Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia

**Consultation Draft November 2019**



**Note:** The contents of thisconsultation draft are not officially endorsed or authorised for use by any agency. Seek advice from the relevant regulatory agency before applying any part of this document.

Are these Guidelines relevant to you?

The Department of Health (DOH) has developed these Guidelines to provide comprehensive practical guidance for environmental sites consultants and auditors on the assessment, remediation and management of asbestos- impacted sites in Western Australia (WA).

Guidance[[1]](#footnote-1) related to these guidelines may be useful to other professionals, including:

* Local Government Environmental Health Officers and site workers
  + **Management of Small-Scale Demolition Asbestos Contamination (under revision)[[2]](#footnote-2)**
  + **Immediate Response Actions (under revision)**
* Local Government
* **Asbestos Management Plans for Parks and Reserves** (to be finalised)
* Developers, owners, the public and local community members

For occupational health issues, advice should be sought from the WA [WorkSafe Division, Department of Mines, Industry Regulation and Safety](https://www.commerce.wa.gov.au/worksafe). Detailed information is provided in the WA WorkSafe Commission guidance note [Occupational Safety and Health Management and Contaminated Site Work 2005](https://www.commerce.wa.gov.au/sites/default/files/atoms/files/contaminated_sites.pdf).

Additional asbestos information is provided by WA [Department of Health](https://ww2.health.wa.gov.au/Articles/A_E/About-asbestos) and [Safe Work Australia](https://www.safeworkaustralia.gov.au/asbestos) and the [Asbestos Safety and Eradiation Agency](https://www.asbestossafety.gov.au/).

Preface

In Western Australia (WA), asbestos was extensively used in building and other products into the 1980s. This legacy, combined with urban redevelopment, removal of aging infrastructure and implementation of the *Contaminated Sites Act 2003* (CS Act), has resulted in asbestos-contaminated sites becoming an important asbestos management issue.

Asbestos is a contaminant that primarily affects humans rather than being a risk to the environment. Asbestos usually occurs discretely in an impacted area and will not degrade over time to form less harmful materials. Its fibres can be uncovered and released into the air through physical disturbance.

The management of asbestos considers community expectations and concerns and conforms with the Asbestos Safety and Eradication Agency National Strategic Plans. As such, conservative investigation criteria have been adopted to allow for appropriate notification of contamination.

Where possible products containing asbestos that are in use should be managed in accordance with existing regulatory requirements regarding removal and disposal and the focus should be on prevention of future contamination of land.

In WA the Department of Water and Environmental Regulation (DWER) is the primary regulator of contaminated sites and also the administrator of the CS Act. However, DWER seeks advice from other agencies on asbestos-related issues due to the significance of asbestos exposure to worker and human health

Where contamination of land has already occurred from poor compliance with removal practices, illegal dumping or legacy burial, the Department of Health (DOH) adopts a risk-based approach to assessment and management.

DOH and DWER recommend a staged approach to contaminated site investigation and management, including for asbestos impacts. Figure 6 provides a generalised flow diagram of this process.

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| The intent of the Guidelines is to ensure that asbestos soil contamination is identified early and managed effectively. |

Inquiries

**Contaminated Sites**

Department of Water and Environment Regulation

Telephone Hotline 1300 762 982

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DWER will refer issues to DOH as necessary in regard to public health.

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Appendix

Appendix – sample list of asbestos containing materials?

# Introduction

These Guidelines aim to provide a consistent and comprehensive approach to the assessment, remediation and management of asbestos- contaminated sites in Western Australia and are an update of the original Guidelines published in 2009.

In WA the Department of Water and Environmental Regulation (DWER) is the primary regulator of contaminated sites and also the administrator of the CS Act. However, DWER seeks DOH advice on asbestos-related issues due to the significance of asbestos exposure to human health

These Guidelines have the same status as the DWER Contaminated Sites Guidelines and should be used in conjunction with the *Assessment and Management of Contaminated Sites* (DWER, 2014).

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| Any departure from these Guidelines should be fully justified and outlined in detail in site reports. |

## Role of the Department of Health

DOH has a statutory role in the regulation of contaminated sites, based on legislative and administrative arrangements with DWER with respect to the CS Act. These Guidelines are a joint publication of DOH and DWER.

DOH also provides advice in regard to asbestos contamination and broader public health risk. DOH is unable to provide advice with respect to occupational safety and health matters, which are the responsibility of Worksafe Division, Department of Mines, Industry Regulation and Safety. Failure to manage asbestos, particularly during demolition activities, in accordance with existing legislative arrangements is the origin of many asbestos-contaminated sites.

The *Health (Asbestos) Regulations 1992*  set out requirements for the handling, demolition and removal of asbestos associated with building structures for residential sites. Further information on the scope and application of these regulations is available from: <https://ww2.health.wa.gov.au/Articles/A_E/About-asbestos>.

## Asbestos as a contaminant

There is a history of production and widespread use of asbestos materials in Western Australia. Crocidolite asbestos, primarily used in asbestos-cement products, was extensively mined at Wittenoom until the mine ceased operation in 1966. Imported amosite asbestos was also used in these products until 1984, and chrysotile asbestos until 1987.

Asbestos may be present in a range of forms, sizes and degrees of deterioration. For the purposes of these Guidelines, the asbestos associated with contamination is divided into the three distinct groups described below.

### Non friable asbestos-containing material (ACM)

The term ACM is used in this document to refer to non-friable asbestos-containing material in sound, intact condition, although possibly broken, weathered or fragmented it retains its basic integrity. With these materials the asbestos fibre is bound by another material or is part of a matrix; for instance asbestos cement sheeting or vinyl tile.



Figure Asbestos cement fragments in soil

In field sampling this corresponds to material that cannot pass through a 7mm x 7mm sieve. This sieve size was selected as it approximates the thickness of common asbestos cement sheeting, and fragments smaller than this may be the result of damaged original source material.

ACM as asbestos cement sheeting in soil is the most common form of asbestos site contamination in Western Australia due to:

* Its widespread use in a range of construction materials
* inadequate removal and disposal of asbestos products during building demolitions
* its historical widespread use as uncharacterised fill material for site landscaping
* fly tipping on vacant or development sites.

If identified before further dissemination or disturbance, the dumping and removal of ACM usually only results in readily rectifiable surface impacts.

Because ACM is bonded, non-friable material if undisturbed ACM usually has a much lower potential to release airborne fibres and may be considered to be a very low health risk. ACM is subject to assessment, remediation and management to protect workers and members of the public from future potential exposures.

### Fibrous asbestos (FA)

Friable asbestos is defined in *Occupational Safety and Health Regulations 1996* as asbestos material that can be broken or crumbled by hand pressure. ACM in a degraded condition (has severely degraded to a state that is friable), low density asbestos fibre board, textile materials may become friable over time.

Figure Friable test - example of hand crumbled low density fibre board found in soil originally in a rectangular form (FA)

Fibrous asbestos also includes loose fibrous material such as insulation products and mining and manufacturing waste.

FA relates to visibly observable material quantities of asbestos (> 7 mm). However, FA may be more difficult to distinguish visibly when it has been coated in soil or mixed with other material.

### Asbestos fines (AF)

Asbestos fines is a size selective term applied to all asbestos that can pass through a 7mm x 7mm sieve. This would include [asbestos contaminated dust or debris (external link)](https://www.safeworkaustralia.gov.au/doc/minor-contamination-asbestos-containing-dust-or-debris-fact-sheet) (ACD) (Safe Work Australia), free fibres/fibre bundles of asbestos and small pieces of bonded material such asbestos cement fragments.

Concentrated amounts of asbestos fines on surfaces may be visually observed as in Figure 3. However, asbestos fines mixed with other materials or in lower concentrations will need to be identified analytically by an NATA accredited laboratory.

The identification and delineation of areas of AF contamination can be difficult because of poorer visual indicators than ACM and FA and analytical limitations associated with quantifying low levels of free asbestos fibres.

### Naturally occurring asbestos (NOA)

Figure Visible amount of AF on hard surface from high pressure cleaning of an asbestos cement roof

Under the CS Act, in situ and undisturbed naturally occurring asbestos (NOA) is not considered contamination.

However, due to the serious health concerns associated with asbestos, affected areas should be effectively assessed and managed in the short and long term. NOA is most likely encountered during geological sampling and mining operations. Management measures similar to those for friable asbestos usually apply **[separate guidance].**

## Human health risks

The health effects of asbestos are well recognised and primarily result from inhalation exposure to airborne (respirable) fibres. If deposited in the lungs, the fibres can initiate diseases that take many years to produce major health effects. These effects include asbestosis, lung cancer and mesothelioma, which has poor prognosis.

These impacts tend to be the result of higher levels and durations of exposure, most often cumulative occupational exposures. However, mesothelioma can result from lower occupational and non-occupational exposures and is considered the most asbestos-related disease with regard to lower concentration, non-occupational, asbestos exposure.

While a threshold has not been established for mesothelioma, similar to other non-threshold carcinogens, the likelihood of disease is known to be related to increased concentration and duration of exposure to respirable asbestos fibres.

The human health risk associated with asbestos-contaminated soil has shown to vary considerably depending on the form of asbestos, its quantity, distribution and likelihood of disturbance. For instance, large amounts of free-asbestos fibre on the surface soils where uncontrolled dust generating activity is occurring has a far greater potential for airborne fibre exposure than walking over an area with broken asbestos cement fragments.

There are many uncertainties related to understanding the exposure to airborne asbestos associated with asbestos in soil. Complications for exposure assessment include:

* the uncertainty associated with determining the degree, nature and extent of the asbestos impacts, especially respirable fibres
* the concentration of respirable dust that may be released from different soils for different activities
* the duration and frequency of exposure to airborne fibres from current and future activities in a contaminated area.

In addition the DOH conservative approach considers community expectations and concerns with regard to finding asbestos contamination and conforms with the [national strategic plan (external link)](https://www.asbestossafety.gov.au/) on the eradication and management of asbestos in the general environment.

DOH bases its screening criteria on the following principles and assumptions:

* fibre type and dimensions are expected to be mixed and it would be uncommon to find a single fibre type (e.g. chrysotile) with asbestos contaminated soils
* all commercial asbestos fibre types are subject to control and regulation by existing WA legislation and the reporting, assessment and management of asbestos contamination under the CS Act provides a mechanism to inform and protect persons from potential future exposure to asbestos-contamination.
* both FA and AF have a higher potential to be released from soil than larger bonded pieces of ACM
* bonded ACM is assumed to eventually degrade to asbestos fines as a result of damage or destruction over time
* exposure to asbestos, which is a non-threshold carcinogen, should be kept as low as reasonably practicable.

## Competency of practitioners

Competent persons are those with sufficient skills, knowledge and experience to undertake particular tasks. In addition, consultants should have sufficient general understanding to provide a client with the necessary information to manage asbestos at a site and be in compliance with all the relative legislative requirements. Where necessary, specialist advice (e.g. naturally occurring asbestos, fibrous minerals, detailed (tier 2) health risk assessment, air quality monitoring) should be obtained.

Environmental consultants employed to investigate and manage asbestos contamination should be supervised by a lead consultant with appropriate asbestos credentials or occupational hygienist. The lead consultant should normally have a minimum of 3 years continuous experience with asbestos soil contamination and relevant tertiary qualifications in environmental science, science or engineering. In addition it is recommended consultants have attended [**title seminar**] run annually by DOH.

General and/or specific industry training must include:

* Understanding of all applicable legislation, codes of practice and Australia Standards that apply to asbestos, including occupational safety and health, public health and waste legislation.
* Field investigators should be able to identify (through training and experience) common materials that have historically been used in their jurisdiction, such as: asbestos cement materials, insulation boards, insulating coatings, pipe insulation, textiles, industrial seals and packing material, linoleum backing, bituminous coating, mastic seals.

# Application of the Guidelines

Application of the Guidelines requires a broader understanding of asbestos management and control in Western Australia. This chapter has been added to provide additional context on how assessment and management of asbestos contamination relates to other State legislative requirements.

