Plant site using two Gillian BDX II Abatement Air Samplers and they were set for a flowrate of 2 litres/minute. They were run for at least four hours and a careful record of the run time was kept. The samplers were placed in the centre of the burnt out area. Air filter cassettes were attached to the sampling pumps and after the sampling run the cassettes were sealed and double-bagged.

2.5 Sample Laboratory Analysis

The samples were sent by courier to EMS Laboratories Incorporated (EMS) located in California in the United States of America for analysis. Analysis of the samples was performed by EMS using ‘Polarised Light Microscopy’. According to EMS the analysis method is a semi-quantitative procedure with the detection limit between 0.1-1% by area and dependent upon 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 reports are provided in Appendix 4.

As per Section 2.2 above, two air samples were taken. Airborne asbestos is monitored using NIOSH Method 7400 (NIOSH is the US National Institute for Occupational Safety and Health). The method involves drawing a measured volume of air through a 25 millimetre diameter membrane filter to collect the airborne dust and fibres. The filters were also sent to EMS Laboratories Incorporated (EMS) for analysis using fibre counting by Phase Contrast Microscopy (PCM). This method assures against “false negatives” but will not guarantee against “false positives”. In order to accurately identify asbestos fibres examination using transmission electron microscopy (TEM) is needed.

3.0 Risk Assessment Methodology

3.1 Description

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. They take 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 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 or many. The setting assessment therefore considers the normal occupant activity in that area of the site and the likelihood of disturbance. Each ACM is again scored and these scores are added to those for the material assessment to produce a total score.

3.2 ACM Assessment

UK HSE (2001) MDHS100 recommends the use of an algorithm to carry out the material assessment. The algorithm is a numerical way of taking into account several influencing factors, giving each factor considered a score. The algorithm in MDHS100 considers four parameters that determine the risk from an ACM: that is the ability to release fibres if disturbed. These 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 1.

Table 1: 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

3.3 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 the HSE guidance, 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 or owners at the majority of surveys is 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 was often extremely difficult to quantify through discussion with the building management contacts.

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The three areas of the algorithm adopted when considered risk posed by the ACM;

- Occupant activity
- Likelihood of disturbance
- Human exposure potential

Each of the above parameters are summarised in the following sections.

Occupant activity

The activities carried out in an area will have an impact on the risk assessment. When carrying out a risk assessment the main type of use of an area and the activities taking place within it should be taken into account.

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 is a lower risk than say in a school classroom lined with an exposed asbestos cement roof, which is occupied daily for six hours by 30 pupils and a teacher.

The algorithm adopted for ranking the ACMs setting is shown in Table 2.

Table 2: HSG227 (2002) Priority Assessment Algorithm

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

Table 3: 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
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 Survey Coverage

Information on the population distribution of Palau was provided by the 2005 population census produced by the Office of Planning and Statistics in the Bureau of Budget and Planning. In 2005, Palau had a population of 19,907 living in 4,707 households distributed across a total land area of 444 km^2. Over 77% of the population (15,399 people) live in Koror and Airai which cover an area of only 62 km^2 and are situated nearby to each other in the southern portion of the country.

The survey covered the islands of Koror and Babeldaob. Aerial photographs of the country were reviewed and residential areas identified. Based on aerial photographic evidence of household distribution, it is estimated that approximately 60% of the residential areas on primary islands in Palau were visited during the survey. External visual assessments of building materials were completed in those areas to gain an understanding of the commonly used building materials. Detailed investigations were undertaken when PACMs were observed from the exterior of the property, or when informants indicated that PACMs may be present. The potential therefore exists for asbestos materials to have been present at a greater number of residential properties than would be concluded from this survey, but due to the time constraints of the survey, it would have been unrealistic to undertake exhaustive door to door assessments.

The remainder of the survey consisted of visits to government buildings, including those which were likely to be frequented by large numbers of individuals. The buildings included (but were not limited to) schools, police and fire stations, hospitals and healthcare centres, power stations, water treatment facilities, research centres and government administration buildings. Representatives from the EQPB were asked to recommend as many government facilities as they could, for the surveyors to visit. It is likely that the EQPM representatives recommended the majority of known government facilities frequented by large numbers of individuals. It is possible that some facilities were either forgotten or judged not to be frequented by many individuals.

The number of facilities visited versus the number of known facilities for different categories of government departments are summarised in Table 4.

Table 4: Proportions of Facilities Visited vs. Numbers of Known Facilities.

Facility	Number Visited	Total in Koror and Babeldaob	Percentage Visited (%)
Public Schools	9	16	56
Hospitals and Dispensaries	5	5	100
Administration	8	?	?
Power Plants	2	2	100
Water Treatment	1	1	100
Police and Fire	4	4	100

The visits consisted of an introduction regarding the purpose of the project and a request for a tour of the facilities. A visual assessment of construction materials was then undertaken while being guided through the buildings. A total of 37 government buildings, 1 private commercial site and 1 residential dwelling were the subject of detailed surveys. A staff member of the EQPB collected a sample from another residential property, but was unable to take the asbestos surveyor to the property during the time available. Specific sites visited in Palau are summarised in Table 5 below.

Table 5: Specific Sites Visited in Palau.

