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

Status Report

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

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Araspring Ltd
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Cover Photo

The cover photo was taken at the disused Forari Manganese Mine on Efate, Vanuatu. After Cyclone Pam hit Vanuatu in March 2015, several families whose homes were destroyed moved to the disused mine and set up their homes there in the shelter of the old buildings. These buildings and the surrounding land are heavily contaminated with broken and decaying asbestos.

Contact for Report

John O’Grady
Director
Araspring Ltd
1684 Motueka River West Bank Rd
Motueka 7196
New Zealand
Email: jogrady@actrix.co.nz
Phone: +64-21-311532

Executive Summary

The first stage of the PacWaste (Pacific Hazardous Waste) project was a four year (2013-2017), €7.85 million, project funded by the European Union and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP) to improve regional hazardous waste management in 14 Pacific island countries, plus Timor Leste, targeting the priority areas of healthcare waste, asbestos, E-waste and integrated atoll solid waste management. The first stage of this PacWaste project has now all been completed and this report focuses on the asbestos component of the work. It describes how the initial survey was carried out and covers the work covered by the resulting first round of remediation, which was included as part of the first stage work.

The second stage of the PacWaste work is due to start soon and will include further work on the wastes focused on in the first stage, plus a focus on some additional waste streams. This report is being prepared in order to assist in deciding on what further asbestos work needs to be carried out.

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

The initial survey included conducting an inventory of the distribution of asbestos-containing materials (ACMs) in thirteen Pacific island countries, and assessing the risks posed to human health by asbestos. The initial remediation work focused on high risk facilities such as schools and hospitals in priority countries.

The PacWaste first stage asbestos work aimed to meet part of the objectives of SPREP'S Pacific Regional Solid Waste Management Strategy 2010–2015, including the strategy set out in the earlier SPREP report 'An Asbestos Free Pacific: A Regional Strategy and Action Plan 2011'.

The thirteen Pacific Island countries that were included in the survey are (in alphabetical order):

- Cook Islands
- Fiji
- Federated States of Micronesia (FSM) – the four states are Yap, Chuuk, Pohnpei and Kosrae
- Kiribati
- Nauru
- Niue
- Palau

- Republic of Marshall Islands (RMI)
- Samoa
- Solomon Islands
- Tonga
- Tuvalu
- Vanuatu

These countries cover a very wide geographical area. They are all subject to hot temperatures and often (but not always) frequent rainfall and occasional cyclones, which are referred to as typhoons in the Northern Pacific. Some at least are not very well resourced in terms of wealth and infrastructure and are therefore not well-equipped to deal with the problems presented by asbestos that is frequently found in a decaying condition.

As a result of the survey it was decided to call tenders to carry out remedial work in the following countries:

- Cook Islands
- Fiji
- Nauru
- Tonga
- Vanuatu

The remediation work chosen to be undertaken in the tendered work was selected as a result of a prioritizing exercise carried out on findings from the initial survey, and mainly focused on schools and hospitals. The Greek firm PolyEco Group carried out the tendered work in Cook Islands, Nauru, Tonga and Vanuatu and the New Zealand firm Contract Environmental Ltd (CEL) carried out the work in Fiji. CEL was the company who also carried out the initial survey work.

In addition to the tendered work, CEL carried out the following further work as part of the remediation phase:

- Cleaning up an asbestos contaminated site resulting from fire in an old hospital in Gizo
- Asbestos training and some removal in Kiribati.
- Asbestos training in Nauru
- Carrying out an asbestos-contaminated soil investigation at the International School in Suva (ISS).

Various methods were used in the extensive survey including the use of a tablet-based application to collect data. A statistical approach was taken to assess the incidence of residential asbestos.

The samples collected were mostly bulk (solid) samples, although some air and wipe samples were also collected. Strict methods were followed for the collection of samples and almost all laboratory samples were sent by courier to EMS Laboratories Incorporated (EMS) located in Pasadena, California, United States of America.

A systematic risk assessment approach was adopted in order to assess the risks that the identified asbestos-containing material presented to site occupants and if applicable the public. The risk assessment adopted was that provided by the UK HSE guidance document 'Methods for the Determination of Hazardous Substances (MDHS100) Surveying, Sampling and Assessment of Asbestos-Containing Materials (2001)' and UK HSE guidance document 'A Comprehensive Guide to Managing Asbestos in Premises (2002)'. The documents present a simple scoring systems to allow an assessment of the risks to health from ACMs. It takes into account not only the condition of the asbestos, but the likelihood of people being exposed to the fibres.

The following general comments can be made about the findings:

- Large numbers of houses (by percentage) have asbestos building materials in two countries, namely Nauru and Niue. Most of the houses in Niue with asbestos are abandoned houses and a program is in place to remove this asbestos. Nauru has also commenced a programme to replace asbestos in their houses.
- The Cook Islands, Kiribati, Solomon Islands, Tonga and Tuvalu have moderate amounts of asbestos building materials in houses and in most cases cladding only.
- Several countries have none or very low quantities of asbestos in houses. Fiji and RMI probably have almost none and FSM, Palau, Samoa and Vanuatu have very little asbestos in houses.
- The above conclusions are based on surveys done on a limited number of islands (namely the main islands). Nauru and Niue are single island states so the information can be relied on. For the countries, that have numerous outer islands, however, the above conclusions regarding asbestos in residences may need to be treated with some caution.
- The countries with the largest amount of non-residential asbestos locations are Nauru, Niue, Cook Islands, Tonga and Vanuatu. Fiji has relatively few such locations.
- Banaba, which is part of Kiribati, presents a special case regarding asbestos remediation. The amount of old and damaged asbestos present on Kiribati is huge and a substantial remediation exercise is clearly needed. The logistical problems of such a clean-up are also huge, however, as there is no airport and no regular shipping.
- Most of the asbestos identified was in the category of non-friable building materials (mainly roofing and cladding). There were very few examples of friable

asbestos. It should be noted, however, that much of the non-friable asbestos identified was in bad or very bad condition and is liable to be releasing asbestos fibres. It could therefore be considered at least partially friable in this state.

- The types of asbestos problems are relatively similar from country to country although there are very significant variations in incidence and quantity of asbestos.
- The predominant form of asbestos is Chrysotile (White) Asbestos, although incidences of Amosite (Brown) Asbestos and Crocidolite (Blue) Asbestos do occur occasionally.
- Labour rates are similar from country to country.
- 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.
- The cost of materials in most countries is similar as almost all materials need to be imported from supplier countries with similar pricing structures.
- 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, Australia and New Zealand.
- 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.
- 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.

Methods of asbestos management were examined in some detail. Much can be done with management of the asbestos while it is still in place, including training as necessary. If remediation is undertaken then removal is preferred although encapsulation is cost-effective, particularly with cladding if it is in good condition.

Disposal was also considered in some detail including with reference to the relevant international conventions. Local land disposal (burial) is preferred if it is locally acceptable and can be done without causing environmental problems. Disposal at sea is legal in relation to the relevant conventions, provided the required conditions are followed, but is not the preferred option. Export to other countries is acceptable but expensive. Australia and New Zealand are the preferred options and quite large amounts of asbestos waste have already been exported to New Zealand in particular.

Remediation costings were developed for various scenarios in order to provide cost estimates to aid decision-making. These costings were based on scenarios priced up in conjunction with a local contractor from Nauru. It was considered that these costings could be extended to other locations in the Pacific as the cost elements were similar.

The following lessons were learnt from the remediation component of PacWaste Stage One.

- The tendering process was quite rushed and was based on short timeframes for tender submission. Better outcomes in terms of price and quality of work may have been achieved with longer timeframes.
- In addition the work was not specified in detail at the tendering stage including the standard that needed to be achieved in terms of following appropriate asbestos management protocols.
- It should be necessary to prepare a detailed asbestos work plan for each project before starting. This work plan is also known as an "Asbestos Removal Control Plan (ARCP)" and this plan should be made available to SPREP and also local environmental /health agencies on request.
- No independent assessment was carried out of the work done, including the need to have an independent asbestos clearance report to ensure that no asbestos hazards remain on site.
- Local workers were widely used which proved cost effective and enabled necessary skills to be transferred to local people in a practical way.
- In future, however, it should be necessary to prove that the local workers have been properly trained and that they are supplied with all the correct PPE.
- Pre-start medical inspections should also be carried out on all local staff used and evidence of these medical inspections should be provided to SPREP.
- Air monitoring should be carried out during the project and clearance air monitoring after job completion, in the cases of large projects or any projects involving friable asbestos. The definition of "friable asbestos" should include any badly decayed "non-friable asbestos" that may be releasing asbestos fibres.
- Better coordination with local agencies is needed, and in particular, proper advance notice to affected stakeholders of the work to be carried out and when.
- Disposal methodologies need to be agreed with local agencies prior to commencing work and in fact this may need to be resolved at the tendering stage as disposal costs could impact significantly on the overall job costs.
- Availability of information for scoping the work is limited, and this needs to be specified as carefully as possible. In some cases of large jobs, visits may be needed to potential job-sites and further sampling and analytical work may be needed.
- There needs to be a robust system in place for processing cost variations, as it is difficult to determine accurately the cost of the jobs at the tendering stage and

unexpected problems and situations may be encountered, once the job is commenced.

A list was developed of non-residential Sites to be considered for remediation in Stage Two of the PacWaste Project. This list was developed from the risk rankings assigned to the various sites, and of course excluded sites that had already been remediated. Privately-owned sites were also excluded except for two high risk sites and three orphan sites. The total value of this work amounts to an estimated $US2.9M.

Banaba sites were excluded due to the very high cost and logistical difficulties. A preliminary estimate is that the cost of removing asbestos from Banaba could be in excess of $US10M. It is also estimated that a detailed report that examines remediation methodologies and costings could be prepared for around $US80,000.

The remediation of all the residential sites in the Pacific would be very expensive and an approximate figure of $US40M has been developed. The problem of asbestos in residential sites needs to be addressed as effectively as possible, however, as it presents considerable potential for health problems. Training and education are needed, as well as more surveys, and possibly subsidies to address the worst situations.

The report presents a detailed discussion of the main issues and also makes the following recommendations:

I. It is recommended that asbestos is treated as a high priority issue in the Pacific as it has the potential to cause a range of asbestos-related diseases. The ones that are of most concern are lung cancer (which is aggravated by smoking) and mesothelioma.
II. The risk posed by asbestos can be effectively quantified and managed. It is therefore recommended that a programme of dealing with asbestos is set in place and implemented in all the countries covered by the PacWaste Survey.
III. The asbestos management programme should include the removal of asbestos where practicable and especially where it presents a significant risk as assessed by the risk ranking score. If the asbestos is to stay in place for the time being then it should be managed safely in a way that fibre production is minimised. Encapsulation should be considered, at least as a temporary measure.
IV. Non-residential priority sites to be remediated have been identified for the second stage of the PacWaste project. The total value of this work is estimated to be approximately $US2.9M. As many of these locations as practicable should be remediated, within the available budget.
V. Careful attention needs to be paid to the “lessons learnt” from the remediation work carried out in PacWaste Stage 1. This includes a better tendering process, better controls on the work including possible independent assessment and review, better management of local workers, and better scoping of the work to be done.

VI. Additional funding may be needed and Disaster Risk Reduction (DRR) should be one of the drivers in seeking such funding as it is much cheaper to deal with asbestos before a disaster such as a cyclone than before the disaster. Asbestos-damaged houses and asbestos debris can cause major problems in post-disaster scenarios and this needs to be clearly acknowledged in any programme to manage asbestos risks.
VII. A special focus is also needed on residential dwellings as at least 80% of asbestos identified is contained in residential dwellings. This is often in deteriorating condition and people living in these dwellings are at real risk of contracting asbestos-related diseases. Some PacWaste Stage Two funding could be made available to assist with remediating residential dwellings, or at least enabling the problem to be better managed.
VIII. A programme of testing cladding in residential dwellings would provide some clarity as to which houses are at risk. The programme should include clearly identifying visually which houses have asbestos roofs.
IX. At the very least, residential houses should be targeted by an awareness-raising campaign that aims to educate and set in place measures to reduce the risks of asbestos-related diseases where possible.
X. Financial assistance with remediation of residential houses could take the form of subsidies available to remediate houses considered most at risk, by removing or encapsulating the asbestos as appropriate.
XI. The matter of disposal of asbestos wastes needs to be addressed in each country and the focus should be placed on local disposal if possible, with suitable measures in place to manage such disposal. If local disposal is inappropriate then assistance should be provided to enable the export of asbestos wastes.
XII. In all cases where there is potential for people to be exposed to asbestos fibres, then before asbestos remediation takes place (and after if all the asbestos is not removed) suitable asbestos management practices and procedures should be set in place. These practices and procedures would deal with the ongoing risk posed to human health by asbestos exposure. This should be accompanied by an appropriate education and training programme.
XIII. Legislation should be enacted in each country to enable the above asbestos work to be carried out and to enable effective management of asbestos in each country, including setting up a trained regulatory team and putting in place systems for notifying regulatory agencies that asbestos removal work is being carried out.
XIV. Legislation is also needed in each country to prevent the import of new asbestos products that will only continue the problem. SPREP could assist in this matter by drafting model legislation to enable bans to take place.
XV. Banaba is a special case due to the large logistical difficulties involved. It represents a huge legacy of deteriorating asbestos materials and waste, however, and this matter should be addressed by a detailed study of the options available for addressing the asbestos problem. This could be done in

conjunction with addressing all the other legacy issues on Banaba arising from the former phosphate industry.

Definitions

ACM: “Asbestos Containing Material” – i.e. 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.
ARCP: Asbestos Management Control Plan
CEL: Contract Environmental Limited
Chrysotile: White Asbestos
Crocidolite: Blue Asbestos
DRR: Disaster Risk Reduction
EMS: EMS Laboratories Incorporated
External: Refers to the top or outside of roof sheeting or the outside of building/wall cladding
Friable: With respect to asbestos-containing material, means able to be crumbled, pulverised or reduced to powder by hand pressure when dry, and includes non-bonded asbestos fabric
GPS: Global Positioning System
Hazard: Is a potential to cause harm
IANZ: International Accreditation New Zealand
Internal: Refers to the underside of roof sheeting, or the inside of building/wall sheeting and structures therein
MDHS100: Methods for the determination of hazardous substances, surveying, sampling and assessment of asbestos-containing materials
Non-Friable: With respect to asbestos containing material means unable to be crumbled, pulverised or reduced to powder by hand pressure when dry
PACM: “Presumed Asbestos Containing Material” – ie any material presumed to contain asbestos, based on observation and knowledge of other relevant factors
PPE: Personal Protective Equipment
Practicable: Able to be done / put into practice having regard to:

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

Risk: Is the likelihood of illness or disease arising from exposure to airborne asbestos fibres
SMF: Synthetic Mineral Fibres
SPREP: Secretariat of the Pacific Regional Environment Programme

Contents

1.0 Introduction

1.1 PacWaste Project

The first stage of the PacWaste (Pacific Hazardous Waste) project was a four year (2013-2017), €7.85 million, project funded by the European Union and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP) to improve regional hazardous waste management in 14 Pacific island countries, plus Timor Leste, targeting the priority areas of healthcare waste, asbestos, E-waste and integrated atoll solid waste management. The first stage of this PacWaste project has now all been completed and this report focuses on the asbestos component of the work. It describes how the initial survey was carried out and covers the work done by the resulting first round of remediation, which was included as part of the first stage work.

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The initial survey included conducting an inventory of the distribution of asbestos-containing materials (ACMs) in thirteen Pacific island countries, and assessing the risks posed to human health by asbestos. The initial remediation work focused on high risk facilities such as schools and hospitals in priority countries.

The PacWaste first stage asbestos work aimed to meet part of the objectives of SPREP'S Pacific Regional Solid Waste Management Strategy 2010–2015, including the strategy set out in the earlier SPREP report 'An Asbestos Free Pacific: A Regional Strategy and Action Plan 2011'.

1.2 Purpose of the Survey Work

The objectives of the survey are summarised as follows:

- To assess the status of, and management options for Asbestos Containing Materials (ACM) throughout the Pacific region; and

- To develop recommendations for future management interventions, including a prioritised list of target locations.

The survey aimed therefore to assess to what extent asbestos is a problem in the Pacific in terms of its frequency of use, the type of asbestos and the situation and state in which it is found. This raw data is then able to be interpreted to arrive at an action plan to address the problems that have been discovered.

1.3 Scope of Work

A copy of the Terms of Reference for the survey work is contained 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*

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.

1.4 Pacific Countries Surveyed

The thirteen Pacific Island countries that were included in the survey are (in alphabetical order):

- Cook Islands
- Fiji

- Federated States of Micronesia (FSM) – the four states are Yap, Chuuk, Pohnpei and Kosrae
- Kiribati
- Nauru
- Niue
- Palau
- Republic of Marshall Islands (RMI)
- Samoa
- Solomon Islands
- Tonga
- Tuvalu
- Vanuatu

These countries cover a very wide geographical area as shown in Figure 1 below. They are all subject to hot temperatures and often (but not always) frequent rainfall and occasional cyclones, which are referred to as typhoons in the Northern Pacific. Some at least are not very well resourced in terms of wealth and infrastructure and are therefore not well-equipped to deal with the problems presented by asbestos that is frequently found in a decaying condition.

Figure 1 – Map of the Pacific Region

1.5 Remedial Work

As a result of the survey it was decided to call tenders to carry out remedial work in the following countries:

- Cook Islands
- Fiji
- Nauru
- Tonga
- Vanuatu

The remediation work chosen to be undertaken in the tendered work was selected as a result of a prioritizing exercise carried out on findings from the initial survey, and mainly focused on schools and hospitals, although some other high risk sites were dealt with such as the old prison on Nauru. The work carried out largely followed the work specified in the tender, although some variations were necessary as a result of on-the-ground investigations once the work was due to commence in the various countries.

The Greek firm PolyEco Group carried out the tendered work in Cook Islands, Nauru, Tonga and Vanuatu and the New Zealand firm Contract Environmental Ltd (CEL) carried out the work in Fiji. CEL was the company who also carried out the initial survey work.

In addition to the tendered work, CEL carried out the following further work as part of the remediation phase:

- Cleaning up an asbestos contaminated site resulting from fire in an old hospital in Gizo
- Asbestos training in Kiribati and the removal and replacement of asbestos sunshades on the MELAD Building in Bairiki.
- Asbestos training in Nauru
- Carrying out an asbestos-contaminated soil investigation at the International School in Suva (ISS). This project developed into a full-scale asbestos clean-up that was funded by the ISS.

1.6 Report Content and Layout

Section 2 of this report gives details of the methodology used for the survey work in each of the thirteen countries, including the approach used for determining the survey coverage, the identification of specific target sites, and the procedures for site inspections and data capture.

Section 3 describes the data collection and analyses.

The relative importance of different sites was assessed using a risk assessment methodology, which is described in section 4.

The findings of the survey are presented in section 5 of the report for each of the thirteen countries, with the residential results described separately from the non-residential results.

Section 6 provides a generic discussion of possible management options for ACMs, and this is followed in section 7 by an analysis of the most appropriate options for those ACMs identified in the various countries.

Section 8 covers disposal issues.

Cost considerations are presented in Section 9, including the basis for arriving at the costs.

Section 10 of the report addresses the work completed as part of the remediation component of PacWaste Stage 1 and Section 11 describes the lessons learnt from the remediation work.

Section 12 presents the non-residential priority sites still to be remediated, including cost estimates and Section 13 estimates the costs of the remediation of the residential sites.

Section 14 contains a discussion of the main asbestos issues and Section 15 presents the recommended actions.

Additional supporting information is given in four appendices.

2.0 Survey Methodology

2.1 Pre-Survey Desk Study

The survey work undertaken during the country visits included meetings with key government agencies, area-wide surveys across the main islands of population and specific investigations of locations with asbestos building materials, and a survey of residences.

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

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

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

Any relevant reports were read and assessed as well. For example in Tonga the following reports were studied:

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

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

Summaries of relevant reports were generally provided in an appendix.

2.2 Residential Survey Coverage

A statistical approach was adopted for the residential part of the survey. The reasons for a statistical approach are the number of residential properties in each country and the logistical difficulties in trying to visually assess these within a very limited time frame. The notion of simply being able to drive around an island and make a quick assessment of the types of building materials in use may work fine for, say, a few hundred properties. However, the resulting estimates of the total numbers of asbestos-containing properties will have a very high level of uncertainty that, on all but the smaller islands will make the results meaningless.

For this survey, there are five countries with populations in the range of 1500 to 30,000 people, five with 30,000 to 300,000 and one (Fiji) with almost 900,000. However it should be noted that FSM (103,000) was being assessed by individual states, so these states individually fell into the smallest population group.

These population figures can be translated into approximate numbers of houses using Samoa as an example: the 2011 census for Samoa reported a population of 187,820 people spread across 26,205 households. These ‘households’ may not exactly match with numbers of houses but they should be quite close. The average household size for Samoa was 7 people, and if we apply that factor to all other countries, the different population ranges given above convert to house numbers of (approx.) 215 to 4300, 4300 to 43,000 and 123,000 (Fiji). Realistically, a quick drive-round assessment may work for the numbers of houses in the smallest group of countries, but it is never going to be realistic in the mid-range group, or in Fiji.

The chosen statistical approach is basically the same as that commonly used in household marketing surveys, political polls and the like. For a specified total population size you calculate the required sample numbers required to give a target level of uncertainty, or conversely, you can determine the uncertainty level associated with an actual sample number. The on-line calculator used in the surveys was set out in http://www.surveysystem.com/sscalc.htm).

The typical numbers can be illustrated by the following examples:

> It appears that the default criteria that most organisations work to is a 95% confidence level and 3.5% margin of error – these help to keep the sample numbers to a manageable level while at the same time keeping the margin of error reasonably small.

Applying these criteria to Samoa, with 26,205 houses, the minimum number of houses that should be sampled is 761. If that was the number of houses actually viewed and, say 275 of them were assessed as potentially containing ACMs we could say that we were 95% confident that the total number of PACM houses in Samoa was between 9,139 and 9,801 (26,205 x 275/761 -=9,470 +/- 3.5%).

Alternatively, if we managed to view 2000 houses in Samoa and found 723 of them were PACMs (723/2000 is the same fraction as 275/761), the margin of error would be only 2.1% and we would be 95% confident that the total number of ACMs was between 9,271 and 9,669 (9,470 +/- 2.1%).

The target sample size is not drastically affected by population numbers, once you get over about 20,000. For Fiji, the target size is only 783. Conversely for very small population numbers the target sample numbers rapidly move towards 100% of the total population; eg. for 215 house in Niue, we would have to sample 167 of those to meet the 95/3.5% criteria.

The use of this statistical approach required that a random method be used for selecting samples.

2.3 Non-Residential Survey Coverage

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

The asbestos surveys had three main objectives:

- As far as reasonably practicable within the time available, to record the location, extent and product type of any presumed or known ACMs.
- To inspect and record information on the accessibility, condition and surface treatment of any presumed or known ACMs based on worst case scenarios.
- To determine and record the asbestos type, either by collecting representative samples of suspect materials for laboratory identification, or by making a presumption based on the building age, product type and its appearance.

2.4 Site Assessment Data Capture

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

The use of the application ensured that data was collected in a uniform manner across all of the surveyed countries regardless of the survey team members. Copies of all of the individual site assessment reports from the tablets for each country are available via SPREP.

3.0 Laboratory Analysis and Methodology

Almost all laboratory samples were sent by courier to EMS Laboratories Incorporated (EMS) located in Pasadena, California, United States of America. The exceptions were the two air samples that were taken in Banaba and the three samples collected during the Emergency RON Hospital clean-up. These five samples were sent to Dowdell and Associates in New Zealand.

An example of the EMS laboratory reports collected for one country, i.e. Niue, is presented in Appendix 2. Niue has been chosen as laboratory reports are the three different kinds are shown – namely bulk analyses, air sample analyses and swab sample analyses.

3.1 Sample Collection

3.1.1 Bulk Sample Collection

Over 500 bulk samples were taken of suspected PACM. Samples were collected only 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 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).

As with any environmental assessment, sampling of a media, in this case building material, can vary both spatially and temporally. 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.

The samples were collected in accordance with the following procedure;

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

3.1.2 Air Sample Collection

Air samples were collected at the following locations:

- Palau (burnt-out Power Station) – two samples
- Kiribati where two samples were collected on the island of Banaba
- Nauru where 77 samples were collected from various locations and three samples were collected during the emergency clean-up at the RON Hospital
- Niue where 12 samples were collected from various locations

The air sampling pumps were hired from the New Zealand Air Monitoring Company CBL Air Monitoring Ltd. The pumps were all Gillian BDX II Abatement Air Samplers and they were set for standard flowrate. They were all run for at least four hours and a careful record of the run time was kept. The air sampling pumps were placed on tripods or at convenient locations where they could be secured with tape – see photos below that were taken in Nauru. Air filter cassettes were attached to the sampling pumps and after each sampling run the cassettes were sealed and double-bagged.

