THE USE OF ASBESTOS-CONTAMINATED SOILS ON BARANGAROO

FINAL REPORT

REPORT TO THE ENVIRONMENT PROTECTION AUTHORITY

ASSOCIATE PROFESSOR TIM DRISCOLL

Sydney School of Public Health
Sydney Medical School
University of Sydney

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BACKGROUND OF THE INVESTIGATOR

This report was prepared by Associate Professor Tim Driscoll (MBBS BSc(Med) MOHS PhD FAFOEM FAFPHM), an associate professor in occupational medicine and public health in the Sydney School of Public Health at the University of Sydney. Associate Professor Driscoll is a specialist in occupational medicine, public health medicine and epidemiology and is a fellow of the Australasian Faculty of Occupational and Environmental Medicine and the Australasian Faculty of Public Health Medicine.

ACKNOWLEDGEMENTS

The investigator would like to thank the staff of the Environment Protection Authority, the Barangaroo Delivery Authority, Lend Lease and their associated contractors, Baulderstone and their associated contractors, members of the safety committees from both sites and their union representatives, Sydney Ports Authority and the relevant union representatives, Unions NSW, representatives of the businesses adjacent to the site, and representatives of the persons living near the site, for their assistance in conducting this review.

GLOSSARY

ACM:	Material containing asbestos that is bonded (typically with cement in construction materials) in some form of matrix
AF:	Asbestos fines - free fibres of asbestos, small fibre bundles and small fragments of ACM that are able to pass through a 7 mm x 7 mm sieve
BDA:	Barangaroo Delivery Authority
EPA:	Environment Protection Authority
f/ml:	Fibres per millilitre
FA:	Fibrous asbestos - any material that is easily powdered or made pasty with clear separation of asbestos fibres by hand pressure
HHERA:	Human Health and Ecological Risk Assessment
OHSMP:	Occupational health and safety management plan
PPE:	Personal protective equipment
RAP:	Remedial action plan
SCSSMP:	Stockpile, Contaminated Soil and Sediment Management Plan
w/w:	weight for weight

EXECUTIVE SUMMARY

BACKGROUND

Barangaroo is the name of the East Darling Harbour site on the western edge of Sydney city that is being re-developed to allow a combination of business, hotel and parkland use. The 22 hectare site is divided into three re-development areas or zones - Barangaroo South, Barangaroo Central and Headland Park.

The development plans for the Barangaroo site call for the re-use of some soil excavated from the site, primarily to help form the Headland Park at the northern end of the site. The material to be re-used was planned to come partly from the excavated material at the southern end of the site, partly from the area to be excavated to form the cove at the southern aspect of the northern zone, and partly from other ground to be excavated in the northern zone to form the shoreline of the Headland Park.

The issue that prompted this review was the presence of much greater asbestos contamination than was expected in the soil in the southern zone. The Human Health and Ecological Risk Assessment produced for Barangaroo allowed for the material in Headland Park to be up to 1% asbestos, as long as the material was buried more than 0.5 metres under the surface. However, the possibility of using material with this degree of contamination in the construction raised concerns amongst several parties. As a result, an independent review by a qualified and recognised expert in the field of public health was commissioned on behalf of the Environment Protection Authority (EPA). The review aimed to ensure there were no:

- unacceptable risks to worker or public health arising from exposure to asbestos as a result of the proposed methods of excavation and transfer of materials by Lend Lease to the Headland Park;
- unacceptable risks to worker or public health arising from exposure to asbestos as a result of the proposed methods of receipt and use of materials at Headland Park by Baulderstone; and
- adverse long-term impacts arising from exposure to asbestos of the Headland Park at completion.

Associate Professor Tim Driscoll, of the Sydney School of Public Health, University of Sydney, conducted the review. The results of the review are reported here.

METHODS

This project was commenced in November 2012 and concluded in March 2013. During that time, the investigator met with members and/or representatives of stakeholder groups; reviewed a range of relevant reports and plans; read relevant public documents such as guidelines, codes of practice and research papers; and visited the site several times.

FINDINGS

The key principles espoused in the relevant guidelines and other such documents relating to dealing with asbestos-contaminated soil are:

- The primary goal must be to minimize exposure to workers and the public;
- Disturbance of asbestos-contaminated soil should be minimized;
- Asbestos-contaminated soil should be managed and remain on site if that is feasible and can occur taking into account the first two principles.

Based on an application of these principles and the most stringent current guidelines in use or proposed for use in Australia, this review finds that:

- It is acceptable to re-use and re-work soil previously contaminated with asbestos as long as the soil is remediated appropriately.

- Material contaminated with fibrous asbestos or asbestos fines (essentially this means material that definitely or probably has asbestos fibres present) should not be re-worked and should be disposed of in an appropriate facility regardless of the apparent concentration of the fibres.

- Material previously contaminated with bonded asbestos-containing material (ACM) can be re-used and re-worked if the total amount of asbestos is less than 0.001% (which means the ACM should be less than 0.006%) and all visible ACM is removed.

- The initially proposed work practices for re-use of material from the Southern zone were not appropriate because they allowed an asbestos concentration of up to 1% ACM (rather than less than 0.01% as required) and did not require the removal of visible ACM.

- The use of material from anywhere on the site (whether from the Southern zone or Northern zone) is acceptable from an asbestos contamination standpoint as long as this material meets the above soil remediation requirements.

- If previously contaminated material is to be re-used or re-worked, it is important that appropriate exposure control and protection mechanisms are in place, rather than just relying on sampling to determine that material is safe to use.

- The excavation, control and monitoring process in the Southern zone appears to have been conducted appropriately in terms of the health of workers and members of the public.

- The proposed criteria of up to 1% for asbestos contamination in soil buried under clean fill at Headland Park would have been acceptable from a public health point of view once the construction phase was completed.

RECOMMENDATIONS

This review recommends:

1) The pedestrian pathway adjacent to the Northern zone be closed until all material potentially contaminated with asbestos has been remediated and used on site or has been transported off site. It is reasonable to allow the walkway adjacent to the Southern and Central zones to remain open if this is considered desirable from a public access or related point of view.

2) The site safety committees be actively involved in the development of work plans to excavate, test, remediate, work with and/or dispose of material initially found to be, or suspected of being, contaminated with asbestos.

3) The final work plans covering the excavation, testing, remediation, working with and/or disposing of material initially found to be, or suspected of being, contaminated with asbestos be discussed with the EPA and Workcover New South Wales, and approved by the site auditor.

4) The criteria for considering soil previously contaminated with asbestos to have been remediated be at least as stringent as those contained in the Western Australia guideline, and specifically that they include:

- no free asbestos or asbestos fibres (i.e. no fibrous asbestos or asbestos fines);
- less than 0.001% asbestos / less than 0.006% asbestos-containing material (ACM)
- no visible ACM.

5) The air monitoring action level for asbestos on the Barangaroo site should be 0.01 fibres/ml, with 0.02 fibres/ml set as the level at which work would typically cease in order to find and control the source of the asbestos fibres.

6) This report be made available to the Barangaroo Delivery Authority; workers on the Barangaroo site and their union representatives; Baulderstone; Lend Lease; the Ports Authority, their workers and the workers' union representatives; Unions NSW; and businesses and residents adjacent to the site.

1. INTRODUCTION

BACKGROUND[1]

Barangaroo is the name of the East Darling Harbour site on the western edge of Sydney city that is being re-developed to allow a combination of business, hotel and parkland use. The 22 hectare site is divided into three re-development areas or zones - Barangaroo South, Barangaroo Central and Headland Park.

The Barangaroo development is a significant excavation and bulk fill construction project. The project called for 570,000 m^3 to be excavated and 210,000 m^3 to be filled, leaving 360,000 m^3 excess material.

The issue that prompted this review, as stated in the briefing document, was as follows:
"In August 2012 Lend Lease commenced delivery of fill material to Port Kembla under a Resource Recovery Exemption (RRE) Licence granted by EPA.

The greater than expected presence of bonded asbestos fragments in the Barangaroo South soil matrix, in terms of volume and spread, resulted in the inadvertent transfer of non-conforming material to Port Kembla and the revocation of the Resource Recovery Exemption.

The RRE licence revocation has caused Lend Lease to export material off-site to landfill and heightened sensitivity around the presence of asbestos impacted material at Barangaroo.

In November the transfer of 100,000 m^3 of material by Lend Lease from Barangaroo South to the Headland Park Contractor, Baulderstone, will commence.

In preparation for this activity, an independent review is to be conducted...

Full access to relevant information and resources will be provided to satisfy the Independent Expert of the purposes of this review. This previous work and information is not to be critiqued but form background information for the purposes of this review....

The Independent Expert will provide a written assessment and commentary.

[1] Much of this section is based on the briefing document for this review.

The review will be made available to the EPA [Environment Protection Authority], Barangaroo Delivery Authority, Lend Lease, Baulderstone, public consultation and media enquiry."