Number	Site Name	Suspected PACM?	Samples Collected of PACM?
1	EQPB admin office	Yes	Yes
2	Malakal power plant	Yes	Yes
3	Aimeliik power plant	Yes	Yes
4	Department of Education admin building	No	No
5	Koror public library	Yes	Yes
6	Department of Public Works (Koror and Malakal)	No	No
7	Division of Environmental Health in the Bureau of Public Health under the Ministry of Health	No	No
8	Palau National Hospital	No	No
9	Koror State administration building	Yes	Yes
10	Ministry of Health admin building	No	No
11	Malekeok Fire and Police Station	Yes	Yes
12	Marine law and mariculture facility	Yes	Yes
13	Palau National Museum	Yes	Yes
14	Museum police station and conservation department	No	No
15	Supreme court building	Yes	Yes
16	Palau Community College	Yes	Yes
17	Palau High School	Yes	Yes
18	Residential property in Malekeok	Yes	Yes
19	Ministry of Justice building including Koror police and fire station	No	No
20	Harbour building in Olei	Yes	No
21	Koror Elementary School	Yes	Yes
22	Maris Stella School	No	No
23	Meyungs School	No	No
24	Palau Aquarium and Coral Reef Research Centre including the Department of Conservation admin annex	Yes	Yes
25	Airai water treatment plant	Yes	No
26	Airai health centre	Yes	Yes
27	Ngaremlengui health centre	Yes	No
28	Ngardmau police and fire station	Yes	Yes
29	Ngarchalong health centre	Yes	No
30	Ngarchalong elementary school	No	No

Number	Site Name	Suspected PACM?	Samples Collected of PACM?
31	Malekeok health centre	Yes	Yes
32	Palau Capitol building in Malekeok	No	No
33	Malekeok elementary school	No	No
34	Ngchesar elementary school	No	No
35	Ngaraard elementary school	No	No
36	Ngaremlengui elementary school in Bkulangriil	No	No
37	Shell Garage Workshop	Yes	Yes
38	Roadside in Imetang Village	Yes	Yes
39	Public Reserve in Ngiwal	Yes	Yes

4.2 Site Assessments

The greatest source of asbestos which could be readily identified in Palau was the public water system infrastructure. The Public Works representative and Manager of the Water Treatment Plant, Dave Dengokl, indicated that the majority of the public water supply is distributed through Asbestos Cement (AC) pipes. There has been a culture of reusing / recycling old AC water pipes in residential properties as they make good pillars / poles to support the roofs of shade houses adjacent to residential dwellings. Stockpiles of excavated pipes were sometimes left in village reserves by the Public Works department for members of the public to take and reuse. The recycled AC pipes are sometimes used as property boundary fencing material or pillars for shade houses, which are used for socialising and cooking.

The majority of residential dwellings observed were constructed using plywood, concrete blocks and corrugated iron, and no asbestos-containing materials were observed apart from the pipes mentioned above. Most shade houses were constructed using traditional materials consisting of tree branches as the pillars and woven palm fronds as the roof cladding.

The majority of government owned buildings have been constructed using concrete blocks, with plywood ceilings / internal walls and corrugated iron roofs. Building materials which could contain asbestos in those buildings consisted of acoustic ceiling tiles and vinyl floor tiles.

Special use buildings such as power stations and facilities where backup power generation is required (hospital, aquarium, etc) were found to contain potential sources of asbestos lagging and / or insulation. The exception was the national hospital where no asbestos materials were encountered as fibreglass was used for insulation of the generator and autoclave.

An assessment report was produced for sites where PACM was encountered and sampled. These assessment reports are substantial and are available electronically through SPREP. A total of 39 sites were surveyed and 24 assessment reports were produced.

5.0 Laboratory Results and Findings

5.1 Laboratory Results

A total of 37 samples, including 2 air monitoring samples, were collected in the Palau survey and the presence of asbestos was confirmed in 4 of them. No asbestos was detected in the air monitoring samples. Copies of the laboratory reports are provided in Appendix 4. Two sites were encountered where laboratory testing was not required to confirm the presence of asbestos. They were pipes of a very similar nature to ones that were tested.

The results are summarised in Table 6 below:

Table 6 – Summary of Laboratory Results

Sample No	Location	Type	Result
PA1	Malakeok Pipe	Pipe	Chrysotile 12%
PA2	Ngiwai Pipe	Pipe	Chrysotile 12%
PA3	Capitol Fire Station Ceiling	Ceiling	None Detected
PA4	Ameliik Old Power Station Middle	Air	Below Detection Level
PA5	Ameliik Old Power Station Back	Air	Below Detection Level
PA6	Ameliik Old Power Station Gasket	Gasket	Chrysotile 14%
PA7	Ameliik Old Power Station Dust Residue 1	Dust	None Detected
PA8	Ameliik Old Power Station Dust Residue 2	Dust	None Detected
PA9	Ameliik Old Lagging	Lagging	None Detected
PA10	Ameliik Pump Lagging	Lagging	None Detected
PA11	Shell Petrol Station by Hospital	Waste Board	None Detected
PA12	Exterior Malakal New Building	Roofing and Cladding	Chrysotile 8%
PA13	Malakal New Control Room Wall	Inside Cladding	None Detected
PA14	Malakal Lagging Building 2	Lagging	None Detected
PA15	Large Mitsubishi Units Pipe Cladding Malakal	Lagging	None Detected
1	Airai Health Care Centre	Cladding	None Detected
2	Malekeok Healthcare	Floor Tile	None Detected
3	Ngardmau Fire Station	Ceiling Tile	None Detected
4	Koror Library and Min of Ed	Floor Tile	None Detected

Sample No	Location	Type	Result
5	Koror Elementary School	Floor Tile	None Detected
6	Koror State Building	Ceiling Tile	None Detected
7	Palau National Museum	Ceiling Tile	None Detected
8	Palau Community College Floor	Floor Tile	None Detected
9	Palau Community College Ceiling Tiles	Ceiling Tile	None Detected
10	Palau High School	Ceiling Tile	None Detected
11	Palau Court Building	Ceiling Tile	None Detected
12	Palau International Coral Reef Research Centre	Ceiling Tile	None Detected
13	EQPB Office	Ceiling Tile	None Detected
14	Dominica Ngoriaki's Residence	Floor Tile	None Detected
15	Icebox Mariculture Centre Gift Shop	Wall Covering	None Detected

Sites where the presence of ACM was confirmed are discussed below, together with photos.