Air Sample Pump on Tripod

Air Sample Pump on Fence

3.1.3 Swab Sample Collection

A total of 95 swab samples (also known as wipe samples) were collected on Nauru and 6 swab samples were collected on Niue. No swab samples were collected in any other countries.

The swab area in each case was 100 mm x 100 mm and was marked out using a template. A horizontal surface was generally chosen. Some swab samples were also taken from air conditioning units. PPE was worn where appropriate.
The swab collection procedure is as follows:

a. Mark off a 100mmx100mm square with masking tape.
b. Unfold wipe (about 150mm square).
c. Wipe the square.
d. Fold in half so that any debris is retained inside the fold.
e. Place in polythene sample bag, seal and label.
f. Place in another polythene sample bag.

The photos below show examples of taking swab samples.

Swab Sample Template

Swab Sample Air-Conditioner

3.2 Sample Analysis

3.2.1 Bulk Sample 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.

It is notable that the EMS results show the following information:

- Type of asbestos – usually chrysotile (white), amosite (brown) and crocidolite (blue)
- The percentage of each type in the sample
- An indication of the nature of the non-asbestos component of the sample.

As with any environmental assessment, sampling of a media, in this case building material, can vary widely depending on when and where the sample is taken. Due to the wide scope of the survey including all residential, public and commercial buildings on the island, only a limited number of samples were collected. The collection of samples was based on the aforementioned considerations but also with the project scope in mind. Where similar building materials were encountered at numerous sites, a single sample was considered sufficient to be used in order to draw conclusions. 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. It was also evident that all asbestos-like roofing material on the island was in fact asbestos. The samples taken indicate that no roofing material was used on the island that looked like asbestos but was not in fact asbestos.

3.2.2 Air Sample Analysis

Analysis of the samples was performed by EMS using Phase Contrast Microscopy – NIOSH Fiber Count (Method 7400, Issue 2, A Rules). A further 9 samples from Nauru were analysed by Transmission Electron Microscopy.

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 are then sent to a laboratory for analysis using fibre counting by Phase Contrast Microscopy (PCM). This method will assure 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.

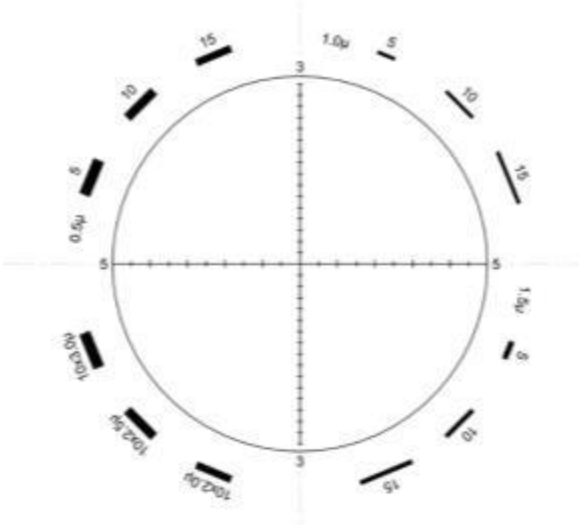
In the laboratory an approximately 90° wedge is cut from the filter and mounted on a microscope slide for examination at 400x magnification using phase-contrast microscopy. The eyepiece of the microscope is fitted with a standard graticule, which is illustrated in Figure 2 below. The circle on the graticule has a projected diameter of 100 microns which covers only a very small fraction (~ 1/50,000) of the exposed surface of the membrane filter. The area covered by the graticule is referred to as a 'field'.

For fibre counting, the analyst positions the graticule near the tip of the filter wedge and then moves progressively up and down, and across the filter, while randomly selecting fields for examination. A minimum of 20 fields must be counted and the counting stops when either 100 fibres have been counted or 100 fields have been examined – whichever occurs first.

This method counts **all** fibres that are 3 times as long as they are wide and at least 5 microns in length. The marks around the edge of the graticule illustrate the different types of fibre shapes that would comply with these criteria. The results are reported as total fibres per 100 fields, which is then converted progressively by calculation to fibres per mm^2 of filter, total fibres per filter, and fibres per cubic centimetre of air sampled. The analytical sensitivity of the method is 1 fibre per field. However, the results are subject to a degree of variability because only a fraction of the filter is being examined, and the fibres are not evenly distributed across all fields. There may also be variability between different analysts because the fibres are sometimes difficult to identify, especially in the presence of other dust particles.

Controlled studies using multiple analysts have determined that the statistical limit of detection is typically about 5.5 fibres per 100 fields, or 7 fibres per mm^2 of filter.

Figure 2: Eyepiece Graticule used for Asbestos Fibre Counting.



3.2.3 Swab Sample 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 carried out using the method described in ASTM 6480 — "Standard Test Method for Wipe Sampling of Surfaces, Indirect Preparation, and Analysis for Asbestos Structure Number Concentration by Transmission Electron Microscopy"

Method ASTM 6480 is used to identify asbestos in samples wiped from surfaces. The method provides the concentration of asbestos structures per unit area of sampled surface.

Asbestos is identified by transmission electron microscopy (TEM) for morphology, by electron diffraction (ED) for crystalline composition and by energy dispersive x-ray analysis (EDXA) for elemental composition. This method defines the type of asbestos present. The method incorporates all asbestos fibers equal or greater than 0.5µm in length.

The analytical sensitivity is reported in asbestos structures per square centimeter and is equivalent to counting one asbestos structure in the analysis. The limit of detection for a single sided distribution is 2.99 times the analytical sensitivity.

Asbestos structures are defined as isolated fibers, bundles composed of 3 or more parallel fibers closer than one fiber diameter, clusters that are intermixed fibers with no single fiber isolated from the group, and matrix in which fibers or bundles are attached or partially concealed by non-fibrous particles. In the method, the surface of known area (100 cm^2 for these samples) is wiped to collect the samples.

The sample is transferred from the wipe to a fiber-free aqueous solution of known volume. To obtain a suitable loading of particulates for TEM examination, aliquots of the suspension are filtered through a membrane filter and transferred to a TEM grid using the direct transfer method. The asbestiform structures are identified, sized and counted by TEM at 18,000X magnification and identified by ED and EDXA.

In these samples, the particulate interferences would have resulted in very poor analytical sensitivities if the analyses were made from the initial aliquots. The membrane filters from the initial aliquots were plasma ashed to remove the heavy organic constituents, washed and acid treated to remove the salts and ubiquitous calcium phosphate on Nauru and then prepared for TEM analysis.

The ASTM 6480 method does not describe procedures for the evaluation of the relationship between asbestos sampled from a surface and potential human exposure. The usual interpretation on the results of wipe testing is that below 10,000 asbestos structures/ cm^2 would be considered a low level of contamination, 10,000 to 100,000 would be considered moderate contamination, and above 100,000 asbestos structures/ cm^2 would be considered significantly contaminated. "*Settled Asbestos Dust Sampling and Analysis*" by Steve M. Hays and James R. Millette, Pages 49 — 51 discusses interpretation of the results, and this is the suggestion the authors make. James Millette was the ASTM vice-chairman on the Sampling and Analysis of Asbestos, until 2007 and chairman from 2007 to 2014.

4.0 Risk Assessment Methodology

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

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

The risk method used presents algorithms that allow a score for each ACM item observed or confirmed by laboratory analysis, to be calculated. The sites with high scores may present a higher risk to human health than those with lower scores.
The risk assessment approach has two elements, the first algorithm is an assessment of the type and condition of the ACMs or presumed ACMs, and their ability to release fibres if disturbed. The final score for each ACM or presumed ACM depends on the type of ACM i.e. concrete vs lagging, the condition of the ACM, if there is any surface treatment and the actual type of asbestos (i.e. chrysotile (white), amosite (brown), or crocidolite (blue).

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

4.1 ACM Assessment

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

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

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

- materials with scores of 10 or more should be regarded as high risk with a significant potential to release fibres if disturbed;

- those with a score between 7 and 9 are regarded as medium risk;
- materials with a score between 5 and 6 are low risk; and
- scores of 4 or less are very low risk.

The material assessment algorithm shown in MDHS100 is reproduced in Table 1.

Table 1: MDHS100 Material Assessment Algorithm

Sample variable	**Score**	**Examples of scores**
Product type (or debris 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

4.2 ACM Setting Assessment

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

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

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

- Occupant activity
- Likelihood of disturbance
- Human exposure potential

Each of the above parameters are summarised below.

Occupant activity

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

Likelihood of disturbance

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

Human exposure potential

The human exposure potential depends on three factors:

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

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

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

Each of the parameters is scored and added together to give a total score between 0 and 21. The setting score is then added to the ACM score to provide an overall score and risk rating in order to rank the sites in order of priority for management and/or remedial action. The scoring system is detailed in Table 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 and significant risk to occupants
7 – 9	11 – 15	17 - 23	Moderate risk
5 – 6	8 – 10	12 - 16	Low risk
0 – 4	0 – 7	0 – 11	Very low risk

5.0 Findings

5.1 Residential Findings

All the residential surveys were based on visual observations of the exterior of the buildings except for a few exceptions such as where vinyl floors were checked. Another common concern was extrapolating the results to islands that were not included in the survey as conditions may be quite different on outer islands to the main island.

If any programme is set in any of the countries (as has been done in Niue) to remove asbestos from residential dwellings then each house would need to be tested prior to removal. Roofing that looks like asbestos generally is asbestos but cladding that looks like asbestos frequently is not asbestos.

Some asbestos sheets were found in hardware stores some countries and there is concern that if regulations are not implemented to prevent the import of asbestos then it may be used in both residential and non-residential locations in many Pacific countries.

The situation with residential properties in each of the 13 countries is set out below.

Cook Islands

There were 2670 residential properties surveyed in Rarotonga and Aitutaki out of a total of 3636 houses. Based on the 2,670 properties, 89 residential buildings were suspected of containing PACM in the exterior material observed (77 with cladding only and 12 with roofs and cladding). Given the large sample size and conclusions based upon it, if this estimate is extrapolated to include the remaining residential properties in Rarotonga and Aitutaki then, based on a 95% confidence with a margin of error of +/- 0.9%, the potential number of households in Rarotonga and Aitutaki to contain PACM would be 146 (of which 20 would also have asbestos roofs. Based on the fibreboard that was analysed (including this survey and K2 results) about 50% was asbestos. If this figure is used then this would reduce the number to 73 houses with ACM.
Extrapolation of the 146 total could be extended to the whole of the Cook Islands to give a figure of 186 houses.

Fiji

Based on the 3,600 properties surveyed, none of the residential buildings were suspected of containing PACM in the exterior material. The majority of the households surveyed were located in and around the towns of Suva, Nadi and Lautoka. Given the large sample size and conclusion based upon it, if this estimate is extrapolated to include the remaining residential properties on Viti Levu and Vanua Levu, and also the outer islands, then based on a 95% confidence level the potential number of households in Fiji to contain ACM would be zero +/-1.7%.

As the survey did not visit the outer islands confirmation that the findings can be assumed for the other islands will need to be made. It can be safely assumed, however, that asbestos has been rarely used in Fiji as a residential building material.

Federated States of Micronesia (FSM)

Residential dwellings observed throughout the FSM were constructed mainly using plywood or fibre board, concrete blocks and corrugated iron. There are also still a number of traditional houses made of natural materials.

Based on aerial photographic evidence of household distribution, approximately 75% of the residential areas on primary islands in FSM were visited. This large coverage was made possible by the generally small populations in each state, except for Chuuk where an effort was made in Weno to cover a large number of houses. Only a few houses were discovered with asbestos as follows (Table 4):

Table 4: Statistical Summary – Population and Households in FSM (census 2010)

Survey	**No of Households**
Total of Households in FSM (2010 Census)	19,502
Households Surveyed	14,626
Households confirmed ACM (cladding only)	2
Extrapolating to full FSM Population – No. of houses with suspected asbestos cladding	3 +/- 0.5%
Households confirmed ACM (all types)	6
Extrapolating to full FSM Population – No. of houses with suspected asbestos (all types)	8 +/- 0.5%

1 house with AC roof but rumours that stockpile was drawn on for other houses.
1 house with AC sheet stockpile with rumours that stockpile was drawn on for other houses.
5 houses with AC pipes acting as roof support columns.

Assuming that the figures presented in Table 5 are a true representation of asbestos material present on residential properties in FSM the number of houses that may have asbestos materials is no greater than 9. Those that may have asbestos cladding only are probably no greater than 4 households.

Kiribati

A Kiribati Government Report was been taken into account in determining how many residences have asbestos. This report examined houses owned by the Kiribati Housing Company (KHC) that were first constructed in the early 1970's. Based on this data obtained from each of the KHC branches in Betio, Bairiki and Bikenibeu, there are 51, 41 and 41 houses consecutively that have asbestos materials used as exterior wall claddings or as ceiling materials or both. That is 133 houses in Betio and South Tarawa. Banaba was also included in the survey. Most buildings on the island are derelict but 295 people still live there and many of the houses have asbestos cladding and roofing.

Table 5 provides a summary of the Kiribati census data and the survey data collected during this assessment.

Table 5: Kiribati Statistical Summary

2010 Census Data				**Survey Data**	
	Population	**Land area (sq km)**	**No of Households**	**No. of Households Surveyed**	**No. of Households ACM Suspected**
National Total	103,058	726	16,043	750	244
Population included in survey					
Banaba	295	6.3	57	52	42
South Tarawa	34,427	14.1	4,728	498	125
Betio	15,755	1.7	1,977	200	77
Potential Survey Total	50,477	22.1	6,762	-	-
	49%	3%	42%	-	-

Based on the 750 properties surveyed, 244 of them were suspected of containing PACM. This included 42 out of a total of 52 properties surveyed on the island of Banaba suspected to contain ACM roofing, drains and/or asbestos cement cladding. The remaining 192 households suspected of containing ACM were randomly surveyed in Betio, Bairiki and Bikenibeu.

The suspected ACM in the 192 properties predominately included a fibre cement exterior cladding observed to be similar in appearance and material properties (i.e. strength, thickness and damage characteristics) to those observed on the KHC properties where asbestos was reported and since corroborated by this survey.

Based on the number of properties surveyed and the statistical approach adopted, an estimate with a 95% level of confidence of the properties within the surveyed area (i.e.

6,705 households in Betio and South Tarawa) to be constructed of asbestos-containing material is approximately 1,940 +/- 3.5%. Based on the survey, all these houses are included because of PACM cladding. It should be noted, however, that the MELAD Report in Appendix 7 also said that AC fibre board was used extensively for ceilings. In addition it was noted that the houses on Banaba had asbestos roofs.

If this estimate is extrapolated to include the outer islands (i.e. 15,986 households - not including Banaba) then the potential number of households to contain ACM is approximately 4,626 +/- 3.5% or 29% of the total households in the nation.
The assumption that the building material may contain ACM has been based on comparisons to the material encountered at the government-owned residential properties which appeared to be of a similar age and construction to the 202 properties identified. Some of the cladding may not be asbestos but some other form of fibre cement board. Two photos below show typical houses in South Tarawa with fibre cement cladding.

Kiribati Houses with Asbestos Cladding

Nauru

The 2011 Census counted 1652 houses including 1647 private houses and 5 non-private dwellings. The survey also identified that 28% of the total number of houses had asbestos roofs, namely 463 houses.

A random "drive-by" sample of 178 houses were surveyed in some detail as part of this project as shown below, although some bias was introduced into the randomness of the survey by the fact that many houses cannot be seen from the road as they are down driveways and so were excluded from the "random" survey.

43.8% of houses have no asbestos
2.8% of houses have 25% asbestos cladding only
1.1% of houses have an asbestos roof and 25% asbestos cladding
8.9% of houses have 50% asbestos cladding only

2.8% of houses have asbestos roof only
30.3% of houses have an asbestos roof and 50% asbestos cladding
0.5% of houses have 75% asbestos cladding only
0.5% of houses have an asbestos roof and 75% asbestos cladding
2.8% of houses have 100% asbestos cladding only
6.1% of houses have an asbestos roof and 100% asbestos cladding

Firstly it should be noted that this survey indicated that 40.8% (1.1+2.8+30.3+0.5+6.1)% of the houses surveyed had asbestos roofs compared with 28% in the census survey. It can be assumed that all the roofs that look like asbestos were in fact very likely to be asbestos as no roofing material similar to asbestos (but not asbestos) was used in Nauru.

Secondly the amounts of cladding that looked like asbestos did vary considerably and the above observations can be used to estimate the amount of this apparent asbestos. Problems arise, however, from the fact that other cladding materials apart from asbestos were used that look like asbestos and these were quite common, based on the bulk sampling that was carried out.

Two photos of residential dwellings with asbestos are shown below:

Nauru Houses with Asbestos

The photos below show an abandoned house littered with asbestos debris and a grassed area with asbestos debris. This abandoned house and grassed area was close to other houses and children were noted playing in the asbestos debris. Such asbestos litter and debris is quite common around houses on Nauru.

Nauru Houses with Asbestos Debris

Niue

Based on the 2011 Census there were 27 occupied houses out of a total of 477 occupied houses that had asbestos roofs. This included 17 with complete asbestos roofs and 10 with a combination of asbestos and steel.

The number of unoccupied houses with asbestos or partial asbestos roofs was not counted in the 2011 survey. A programme of removing asbestos from houses has been going on however, and a 2014/2015 report from Project Manager in charge of this removal work indicates that, as at September 2014, a total of 317 unoccupied houses were counted as having asbestos roofs. By January 2015 a total of 126 of these roofs had been removed from unoccupied houses, leaving 191 remaining. Concern was expressed in this report about the difficulty of obtaining consents to remove the roofs from the unoccupied houses. Reference is made in the report to the ability to exercise powers provided by a local regulation but that there is reluctance to use this power.

To quote from the report: *"It's a big task trying to convince the owners and custodians of the remaining houses to provide consents so we can take out the roofs and effectively complete this part of the project. We could have easily used the regulation available but we had to respect the wishes of the family first and always tried to maintain a constructive approach for an appropriate end result."*

The report said that the house owners were looking for a deal to remove the asbestos roofs and replace them with steel roofs but that this was beyond the budget of the project. It is noted that if the asbestos roofs are to be removed from the 27 occupied houses that have asbestos roofs then this needs to be done in conjunction with the replacement with steel roofs. It should also be noted that some of these occupied houses with asbestos roofs may already have had the asbestos roofs replaced.

During the first visit of the PacWaste team, it was decided to carry out a survey of houses with fibreboard cladding. This was done via a drive around the island where houses were counted with clickers. A total of 865 houses (occupied and unoccupied) were counted. A total of 85 unoccupied houses were counted with cladding and 79 occupied houses were counted with cladding. If a simple scale-up is applied from the 865 houses counted to the 1015 houses counted in the 2011 Census, then there will be 100 unoccupied houses with fibreboard cladding and 93 occupied houses with fibreboard cladding.

The question now remains as to how many of the houses with fibreboard cladding actually have asbestos board cladding. Some assistance can be gained from analysing the cladding part of the results from the overall survey. A total of 34 cladding samples were analysed and 21 samples were positive for asbestos, or 61.8%. Based on this figure, there are therefore 62 unoccupied houses with asbestos cladding and 57 occupied houses with asbestos cladding.

Palau

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.

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.

Republic of Marshall Islands (RMI)

The majority of residential dwellings observed on Majuro were constructed using plywood, concrete blocks (often with cement plaster) and corrugated iron. No asbestos-containing materials were observed.

RMI had a population of 53,158 in 2011 across the nation’s 26 atolls/islands and total land area of 181 km^2. The most populated atoll is Majuro with 27,797 residences in 2011. The population are reportedly housed in approximately 7,785 residential households with over half of those households in Majuro.

As Majuro is a relatively small atoll and residential areas are limited to a narrow strip of land in many places, all of the residential areas were visited and residential houses assessed (4,707 households). A clear understanding of the common building materials was reached.

Samoa

Table 6 below provides a summary of the Samoan census data and the survey data collected during this assessment.

Table 6: Statistical Summary – Population and Households in Samoa

Region	Samoa	Apia Urban Area	North West Upolu	Rest of Upolu	Savai'i
Population	187,820	36,735	62,390	44,293	44,402
Households	28,182	6,003	9,507	6,237	6,435
Households surveyed	2800	1400	400	500	500
PACM identified	1	0	0	0	1

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

Based on the 2800 properties surveyed, a single residential building was suspected of containing PACM in the exterior material. Given the sample size and conclusion based upon it, if this estimate is extrapolated to include the remaining residential properties in Samoa then based on a 95% confidence with a margin of error of 1.76% the potential number of households in Samoa to contain ACM would be 10 houses.

Solomon Islands

Table 7 below sets out the summary of the 2009 census data that forms the basis of the residential calculations.

Table 7 Solomon Islands Census Data

2009 Census Data				Survey Data	
	Population	Land area (sq km)	No of Households	No. of Households Surveyed	No. of Households PACM Suspected
National Total	515,870	27,540	92,241	2,327	
Guadalcanal	93,613	5,336	17,379	1,200	

2009 Census Data				Survey Data	
Gizo	76,649	7,509	13,998	300	
Malaita	137,596	4,224	24,556	489	
Makira	40,419	3,187	7,311	338	
Total	348,277	20,256	63,244	2,327	150
Survey Percentage of National Total	67	73.5	68.5	2.5	0.16

Out of the 2,327 residential properties surveyed, 150 were observed to be constructed either entirely or in part with some form of fibre board. No asbestos roofs were detected. Most of the observations were at a distance from the edge of the property boundary or road and therefore a close inspection of the material could not be made. Where a closer inspection and full survey was possible, a conclusion that the material was likely or unlikely to contain asbestos could often be made.

A conservative estimate based on 150 of the 2327 residential dwellings potentially containing ACM would result in an estimate for Solomon Islands with a 95% level of confidence of 5,946 +/- 2.0% households potentially containing ACM. However that estimate assumes all of the 150 properties in the survey would contain ACM.

Of the 7 residential properties able to be sampled, only 2 returned a positive detect for asbestos. Based on this result, of the 150 houses suspected of containing ACM based on their appearance, potentially 28.5 % (43 properties) would return a positive ACM result.

Using this assessment method, the number of properties in the Solomon Islands containing ACM is estimated to be 1704 +/- 2.0%.

However, PACM products were encountered on other building types throughout Solomon Islands. Of the 42 PACM samples that were analysed only 9 returned positive detects for asbestos (See Section 5). Therefore, based on this, an estimate of 1268 +/- 2.0% properties in Solomon Islands would contain ACM.

Tonga

The survey area covered Tongatapu and Vavau, which had 15,738 households based on the 2011 Census. Based on the 1,600 properties surveyed, 30 residential buildings were suspected of containing PACM in the exterior material observed. The 30 sites where PACM was suspected were all based on the roofing material and were all either formerly owned or currently owned government quarters. Given the sample size and conclusions based upon it, if this estimate is extrapolated to include the remaining residential properties in Tongatapu and Vava'u then based on a 95% confidence with a margin of error of 2.3% the total number of households potentially containing ACM would be 295.

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

Tuvalu

The majority of residential dwellings observed in Funafuti were constructed using plywood or fibre board, concrete blocks and corrugated iron, but fibre board external walls were the dominant type. Most shade houses were constructed using traditional materials consisting of tree branches as the pillars and woven palm fronds as the roof cladding.

Tuvalu had a population of 10,387 (2012 census) across the nation's 9 islands and total land area of 25.6 km^2. The population were reportedly housed in approximately 1,568 residential households with over a third of those households in Funafuti on Fongafale Island.

Table 8 below sets out the results of the residential survey in Tuvalu.

Table 8: Tuvalu Statistical Summary and Conclusion

Household Survey	**No of Households**
Total of Households in Funafuti (2012 Census)	639
Households Surveyed	350
Households PACM Suspected (Cladding Only)	161
Extrapolating to full Funafuti Population (95% Confidence Level) - No of houses with suspected asbestos cladding:	294 +/- 3.5%
Conclusion from Results	**No of Households**
Total Cladding Samples taken	38
Cladding Samples Positive	7
Percentage of Cladding Positive	18.4
Based on 18.4%, no of houses inspected that have asbestos cladding	30
Extrapolating to full Funafuti Population (95% Confidence Level) - No of houses with asbestos cladding:	55 +/- 3.5%

Assuming that the 18.4% figure is correct for the number of houses in Funafuti that have cladding that contains asbestos is 55+/-3.5%.

The total 2012 number of private residences in Tuvalu is 1568. By direct proportion based on the above figure, the number of residences in Tuvalu with asbestos cladding is therefore 130 – 140 houses.

It is also understood that there was a recent AusAID rainwater harvesting programme that resulted in the removal and replacement of asbestos roofs in Funafuti. There may, however, still be dwellings in the outer islands that have asbestos roofs in unknown numbers.