The information provided in these guidelines may be used in assessment and remediation of any asbestos contamination, including those circumstances that do not require reporting under the CS Act.

## Regulatory framework

There are a number of legislative arrangements for the assessment and management of asbestos in the built environment. Consultants who provide advice for asbestos-contaminated sites must be familiar with all the applicable legislative requirements and how they apply in various circumstances.

Adequate removal and management of existing asbestos containing products and materials and prevention of soil contamination should be the primary focus of any asbestos management program.

Removal/demolition work is controlled by the *Occupational Safety and Health Regulations 1996* (OSH Regulations) for workplaces and the *Health (Asbestos) Regulations 1992* (Health Regulations) for residential and other non-commercial settings.

Minor and/or localised asbestos-contaminated dust and debris (ACD[[3]](#footnote-3)) on structures and asbestos fines (AF) material in soil may be expected from the long term presence and use of structures made with asbestos containing materials. Clean up and removal of minor AF contamination in soil (e.g. water tank sediment, soak wells receiving run-off from asbestos cement rooves, roof drip lines, damaged pipe insulation) will be required during removal works as it is for minor ACD. This material, associated with structures, should be considered as part of the removal works and conducted in accordance with the requirements of the OSH Regulations and associated *Code of Practice for the Safe Removal of Asbestos* [NOHSC:2002 (2005)]. Removal of soil may be included as part of the asbestos removal control plan and delineation of soil impacts may be determined by a competent person (see Section 3.7.1).

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| Clearance reports should include some verification that soil impacts have been addressed as part of the removal works. |

Non-compliances with legislation (Table 1) for existing asbestos products should be addressed in the first instance using OSH and Health Regulations, including reports of contamination from:

* incomplete removal and/or clean-up of soil directly following demolition
* broken and damaged sections of bonded materials from existing structures, such as fencing
* illegal dumping of bonded asbestos cement material with simple surface impact
* incident response from contamination arising from a single incident, e.g. fire, high pressure water hose cleaning of a roof.

Figure Broken ACM sheeting

Table 1 Legislative framework

|  |  |  |
| --- | --- | --- |
| Source of asbestos | Legislation | Responsible Agency |
| Existing asbestos products | | |
| Commercial / Industrial and other workplaces | *Occupational Health and Safety Regulations 1996* | WorkSafe Division, DMIRS |
| Residential | *Health* (Asbestos) *Regulations 1992* | Local Government Authority |
| New products | National Ban since 2003 | National Industrial Chemicals Notification and Assessment Scheme |
| Mining and mineral extraction | *Mines Safety and Inspection Regulations 1995* | Resources Safety, DMIRS |
| Pollution (large quantities)  Illegal dumping - minor | *Environmental Protection Act 1986* | DWER  Local Government Authority |
| Contamination of Land | *Contaminated Site Act 2003*  *Contaminated Site Regulations 2006* | DWER |
| Recycled products and waste | *Environmental* (Controlled Waste) *Regulations*  *The Waste Avoidance and Resource Recovery Levy Act 2007*  *Landfill Waste Classification and Waste Definitions 1996* (as amended 2018) | DWER |

## Small scale or limited surface impacts

As per Section 5.5 of the[*Contaminated Sites Guidelines: Identification, reporting and classification of contaminated sites in Western Australia (2017) (external link)*](https://www.der.wa.gov.au/images/your-environment/contaminated-sites/Guideline_ID_Reporting_and_Classification.pdf)*,* in certain circumstances, ACM can be managed by existing provisions in regulations described in Section 2.1.

DOH allows for a qualitative approach to be applied to small amounts or localised surface contamination of low-risk sites impacted with only ACM. This includes single residential lots with minor or localised bonded ACM contamination. Such contamination may result from damaged structures or on-site demolition or dumping. Surface clean up, as outlined in Section 6.3.1 may be sufficient to manage this type of contamination.

It is important to remember that investigation, assessment and management of small scale or limited surface contamination may be required by the OSH and Public Health legislation even where the requirements to report under the CS Act 2003 are not met (See Section 2.5 for further information).

Where limited surface contamination arises from damage to an existing structure action may include the prioritised removal of the remaining structure.

Single residential lots should be assessed and managed in the first instance by Local Government Environmental Health Officers in conjunction with DOH so that more formal and demanding processes associated with the CS Act are not disproportionately imposed on homeowners.

The management process for small scale or limited surface impact sites is more fully described in [**separate guidance document]*.***

Examples of small scale or limited surface impacts are:

* Broken or removed asbestos cement sheeting on a ground surface from recent maintenance/removal, illegal dumping or damaged structures. Mostly applicable where any broken asbestos cement sheeting has not yet been dispersed and mixed with soil and can be readily removed, wrapped and transported to a licensed waste disposal facility. The immediately impacted surface soil may be remediated by raking of top surface soil to uncover and pick large pieces/fragments or by soil surface scraping of small, crushed fragments mixed in the soil. A final visual clearance inspection should be conducted and recorded to ensure that the site is visibly free of asbestos.

Figure Asbestos Cement sheeting on ground - simple surface impact

* Incomplete clean-up from recent demolition work or non-compliance with asbestos removal control plan, i.e. where a site has not been adequately inspected/cleared following removal work. This should be immediately followed up in the first instance through OSH Regulations. Where minor AF material remains on or around structures as part of recent demolition work it should be removed and managed in the same way as existing [minor contamination](https://www.safeworkaustralia.gov.au/doc/minor-contamination-asbestos-containing-dust-or-debris-fact-sheet) (external link) requirements.
* Clean up as a result of an incident, such as from fire damage or non-compliance incident that disturbs material in a structure (e.g. cutting, high pressure cleaning) at a site; provided clean-up is conducted in a reasonable time from the time of the incident and completed in accordance with the applicable legislation and guidelines (see [Figure 2: Contaminated Sites Guidelines: Identification, reporting and classification of contaminated sites in Western Australia (2017) (external link)).](https://www.der.wa.gov.au/images/your-environment/contaminated-sites/Guideline_ID_Reporting_and_Classification.pdf)  Such clean-up will require an asbestos removal control plan, provision for providing a clearance report by a competent person that verifies asbestos has been removed.

Where timely response is not possible, such as for large fires, natural disasters or incidents causing extensive contamination, particularly where multiple properties are affected by debris, reporting under the CS Act will be necessary to ensure adequate investigation and remediation of all the affected properties. Where in situ management is the most suitable remediation option to prevent exposure sites should be reported.

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| Where asbestos impacts are widespread across a site, is located at depth, or cannot be removed in a timely manner, the site should be reported and assessment and managed in accordance with the CS Act, ASC NEPM, DWER CS guidelines and this document. |

## Removal and demolition

Planned removal work and demolition of structures should be closely monitored to ensure all asbestos is removed in accordance with OSH Regulations. In addition, care should be taken with site management practices during removal and demolition to prevent the spread of any possible contamination.

Asbestos removal licence holders have an obligation to ensure asbestos clearance inspections for any friable asbestos removal work. However, clearance inspections/reports are recommended for all removal work.

The clearance inspection should be undertaken by an independent competent person[[4]](#footnote-4) who:

* is independent of the removal business, isn't involved in the asbestos removal work, and doesn't have a perceived conflict of interest
* meets the competency requirements under the OSH legislation and nominated Codes of Practice.

The person undertaking clearance inspections needs to make sure:

* they are satisfied asbestos is not visible[[5]](#footnote-5) in the removal area or its immediate surrounds
* the clearance certificate is issued before the area is re-occupied or before any further demolition or refurbishment work takes place
* the clearance certificate/report contains sufficient information regarding he outcomes of the clearance inspection.

Clearance inspections may include some asbestos sampling, especially following removal of material that has been subject to task/activities that have the potential to generated asbestos fibres (e.g. use power tools, high pressure cleaning equipment, excessive breakage, exposed ACM in poor condition). The sampling requirements for clearance certificates/reports should be determined by a competent person.

## Land development and construction sites

Asbestos contamination may be found in soil on any brownfield site, including commercial and residential sites, where there have been buildings and structures containing asbestos or where imported fill has been used. These properties may have not been properly cleaned up, particularly where impacts occurred prior to the introduction of current legislative controls for asbestos removal and management.

Reporting of bonded ACM distributed through the soil at a site is necessary where the number and distribution of fragments and other bonded asbestos containing products at surface or within fill are likely to exceed screening criteria. Sites which have significant asbestos in soil contamination from ACM and FA will need to be investigated and assessed in accordance with the CS Act and these Guidelines.

For some sites, there may only be a small number of isolated, sparsely distributed fibre cement fragments from past incidental contamination or left behind following previous or recent removal and demolition of buildings and structures. Where the distribution is below the screening criteria these pieces may be managed by onsite occupational safety and health procedures, where available. In general, a small number of fragments can be carefully collected, secured in a labelled, heavy duty plastic bag or wrapped in heavy duty plastic (minimum 0.2 mm thickness) for transport and disposal to a licensed waste facility.

Procedures for reporting and handling a small number of dispersed asbestos cement fragments and arrangements for reporting larger quantities will need to be addressed through site specific work health and safety procedures, site inductions and awareness training.

Contact WorkSafe Division, Department of Mines, Industrial Regulation and Safety for further information.

## Decision to report under the Contaminated Sites Act 2003

A decision will need to be made on whether it is necessary to [report a site (external link)](https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/Fact_sheets_tech_advice/Fact_sheet_1.pdf)  and will be based on the information available or site inspections.

Information may be available from property and building records, anecdotal information or observation of any suspect materials at the site. Signs of possible contamination include the presence of:

* uncontrolled fill containing building waste
* building or industrial waste
* suspect asbestos containing materials.

Where evidence of asbestos contamination at depth and above screening levels is available, it will be necessary to report the site under the CS Act as a known contaminated site.

Reporting is may also be required where asbestos impacts cannot be managed by an existing legislative process, the level of contamination is non-trivial[[6]](#footnote-6) and/or where contamination cannot be immediately resolved.

Reporting under the CS Act is suggested where:

* friable asbestos is observed to be buried at the site or there is historical evidence of it being buried at the site
* ACM is known to be buried on site, as identified by material analysis or assumed to contain asbestos by a competent person[[7]](#footnote-7)
* friable or non-friable material was not adequately identified and removed during an earlier demolition/removal and has since been spread across the breadth and/or depth of a site
* historical incidents/soil impacts where contamination occurred has not been previously managed.

If in doubt, it is best to report the site. The obligation to report falls on the owner, the polluter and the contaminated sites auditor, where appointed. However, others, such as an environmental consultant or Local Government officer, may also report the site.

### Structures above and below ground

Structures are exempt under the contaminated sites legislation. Underground infrastructure, whether in live service or disused, e.g. asbestos cement pipes, may be managed through existing statutory arrangements, including inclusion on organisational registers and/or prioritised removal.

Where land is being redeveloped a plan should be made to demolish and remove any remaining unrequired or disused above and below ground asbestos structures, in accordance with the OSH legislation.

Where obsolete underground infrastructure is unable to be removed or has been severely damaged and mixed with soils, it is recommended that the site is reported under the CS Act to ensure a Memorial on Title (MOT) can be applied to the impacted land and appropriate remediation, or ongoing management and containment is implemented to prevent potential future exposures.

# Assessment of asbestos-contaminated sites

## Overview of the assessment, remediation and management process for reported sites

Once a site is reported, the investigation and management process for the asbestos-contaminated sites follows the same sequence and form as outlined for contaminants in general [in Contaminated Sites Guidelines](https://www.der.wa.gov.au/your-environment/contaminated-sites/61-contaminated-sites-guidelines) (external link) and ASC NEPM.

The process commences with a Preliminary Site Investigation (PSI), which may lead to a more comprehensive Detailed Site Investigation (DSI). A program of sampling and analysis will normally be prepared to address data gaps and for any validation sampling that occurs.

Depending on the findings, a site remediation and validation plan and/or site management plan is likely to be developed and implemented.