1. **Malakal Power Plant** - The generator building at the rear of the power station contains exterior corrugated roofing and cladding that tested positive for asbestos (chrysotile 8%). This was a relatively new building and was about 15 years old. The total area of asbestos material is about 2000m^2. The building is shown in Photo 1 below and is in reasonable condition.

Photo 1 – Malakal Power Station New Generator Building

2. **Palau Water Treatment Plant, Airai** – Quite a large number of old asbestos water pipes (Chrysotile 12%) are stored at the water treatment plant as shown in Photos 2 and 3 below. It is difficult to estimate how many as they are covered by vegetation. The appear to be in reasonable condition although some may be broken, in which case a site clean-up will be needed.


Photos 2 and 3 – Old Asbestos Pipes at Palau Water Treatment Plant

3. **Public Reserve in Ngiwai** – Several asbestos-cement pipes (Chrysotile 12%) were discovered in a public reserve in Ngiwai Village (see Photo 4 below). They are damaged and in poor condition.

Photo 4 – Old Pipes in reserve in Ngiwai Village

4. **Roadside in Imetang Village** – Photo 5 below shows an asbestos-cement pipe (chrysotile 12%) on the side of the road in Imetang Village. There may be other similar pipes in residential areas.

Photo 5 – Asbestos-cement Pipe on Roadside at Imetang Village

5. **Ameliik Power Plant**: The old Ameliik Power Plant burnt down in 2011 and a new power plant has now been constructed next to the old plant. There was a concern that the old burnt-out power plant contained asbestos which would have been a significant problem as fire distributes the asbestos and neighbouring workers, as well as the workers demolishing the old plant, would have been at risk of exposure to asbestos fibres. Two samples of dust residues were taken as well as one sample of the old lagging and one sample of gasket material. In addition air monitoring was carried out in the middle and the back of the burnt out area. All these results were negative except for the gasket sample. Photo 6 below shows the old burnt-out power plant and Photo 7 below shows the insulating material near the entrance.

Photo 6 – Ameliik Old Burnt-out Power Plant

Photo 7 – Insulating Material in old Power Plant

6. **Residential Property in Malekeok:** At a residential property in Malekeok two examples were discovered of asbestos-cement piping (12% Chrysotile) being used for “non-piping” uses. Photo 8 shows concrete-filled asbestos-cement pipes used as roof supports and Photo 9 shows a temporary fence that includes an asbestos-cement pipe.

Photo 8 – Roof Supports **Photo 9 – Part of a Temporary Fence**

5.2 Residences

The 2005 Palau Census stated that there were 4345 houses in Palau. It is unlikely that any houses built since then contained asbestos. A total of 2607 houses in Koror and Babeldaob were inspected by driving by them and no asbestos roofing or cladding was noted. This was 60% of the houses in the country based on the 2005 Census. It is probably reasonably safe to assume, therefore, that no houses in Palau have asbestos roofing or cladding. Statistically, applying a 95% confidence level to a sample this size, it can be said that it would be expected that there would be no more than 52 houses with asbestos cladding. The skewed nature of the survey would also, however, have to be taken into account as only houses in Koror and Babeldaob were surveyed.

One house was noted to have concrete-filled asbestos-cement pipes as roof supports, as noted in Section 4.2 above and this residence also had an asbestos pipe as part of a temporary fence. It is possible that there are other houses with asbestos-cement pipes acting as roof supports.

A total of six floor tiles were tested including floor tiles in one residential dwelling. These tests were all negative.

5.3 Results Discussion

The potential exists for more asbestos cement pipes to be present in some residential properties. However, based on the apparent rarity of the pipes, the number of affected properties is considered likely to be low.

Future sources of asbestos-containing materials are likely to be limited to asbestos cement water pipes which may be excavated when the aging infrastructure is replaced with PVC or HDPE pipes. However, if asbestos regulations are not incorporated into the Palauan legislature, new asbestos-containing products could be imported and used for construction purposes, as happened 15 years ago with the new Malakal Generator Building.

6.0 Risk Assessment

Utilising the algorithms described in Section 3 of this report and based on the laboratory analysis data of ACM samples (where available) as well as observations of the sites visited, the sites are listed in order of priority in Table 7.

Table 7: Risk Ranking Scores

Site Name	Building Material Type	Asbestos Type and %	Risk Ranking Scores		
			ACM	Setting	Total Score
Residential Property, Malekeok	Cement pipe	Chrysotile 12%	4	14	18
Malakal Powerplant	Cement cladding	Chrysotile 8%	4	14	18
Aimeliik Power Plant	Generator gaskets	Chrysotile 14%	5	8	13
Airai Water Treatment Plant	Cement pipe	Chrysotile 12%	4	8	12
Public Reserve, Ngiwal	Cement pipe	Chrysotile 12%	4	6	10
Roadside, Imetang Village	Cement pipe	Chrysotile 12%	4	4	8

The risk assessment scoring and prioritisation presented in Table 7 above indicates that there are 2 moderate risk ACM sites which would benefit from additional ACM management. The 4 remaining sites are considered to present a low to very low risk to occupants and the public in their current state, but can pose greater risks in the future if they are not managed appropriately.