Vanuatu

The survey of the islands of Efate and Santo covered 600 houses and the total number of houses was 21,055 on those two islands combined. This gives a margin of error for the survey of 3.94%. Based on this information it can therefore be said that there are about 35 houses with asbestos roofs and about 140 houses with asbestos cladding. The houses in the samples were not, however, selected randomly over the islands but were focussed on Port Vila and Luganville, which would skew the result. For example houses in rural areas tend to be constructed more of traditional local materials. It should also be noted that the sole example of an asbestos roof was in Luganville where the roof was scavenged from old WWII buildings.

An adjustment should be made to account for the fact that out of the 23 collected cement sheeting samples 11 returned positive. Therefore about 50% of the fibre-cement cladding on Vanuatu may not be asbestos. This would reduce the figures to about 70 houses with asbestos cladding (not necessarily the same houses as those that have asbestos roofs).

If the result is extended to the total population of Vanuatu, then there would be 152-164 houses with asbestos cladding.

Overall Summary Table

Table 9 below contains an overall summary of the data collected for asbestos building materials on residences in the 13 countries surveyed.

Table 9: Overall Residential Survey Data

Country	Houses Surveyed	Houses with Asbestos in Survey			Total Houses	Estimate of Total Houses with Asbestos *		
		Roofs	Cladding	Other		Roofs	Cladding	Other
Cook Islands	2670	12	89	0	4499	20	150	0

Country	Houses Surveyed	Houses with Asbestos in Survey			Total Houses	Estimate of Total Houses with Asbestos *		
Fiji	3400	0	0	0	167400	0	0	0
FSM	10677	1		5 with pipe columns and debris	16767	1	0	8
Kiribati (Excluding Banaba)	698	0	79	0	16043	0	1815	0
Nauru	178	73	24	0	1652	678	222	0
Niue								
Palau	2607	0	0	One with pipe columns	4345	0	0	2
RMI	4704	1 for demolition	0	0	7785	1	0	0
Samoa	2800	1	0	0	28182	10	0	0
Solomon Islands	2327	0	32	0	92241	0	1268	0
Tonga	1600	30	0	0	15738	295	0	0
Tuvalu	350	0	11	0	1568	0	49	0
Vanuatu	600	2	4	0	47373	158	316	0

* This is a straight proportional number which has a +/- statistical range

5.2 Non-Residential Findings

A full list of all the locations identified in the 13 Pacific Island countries is presented in Appendix 1 of the SPREP Circular which is in turn included as Appendix 3.
The notable findings in each country are described below.

Cook Islands

A total of 21 samples were collected in the Cook Islands survey. Asbestos was confirmed in 7 of these samples.

In addition to the Site Specific Detailed Surveys carried out as part of this project, Cook Islands Investment Corporation (CIIC) also provided the survey team with previous asbestos investigation reports undertaken by K2 Environmental. K2 Environmental was requested by CIIC to visit a number of government owned buildings to test for asbestos.

The PacWaste survey covered only Rarotonga and Aitutake and only the locations not covered by the K2 Environmental surveys. The K2 Environmental surveys also covered the additional islands Atiu, Mangaia, Mitiaro and Mauke which provided a greater depth of data. The K2 Environmental surveys did not, however, provide areas and quantities of asbestos so this information has had to be estimated, in some cases probably inaccurately. In addition it has been reported that some of the locations surveyed by K2 Environmental have since been remediated.

The following cases of asbestos building materials were identified:

- A total of 16 schools have been identified with asbestos problems in several islands – Rarotonga, Aitutaki, Aitu, Mangaia, Mauke and Mitiaro.
- Two churches have asbestos cladding issues,
- Two hospitals have also been identified with asbestos cladding (Aututaki and Atui). There is also an old hospital at Mauke with asbestos cladding.
- There are several Government Buildings in Rarotonga, Aitutaki, Atui, Mangaia and Mitiaro with various asbestos isues, including the International Airport at Rarotonga which has roofing and cement board ceiling.
- Several commercial buildings have asbestos building materials.
- The New Zealand High Commission in Rarotonga has an asbestos roof.

Disposal is an issue in the Cook Islands as the current landfill on Rarotonga is unsuitable for receiving asbestos. Asbestos waste materials are currently being stored awaiting export see two photos below.

Rarotonga Government Collection Point for ACM

Considering the limitations of the survey, the potential exists for more asbestos to be present in the Cook Islands. The major sources of asbestos that were difficult to observe, given time and other constraints, include, but are not limited to:

- Buried cement pipes; and

- Internal building material such as floor tiles and internal partition walls, especially in ablution areas.

Based on the methodology for the replacement of the water ring main, to leave the existing pipe in the ground, the impacts from buried cement pipes is considered to be small, although correct procedures are needed to make sure that any work involving asbestos pipes is done correctly.

Internal building material, where observed (e.g. hospital, schools and government offices) contained little or no ACM. The amount of material thought to potentially contain asbestos is therefore considered to be limited.

Fiji

A total of 60 samples of suspected asbestos containing material were collected in the Fiji survey from 29 individual sites. Laboratory analysis confirmed asbestos present at 16 of the 29 sites. The Fiji survey covered the whole of Viti Levu and also Vanua Levu. Thus there were many outer islands that were excluded.

The following cases of asbestos building materials were identified:

- At the Tamavua-Twomey Hospital where large quantities of asbestos was discovered. Emergency work was carried out as part of the PacWaste Project to remove the worst asbestos risks from friable asbestos around disused boilers. There is still much work to do including removal of asbestos from around pipe lagging in corridors, and outside areas, from around in-use boilers and from an old derelict building (Ward 5). There is also quite a large amount of contaminated soil.
- Suva Grammar School – vinyl flooring, exterior wall and window panels
- Savusavu Hospital – vinyl flooring
- Labasa Hospital – Booiler rope insulation and sunshades
- Labasa College - Sunshades
- Water Authority of Fiji (WAF) – numerous deposits of asbestos piping, also pipes in various locations now not under the control of WAF

Photos below show examples of asbestos in Fiji.

Pipes – WAF Labasa **Suva Grammar School Vinyl Floor**

Tamavua-Twomey Hospital Lagging on Pipes and Hospital Boiler

Federated States of Micronesia (FSM)

A total of 62 samples were collected from 38 sites in the FSM survey and the presence of asbestos was confirmed in 9 of them. A further 13 sites were encountered where laboratory testing was not necessary to confirm the presence of asbestos.
Some of the samples that tested positive were residences and these are discussed in Section 4.1 above. The examples where asbestos building materials in non-residential locations were identified include:

- Yap – Colonia Catholic Church roof, floor tiles in Dept of Education Admin and Fisheries and Maritime Institute, and various examples of disused water pipes

- Chuuk – Catholic Church roof, State Court ceiling tiles
- Pohnpei – Kolonia Public Market Fence, LP Gas Corporation cladding, Fishing Corp generator shed, asbestos debris in public reserve area, roof of old Spanish Building in Botanic Gardens, and some roadside pipes
- Kosrae – Telecom generator exhaust lagging and old columns in the hospital

The photos below illustrate some of the asbestos locations:

Yap – Education Dept Floor Tiles

Chuuk – State Court Ceiling

Pohnpei – LPG Gas Corporation

Kosrae – Old Hospital Columns

The greatest source of asbestos which could be readily identified in FSM was the public water system infrastructure. The Public Works representative indicated that the public water supply is distributed through Asbestos Cement (AC) pipes. The majority of excavated AC pipes had been either removed to the water treatment facilities for storage, or disposed of (sometimes at sea). However, a few cases existed where members of the public had been able to obtain AC pipes for use at their residential properties. The uses varied from culverts or bridges to pillars supporting the roofs of shade houses.

Similarly, the majority of government owned buildings have been constructed using concrete blocks, with plywood ceilings / internal walls and corrugated iron or flat concrete roofs. Building materials which could contain asbestos in those buildings consisted of acoustic ceiling tiles, cement fibre boards and vinyl floor tiles.
Future sources of asbestos-containing materials are likely to be largely limited to asbestos cement water pipes which may be excavated when the aging infrastructure is replaced with PVC or HDPE pipes.

Kiribati

A total of 20 samples of suspected asbestos containing material were collected in the South Tarawa survey from 12 individual sites. Laboratory analysis confirmed asbestos present at 8 of the 12 sites.

In addition a visit was made to Banaba and a total of 55 sites were surveyed there with asbestos identified at 52 sites. Samples were collected at 22 sites and asbestos detected by laboratory analysis at all these sites.

The following cases of asbestos building materials were identified in South Tarawa:

- Ministry of Lands, Environment and Agricultural Development (MELAD), Bairiki – Loose fibre board and vinyl floor tiles
- Ministry of Fisheries, Bairiki – Guttering
- Ministry of Finance, Betio – Sunshades and facades
- Bonriki International Airport – Guttering
- Kiribati Community Club, Bairiki – Guttering
- Old Powerhouse – Loose fibreboard
- Bobotin Kiribati – Exterior cladding, roof and guttering
- Numerous sites in Betio Town – Loose Asbestos Tiles

In addition many locations were discovered on Banaba where asbestos was in a deteriorating condition. Some of these locations were very large, such as the former phosphate processing plant (a huge clean-up), seven large old warehouses, and the major workshop. Apart from numerous residences mentioned in Section 5.1 above there are also many other locations containing asbestos such as the hospital, schools, meeting houses, guest houses, churches, power house, police station, boatsheds and restaurant.

Some of the above locations are presented in the photos below

Ministry of Fisheries **Bobotin -Kiribati**

Bobotin Kiribati

Banaba Hospital – ACM Roof

Banaba former power house

Banaba former phosphate processing plant. In disrepair with significant ACM scattered across entire site.

Banaba Warehouse 3 – badly damaged ACM roof and walls.

Apart from residences there were only a few locations where asbestos building materials were detected in Betio, Bairiki and Bikenibeu. By far the largest amount of asbestos is found on the Bobotin (BKL) building in Betio.

Banaba Island is quite different and has very large deposits of badly decayed asbestos. Of the 26 samples analysed by the laboratory, asbestos fibres were detected in all 26 samples analysed. Chrysotile fibres were detected in 23 of the 26 samples with percentages reported between 7 – 95%, amosite detected in four samples at percentages between 10 – 95% and crocidolite was detected in eight of the 26 samples at concentrations between 2 – 5%.

No fibres were detected in either of the two air samples collected on the island of Banaba which was somewhat reassuring. There is a major asbestos clean-up needed on Banaba, however, and it will be difficult to carry out, given the difficulties with access. There is no airport or regular shipping and the logistical problems of carrying out a major clean-up would be huge.

Nauru

Nauru has very large amounts of asbestos both in buildings that are still in use (including residences) and in derelict buildings. Most of the asbestos present was obvious in roofing and corrugated cladding and not so obvious in sheet cladding.

The following information is of note from the Nauru survey:

- The Phosphate Industry has very extensive sites where asbestos has been used widely for building materials, mainly roofing and cladding. These include several large storage bins, processing buildings, workshops, offices, sheds and conveyor structures. There is also the large workshops up on Topside. Most of the asbestos is in very bad condition.
- The hospital has extensive asbestos cladding and roofing. Part of the hospital was damaged in a fire over a year prior to the survey visit and most of the asbestos debris was removed without using correct asbestos safety protocols. The remaining debris was removed safely in an emergency project carried out by the survey team.
- The Power Station has extensive asbestos roofing and cladding. A survey was carried out by the Australian company GHD in 2007 and this data was used in by the survey team.
- There was a fire (arson) in the Prison and Police Station in 2007 and the Police Station was rebuilt. The prison, however, was not rebuilt and there is still fire debris and damaged buildings obvious from the fire.
- Some of the asbestos has been removed from schools but large amounts of asbestos cladding still remains in three schools for small children.
- Asbestos is present in numerous other buildings such as churches, shops, petrol stations and restaurants.

A major asbestos risk assessment exercise was carried out in Nauru with air monitoring carried out at 77 locations. The initial analyses were carried out using the PCM method and some results obtained were quite high. These were checked using the definitive TEM method and no asbestos was found in any of these samples which provided some reassurance. A range of organic and inorganic fibres were discovered which the PCM method does not distinguish from asbestos fibres.

There were also 96 locations where swab samples were taken and some significant concerns were raised as follows:

- The following locations exhibited significantly high results: RON Hospital (3 locations), Seaport (1 location), Power Plant / RO Units (4 locations), Prison (2 locations including 1 very high) and Government Building (1 location).
- In addition several swab test locations were moderately high: RON Hospital (3 locations), House 9 Air Con Unit (1 location), Seaport (1 location), Ewa Refugee Accommodation (1 location), Power Plant / RO Units (1 location), Prison (1 location), Fisheries Main Office (1 location), Menin Hotel Air Con (1 location), Jules Restaurant (1 location), Airport (2 locations), Government Building (1 location), Plant Nursery (1 location).

As well as the very high incidence of asbestos on Nauru, there is also extensive site and ground contamination. Many locations have ground contaminated with asbestos debris which would generate fibres and this includes many locations around houses. For example the Aiwo School which contained asbestos was burnt down in 2007 and the now vacant site is likely to still be contaminated with asbestos fibres. Furthermore the fire in the Prison and old Police Station in 2007 would have caused asbestos debris and fibres to be widely scattered. The prison swab samples were high and the neighbouring Government Buildings (which do not contain asbestos in their building materials) also had high swab samples.

The following is a short photographic record, together with comments, of some of these locations. Some of these locations have now been remediated.

RON Hospital

Most of the hospital has now been remediated and the photos below are therefore historical.

Old Hospital Block

Hospital Parapet Roof

Schools

All schools on Nauru were visited and inspected. All but three were found to be free of asbestos, and these three were Anetan Infant School, Boe Infant School and Nibok Infant School

In the cases of the three infant schools shown below, only the cladding (and not all the cladding) has been confirmed as asbestos). The vinyl floors were checked at the Anetan and Nibok Schools and found to be negative for asbestos.

Boe Infant School Asbestos Cladding

Nibok Infant School Asbestos Cladding and Suspected Ceiling

Anetan Infant School Asbestos Cladding

National Rehabilitation Corporation (NRC) Area

The NRC workshops and maintenance area is up on Topside and all the buildings are clustered together in one area. Most of them have asbestos cladding, much of which is deteriorating. Photos 32-39 below show the main buildings:

Buildings in NRC Workshop Area with Asbestos Roofing and Cladding

Republic of Nauru Phosphate Corporation (RonPHOS)

The RonPHOS buildings cover a wide area, including the administration and workshops and the phosphate processing area. The photos below are illustrative of the large number of buildings that have asbestos roofs and cladding.

Central Office Building

Old Phosphate Storage Bin by Sports Field

RonPHOS Phosphate Processing Area

The photos below show some of the various components of the phosphate processing plant, which is still partly operational although some sections are not used now and are falling into disrepair. The first photo shows the conveyor from the processing area to the storage area.

The Old RonPHOS Processing Area

Prison

There was a fire in the combined Prison and Police Station in 2007. The Police Station was relocated but the prison remained on the same location. Some of the burnt-out buildings are still in place together with some of the old debris. They have damaged asbestos roofing and cladding – see Photos below.

Prison Asbestos in Burnt Area including Asbestos Debris

Power Station

The Power Station has asbestos roofing and cladding in several locations – see Photos 79-80 below. It was the subject of a separate GHD investigation in 2007.

Power Station Asbestos Roofing and Cladding

Niue

Niue has a substantial amount of asbestos although most of the asbestos present is associated with residential houses. This matter has been dealt with in Section 5.1 above. There are, however, significant quantities of asbestos associated with non-residential buildings.

There has been a major programme over the last few years to remove asbestos from Niue and this has focussed on residences. The asbestos is being packed and shipped to New Zealand in containers. As part of the PacWaste project Dirk Catterall of the New

Zealand company Morecroft Contracting visited Niue to carry out training in support of EU funding being granted to assist with the ongoing removal project.

The following non-residential buildings in Niue were identified as containing asbestos building materials:

- Primary School – Cladding, soffits and debris
- Secondary School – Cladding
- Old Schools – Avatele (panels), Hakupu (cladding) and Lakepa (waste stockpiles – now mainly dealt with)
- Lakepa Pre-school – cladding
- Nuie Broadcasting – Cladding and Soffits
- Police Station - Cladding
- Alofi South Hall – Cladding
- Prison – Cladding
- Tuapa Hall – Cladding
- Toi Meeting Hall – Cladding
- St Joseph Automechanics and Peta Paints – Roofing and Cladding
- Churches – Catholic Church roof and Avatele Church outer panels
- Honey Processing Building – Roof
- Several other commercial buildings – Vai/Mamali / RockBak Building (Cladding), Alofi Bread Shop (Cladding and Soffits), Makini Handcrafts (Fence), Jenna's Restaurant (Cladding), Sassy Fashions (Cladding), Peleni's Travel (Cladding), Abbatoir (Roof).

In addition there are at least four old bitumen tankers abandoned on Niue by Fulton Hogan from an earlier roading project on Niue (see below).

Some air samples were also carried out at 12 locations over two visits. The nine samples taken during the PacWaste visit were below levels of detection. On the second visit three air samples were taken around the operational activities of packing up the asbestos. As the PCM results obtained were all above the Level of Detection, the samples were then further examined using the TEM method. The TEM results confirmed that asbestos fibres were present in the air for all three samples. A matter of further concern was that amosite was present in all three samples.

On the first visit four wipe samples were taken and two further wipe samples were taken on the second visit including an additional one in Peta Paints where a high wipe result was obtained on the first visit. The high Peta Paints result was confirmed on the second test. The wipe tests also revealed high results for other areas in contact with the public.

Numerous non-residential buildings therefore have asbestos roofs and cladding and many of these are in Alofi. Some photos and descriptions are also set out below.

Public Works Department Cladding **Honey Processing Building Roof**

It should be noted that a wipe sample taken in the Honey Processing Building on the second visit produced a moderately high result for chrysotile of 71,000 Str/cm2.

Primary School – Cladding and Soffits **Secondary School Cladding**

Police Station Cladding **Alofi South Hall Cladding**

Photo 21: Peleni's Travel Cladding **Photo 22: St Joseph's/Peta Paints Roof/Cladding**

The old building housing the St Joseph's Automotive Repair Shop and the Peta Paints Retail Shop has a large amount of old asbestos roofing and cladding. An air sample was taken inside Peta Paints that proved to be negative. A wipe sample taken on the first visit produced a very high result of 910,000 Str/cm2 for chrysotile and a moderately high result of 81,000 Str/cm2 for amphibole (amosite and crocidolite). A second sample was taken on the second visit and chrysotile was still high at 350,000 Str/cm2 and amphibole was still significant at 12,000 Str/cm2.

This building needs to have the asbestos removed and the structure needs to be cleaned. It is an old high building and some significant safety issues need to be addressed, regarding the removal of the asbestos.

Reservoir Bitumen Tank A

Three Reservoir Bitumen Tanks

The bitumen tanks were abandoned by Fulton Hogan from an earlier roading project. There are three tanks in one location on the road to the hospital near a reservoir and at least one (and possibly more than one) near the entrance to the Hui Hui hazardous waste site. A large amount of the lagging in these tankers is amosite asbestos. This large amount of lagging is friable asbestos and the removal of this asbestos, as well as the clean-up of the contaminated ground under the tanks, is a major and specialist project that needs to be carried out using appropriate asbestos management protocols.

Palau

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.

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

Malakal Power Plant

The generator building at the rear of the power station contains exterior corrugated roofing and cladding that tested positive for asbestos. 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 the Photo below and is in reasonable condition.

Malakal Power Station New Generator Building

Palau Water Treatment Plant, Airai

Quite a large number of old asbestos water pipes are stored at the water treatment plant as shown in the photo below. It is difficult to estimate how many as they are covered by vegetation. They appear to be in reasonable condition although some may be broken, in which case a site clean-up will be needed.

Old Asbestos Pipes at Palau Water Treatment Plant

Pipes in roadside Locations

Several asbestos-cement pipes were discovered in roadside locations. They are damaged and in poor condition.

Old Pipes in Reserve in Ngiwai Village

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. 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. The photo below shows the old burnt-out power plant.

Ameliik Old Burnt-out Power Plant

The amount of asbestos present in Palau is low and mostly limited to asbestos water pipes, except for the new generator building at the rear of the Malakal Power Station. The building is only 15 years old and there is still potential for asbestos to be imported into the county for new buildings.

Republic of Marshall Islands (RMI)

Of the 23 non-residential buildings that were visited, 4 were considered to have ACM present and did not require samples to be collected while one was considered to have PACM and therefore a sample was collected and sent for analysis. The sample was retrieved from deteriorating lagging from the exhaust of a disused generator located at

Majuro Hospital.

The analysis of the one sample that was collected in the RMI did not detect any asbestos fibres and therefore no further action is required.

The few sites in Majuro where asbestos was detected are as follows:

- Ace Hardware – corrugated cement roof
- College of the Marshall Islands – cement water pipes and corrugated cement roof
- Majuro Japan Construction Company – corrugated cement roof
- Majuro Airport – Cement water pipes

The largest source of asbestos which could be readily identified in RMI was the public water system infrastructure. The Water and Sanitation Advisor to the Majuro Water and Sewer Company indicated that the majority of the public water supply is distributed through Asbestos Cement (AC) pipes.

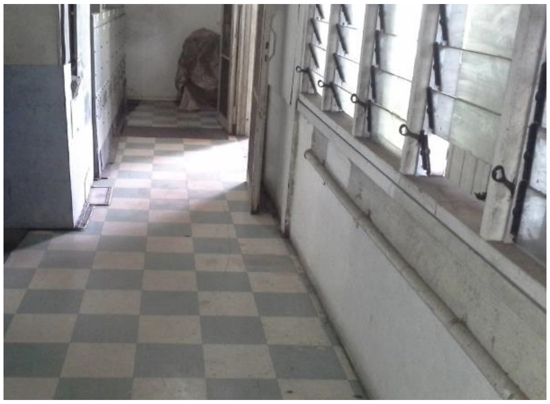
Samoa

A total of 48 samples of suspected asbestos containing material were collected in the Samoa survey from 32 individual sites. Laboratory analysis confirmed asbestos present at 15 of the 32 sites

The examples where asbestos building materials in non-residential locations were identified include:

- Customs House Apia Port – exterior façade
- Meterological Station, Apia – corrugated roof
- Femei Matata Statistics Office – ceiling panels
- Stockpiles of Debris at University of South Pacific (USP), Savai'i, Meterological Station, Fagamalo and Fasito'o Villages
- Paul VI college – corrugated roof
- USP – Apia (corrugated roof and boiler insulation), Savai'I (toilet block roof)
- Tuiala Power Station, Upolu – vinyl floor
- Churches – Manono-uta Church, Upolu (vinyl tiles) and Safofu Church (roof)
- WSLAC House, Apia – Sunshades
- Old Timber Site, Savai'i – roof and boiler pipe insulation
- Tafaigata Landfill – water pipes

Some of the above locations are presented in the photos below.



Tuiala Power Station (vinyl tiles)

Office of Statistics (ceiling panels)

Paul VI College (Roof)

Loose Debris, Fagamolo Village

The overall picture is that there is very little asbestos in Samoa. The few examples identified could be dealt with quite easily.

Solomon Islands

A total of 42 samples of suspected asbestos-containing material were collected in the Solomon Islands survey and the presence of asbestos was confirmed in 9 of those samples collected at 8 sites.

The examples where asbestos building materials in non-residential locations were identified include:

- Ministry of Infrastructure and Development, Honiara – Floor Tiles
- Waimpuru Secondary School, Makira – Cladding
- Council Building, Gizo – Cladding
- Court Building – Gizo

About 50 sheets of asbestos board were also identified in a hardware store in Gizo. The photos below show the asbestos that was identified in the Lands and Survey Building and also in the Gizo Hardware Store.

Lands & Survey Building – AC Panels

Asbestos cladding for sale in Gizo

There are a few Government buildings that have asbestos-cement cladding in the Solomon Islands, such as the Lands and Survey Building and the Ministry of Infrastructure and Development Building in Honiara. In general, however, there is only a small amount of asbestos that was observed on non-residential buildings in the Solomon Islands. It is important to note above that the ACM detected at the hardware store is new asbestos cladding that is being sold to the public for construction purposes.

This means that the asbestos problem in the Solomon Islands may not just be historical one, and the number of buildings with asbestos is probably growing.

Tonga

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

The examples where asbestos building materials in non-residential locations were identified include:

- Tonga Post Ltd – Roof and Soffits
- MOI WOF Centre – Roof and Cladding and Toilet Block Roof
- Fua’amotu Domestic Airport – Roof and Facades
- Tonga Water – Roof and Facades
- Government Service Centre, Pausa – Roof
- St Andrews School – Cladding
- Viola Hospital – Walkway Roof
- Several large locations on Vava’u including the Prince Ngu Hospital (large area of roofing), the Neiafu Former Market (roofing and cladding), and the Former Bulk Fuel Depot (derelict Buildings and broken asbestos)
- Several commercial and industrial locations in Tongatapu including a plumbing shop, Industrial Areas 1 and 2, the CAT Depot and the Small Business Centre.