It was agreed during the early stages of the process that the review report would also be made available to the workers and their union representatives.

TERMS OF REFERENCE

The final agreed terms of reference for the review were to consider whether there were:

- unacceptable risks to worker or public health arising from exposure to asbestos as a result of the proposed methods of excavation and transfer of materials by Lend Lease to the Headland Park;
- unacceptable risks to worker or public health arising from exposure to asbestos as a result of the proposed methods of receipt and use of materials at Headland Park by Baulderstone; and
- adverse long-term impacts arising from exposure to asbestos of the Headland Park at completion.

The investigator was to make whatever recommendations were considered appropriate given the areas considered by the review.

REPORT STRUCTURE

This report has seven chapters. Chapter 1 provides background to the review and presents the Terms of Reference. Chapter 2 describes the methods used in the review and Chapter 3 provides an overview of the intended work practices and what is known about asbestos contamination on site. Chapter 4 considers relevant concepts, documents and other information. Chapter 5 considers the key relevant principles and potential options for dealing with asbestos-contaminated soil at Barangaroo. Chapter 6 contains a summary of the main findings and associated recommendations; and Chapter 7 contains the references for the review.

2. APPROACH

INTRODUCTION

This project was commenced in November 2012 and concluded in March 2013. During that time the investigator met with members and/or representatives of stakeholder groups, reviewed a range of relevant reports and plans, read relevant public documents such as guidelines and codes of practice, and visited the site several times.

The following stakeholder groups were consulted:

- the Environment Protection Authority;
- the Barangaroo Delivery Authority;
- Lend Lease and their relevant contractors;
- Baulderstone and their relevant contractors;
- the safety committees of the southern and the northern worksites;
- union representatives of workers at the southern and the northern worksites;
- the Ports Authority and the relevant union representatives;
- Unions NSW;
- representatives of businesses adjacent to the site;
- persons living near the site; and
- WorkCover New South Wales.

The reports and plans provided by the Barangaroo Delivery Authority and EPA that were reviewed included:

- Stockpile, contaminated soil and sediment management plan. Barangaroo Headland Park main works contract: Baulderstone, September 2012;
- Air quality management plan: Baulderstone, September 2012;
- Remedial Action Plan Barangaroo Headland Park: JBS, November 2011;
- Barangaroo Headland Park Human Health and Ecological Risk Assessment: JBS, August 2011;
- Asbestos management Plan: Baulderstone, 2012
- Northern Cove Excavation/Fill Briefing Note: Baulderstone, December 2012

Public documents consulted included:

- Guidelines for consultants reporting on contaminated sites: Office of Environment and Heritage, 2011[1];

- Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia: Western Australia Department of Health, 2009[2];
- Guidelines on the duty to report contamination under the Contaminated Land Management Act 1997: Department of Environment and Climate Change, 2009[3];
- How to manage and control asbestos in the workplace: Safe Work Australia, 2011[4];
- How to manage and control asbestos in the workplace – code of practice: WorkCover New South Wales, 2011[5];
- Management of asbestos in the non-occupational environment: enHealth, 2005[6]
- Managing land contamination planning guidelines SEPP 55 – Remediation of Land: Department of Urban Affairs and Planning and Environment Protection Authority, 1998[7];
- National Environment Protection (assessment of site contamination) Measure 1999, the 2005 issues paper, and the proposed revised schedules B1 and B2 from 2011: National Environmental Protection Council[8-11];
- Chrysotile asbestos Priority Existing Chemical report: National Industrial Chemicals Notification and Assessment Scheme[12]; and
- Australian Standard AS4964-2004 - Method for qualitative identification of asbestos in bulk samples: Standards Australia, 2004[13].

3. PLANNED EXCAVATION AND USE OF SOIL AT BARANGAROO

INTRODUCTION

This chapter provides information about the excavation and use of soils at the Barangaroo site that is relevant to the main considerations of the review.

GENERAL ASPECTS OF THE BARANGAROO DEVELOPMENT

As mentioned, the Barangaroo site is divided into three re-development areas or zones - Barangaroo South (southern zone), Barangaroo Central (central zone) and Headland Park (northern zone). The cove area is part of the northern zone. Construction activity is currently being undertaken on the southern and northern zones, with the central zone area being used for offices, sheds, car parks, etc. There is a cruise ship passenger terminal on the junction of the central and northern zones. This is to close in April 2013. A pedestrian walkway runs along the shoreline adjacent to the development area. Once the Headland Park area construction is significantly underway, a pedestrian walkway is to traverse the site to allow pedestrian access from Darling Harbour to the Millers Point area.

EXCAVATION OF MATERIAL AT BARANGAROO SOUTH

A large amount of material is being excavated from Barangaroo South. The excavation area is sealed off by plastic barrier fencing and treated as an exclusion zone, with all workers within the zone having to wear appropriate personal protective equipment (PPE) for an asbestos-contaminated zone. In addition, workers have to enter and exit through a designated area, with exiting workers passing through dirty and then clean areas. Trucks are loaded in the exclusion zone, drive to a transfer area elsewhere on site, dump their load of soil and return to the exclusion zone. Trucks from off the site drive to the dump area, are loaded with the soil and drive off site with the load covered, dumping the soil at an approved landfill. Trucks going off site drive through a wheel wash area prior to leaving the site.

Detailed perimeter and personal monitoring has been undertaken since early in the excavation process. All atmospheric and personal monitoring results have been below the detection limit (<0.01 f/ml).

CURRENT PLANS FOR THE USE OF ASBESTOS-CONTAINING SOIL

The development plans for the Barangaroo site (as at November 2012) call for the re-use of some soil excavated from the site, primarily to help form the Headland Park at the northern end of the site. The material to be re-used is planned to come partly from the excavated material at the southern end of the site, partly from the area to be excavated to form the cove at the southern aspect of the northern zone, and partly from other ground to be excavated in the northern zone to form the shoreline of the Headland Park.

The excavated material from the southern zone to be used in the northern zone is first to be transported to another part of the site in the southern zone and put through a mechanical process to sieve out any material greater than 15cm in cross-section. This process is not to remove asbestos-containing material but to ensure the soil is suitable from an engineering point of view to be able to be compacted sufficiently in the northern zone. The sieved soil is to be placed in piles in the northern aspect of the southern zone while the results of soil testing (for asbestos, heavy metals and hydrocarbon contaminants) are obtained. A maximum of 1% of asbestos weight/weight (w/w) in soil is allowed according to the approved plans. Once cleared, the soil is to be transported via truck to the northern zone. The trucks will traverse a short part of Hickson Road before returning to the site at the northern zone.

In the northern zone, the soil is to be stored in piles until ready for use, with the expectation that most of the soil will be used almost immediately. Some (about 5,000m^3) will be stored in a pile at the northern-most aspect of the site for later use.

The soil from the southern zone is to be used in the lower aspects of the headland at Headland Park. The engineering approach calls for the soil to be placed in layers of about 30cm and compacted using driven heavy rollers and hand compactors. At various stages, some of the compacted material will need to be excavated for the placement of pipes and structures to provide structural integrity for Headland Park.

While this soil is being delivered and rolled, workers will be nearby constructing the concrete retaining wall that will form the outer wall of the car park and building which will be situated under the eastern aspect of Headland Park. The planned work practices call for workers to be protected from potential asbestos exposure by wearing appropriate respirators and overalls.

The details of the proposed work plans are documented in the Asbestos Management Plan (Baulderstone, 2012) and the Northern Cove Excavation/Fill Briefing Note (Baulderstone, December 2012).

Material excavated from Barangaroo South that is not re-used on site is being disposed of at approved landfills. The same will occur for excess material excavated from Headland Park.

EXTENT OF ASBESTOS CONTAMINATION OF SOIL AT THE SOUTHERN END

At the time the plans were developed, there had been expectation that some of the excavated soil would be contaminated with a range of materials, including asbestos. Hundreds of core holes had been drilled in the southern zone, with less than 10 showing the presence of asbestos. Therefore, the initial expectation by Lend Lease and the BDA had been that any asbestos contamination would be minor, in isolated areas and infrequent. Once excavation was commenced it was found that asbestos was widespread through the excavated material – very few of the tested soil loads were free of asbestos. This asbestos was virtually all in the form of bonded asbestos, primarily as sheeting. Only one soil sample to date has shown to contain any free asbestos fibre, and only two samples have shown asbestos in friable[2] form (fibrous asbestos, as described later). The one formal assessment of the concentration of asbestos in soil was reported to the investigator to have found 6 kg of asbestos sheeting in about 1,600 tonnes of soil (i.e. 6 / 1,600,000 kg, or $3.8*10^{-6}$, or 0.00038%. Assuming 15% of asbestos-containing material (ACM) by weight is asbestos (based on the Western Australia guideline approach), this would be 0.00006% asbestos). As mentioned, extensive monitoring of soil and airborne dust has been undertaken in the southern zone during excavation work. All atmospheric and personal monitoring results have been below the detection limit (<0.01 f/ml).