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 3 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 3: ACM Management Flow Chart

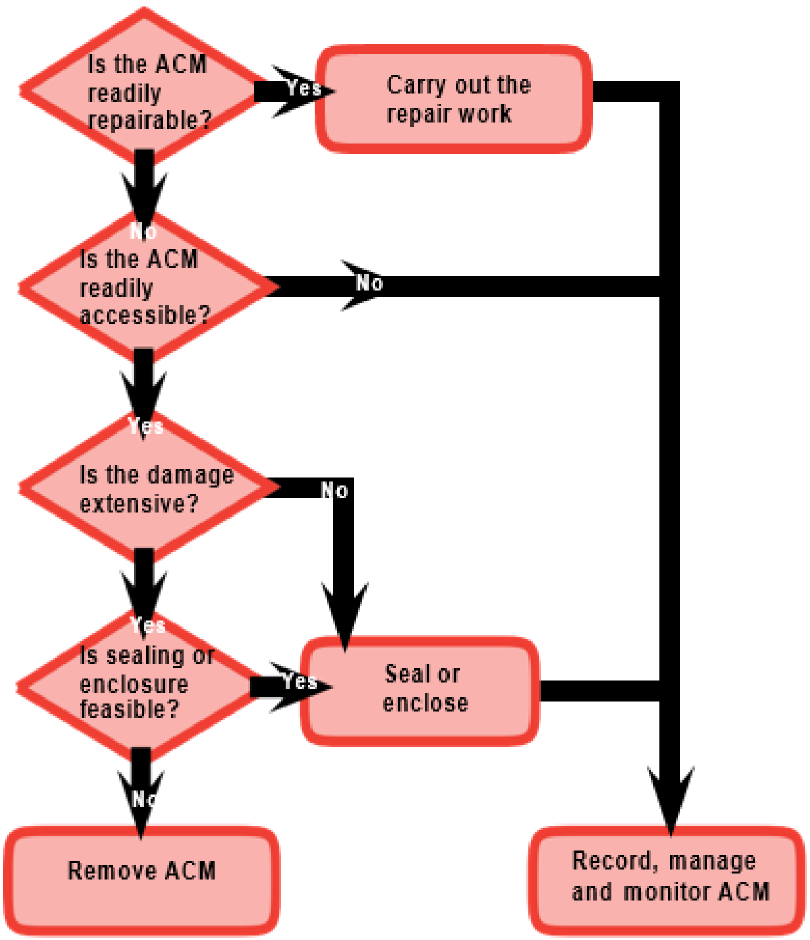

Figure adapted from; UKHSE HSG227 'A Comprehensive Guide to Managing Asbestos in Premises'.

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 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 Figures 4 & 5 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 10 and 11 below. There are special ones for roofing sizes.

Photos 10 and 11: 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.

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 Palau

Table 8 below shows the sites on Palau that returned a positive result for ACM and the most suitable, cost effective remedial options based on the flow chart process described above.

Table 8: Possible Remedial Options for Palau

Location	Type	Recommended Action	Area (m2)	Cost/m2	Total Cost	Risk Ranking
Aimeliik Power Plant	Gaskets	Carefully Remove Gaskets as part of Demolition Process	1	LS	1000	14
Airai Water Treatment Plant	AC Pipes	Remove Pipes to Landfill and Cover	500	LS	5000	13
Public Reserve, Ngiwal	AC Pipes	Remove Pipes to Landfill and Cover	12	LS	500	12
Roadside, Imetang Village	AC Pipe	Remove Pipes to Landfill and Cover	1	LS	200	10

Location	Type	Recommended Action	Area (m2)	Cost/m2	Total Cost	Risk Ranking
Malakal Power Plant	Cladding	Cladding is 15 years old from Japan - Encapsulation is appropriate but need to do both sides	2000	50	100000	8

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 9 below.

Table 9: 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 Appropriate to Palau

Palau has a landfill that is well managed and it is recommended that a special small cell is prepared for the asbestos pipe wastes that are received, as well as any other asbestos wastes, such as from the old power plant.

The large project to encapsulate the asbestos roofs and cladding at the Malakal Power Plant will produce little or no asbestos wastes, unless sections are found that need to be replaced.

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 5). We acknowledge that costs will likely vary according to local conditions but we have cross checked the rates against established rates in New Zealand, and also informally with contractors in other Pacific countries, and believe 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 5 and a summary is presented as follows:

<u>Roof Encapsulation</u>

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.

<u>Cladding Encapsulation</u>

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 5 and a summary is presented as follows:

<u>Roof Removal and Replacement</u>

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 disposal is addressed separately.

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 disposal is addressed separately.

Table 10: 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	

Remediation Method	Cost per m² (face area) $US
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 added as an extra.

10.3 Local Palau Situation

The amount of asbestos to remediate in Palau is quite small but there is potentially a large project to be done, namely the remediation of 2000 m^2 of roofing and cladding at the Malakal Power Station. This building does not have a ceiling (see Photo 12) so encapsulation would provide a cost advantage. Based on the above, the rate of $US46/$m^2$ could be used plus a small contingency for some imported supervision to ensure that asbestos protocols are followed and the work is done safely. A figure of $US50/$m^2$ could therefore be used for a budget cost. One additional advantage of encapsulation is that there is no issue with disposal and also the disposal costs do not need to be factored in. The cost would therefore be 2000 x $US50 = $US100,000. The rough figure of 100,000 m^2 would need to be checked.

Photo 12 – Malakal Power Station Roof Underside

Local contractors could not provide day rates for labour or plant. However, formal quotes for work on the Malakal Power Plant (options to paint the existing cladding or to replace the cladding with steel) were obtained. The costs of materials were obtained by contacting the local hardware store.

Rates obtained from neighbouring countries are provided as an indicative guide to potential costs. These costs exclude personal protective equipment and other consumables required during asbestos removal/repair work. The rates are summarised in Table 10.