The photos below show some of the examples where asbestos was identified:

Tonga Post **MOI Workshop**

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

Industrial 01 Building **Small Business Centre Office**

The photos below show the Vaiola Hospital Walkway Roof in Tongatapu and the Prince Ngu Hospital Roof in Vava'u. This hospital has four asbestos roofs as well as some loose asbestos. The total roof area is about 3100 m2.

Viola Hospital **Prince Ngu Hospital**

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

Vava'u Former Bulk Fuel Terminal

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

Former Neiafu Market.

Tuvalu

A total of 49 samples of suspected asbestos containing material were collected in the Tuvalu survey and the presence of asbestos was confirmed in 11 of those samples collected at 9 sites.

Apart from the residences a few locations were identified with asbestos as follows:

- Meterological Centre – Roof
- Sanus Service Station – Front wall cladding
- Princess Margaret Hospital – debris
- There was also some asbestos debris and pipes spotted at two public locations.

Apart from the cladding on residences discussed in Section 5.1 above, asbestos is not a major issue in Tuvalu.

Vanuatu

A total of 53 samples were collected in the Vanuatu survey of which 35 were collected at Efate and 18 at Santo. The presence of asbestos was confirmed in 10 samples collected at Efate and in 5 samples collected at Santo. In addition five sites at Efate and three sites at Santo were encountered where laboratory testing was not required to confirm the presence of asbestos.
The examples where asbestos building materials in non-residential locations were identified include:

- Ministry of Lands and Natural Resources – cladding, gables and soffits
- Paonangisu Health Centre – cladding
- Port Vila Central Hospital – cldding, vinyl flooring and pipe lagging in ducting under corridors. The pipe lagging was friable asbestos.
- Presbyterian College – cladding and soffits
- Malapoa College – Cladding and Bitumen Roof
- Manganese Mine, Forari – Roofing and Cladding on a large old abandoned mine that is due for demolition.
- Northern Provincial Hospital – an unknown amount of underground pipes.
- A supply of asbestos sheeting was also identified that was being sold in a Chinese Hardware store.

The following photos below illustrate the positive sample locations identified above. The first photo below shows an AC sheet at the entrance to a Chinese Hardware Store (MOK 3) in Elluk Rd. The shop manager had previously reported that he sometimes sells asbestos cement sheeting but that he did not have any in stock at the moment. The above panel was then found and sampled. The second photo shows AC cladding on the Ministry of Land and Natural Resources building at Port Vila.

Hardware Store New Sheeting **Ministry of Lands and Natural Resources**

The first photo below shows AC cladding on the Paonangisu Health Centre. The sample was collected at the reception area but ACM has presumably been used on all the five structures present at the site. The second photo below shows at the Port Vila Central Hospital. Photo 6 shows services and heating pipes running the length of the covered walkways connecting the buildings at the Port Vila Central Hospital.

Paonangisu Health Centre **Port Vila Central Hospital**

The first photo below shows cladding and roofing at the Malapoa College. The second photo has been taken at the abandoned manganese mine in Forari, and there is AC cladding and roofing on four remaining structures. The site is abandoned and in a rural area.

Malapoa College

Manganese Mine Forari

It was reported that most schools within Port Vila have been built during the nineties. Only Malapoa College was built during colonial times. Because ACMs were only encountered at the this school and not at the other visited schools within Port Vila (i.e. Port Vila Central School, Lycee Bougainville, USP Emalus Campus, Ulei Junior Secondary School and Vila East Kindergarden), the survey results show that ACMs are unlikely to be found in the post 1980 school buildings within Port Vila.

A total of eight hardware stores (five in Port Vila and three in Luganville) were visited and a sample of the cement cladding available for purchase was collected at most of them. AC cement sheeting was only identified at one of them; Chinese Hardware store in Port Vila - MOK 3. This proves that ACMs are still being imported into Vanuatu. The presence of ACM can therefore not entirely be ruled out in more recent buildings.

Evidence was found that some of the remaining WWII structures of the Allied forces at Santo contain ACMs. However, very little of these ACMs remain: only one residential dwelling was encountered in Luganville with AC roofing and cladding sourced from a WWII structure. Residents reported that most the houses in the surrounding area (approximately 100 dwellings) used to have AC roofing but that most of it had been replaced over the years. It is unclear where the ACMs have been deposited.

The most abundantly encountered AC building material was cement sheeting. This AC cement sheeting is mostly applied as wall cladding and can also be encountered in soffits, gables, pathways connecting buildings, etc. The conditions in which the AC cement sheets were encounter varied from badly damaged (residential demolition site in Port Vila and a residential dwelling in Luganville) to very good (the Presbyterian College and the Paonangisu Health Centre).

Out of the 23 collected cement sheeting samples 11 returned positive. The positive samples were mostly collected from what appeared to be the older cement sheets.

Vinyl flooring was abundantly present and a total of 20 samples were collected. Only one sample returned positive. The sample collected at the Port Vila Central Hospital contained 2% chrysotile. This suggests that a very limited quantity of the vinyl flooring used at Vanuatu contains asbestos.

The presence of AC cement pipes was proven at the Northern Provincial Hospital at Santo. No further information was collected about the presence of AC cement pipes and therefore large uncertainty remains about to what extent these kinds of pipes have been used in Vanuatu.

5.3 General Comments on the Findings

The following general comments can be made about the findings reported on in Sections 5.1 and 5.2 above:

- Large numbers of houses (by percentage) have asbestos building materials in two countries, namely Nauru and Niue. Most of the houses in Niue with asbestos are abandoned houses and a program is in place to remove this asbestos. Nauru has commenced a programme to replace asbestos in their houses.
- The Cook Islands, Kiribati, Solomon Islands, Tonga and Tuvalu have moderate amounts of asbestos building materials in houses and in most cases cladding only.
- Several countries have none or very low quantities of asbestos in houses. Fiji and RMI probably have almost none and FSM, Palau, Samoa and Vanuatu have very little asbestos in houses – none except for isolated examples.
- The above conclusions are based on surveys done on a limited number of islands (albeit the main islands). Nauru and Niue are single island states so the information can be relied on. For the countries, that have numerous outer islands, however, the above conclusions regarding asbestos in residences may need to be treated with some caution.
- The countries with the largest amount of non-residential asbestos locations are Nauru, Niue, Cook Islands, Tonga and Vanuatu. Fiji has relatively few such locations but these (and the Tamavua-Twomey Hospital in particular) need to be dealt with.
- The remediation components of the PacWaste Project Stage One focused on Nauru, Cook Islands, Fiji, Tonga and Vanuatu. Niue is managing its own remediation work and is being partly funded by the PacWaste project.
- The situation in Vanuatu needed to be reviewed in light of the impact of Cyclone Pam which had a devastating effect on Vanuatu and especially around Port Vila. Some of the buildings that have been identified as containing asbestos may have been damaged by Cyclone Pam and this will alter the costs and methodology for the remediation. The costs are likely to increase and the remediation will be

extended to include remediation of contaminated areas, assuming these areas have not been cleaned up already.

- The “lessons learned” from Cyclone Pam should have implications for Disaster Risk Reduction (DRR) which is a systematic approach to identifying, assessing and reducing the risks of disasters. In cyclone-prone areas of the Pacific it would make sense to remove asbestos from properties before cyclones strike to reduce the costs cyclone relief and environmental damage that cyclones cause. This need is reinforced by Cyclone Ian that caused extensive damage to the Ha’apai Group in Tonga and required an expensive clean-up of asbestos as part of the cyclone relief work.
- Banaba, which is part of Kiribati, presents a special case regarding asbestos remediation. The amount of old and damaged asbestos present on Kiribati is huge and a substantial remediation exercise is clearly needed. The logistical problems of such a clean-up are also huge, however, as there is no airport and no regular shipping. Ships can take 3-4 days to reach the island. There are also no supplies on the island and no accommodation for workers. If any clean-up is carried out it would best be done as part of an overall clean-up of the island including the overall demolition of the substantial decaying infrastructure that was set up to mine phosphate from the island for decades and which was just abandoned in an irresponsible manner.
- Most of the asbestos identified was in the category of non-friable building materials (mainly roofing and cladding). There were very few examples of friable asbestos with the most notable being at the Tamavua-Twomey hospital in Suva (lagging around pipes, boilers and hot water vessels). It should be noted, however, that much of the non-friable asbestos identified was in bad or very bad condition and is liable to be releasing asbestos fibres. It could therefore be considered at least partially friable in this state.

6.0 Remedial and Management Options

6.1 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 fibre release has 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.

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, Australia and New Zealand.

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.

6.2 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.

6.2.1 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.

6.2.2 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.

6.2.3 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.

6.3 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.

6.3.1 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.

6.3.2 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.

6.3.3 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.

6.3.4 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

7.0 Selection of Possible Remedial Options

7.1 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

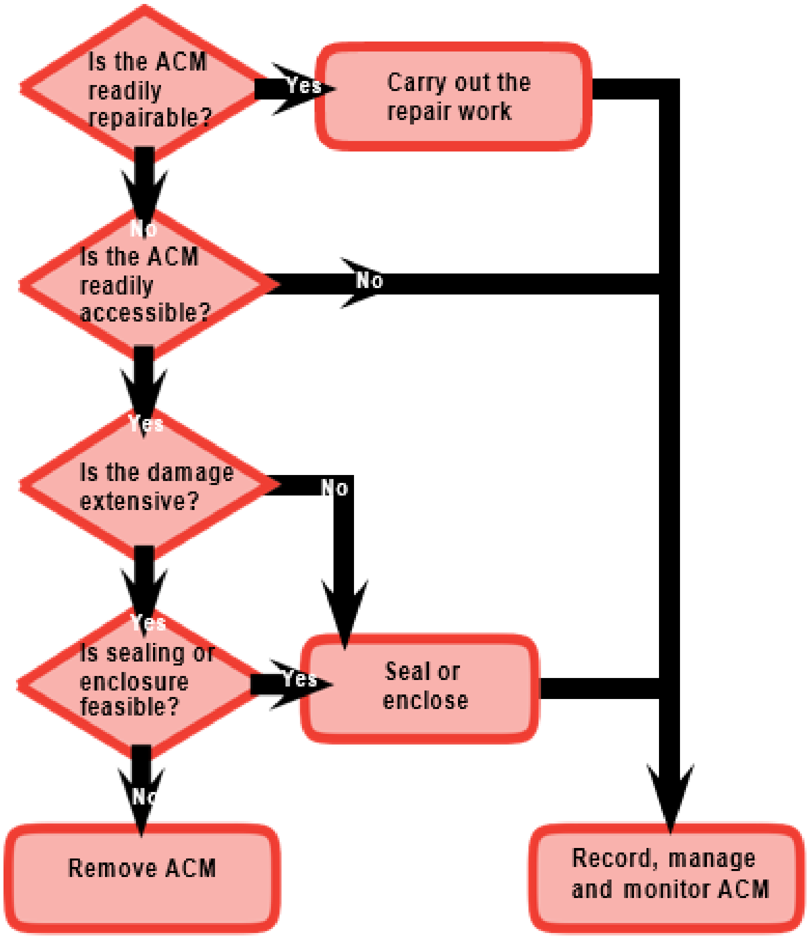


Figure adapted from; UKHSE HSG227 'A Comprehensive Guide to Managing Asbestos in Premises'.

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.

7.2 Appropriate Asbestos Management for the Pacific

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

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

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

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

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

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

Encapsulation is discussed further in Section 8.3 below.

Removal of the asbestos roof would require all the appropriate asbestos management controls to be put in place as well as edge protection / fall arrest for safe working at heights and procedures for working on a brittle asbestos roof. Once the roof has been removed then the asbestos dust would need to be carefully vacuumed up in the ceiling space. Then a new roof would need to be put in place. With the hot conditions in the

Pacific an insulating layer would also be required. Asbestos does have the merit of being cool to live under.

Removal is discussed further in Section 8.4 below.

7.3 Encapsulation

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

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

Normal priming type paints (especially oil or mineral turps based paints) generally do not bind well to asbestos cement roofs and cladding and special high quality alkali resistant primers are recommended prior to using a typical high quality 100% acrylic based exterior undercoat and exterior top coat system.

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

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

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

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

a) Prepare asbestos removal plan, set up asbestos boundaries and signage, prepare PPE and decontamination area.
b) Set up scaffolding to both sides of building for access to roof sheeting & to remove asbestos guttering from building. Set up anchor point for fall arrest systems.
c) Spray with a particle capture technology such as Foamshield (www.foamshield.com.au) to the inside of the ceiling space before removal of the ceiling. This will control any asbestos dust in the ceiling space before removal of the ceiling. Alternatively the ceiling space could be vacuumed thoroughly if safe access is possible to all the ceiling space.
d) Lay down black plastic sheeting to the floor of each room, remove all ceiling linings and place all rubbish into suitable containers for disposal (plastic lined bins or fabric bags such as “Asbags” – see Photos 17 and 18 below) for correct removal & disposal. All ceiling material will need to be treated as asbestos-contaminated as debris and fibres fall from the roofing with roof movement and wear.
e) Disconnect & remove all electrical items, ceiling fans, lights, extractor fans. Vacuum thoroughly and store safely ready for reconnection after new ceilings are installed. Ensure all wiring is made safe for ongoing work.
f) Vacuum the underside of the existing roof sheeting and all timber roof framing. After removal of ceiling materials and plastic, vacuum all the inside of the premises.
g) Spray 3 coats of protective paint system (pre-coat, undercoat and top coat) to the underside of all the asbestos roof sheeting. Ensuring that all surface areas are correctly coated.
h) Supply & fix appropriate ceiling sheeting to ceilings of all rooms. Supply & fix timber battens to all sheet joints & to perimeter of each room.
i) Paint with 2 coats of acrylic ceiling paint to all new ceiling sheets & perimeter battens.
j) Reposition all wiring for lights & fans and connect up all fittings as previously set out.
k) Spray 3 coats of specialist paint finish (pre-coat, undercoat and top coat) to all the exterior roof area according to painting specifications.
l) Remove, and contain for disposal, asbestos gutters and downpipes from both sides of the building and supply & install new suitable box gutters (e.g. Colourbond) with down pipe each side leading to water tank.
m) Remove asbestos boundaries and signage and decontamination area and decommission from site.

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

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

Photos 17 and 18: Asbags in use

7.4 Removal

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

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

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

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

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

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

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

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

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

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

8.0 Disposal

8.1 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 10 below.

Table 10: 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.

8.2 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.

8.3 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.

8.4 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.

9.0 Costs and other Related Issues

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

9.1 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 3 and a summary is presented as follows:

Roof Encapsulation

Costs:

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

Assumptions:

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

Cladding Encapsulation

Costs:

- Encapsulate wall cladding where there is no internal wall sheeting: USD25.92/^{m2} (face area)
- Encapsulate wall cladding where there is internal wall sheeting in good condition, which means only the exterior needs to be encapsulated: USD17.92/^{m2} (face area)
- Encapsulate wall cladding where there is internal wall sheeting in poor condition, which must be treated as asbestos contaminated and removed and replaced: USD65.92/^{m2} (face area)

Assumptions:

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

9.2 Removal and Replacement

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

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

Roof Removal and Replacement

Cost:

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

Assumptions:

- Rates assume that the existing roofs are replaced with Colourbond Ultra grade roof sheeting (for sea spray environments) with 50mm of foil coated fibreglass insulation (to address heat issues).
- Rates have been built up based on a roof of a single storey building with a floor area of 14m x 12m with a roof pitch of 30 degrees. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.
- Rates do not allow for any costs relating to disruption of the usual activities undertaken in the building being worked on – eg moving furniture in and out.
- A 10% contingency has been allowed for tidying up any damaged or inadequate rafters purlins and barge boards.
- Rates are approximate only and there will be country specific variances depending on the availability of resources and materials.
- Rates assume asbestos waste secure wrapping and disposal to a suitable nearby local landfill. If the waste needs to be exported or if sea disposal is being considered, then this will need to be costed as an extra.

Cladding Removal and Replacement

Costs:

- Remove and replace cladding: USD76.04/m3 (face area)

Assumptions:

- Rates assume that the existing cladding is replaced with a cement fibre board with treated timber battens to make water tight. An allowance has also been made to wrap the building in foil and to apply two coats of paint to complete the works.
- Rates have been built up based on a single storey building with a floor area of 14m x 12m and walls 2.4m high. Extra will be required for scaffolding for buildings greater than 1 storey high.
- Rates assume that work is done in a tradesman like fashion to New Zealand or Australian standards, including compliance with applicable safety requirements relating to working at height and working with asbestos.
- Rates allow for an independent SPREP appointed representative to oversee works to ensure quality, safety and commercial requirements are complied with.

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

Table 11 below presents a summary of the costs for the various remediation options.

Table 11: Summary of Costs for Various Remediation Options (Costs rounded to nearest $US)

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

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

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

9.3 Local Contractors

The availability and competence of local contractors was also assessed. This was done by whatever means was available, mainly by asking government agencies and local people about construction businesses operating in the countries surveyed. Once a list was obtained then where time permitted, personnel in those businesses were interviewed and their competence and experience assessed, especially in terms of asbestos remediation.

Several countries had contractors who had experience and training in managing asbestos, for example Nauru, Tonga, Fiji, Cook Islands and Samoa. Niue had a team working on the systematic removal and packaging of asbestos roofing and cladding for shipment of asbestos for disposal in New Zealand. It did not follow, however, that where there were experienced and trained contractors, asbestos was being properly managed in those countries.

If local contractors can be used for the remediation of asbestos then the overall costs will be substantially reduced. The work could be done in conjunction with overseas asbestos specialist oversight.

9.4 National Legislation and Policies

Efforts were also made to assess any laws and regulations that were relevant to asbestos in the countries surveyed. In most cases little of no mention was made of asbestos in national legislation although in some countries there was general health legislation that could be used to assist with the management of asbestos. Fiji has made specific mention of asbestos as a hazardous substance in its health and safety legislation and has set up a system of licensing asbestos contractors.

The main exception is Samoa where the Occupational Safety and Health Act 2002, No.5 came into force in 2004. The Act applies to all workplaces including schools and hospitals. In June 2014 the Occupational Safety and Health Regulations 2014 were introduced pursuant to the Act. Part 11 of the regulations covers Hazardous Substances while section 65 specifically relates to work with asbestos. The regulations state that a licence is required to remove asbestos cement greater than 10m^2 in area, or greater than 0.5m^2 in area of insulation.

Considering that there were cases identified in the Pacific of asbestos sheeting being sold in hardware stores (Solomon Islands and Vanuatu) it is considered important for countries in the Pacific to consider banning the importation and sale of asbestos-containing building materials. There is little point in a programme that aims to remove asbestos from the Pacific if hardware retail companies and others continue to import asbestos-containing products.

An attempt was also made to assess strategies and policies in each country for managing asbestos. This was mainly done by discussions with the relevant government agencies. In most cases there were no such specific strategies, with the main exception being Niue which has a large asbestos problem and is implementing an effective programme for dealing with this problem.

Nauru is another country with a major asbestos problem and has recently undertaken to begin replacing asbestos roofs on houses. There is still a need in Nauru, however, to set in place a comprehensive asbestos strategy.

Some other efforts have been made in specific circumstances in other countries such as the management of asbestos waste arising from Cyclone Ian in the Ha'apai group of islands in Tonga, and the survey of houses owned by the Kiribati Housing Corporation in Kiribati. Generally, however, there is a lack of relevant strategies of managing asbestos in the countries visited.

SPREP prepared a regional asbestos strategy document in 2011 "An Asbestos-Free Pacific: A Regional Strategy and Action Plan", which all countries visited support. In a sense this document therefore acts as an asbestos strategy document for all the countries covered by the survey and the SPREP document was a forerunner to the asbestos component of the PacWaste project.

When the Nauru asbestos training was carried out by CEL as part of the PacWaste Stage One work, a Draft Cabinet Paper was prepared proposing reforms that could be implemented in Nauru, including the endorsement of the regulatory team that was trained. Another important feature was the preparation of a simple "Asbestos Removal Plan" (ARP) by anyone removing asbestos. This ARP would need to be submitted to the regulatory authority who would need to endorse it before the work proceeded. The draft Nauru Cabinet Paper is contained in Appendix 4 and it is suggested that variations on this document may be relevant to other countries.

10.0 Work Completed During the Remediation Component of PacWaste Part One

The following locations were remediated in the remediation component of PacWaste Part One, as shown in Table 12.

Table 12: Locations Remediated During the Remediation Component of PacWaste Part One.

Country	Location	Type of ACM	Contractor	Actions Carried Out
Cook Islands	Tereora College, Rarotonga	Cladding	PolyEco	Remove and Replace
Cook Islands	Tuarai Community College, Rarotonga	Cladding	PolyEco	Remove and Replace
Cook Islands	Takatimu School, Rarotonga	Cladding	PolyEco	Remove and Replace
Cook Islands	Titikaveka College, Rarotonga	Cladding	PolyEco	Remove and Replace
Cook Islands	Aorangi School, Rarotonga	Cladding	PolyEco	Remove and Replace
Cook Islands	Mauke School, Mauke	Cladding	PolyEco	Remove and Replace
Cook Islands	Mauke Old Shed	Roof	PolyEco	Remove
Cook Islands	Enuamanu Shed, Atiu	Cladding	PolyEco	Remove and Replace
Cook Islands	Atiu Hospital	Cladding	PolyEco	Remove and Replace
Cook Islands	Mitiaro School Mitiaro	Cladding	PolyEco	Remove and Replace
Fiji	Tamavua / Twomey Hospital	Old Pipe and Vessel Insulation	CEL	Remove
Fiji	Suva Grammar School	Vinyl Flooring	CEL	Remove and Replace
Fiji	Labasa Hospital	Old Pipe Insulation	CEL	Remove and Replace
Kiribati	MELAD Bairiki	Sunshades	CEL	Remove and Replace
Nauru	RON Hospital	Roofing	PolyEco	Remove and Replace

Country	Location	Type of ACM	Contractor	Actions Carried Out
Nauru	Prison	Roofing	CEL	Remove and Replace
Solomon Islands	Old Gizo Hospital	Fire-Damaged Cladding and Contaminated Soil	CEL	Remove and Replace
Tonga	MOI WOF Centre	Cladding	PolyEco	Remove and Replace
Tonga	St Andrews School	Cladding	PolyEco	Remove and Replace
Tonga	Tonga Post	Roofing, Soffits	PolyEco	Remove and Replace
Tonga	Viola Hospital, Tongatapu	Walkway Roof	PolyEco	Remove and Replace
Tonga	Fua'amtu Domestic Airport	Roofs	PolyEco	Remove and Replace
Tonga	Neiafu Former Market, Vava'u	Roofing	PolyEco	Remove and Replace
Tonga	Prince Ngu Hospital, Vava'u	Roofing and Loose Material	PolyEco	Remove and Replace
Vanuatu	Paonangisu Health Centre	Cladding	PolyEco	Remove and Replace
Vanuatu	Presbyterian College	Cladding	PolyEco	Remove and Replace
Vanuatu	Malapoa College	Bitumen Roof	PolyEco	Remove and Replace
Vanuatu	Port Vila Central Hospital	Cladding and Pipe Lagging	PolyEco	Remove and Replace

11.0 Lessons Learnt from the Remediation Component of PacWaste Stage One

The following lessons were learnt from the remediation component of PacWaste Stage 1. This information was obtained by being part of the tendering process and remediation work and also from listening to feedback from various parties including SPREP.

1) The tendering process was quite rushed and was based on short timeframes for tender submission. Better outcomes in terms of price and quality of work may have been achieved with longer timeframes.

2) In addition the work was not specified in detail at the tendering stage including the standard that needed to be achieved in terms of following appropriate asbestos management protocols. This should include setting up proper decontamination procedures and managing asbestos boundaries, correct signage, proper PPE, correct handling and sealing of removed asbestos materials, and proper disposal in accordance with local requirements.
3) It should be necessary to prepare a detailed asbestos work plan for each project before starting. This work plan is also known as an "Asbestos Removal Control Plan (ARCP)" and this plan should be made available to SPREP and also local environmental /health agencies on request.
4) No independent assessment was carried out of the work done, including the need to have an independent asbestos clearance report to ensure that no asbestos hazards remain on site.
5) Local workers were widely used which proved cost effective and enabled necessary skills to be transferred to local people in a practical way.
6) In future, however, it should be necessary to prove that the local workers have been properly trained and that they are supplied with all the correct PPE.
7) Pre-start medical inspections should also be carried out on all local staff used and evidence of these medical inspections should be provided to SPREP.
8) Air monitoring should be carried out during the project and clearance air monitoring after job completion, in the cases of large projects or any projects involving friable asbestos. The definition of "friable asbestos" should include any badly decayed "non-friable asbestos" that may be releasing asbestos fibres.
9) Better coordination with local agencies is needed, and in particular, proper advance notice to affected stakeholders of the work to be carried out and when. Neighbours may also need to be notified if there is potential for them to be affected in any way, or even if they may become concerned. Stakeholders may also need a copy of the ARCP.
10) In the remediation work carried out so far, local disposal has been employed, although in Nauru, this was no permitted and the waste has been stored in shipping containers at the Port, awaiting a future solution. Disposal methodologies need to be agreed with local agencies prior to commencing work and in fact this may need to be resolved at the tendering stage as disposal costs could impact significantly on the overall job costs.
11) Availability of information for scoping the work is limited, and this needs to be specified as carefully as possible. In some cases of large jobs, visits may be needed to potential jobsites and further sampling and analytical work may be needed.
12) There needs to be a robust system in place for processing cost variations, as it is difficult to determine accurately the cost of the jobs at the tendering stage and unexpected problems and situations may be encountered, once the job is commenced. For example, the work involved in removing and replacing a vinyl floor can vary very significantly from job to job and it also needs to be assessed

whether the mastic glue that holds the floor in place contains asbestos. It frequently does contain asbestos.