EXTENT OF ASBESTOS CONTAMINATION OF SOIL AT THE NORTHERN END

The information on the level of asbestos contamination of soil in the cove area that is to be excavated is conflicting. Preliminary bore holes have not suggested significant contamination, but similar bore holes in the southern zone also did not suggested significant contamination. A trench dug to two metres (the cove is to be excavated to about 4.6 metres) in part of the cove did not identify any asbestos contamination, instead finding predominantly sandstone rubble. Some preliminary digging near the proposed new shoreline and elsewhere on the northern end of the site has identified some isolated asbestos in the form of

[2] According to Clause 42 of the Protection of the Environment Operations (Waste) Regulation 2005, friable asbestos material means any material that contains asbestos and is in the form of a powder or can be crumbled, pulverised or reduced to powder by hand pressure when dry.

pipes, and when the piping was removed there was a small amount of friable asbestos. Once this was removed, no fibres were detected. An archaeological excavation on site found some sheeting with bonded asbestos fragments but no friable asbestos. Some small amounts of ACM have been found elsewhere in the northern zone. Photos of the area from the 1970s appear to indicate the northern finger wharves were filled in after the wharves at the southern end, suggesting that if builders' waste had been used it would be likely to have contained asbestos.

4. CONSIDERATION OF RELEVANT CONCEPTS, DOCUMENTS AND OTHER INFORMATION

INTRODUCTION

This chapter provides background information relevant to the main considerations of the review.

KEY INFORMATION AND CONCEPTS REGARDING ASBESTOS

Asbestos is a naturally occurring fibrous mineral consisting of hydrated silicates and various additional substances. Asbestos commonly occurs as a long, thin fibre or bundle of fibres. Fibres smaller enough to penetrate into the small airways of the lung are known as *respirable fibres*.

Respirable fibres of asbestos are dangerous because they are known to increase the risk of developing several important diseases - mesothelioma (a cancer of the tissue lining the outside of the lungs and the inside of the chest wall, as well similar linings of some other body cavities), lung cancer, laryngeal cancer, ovarian cancer and asbestosis (a fibrotic condition of the lung)[14]. Asbestos-containing materials that do not result in respirable fibres pose virtually no risk to health.

The risk of developing an asbestos-related disorder increases with increasing total exposure to respirable asbestos, but low level exposure can result in both mesothelioma and lung cancer. The commonly used concept that “one fibre of asbestos can kill” serves to highlight the importance of minimizing exposure to asbestos. However, it is rarely a useful concept when considering approaches to manage risks related to asbestos (or other carcinogenic substances)[6], especially when the vast majority of the Australian population[15] and elsewhere[16] will have a considerable number of fibres in their lungs. It is correct to say that the only way to eliminate the possibility of risk from a carcinogenic exposure is to eliminate the exposure entirely. However, in the case of asbestos, like many other carcinogens, this is often not feasible because it is widespread in the environment, fortunately usually at very low levels. Complete elimination of exposure may be extremely costly, or have significant adverse consequences in other areas. For most carcinogens, including asbestos, exposure at very low levels is likely to result in no discernible increase in the risk of developing any of the diseases of relevance to the exposure. Therefore, for any carcinogenic exposure, including asbestos, the community should (and does) implement exposure control strategies

by balancing the health benefits gained from eliminating exposure, the feasibility and costs of such elimination, and the risk of ill health at various levels of exposure.

FORMS OF ASBESTOS IN CONTAMINATED SOILS

As described in the National Environment Protection Measure[8-11] and Western Australia guideline[2] (considered below), most asbestos contamination of soil is in the form of ACM, which is asbestos bonded in a matrix (usually a cement matrix). This form of asbestos typically does not release free respirable asbestos fibres unless it is extremely weathered, exposed to acid material or subject to severe mechanical forces.

Asbestos fines (sometimes called 'AF') is the term used to describe asbestos in the form of free fibres or small bundles or fragments of ACM (for the purposes of the relevant guidelines, a fragment of ACM is something small enough to pass through a 7 mm x 7 mm sieve). *Fibrous asbestos* ('FA') is asbestos-containing material that has little remaining bonding of asbestos fibres. Such material can be easily disintegrated with hand pressure. Asbestos fines and fibrous asbestos are of concern because they can more readily result in the production of respirable fibres.

RE-USE AND RE-WORKING OF ASBESTOS-CONTAMINATED SOIL

For the purposes of this report, re-use of soil describes the movement of soil from one part of a site to another. Re-working of soil describes the use of such soil for construction purposes.

RELEVANT CODES OF PRACTICE OR GUIDANCE

There appears to be no written guideline that specifically covers the originally proposed re-working of potentially contaminated soil at Barangaroo. Documents which provide guidance include:

- the National Environment Protection Council's *National environment protection (assessment of site contamination) measure* (1999) and the 2011 proposed revisions which are still under consideration;
- enHealth's *Management of asbestos in the non-occupational environment* (2005);
- the Western Australian Department of Health's *Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia* (2009)[2]; and
- WorkCover New South Wales' code of practice titled *How to manage and control asbestos in the workplace* (2011)[5], which is heavily based on a Safe Work document of the same name released in November 2011[4].

The key principles espoused in these documents relating to dealing with contaminated soil are:

- the primary goal must be to minimize exposure to workers and the public;
- disturbance of asbestos-contaminated soil should be minimized; and
- asbestos-contaminated soil should be managed and remain on site if that is feasible and can occur taking into account the first two principles.

The Western Australia guideline has the most detailed consideration of remediation options. The three options proposed are:

- leaving the material where it is and covering it with clean fill and/or vegetation (known as *management in situ*);
- removing as much of the asbestos as possible through picking up visible pieces by hand, tilling the surface soil and screening the soil (with a mesh of less than or equal to 7mm * 7mm recommended, or a larger screen if necessary and if combined with validation) (known as *treatment on-site*); or
- removing the contaminated material off-site.

None of the documents appear to anticipate the approach initially proposed at Barangaroo in which soil known to be contaminated with considerable amounts of asbestos (up to 1%) is handled several times, processed and re-excavated. In fact, all the documents have an explicit or implicit assumption that material to remain on site will be buried or will be free of asbestos (which the documents define as meaning that all visible asbestos has been removed and the total concentration of asbestos in the soil is less than a given level considered “acceptable”).

The Western Australia guideline proposes an “acceptable level” of asbestos contamination in soil of 0.001% for “free fibre-related materials”. The level proposed in the Western Australia document for asbestos-containing material is “at least 10-fold higher…for asbestos-containing materials (ACM) in sound condition”. Different acceptable levels for soil contaminated only with ACM are proposed in the Western Australia guideline, depending on the intended use of the site. The proposed level for “commercial/Industrial”, the category which seems closest to the intended use in the Headland Park, is “0.05% weight/weight asbestos for ACM”. This level is the final level allowed in the soil once the remediation has taken place. Higher levels would be accepted if the material was covered with a clean barrier that essentially formed a barrier between the contaminated material and the surface. It appears that the guideline considers soil remediated to meet these requirements is essentially asbestos-free, although there is no explicit statement to that effect. In practice, the soil is never likely to be completely free of asbestos because asbestos fibre is spread

throughout the community and is likely to appear at very low levels in most soils. The remediation levels suggested by the Western Australia guideline and the enHealth documents appear aimed to provide a risk level low enough to be considered close to background risk levels and acceptable for the general community.

Under the New South Wales WorkCover code of practice, soil known to contain, or to have contained, asbestos is permitted to be re-used and re-worked in certain specific circumstances. The code states *"Work involving asbestos-contaminated soil is not prohibited as long as a competent person has determined the soil does not contain any visible ACM or friable asbestos. If friable asbestos is visible, it should not contain more than trace levels of asbestos determined in accordance with AS4964:2004 Method for the qualitative identification of asbestos in bulk samples.".* Note that 'trace levels' as per AS4964 is equivalent to <0.1 g/kg, or <0.01%, asbestos in soil w/w[13]. The code does not provide details as to how any soil remediation might be undertaken.

The NSW EPA prohibits the re-use of asbestos-contaminated material on another site[3]. However, the EPA does not prohibit asbestos-contaminated material remaining on site – in fact, this is seen as preferable to transporting the material and dumping it in an approved site if the asbestos can be appropriately isolated. Re-use of asbestos-containing material is allowed if it is on site. Whether re-working of asbestos-containing material on the same site (prior to remediation) is explicitly allowed under EPA regulations is not clear. Any such re-working on a work site is overseen by WorkCover under the WorkCover code of practice mentioned in the previous paragraph. The whole Barangaroo development area is covered by a single EPA licence and is considered for EPA purposes to be a single site.