Table 10: Costs of Labour and Materials in Palau

Item	Cost (US$)
Rubberised acrylic primer	$115 per 5 Gal
Rubberised acrylic exterior finish	$70 to $115 per 5 Gal
Landfill Disposal	No charge
Labour	$85 per day
Truck with driver	$150 per day

There are numerous variables associated with producing a cost estimate for the management and removal of ACM at the identified properties. Costs would be dependent upon the buildings location and condition of the structure. Where ACM is present, it indicates the building is likely to be at least 30 years old and may require other structural engineering repairs or upgrades prior to removing and replacing the ACM.

The scope would need to be defined on a site by site basis and based on consultation with all of the properties stakeholders.

The other main project that needs to be carried out on Palau is the removal of the asbestos piping found in various locations. These pipes could be taken to the local landfill and covered over. The ones out in the open can be removed easily and transported to the landfill. The pipes at the Palau Water Treatment Plant in Airai will need to be uncovered from the vegetation so the cost may be slightly higher. Any broken pieces, plus contaminated vegetation and soil, will also need to be removed.

The residence with asbestos pipe columns should have the columns encapsulated and the residents should be made aware not to disturb or drill into the asbestos piping wall. If there are any similar situations in other residences then the same will apply.

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 contractors with expertise in asbestos management, repair and removal.

During discussions with the EQPB and the Bureau of Public Works, the topic of potential contractors considered suitable to remove asbestos was discussed. Potential contractors were visited, if possible, and asked whether they were interested in undertaking work such as pickup of asbestos-containing water pipes or painting asbestos-containing materials. The following contractors were identified:

- Surangel's Construction Company (ph: 488 1011 or 488 2251)
- Galaxy Builders (ph: 488 2066)

- KNB Construction Company (ph: 488 2432)

11.0 Review of Relevant Local Issues

11.1 Relevant National Laws and Regulations

Discussions with representatives from the EQPB and MoH indicated that no regulations specific to asbestos have been developed by the Palauan Government. To date, asbestos has been regulated as a hazardous substance under the existing legal framework to prevent general pollution. However, according to representatives from the MoH, work is being undertaken to develop an asbestos policy and regulations.

As already mentioned, Palau is a party to the Basel Convention which will regulate any trans-boundary movement of asbestos waste to any other Basel Convention member countries.

11.2 Relevant National Programmes and Policies

With the exception of the SPREP (2011) 'An Asbestos-Free Pacific: A Regional Strategy and Action Plan' there are currently no national strategies or policies related to asbestos exposure or asbestos removal and management implemented in Palau.

Palau has confirmed its support for the aims and objectives of the PacWaste Project.

The Solid Waste educator, employed under the Bureau of Public Works, indicated that a public awareness campaign would be undertaken when specific asbestos regulations are introduced.

Members of the MoH Division of Environmental Health in the Bureau of Public Health indicated that two of their staff had recently completed training in Korea to enable them to count asbestos fibres using a microscope. They expressed the desire to establish a field lab in Palau which could assess the presence of asbestos in samples, so that risks to public health from asbestos could be assessed on an ongoing basis. Although samples of PACM could be sent to international laboratories for analysis, the MoH in Palau does not have sufficient funding to enable this option. Given the relative rarity of asbestos-containing materials in Palau, the cost of establishing a laboratory in Palau is, however, unlikely to be economically viable relative to using off-island asbestos laboratory services.

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 Palau. Based on an algorithm adopted as part of the risk assessment to prioritise asbestos management, this study has identified that there are two sites in Palau that are considered moderate risk with regard to occupant and public potential exposure to asbestos, namely the new building at the Ameliik Power Plant and the old pipes stockpiled at the Palau Water Treatment Plant in Airai.

The remaining sites identified are considered to present a low risk to human health. The current risk ranking scores for those sites do not, however, cover the potential for the materials to present a greater risk in the future and it is recommended that the materials are treated as presenting the potential for a high risk exposure scenario because members of the public could collect and reuse the materials in a residential setting. One of the sites represents the result of that scenario, where AC pipes have been used to construct a shade house and a property boundary fence.

As no regulations currently exist, the remediation methods can be easily implemented without the need for permits. Asbestos cement water pipes can be collected under specialist supervision and transported to the government landfill for secure disposal. It is recommended that the EQPB and Ministry of Works are invited to assist with the collection and disposal of the materials as a capacity building initiative that will allow the departments to manage similar projects in the future (if required).

It was reassuring to discover that the old burnt-out Power Station at Ameliik was substantially asbestos-free, based on bulk and air samples that were taken. Asbestos was, however, discovered in gasket material and so care still needs to be taken with the demolition process.

There is one major project that needs to be undertaken and that is the remediation of the recently-constructed generator building at the Malakal Power Station. The roofing and cladding is asbestos-containing material and encapsulation using a suitable paint system should be undertaken. The encapsulant needs to be carefully chosen and the project should be regarded as an asbestos project with the use of suitable relevant protocols. There are several local contractors who could undertake this work.

Management procedures should also be put in place prior to and after the Malakal encapsulation has taken place, including methods for maintaining the cladding and roofing to avoid exposure to asbestos fibres.

Suitable legislation should be enacted to prevent any further importation of asbestos into Palau.

12.2 Recommendations

The following recommendations are therefore made:

I. The two main asbestos risks on Palau should be addressed - namely the new building at the Ameliik Power Plant and the old pipes stockpiled at the Palau Water Treatment Plant in Airai.
II. The remaining sites identified are considered to present a low risk to human health, but the asbestos-containing materials are treated as presenting the potential for a high risk

exposure scenario because members of the public could collect and reuse the materials in a residential setting.