12.0 Sites Still to be Remediated by the PacWaste Project

SPREP decided in the remediation component of the PacWaste Stage One work to exclude sites with a risk ranking less than 17 from assistance in the PacWaste Project although it is acknowledged that sites with a risk ranking less than 17 still present a risk to those people at or near the site, albeit a lesser risk.

Residential sites were excluded due to the large numbers and logistical difficulties, although it was noted that these sites represented a potentially significant risk to those living in the residences depending on the state of the asbestos. The state of the asbestos in residential locations was often poor to very poor.

All the Banaba sites scored high on the risk ranking scale and some very high but due to the logistical difficulties already described in Section 5.3 above, the Banaba sites were excluded from assistance. Banaba is, however, quite high on the list of priorities for the Kiribati Government and may need to be addressed as a separate issue.

Also excluded from initial assistance were commercial and industrial sites. Churches were also excluded on the basis that they are privately owned. Some churches have in fact now received attention privately since the survey was carried out.

Three former industrial sites are now derelict (orphan) sites. These are:

- Vava'u Former Bulk Fuel Terminal, Tonga
- Manganese Mine, Forari, Vanuatu
- Old Timber Site, Savai'i, Samoa

The decision to exclude these sites may have to be reconsidered. In view of the Forari Mine now being inhabited by several families (see photo on the cover of the report), the risk rating has been increased from 21 to 27. This could of course be reduced by moving the families out, but the mine offers convenient shelter and is close to the road, so it could easily be re-occupied. The other two sites also present significant hazards.

The Niue sites were excluded from the remediation component of Stage 1 as Niue was already receiving funding assistance from the first stage of the PacWaste project. Niue sites should now be included again for consideration.

Relevant sites with risk rankings 16 and 15 have also now been added in seeing as quite a number of higher ranked sites have now been dealt with. Also the BKL Building in Kiribati was previously wrongly ranked. It is very large old building in Betio that has a substantial amount of badly deteriorating asbestos. It is also a widely used building with numerous people working there every day. It has been reassigned a ranking from 15 to

24 and may now need to be considered for assistance because of the hazards it presents, despite being an industrial building.

A badly deteriorated industrial site in Niue (the St Josephs site) may also need to be considered for assistance, despite being an industrial site. Very high levels of wipe sampling were recorded on two occasions. Workers occupying this building are therefore being placed at significant risk.

The Bonriki International Airport at Kiribati and Nadi Airport in Fiji are currently being upgraded (with asbestos issues being dealt with) and so have been removed from the original list.

Table 13 below therefore presents the sites to be considered for remediation in Stage 2 of the PacWaste project.

The privately owned sites are shown in blue (e.g. industrial, commercial, churches) and two of the industrial sites are shown in yellow (St Joseph in Niue and BKL in Kiribati). Both these sites are considered to be hazardous enough for SPREP to consider at least partly funding a remediation project, perhaps in conjunction with the owners of the sites. Several RONPhos and NPC sites also have high risk rankings. RONPhos and NPC are both Nauru Government owned corporations and they should also be encouraged if possible to deal with their asbestos issues.

Based on the costings from the remediation work carried out in the remediation component of PacWaste Stage 1 (see Section 9.0 above) and also based on other information gained since these costings were put together, rough costs have been assigned to all the individual projects listed in Table 13. These costs include estimates to cover accommodation and flights. The costs are presented as a rough guide only and the real test of the costs will be the tendering process. All costs are for removal and replacement unless “Removal Only” is stated. Costs have not been assigned to privately-owned sites except for the “yellow” sites.

There are three orphan sites coloured in light green (and mentioned above) and these should also now be considered for remediation funding by SPREP. These sites are also costed.

Information on the size, laboratory analysis and type of work will need to be obtained from the original PacWaste Reports, which are available on the SPREP website. This information will be important for tenderers. Alternatively it could be specified in the tender documents, which would be preferable.

Sites to be considered for Remediation in Stage Two of the PacWaste project are therefore presented in Table 13 below. The sites highlighted in blue should not be considered for remediation by PacWaste as they are privately-owned sites, but they should still be regarded as needing remediation.

Table 13: Sites to be Considered for Remediation in Stage Two of the PacWaste Project

Country	Location	Type of Building Material	Rough Cost Estimates (USD)	Risk Ranking
Vanuatu	Manganese Mine, Forari	Cladding and Roofing (Removal Only)	250,000	27
Nauru	RonPHOS Workshop	Cladding		26
Niue	St Francis Automechanics / Peta Paints	Roofing / Cladding	200,000	26
Cook Islands	Rarotonga, Avarua School	Cladding	20,000	25
Cook Islands	Rarotonga, Avatea Primary School	Cladding	35,000	25
Cook Islands	Rarotonga, Seventh Day Adventist School	Cladding	30,000	25
Cook Islands	Mangaia, Mangaia School	Cladding	35,000	25
Nauru	Power Station Building	Gable / Main Eastern Entrance Cladding	20,000	25
Nauru	Power Station Building	Roof, Northern Side	30,000	24
Nauru	Power Station Building	Wall Entrance to Switchboard Corridor, (North Side)	20,000	22
Nauru	Power Station Building	Cool Store Roof, Southern Side	20,000	23
Nauru	Power Station Building	Water Services Building Roof and Gables	20,000	21
Nauru	Power Station Building	Cable Shed Western Wall, Northern End	15,000	20
Nauru	Power Station Building	West Wall, Northern End	20,000	20
Nauru	RONPhos Main Conveyor	Roof and Cladding		25
Nauru	RONPhos Workshop Store and Toilet	Roof and Cladding		25
Nauru	RONPhos Offices and Stores	Roof and Cladding		25

Country	**Location**	**Type of Building Material**	**Rough Cost Estimates (USD)**	**Risk Ranking**
Nauru	RONPhos Tall Building by Road	Roof and Cladding		25
Nauru	RONPhos Siloes Cover	Roof		25
Nauru	RONPhos Conveyor Roof	Roof		25
Nauru	RONPhos Small Shed Roof	Roof		25
Samoa	Customs House, Apia Port	Exterior Façade	20,000	25
Cook Islands	Rarotonga, Nikao School	Cladding	20,000	24
Cook Islands	Aitutaki, Araura College	Cement Board Divider Panels	15,000	24
Cook Islands	Aitutaki, Araura Primary	Cement Board Divider Panels	15,000	24
Cook Islands	Mangaia, Old Government House	Roof (Burnt Building) (Removal Only)	20,000	24
Cook Islands	Mangaia, Old Government House	Debris and Contaminated Soil	15,000	24
Fiji	Tamavua Hospital	Old Ward 5 Building (Removal Only)	120,000	24
Fiji	Suva Grammar School	Vinyl Tiles - Numerous Classrooms and Other Areas	350,000	24
Kiribati	Bobotin Kiribati Ltd (BKL), Betio	Roofing, Cladding and Guttering	250,000	24
Nauru	RONPhos Conveyor Building	Roof and Cladding		24
Nauru	RONPhos Old NPC Club	Roof		24
Nauru	RONPhos Old Phosphate Bin by Hotel	Roof and Cladding		24
Nauru	RONPhos Processing Plant Building	Roof and Cladding		24
Nauru	NPC Workshop	Roof and Cladding		24
Nauru	NPC Shelter	Roof		24
Nauru	NPC Paint Shed	Roof and Cladding		24
Nauru	NPC Tyre Bay	Roof and Cladding		24
Cook Islands	Aitutaki Hospital	Cladding	30,000	23
Cook Islands	Aitutaki, Tekaaroa School	Cladding	15,000	23
Cook Islands	Mangaia, Ivirua School	Roof	20,000	23

Country	**Location**	**Type of Building Material**	**Rough Cost Estimates (USD)**	**Risk Ranking**
Cook Islands	Mangaia, Ivirua School	Cladding	15,000	23
Cook Islands	Mauke, Old Hospital	Cladding	10,000	23
Nauru	Anetan Infant School	Front Classroom Cladding	15,000	23
Tuvalu	Meterological Centre	Roof	20,000	23
Tuvalu	Former Power House	Roof and Wall Cladding	15,000	23
Cook Islands	Rarotonga, Arorangi Church	Cladding		22
Nauru	Boe Infant School	Old School - Cladding Mid -area	10,000	22
Nauru	Conrad Restaurant – Beitsi	Roof		22
Nauru	RONPhos Old Phosphate Store by Sports-ground	Roof		22
Nauru	RONPhos Phosphate Storage Bin by Sea	Roof		22
Nauru	RONPhos Training Centre	Roof		22
Niue	Former Primary School	Cladding / Soffits / Debris	30,000	22
Niue	Honey Processing	Roofs	25,000	22
Samoa	Meterological Station, Apia	Corrugated roof	25,000	22
Kiribati	Kiribati MELAD, Bairiki	Vinyl floor tiles	40,000	21
Kiribati	Ministry of Fisheries, Bairiki	Sunshades	20,000	21
Kiribati	Ministry of Finance, Betio	Sunshades	20,000	21
Nauru	Nibok Infant School	Cladding	15,000	21
Nauru	Old Cinema in Location	Roof (Removal Only)	15,000	21
Nauru	Old Laundry for Expats – Denig	Cladding		21
Nauru	3 in 1 Store Ewa	Cladding		21
Nauru	My Store (DHL) Yaren	Cladding		21
Nauru	TAB Menen	Cladding		21
Nauru	RonPHOS Workshop	Roofing		21
Nauru	RONPhos Shed next to NPC Club	Roof		21

Country	Location	Type of Building Material	Rough Cost Estimates (USD)	Risk Ranking
Nauru	RONPhos Vehicle Workshops	Roof and Cladding		21
Samoa	Femei Matata Statistics Office	Ceiling Panels	15,000	21
Tonga	Plumbing Shop	Roof and Facades		21
Tonga	Pacific International (Tonga) Ltd	Roof		21
Cook Islands	Rarotonga Met Office	Roof	25,000	20
Nauru	RONPhos Head Office	Roof		20
Nauru	RONPhos Waste Pile by Road	Stockpile		20
Niue	Secondary School	Cladding	40,000	20
Niue	Alofi South Hall	Cladding	20,000	20
Niue	Lakepa Pre-School	Cladding	15,000	20
Samoa	Paul VI College	Roof	25,000	20
Samoa	Manono-uta Church, Upolu	Vinyl tile		20
Solomon Islands	Lands and Survey Building, Honiara	Floor Tiles	50,000	20
Solomon Islands	Min of Infrastructure and Development, Honiara	Floor Tiles	50,000	20
Tonga	Industrial 01, Nuku'alofa	Roof		20
Tonga	Vava'u Former Bulk Fuel Terminal	Roof		20
Vanuatu	Port Vila Central Hospital	Vinyl Flooring	60,000	20
Cook Islands	Atiu, Agriculture Building	Cladding	20,000	19
Nauru	Small Shed by Road – Denig	Roof		19
Nauru	Naoero Central Minimarket	Roof		19
Nauru	Meage Store Nibok	Cladding		19
Nauru	RONPhos - Stacked Sheets	Stockpile		19
Niue	Police Station	Cladding / Soffits	25,000	19
Niue	Old Hakupu School	Cladding	30,000	19
Niue	Vai Mamali / Rockbak Building	Cladding		19
Niue	Alofi Bread Shop	Cladding / Soffits		19

Country	**Location**	**Type of Building Material**	**Rough Cost Estimates (USD)**	**Risk Ranking**
Cook Islands	Rarotonga, Arorangi Commercial Bldg	Cladding		18
Cook Islands	Atiu, Marine Building	Cladding	20,000	18
FSM	Dept of Education Admin, Yap	Floor tiles	40,000	18
FSM	FSM Fisheries & Maritime Inst, Yap	Floor tiles	40,000	18
Nauru	Bridge Rd Trader – Aiwo	Roof		18
Nauru	Petrol Station / Chinese Restaurant	Roof and Cladding		18
Nauru	Green Tiled Building Sea Side Menen	Cladding		18
Nauru	I J Store	Cladding		18
Nauru	2 Small RONPhos Buildings	Roofs		18
Nauru	RONPhos - 6 Small Houses	Roofs		18
Nauru	RONPhos - Old NPC Bakery	Roof		18
Nauru	RONPhos - 2 Buildings Behind Power Stn	Roof and Cladding		18
Niue	Niue Broadcasting	Cladding / Soffits	30,000	18
Niue	Tuapa Hall	Cladding	35,000	18
Niue	Makini Handcrafts	Fence made from Roofing		18
Niue	Jenna's Restaurant	Cladding		18
Niue	Sassy Fashions / Breakthrough	Cladding		18
Niue	Peleni's Travel	Cladding		18
Niue	Abbatoir / Meat Processing	Roof	15,000	18
Niue	Avatele Church Panels	Panels		18
Niue	Old Fulton Hogan Bitumen Tankers	Lagging	140,000	18
Samoa	Tuiala Power Station, Upolu	Vinyl floor, control room	40,000	18
Samoa	Old Timber Site, Savai'i	Cladding, Boiler Pipe Insulation	40,000	18

Country	Location	Type of Building Material	Rough Cost Estimates (USD)	Risk Ranking
Solomon Islands	Waimpuru Secondary School, Makira	Cladding	30,000	18
Tonga	Industrial 02, Nuku'alofa	Roof		18
Tonga	CAT Depot, Nuku'alofa	Soffit		18
Cook Islands	Atiu, Hospital	Cladding	25,000	17
Cook Islands	Mitiaro, Administration Building	Cladding - Exterior and Interior	30,000	17
Fiji	Labasa College	Library sunshade	15,000	17
Kiribati	Kiribati Community Club, Bairiki	Guttering	15,000	17
Kiribati	Former Power House	Rope lagging	10,000	17
Nauru	C-Store Market	Roof, Soffits		17
Nauru	Onion Store Boe	Cladding		17
Nauru	Nauru Independent Church / House Boe	Roof		17
Niue	Avatele Old School	Panels	15,000	17
Niue	Toi Meeting Hall	Cladding	20,000	17
Samoa	Safofu Church	Roof		17
Samoa	WSLAC House	Sun shade		17
Tonga	Small Business Centre Management Office	Cladding	15,000	17
FSM	Pohnpei Fishing Corporation Generator Shed	Cladding	20,000	16
FSM	Immaculate Heart of Mary Church, Chuuk	Cement Roof		16
Solomon Islands	Council Building, Gizo	Cladding	20,000	16
Vanuatu	Ministry of Lands and Natural Resources	Cladding, Gables, Soffits	30,000	16
Total			**2,900,000**	

13.0 Residential Asbestos Remediation Costs

The residential costs are shown below in Table 14 for the surveyed countries. Some experience has been gained since the survey and the numbers have been adjusted accordingly. **The figures presented in Table 14 therefore differ in some respects to those given in Section 5.1 above.**

The following points should be noted:

- The number of residences generally varies with a 3.5% margin of error, based on the statistical method used to calculate the number.
- There is little saving in the cost of encapsulation compared with "removal and replacement" for asbestos roofs, as the underside of the roof needs to be encapsulated as well as the top and this involves ceiling replacement and dealing with asbestos dust in the roof space.
- There is, however, a significant saving in encapsulation of cladding compared with "removal and replacement". In practice, encapsulation would therefore be favoured for cladding unless there has been significant deterioration in the cladding, which is often the case in the Pacific.
- The "other" category is only encountered in FSM and Palau and refers to asbestos columns filled with concrete that are part of the house structure. These columns could easily be encapsulated.

If approximately 30% of the houses have cladding that is sufficiently deteriorated to justify "removal and replacement" rather than encapsulation then the total cost of remediating all roofs and cladding on residences in the Pacific would be about $US41.4M. Given the level of uncertainty in the figures it is probably sufficient to say that the cost would be around $US40M.

Table 14: Residential Asbestos Remediation Costs

Country	Estimate of Total Houses with Asbestos			Cost of Removal and Replacement based on averages of 200 m2 for a roof and 120 m2 for cladding		Cost of Encapsulation based on averages of 200 m2 for a roof and 120 m2 for cladding		
	Roofs	Cladding	Other (e.g. Columns)	Roofs	Cladding	Roofs	Cladding	Other (e.g. Columns)

Country	**Estimate of Total Houses with Asbestos**			**Cost of Removal and Replacement based on averages of 200 m2 for a roof and 120 m2 for cladding**		**Cost of Encapsulation based on averages of 200 m2 for a roof and 120 m2 for cladding**		
Cook Islands	20	150	0	384000	1368000	364000	1134000	0
Fiji	10	20	0	192000	182400	182000	151200	0
FSM	10	20	8	192000	182400	182000	151200	32000
Kiribati (Excluding Banaba)	10	520	0	192000	4742400	182000	3931200	0
Nauru	580	230	0	11136000	2097600	10556000	1738800	0
Niue	230	190	0	4416000	1732800	4186000	1436400	
Palau	0	0	2	0	0	0	0	4000
RMI	0	0	0	0	0	0	0	0
Samoa	5	20	0	96000	182400	91000	151200	0
Solomon Islands	5	1200	0	96000	10944000	91000	9072000	0
Tonga	150	50	0	2880000	456000	2730000	378000	0
Tuvalu	0	50	0	0	456000	0	378000	0
Vanuatu	70	150	0	1344000	1368000	1274000	1134000	0
Total Costs				**20928000**	**22344000**	**19474000**	**19656000**	**36000**

14.0 Discussion

A WHO Symposium lead by Dr Jorma Rantanen in Fiji in April 2015 presented the following information:

- Exposure to asbestos causes a range of diseases, such as lung cancer, mesothelioma, and asbestosis (fibrosis of the lungs), as well as pleural plaques, thickening and effusions. In March 2009 the International Agency for Research on Cancer reviewed the evidence about the carcinogenicity of the different forms of asbestos.
- Epidemiological evidence has increasingly shown an association of all forms of asbestos (chrysotile, crocidolite, amosite, tremolite, actinolite, and anthophyllite) with an increased risk of lung cancer and mesothelioma. Although the potency of different fibre types and dimensions is debated, the fundamental conclusion is that all forms of asbestos are "carcinogenic to humans". Mineral substances containing asbestos (e.g., talc) or vermiculite-containing asbestos should also be deemed "carcinogenic to humans".
- Sufficient evidence is now available to show that asbestos also causes cancer of the larynx and of the ovary.
- The incidence of asbestos-related diseases is related to fibre type, fibre size, fibre dose and to industrial processing of the asbestos. No threshold has been identified for the carcinogenic risk of chrysotile. Cigarette smoking significantly increases the risk of lung cancer from asbestos exposure.
- The Global Comparative Risk Assessment study carried out by WHO in 2002 showed then that about 124 million people in the world were exposed to asbestos and thus are at risk of developing lethal asbestos-related diseases. There are many reasons to believe that this number is now much higher.
- Exposure to asbestos occurs through inhalation of fibres primarily from contaminated air in the working environment, as well as from ambient air in the vicinity of point sources, or indoor air in housing and buildings containing friable asbestos materials.
- The highest levels of exposure occur during repackaging of asbestos containers, mixing with other raw materials and dry cutting of asbestos-containing products with abrasive tools.
- Friable chrysotile and/or amphibole-containing materials are still in place in many buildings and continue to give rise to exposure to both chrysotile and amphiboles (other forms of asbestos) during maintenance, alteration, removal and demolition.

- According to the WHO global estimates at least 107,000 people die each year from asbestos-related lung cancer, mesothelioma and asbestosis resulting from occupational exposures.
- In addition, it is believed that several thousands of deaths can be attributed to other asbestos-related diseases as well as to non-occupational exposures to asbestos.
- Asbestos is the most important occupational carcinogen causing one third of all deaths from occupational cancer and therefore WHO attaches high priority to actions for elimination of asbestos-related diseases.
- The burden of asbestos-related diseases is still rising, even in countries that have banned the use of asbestos in the early 1990s. Because of the long latency periods attached to the diseases in question, stopping the use of asbestos now will only result in a decrease in the number of asbestos-related deaths after a number of decades.

In sum, the work of WHO on asbestos carried out by the International Programme for Chemical Safety and the International Agency for Research on Cancer led to the following conclusions:

1. All types of asbestos cause asbestosis, mesothelioma and lung cancer
2. No safe threshold level of exposure has been identified
3. Safer substitutes exist
4. Exposure of workers and other users of asbestos-containing products is extremely difficult to control
5. Asbestos abatement is very costly and difficult to carry out in a completely safe way

One measure of the impact of diseases is the “Disability-Related Life Year” (DALY). This is the number of years lost due to ill-health, disability or early death. WHO estimates that the total global DALY is about 1.6 million per year (including Mesotheliomas 564 000, Lung Cancers 969 000)

The WHO also estimates that over 130 countries are still ineffectively regulated (including all the Pacific Island Nations). In many countries registration of exposed workers, diagnostics and registration as well as compensation of ARDs are still either non-existent or very ineffective.

The WHO Symposium proposed that there is currently a global epidemic of asbestos and is seeking a global ban on the production of asbestos in all forms. About 2 million tonnes of asbestos products are still produced annually – almost exclusively now using chrysotile. About 56 countries have banned the import of asbestos products but presumably most of the remaining countries still import and use asbestos products. No Pacific country has banned the import of asbestos products and the PacWaste Stae One work discovered asbestos sheeting building material being sold in hardware shops in Vanuatu and the Solomon Islands. It is quite possible that asbestos sheeting is also being sold in other Pacific countries.

In view of the concerns expressed by WHO and the facts they have made available, asbestos presents a serious risk in the Pacific and elsewhere. The data gathered by the PacWaste Survey and presented in this report enables this risk to be quantified and addressed.

It is clear from the survey that there is a serious although uneven asbestos problem in the Pacific, in the countries that were surveyed. Nauru and Niue have substantial amounts of asbestos, and Cook Islands, Tonga and Vanuatu also have large amounts. Solomon Islands and Kiribati (excluding Banaba) have quite large amounts of residential cladding but no roofing and Tuvalu also has residential asbestos in some dwellings. It should be noted that the estimated amounts of residential asbestos in countries with multiple islands is quite speculative. Also only the main islands were visited and extrapolations have been made based on data from the main islands.

Fiji is unusual as it has very little asbestos seeing as it is the largest Pacific Island country but it does have a few serious problems. Samoa is somewhat similar to Fiji in that only one residence with an asbestos roof was found and none with asbestos cladding. There were, however, some moderately serious non-residential asbestos issues.

Palau, FSM and RMI had very little asbestos, with the main issue being asbestos-cement water pipes and some columns made from these pipes. A few other examples were found such as deteriorating non-residential buildings on Pohnpei, churches with asbestos roofs on Yap and Chuuk and a large recently constructed power station building on Palau. Overall, however, these countries were largely asbestos-free.

Banaba has huge asbestos issues but must be treated as a special case. There are substantial logistical issues in carrying out an asbestos remediation operation on Banaba as the access is very difficult with no airport and no regular shipping. There are also no supplies available on the island and no accommodation. The residents are exposed to serious levels of asbestos, however, and are considerably at risk of suffering asbestos-related diseases.

There are many other problems to be dealt with on Banaba with the huge deteriorating remains of the once-thriving phosphate industry that operated on the island. It would make sense to deal with all these problems together as a combined effort. The asbestos component of this project may well be in excess of $US20M. It is, however, estimated that a detailed report could be prepared for the Banaba asbestos work, including a detailed methodology, for about $US80,000. This would involve a visit to Banaba by a small team for several weeks as well as some other investigations. The resulting report could then be used to raise funds for the Banaba clean-up work.

As shown in Section 12 above, most of the major non-residential asbestos in the Pacific (at least that which has been identified by the PacWaste survey work) can be dealt with for around $US3M. This excludes Banaba, and also privately-owned buildings, except for two privately owned buildings that are considered urgent and three sites that have become orphan sites.

The residential asbestos remediation and replacement costs, based on PacWaste surveys and statistical calculations, come to around $US35M although it should be noted that much of this is based on somewhat doubtful estimates including extrapolating to include outer islands that were not surveyed. It should also be noted that much more testing is needed before embarking on a programme of dealing with the residential asbestos.

There is little doubt that what appears to be asbestos roofing is in fact asbestos roofing. It is different, however, with cladding. A high percentage, often more that 50%, of fibre cement board that may contain asbestos fibres, does in fact contain fibres that are not asbestos and this can only be verified by testing the cladding on every house individually.