THE SCIENTIFIC BASIS OF LIMITS SET FOR REMEDIATED SOIL

The Western Australia guideline levels of 0.001% asbestos w/w (and the higher levels for ACM) was based on the enHealth 2005 document mentioned earlier and particularly on a more recent Dutch study[17]. The level is <u>not</u> based on a health risk assessment but on a level that was judged to be "acceptable". The main study[17] on which the Western Australia guideline is based suggests a higher level of contamination in soil would be acceptable – the study by Swartjes and Tromp propose 0.01%, calculated giving more weight to crocidolite than chrysotile because of the presumed greater toxicity of crocidolite (*"the sum of the concentration of chrysotile asbestos and ten times the concentration of amphibole asbestos, for bound (non friable) as well as for friable asbestos"*), and the Western Australia guideline states *"The cancer risk from asbestos should be kept as low as practical and preferably no*

[3] See Clause 42 of the Protection of the Environment Operations (Waste) Regulation 2005

more than one occurrence in one million over a lifetime for the exposed population. Mesothelioma is used here as the most sensitive health impact of asbestos exposure". The Western Australia guideline states that the above criteria *"...should keep asbestos air levels below 0.001 f/ml and probably around 0.0001 f/ml."*.

An earlier study conducted at the Institute of Occupational Medicine in Edinburgh produced similar findings, although it suggested somewhat higher airborne concentrations of asbestos for a given soil concentration in some circumstances[18]. In that study, various types of soils, asbestos, asbestos concentrations and degrees of soil wetting were investigated. The main conclusions from the study were that soil with asbestos concentration of less than 0.001% should not generate airborne asbestos fibres above a concentration of 0.01 fibres/ml. However, the study did report that *"even 0.001% of asbestos in a dry loose mixture was capable of producing airborne respirable asbestos concentrations in excess of the 0.01 f/ml clearance limit"*. Considerably lower airborne concentrations were found for soil where water spray was used for dust suppression and where the asbestos was chrysotile (as compared to crocidolite). The study used asbestos fibres (*"with the consistency of soft asbestos lagging"*) rather than ACM.

The EnHealth document[6] reports that *"Imray and Neville (1993) suggested a level of <0.001 f/mL in air and <0.001 per cent in soil to classify a site as uncontaminated or unrestricted and suitable for all land uses..."*, with Imray and Neville[19] having developed this suggestion using the results of the above study by Addison and co-workers[18]. However, the enHealth document and others caution that it is very difficult to accurately predict the concentration of airborne respirable fibres on the basis of soil contamination levels.

Based on the above information, 0.001% for asbestos in soil should provide levels of risk of asbestos-related disease well below levels of risk generally considered "acceptable" in an occupational or public setting, especially if the asbestos is in the form of ACM. However, the difficulties in accurately measuring fibrous asbestos and asbestos fines means that it some circumstances it would be prudent to dispose of soil that has any presence of fibrous asbestos and asbestos fines, rather than relying on the apparent concentration of these in the soil. If the asbestos is in the form of bonded material, the measured concentration should be reasonably accurate and suitable for deciding whether the remediation level has been appropriately met. Given the uncertainties involved in sampling and in accurately assessing the level of asbestos contamination in soil, it is still important that dust suppression techniques and monitoring of airborne exposure levels are undertaken where asbestos is known or reasonably suspected of contaminating soil to be processed in some way.

RE-USING MATERIAL ON SITE COMPARED TO TRANSPORTING IT TO LANDFILL

Minimising the amount of material removed from any construction site appears sensible from a community perspective. Landfills are a limited resource. Transporting contaminated material to a landfill involves the use of heavy trucks, which are a traffic hazard. There is also the potential for a spill of material and exposure of the general public to airborne asbestos (or other contaminants) if significant quantities of asbestos fibres are in the transported soil, and potential exposure of workers and members of the public in and around the landfill.

In contrast, keeping contaminated material on site increases the potential for workers and members of the public in and around the site to be exposed during the construction phase. The risk associated with this exposure can be eliminated if the material is removed from the site, although the process of excavating and transporting asbestos-contaminated material necessarily carries more risk of exposure than would occur if the material was undisturbed and/or simply covered with uncontaminated material. Remediating soil that was initially contaminated with asbestos is intended to address concerns about exposure during the construction phase or through other uses by removing all or enough contamination that the soils are essentially considered asbestos-free in terms of the likelihood of generating respirable fibres. The potential for exposure during the remediation phase remains, although this potential should be very small if the asbestos is mainly in the form of ACM.

Balancing the two competing approaches of removing all contaminated soil or remediating contaminated soil on site can be difficult. This is necessarily guided by consideration of issues of occupational health, environmental health, public health, the physical environment, financial resources and community resources. A decision in any one situation must take all these aspects into account. Guidelines on remediating contaminated sites consider all these, but place an emphasis on re-using material where-ever possible, provided that associated potential risks can be appropriately managed. This review takes all the components into account, but with an emphasis on occupational, public and environmental health. It is beyond the scope of this review to make a detailed consideration of the arguments for and against the general issue of remediating contaminated material versus transporting and dumping contaminated material.

HIERARCHY OF CONTROL

A fundamental pillar of occupational health and safety is the approach that should be taken in controlling risks arising from hazards in the workplace. The hierarchy of control describes the list of possible control options, ordered from most preferable to least preferable. The top

of the hierarchy (the most preferred option) is elimination of the hazard. The key principle of occupational health and safety is not to introduce a hazard if this can be avoided, and to minimise risk arising from any hazard that cannot be eliminated. This risk minimisation occurs through substituting with a lower risk hazard, isolating the hazard from the worker, using engineering controls (such as ventilation) or methods of work (such as spray for dust suppression), administrative approaches (such as having work proper procedures) and, finally, the use of personal protective equipment. Exposure monitoring should also form part of the control strategy.

HUMAN HEALTH RISK ASSESSMENT

Health risk assessment describes the process to estimate the probability that a particular adverse health event will occur. The risk of a particular outcome is usually considered "acceptable" when the probability of an event occurring is less than a level deemed "acceptable" to the community.

Health risk assessment is an important part of any approach to risk control that does not involve elimination. It is not required if the hazard is eliminated because if the hazard is not present the risk arising from the hazard is zero.

The health risk assessment (more formally called a Human Health and Ecological Risk Assessment (HHERA)) undertaken for the Barangaroo project was by JBS Environmental. This used exposure estimates based on Dutch studies of respirable fibre concentration in a range of real-life situations with different concentrations of soil contamination of asbestos[17]. Based on these, the HHERA adopted a "*…criterion for asbestos of 1% present as fibre cement sheet…for a sub-surface maintenance worker exposure*". This criterion is to be adopted for all soils more than 0.5 metres under the surface. It appears this criterion of 1% has been developed because risk assessment suggests the risk of adverse asbestos-related health event at that concentration of material in soil is less than 1 in 10^{-5} (one in 100,000). The health risk assessment was developed for the purpose of assessing risk once the Headland Park development was completed. It did not consider in any detail the implications to the health of workers or the public of contaminated material during construction of the Headland Park. For example, on page 125 of the health risk assessment there is a table (Table 20) which lists various activities involving asbestos cement sheeting which have been shown to result in significant levels of airborne asbestos fibres. These activities include "throwing sheets into a lorry", and the table is followed by the text "*By review of Table 8.20, each of the activities listed are highly unlikely to be replicated in the urban environment of the proposed Headland Park.*" Specifically, the health risk assessment was <u>not</u> developed to

identify an acceptable level of asbestos contamination in soil based on the work methods proposed for the construction of the Headland Park. In fact, the proposed construction methods had not been developed at the time the health risk assessment was undertaken.

REMEDIAL ACTION PLAN FOR HEADLAND PARK

There is a Remedial Action Plan (RAP) for the whole Barangaroo site and separate RAPs for different parts of the site. Specifically, there is a RAP (with some amendment documents) for the southern zone and a separate RAP for Headland Park. The RAP for Headland Park was delivered in November 2011. This had three stated objectives:

- "to document the procedures and standards to be followed in order to remove the risks posed by contamination at the Headland Park Site to future site occupants and the surrounding environment (incl. human and ecological receptors);
- to document the procedures and standards to be followed in order to ensure the suitability of site materials relocated from the broader Barangaroo Project Site onto the Headland Park Site; and
- to enable a Site Audit Report and Site Audit Statement(s) to be prepared by the appointed independent NSW EPA Accredited Site Auditor, confirming that the Headland Park Site can be made suitable for the proposed uses subject to the successful implementation of the proposed remedial/management measures. "

It is clear from these objectives and the content of the document, and confirmed by information from the EPA and one of the RAP's authors, that the purpose of the RAP was to ensure the completed Headland Park did not contain contaminated material that posed unacceptable risk to the public, workers or the environment once the Park was completed. The RAP did not consider in any detail the implications to the health of workers or the public of contaminated material during construction of the Headland Park. A recommendation relevant to this was made in the RAP: "*An Occupational Health and Safety Management Plan (OHSMP) to document the procedures to be followed to manage the risks posed to the health of the remediation workforce*." (page xiii), and the report stated that the remediation contractors were required to "*Develop and implement a comprehensive Occupational Health and Safety Management Plan (OHSMP) to manage, monitor, maintain and report health, safety and rehabilitation measures*." (page 22). Section 9 of the report addresses health and safety. Relevant parts of this section include that the OHSMP should "*…apply standard procedures that minimize[s] risks resulting from the works", there should be "an evaluation of hazards*", "*monitor[ing of] potential hazards and implementation of corrective measures*", and that "*As a precautionary measure, the OHSMP should include the requirement for the plan to*

be revised in the event of an unexpected find of contaminated material during remediation construction.".