III. It would not be difficult to remove and landfill asbestos-cement pipes by roadsides and in village reserves and some have already been identified. Wherever such pipes are identified then they should be removed and landfilled.

IV. Asbestos wastes could be placed in a special cell in the Palau Landfill, and covered over when the wastes are received.

V. One residence has been identified as containing concrete-filled asbestos-cement columns as roof supports (a shade house.) These columns should be encapsulated with a suitable paint system and if others are identified then they should be similarly managed.

VI. The gaskets that tested positive at the old burnt-out power plant at Ameliik indicate that all gaskets should be treated carefully during the demolition process, especially where flanged pipe joints are unbolted.

VII. The EQPB and Ministry of Works should be invited to assist with the collection, disposal and remediation of asbestos-containing materials as a capacity building initiative that will allow the departments to manage similar projects in the future (if required).

VIII. Consideration should be given to carrying out the remediation of the one major project that needs to be undertaken, namely the remediation of the recently-constructed generator building at the Malakal Power Station. The roofing and cladding is asbestos-containing material and encapsulation using a suitable paint system should be undertaken.

IX. The Malakal project should be regarded as an asbestos project with the use of suitable relevant protocols, and the encapsulant should be carefully chosen. There are several local contractors who could undertake this work and it is recommended that prices be obtained from them.

X. Management procedures should also be put in place prior to and after the Malakal encapsulation has taken place, including methods for maintaining the cladding and roofing to avoid exposure to asbestos fibres.

XI. There is likely to be asbestos-cement pipes present in the water reticulation system. Care needs to be given to the maintenance of this system, especially when pipes are removed. Procedures and training are therefore needed for personnel maintaining the reticulation system.

XII. Suitable legislation should be enacted to prevent any further importation of asbestos into Palau.

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, Palau
- 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 Palau took place from 8 to 14 June 2014. The consultants were John O'Grady and Claude Midgley. They were based in Koror but also visited the island of Babeldaob.

The primary agency for liaison was the Palau EQPB, and the following personnel were involved:

Roxane Sengebau, Director of the EQPB

Mengkur Rechelulk, Solid Waste Educator at the Bureau of Public Works

The EQPB officers were very helpful and provided considerable support during the visit.

Numerous other people were visited and considerable assistance was willingly provided. Full contact details are given below.

A2.2. List of Contacts

Roxane Sengebau, Executive Director
Palau Environmental Quality Protection Board, Main Road, Koror
Phone: (680) 488 1639 / 3600 Email: eqpb@palaunet.com

Mengkur Rechelulk, Solid Waste Educator
Bureau of Public Works, Main Road, Koror
Phone: (680) 488 2850 Email: monkwr@yahoo.com

Dave Dengokl, Manager
Water Treatment Plant, Bureau of Public Works, Main Road, Malakal Island.
Phone: (680) 775 8763 Email: bpw@palaunet.com

Patrick Tellei, President
Palau Community College, Main Road, Koror
Phone: (680) 488 1669 Email: tellei@palau.edu

Rosemary Kiep and Rosalita Tadao, Environmental Health Specialists
Ministry of Health Bureau of Public Health, Division of Environmental Health, Malakal Island.
Phone: (680) 488 6073 / 6345 Email: rlitatadao@yahoo.com; rmkiep@gmail.com

Tom Watson, General Manager

Mason's Hardware Do It Centre, Lower Ikelau Road, Koror.
Phone: (680) 488 3670 Email: tom@surangel.com

Wridon Ngarilmau, Safety Officer / Fleet Manager
Palau Public Utilities Company, Main Road, Koror
Phone: (680) 488 3870 Email: wridon@ppuc.com

Jose Arnel Tabing, Senior Civil Engineer
Surangel's Construction Company, Main Road, Koror
Phone: (680) 488 1101 Email: arnel@surangel.com

Appendix 3: Summaries of in-Country Discussions

Roxane Sengebau, Executive Director of the EQPB

The EQPB is responsible for administering the earthmoving regulations of the Palau Government. Specifically, the EQPB regulations cover Erosion and Sediment Control, Discharges of Substances to the Environment and Permitting Proposed Works. The process includes the review of applications, drafting conditions under which works can be undertaken and monitoring work sites to ensure compliance with the Permit Conditions.

Asbestos is managed under the regulations to prohibit the discharge of hazardous substances. However, specific regulations regarding asbestos are proposed and are in the process of being drafted.

Dave Dengokl, Bureau of Public Works

The Bureau of Public Works is responsible for the water and electrical supply for Palau under the government owned Palau Public Utilities Corporation (PPUC). Mr Dengokl indicated that the majority of the reticulated water supply is transferred through AC pipes. Their locations are recorded in a Computer Aided Design (CAD) system which is maintained by the Palau Government Survey Office.

Mr Dengokl indicated that future work on the AC pipes would be completed using industry best practise procedures, if a set of procedures could be supplied to him as there were no staff who had knowledge or training of safe work methods for asbestos-containing materials.

Mr Dengokl also indicated that when the existing pipes were replaced by PVC or HDPE alternatives in the future, the AC pipes would be left in place to minimise their disturbance and potential to result in discharges to the environment. New pipes would be installed near to the existing pipes, with enough clearance that the AC pipes would not be disturbed during future maintenance of the PVC / HDPE infrastructure.

Mengkur Rechelulk, Bureau of Public Works

Mr Rechelulk is responsible for public education with respect to solid waste management. He indicated that a public awareness campaign would be implemented to educate Palauans on identifying PACMs as well as safe handling procedures for disposal at the public landfill.

Rosemary Kiep, Environmental Health Specialist in the MoH

Mrs Kiep provided a short report titled "*A Profile of Asbestos in the Republic of Palau*" published by the World Health Organization in January 2012. The report provides little information regarding the physical locations of PACM, with the exception of mentioning the water reticulation infrastructure.