Remediation options are preferred which minimise the potential for exposure to airborne asbestos fibres and also minimise the amounts of contaminated material that are removed to landfill.

Management of asbestos in situ is encouraged, which may include covering the contamination with clean fill and/or other protective layers as well as registering a memorial on the site’s certificate of title.

A common alternative of complete removal of asbestos from a site often involves extensive and costly investigative and confirmatory sampling and is sometimes not effective.

These [guidelines] also provide a simplified investigation and management approach primarily for limited surface or low scale impacts, for example, as a result of asbestos contamination through illegal dumping or incomplete clean up following demolition. This guidance makes use of visual contamination indicators, site knowledge and allows for straightforward remediation for what is usually a low risk, or readily actioned response. Details are provided in [separate guidance].

Details of long–term future management of the site will be required if asbestos remains in situ. Depending on the circumstances this may be addressed through restrictions on land use/activities or by an ongoing site management plan.

All reports related to the above processes will need to be submitted for assessment by DWER either directly or via an auditor if required by a planning condition or Regulation 31 of the Contaminated Sites Regulations 2006.

## Consultative process[[8]](#footnote-8)

Appropriate public and stakeholder consultation is required throughout the site investigation, remediation, management and development process. This should include information provision and collection and complaint resolution.

The extent of consultation will vary with the size, sensitivity and complexity of the site, and stage of the development management process.

Consultation with stakeholders should be an interactive process where possible and not just an awareness-raising and information session. The need for this especially applies to asbestos, which can be an emotional issue and can become difficult to manage if an investigation becomes contentious.

Figure 6 Site investigation and management process

Links provided to relevant sections of guidelines[[9]](#footnote-9) (ctrl +click underlined text to follow links)

[**Suspect contamination or site referral**](#Suspect)

[**Preliminary Investigation**](#Investigation) **to review historical and current data**

* Site history
* Site inspection

**Residential property or small scale?**

**Report to DWER**

No

No

Yes

No

[**Simple surface impact**](#Simple)

Yes

[**What is the nature & extent?**](#Characterisation)

**Complete**[**Remediation Plan**](#remediation) **→ Remediate →** [**Validate**](#validation) **→Implement** [**Site Management Plan**](#OMP)

[**Complete detailed site investigation**](#DSI)

* consider potentialforairborne fibre exposure

**Asbestos presence likely?**

Yes

**Refer to Local Government or conduct clean-up**

Yes

[**Is there a threat of fibre release and exposure?**](#Exposure)

**Are there data gaps?**

**Implement immediate temporary controls**

**Significant remediation / management required**

**Report and record findings**

## Preliminary site investigation

The Preliminary Site Investigation (PSI) is the initial stage of an investigation undertaken for assessment and management of contaminated sites. It includes checking the site history, a visual site inspection and possibly preliminary sampling. It is important in determining the likely presence of contamination and in directing any subsequent investigation and management actions.

Given the physical nature of asbestos-contamination, much more information can be gathered at the PSI stage than for other contaminants as immediate results are available from limited site sampling and data gaps may be addressed as they arise. The process outlined in this section may be undertaken during the DSI stage of investigations where there is extensive contamination across a large site or where investigations for other contaminants are undertaken at the same time.

The key elements of a PSI are outlined in the *Contaminated Sites Guidelines: Assessment and management of contaminated sites, (DWER 2014)* and are augmented by asbestos-specific advice in these Guidelines.

If asbestos contamination is missed and is then accidentally disseminated across the site through earth disturbance, a much larger area may require investigation and remediation. This would prove to be a protracted and costly exercise. Case Study **[to be provided]** demonstrates the results of an inadequate investigation.

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| Asbestos contamination needs to be identified early and properly handled, to ensure subsequent disturbance and dissemination does not occur across the site and result in costly delays and extra investigative and remediation effort. |

### Site history

A site history or desktop investigation consists of compiling and assessing information from relevant records and interviews. This investigation should include:

* historical site use, including site buildings, structures and associated utilities which have the potential to contain asbestos
* an evaluation of records to determine the presence of asbestos in any remaining or demolished structures, including any:
  + asbestos register
  + demolition and asbestos removal plans
  + site or building plans
  + previous environmental or geotechnical investigations identifying building or commercial/industrial waste
  + local authority records/permits
  + [Landcorp](http://www.landcorp.com.au) (external site) records
* anecdotal information regarding the site history and use
* building plans for structures
* analysis of historical aerial photographs to identify past structures and possible disposal, burial and dumping activities
* information relating to the character and disposition of any fill material, especially which was derived from building waste
* the likelihood of an unexpected discovery of building(s) and/or structure(s) that main contain asbestos that may be in the pathway of planned soil disturbance.

The above information should be reviewed to identify situations where asbestos contamination may be expected or suspected to be present, such as:

* industrial land, e.g., asbestos-cement manufacturing facilities, former power stations, and rail and ship yards, especially workshops and depots
* waste disposal or dumping sites, e.g., building waste
* pre-1990 buildings or structures damaged by fire or storm
* land with fill or foundation material of unknown composition
* commercial and residential sites where buildings or structures have been constructed using ACM or where asbestos may have been used as insulation material, e.g., asbestos roofing, sheds, garages, reservoir roofs, water tanks, boilers
* sites where pre-1990s buildings or structures have been improperly demolished or renovated, or where relevant documentation is lacking
* disused services made from asbestos cement – e.g., water pipes, telecommunication trenches or pits.

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| Where a clearance certificate/report has been provided for site demolition and removal activities it may be relied on without further site investigation being necessary, unless there is further evidence of additional asbestos contamination either from recent or past use and activities at the location which provides a reason for additional investigation. |

### Site inspection

When reporting the visual inspection results, it is critical that a competent inspector comments specifically on the presence or absence of asbestos material and on the inspection methodology. The initial site visual inspection or walkover provides important information on potential exposure to asbestos fibres and informs the decision for appropriate short and long term management.

Consideration needs to be given to selecting an inspection methodology that is based on set data objectives developed from a conceptual site model. Consider the following:

* likely areas of contamination or evidence of contamination
* likely distribution, depth and scale of contamination
* the need for grid-based visual inspection for detection of visible[[10]](#footnote-10) asbestos
* hidden contamination (e.g. dense vegetation)
* soil type and compaction.

More intensive inspection methodology is recommended at the PSI stage for asbestos-contaminated sites and may require the planned removal of vegetation, raking and/or test pitting to adequately inform decision making for subsequent stages of investigation or management.

The decision making and methodology used for inspection, including any variations from these guidelines, should be justified and reported.

The focus should be on judgmental sampling, where appropriate, of particular areas that have (or are suspected to have) higher levels of contamination to reflect worst case, e.g. “hot spots”, former building footprints.

Grid sampling may be appropriate if the contamination is very widespread or hot spots are not found and there is a need to confirm that site levels are below soil investigation criteria.

Areas requiring more detailed assessment may be identified in addition to any further suspect locations (see Chapter 5).

Safe operating procedures should be established for site inspections that prevent exposing field workers to asbestos and further degradation or distribution of asbestos-contamination.

#### Visual indicators

In many scenarios, especially for commonly encountered asbestos cement sheeting fragments, asbestos contamination will be visibly identifiable when on the surface and in significant quantities. Asbestos cement sheeting pieces and fragments are generally in the clearly identifiable “original form”.

It may not always be possible to precisely confirm the identity of all the type of different ACMs present when mixed with soil and/or building or commercial waste, e.g. it may be difficult, or impossible, to positively confirm that debris is insulating board or asbestos cement, based on appearance. The confirmation of ACM type by visual identification of small fragments or pieces of degraded ACMs in the ground is sometimes complicated by degradation of the material and coating with soil, which may disguise appearance to the extent that asbestos contamination may become difficult to spot.

A competent person may be able to identify visible material and assume asbestos is present, but laboratory confirmation of a representative material sample is appropriate when there is any uncertainty.

If the investigation area is heavily vegetated, then confidence in the results of the visual inspection will be lessened. Alternate methodologies will need to be considered for adequate characterisation, such as careful vegetation clearance of the investigation area and subsequent grid based walkover or grid based spot/test pit sampling.

The investigation should include any asbestos-containing structures, especially if in poor repair, footprints of demolished structures (including fences, drains and soakwells), debris on the surface of the site and any uncontrolled fill (particularly if it contains building waste).

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| Visual inspection reports need to include comments on the presence or absence of any asbestos materials and the inspection methodology. |

Persons conducting visual inspections and field investigations must be familiar (through appropriate training and experience) with the range of asbestos products used in Western Australia and their properties (for example: asbestos cement materials, insulation boards, insulating coatings, pipe insulation, fire blankets, industrial seals and packing material, linoleum backing, etc.).

Where contamination is visible, ACM or FA may be used as the primary measure of contamination (See Section 5.1). Where the investigation area is obviously or heavily impacted above Guidelines screening levels, field sampling can be excluded from heavily impacted areas and be focussed on outer boundaries to delineate area of impact for remediation and/or management.

In the case of contamination being from broken asbestos cement sheeting, or other ACM, and where the material retains its integrity, any co-located AF may be considered ‘trivial’ and the focus should be on the assessment and remediation of the visually identifiable asbestos cement. This applies even if the material is showing signs of damage or weathering, but is not severely degraded (Figure 7. Shows degraded asbestos cement sheeting[[11]](#footnote-11))

Quantification of AF may be required where site investigations, field sampling, or other evidence is insufficient to characterise the asbestos content in soil (See Section 5.1.1). For example:

* FA is suspected to be present but may be broken down into AF, mixed with soil and difficult to identify and quantify as being above screening levels visually
* There is evidence or information available that AF is present from:
  + cutting, sawing, sanding, or other mechanical breakdown of ACM, particularly through the use of power tools

Figure Severely degraded asbestos cement with friable asbestos and asbestos fines observed.

* + use of high pressure cleaning of asbestos cement sheeting.
  + damage by fire or other natural disasters
  + severe degradation through weathering/deterioration.

### Sampling during PSI

Field sampling will:

* assist in characterising and delineating the area of contamination
* in understanding potential for airborne asbestos exposure
* may be used to validate concurrent remediation activities.

Depending on site specific circumstances it may be that including field sampling as part of the PSI for asbestos-contaminated sites may expedite decision making for preferred remediation/management options, without proceeding to a full scale DSI. Written sampling objectives must be reported based on the data gaps being addressed.

Material and soil sampling during a comprehensive PSI may be able to:

* confirm presence/absence of asbestos in suspect material samples (e.g. fibre-cement board/sheet, rope, textile material, bituminous coating, fibre insulation) and estimate asbestos content (analysis by NATA accredited laboratory in accordance with AS 4964))
* use field sampling to approximate the level of contamination and the lateral and vertical extent
* obtain additional data required to support preferred management options
* validate remediation activities (concurrent surface remediation).

Air quality monitoring will be relevant where exposure may occur during investigation or remediation actives or if immediate response actions are required.

Material sampling would most likely be undertaken for surface hand-picked material or material found in targeted test pit field sampling. Information on common analytical methods used for asbestos is provided in Chapter 4 – Sampling, Monitoring and Analytical Methods

## Detailed site investigation

The assessment and management of contaminated sites may require more detailed investigations that confirm and delineate potential or actual contamination through a more comprehensive sampling program (see Section 5). The key elements of a DSI are outlined in [the Contaminated sites guidelines: Assessment and management of contaminated sites, (DWER 2014) (external link).](https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/Assessment_and_management_of_contaminated_sites.pdf)

A full DSI report may not be necessary where sufficient evidence is obtained in the PSI to develop a remediation, validation and/or management plan. A DSI may be needed where a better understanding is required of the airborne fibre generating potential of an asbestos-contaminated material.