HEADLAND PARK ASBESTOS MANAGEMENT PLAN AND APPROACH TO CONSTRUCTION

The December briefing note from Baulderstone states that "*The methods to be implemented acknowledge the potential for finding asbestos, in line with the project planning approvals, and the procedures to be adopted are detailed in the Asbestos Management Plan. WorkCover has reviewed the Asbestos Management Plan and confirms that this plan complies with all industry standards in regard to asbestos treatment. The Asbestos Management Plan and associated testing and acceptance criteria also complies with the Remedial Action Plan (RAP) for the Headland Park and approved by the EPA, an independent auditor and the Minister for Planning.*"

This document suggests that, if Baulderstone undertook the work as described, even if the material to be re-worked is contaminated with up to 1% asbestos in the form of ACM, the control measures in place were considered acceptable based on industry and environmental standards. It is not clear whether this is actually the case, nor the status of the WorkCover New South Wales confirmation of compliance. Nevertheless, this does not address the issue as to whether such re-working is appropriate in the first place. As mentioned earlier, no code of practice or equivalent appears to anticipate the type of re-working of soil potentially contaminated with the level of asbestos originally approved for use at Barangaroo. In addition, also as mentioned, the 1% level for asbestos cement sheeting mentioned in the health risk assessment and the RAP was based on the assessment of risks after the Headland Park had been constructed, not during the construction phase.

The briefing note also states that the concrete retaining wall will be largely constructed prior to the use of cove material on site, thereby lessening the chance of meaningful exposure to asbestos of workers involved in the construction of the wall and making it easier to modify work methods if necessary to further minimize the chance of worker exposure.

PERSONS POTENTIALLY AT RISK FROM ASBESTOS-CONTAMINATED SOIL AT BARANGAROO

In the instance of asbestos contamination on a worksite, several groups of people are potentially at risk. On a site such as Barangaroo, if asbestos is present on site it potentially produces increased risk to the workers on site and members of the public on or around the site. However, if the asbestos is taken off site to a designated landfill, there is potential risk to persons (the truck driver and members of the public) who may be exposed during

transport and workers who may be exposed at the disposal site during unloading and covering of the contaminated soil.

IS BARANGAROO A SINGLE WORKSITE?

As mentioned, the whole Barangaroo development area is legally considered a single worksite for EPA purposes. However, different aspects of the site are being developed at different times, different companies are responsible for the development at different parts of the site, and different workforces work in different parts of the site. Discussions with the safety committees of the southern and northern workforces clearly showed that the workers do not consider the two sites to be the same in a practical sense.

THE POSITION OF THE WORKERS

The investigator does not pretend to speak on behalf of the workers or unions on site but presents here his understanding of their main concerns or opinions relevant to the review.

The workers and their representatives were strongly opposed to the original proposal to prepare and transport asbestos-contaminated soil (potentially with up to 1% asbestos) from the southern zone to the northern zone and to then to lay, compact and work with the soil. They considered this presents unnecessary risk to the workers in both the southern and northern zones. Their position was that this contaminated soil should be removed off site to an approved asbestos landfill. The position of the workforce from the northern zone on the potential re-use and re-working of asbestos-contaminated soil from the northern zone appeared to be not fixed. There appeared to be a feeling that the workforce would be in a better position to manage risk associated with any asbestos that might be present in the northern zone than they would be to manage risk associated with asbestos-contaminated soil from the southern zone. Nevertheless, there did appear to be concern that if highly contaminated soil was found in the northern zone it might be required to be re-used and re-worked without proper remediation. Concerns were also raised about the appropriateness of the risk assessment, and the cultural appropriateness of transporting asbestos-contaminated soil to re-build a Headland Park that belonged to the indigenous community at the time of white settlement.

THE POSITION OF PERSONS WORKING NEAR THE SITE

The investigator does not pretend to speak on behalf of persons working near the site but presents here his understanding of their main concerns or opinions relevant to the investigation.

The business representatives appeared broadly supportive of the development. Although they had concerns about the presence of asbestos and the potential for exposure, they were re-assured by the results of the monitoring at the southern zone and the proposed control measures to minimise the impact of site exposures on the surrounding businesses. There was concern from the Sydney Ports Corporation of the potential for dust exposure on hot days with a strong westerly wind and whether there might be a need for Ports employees to be asked to supply water to keep dust-exposed areas moist to minimise airborne dust.

THE POSITION OF PERSONS LIVING NEAR THE SITE

The investigator does not pretend to speak on behalf of persons living near the site but presents here his understanding of their main concerns or opinions relevant to the investigation.

Like the business representatives, persons living near the site appeared broadly supportive of the development. Their main concerns related to the levels of general dust and noise related to the site. These persons did have concerns about the presence of asbestos and the potential for exposure, but they were re-assured by the results of the monitoring at the southern zone and the proposed control measures to minimise the impact of site exposures on the surrounding residences.

THE PEDESTRIAN WALKWAY

The Barangaroo development was intended to be undertaken in a manner that would allow members of the public to have access to a walkway along the foreshore border of the site throughout the construction phase. This walkway currently allows members of the public to walk from the Darling Harbour (southern) end of the Barangaroo development, along the water's edge to near the northern tip of the site, and then to walk through the site to Millers Point. At the junction of the Central and Northern zones, and the Central and Southern zones, there are walkways from the water's edge, across the asphalted area to Hickson Road. These are to allow passengers on docked cruise ships to have access to and from the ship. This access will no longer be required from some time in April, because the cruise ship terminal will be closed prior to moving to White Bay.

At the southern end of the site, the walkway is 10 to 15 metres above the level of the excavation and separated from it by at least 10 or 15 metres. This excavation is near to completion. No respirable asbestos fibres have been detected with the air monitoring undertaken to date at the Barangaroo development boundaries adjacent to the pedestrian walkway in the Southern zone.

At the northern end of the site the walkway is at ground level. The building works in this area will involve significant excavation, mainly in the cove area. This excavation will be much shallower than in the Southern zone. As the headland is built, some of the works will be above ground level.

5. POTENTIAL OPTIONS FOR DEALING WITH ASBESTOS-CONTAMINATED SOIL AT BARANGAROO

INTRODUCTION

The principles of dealing with asbestos-contaminated sites should guide the decisions on acceptable approaches to managing asbestos-contaminated material at Barangaroo. The available guidelines, particularly the Western Australia guideline, provide the best basis for determining the specific practices to use.

GENERAL PRINCIPLES

PRINCIPLES GUIDING THE GENERAL APPROACH TO MANAGING ASBESTOS-CONTAMINATED MATERIAL AT BARANGAROO

The principal of minimising exposure to workers and the public at Barangaroo would lead to a decision to remove all asbestos-contaminated material from the site and replace it where needed in Headland Park with clean fill. If workers at disposal sites and members of the public potentially affected during transport of contaminated material are also taken into account, the decision is less clear but on balance this would still lead to the removal of all contaminated material.

The principal of managing asbestos-contaminated soil on site would lead to a decision to re-use (and potentially re-work) as much site material as possible, minimising transport of such material off-site. This is compatible with the first principle if the soil can be appropriately remediated.

PRINCIPLES GUIDING THE SPECIFIC APPROACH TO MANAGING ASBESTOS-CONTAMINATED MATERIAL AT BARANGAROO

Acceptable levels of asbestos in soil

The Western Australia guideline, en-Health guideline and proposed NEPM approach consider soil that has been contaminated with asbestos to be suitable for use in any form if the percentage of asbestos in soil is less than 0.001% w/w (note that Australian Standard AS4964 considers the reporting limit for detecting fibres in soil is 0.1g/kg, equivalent to 0.01% w/w). Given the conservative assumption that ACM contains 15% asbestos, and that all asbestos in ACM can be released, this gives a cut-off for acceptable ACM to be less than 0.0067% w/w. The Western Australia guideline considers that an ACM level of less than 0.01% w/w is acceptable (and less than 0.04% w/w in some circumstances).