She indicated that the MoH was in the process of drafting an asbestos policy to improve public health. She also indicated that two members of the Division of Environmental Health had recently received training in Korea to count asbestos fibres using a microscope. The Environmental Health staff are eager to set up a field laboratory to enable ongoing identification of asbestos-containing materials in Palau and suggest it could be of benefit to local neighbouring island nations. They requested funding to enable the laboratory to be established and to train staff on procedures required to manage a laboratory to an appropriate standard.

Tom Watson, General Manager of a hardware store responsible for importing building materials

Mr Watson indicated that most, if not all, products imported for sale in the hardware store are sourced from the USA. He did not expect asbestos to be present in any products as the regulations in the USA prohibit its use.

Captain Jerrod McComb, US Air Force Officer in Charge of the Civic Action Team

The Palau Civic Action Team (CAT) consists of a rotating crew of US military staff who assist, train and supervise local workers to complete projects that improve the public domain. They have a variety of different types of equipment available, including trucks and excavators. Projects are selected from applications made to the CAT using their Request Application forms. The current OIC of the CAT team indicated that asbestos work would not be considered by his organising committee.

Appendix 4: Copies of Laboratory Reports

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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 119 Johnson Rd. West Melton Christchurch NZ	PAGE #:	1 of 3
		REPORT #:	0161570
		PROJECT:	PLM ANALYSIS
CONTACT:	John O'Grady	DATE COLLECTED:	06/08/2014
REFERENCE:	SPREP Asbestos	COLLECTED BY:	
METHOD:	EPA 600/R-93/116	DATE RECEIVED:	06/16/2014
		ANALYSIS DATE:	06/19/2014

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	(%)
0161570-001 PA1	Cream/Brown, Non-homogeneous, Chalky/Powdery, acid, non-friable Note: 26°C	LAYER 1 100%	Chrysotile	12%	Cellulose Fiber Non-Fibrous Material	5% 83%
0161570-002 PA2	Brown, Homogeneous, Chalky, acid, non-friable Note: 26°C	LAYER 1 100%	Chrysotile	12%	Cellulose Fiber Non-Fibrous Material	5% 83%
0161570-003 PA3	White/Gray, Non-homogeneous, Paint/Fibrous, acid/tease, friable Note: 26°C	LAYER 1 100%	None Detected		Cellulose Fiber Fibrous Glass Perlite	35% 30% 15%
0161570-004 PA6	Green/Brown, Non-homogeneous, Fibrous, melt/tease, non-friable Note: 26°C, 1.550	LAYER 1 100%	Chrysotile	14%	Cellulose Fiber Non-Fibrous Material	15% 71%
0161570-005 PA7	White/Black, Non-homogeneous, Chalky/Powdery, crush, non-friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	3% 97%
0161570-006 PA8	Cream/Black, Non-homogeneous, Granular, crush, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Non-Fibrous Material	100%

CUSTOMER:	Contract Environmental	PAGE #:	2 of 3
	119 Johnson Rd. West Melton	REPORT #:	0161570
	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	(%)
0161570-007 PA9	Beige, Homogeneous, Fibrous, tease, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	75% 15% 10%
0161570-008 PA10	Beige, Homogeneous, Fibrous, tease, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	75% 15% 10%
0161570-009 PA11	White, Homogeneous, Fibrous, tease, non-friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	45% 55%
0161570-010 PA12	Gray, Homogeneous, Fibrous, tease, non-friable Note: 26°C, 1.550	LAYER 1 100%	Chrysotile	8%	Cellulose Fiber Non-Fibrous Material	5% 87%
0161570-011 PA13	Cream/Gray, Non-homogeneous, Fibrous/Paint, tease/ash, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Cellulose Fiber Fibrous Glass Perlite	40% 20% 15%
0161570-012 PA14	White, Homogeneous, Fibrous, tease, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	90% 8% 2%
0161570-013 PA15	Yellow, Homogeneous, Fibrous, tease, friable Note: 26°C, 1.550	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	60% 25% 15%

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CUSTOMER:	Contract Environmental	PAGE #:	3 of 3
	119 Johnson Rd. West Melton	REPORT #:	0161570
	Christchurch NZ	PROJECT:	PLM ANALYSIS

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.

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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 119 Johnson Rd. West Melton Christchurch NZ	PAGE #:	1 of 4
		REPORT #:	0161689
		PROJECT:	PLM ANALYSIS
CONTACT:	John O'Grady	DATE COLLECTED:	06/11/2014
REFERENCE:	SPREP PALAU	COLLECTED BY:	
METHOD:	EPA 600/R-93/116	DATE RECEIVED:	06/24/2014
		ANALYSIS DATE:	06/30/2014

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	(%)
0161689-001 1	Airai Heath Center Drywall, White/brown, Non-homogeneous, granular/fibrous, crush, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% 3% 87%
0161689-002 2	Malekeok Healthcare Center LAYER 1 Floor Tile, Beige, Homogeneous, Granular, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 1 95%	None Detected		Non-Fibrous Material	100%
	LAYER 2 Mastic, Brown, Homogeneous, solid, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 2 5%	None Detected		Cellulose Fiber Non-Fibrous Material	<1% 100%
0161689-003 3	Nghardmau fire station Ceiling Tile, white/gray, Non-homogeneous, paint/fibrous, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Fibrous Glass Non-Fibrous Material	60% 15% 25%