The need for a more extensive investigation and health risk assessment will depend on site-specific data objectives, such as:

* a need for greater accuracy in delineating the lateral and vertical extent of impacts for implementation for deciding, proposing or undertaking remediation
* confirmation on the quantity, extent and/or distribution of asbestos-contamination from friable or free-fibre is required
* A better understanding of future land uses and possible receptors:
* maintenance workers for underground services, trespassers, recreational activities, construction/site works
* land uses and area management plans are to be determined and delineated according to the extent and nature of asbestos contamination.

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| A DSI may resolve uncertain findings or data gaps from the PSI, or assist decision making by examining the feasibility and effectiveness of alternative remediation and management options. |

Further investigations may also be necessary where new evidence of contamination arises, such as:

* vandalism or degradation of structures containing asbestos
* identifying new contaminated areas, e.g. following site excavations
* cross-contamination by earthworks and movement of materials and stockpiles
* wind or storm damage.

Further investigation may also be necessary to update conceptual site models from any changes in site conditions, surrounding environment and possible receptor exposures, as informed by an exposure assessment.

### Occupational health risk assessment

The risk assessment process must include risk to all employees who are part of the investigation and remediation activities. The risk assessment should identify the appropriate licensing requirements for removalists, based on the nature and extent of contamination and the control measures required to mitigate exposure during removal works. A description of the remediation work to be carried out, control measures required and the expected scale and duration of works should be provided in the remediation action plan.

Further information on application of OSH legislation should be obtained from WorkSafe Division, DMIRS.

## Soil screening criteria

DOH established screening criteria in 2009 based on international research by Swartjes and Tromp in The Netherlands (2008).

The determination of asbestos in soil has some differences with other contaminants. Mainly:

* fibres are physical structures of various sizes and dimensions, rather than a chemical molecule
* the available analytical methods provide semi-quantitative (estimate of) concentrations and depend on adequate representative sampling and consideration of other supporting information to characterise contamination
* concentration in soil does not consider the potential for release of airborne fibres and there is poor correlation between the two; therefore, Tier 2 exposure assessment requires air monitoring.

The basis for the screening criteria is two-fold:

1. Asbestos is a banned and controlled substance, therefore criteria must be below current cut off concentrations (See Section 3.5.1) for OSH legislative control of asbestos (applicable in WA), otherwise other legislative controls associated with OSH and Health regulations apply, e.g. restriction on sale and supply, notification, labelling, etc.
2. The concentrations of 100 mg/kg or 0.01% w/w asbestos are expected to keep outdoor airborne fibre levels below 0.001 f/ml and probably around 0.0001 f/ml.

DOH applied this criteria to ACM, depending on site use. These mirror the Assessment of Contaminated Sites (ASC) National Environmental Protection Measure (NEPM) (1999) site uses and associated default exposure ratios.

The lower criterion has been applied to both FA and AF as activity and disturbance may result in their suspension in air. The 100mg/kg was divided by a factor of 10 to account for greater dryness and dust-generating potential of local soils and the fact that current [exposure standards](http://hcis.safeworkaustralia.gov.au/) treats the mineralogical forms of asbestos as equivalent.

**Note:** For low concentration exposures (cumulative exposure of less than 0.01 f/mL.yr), the risk of mesothelioma from crocidolite fibre (the most potent fibre) is considered the most applicable health outcome. There are generally accepted quantitative estimates of disease, extrapolated from dose response relationships established for higher occupational exposures. These are those presented by WHO (2000) and Hodgson and Darnton (2000). The estimates suggest that asbestos at below 0.0002 f/ml.yr is likely to be less than the lifetime risk of 1 x 10-5 and possibly less than 1 x 10-6 (WHO 2000 and Hodgson and Darnton, 2000). These are lifetime cancer risks estimates that are broadly acceptable with regard to environmental contaminant hazards.

These criteria are summarised below.

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| Site uses | Soil asbestos screening criteria |
| All site uses | FA – 10 mg/kg (0.001 %) w/w asbestos |
| All site uses | AF – 10 mg/kg (0.001%) w/w asbestos |
| Residential use, schools and day care, playground, etc. | ACM – 100 mg/kg (0.01 %) w/w asbestos |
| Parks and reserves, public open spaces, playing fields, etc | ACM – 400 mg/kg (0.04%) w/w asbestos |
| Non sensitive commercial and industrial sites | ACM – 500 mg/kg (0.05%) w/w asbestos |

In addition to meeting the above criteria, the accessible ground surface (nominally 10cm depth) should be free of all visible ACM and FA at the conclusion of remedial site works. There are two main objectives for remediating the soil surface to be visibly free of asbestos:

1. Minimises the potential for any accidental fibre release (either from activities at the site or from the contamination being inadvertently picked up and mishandled).
2. Address aesthetic and public perception and concerns regarding asbestos and community expectations regarding the acceptable extent of site remediation.

A clean surface may be achieved by installing a layer of stable, clean fill or in the case of bonded ACM decontamination by several cycles of surface remediation.

However, DOH would consider other means of surface remediation, such as installing a long-term hardcover over it.

The criteria for FA and AF remain fixed for all site uses as the uncertainty and error associated with this quantifying this value means establishing concentration differences within the same order of magnitude at this level of detection is difficult.

As for other contaminants, the interpretation of single sample results should occur in the context of the other information obtained from the site investigation and requires knowledge of the site and professional judgement (by a competent person) on whether the criteria have been exceeded.

### Clean up criteria

These screening criteria are often used as soil clean-up goals. Alternatively, site-specific goals can be developed and may be higher than the Tier 1 screening levels if any of a range of mitigating factors apply, such as the depth or form of contamination, binding or stabilising soil characteristics, or the nature of surface coverings (see Chapter 4).

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| Site specific goals are limited to levels of asbestos as regulated by OSH Regulations[[12]](#footnote-12) (currently 0.1%). |

## Air screening criteria

A practical air quality control limit of 0.01 fibres per millilitre (f/ml) asbestos applies to all removal work, including around contaminated sites, as described by the membrane filter method.

Based on the risk estimates outlined in Hodgson and Darnton (2000), a cumulative exposure of 0.01 f/ml.yr could result in an increased risk, above 1 x 10 -5 for amphibole fibres (crocidolite and amosite). As the control monitoring limit can only be applied for a short exposure duration (used only in the context of removal or remediation activities) this limits the impact on lifetime, cumulative exposure, and is considered to be an acceptable level of control. However, the control limit should not be used to evaluate risks associated with cumulative or longer term exposure durations (DOH suggests no greater than 6 months) and exposure should always be minimised to as low as can be achieved through implementation of effective controls.

Dust monitoring may be also used to complement asbestos sampling, especially since it allows for more immediate responses to any failures in dust management measures. The Air NEPM 24-hour guidance goal of 50 µg/m3 for PM10 (particulate matter with an equivalent aerodynamic diameter of 10 µm or less) may be applied as an action level. Adherence to this limit can be used to help protect the community against exposure to all particulates, including fibres, especially where soil asbestos fibre content is <0.1% w/w asbestos (Addison et al 1988).

## Characterisation of contamination

DOH takes a conservative approach to characterising asbestos contamination from investigations. Consequently, results presented as below screening criteria will have to be based on rigorous and justified investigative work, especially when not following DOH preferred procedures. Care is necessary in extrapolating any information or results and demonstrating reliability.

The level of remediation and control measures applied to protect people from exposure to airborne fibres will depend on:

* the nature, condition and sources of asbestos contamination
* the extent of contamination, including the total quantity and concentration/ distribution of material, depth, location and affected area.
* potential for disturbance.

A determination needs to be made whether the asbestos contamination can be characterised as “trivial” contamination or contamination requiring reporting under the CS Act. The decision will be largely judgemental and based on whether there is sufficient asbestos contamination based on the quantity of ACM, FA and AF found and its distribution throughout the soil profile at the site.

Where AF contamination is at high concentration, and possibly clustered and visible, treatment of AF should be as for FA as in these circumstances it is likely to be the greater contributor to contamination levels. Examples where high concentrations of visible AF contamination may be present include: use of high pressure water on asbestos roof, fire damaged materials, use of power tools on materials.

The following descriptors may be used to characterise contamination:

* no visible asbestos contamination
* occasional occurrences of visible contamination with description of material found
* isolated/sporadic occurrences of visible contamination with description of material found
* visible contamination found above the screening criteria with description of material found, an estimate of level of contamination provided along with a description of the location and lateral and vertical extent of contamination (for each location).

Appropriate characterisation facilitates the planning of effective and compliant remediation and long term management solutions and will reduce or eliminate project delays and costs.

Where there is supporting evidence that original material, which may have been an ongoing source of asbestos fibres, is no longer present at a site, the presence of trivial concentrations of asbestos remaining in the environment, such as from isolated amounts quantifiable AF in soil, is not strictly an amount of asbestos that requires further action (See Section 2.5).

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| A competent person may determine that the amount of asbestos present does not contribute to more than a negligible risk of airborne fibre exposure and does not require reporting under the CS Act. |

There will still be a need to remove isolated/sporadic amounts of [visible](#visible) contamination in compliance with OSH or Health legislation and to meet community expectations regarding remediation of asbestos.

### Delineating extent of contamination

The following approach is generally appropriate with delineating the extent of contamination where material is present at above screening levels:

* where there is good historic information on the origin of the asbestos contamination, the estimated surface area of contamination can be considered equivalent to slightly beyond the visually delineated area of impact (up to 1 m in all directions, depending on uncertainty)
* the depth of contamination may be inferred from the desktop investigation, or later informed by targeted sampling. In either case, include up to an additional 30 cm depth, depending on uncertainty
* the condition of bonded ACM should be considered equivalent to the most degraded samples found in an area, noting that this may vary across different areas
* If FA derives from co-located ACM, it may be possible to conclude that site conditions are conducive to such degradation particularly for some products that are more readily subject to friability (eg. low density fibre board, textile products).
* where significant amounts of free asbestos fibres may have been exposed over time, the immediate surrounding soils should also be considered contaminated.

### Risk evaluation

A conceptual site model with illustrated source-pathway-receptors must be derived that includes all activities associated with the site for the current, during remediation and future uses. Possible receptors include:

* site remediation personnel
* earth moving and construction workers
* site visitors and trespassers
* future owners/occupiers
* adjacent residents or workers
* underground service maintenance workers.

Consideration should be given to any asbestos remaining in structures which will be subject to demolition or disturbance so that they can be handled in compliance with the OSH legislation.

The only exposure pathway of concern is inhalation of airborne fibres. As such, consideration must be given to the potential for human activities to generate or release airborne fibres. While natural erosion forces may be considered, in most circumstances, these are unlikely to significantly contribute to concentrated release of particulates within a persons’ breathing zone. There is now significant monitoring evidence that has been submitted over the last decade from assessment and remediation of asbestos-contaminated sites to confirm that the presence of undisturbed ACM in soil does not lead to an exceedance of the control limit of 0.01 f/ml.

Generally a pathway should be considered complete unless there is no activity at the site or if the asbestos-contaminated material is unavailable for contact for a particular recipient (e.g. buried or under hardstand).

For a Tier 1 level assessment the contamination concentrations should be compared against the soil investigation criteria.

In some cases, visible minor contamination, below the reporting criteria, in the form of isolated asbestos cement fragments or other ACM, may continue to be encountered at a site. These should be managed as small scale, minor contamination in compliance with good practice and legislative requirements.

If exceedances of the soil screening criteria occur the criteria may be used as clean-up goals or other forms of remediation undertaken.

If the screening criteria are not considered strictly applicable to the site due to the fact that their underlying assumptions do not apply or mitigating factors are operating, then it is possible, subsequent to a Tier 2 or 3 assessment being completed, for site-specific clean-up goals to be developed. This will allow a case to be made that no clean-up is necessary. However, more extensive information will need to be provided on the nature and extent of contamination and possible exposure scenarios. For instance, the potential risk might be less by virtue of the depth and type of contamination, the nature of surface coverings, the soil conditions, soil type and moisture content or the form of future site use (see Chapter 4).

Any conclusions regarding the risk should explained; for instance, the basis or the meaning of a “low”, “medium” or “high” risk statement should be provided.