Acceptable form of asbestos in soil

The Western Australia guideline accepts fibrous asbestos and free fibre (equivalent to asbestos fines) in soil as long as the concentration is less than 0.001%. However, the concentration of fibrous asbestos and asbestos fines is very difficult to reliably assess, and both have a much higher potential for generating respirable fibres than does ACM. Therefore, it is considered by the investigator that soil at Barangaroo contaminated by asbestos in the form of fibrous asbestos or asbestos fines is not suitable for remediation and must be disposed of in an approved asbestos disposal site.

Visible ACM in soil

Visible ACM should be removed, even if the overall concentration of asbestos is less than 0.001% (i.e. ACM concentration less than 0.006%).

IMPLICATIONS OF THE GENERAL PRINCIPLES FOR THE BARANGAROO SITE

Current guidelines mean soil known to have contained asbestos but remediated to meet the above requirements should be considered free of asbestos for all practical purposes. Such material could reasonably be considered appropriate for re-use and for re-working in the manner proposed for Headland Park, although control measures and PPE should be still be used as a precaution during the construction process.

Using these principles and other content of the relevant documents, the following conclusions arise:

- It is acceptable to re-use and re-work soil previously contaminated with asbestos as long as the soil is remediated appropriately.

- Material contaminated with fibrous asbestos or asbestos fines (essentially this means material that definitely or probably has asbestos fibres present) should not be re-worked and should be disposed of in an appropriate facility regardless of the apparent concentration of the fibres.

- Material previously contaminated with ACM can be re-used and re-worked if the total amount of asbestos is less than 0.001% (which means the ACM should be less than 0.006%) and all visible ACM is removed.

- The initially proposed work practices for re-use of material from the southern zone were not appropriate because they allowed an asbestos concentration of up to 1%

ACM (rather than less than 0.01% as required) and did not require the removal of visible ACM.

- The use of material from anywhere on the site (whether from the southern zone or northern zone) is acceptable from an asbestos contamination standpoint as long as this material meets the above soil remediation requirements.

- If previously contaminated soil is to be re-used or re-worked, it is important that appropriate exposure control and protection mechanisms are in place, rather than just relying on sampling to determine that the soil is safe to use.

As far as can be determined, if these criteria are used, the Barangaroo site will be adopting the most stringent conditions in place in Australia for remediation of asbestos-contaminated soil.

OPTIONS FOR BUILDING HEADLAND PARK

Soil being excavated in the southern zone of the site is known to have significant asbestos contamination, although the nature and level of this contamination is not clear (the single measurement to quantify the amount asbestos contamination found levels well below what is considered acceptable in remediated soil). Soil to be excavated from the cove and new foreshore area in the northern zone clearly have some asbestos contamination present but to date there has not been evidence of extensive contamination nor the suggestion of significant presence of fibrous asbestos or asbestos fines.

Soil contaminated with asbestos needs to be remediated, remain on site in some form, or be transported off-site to an official asbestos disposal site. Contaminated soil that is to remain on site could be cleared of asbestos and re-used, or buried somewhere else on site, in the same way as would occur at an asbestos disposal site.

The nature of contamination of soil in the southern zone may make it difficult, but not impossible, to clear it of enough asbestos to allow the remediated soil to be considered suitable for re-use and re-working. If contamination in the northern zone is not extensive, it may be possible to remove asbestos material as it is found, leaving the remaining soil to be considered essentially asbestos-free based on current guidelines.

Five main options for dealing with asbestos-contaminated soil on site are considered.

1) ONLY USE NORTHERN ZONE MATERIAL BUT ALLOW THE USE OF PREVIOUSLY CONTAMINATED SOIL AFTER IT HAS BEEN REMEDIATED

Allow the planned re-use and re-working of soil originally contaminated with asbestos and excavated from the northern zone, provided it is appropriately remediated, with disposal of unsuitable material off-site.

This option is acceptable.

If soil to be excavated from the cove and new foreshore area in the northern zone does not have significant asbestos contamination then the construction of the Headland Park could proceed as planned without the concern about significant potential exposure to asbestos. Isolated asbestos contamination (such as drainage pipes) could be safely dealt with if and when it is found. Baulderstone would have greater control of when potentially contaminated material was required to be used than they would have if such material was coming from the southern zone.

If the soil does contain significant asbestos contamination, it would still be possible to re-use and re-work the soil provided it can be appropriately remediated. This would need to be undertaken following the principles mentioned earlier in the chapter and would also require an extensive exposure control and monitoring system. During the remediation process there would clearly be higher potential for exposure to asbestos than if the material was transported directly off-site, but as long as the asbestos contamination was primarily in the form of bonded asbestos the potential for exposure to airborne asbestos fibres would be very low and should be able to be controlled and monitored. Even if the level of contamination is significant, once the remediation has taken place the remediated soil is considered to be essentially free of asbestos. However, the unavoidable uncertainties in the soil sampling process mean that if the soil does initially have significant asbestos contamination then the work practices and sampling will need to be different to those required if all material used on the site had always been uncontaminated or if all contaminated soil was removed from site without being remediated.

The main advantages in this scenario are:

- even if the excavated material in the northern zone does have some asbestos present, the levels of contamination may be low and be able to be dealt with easily and acceptably prior to re-use;
- the northern zone, which may not have significant contamination, would not be contaminated with soil from the southern zone that is known to be contaminated;

- most workers may not have to wear asbestos-related PPE as much or at all most of the time;
- there is potentially less off-site transport of contaminated soil to approved disposal sites; and
- there should be less concern from northern zone workers about being exposed unnecessarily to previously contaminated soil from what they perceive as a different worksite.

However, it is possible that the cove area (and perhaps the foreshore) could have widespread asbestos contamination, as is the case in the southern zone. If that is the case, extensive work may be required to appropriately remediate the soil and this may prove infeasible.

The main disadvantages would be:

- many workers would potentially still be required to wear PPE for significant periods of time because the soil had previously been contaminated with asbestos (if the material derived from the northern zone has widespread asbestos contamination); and
- the planned harbour foreshore walk would probably have to be closed to minimise the potential for exposure of members of the public.

Conclusion: This option is acceptable because it follows the relevant principles. However, if the cove does have significant levels of asbestos contamination then more work would be required to remediate the soil and there would be a higher (although probably still very low) potential for asbestos exposure because the soil is being handled more than it would be if taken directly off site. The advantage of not having to transport the material off-site and re-using material on site needs to be balanced with concerns about the additional potential for exposure when such exposure would be avoidable through the use of clean fill.

2) ALLOW USE OF MATERIAL FROM THE SOUTHERN ZONE IN ADDITION TO MATERIAL FROM THE NORTHERN ZONE AS LONG AS PREVIOUSLY CONTAMINATED SOIL HAS BEEN REMEDIATED

Allow the planned re-use and re-working of soil originally contaminated with asbestos and excavated from both the northern zone and southern zone, provided it is appropriately remediated, with disposal of unsuitable material off-site.

This option is acceptable.

This option is the same as Option 1 but in addition allows the use of material from the southern zone. Soil being excavated from the southern zone is known to have widespread asbestos contamination, but the nature of the contamination (in the form of ACM) should be amenable to remediation. It is not clear whether such remediation is feasible. If southern zone material is to be re-used it would require an acceptable method for removing visible ACM; identifying and excluding soil containing free asbestos; and determining the extent of any remaining asbestos to make sure the overall concentration was less than 0.001% (0.006% ACM).

The main advantages in this scenario are that it potentially means a smaller amount of site material would need to be transported off-site. Otherwise the advantages are much as described in Option 1.

The main disadvantages, in addition to those listed for Option 1, are

- the greater handling (and so potential for exposure) required to allow the assessment and use of material from the southern zone in the northern zone;
- greater challenges for Baulderstone in coordinating the delivery and use of material from the southern zone; and
- the potential disenchantment of northern zone workers perceiving that they are being required to work with previously contaminated material from another workplace.

Conclusion: This option is acceptable for the reasons outlined in Option 1. Whether the advantages of decreasing the overall transport of material off site outweigh the additional disadvantages of using southern zone material is open to question.

3) TRANSPORT ALL CONTAMINATED SOIL OFF-SITE WITHOUT REMEDIATION

Transport all excavated contaminated soil to an official off-site asbestos disposal site. This would involve bringing to the site clean fill from elsewhere.

This option is acceptable.

If all soil contaminated with asbestos is transported off-site rather than being remediated then there is no additional short-term or long-term risk to workers or the public on site beyond that arising from the excavation of the soil. Uncontaminated fill is readily available and can be used in the construction of the Headland Park using the compaction techniques currently planned. If the cove area does not have significant asbestos contamination then the amount of clean fill to be imported to the site would be relatively small. If there is contaminated soil

found on the northern site, once it is removed the site will be able to be considered asbestos-free.

The main advantages of this approach are:

- the potential exposure of workers in the southern and northern zones, and of members of the public around the site, is minimised;
- workers will be able to use their usual work practices with minimal use of asbestos-related PPE; and
- the planned harbour foreshore walk may be able to remain open during the construction phase in the northern zone, once asbestos-contaminated material has been removed from the site.