The total cost of overall asbestos remediation in the 13 countries surveyed is therefore of the order of $US46.8M although given the accuracy of the figures this could probably be better stated as $US40-50M (excluding Banaba). The second stage of the PacWaste Project is covering about $US2M so there is a substantial shortfall.
There would be a case for seeking additional funding from international agencies involved with Disaster Risk Reduction (DRR) as the cost of remediating asbestos-containing structures is substantially more after a disaster than before a disaster.

The use of the Risk Ranking process described in Section 4 above has proved very useful in assessing priorities in each country and in allocating the scarce resource of the second stage of PacWaste asbestos funding. The scores allocated are logical and reasonably consistent in their derivation, although the different persons who conducted various parts of the survey may have had slightly different ways of interpreting the Risk Ranking criteria.

Almost all the asbestos discovered by the survey of the 13 countries is non-friable asbestos, or at least it was when installed. When non-friable asbestos, such as roofing and cladding, deteriorates as is the case in much of the Pacific, it starts to become friable in that it breaks down and releases fibres. The cases of actual friable asbestos are few, however, and they include the Tamavua-Twomey Hospital in Suva and the Fulton Hogan bitumen tankers on Niue.

Disposal of asbestos is an issue in Pacific countries as landfills are often better described as dumpsites and are usually inadequate for safely managing asbestos. Procedures can be put in place, however, for improving management systems at poorly run landfills and the aim should be local disposal if possible. The alternative is export to Australia or New Zealand and this can be successfully done at a reasonable cost. In fact several such exports of asbestos waste have already taken place.

The second stage of the asbestos component of the SPREP PacWaste project will deal only with a small percentage (probably about 5%) of the asbestos present in the 13 countries surveyed. All efforts should be made to seek funding to deal with the at least part of the remaining 95% and until this can be achieved, temporary measures should be put in place, as outlined in Section 7.2 of this report, for minimising the risks as much as possible.

Improvements in individual country regulations are needed to ensure that asbestos hazards are better managed. A regulatory team needs to be set up and procedures such as are outlined in Appendix 4 are needed, including the preparation of Asbestos Removal Plans.

In addition all Pacific countries need to implement a ban on the importation of asbestos-containing products into their countries. Model legislation for implementing such a ban should be prepared by SPREP. Otherwise asbestos will continue to be imported into Pacific countries to be used in an uncontrolled manner, including cutting and handling practices that generate harmful fibres.

Damaged houses with asbestos, and also asbestos debris, has the potential to become a major issue in disasters such as cyclones. There have been several recent instances of asbestos problems arising in such cyclone disasters, such as Cyclone Pam in Vanuatu and other neighbouring countries, and Cyclone Ian in Tonga. It is much cheaper to deal with asbestos pro-actively before it becomes a problem, rather than having to deal with it in a post-disaster scenario.

Finally it needs to be stressed that the asbestos remediation work must be carried out to a high standard in a manner that meets all recognised asbestos remediation procedures. Such procedures are, for example, set out in regulations in Australia and New Zealand. Contractors carrying out the second stage asbestos work could employ local staff or could be local contractors but they would need specialist overseas supervision. It would also be useful to have third party verification that the right procedures are being followed. This would ensure the necessary measures were in place to protect workers and the public.

15.0 Recommended Actions for PacWaste Stage 2 Asbestos Work

A. It is recommended that asbestos is treated as a high priority issue in the Pacific as it has the potential to cause a range of asbestos-related diseases. The ones that are of most concern are lung cancer (which is aggravated by smoking) and mesothelioma.
B. The risk posed by asbestos can be effectively quantified and managed. It is therefore recommended that a programme of dealing with asbestos is set in place and implemented in all the countries covered by the PacWaste Survey.
C. The asbestos management programme should include the removal of asbestos where practicable and especially where it presents a significant risk as assessed by the risk ranking score. If the asbestos is to stay in place for the time being then it should be managed safely in a way that fibre production is minimised. Encapsulation should be considered, at least as a temporary measure.
D. Non-residential priority sites to be remediated have been identified for the second stage of the PacWaste project. The total value of this work is estimated to be approximately $US2.9M. As many of these locations as practicable should be remediated, within the available budget.
E. Careful attention needs to be paid to the "lessons learnt" from the remediation work carried out in PacWaste Stage 1. This includes a better tendering process, better controls on the work including possible independent assessment and review, better management of local workers, and better scoping of the work to be done.
F. Additional funding may be needed and Disaster Risk Reduction (DRR) should be one of the drivers in seeking such funding as it is much cheaper to deal with asbestos before a disaster such as a cyclone than before the disaster. Asbestos-damaged houses and asbestos debris can cause major problems in post-disaster scenarios and this needs to be clearly acknowledged n any programme to manage asbestos risks.
G. A special focus is also needed on residential dwellings as at least 80% of asbestos identified is contained in residential dwellings. This is often in deteriorating condition and people living in these dwellings are at real risk of contracting asbestos-related diseases. Some PacWaste Stage Two funding could be made available to assist with remediating residential dwellings, or at least enabling the problem to be better managed.
H. A programme of testing cladding in residential dwellings would provide some clarity as to which houses are at risk. The programme should include clearly identifying visually which houses have asbestos roofs.
I. At the very least, residential houses should be targeted by an awareness-raising campaign that aims to educate and set in place measures to reduce the risks of asbestos-related diseases where possible.

J. Financial assistance with remediation of residential houses could take the form of subsidies available to remediate houses considered most at risk, by removing or encapsulating the asbestos as appropriate.
K. The matter of disposal of asbestos wastes needs to be addressed in each country and the focus should be placed on local disposal if possible, with suitable measures in place to manage such disposal. If local disposal is inappropriate then assistance should be provided to enable the export of asbestos wastes.
L. In all cases where there is potential for people to be exposed to asbestos fibres, then before asbestos remediation takes place (and after if all the asbestos is not removed) suitable asbestos management practices and procedures should be set in place. These practices and procedures would deal with the ongoing risk posed to human health by asbestos exposure. This should be accompanied by an appropriate education and training programme.
M. Legislation should be enacted in each country to enable the above asbestos work to be carried out and to enable effective management of asbestos in each country, including setting up a trained regulatory team and putting in place systems for notifying regulatory agencies that asbestos removal work is being carried out.
N. Legislation is also needed in each country to prevent the import of new asbestos products that will only continue the problem. SPREP could assist in this matter by drafting model legislation to enable bans to take place.
O. Banaba is a special case due to the large logistical difficulties involved. It represents a huge legacy of deteriorating asbestos materials and waste, however, and this matter should be addressed by a detailed study of the options available for addressing the asbestos problem. This could be done in conjunction with addressing all the other legacy issues on Banaba arising from the former phosphate industry.

Appendix 1: Edited Copy of the Terms of Reference for the Survey Work

Background

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

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

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

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

Objective

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

Scope of Work

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

Tasks

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

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

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

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

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

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

Project Deliverables

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

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

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

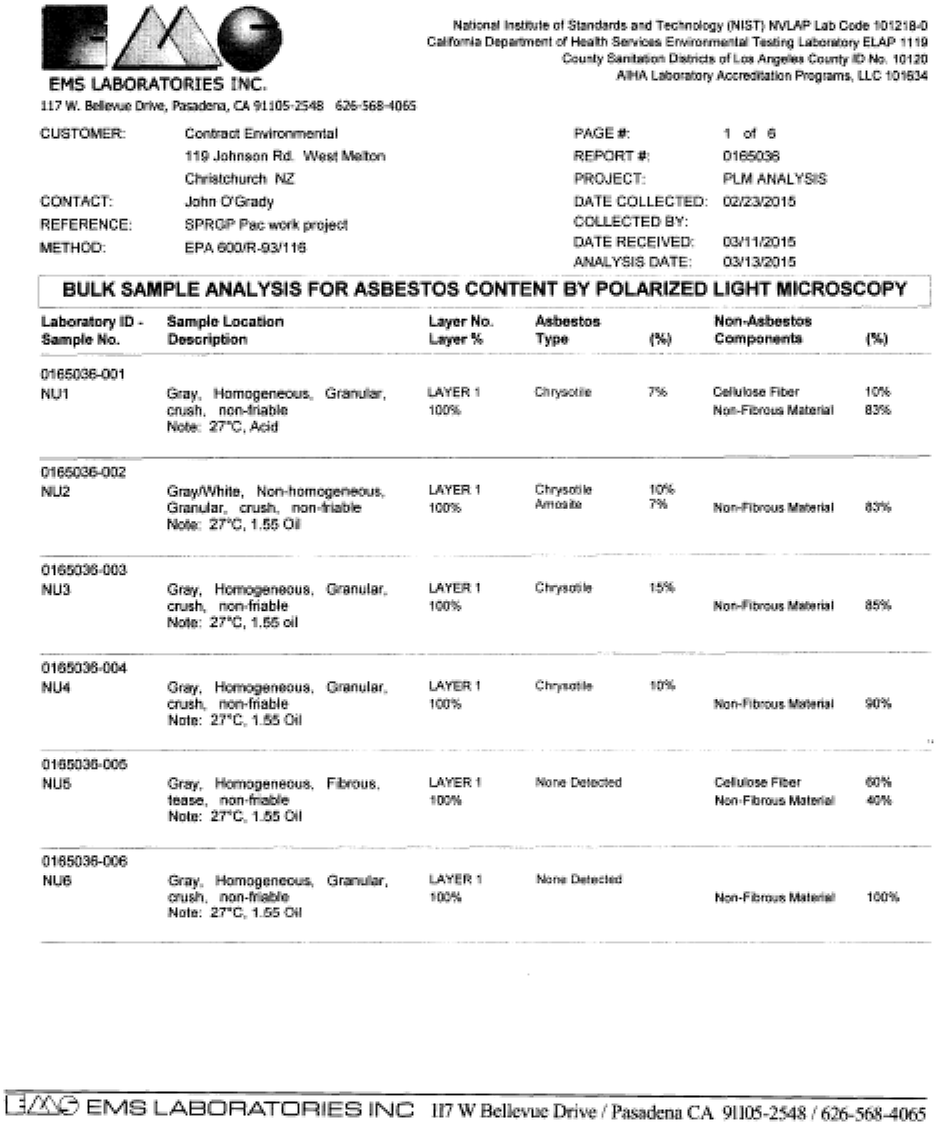
4. Final report presenting costed priority actions necessary to minimise the exposure of the local population to asbestos fibres for each Pacific Island country identified in the work region(s).

Project Timeframe

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

Appendix 2: Typical Laboratory Reports – Niue

Niue First Bulk Results



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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
CONTACT: John O'Grady
REFERENCE: SPRGP Pac work project
METHOD: EPA 600/R-93/116

PAGE #: 1 of 6
REPORT #: 0165036
PROJECT: PLM ANALYSIS
DATE COLLECTED: 02/23/2015
COLLECTED BY:
DATE RECEIVED: 03/11/2015
ANALYSIS DATE: 03/13/2015

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	(%)
0165036-001 NU1	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, Acid	LAYER 1 100%	Chrysotile	7%	Cellulose Fiber Non-Fibrous Material	10% 83%
0165036-002 NU2	Gray/White, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	10% 7%	Non-Fibrous Material	83%
0165036-003 NU3	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-004 NU4	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	10%	Non-Fibrous Material	90%
0165036-005 NU5	Gray, Homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	60% 40%
0165036-006 NU6	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%

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Christchurch NZ

PAGE #: 2 of 6
REPORT #: 0165036
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	(%)
0165036-007 NU7	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	2% 98%
0165036-008 NU8	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	10% 7%	Non-Fibrous Material	83%
0165036-009 NU9	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	10% 90%
0165036-010 NU10	Gray, Homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	60% 40%
0165036-011 NU11	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-012 NU12	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	10% 10%	Non-Fibrous Material	80%
0165036-013 NU13	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	7%	Non-Fibrous Material	93%
0165036-014 NU14	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, Acid	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-015 NU15	Gray/Cream, Non-homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	20% 80%

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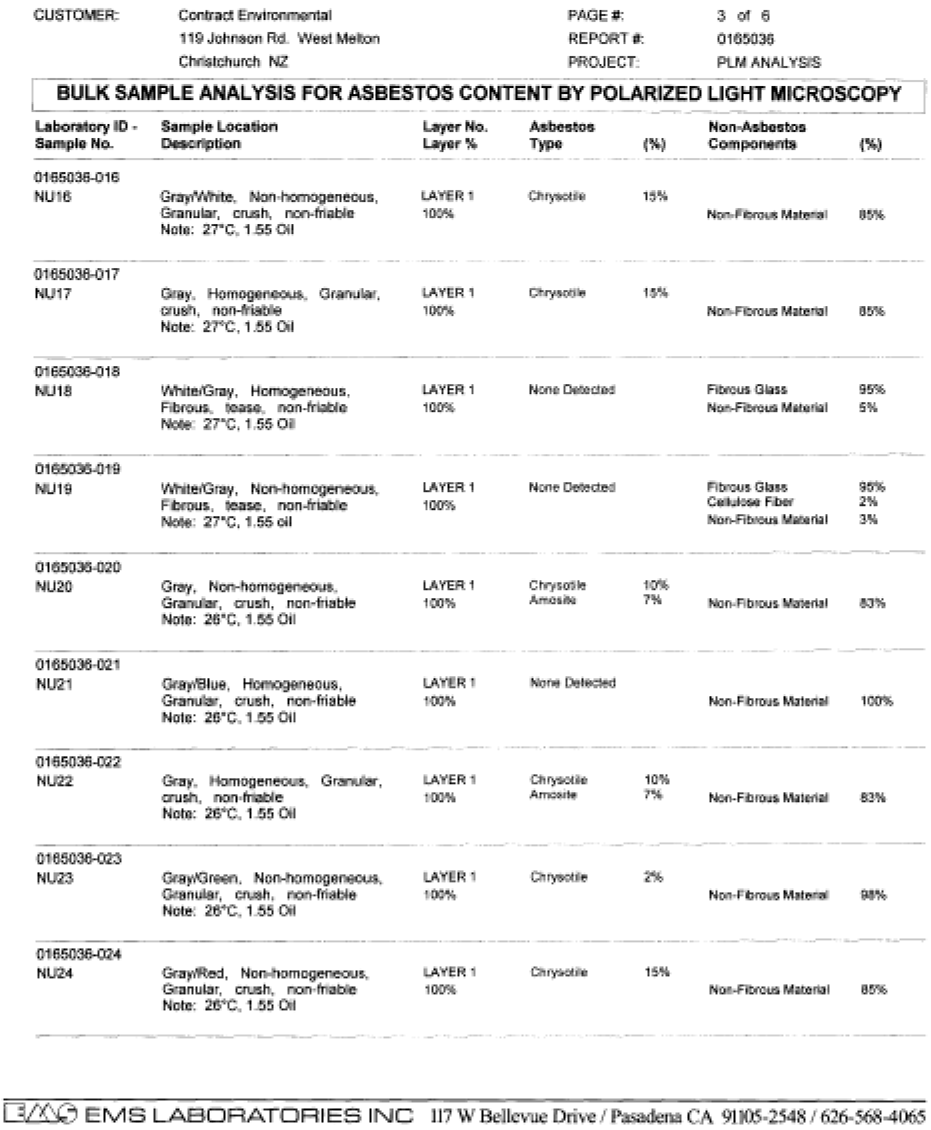

CUSTOMER:	Contract Environmental 119 Johnson Rd. West Melton Christchurch NZ	PAGE #: REPORT #: PROJECT:	3 of 6 0165036 PLM ANALYSIS

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	(%)
0165036-016 NU16	Gray/White, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-017 NU17	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-018 NU18	White/Gray, Homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Fibrous Glass Non-Fibrous Material	95% 5%
0165036-019 NU19	White/Gray, Non-homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 oil	LAYER 1 100%	None Detected		Fibrous Glass Cellulose Fiber Non-Fibrous Material	95% 2% 3%
0165036-020 NU20	Gray, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	10% 7%	Non-Fibrous Material	83%
0165036-021 NU21	Gray/Blue, Homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-022 NU22	Gray, Homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	10% 7%	Non-Fibrous Material	83%
0165036-023 NU23	Gray/Green, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile	2%	Non-Fibrous Material	98%
0165036-024 NU24	Gray/Red, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%

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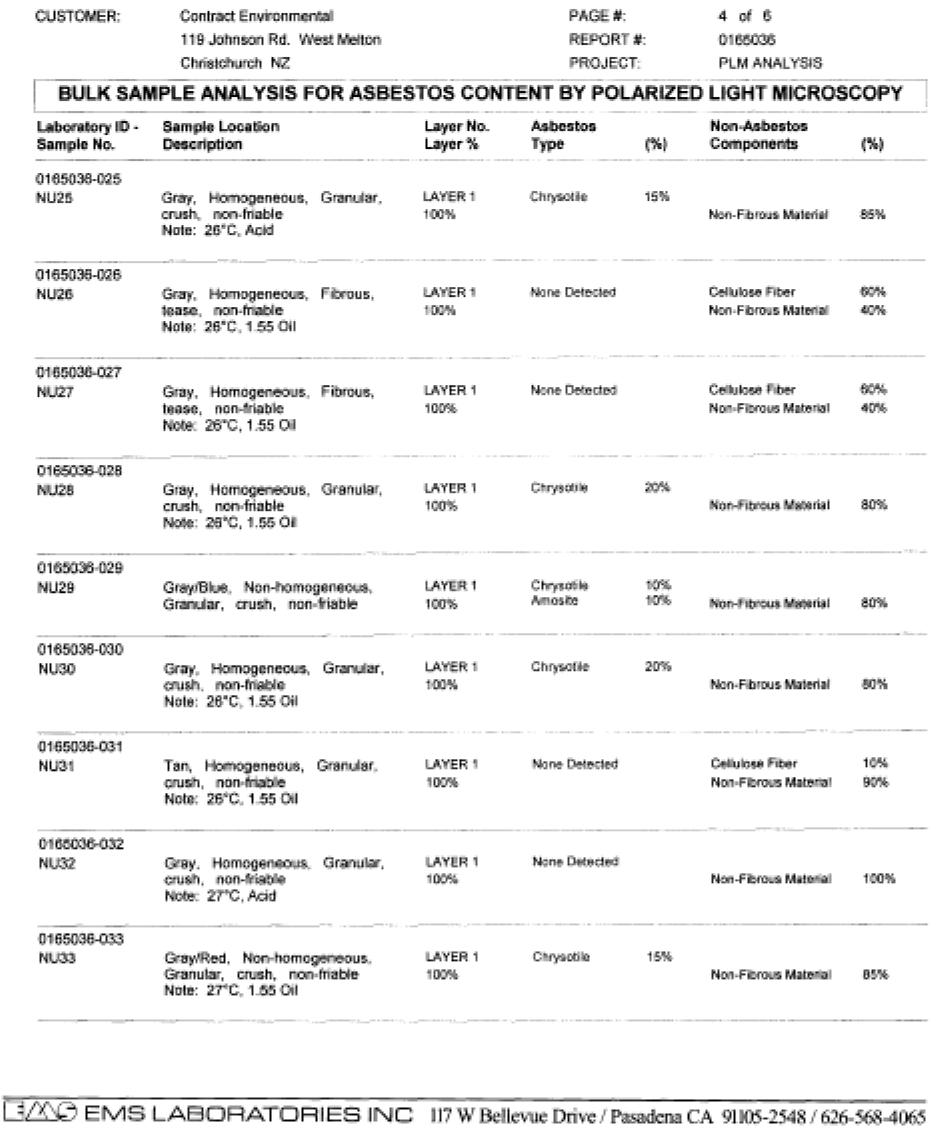

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Christchurch NZ

PAGE #: 4 of 6
REPORT #: 0165036
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	(%)
0165036-025 NU25	Gray, Homogeneous, Granular, crush, non-friable Note: 26°C, Acid	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-026 NU26	Gray, Homogeneous, Fibrous, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	60% 40%
0165036-027 NU27	Gray, Homogeneous, Fibrous, tease, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	60% 40%
0165036-028 NU28	Gray, Homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile	20%	Non-Fibrous Material	80%
0165036-029 NU29	Gray/Blue, Non-homogeneous, Granular, crush, non-friable	LAYER 1 100%	Chrysotile Amosite	10% 10%	Non-Fibrous Material	80%
0165036-030 NU30	Gray, Homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile	20%	Non-Fibrous Material	80%
0165036-031 NU31	Tan, Homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	10% 90%
0165036-032 NU32	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, Acid	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-033 NU33	Gray/Red, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%

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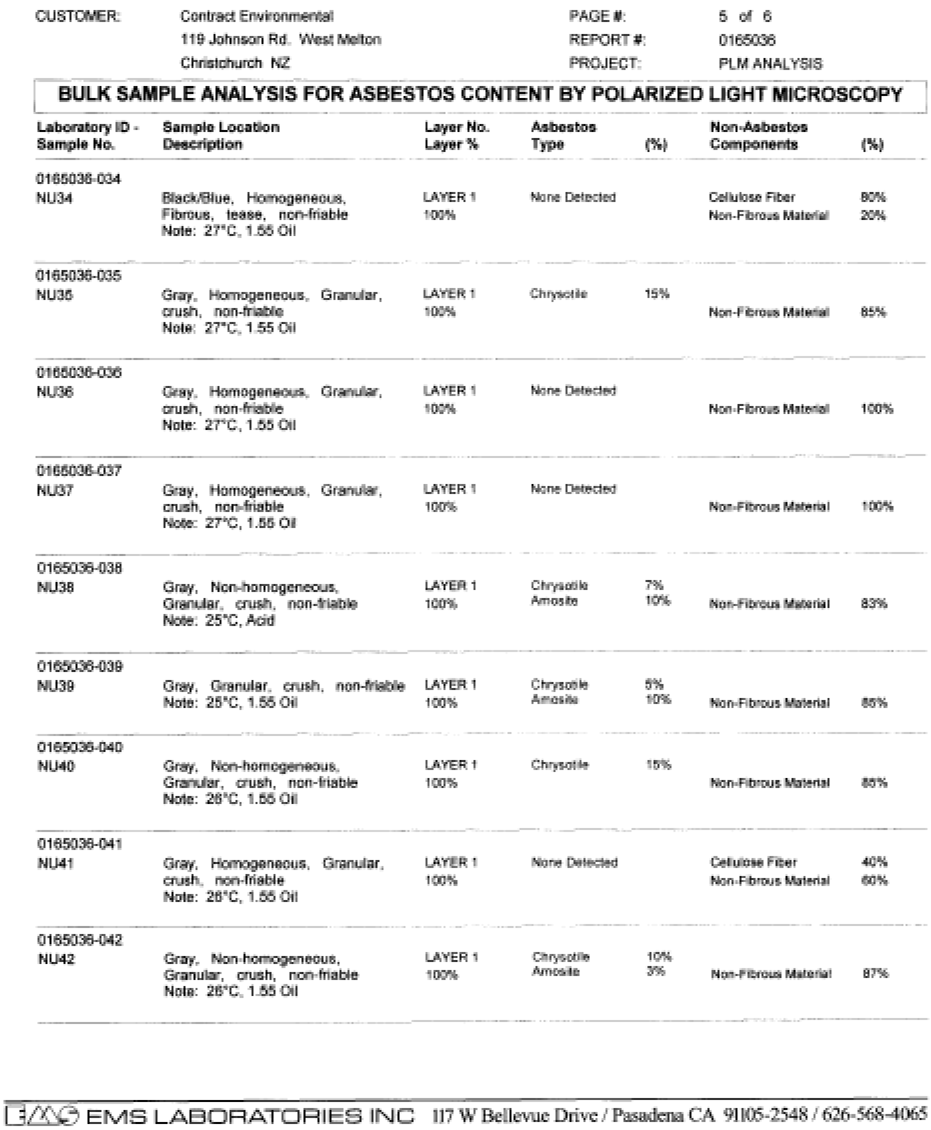

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PAGE #: 5 of 6
REPORT #: 0165036
PROJECT: PLM ANALYSIS

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	(%)
0165036-034 NU34	Black/Blue, Homogeneous, Fibrous, tease, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	80% 20%
0165036-035 NU35	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-036 NU36	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-037 NU37	Gray, Homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-038 NU38	Gray, Non-homogeneous, Granular, crush, non-friable Note: 25°C, Acid	LAYER 1 100%	Chrysotile Amosite	7% 10%	Non-Fibrous Material	83%
0165036-039 NU39	Gray, Granular, crush, non-friable Note: 25°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	5% 10%	Non-Fibrous Material	85%
0165036-040 NU40	Gray, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%
0165036-041 NU41	Gray, Homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Cellulose Fiber Non-Fibrous Material	40% 60%
0165036-042 NU42	Gray, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	10% 3%	Non-Fibrous Material	87%