The report should also comment on the limitations and uncertainties associated with the process, such as confidence in the exposure factors applied, sampling results and the calculated level of contamination.

It is important that the overall risk evaluation process be transparent, logical and reliable. In those cases where there are particular concerns from the local community or other stakeholders, consideration should be given to managing the perceived, as well as the real, risks associated with the site. Note that any reports may also be used to provide information about risks to interested parties.

If the elements of the risk determination change during the subsequent site operations, such as by uncovering unexpected additional asbestos material or as indicated by the results of air monitoring, the risk assessment should be reviewed and any appropriate actions implemented.

The need for immediate exposure control measures should also be considered as per **[separate guidance -** **Immediate Response Actions and Contingency Plans]**.

# Site specific criteria/clean up goals

If clean up criteria are employed or remediation approaches adopted which are not consistent with these Guidelines, then a strong supporting case should be made that the contamination does not present an increased risk to health supported by an adequate health risk assessment.

As mentioned previously, the confident estimation of human risks associated with the release of fibres from soil contamination is difficult as translating soil concentrations of various forms of asbestos into quantified air levels and then into potential human health impacts is dependent on a range of exposure factors.

In most circumstances it is not possible to undertake a quantitative health risk assessment for an asbestos-contaminated site without accounting for unknown exposure factors. Therefore, a semi-quantitative or qualitative assessment may have to suffice that assumes reasonable worst case exposure scenarios. Such an assessment can provide additional confidence in conclusions and recommendations presented.

The approach and references used by DOH in developing its asbestos investigation criteria may be a useful basis for estimating a site’s risk, taking account of site-specific circumstances. For example, the ability for a soil to release fibre may be considered with regard to:

* soil type
* presence of vegetative cover
* moisture content.

Reasonable worst case seasonal variations would need to be considered. It is also important to note that while these factors are suitable for assessing relatively undisturbed sites (passive uses), in most cases the most significant contributing factor to airborne fibre exposure will be human activities that are undertaken at a site that may create or release dust and airborne fibres. This is supported by asbestos in air measurements associated with surface friable material, such as from fires or use of high pressure cleaning equipment on roofs, where non detectable levels were found in air for undisturbed contamination despite windy conditions.

Therefore, site-specific clean-up methodology is limited to criteria where baseline site parameters differ from the actual site conditions and the emphasis will be only modifying those parameters which will be largely ongoing and that will not change in character with time. For instance, surface cover is less useful as its extent and integrity can change, whereas contamination depth is less likely to change. In applying this methodology it is important that use of each parameter be justified and supported by adequate sampling. The justification will have to be quite strong if the applicant is seeking to vary from how screening criteria is applied.

In practice, if all the mitigating factors described here are applied to the maximum applicable or default level, it is possible that ACM clean-up levels could be raised by up to 120 fold. In the case of AF and FA, this might be increased even further depending on the site use and analytical procedure, for an industrial site the factor could be 5 fold. However, the second objective of site specific criteria is to ensure information is available to site owners, occupiers and users regarding the presence of asbestos for compliance with other legislation and community expectations. As such the screening criteria may not exceed the maximum level adopted in Section 3.5.1 As such, the derived clean-up target levels as a result of this methodology may allow a less rigorous or extensive form of remediation or, in some cases, no remediation to be necessary. This would be the easiest result to implement.

The parameters that DoH considers best lend themselves to modification are:

* soil Character
* asbestos Minerology
* contamination Depth
* contamination Lateral Spread
* analytical method

If any of these parameters are demonstrated to be mitigating for a particular site, they can apply to any of the asbestos types present i.e. ACM, AF and FA. The only exception is the analytical method parameter, as it relates only to AF.

None of the parameters should be used for the pure purpose of determining whether investigation levels have been exceeded. Site characteristics will need to be established as part of the investigations and additional sampling will have to be undertaken to confirm parameters, comparable with a DSI, to provide confidence in any new clean-up levels that are proposed for a specific site.

The semi-quantitative approach does not exclude use by consultants or other proven quantitative clean-up target development methodologies or application of other parameters at least in a qualitative sense. However, justification and proof in use will need to be provided.

## Soil character and asbestos minerology

These two parameters are considered together because they were combined to derive the 0.001% w/w for AF and FA, namely

* division of Dutch figures by a factor of 10 in consideration of the greater dryness and dust-generating potential of local WA soils
* DOH treats the mineralogical forms of asbestos as equivalent for health risk assessment.

These parameters may be modified where the 10 times reduction factor is not relevant to a particular site.

Although it may be possible to tease different soil parameters apart and ascribe portions of the 10 factor to them this would be quite arbitrary and will not be attempted here.

Instead, if the both of the main parameters meet specific conditions described below, this may permit the nullification of the 10 times factor.

The basis for the soil character mitigating potential for asbestos fibre release is primarily related to moisture content and also presence of clay or silt. These, when present at sufficient levels, have been shown by Addison (1998) and separately by Tromp and Swartjes to be able to reduce the fibre releasability by factors of 10 or more depending on their magnitude.

Friability of a material relates to how easily it is broken up and how readily fibres will be released into the air. Generally speaking, the more friable the material is, the more likely it will release airborne fibres when handled or disturbed. However, in soil the same material may be wetted (depending on soil moisture content) and coated with the soil, thereby, reducing the tendency to release asbestos fibres.

The sandy and often dry soils of many WA urban centres, especially on the coast, do not meet these conditions and hence the basis for applying the factor in the derivation of the screening criteria.

Consequently if it can be demonstrated that a soil will maintain a moisture content of 10% or more into perpetuity or substantial clay/silt content for the area impacted by asbestos, then this soil mitigation feature will be considered to be met.

In the case of moisture content this may be difficult to prove in the longer term, especially with projected climate changes, but features such as substantial year round rainfall or depth of contamination may be of assistance.

For clay/silt content, this feature will be deemed to be achieved if the impacted soil can be classified as Fine Grain Soils – Silts and Clays under the AS 1726:1993.

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| Moisture, clay content and asbestos type (where predominantly chrysotile) may allow adjusting of the screening criteria by x10 where such conditions are a permanent feature of the site. |

In regard to the mineral form of the asbestos, the amphiboles, particularly crocidolite, are widely believed to be more potent for mesothelioma. For many contaminated sites mixed fibre types are found. However, if it can be demonstrated that only chrysotile is present then this will meet the other minerology condition.[[13]](#footnote-13)

## Contamination depth

If contamination is prevented from coming into contact with people such as by surface barriers or depth then it presents a decreased potential for exposure. However, the presence of a surface barrier may be difficult to guarantee in perpetuity and even buried contamination may result in exposure if subsequently disturbed.

In regard to depth DOH considers the deeper the contamination the lower the potential for current or future contact with the contamination and that 3 m of clean material does not require ongoing institutional management controls. However, the presence of contamination should be reported and the site classified under the CS Act to provide a MOT and consideration of controls in case future contact with the material occurs and persons can implement suitable control measures.

Contamination from below 1 m is less likely to be disturbed and still more so with increasing depth. If such material is disturbed, such as by deep digging or excavation, any associated exposure may be short-lived as an infrequent activity with the material being reinstated or taken off site for disposal subject to waste disposal regulations. Also, the deeper the contamination the greater the likelihood of dilution. For instance a contamination layer that is 2 metres down (upper boundary) and 0.6 m thick may be diluted by nearly 4 fold by the time any of it was dug up, assuming no additional dilution by lateral spread.

Consequently, any buried asbestos contamination with upper boundary deeper than 0.6 m and thickness midpoint at 1 m or more of depth may be subject to a risk mitigation factor. The factor is the depth of the contamination midpoint, up to a maximum of 3. The 0.6 m requirement was selected because it is the depth that may more commonly be reached as part of residential buried utility installation.

This multiplication factor correlated to depth in this graduated way is regarded as still being conservative and is readily applicable when it arises.

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| The depth of the thickness midpoint of an asbestos contamination layer may be applied to the appropriate screening level as a mitigating factor to a maximum of 3 and provided that the upper boundary of the layer is deeper than 0.6 m. |

## Contamination lateral spread

The extent of asbestos contamination as a proportion of the total used area represents a parameter for mitigating risk. The total volume of the contamination may also be a mitigating condition but is less easy to use, and may not offer sufficient conservatism where human activities may be difficult to predict.

DOH will allow the proportion of contamination area against the total used area of a site as a mitigating factor, up to a default maximum of 4 (after inversion)[[14]](#footnote-14). The maximum allows for uncertainty about human activity patterns, the location of the contamination, and the size and use of the site. For instance the site may be a large park with a small area of contamination in a highly frequented place.

For this application, it is assumed that exposure will be related primarily to disturbance through personal exposure from discrete tasks/activities (vs major site works) and proximity to and time spent in the area of contamination.

The application of this process may not be permissible in this form if the site may be subsequently subdivided into smaller blocks for residential use.

Based on the particular circumstances of a site, it is possibly that a mitigating factor of greater than 4 might be presented, but this would have to be agreed directly with DOH before implementing as part of the remediation or management process.

An example of limited contamination where this parameter might apply is in relation to soil impacts limited to a narrow drip line along an un-guttered residential asbestos roof.

However, for this and some other limited area contamination situations, it may be simpler and faster to just do an excavation and appropriate waste disposal.

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| The proportion of the total usable site area divided by area of contamination up to a maximum of 4 may be applied to the appropriate screening criteria as a mitigating factor, subject to certain conditions. |

## Supporting sampling

Since variation in the site clean-up levels is being sought and some of the parameters used as the basis for this may be technically specialised, there can be a need for supporting sampling and analysis beyond the standard expectations.

For instance, location and concentration-related mitigating factors will require a higher sampling rate to be confident of the patterns being used as a basis for clean-up variation e.g. lateral and vertical distribution and concentration range.

Separately, if soil parameters are being used then feature specific sampling will need to be done and shown to be widespread to support the proposal e.g. soil composition and moisture level.

## Analytical methods

The derivation of the screening level for FA and AF was fixed for all site uses because of the difficulty in measuring free fibre and fibre bundle concentrations at the level of detection used. That is, an accurate quantification between 0.01% and 0.001% asbestos (weight/weight) is not possible.

Since that time international methodologies have emerged that offer greater sensitivity and which have been accepted for use by DOH[[15]](#footnote-15). If these or other sufficiently sensitive DOH accepted analytical methods are employed it is possible that the screening criteria for AF and FA can be varied to reflect the type of ASC NEPM (1999) site use and associated default exposure ratios as were applied for the Guidelines’ ACM screening levels.

Where other mitigation factors for a particular site are being applied for AF and FA there is even further justification to use of the ASC NEPM 1999 exposure ratios because the resulting clean-up levels will be more easily measured. In cases of multiple mitigating factors being involved, AS4964 may be suitable for the associated measurements.

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| Where asbestos in soil analytical methods of sensitivity greater than 0.001% w/w accepted by DOH are used, the AF and FA screening levels for investigation or clean-up may be modified to reflect ASC NEPM 1999 site use exposure ratios. |

## Other factors

Other factors that have not been used in this methodology but may be worth a consultant considering in at least for health risk assessment if they appear to be mitigating risk include:

* rainfall level
* wind erosion potential
* soil compaction
* surface cover, noting that this may vary with time
* soil chemistry (which may be stabilising rather than conducive to bonding breakdown)
* air sampling results
* physical form of the asbestos
* asbestos fibre characteristics
* total mass of asbestos
* site isolation.

In making use of such factors, it is important not to exclude other factors that might have more of a risk increasing role, such as the asbestos being present as pure crocidolite.

It is also worth noting that DOH original basis for developing the screening criteria assumed a 70 year exposure and the current ASC NEPM applies 30-35 years. This difference is not considered by DOH to have a role in this methodology since the average time for the development of mesothelioma is 40 years, and so late life exposure will not have an opportunity to manifest as this disease.

However, this does not exclude a consultant from trying to apply and justify exposure patterns for contamination clean-up mitigation purposes on a site-specific basis.