The main disadvantages are the:

- required transport through the community of potentially large amounts of contaminated soil in trucks to a waste disposal site;
- use of a waste disposal site, such sites being a finite resource that should be used only when necessary; and
- the need to transport large amounts of clean fill to the site.

Conclusion: This option provides the smallest potential for exposure of workers and members of the general public around Barangaroo during construction, although the potential for meaningful exposure is very low provided the soil is properly remediated. It also requires the largest amount of transport of material off-site and onto the site. It is the preferred option from an occupational health and safety point of view but not necessarily from a public health and environment point of view, and certainly not from the perspective of financial resources and community resources. These relative advantages and disadvantages are difficult to balance.

In practice, there is little or no difference between this option and the earlier options if the asbestos contamination in the cove is low.

4) CONTAIN CONTAMINATED SOIL ON SITE BUT DON'T RE-WORK

Change the plans so that asbestos-contaminated soil can be transported from the southern zone to the northern zone without initial or later processing and dumped in an artificial "pit" in the northern zone. Significantly contaminated soil from the northern zone could similarly be dumped without prior or additional processing.

This option would be acceptable if feasible.

If the Headland Park area had a hole that needed to be filled with soil then disposal of the asbestos-contaminated soil in such a pit would be a viable option. This would in essence be no different to what occurs at a landfill and would avoid the transport of asbestos-contaminated material in trucks through the community to a designated disposal site. The material could be covered with clean fill, as occurs in a standard disposal site. The main difference to a standard disposal site is that a standard disposal site has very few workers and few members of the public living or working immediately adjacent to the area. In contrast, at Barangaroo the disposal area would be a worksite with many workers, and there are a lot of members of the general public living and working adjacent to the site. Unfortunately, there is no such hole requiring filling at Barangaroo and under the current plans any material used to form the Headland Park is required to be compacted considerably to provide the structural integrity of the Headland Park. If it is possible to change the approach to construction such that an artificial pit is constructed by building walls in addition to the one planned on the eastern side of the Headland Park, and heavy compaction is not required, the contaminated soil could essentially just be dumped in the 'pit', covered with clean fill and rolled.

The main advantages of this approach over others is that there would be less off-site transport of contaminated soil to an approved disposal site; less chance of workers and members of the public being exposed because the contaminated soil would not be re-worked; and workers would not have to wear asbestos-related PPE as much and most probably not at all most of the time.

The main disadvantages are that there is still some potential for avoidable exposure of workers and the surrounding public; a small number of workers would be required to cover the contaminated soil with clean fill on a regular basis and so would have to be properly protected during this activity (although note this would occur at a standard disposal site as well); the planned harbour foreshore walk would probably still have to be closed to minimise the potential for exposure of members of the public while the material was being dumped; and the approach may not be feasible depending on when material from the southern zone is ready for transport and because the Headland Park material may have to be more heavily compacted for engineering purposes than is possible with the approach described.

Conclusion: This option allows contaminated material to remain safely on site and the potential for exposure of workers and the public during construction is low enough to consider this a better option than transporting all contaminated material off-site, as such transport also has some potential for exposure to workers and the public and involves more

trucks on the road. Workers would not be required to perform construction work with asbestos-containing material. However, the approach appears not to be feasible due to the engineering requirements of the Headland Park construction.

5) USE THE ORIGINAL PLAN

Use the originally proposed approach of transporting asbestos-contaminated soil from the southern to the northern zone and use the soil as planned in constructing the Headland Park.

This is not considered acceptable.

As mentioned earlier, the proposed plan for re-use of the material from the southern zone involved multiple stages of handling and processing the contaminated soil. There was no intention to remove asbestos-containing material from the soil, except as would occur through the sieving process designed to remove large pieces of rock or material that would interfere with the planned compaction. The contaminated soil was allowed to have up to 1% asbestos in the form of bonded asbestos-containing material.

The major advantage of this approach was that the material did not need to be taken off site. This means it minimised potential exposure to asbestos, and to the traffic hazard arising from trucks, for the general public between Barangaroo and the waste disposal site. It also didn't use up the finite resources of a waste disposal site. The approach provided material to help form the Headland Park, which means less material would need to have been brought to the site from elsewhere. The formal health risk assessment predicts that the end result of the finished Headland Park would have an acceptably low level of risk arising from potential asbestos exposure, but it does not provide an assessment of the safety or acceptability of the planned work practices.

The main disadvantages of the planned approach were:

- potential exposure to workers in the southern zone through the sieving, storing and re-loading of contaminated soil in the southern zone;
- potential exposure in the northern zone of workers who are involved in the laying and compaction of the soil, and of workers operating nearby. These workers were likely to have to wear personal protective equipment that would be difficult to wear, particularly on hot days, and would interfere with the work activity of other workers working nearby.
- workers in the northern zone do not consider themselves to be part of the same worksite as the southern zone and so perceive the asbestos-contaminated material,

and the accompanying potential for exposure to asbestos, is being imposed upon them;

- members of the public around the site would have a higher potential for exposure; and
- the planned harbour foreshore walk would have to be closed during construction to minimise the potential for exposure of members of the public.

Workers would not simply be dumping the soil in a hole and covering it up with clean fill, as would occur at a disposal site. Instead, they would be compacting the material, and then later digging some of it up for the laying of pipes and for engineering work. Such re-working of asbestos-contaminated soil does not appear to be envisaged in any Australian code of practice or guideline that addresses the remediation of asbestos-contaminated sites. Instead, the intention of these documents appears to be that soil to be re-used (and perhaps re-worked) is first cleared of asbestos, down to a level below 0.001% (0.01% for ACM) and with removal of all visible pieces of asbestos.

The area in the northern zone where the soil from the southern zone is to be used is not currently known to be significantly contaminated with asbestos. Therefore, this potential exposure of workers in the northern zone may be largely avoidable if the contaminated soil from the southern zone is not transported to the northern zone. Similarly, workers in the southern zone have a higher potential of exposure due to the multiple handling and processing of the material prior to transport to the northern zone. This additional potential for exposure is entirely avoidable by not processing the material as planned. Also, the plan proposed to store a pile of asbestos-contaminated soil for a period of time at the northern tip of the site in an uncovered form, although appropriate dust minimisation measures were to be put in place. This raised the potential for exposure if the pile became unexpectedly disturbed by wind or site activity. Again, this potential for exposure is entirely avoidable.

Conclusion: On the basis of standard occupational health and safety and public health principles it appears difficult to justify the additional potential for exposure arising from the approaches in the originally proposed work plan when such exposure is clearly easily avoidable. The health risk assessment that allowed up to 1% asbestos (as ACM) did not take into account the construction phase of the project and does not meet the requirements for remediation of asbestos-contaminated soil as per relevant guidelines. The advantage of not having to transport the material off-site and of re-using material on site does not outweigh these concerns.

APPROACH TO SAMPLING

Some reference to soil sampling is made in the Western Australia guideline[2], the NEPM draft schedules B1[8] and B2[9], the enHealth[6] document and Australian Standard 4964[13]. However, none of these documents provides a detailed approach suitable for use at Headland Park. It is likely that a three-dimensional grid pattern will need to be used, but the development of the exact approach is the responsibility of Baulderstone, working with their site safety committee. This approach should be confirmed with the EPA and Workcover New South Wales, and approved by the site auditor.

APPROACH TO REMEDIATION, IF REQUIRED

Approaches to remediation are documented in the Western Australia guideline[2] and the NEPM draft schedules B1[8] and B2[9] (the NEPM schedules rely heavily on the Western Australia guideline). These should serve as a reference for the development of the remediation approach used on Headland Park, but the final approach may appropriately differ in some aspects. For example, the documents above mention using a 7mm*7mm sieve. This would probably work for very dry and sandy soils, but is likely to be impractical for use on the Barangaroo site. The development of the exact approach to remediation is the responsibility of Baulderstone, working with their site safety committee. This approach should be confirmed with the EPA and Workcover New South Wales, and approved by the site auditor.

APPROACH TO EXPOSURE CONTROL MEASURES

It needs to be kept in mind that sampling, by definition, does not provide a guaranteed accurate description of all the material from which the sample was taken. If the volume of soil from which each sample is taken is kept small, and the samples taken are from a typical part of the volume, the results are likely to be valid for the whole volume. However, this cannot be known for certain. Therefore, it will be necessary to maintain appropriate control measures during the phases of Headland Park that involve the excavation of soils potentially containing asbestos or the use of soils previously contaminated but which have been remediated. These control measures should include environmental measures, such as dust suppression; personal measures such as the use of appropriate PPE; and an extensive and on-going monitoring approach, as described in the next section. In developing these procedures, it should be kept in mind that PPE is commonly difficult to wear, particularly on hot days, and must be well maintained. The development of the exact approach to exposure control is the responsibility of Baulderstone, working with their site safety committee. This approach should be confirmed with the EPA and Workcover New South Wales, and approved by the site auditor.