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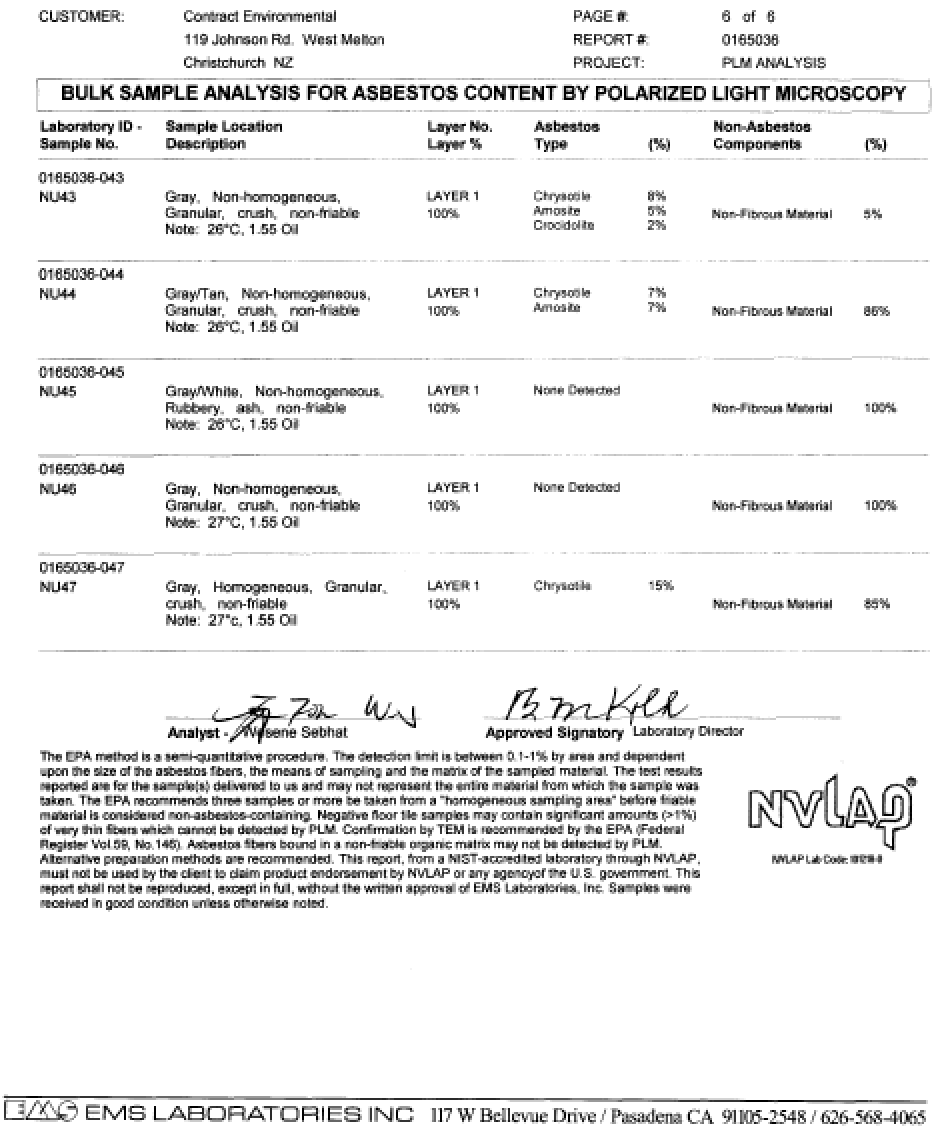

CUSTOMER: Contract Environmental
119 Johnson Rd. West Melton
Christchurch NZ

PAGE #: 6 of 6
REPORT #: 0165036
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	(%)
0165036-043 NU43	Gray, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite Crocidolite	8% 5% 2%	Non-Fibrous Material	5%
0165036-044 NU44	Gray/Tan, Non-homogeneous, Granular, crush, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	Chrysotile Amosite	7% 7%	Non-Fibrous Material	86%
0165036-045 NU45	Gray/White, Non-homogeneous, Rubbery, ash, non-friable Note: 26°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-046 NU46	Gray, Non-homogeneous, Granular, crush, non-friable Note: 27°C, 1.55 Oil	LAYER 1 100%	None Detected		Non-Fibrous Material	100%
0165036-047 NU47	Gray, Homogeneous, Granular, crush, non-friable Note: 27°c, 1.55 Oil	LAYER 1 100%	Chrysotile	15%	Non-Fibrous Material	85%

Analyst - Wosene Sebhat

Approved Signatory Laboratory Director

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

NVLAP Lab Code: [illegible]

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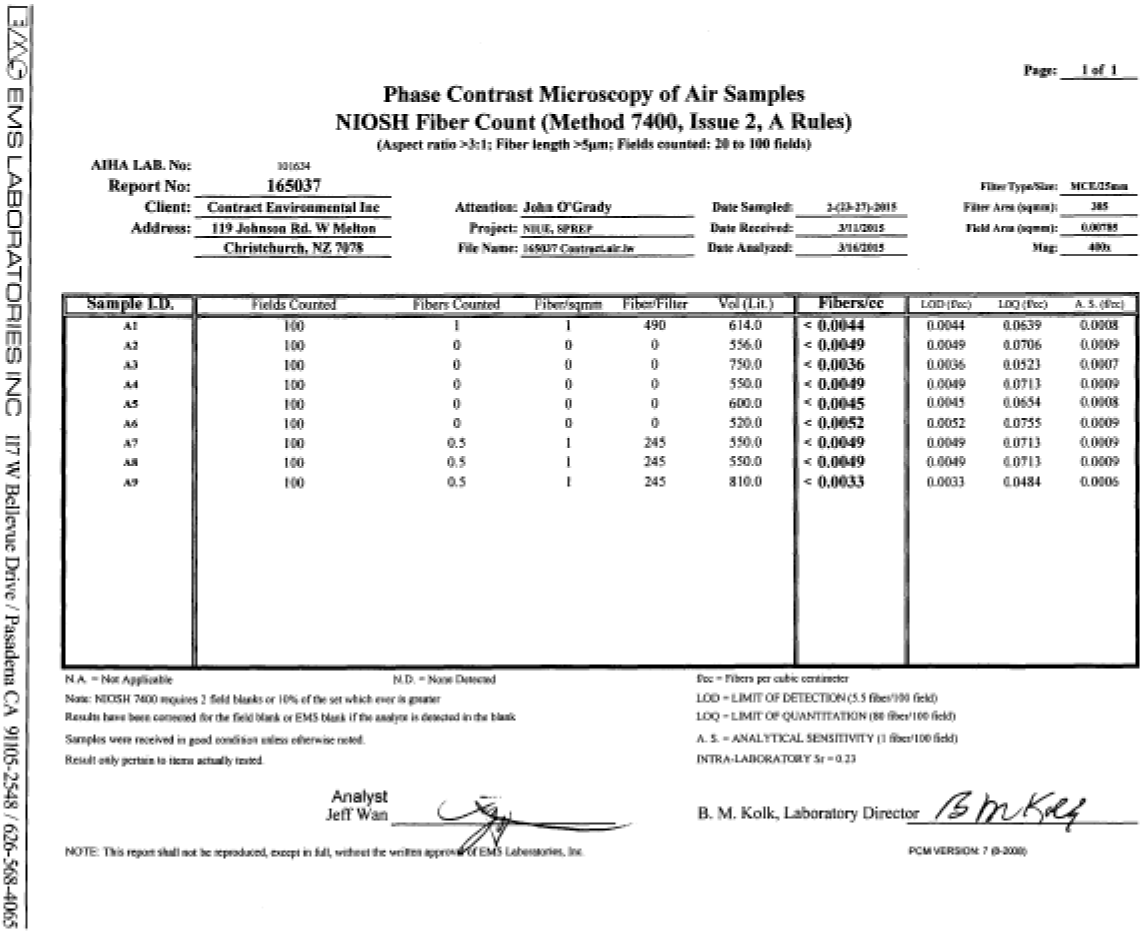
Niue First Air Results



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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: 165037
Client: Contract Environmental Inc
Address: 119 Johnson Rd. W Melton
Christchurch, NZ 7078

Attention: John O'Grady
Project: NIUE, SPREP
File Name: 165037 Contract.air.lw

Date Sampled: 2-(23-27)-2015
Date Received: 3/11/2015
Date Analyzed: 3/16/2015

Filter Type/Size: MCE/25mm
Filter Area (sqmm): 385
Field Area (sqmm): 0.00785
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)
A1	100	1	1	490	614.0	< 0.0044	0.0044	0.0639	0.0008
A2	100	0	0	0	556.0	< 0.0049	0.0049	0.0706	0.0009
A3	100	0	0	0	750.0	< 0.0036	0.0036	0.0523	0.0007
A4	100	0	0	0	550.0	< 0.0049	0.0049	0.0713	0.0009
A5	100	0	0	0	600.0	< 0.0045	0.0045	0.0654	0.0008
A6	100	0	0	0	520.0	< 0.0052	0.0052	0.0755	0.0009
A7	100	0.5	1	245	550.0	< 0.0049	0.0049	0.0713	0.0009
A8	100	0.5	1	245	550.0	< 0.0049	0.0049	0.0713	0.0009
A9	100	0.5	1	245	810.0	< 0.0033	0.0033	0.0484	0.0006

N.A. = Not Applicable
N.D. = None Detected
f/cc = Fibers per cubic centimeter

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.

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 B M Kolk

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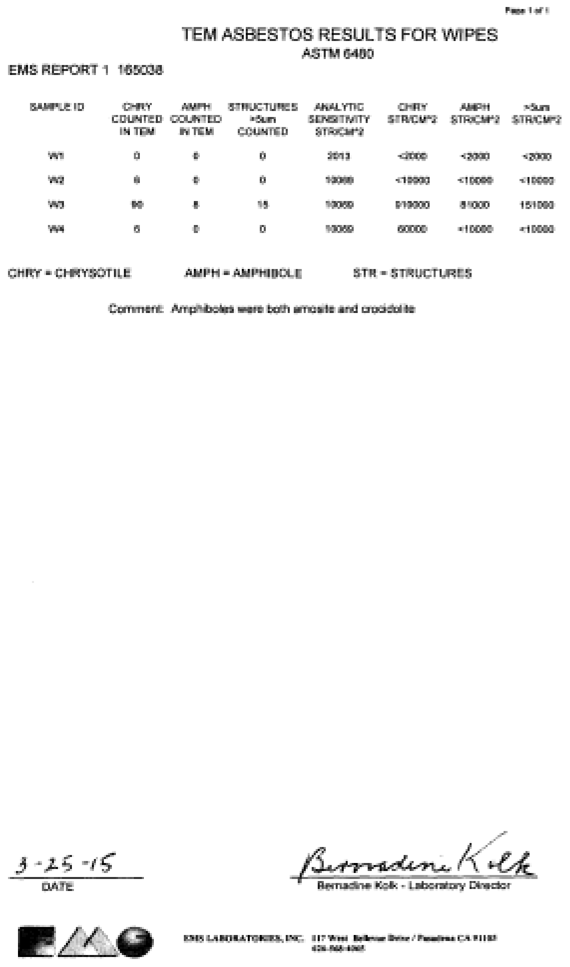
PCM VERSION: 7 (8-2008)

Niue First Wipe Test Results



Page 1 of 1

TEM ASBESTOS RESULTS FOR WIPES

ASTM 6480

EMS REPORT 1 165038

SAMPLE ID	CHRY COUNTED IN TEM	AMPH COUNTED IN TEM	STRUCTURES >5um COUNTED	ANALYTIC SENSITIVITY STR/CM^2	CHRY STR/CM^2	AMPH STR/CM^2	>5um STR/CM^2
W1	0	0	0	2013	<2000	<2000	<2000
W2	0	0	0	10069	<10000	<10000	<10000
W3	90	8	15	10069	910000	81000	151000
W4	6	0	0	10069	60000	<10000	<10000

CHRY = CHRYSOTILE AMPH = AMPHIBOLE STR = STRUCTURES

Comment: Amphiboles were both amosite and crocidolite

3-25-15
DATE

Bernadine Kolk
Bernadine Kolk - Laboratory Director

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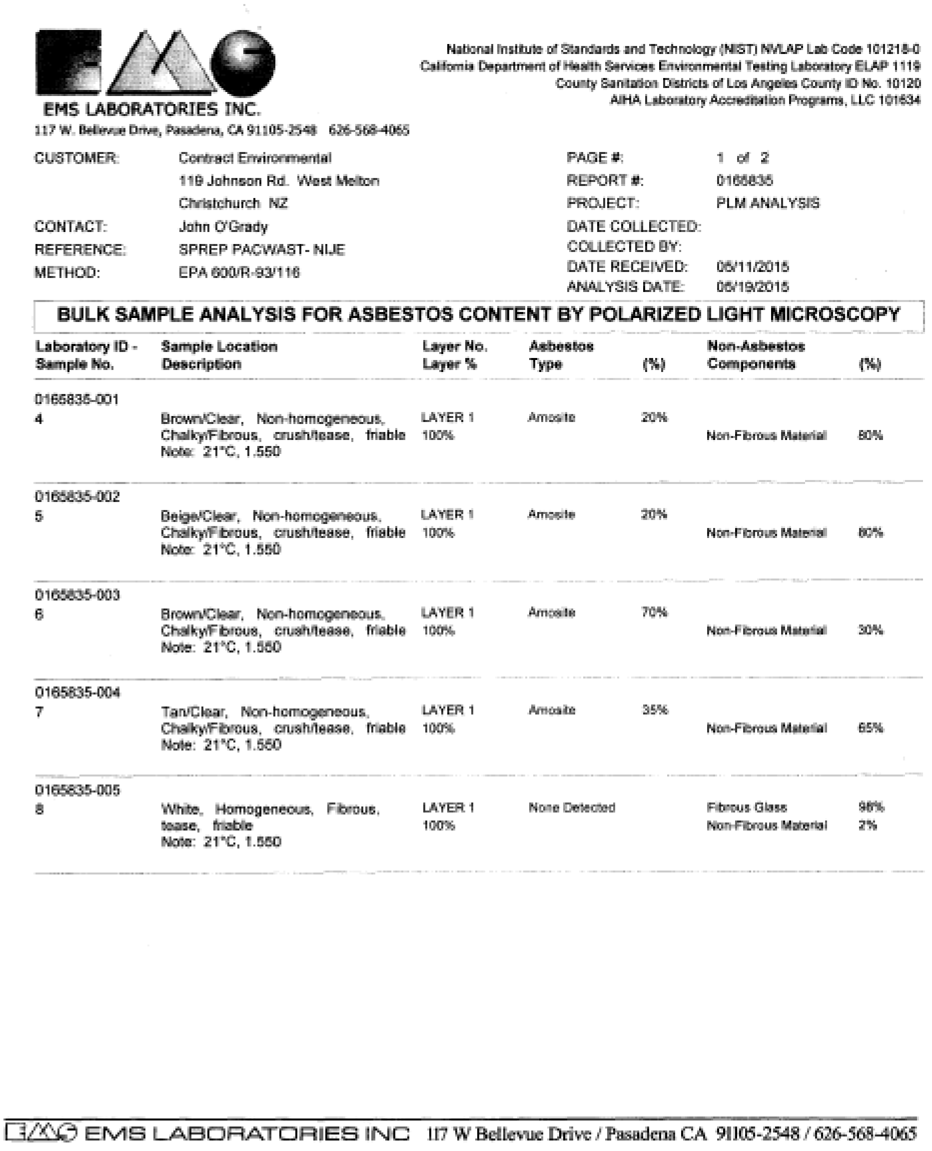
Niue Second Bulk Sample Results



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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
CONTACT: John O'Grady
REFERENCE: SPREP PACWAST- NIJE
METHOD: EPA 600/R-93/116

PAGE #: 1 of 2
REPORT #: 0165835
PROJECT: PLM ANALYSIS
DATE COLLECTED:
COLLECTED BY:
DATE RECEIVED: 06/11/2015
ANALYSIS DATE: 06/19/2015

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	(%)
0165835-001 4	Brown/Clear, Non-homogeneous, Chalky/Fibrous, crush/tease, friable Note: 21°C, 1.550	LAYER 1 100%	Amosite	20%	Non-Fibrous Material	80%
0165835-002 5	Beige/Clear, Non-homogeneous, Chalky/Fibrous, crush/tease, friable Note: 21°C, 1.550	LAYER 1 100%	Amosite	20%	Non-Fibrous Material	80%
0165835-003 6	Brown/Clear, Non-homogeneous, Chalky/Fibrous, crush/tease, friable Note: 21°C, 1.550	LAYER 1 100%	Amosite	70%	Non-Fibrous Material	30%
0165835-004 7	Tan/Clear, Non-homogeneous, Chalky/Fibrous, crush/tease, friable Note: 21°C, 1.550	LAYER 1 100%	Amosite	35%	Non-Fibrous Material	65%
0165835-005 8	White, Homogeneous, Fibrous, tease, friable Note: 21°C, 1.550	LAYER 1 100%	None Detected		Fibrous Glass Non-Fibrous Material	98% 2%

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Christchurch NZ

PAGE #: 2 of 2
REPORT #: 0165835
PROJECT: PLM ANALYSIS

Analyst - MEGHAN SWEENEY

B McKoll
Approved Signatory Laboratory Director

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

NVLAP Lab Code: [illegible]

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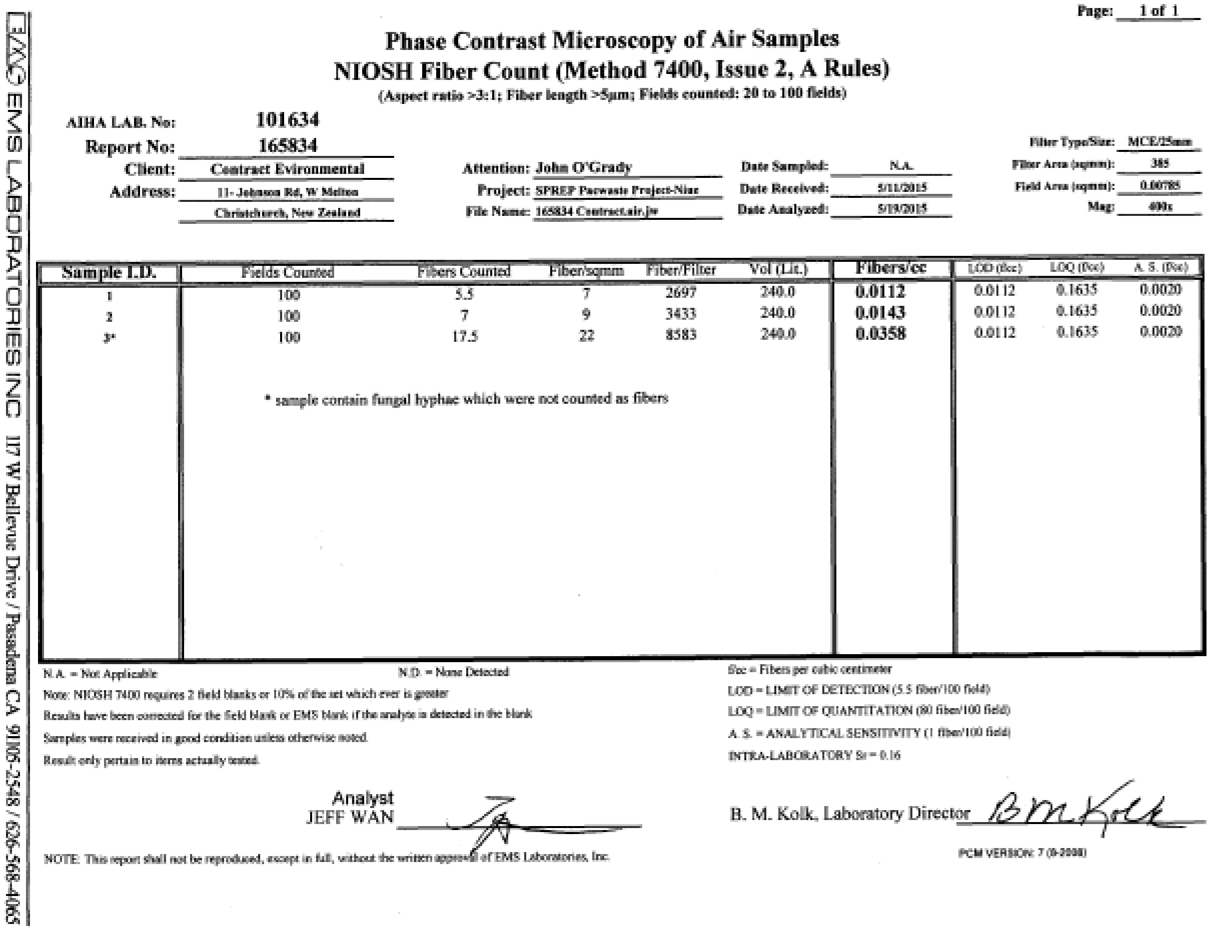
Niue Second Air Sample Results



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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: 165834
Client: Contract Evironmental
Address: 11- Johnson Rd, W Melton
Christchurch, New Zealand

Attention: John O'Grady
Project: SPREP Pacwaste Project-Niue
File Name: 165834 Contract.air.jw

Date Sampled: N.A.
Date Received: 5/11/2015
Date Analyzed: 5/19/2015

Filter Type/Size: MCE/25mm
Filter Area (sqmm): 385
Field Area (sqmm): 0.00785
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)
1	100	5.5	7	2697	240.0	**0.0112**	0.0112	0.1635	0.0020
2	100	7	9	3433	240.0	**0.0143**	0.0112	0.1635	0.0020
3*	100	17.5	22	8583	240.0	**0.0358**	0.0112	0.1635	0.0020

* sample contain fungal hyphae which were not counted as fibers

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 = 0.16

Analyst
JEFF WAN

B. M. Kolk, Laboratory Director B M Kolk

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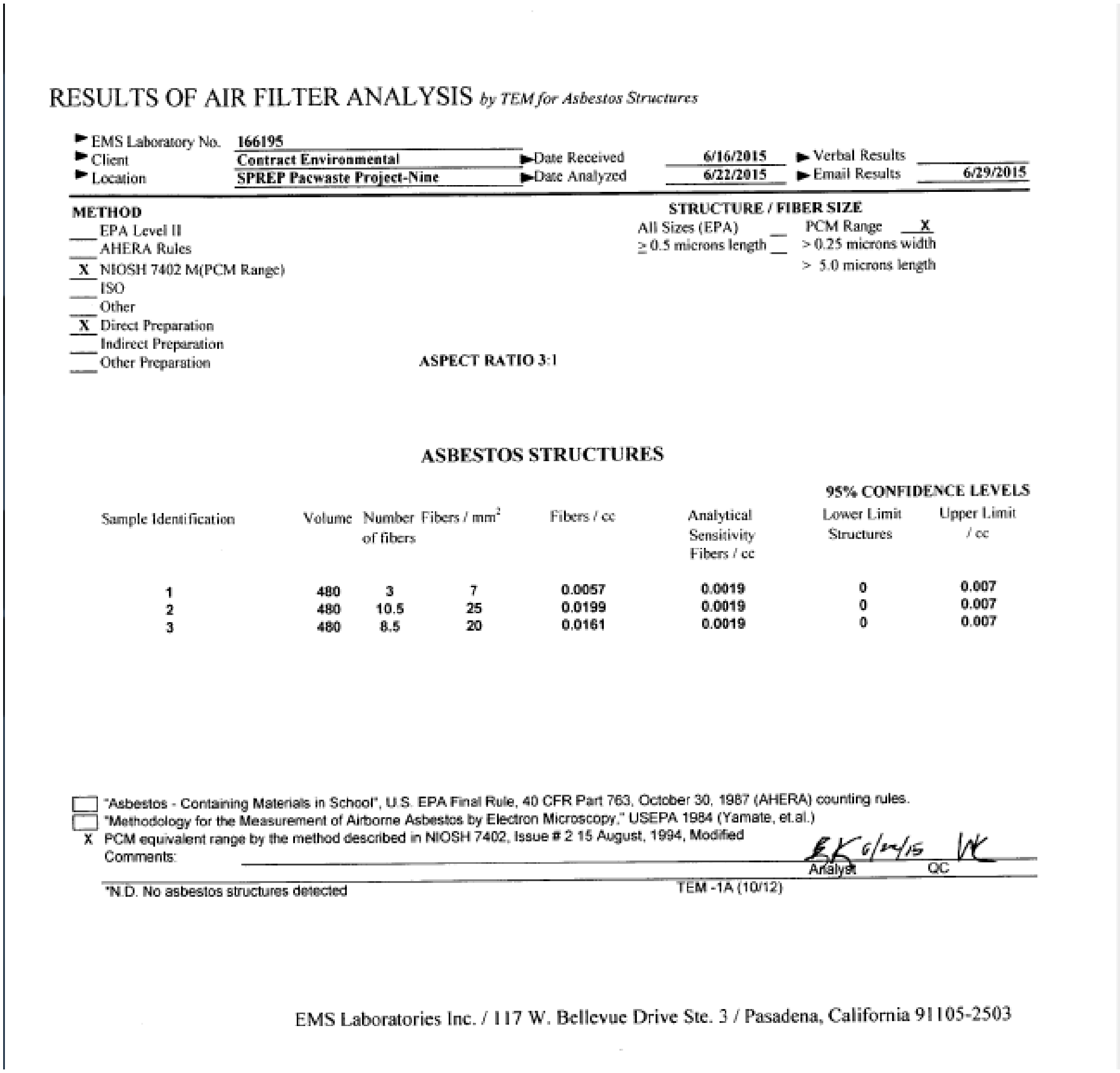
PCM VERSION: 7 (9-2008)