# Sampling and analysis

A sampling and analysis plan (SAP) should be developed that is based on data objectives influenced by site specific variables and project specific goals. A conceptual site model may be used to clarify any data gaps that may be present. The sampling and analysis plan should comply with the *Assessment and Management of Contaminated Sites (DWER, 2014).*

For example, an investigation to determine the extent of asbestos debris from a known source may entail a less rigorous sampling program than an investigation to the extent of contamination that has been mixed and scattered through the soils at a site. Similarly current or future property use considerations may influence investigation design, for example, small grid spacing and increased sampling density might be appropriate in areas of future residential development, whereas larger gird spacing and lower sampling density might be used for commercial development with limited future soil access.

When designing the SAP the following key questions should be addressed:

* What is the investigation intended to demonstrate?
* What is the current conceptual site model or hypothesis and how will data be used to verify, disprove or modify the site model?
* How will data gathered be used to make management or remedial decisions?
* What confidence level is necessary to aid in decision-making?

Where necessary or in doubt, sampling for ACM, FA and/or AF, should occur and the findings compared against the relevant investigation criteria. The methodology for calculating asbestos concentrations is outlined in Section 5.6.

The SAP should provide for additional, discretionary asbestos contamination sampling to be conducted as necessary should suspect material be encountered during other contaminated sites works. As results from field sampling are immediately available, allowance should be made in the SAP to undertaken additional confirmatory or delineation sampling.

The extent of field sampling undertaken will depend on the overall data objectives of the sampling program and on data from initial sampling results.

In locations where asbestos exceeds the relevant investigation criteria, delineation of the impact should follow unless it is taken to be widespread and managed appropriately or addressed by post-remediation validation. Any delineation sampling regimen will depend on the contamination circumstances but should ensure the impacted area is confidently captured, especially for higher asbestos concentrations and fibre-generating material

If the contamination is associated with a layer of uncontrolled fill, then the whole extent of the fill may need to be considered impacted unless a strong argument or a more intensive sampling regime can demonstrate otherwise.

For naturally occurring asbestos, such as may be found on mining sites, the emphasis should be on sampling those areas where soil or rock disturbance and therefore potential human health risk may be likely, rather than delineating contamination zones.

Consideration should be given to collection of air sampling data to assess exposure potential.

## Visible ACM and FA as a primary measure of contamination

These guidelines and the ASC NEPM (1999) recommend that visible ACM or FA is used as the primary measure of contamination, where conditions are met.

Visible ACM and FA may be present on the surface or mixed with other soil or waste materials. Field sampling can assist in identifying and characterising contamination in mixed materials and soils (see Section 3.3).

In most cases, for bonded asbestos cement fragments in reasonably good condition, it can be assumed that the distribution of any co-located AF associated with the ACM is likely to be less than 10% of the total material present. As such, where visible ACM contamination is at 0.01 % w/w asbestos, it can be assumed that AF impacts are trivial and unlikely to exceed 0.001 % w/w asbestos across the soil profile. Therefore, comprehensive field sampling should be the focus of any sampling plan.

Similarly, where FA is not detected by systematic visual inspection of ground surfaces, exposed excavations and field samples, then quantification is not required as it can be assumed that the soil level of FA is <0.001%w/w across the area being investigated. Note that sieving is not the preferred field sampling method for FA (see Section 5.5) as sampling methods used should minimise disturbance of FA.

Where ACM has been subject to crushing, extensive mechanical damage (e.g. use of power tools) the proportion of AF may be greater, even to the extent that it may be concentrated and visible. In such cases, AF can be assumed to exceed criteria and sampling and analysis may be undertaken to delineate the impacted area if required.

### Collection of AF samples

AF mixed with other material may be very difficult to detect visibly and if suspected to be present a separate, targeted, representative (without field sieving) sample should be taken of any areas that may be considered or suspected to have AF contamination. Inspection of AF samples should be completed by a laboratory (Section 5.7). If easily visible AF or small fibre bundles are detected, then it may be possible to undertake semi-quantitative estimates of the % w/w AF by conventional gravimetric methods.

These fine materials may be considered equivalent to friable contamination if an evaluation of their structural integrity reveals a capacity to generate free fibre. More detailed investigation and appropriate management action may be required where a competent person has established that AF contamination exceeds the screening criteria.

Note that if loose fibres are observed within an AF sample, there is currently no nationally recognised method to reliably quantify dispersed fibres at low concentration levels. Semi-quantitative methods may be used to provide information for characterising contamination. Further information on interpretation of sample results is provided in Section 5.7.

## Judgemental sampling

Judgmental sampling targets particular areas of a site based on known or likely contamination, which is the preferred approach. Judgemental sampling depends heavily on a thorough PSI that properly identifies the investigation area. Judgmental sampling can help avoid unnecessary broad area sampling.

Grid sampling is most appropriate when asbestos contamination is widespread or may be present at unknown locations. If the contamination is buried then test pits in particular are used for either the judgmental or grid-based regimes.

The following situations are examples of judgmental sampling

* “hot spots” are identified by the PSI and further sampling is required to confirm the lateral and/or vertical extent
* former building ‘footprint’ of removed building structures where legacy contamination is likely to be from previously removed structures that contained ACM
* delineation and validation sampling for the removal of disused, asbestos-containing, below ground infrastructure.

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| Buildings removed after the introduction of OSH Regulations where removal was properly managed and documented may not require further investigation and sampling if there is no other evidence of contamination is present. |

For pre-1990[[16]](#footnote-16) buildings, footprint sampling considerations are:

* the depth of “surface” sampling should be determined based on site specific information on the area of disturbed surface soils with default values of 30 cm depth and 50 cm beyond footprint perimeter
* a sampling interval of 5 to 10 m along and within the footprint area (recommended)
* sampling of areas that remain covered by hardstand may be assumed to contain asbestos based on information available on the likely source and extent of contamination
* targeted, representative sampling of asbestos fine material is important for characterisation of contamination
* soak wells and roof rainwater run-off locations should be considered.

## Sampling triggers and densities

Greater sampling densities and sample volumes are generally used for asbestos than those considered appropriate for other contaminants. The main considerations for this are:

* high feasibility for additional field sampling of visible asbestos-contamination
* asbestos contamination can be widespread and heterogeneous.

Where grid sampling is appropriate, the density should be some multiple (see Table 2) of the minimum density listed. While the list was not designed for asbestos sampling experience is that it can provide a suitable guide for asbestos sampling in conjunction with a multiplication factor (from 0.5 to 2) depending on the likelihood of contamination. For localised, higher risk contamination, a denser sampling regime should be used, such as for investigating asbestos fines that may have been carried by rainwater into soil from large expanses of asbestos roofing. The density selected will be primarily at the investigator’s discretion.

The first three categories are primarily for screening purposes. They may be included as part of the scope of a PSI.

The fourth category, ‘Likely’, may be for screening, confirmation or delineation purposes, depending on the circumstances. Sampling associated with the ‘Known’ contamination is likely to be used for confirmation and precise delineation. Depending on the findings, it may be necessary to adopt a more detailed sampling regime for subsequent work, which can build upon sample locations already used.

Table 2 Sampling densities

|  |  |  |
| --- | --- | --- |
| Likelihood of asbestos | Example Scenarios | Sampling regime following PSI and site walkover: |
| Unlikely | * grazing land with no building history * site developed after 1990 | * no sampling required without evidence of contamination |
| Possible | * uncontrolled fill without building waste * undeveloped site (possible dumping) | * sampling of uncontrolled fill at 0.5 times grid sampling. |
| Suspect | * uncontrolled fill with building waste * dumped waste material * demolished structure footprints (pre-1987) | * grid sampling (1x) for uncontrolled fill with at least 1 sample per final lot for subdivisions * every 5 – 10 m for building footprint * hot spot sampling for dumped material |
| Likely | * industry associated with asbestos * some isolated asbestos found * landfill present | * grid sampling (2x) across surface and depth. |
| Known | * asbestos has been identified and needs further delineation | * judgmental, graduated targeted sampling for linear extent and depth |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Investigation area ha (m2) | Number of sampling points | Equivalent sampling density (points/ha) | Diameter of hotspot that can be detected with 95% confidence | Grid size (m) |
| 0.05 (500) | 5 | 100.0 | 11.8 | 9.5 |
| 0.1 (1000) | 6 | 60.0 | 15.2 | 12.9 |
| 0.2 (2000) | 7 | 35.0 | 19.9 | 16.9 |
| 0.3 (3000) | 9 | 30.0 | 21.5 | 18.2 |
| 0.4 (4000) | 11 | 27.5 | 22.5 | 19.1 |
| 0.5 (5000) | 13 | 26.0 | 23.1 | 19.6 |
| 0.6 (6000) | 15 | 25.0 | 23.6 | 20 |
| 0.7 (7000) | 17 | 24.3 | 23.9 | 20.3 |
| 0.8 (8000) | 19 | 23.8 | 24.2 | 20.5 |
| 0.9 (9000) | 20 | 22.2 | 25.0 | 21.2 |
| 1.0 (10 000) | 21 | 21.0 | 25.7 | 21.8 |
| 1.5 (15 000) | 25 | 16.7 | 28.9 | 24.5 |
| 2.0 (20 000) | 30 | 15.0 | 30.5 | 25.4 |
| 2.5 (25 000) | 35 | 14.0 | 31.5 | 26.7 |
| 3.0 (30 000) | 40 | 13.3 | 32.4 | 27.4 |
| 3.5 (35 000) | 45 | 12.9 | 32.9 | 27.9 |
| 4.0 (40 000) | 50 | 12.5 | 33.4 | 28.3 |
| 4.5 (45 000) | 52 | 11.6 | 34.6 | 29.3 |
| 5.0 (50 000) | 55 | 11.0 | 35.6 | 30.1 |

**Notes:**

1. The provision in this table of the number of sampling points does not imply that minimum sampling is good practice for a given site. The investigator should be prepared to justify the appropriateness of applying this table or any other sampling rationale.
2. No guidance is provided for sites larger than five hectares (50 000 m2). Such sites are usually subdivided into smaller areas for more effective sampling.
3. Judgmental sampling is preferred to grid-based where possible.

## Sampling methodology

The SAP should include a written protocol and procedures for the proposed sampling. Standard procedures may be included as an appendix to the investigation report. The methodology should be demonstrated to be effective in previous investigations or trials.

### Field sampling

A competent technician or lead investigator can determine which suspect materials (e.g. fibre-cement sheeting) are likely to be ACM or FA and decide on their condition. Identification of asbestos in suspect ACM and FA can be confirmed through identification analysis by a NATA accredited laboratory. It is recommended that representative samples are collected of the various materials present that are likely to contain asbestos.

Most soil contamination is from asbestos cement fragments or other visible forms of ACM. Field sampling allows information to be collected on the fragment size, distribution and relative proportions of fragments collected for any consecutive sampling passes.

Results from field sampling are immediately available and may be used to implement pre-considered remediation and validation actions. For example, for an investigation area with simple surface impacts it may be possible to concomitantly complete the site investigation, delineate the impacted area through successive surface sampling, undertake multiple passes to remove the surface impact and validate the area as clear of visible contamination on the final pass.

#### Surface sampling

Surface asbestos cement fragments > 7mm may be sampled by hand (emu-bob) picking. Handpicking primarily refers to the observation, manual collection and weighing of any visible material across the surface of a site. The surface should include the readily accessible and disturbed surface layer (default 10 cm depth) which may vary depending on the soil type and compaction of the soil surface. These Guidelines require that all visible surface contamination is cleaned up. Quantification using these Guidelines is useful to determine whether the site is reportable and subject to the requirements of the CS Act, Regulations and guidelines and to provide a reliable and consistent means of describing contamination present at a site prior to remediation. Where contamination is below the reporting limits, there may still be a requirement to report where visible surface contamination remains at a site.

Table 3 describes the sampling method and includes removal and validation process from handpicking to remove asbestos material.