APPROACH TO MONITORING

The Stockpile, Contaminated Soil and Sediment Management Plan (SCSSMP) specifies approaches to monitoring (pages 23 and 24 and Tables 13). This should be seen as the minimum monitoring that should be undertaken. The final approach to monitoring is the responsibility of Baulderstone, working with their site safety committee. This approach should be confirmed with the EPA and Workcover New South Wales, and approved by the site auditor.

This SCSSMP mentions an air monitoring action criterion of "0.1 fibres/ml as asbestos fibres and attributable to site works" for airborne fibres. The report says (page 24) "*The concentration of asbestos fibres shall be compared to the action criteria. Where an action criterion is exceeded, all works shall be ceased and asbestos-contaminated materials removed from site as per strict controls.*" The level of 0.1 fibres/ml is the exposure standard for asbestos in Australia[20]. It is usual that an action level is well below the exposure standard. Typically with asbestos in an occupational context, the action level would be 0.01 fibres/ml (that is, detectable fibres) and at 0.02 fibres/ml work would typically cease in order to find and control the source of the asbestos fibres. In addition, the community exposure level recommended by enHealth[6] and supported by the Western Australia guideline[2] is 0.01 fibres/ml (the documents describe this as "para-occupational"). If 0.1 fibres/ml really is the proposed air monitoring action criterion, it is recommended this be reviewed in the light of the above comments and that a level of 0.01 fibres/ml is adopted.

LONG-TERM IMPACTS OF THE HEADLAND PARK AT COMPLETION

The main focus of this review was the occupational health and safety and related issues relevant to the potential use of asbestos-contaminated material in the construction of Headland Park.

The terms of reference also called for a consideration of the long term impacts of the Headland Park at completion, in relation to asbestos. The Human Health and Ecological Risk Assessment appears to have been conducted thoroughly and appropriately. It has also been reviewed by several other independent persons or government authorities. The approach to construction of Headland Park calls for excavated material used in the construction of Headland Park to be covered by at least 0.5 metres of clean fill. Therefore, there seems to be minimal risk of exposure to asbestos for workers and the public once the Headland Park is constructed. This would be the case even if the buried material did contain up to 1% asbestos. If the buried material contains less than 0.001% asbestos (0.006% ACM) it is essentially considered to be free of asbestos and therefore to pose minimal risk to health.

6. SUMMARY OF FINDINGS

INTRODUCTION

This chapter provides a summary of the main findings and makes recommendations arising from these findings.

FINDINGS

Based on the most stringent current guidelines in use or proposed for use in Australia, the following conclusions arise:

- It is acceptable to re-use and re-work soil previously contaminated with asbestos as long as the soil is remediated appropriately.

- Material contaminated with fibrous asbestos or asbestos fines (essentially asbestos fibres) should not be re-worked and should be disposed of in an appropriate facility regardless of the apparent concentration of the fibres.

- Material previously contaminated with ACM can be re-used and re-worked if the total amount of asbestos is less than 0.001% (which means the ACM should be less than 0.006%) and all visible ACM is removed.

- The initially proposed work practices for re-use of material from the southern zone were not appropriate because they allowed an asbestos concentration of up to 1% ACM (rather than less than 0.01% as required) and did not require the removal of visible ACM.

- The use of material from anywhere on the site (whether from the southern zone or northern zone) is acceptable from an asbestos contamination standpoint as long as this material meets the above soil remediation requirements.

- If previously contaminated material is to be re-used or re-worked, it is important that appropriate exposure control and protection mechanisms are in place, rather than just relying on sampling to determine that material is safe to use.

- The excavation, control and monitoring process in the Southern zone appears to have been conducted appropriately in terms of the health of workers and members of the public.

- The proposed criteria of up to 1% for asbestos (as ACM) contamination in soil buried under clean fill at Headland Park would have been acceptable from a public health point of view once the construction phase was completed.

As far as can be determined, if these criteria are used, the Barangaroo site will be adopting the most stringent conditions in place in Australia for remediation of asbestos-contaminated soil.

RECOMMENDATIONS

This review recommends that:

1) **The pedestrian pathway adjacent to the Northern zone be closed until all material potentially contaminated with asbestos has been remediated and used on site or has been transported off site. It is reasonable to allow the walkway adjacent to the Southern and Central zones to remain open if this is considered desirable from a public access or related point of view.**

Justification: Asbestos is almost certainly only a threat to health if in respirable form. The potential for production of respirable fibres from soil on the Barangaroo site prior to remediation is considered very low because the asbestos is likely to be in bonded material (ACM). Once the soil has been remediated or any contamination has been found to be below the accepted concentration level, the potential for production of respirable fibres is exceptionally low. Nevertheless, it is prudent that the potential for production of respirable fibres is recognised and that workers in the vicinity of the excavation or remediation of potentially contaminated soil, or where remediated soil is being re-worked, wear appropriate PPE and that appropriate exposure control measures are used. Allowing the public to walk through or next to a worksite in such circumstances seems imprudent, even though the potential for exposure is likely to be very low. Removing the walkway temporarily would probably also allow Baulderstone to undertake the required work more efficiently, allowing this phase of the work to be completed earlier. A public walkway could then be re-constructed if this is considered desirable from a public access or related point of view.

The appropriate approach to take with the current pedestrian walkway adjacent to the Southern and Central zones is not as clear. This is because the significant distance between the area of excavation and the walkway, the fact that excavation in the Southern zone has almost been completed, and the lack of any respirable asbestos fibres in monitoring to date, all suggest any associated risk to members of the public from exposure to asbestos would be exceptionally low. This provides greater certainty regarding exposure than in the Northern zone, where the circumstances are quite

different, with excavation just commencing, the level of asbestos contamination in soil not known for certain, and the depth of excavation much less than in the Southern zone. Taking all this into account, it is seems appropriate to allow the pedestrian walkway adjacent to the Southern and Central zones to remain open if this is considered desirable from a public access or related point of view.

2) The site safety committees be actively involved in the development of work plans to excavate, test, remediate, work with and/or dispose of material initially found to be, or suspected of being, contaminated with asbestos.

Justification: Basic occupational health and safety principles require workers to be involved in designing and implementing all work plans and methods that can reasonably be expected to potentially impact their health. This is also sensible in terms of developing the most appropriate approaches; providing workers a good understanding of the potential risks involved and how they will be controlled; and giving the workers a sense of ownership of the work methods.

3) The final work plans covering the excavation, testing, remediation, working with and/or disposing of material initially found to be, or suspected of being, contaminated with asbestos be discussed with the EPA and Workcover New South Wales, and approved by the site auditor.

The Western Australia guideline and other guidelines provide good guidance of the content of these work plans, but local variation will definitely be needed. It is likely that the final approach used at Headland Park will be more stringent than that proposed in the Western Australia guideline (e.g. the disposal of all soil contaminated with fibrous asbestos or asbestos fines, regardless of apparent concentration level). It is appropriate that all such plans be reviewed by relevant external and independent parties.

4) The criteria for considering soil previously contaminated with asbestos to have been remediated be at least as stringent as those contained in the Western Australia guideline, and specifically that they include:

- **no free asbestos or asbestos fibres (i.e. no fibrous asbestos or asbestos fines);**
- **less than 0.001% asbestos / less than 0.006% asbestos-containing material (ACM)**
- **no visible ACM.**

Justification: The Western Australia guideline contains the same criteria for remediation as the proposed NEPM guideline. These are probably the most stringent such criteria in the world. Those guidelines allow ACM of less than 0.01%, whereas a strict translation of

the 0.001% level to ACM, assuming a concentration of asbestos of 15% and that all of this could be liberated from the ACM, gives a concentration of 0.0067%, which is rounded down (to remain conservative) to 0.006%. Given the uncertainties at this low level of concentration, a cut-off of 0.01% would not be unreasonable, but in order to err on the side of safety, a value of less than 0.006% for ACM is proposed.

5) The air monitoring action level action level for asbestos on the Barangaroo site should be 0.01 fibres/ml, not 0.1 fibres/ml, with 0.02 fibres/ml set as the level at which work would typically cease in order to find and control the source of the asbestos fibres.

Justification: When dealing with a potentially very hazardous exposure, it is prudent to take action to improve exposure control well before the exposure gets close to the relevant exposure standard level. Typically this action level would be 10% of the exposure standard. That is the approach proposed in the Western Australia guideline and it is considered appropriate for use at Barangaroo.

6) This report be made available to the Barangaroo Delivery Authority; workers on the Barangaroo site and their union representatives; Baulderstone; Lend Lease; the Ports Authority, their workers and the workers' union representatives; Unions NSW; and businesses and residents adjacent to the site.

Justification: All parties consulted as part of this review should have the opportunity to learn of the findings and recommendations arising from it.

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