Niue Air TEM Results for Second Air Samples



RESULTS OF AIR FILTER ANALYSIS *by TEM for Asbestos Structures*

► EMS Laboratory No.	**166195**				
► Client	**Contract Environmental**	►Date Received	**6/16/2015**	► Verbal Results	
► Location	**SPREP Pacwaste Project-Nine**	►Date Analyzed	**6/22/2015**	► Email Results	**6/29/2015**

METHOD

___ EPA Level II
___ AHERA Rules
X NIOSH 7402 M(PCM Range)
___ ISO
___ Other
X Direct Preparation
___ Indirect Preparation
___ Other Preparation

STRUCTURE / FIBER SIZE

All Sizes (EPA) __
≥ 0.5 microns length __
PCM Range X
> 0.25 microns width
> 5.0 microns length

ASPECT RATIO 3:1

ASBESTOS STRUCTURES

Sample Identification	Volume	Number of fibers	Fibers / mm²	Fibers / cc	Analytical Sensitivity Fibers / cc	95% CONFIDENCE LEVELS Lower Limit Structures	95% CONFIDENCE LEVELS Upper Limit / cc
1	480	3	7	0.0057	0.0019	0	0.007
2	480	10.5	25	0.0199	0.0019	0	0.007
3	480	8.5	20	0.0161	0.0019	0	0.007

☐ "Asbestos - Containing Materials in School", U.S. EPA Final Rule, 40 CFR Part 763, October 30, 1987 (AHERA) counting rules.
☐ "Methodology for the Measurement of Airborne Asbestos by Electron Microscopy," USEPA 1984 (Yamate, et.al.)
X PCM equivalent range by the method described in NIOSH 7402, Issue # 2 15 August, 1994, Modified
Comments:

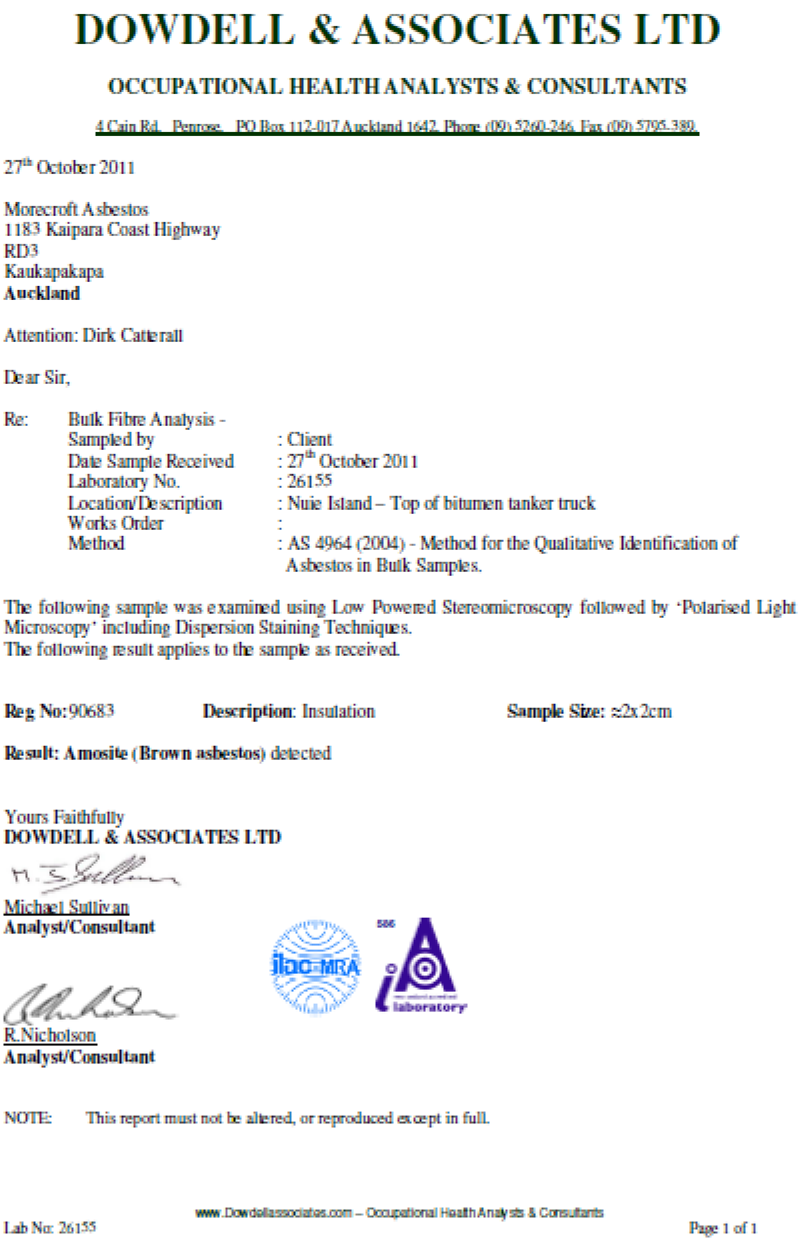
6/24/15
Analyst QC

*N.D. No asbestos structures detected

TEM -1A (10/12)

EMS Laboratories Inc. / 117 W. Bellevue Drive Ste. 3 / Pasadena, California 91105-2503

Dowdells Bitumen Tanker Results



DOWDELL & ASSOCIATES LTD

OCCUPATIONAL HEALTH ANALYSTS & CONSULTANTS

4 Cain Rd. Penrose. PO Box 112-017 Auckland 1642. Phone (09) 5260-246. Fax (09) 5795-380.

27th October 2011

Morecroft Asbestos
1183 Kaipara Coast Highway
RD3
Kaukapakapa
Auckland

Attention: Dirk Catterall

Dear Sir,

Re: Bulk Fibre Analysis -
Sampled by : Client
Date Sample Received : 27th October 2011
Laboratory No. : 26155
Location/Description : Nuie Island – Top of bitumen tanker truck
Works Order :
Method : AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples.

The following sample was examined using Low Powered Stereomicroscopy followed by 'Polarised Light Microscopy' including Dispersion Staining Techniques.
The following result applies to the sample as received.

Reg No: 90683 **Description**: Insulation **Sample Size:** ≈2x2cm

Result: Amosite (Brown asbestos) detected

Yours Faithfully
DOWDELL & ASSOCIATES LTD

Michael Sullivan
Analyst/Consultant

R.Nicholson
Analyst/Consultant

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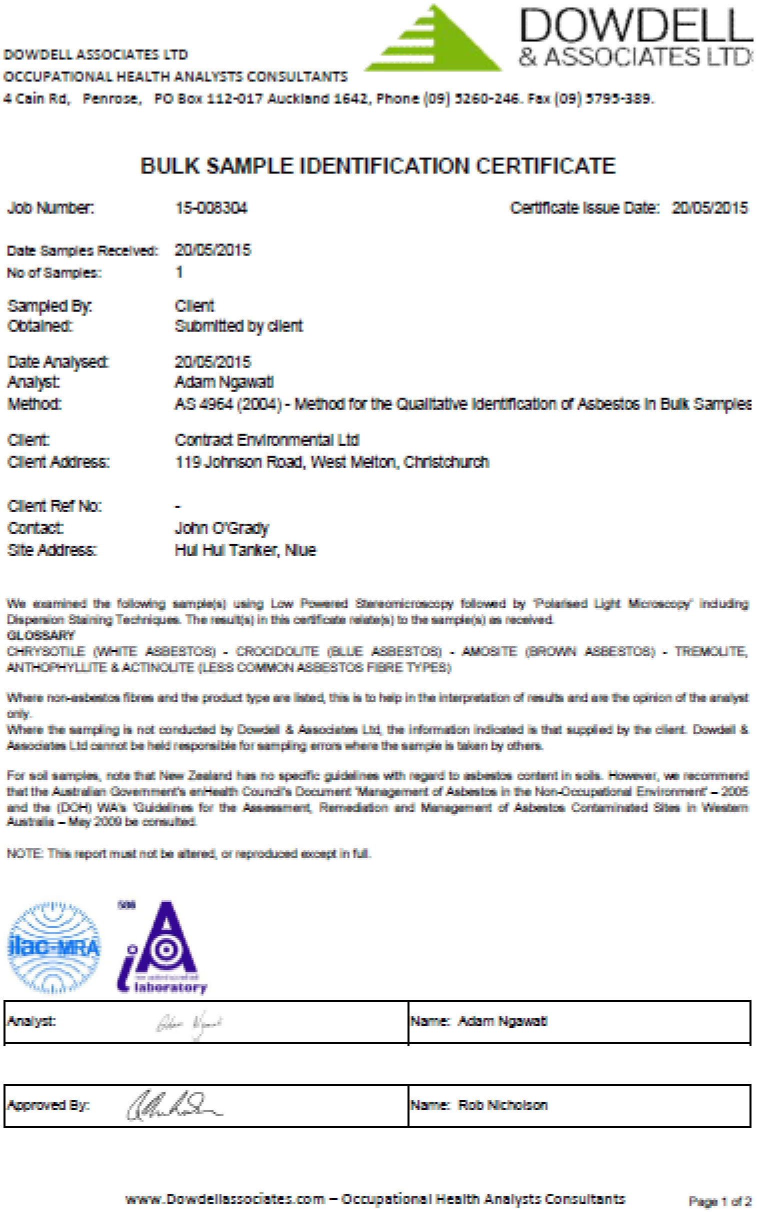
Lab No: 26155

Page 1 of 1



DOWDELL ASSOCIATES LTD
OCCUPATIONAL HEALTH ANALYSTS CONSULTANTS
4 Cain Rd, Penrose, PO Box 112-017 Auckland 1642, Phone (09) 5260-246. Fax (09) 5795-389.

BULK SAMPLE IDENTIFICATION CERTIFICATE

Job Number: 15-008304 Certificate Issue Date: 20/05/2015

Date Samples Received: 20/05/2015
No of Samples: 1

Sampled By: Client
Obtained: Submitted by client

Date Analysed: 20/05/2015
Analyst: Adam Ngawati
Method: AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples

Client: Contract Environmental Ltd
Client Address: 119 Johnson Road, West Melton, Christchurch

Client Ref No: -
Contact: John O'Grady
Site Address: Hui Hui Tanker, Niue

We examined the following sample(s) using Low Powered Stereomicroscopy followed by 'Polarised Light Microscopy' including Dispersion Staining Techniques. The result(s) in this certificate relate(s) to the sample(s) as received.
GLOSSARY
CHRYSOTILE (WHITE ASBESTOS) - CROCIDOLITE (BLUE ASBESTOS) - AMOSITE (BROWN ASBESTOS) - TREMOLITE, ANTHOPHYLLITE & ACTINOLITE (LESS COMMON ASBESTOS FIBRE TYPES)

Where non-asbestos fibres and the product type are listed, this is to help in the interpretation of results and are the opinion of the analyst only.
Where the sampling is not conducted by Dowdell & Associates Ltd, the information indicated is that supplied by the client. Dowdell & Associates Ltd cannot be held responsible for sampling errors where the sample is taken by others.

For soil samples, note that New Zealand has no specific guidelines with regard to asbestos content in soils. However, we recommend that the Australian Government's enHealth Council's Document 'Management of Asbestos in the Non-Occupational Environment' – 2005 and the (DOH) WA's 'Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia – May 2009 be consulted.

NOTE: This report must not be altered, or reproduced except in full.

Analyst:	Name: Adam Ngawati

Approved By:	Name: Rob Nicholson

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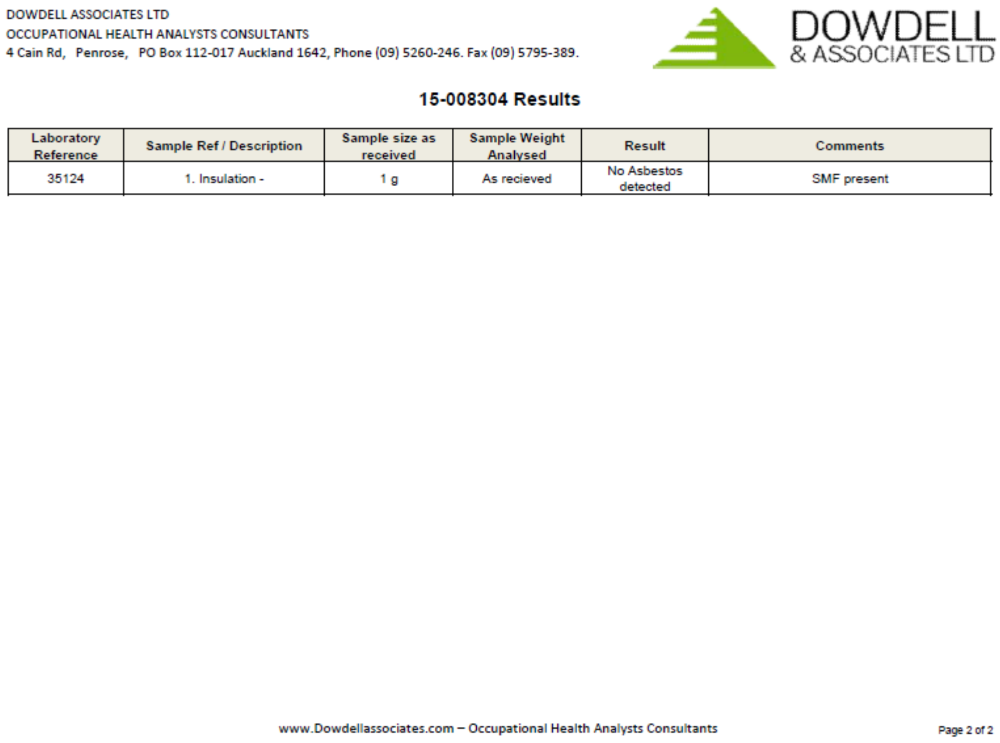

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4 Cain Rd, Penrose, PO Box 112-017 Auckland 1642, Phone (09) 5260-246. Fax (09) 5795-389.

DOWDELL
& ASSOCIATES LTD

15-008304 Results

Laboratory Reference	Sample Ref / Description	Sample size as received	Sample Weight Analysed	Result	Comments
35124	1. Insulation -	1 g	As recieved	No Asbestos detected	SMF present

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Page 2 of 2

Niue Second Wipe Sample Results

Page 2 of 2

TEM ASBESTOS RESULTS FOR WIPES

ASTM 6480

EMS REPORT 1 165836

SAMPLE ID	CHRY COUNTED IN TEM	AMPH* COUNTED IN TEM	STRUCTURES >5um COUNTED	ANALYTIC SENSITIVITY STR/CM^2	CHRY STR/CM^2	AMPH* STR/CM^2	>5um STR/CM^2
9	37	3	11	1919	71000	5800	21000
10	111	4	45	3198	350000	13000	140000

CHRY = CHRYSOTILE AMPH = AMPHIBOLE STR = STRUCTURES

*Amphibole identified as amosite.

27-May-15
DATE

Bernadine Kolk - Laboratory Director

EMS LABORATORIES, INC. 117 West Bellevue Drive / Pasadena CA 91105

.

Appendix 3: 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

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 underside of the existing roof sheeting and all timber roof framing.	350.00	280.00	254.55
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

Appendix 4 – Suggested Draft Nauru Cabinet Paper on Asbestos

1. Background

Asbestos is a naturally occurring fibrous material that has been very widely used, especially for the manufacture of construction materials, due to its useful characteristics. When the fibres are released into the air, however, they cause very serious harmful health effects, and especially lung cancer and mesothelioma (cancer of the chest cavity). The harmful health effects are almost solely caused by breathing in the needle-like fibres.

Based on WHO estimates, at the peak of production worldwide, about 5 million tonnes of asbestos products were being manufactured. Unfortunately there are still about 2 million tonnes being manufactured in various countries today although nearly 60 countries have placed a ban on importation.

Asbestos has been widely used as a building material in Nauru during the early years of phosphate manufacturing and this legacy remains today as a problem that is largely still to be addressed.

Late in 2014 the SPREP PacWaste (Pacific Hazardous Waste) project carried out an extensive survey of the quantities and harmful effects of asbestos in Nauru. Some budgetary costs for addressing the problems were also provided.

The PacWaste project included:

a) An extensive assessment of asbestos incidence and quantities and condition in Nauru.
b) Analysis of numerous bulk samples.
c) The carrying out of asbestos air sampling tests at 77 locations, followed by analysis.
d) The taking of 94 swab samples followed by analysis

The project discovered that:

a) There is a substantial quantity of asbestos in Nauru. Based on the survey completed the amount is estimated to be around 200,000 square metres or about 2000 tonnes.
b) Almost all the asbestos is in the form of asbestos-cement in roofing and cladding on houses and buildings although there are some stockpiles of waste.
c) All asbestos is old and in various stages of deterioration. In many cases it is in an advanced stage of deterioration.

d) Asbestos-cement roofing and cladding is normally considered to be “non-friable” with the harmful fibres locked up in a cement matrix. However when roofing and cladding deteriorate to the extent it has done on Nauru then it can be considered to be partially friable and will be releasing fibres into the air.

e) Based on the numerous bulk analyses that were carried out, most of the asbestos on Nauru is Chrysotile (White) Asbestos although some examples of Amosite (Brown) Asbestos and Crocidolite (Blue) Asbestos were also found.

f) The air monitoring of 77 locations that was carried out as part of this project did not pick up any asbestos in the air above the monitoring thresholds in any of the locations. It is noted that nine locations were identified as having potentially significant levels of asbestos in air when measured by the PCM (Phase Contrast Microscopy) method which does not positively identify asbestos but simply identifies asbestos-like fibres. When these nine air samples were examined further by the TEM (Transmission Electron Microscope) method, however, they were all found to be completely free of asbestos fibres, which was a reassuring result.

g) The swab testing results were, however, less reassuring, with the following exhibiting very high results: RON Hospital (3 locations), Seaport (1 location), Power Plant / RO Units (4 locations), Prison (2 locations) and Government Building (1 location).

h) In addition several swab test locations were high including: RON Hospital (3 locations), House 9 Air Con Unit (1 location), Seaport (1 location), Ewa Refugee Accommodation (1 location), Power Plant / RO Units (1 location), Prison (1 location), Fisheries Main Office (1 location), Menin Hotel Air Con (1 location), Jules Restaurant (1 location), Airport (2 locations), Government Building (1 location), Plant Nursery (1 location).

i) As well as the high incidence of asbestos on Nauru, there is also extensive site and ground contamination. Many locations have ground contaminated with asbestos debris which would generate airborne fibres if disturbed and this includes many locations around houses, as well as several locations where there have been fires.

j) There will be some money available from the SPREP PacWaste project to deal with high priority asbestos removal projects, such as schools and the power station and prison.

k) Asbestos fibres in areas where people are able to inhale them do pose an on-going and real health risk of asbestos-related diseases including debilitating conditions such as asbestosis and also cancers, namely lung cancer, and cancer of the outer lining of lung / internal chest wall (mesothelioma).

SPREP has just recently funded the training of several Government personnel to be asbestos regulators. This training included theoretical and practical training. This training was an essential first step to set up a regulatory regime on Nauru for asbestos. Some issues arose from this training:

- A key part of setting up a regulatory regime for asbestos on Nauru will be the requirement that the proponents of all projects involving asbestos are to prepare an “Asbestos Removal Plan” (ARP), which would be submitted to the new regulatory team for approval. This would form the basis of inspections. A draft ARP Form is attached (Appendix 1).
- The wearing of correct safety clothing or Personal Protective Equipment (PPE) is basic to carrying out a safe removal project. This PPE needs to be readily available at a reasonable cost on Nauru, probably via commercial providers. The key items of this PPE are disposable overalls, half face masks with asbestos filters, gloves and rubber boots.
- The availability of plastic sheeting and plastic tape, warning signs and warning tape, is also a key part of carrying out a safe removal project, and these items should also be readily available through commercial providers.
- The new regulatory team can now provide training and such knowledge will also be brought to Nauru by competent overseas contractors.
- The new regulatory team will need to have authority to control unregulated asbestos removal where an ARP has not been prepared or the ARP is not being followed.
- Based on analyses carried out in Nauru and throughout the Pacific, asbestos in roofing is obvious but not asbestos in cladding. On average about 50% of fibreboard cladding contains asbestos. In Nauru, fibreboard cladding could be assumed to be asbestos, or samples could be collected and sent for analyses.

2. Discussion

In view of the above, some reassurance can certainly be taken from the fact that no asbestos was found in the air in Nauru. It is suggested that this is due to the high humidity levels on Nauru, which keeps fibres suppressed. The fact that so many asbestos fibres have, however, been found in numerous swab samples in areas of high human habitation, means that the health risk from asbestos in Nauru must be viewed with serious concern. Also the fibres can only have been deposited by travelling through the air.

There is little that can be done to protect worker and resident health except to commence a detailed and coordinated programme of properly managed asbestos removal with highest risk locations dealt with first (funded by the SPREP PacWaste project). These locations include the hospital, schools, power station and prison. Then a steady and planned removal should be embarked on as funding availability permits. RonPHOS and NRC should also be encouraged to commence a steady removal programme as well, that is coordinated into the overall removal programme.

Much asbestos is of course currently being removed, especially with the current level of building activity on Nauru, but this removal is not being properly managed and may be causing significant health issues.

There is a vigorous and capable contracting environment in Nauru so there is local capacity to support an asbestos removal programme. Training would be needed and a regulatory regime needs to be established. The removal of asbestos from buildings that are still used would need to be accompanied by replacement with suitable non-asbestos roofing and cladding.

The issue of disposal would need to be resolved. Disposal to landfill, although widely practiced in the past, is unacceptable due to landowner concerns. Sea disposal is being explored and is logistically not difficult to carry out. For example the asbestos could be placed in large fibre bags and a barge could be modified to allow a quick release of such bags. Nauru is, however, signatory to the London and Noumea Conventions, both of which regulate sea disposal and both of which would require a detailed environmental impact assessment.

If sea disposal is found to be unacceptable then the only other option is export and the 2014 PacWaste Report concluded that Brisbane would be the be the best location to use. The Australian Government would not oppose such export if Basel Consent and biosecurity procedures were followed. There are also landfills in Brisbane prepared to accept the waste.

Sea disposal would be cheaper and would add about 2% to the total cost of removal and replacement. Export to Brisbane would add about 9%.

Until the matter of disposal is resolved, a staging area is needed for waste awaiting disposal. This area needs to be in a convenient location and it would be logical to place it near the sea port area if there is room. Only waste that is properly contained in sealed plastic should go to this area and the placement of waste in this area needs to be regulated and recorded as to who placed it there and when. Plastic will deteriorate in the weather so the area should be covered or old shipping containers could be used for temporary cover.

Some asbestos waste will still need to be placed in the landfill and buried, such as bags of small asbestos debris and used PPE, and also contaminated soil.

Until the asbestos can be removed, it is important that the presence and risk posed by the asbestos is managed as much as possible. There are a range of measures that can be put in place to minimise the generation of fibres arising from the deteriorating asbestos building materials on Nauru and a public education programme is needed.

3. Recommendations

a) The matters above are noted, including the recognition that asbestos is a serious health threat in Nauru.

b) Endorsement is given to the new team of trained Government regulators.

c) The proponents of any building projects being undertaken that involve the removal of asbestos will now be required to submit an "Asbestos Removal Plan" (ARP) as per the prescribed form.

d) The availability of PPE and other essential supplies will be assured, via Government provision if necessary, until this can be guaranteed by commercial providers.

e) Once the necessary supplies are available, the new team of regulators will have authority to regulate (including stopping) projects where an ARP has not been prepared or is not being followed.

f) Sea disposal is to be investigated as the preferred disposal method, with export kept as a back-up. Until the disposal issue is resolved, an asbestos staging waste staging area will be established at a location to be determined. Only waste that is properly packaged and contained can go to this area. It should be covered and managed with records kept of who placed it in the area and when.

g) A public education programme is needed to inform householders of the risks of asbestos and the best methods for managing those risks.

Appendix 1

Asbestos Removal Plan

NB: This plan is to be completed by any party planning to carry out a building or demolition project involving the removal of asbestos.

Location:

Date and duration of work:

Type and quantity of asbestos to be removed (including details of any analyses carried out):

Who will do the work (include description of personnel involved with expertise in asbestos management, and this can include any Nauru regulator):

How will it be done (including a description of tools, PPE to be used and methodology)?

How will any contaminated soil be dealt with?

How will the asbestos waste be disposed?