For loose soils, surface inspection may require raking to ensure that all the readily accessible surface soil is observed. Where raking across the surface is impractical or limited by dense vegetation, shallow surface trenching/excavation may be used that targets the cross section of the readily disturbed top soil. A 10L sample of impacted surface soils can then be used for estimating asbestos content as per the test pitting method (using relevant sampling densities).

Figure Surface sample

10 litres

### Sampling results

Where asbestos contamination is found, its quantification should relate to that particular immediate grid area or volume. Care should be taken in any compilation of results not to permit averaging, which might result in inappropriate “dilution” of the calculated level of contamination. For instance, the level of contamination should not be determined across a whole large tilled area or one with an unreasonably large grid size, such as 40 x 40 m.

Where fragments are all very small, there is the possibility of missing significant amounts of asbestos that fall under the sub 7mm category and so the area should be regarded as contaminated with AF with separate AF sampling undertaken.

## Sampling methods

### Hand picking, raking and tilling

Handpicking may be used to sample and to concurrently remediate surface impacts. Table 3 describes the process and reporting of handpicking to remove asbestos material

For successive passes, if the amount found in each is quite large, (such as > 0.1 % w/w asbestos) and does not show a substantial sequential reduction, then the contamination may be such that its remediation cannot be achieved by the particular method.

Table 3 Summary of hand picking sampling method

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| Process   * Can use a rake in sandy soils to reveal covered material in the accessible surface layer. * Most suitable for asbestos cement sheeting fragments or other well bonded ACM. * Relevant where contamination is known or considered to be only on soil surface (attributed to a defined event such as removal or dumping). * Limited application for assessing deeper contamination or if there is surface vegetation or debris. * Used to characterise the extent and level of contamination and to validate surface clean up.   Implementation   * Locations and weights of collected asbestos material should be recorded and reported. * Rakes should be selected or purpose made with tines of the smallest practical width and appropriate to reach depth of surface soils being investigated. * At least 2 passes of picking (and raking if appropriate) made with a 90º direction change between each and using a grid pattern. * Material should not be further damaged or buried by the process. * Level of contamination may be calculated as per Section 5.6 using 1cm as soil depth or rake depth, as appropriate. * Final visual inspection of the area should not detect surface impacts. |

Tilling may also be used for surface sampling and remediation. Tilling refers to the process of mechanically turning over surface soils to facilitate the presentation and collection of asbestos cement fragments.

Table 4 Summary of tilling sampling method

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| Process   * Most suitable for asbestos cement sheeting fragments on other well bonded ACM. * Generally conducted for large areas of impact across the entire zone of suspected impact. * Relevant where contamination is present in the cleared top soil - limited application for deeper contamination or if there is surface vegetation or debris. * Used to characterise the extent and level of contamination, whilst concurrently reducing ACM impact.   Implementation   * Usually preceded by removal of obvious larger ACM pieces. * Locations and weights of asbestos material should be recorded. * Soils should be pre-wet to the tilling depth, dust controlled, and personal and control monitoring undertaken during works. * May require approval by WorkSafe Division, DMIRS. * Rows of tines (preferably non rotary) should be spaced and designed to optimally reveal ACM for 1 or 2 spotters closely following depending on speed, till breadth and contamination level. * Material should not be further damaged or buried from the process. * At least 2 passes with 90º direction change using a grid pattern. * Evaluated areas normally cannot be considered representative of other locations. * Level of contamination may be calculated as per Section 5.6 using an estimate of the average tilled depth and area for each grid. * Final visual inspection of the area should not detect surface ACM. |

### Screening

The term ‘screening’ is applied to both the small-scale separation of ACM from localised soil samples and to the large-scale mechanical screening of soil from a contaminated area. Sampling may be used to detect and quantify asbestos contamination, with concomitant remediation.

Mechanical screening is most commonly undertaken for remediation of low level impacts of asbestos cement fragments in (sandy) fill material. The sampling method is outlined in Table 5.

Alternatives to mechanical screening that do not require extensive dust management are often available and are preferred, particularly where sensitive receptors are located nearby. Mechanical screening may be subject to additional local government or DWER approval.

Screening is not considered suitable for remediation where FA contamination is present.

Table 5 Summary of screening validation sampling

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| Process   * Most suitable for minor impact from asbestos cement fragments and other well bonded materials. * Generally conducted across the entire zone of suspected impact. * Relevant for larger volumes of reasonably accessible and delineated contamination. * Used to effectively confirm and characterise the extent and level of contamination, whilst concurrently reducing ACM impact.   Implementation   * May be preceded by hand picking or excavation of concentrated amounts, if appropriate. * May follow a process of ‘screening down’ from larger mesh sizes to the final screening mesh (< 7 mm is recommended). * Mesh sizes >7mm require validation sampling as outlined in Section 5.5. * The level of contamination should be closely correlated to representative areas or stockpiles to Allow re-sampling or segregation if required. * Impacted soil should not be mixed with other soil in a way that might compromise the concentration calculations (i.e. dilution is not permitted). * Soils should be pre-wet and procedure subject to ongoing dust suppression and monitoring in a detailed Dust Management Plan that includes community and stakeholder consultation, where appropriate. * Evaluated areas normally cannot be considered representative of other locations. * The level of contamination may be calculated as per Section 5.6 using the weight of asbestos found for a particular strata, area or volume. * Final visual inspection of the stockpile surface should be clear of contamination. |

### Test pitting and trenching

If asbestos extends below surface top soils or is deeper than 30cm, then sampling by test pits and trenches is the most common and effective sampling method, especially if contamination distribution is uncertain.

Test pits and trenches are used instead of boreholes to more readily identify visible ACM and FA. Excavation allows observation of differing strata and provides more sampling flexibility.

Large sample sizes should be used for both methods with reliance on visual methods of suspect asbestos contamination and quantification wherever possible. The process and its implementation are outlined in Table 6.

Table 6 Summary of test pit and trenching sampling methods

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| Process   * Suitable for all asbestos types, but especially visible ACM, and FA (where fibre disturbance is manageable). * Relevant if contamination is buried and of unknown location, distribution and depth.   Implementation   * Sampling should be conducted to 30 cm below the likely lower limit of potential contamination. * Suspect asbestos material or building debris should be targeted and all sample locations noted. * Precautions are necessary to protect workers and public from wall collapse or hole hazards, and potential fibre release from excavation/sampling.   ACM and FA   * At least one 10 L sample from each relevant stratum (or per 1 m depth) of one wall, and discretionary samples from other suspect spots. * Sample screened manually on-site through a < 7 mm sieve or spread out for inspection on a contrasting colour material (recommended for suspect FA to minimise disturbance). * Identified ACM and FA weighed to calculate asbestos soil concentration for individual samples as per Section 5.6.   AF   * At least one targeted, wetted 500 mL sample from each representative strata or section of waste material and discretionary samples from other suspect spots. * May be done in the same representative location as ACM/FA sampling, either taken first (before screening) or at another wall position. * Whole sample submitted for laboratory analysis. |

### Bore samples

Although Test pits and trenches are recommended, bore hole sampling may be appropriate where the main origin of contamination is FA and additional information is required on material profile, distribution and depth.

The process and its implementation are outlined in Table 7.

Figure Buried waste FA found during site works



**Buried FA**

Table 7 Summary of bore sampling method

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| Process   * Most suitable for buried FA (e.g. buried insulation or industrial waste). * Relevant if contamination is buried and of unknown location, distribution and depth.   Implementation   * Sampling should be conducted to 30 cm below the likely lower limit of potential contamination where vertical delineation is required. * Suspect material or construction debris should be targeted and all sample locations/ depths noted. * Corer diameter should be at least 15 cm. * For FA samples, a split tube core sample is recommended to better identify soil/material layers and allow for collection and separation of the suspect material or soil layer for identification by a NATA accredited laboratory (it is recommended the entire core sample is submitted to the laboratory to be examined under controlled conditions). |

### Stockpile sampling

Soil stockpiles intended for re-use should meet the requirements for “uncontaminated fill”. The sampling plan should be based on the likely contaminants, whether friable or non-friable material is likely to be present and whether the stockpile has been subject to any crushing or screening. If there is a high degree of confidence that the stockpile is contaminated with bonded asbestos cement fragments only, then a visual assessment would be sufficient. Where AF is suspected to be present, sampling should target any suspect material or a number of sampling points representing the entire stockpile should be selected, as per Table 8.

If the contaminants are below the thresholds in Table 6 of the [waste classification criteria](https://www.der.wa.gov.au/images/documents/our-work/licences-and-works-approvals/WasteDefinitions-revised.pdf) then the material can be used at the site as “uncontaminated fill” rather than taken to a licensed disposal facility.

Where the original or contents of a stockpile are unknown, DOH adopts a conservative approach to stockpile assessment and use because of associated uncertainties and risks.

If the stockpiles originated on the site from areas not likely to be contaminated, for instance, no indication of building activity or waste, the assessment can consist of a close visual examination over the whole stockpile surface. If any asbestos is found or the soil came from asbestos suspect areas on site, then the stockpiles should normally be considered contaminated.

Asbestos-contaminated waste mounds (as distinct from “fresh” stockpiles) at a site may be assessed against contaminated sites criteria using the stockpile sampling method.

Table 8 Summary of stockpile sampling method

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| Process   * Suitable for all asbestos types * Confidence in results can be improved with adequate information on the history and origin of the stockpile material and its potential to be contaminated with asbestos.   Implementation   * Visually inspect the entire surface of the stockpile and note materials observed. * Sampling should be evenly spread over the stockpile at a minimum of 14 locations per 1000 m3  (1 sample every 70 m3). * Suspect asbestos material or construction debris should be targeted and all sample locations noted.   ACM and FA   * At least one 10L sample from each location . * Sample screened manually on-site through a <7mm sieve or spread out for inspection on a contrasting colour fabric (recommended for suspect presence of FA). * Identified ACM and FA weighed to calculate asbestos soil concentration.   AF   * At least one wetted 500mL or 1kg sample from each location. * May be taken at the same representative location albeit from another spot than the 10L sample. * Whole sample submitted for laboratory analysis. |

## Determining soil asbestos concentrations

Determining accurate asbestos concentration in soil can sometimes be difficult because of its discrete and heterogeneous occurrence and the different physical forms it can take.

The most common contamination is from bonded asbestos cement fragments and this is the simplest to assess given the relative ease of visual detection. As indicated in previous sections, visible material is the recommended measure for total asbestos contamination where AF is not likely to be significant.

Using the sampling procedures previously outlined, asbestos concentrations can be calculated based on the weight of asbestos for a given weight of soil using the method described below. Asbestos weight in ACM is often estimated, such as by using manufacturing information or laboratory estimates of asbestos proportion; therefore confidence in the results is reduced.

The confidence in the calculation and extent of application will vary based on site specific information on the nature of contamination, the quantity and distribution and the investigative method used. Ultimately, professional judgement must be used to determine whether screening criteria has been exceeded.

Some important considerations for calculating asbestos concentration for site characterisation include:

* asbestos concentrations in relevant impacted strata and sampling targeted to impacted soils
* weight by weight concentrations should be specific to the representative sampled material and should not be averaged across a larger mass of material or area
* where more than one distinct stratum is impacted by asbestos, separate asbestos concentration estimates should be made for each
* the applied soil density should be confirmed to be applicable or preferably use field scales to weight the 10L sample.

Generally accepted assumptions:

* soil weight may be directly measured in the field or calculated. Sandy soil density (1.65 kg/L) may be used as a default in WA, therefore, a 10L soil sample can be estimated to weight 16.5 kg
* % asbestos in ACM from asbestos cement sheeting may be assumed to be 15% and for any other products the proportion of asbestos must be decided based on either manufacturing information for the specific product or suitable estimates of concentration.

More representative results for asbestos concentration in soil may be calculated if the values used are measured rather than assumed. This is the preferred approach. Care should be taken in ensuring transparency for any methods adopted.