CUSTOMER:	Contract Environmental 119 Johnson Rd. West Melton Christchurch NZ	PAGE #: REPORT #: PROJECT:	2 of 4 0161689 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	(%)
0161689-004 4	Koror Libaray LAYER 1 Floor Tile, Blue, Homogeneous, Granular, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 1 95%	None Detected		Cellulose Fiber Non-Fibrous Material	<1% 100%
	LAYER 2 Mastic, Yellow, Homogeneous, solid, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 2 5%	None Detected		Cellulose Fiber Non-Fibrous Material	<1% 100%
	LAYER 3 Roof Tile, White/gray, Non-homogeneous, paint/fibrtous, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 3 100%	None Detected		Cellulose Fiber Non-Fibrous Material	85% 15%
0161689-005 5	Koror Elementary LAYER 1 Floor Tile with paint Top, Gray, Homogeneous, Granular, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 1 50%	None Detected		Non-Fibrous Material	100%
	LAYER 2 Floor Tile, Black, Homogeneous, Granular, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 2 50%	None Detected		Non-Fibrous Material	100%
0161689-006 6	Koror State Bldg Ceiling Tile, White/gray, Non-homogeneous, paint/fibrous, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	50% 30% 20%
0161689-007 7	Palau National Museum Ceiling Tile, white/gray, Non-homogeneous, paint/fibrous, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	50% 30% 20%

CUSTOMER:	Contract Environmental 119 Johnson Rd. West Melton Christchurch NZ	PAGE #: REPORT #: PROJECT:	3 of 4 0161689 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	(%)
0161689-008 8	Palau Community College LAYER 1 Floor Tile, Gray, Homogeneous, Granular, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 1 95%	None Detected		Non-Fibrous Material	100%
	LAYER 2 Mastic, Yellow, Homogeneous, solid, melt, non-friable Note: 26°C, 1.55 Oil	LAYER 2 5%	None Detected		Cellulose Fiber Non-Fibrous Material	<1% 100%
0161689-009 9	Ceiling Tile, Gray/White, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	45% 55%
0161689-010 10	Ceiling Tile, Gray/White, Non-homogeneous, Fibrous, tease, non-friable Note: 28°C, 1.55	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	40% 60%
0161689-011 11	Palau Court bldg Ceiling Tile, Gray, Homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 oil	LAYER 1 100%	None Detected		Fibrous Glass Non-Fibrous Material	75% 25%
0161689-012 12	Palau International center white/tan, Non-homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Fibrous Glass Non-Fibrous Material	60% 40%
0161689-013 13	EQPB Office Ceiling Tile, White/gray, Non-homogeneous, paint/fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	40% 35% 25%

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CUSTOMER:	Contract Environmental 119 Johnson Rd. West Melton Christchurch NZ	PAGE #: REPORT #: PROJECT:	4 of 4 0161689 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	(%)
0161689-014	Dominica Ngonakl's Resid.,Mokko, IDID,Hamlet					
14	LAYER 1 White/gray, Non-homogeneous, paint/fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Fibrous Glass Non-Fibrous Material	85% 15%
	LAYER 2 Drywall, White/brown, Non-homogeneous, granular/fibrous, crush, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 2 95%	None Detected		Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% 2% 88%
	LAYER 3 White, Homogeneous, paint, ash, non-friable Note: 27°C, 1.55 Oil	LAYER 3 10%	None Detected		Non-Fibrous Material	100%
0161689-015 15	Ice box, Mariculture center Wall Covering, white/tan/gray, Non-homogeneous, paint/paint/granular, ash, crush, acid, non-friable Note: 27°C	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	5% 95%

Analyst - JEFF WAN **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.

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Page: 1 of 1

Phase Contrast Microscopy of Air Samples
NIOSH Fiber Count (Method 7400, Issue 2, A Rules)

(Aspect ratio >3:1; Fiber length >5μm; Fields counted: 20 to 100 fields)

AIHA LAB. No:	101634						
Report No:	161571					Filter Type/Size:	MCE/25mm
Client:	Contract Environmental	Attention:	John O'Grady	Date Sampled:	6/6/2014	Filter Area (sqmm):	385
Address:	119 Johnson Rd., W.Melton	Project:	SPREP Asbestos	Date Received:	6/16/2014	Field Area (sqmm):	0.00785
	Christchurch, New Zealand	File Name:	161571 Contract Envir.air.jw	Date Analyzed:	6/18/2014	Mag:	400x

Sample I.D.	Fields Counted	Fibers Counted	Fiber/sqmm	Fiber/Filter	Vol (Lit.)	Fibers/cc	LOD (f/cc)	LOQ (f/cc)	A. S. (f/cc)
PA 4*	100	0	0	0	480.0	< 0.0056	0.0056	0.0817	0.0010
PA 5*	100	2	3	981	480.0	< 0.0056	0.0056	0.0817	0.0010

* Samples with missing volume

N.A. = Not Applicable

N.D. = None Detected

Note: NIOSH 7400 requires 2 field blanks or 10% of the set which ever is greater

Results have been corrected for the field blank or EMS blank if the analyte is detected in the blank.

Samples were received in good condition unless otherwise noted.

Result only pertain to items actually tested.

f/cc = Fibers per cubic centimeter

LOD = LIMIT OF DETECTION (5.5 fiber/100 field)

LOQ = LIMIT OF QUANTITATION (80 fiber/100 field)

A. S. = ANALYTICAL SENSITIVITY (1 fiber/100 field)

INTRA-LABORATORY Sr = 0.23

Analyst
Jeff Wan ______________________

B. M. Kolk, Laboratory Director ______________________

PCM VERSION: 7 (6-2008)

EMS LABORATORIES, INC. 117 West Bellevue Dr., Suite # 3 / Pasadena, CA 91105-2503 / 626-568-4065 / FAX:626-796-5282

Appendix 5: 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

central meridian inc

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

02.12.14

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