When FA is being calculated the percent asbestos content will need to be determined or estimated depending on the origin of the FA and information on the original product and the degree of friability. Greater care needs be taken to manage associated fibre release during sampling, and AF and free fibre should simply be assumed to be present in the immediately surrounding soil.

As yet, there is no validated method of reliably estimating the concentration of free asbestos fibres in soil. Soil contamination by free asbestos fibres can only therefore be simply determined according to the presence or absence of fibres. Where free asbestos fibres are found in a laboratory sample, the consultant must make a determination regarding the interpretation of the findings based on their data objectives and the site conceptual site model.

Care should be taken in interpreting the results of individual AF samples because of detection limitations and the relatively small size of samples. Similar to other contaminants, decision making against criteria should be based on all the information available from the site investigation rather than individual sample results. In the case of fibre, a few minor detects may sometimes be construed as trivial, incidental or background, especially if contamination is not suggested by site history or the main contributing source of fibre has been removed. The context, conceptual site model and frequency and occurrence of other positive and negative results should be considered.

Some sites may contain combinations of different forms of asbestos contamination, each at significant levels. In those cases or if in doubt, the respective investigation criteria and concentration calculation methods should be applied and where applicable, combined.

The concentration of asbestos in soil may be calculated as below:

**Equation 1:**

mg/kg = proportion of asbestos x weight of ACM or AF or FA (mg)

Soil weight (kg)

**Equation 2:**

% (w/w) asbestos = % asbestos in ACM x weight of ACM or AF or FA (kg)

Soil weight (kg)

Note Equation 2 is simplified to remove conversion required for percent values and could otherwise be written as.

% (w/w) asbestos = (%asbestos/100) in ACM x weight of ACM or AF or FA (kg) x 100

Soil weight (kg)

Table 9 Example calculations

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| Example calculations |
| Example 1:  A 2.5 g piece of asbestos cement and 500 mg piece of woven textile material (assumed to be 100% asbestos content) has been found in 1kg of soil  mg/kg = (0.15 x 2500mg) + (1 x 500 mg)  1  mg/kg = 875 mg/kg asbestos  Example 2:  Two fragments of asbestos cement sheeting have been found in a 10 L sample of soil. One fragment weighs 100 g and the other weighs 50 g. Total weight of asbestos cement fragments is 150 g (0.15kg).  % (w/w) asbestos = 15% x 0.15 kg  16 kg  = 0.14 % (kg/kg) asbestos |

## Analytical procedures

Where asbestos may be present as fibrous, friable, fine or free fibre material (see Glossary), then laboratory analysis may be useful to better understand the nature and extent of contamination.

| **As adequate analysis of AF samples requires careful examination it is important that AF samples are collected as separate, targeted and representative samples, linked to data objectives.** |
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While there are a number of analytical methods available internationally, there are few methodologies that have been accredited in Australia. Light microscopy techniques are the mainstay for Australian laboratories, until such time as accreditation for more advanced electron microscopy approaches become accepted.

It is important to note that inadequate sampling strategies, rather than lack of accuracy in the adopted analytical methods, characteristically limit the effective evaluation of sites contaminated by asbestos.

For fibre identification, phase-contrast microscopy (PCM) for membrane filter samples or polarised-light microscopy (PLM) for material samples are acceptable for most investigations.  Light microscopy has the advantage of being readily available and somewhat cheaper than electron microscopy in Australia. This allows for greater sampling densities and, where practicable, more extensive site characterisation.

Soil asbestos analysis should comply with existing approved Australian Standards.  The current *AS4964–2004 Method for the qualitative identification of asbestos in bulk samples* provides for a tiered approach to detecting the presence of asbestos in soil samples.  The detection limit of this technique is limited by the sensitivity of the trace analysis criteria. The DOH has requested the presence of asbestos is reported for contaminated sites assessments, even where it is below the detection limit and non-respirable, as this may provide supporting information to other site investigations findings.

***The reason for submitting a minimum 500 ml sample is to increase the likelihood of identifying asbestos material that cannot pass through the required 2 mm sieve.*** That is, larger soil samples allow for improved quantification of asbestos finds within the 2 to 7 mm size fraction.  However, these samples must be representative of the contamination for the results to be meaningful.

Provision of a larger analytical sample will result in the less than 2 mm material being subject to sub-sampling procedures before subsequent stages of fine material analysis, including trace analysis.  These subsample results have to be interpreted based on data quality objectives and how representative the sample is of site contamination, prior to comparison against site assessment criteria.

It is important to ensure that a sample submitted for analysis is representative of the asbestos contamination and not seeded with incidental finds nor diluted with uncontaminated material.  Where it is expected the form of asbestos contamination is predominately less than 2 mm, submission of a smaller sample may be possible.  Any variations or decisions regarding sample size should be justified by the sampling plan and data objectives and discussed with the laboratory undertaking the analysis.

It is important to note that the laboratory is seeing a very small sample of material where the origin of AF may be unknown to the analyst. As such, analysts do not have the information necessary, unless provided by the sampler, to determine whether the origin of any AF should be managed as friable or non-friable or minor contamination of dust and debris.

Larger amounts of friable material (>7 mm) may be described as FA and the laboratory may use any agreed in-house descriptive terms for AF (<7mm) material observed such as:

* fibre-cement piece/debris
* loose fibre bundle
* loose fibre-cement bundle
* loose fibres.

The steps below must be completed for all asbestos in soils samples analysed to comply with these Guidelines and AS4964.

Table 10 Examination of samples

| **Examination of AF (soil) samples by the laboratory  (incorporating requirements of AS 4964-2004, 8.2.3)[[17]](#footnote-17)**   1. Weigh the submitted soil sample (dry weight) 2. Screen the entire sample through a 10mm sieve 3. Examine the +10 mm matter by eye or magnifying glass and separate to weigh all suspect ACM and FA as subsamples and for identification by PLM - note appearance, dimensions and estimated asbestos content. 4. Optional steps for reporting +7mm weights    1. Screen the entire sample through a 7mm sieve where available and repeat step 3    2. Report +7mm suspect material found in Step 6 separately 5. Screen the -10 mm fraction through a 2 mm sieve. 6. Examine the -10 mm to +2 mm fraction by eye or magnifier and separate and weigh all suspect material containing asbestos, including small pieces of bonded material and fibrous matter, for  identification by PLM and DS – note appearance, size and asbestos content . 7. Spread out and examine the entire - 2mm fraction by using eye, magnifier or stereo-microscopy. If sample is large, selectively examine suspect material under stereo-microscopy prior to reducing the sampling and extract any material for later identification by PLM noting appearance and dimensions (weigh if possible). 8. Reduce, spread out and examine -2mm fraction using stereo-microscopy, extracting any fibre bundles or fibrous matter for identification by PLM and noting appearance and dimensions (weigh if possible). 9. Conduct a trace analysis on (reduced) -2mm fraction.   For split tube core samples, open tube and examine each layer and separate suspect layers for more detailed analysis, i.e. more time should be spent examining those layers.[[18]](#footnote-18)  AS 4946 requires all asbestos-containing matter to be weighed or measured and allows for the estimate of weight to occur based on the appearance and dimension of the matter found or knowledge of the asbestos-containing materials found and likely asbestos content (see AS 4964, Section 8.2.3 (m).  For small pieces of bonded materials with fibres still retained in the bond it may be possible to assign a portion of the weight as asbestos (e.g. 15% asbestos for -7mm asbestos cement).  Proportion of asbestos content attributed to AF matter should be conservative.  An assumptions may be made that any “like” material separated from the sample in Steps 1 to 8 above is asbestos, where similar material has been identified as asbestos by PLM[[19]](#footnote-19). Assumptions should be reported as such.  Depending on data quality objectives, it may be important, especially for Tier 2 assessment, for all the supporting information gathered during analysis to be provided (i.e. information on the appearance, size and asbestos content of materials identified as asbestos).  If possible, such a detailed report should differentiate between empirical and estimated values, including weights and dimensions.  Following analysis, weights will likely be available for:   * +7mm ACM and FA * 7 mm to 2 mm AF (including small pieces of bonded material and fibrous matter) * - 2mm AF (prior to sub sampling)**.**   For the purpose of these guidelines, laboratories may report the total dry weight asbestos of the +7mm ACM, +7mm FA and all – 7mm AF material/matter identified to contain asbestos as a percentage of the total dry weight of the sample. Even when using a 10 mm screen in the laboratory, all AF +7mm should be reported separately to -7mm to 2 mm material for compliance with these guidelines.  The +7mm FA and – 7mm to 2mm AF result may be combined to conservatively assess against the 10 mg/kg criteria.  Calculated results from subsampling and trace analysis may provide useful information, especially for tier 2 assessment, but are subject to interpretation prior to comparison with screening criteria. |
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AS4964 trace analysis allows for assessment of discrete fibres and fibre bundles in a small subsample for the purposes of identifying free asbestos fibres.  Limitations of this light microscopy technique should also be considered, especially when fibres are particularly fine (e.g. small diameter not able to resolved by light microscopy) or occluded by interfering materials in the sample matrix.

Trace analysis and other internationally validated techniques, such as electron microscopy (e.g. ASTM and ISO methods, etc) or elutriation and disposition methods (e.g. The Quantification of Asbestos in Soil: Methods for the Examination of Waters and Associated Materials (Standing Committee of Analysts, 2017, “Draft”) may provide information regarding the presence and relative quantities/contribution of free asbestos fibres in a sample.  The information provided by such techniques must be interpreted in the context of the information obtained from the broader site investigation.

Alternatives to AS4964 may be acceptable to DOH if fully justified and demonstrated to achieve at least the same level of effectiveness.  Methods accredited to ISO:17025 (i.e. by NATA or equivalent ILAC member organisation) are preferred. Additional approval may be required from WorkSafe, DMIRS for use of any non-NATA accredited methods (to be confirmed).

Where these Guidelines recommendations inadvertently conflict with Australian Standards or in-house NATA accreditation requirements, then laboratories should approach DOH to discuss and help resolve these differences.

## Air quality monitoring

Undisturbed asbestos material in soil does not directly translate to a risk to health. The risk to health is dependent on the potential for free fibres and fibre bundles to become airborne, the concentration of particulates in air (dust generated) and the frequency and duration of recipient exposure.

The membrane filter method is the only nationally recognised measurement technique regularly employed for determining airborne asbestos. The resolution of PCM is limited (i.e. small diameter fibres <0.25 um are more difficult to detect using PCM) and does not distinguish fibre type. PCM used in the non-occupational setting may result in a significant underestimation and sometimes overestimation of the fibre concentration in air. A background level of fibres is present in the environment (organic and other mineral fibres) and may also be present on manufactured filters. Therefore, the accepted limit of reporting is considered to be 0.01 f/mL. The membrane filter method only provides an index or estimate of exposure to fibres.

Control monitoring may be required for contaminated sites, particularly during remediation works, to show that public health exposure is effectively managed. Control monitoring must be completed where confirmation that control measures have been effective in managing exposures during works is required.

Where best practice dust control measures are used, it is expected that static airborne fibre levels will remain below the limit of reporting, which is used as the control limit. Control monitoring will provide confidence and evidence that control measures were effective and can be used to allay concerns in sensitive situations.

The air monitoring program must consider the need for exposure monitoring of workers undertaking tasks that may expose them to elevated levels of particulate emissions. Personal monitoring of asbestos in air to assess and control workplace exposure is an occupational health and safety issue, however, results may be used to show that controls have been effective in minimising fibre release and protecting public health. The WorkSafe Division, Department of Mines Industry and Safety is the lead agency with regard to employee exposure.

Air sampling results taken during periods of no activity or when effective remediation controls are in place should not be used to conclude that there has been no asbestos fibre release from soils or to justify use of less stringent site management measures, as the sampling methodology is not representative of all site conditions. A specific sampling plan should be considered for detailed risk assessments where more information is required to characterise health risks.

The potential for airborne fibre release associated with the presence of friable asbestos, free fibre and fibre bundles is much greater than for bonded material of any size. However, any activity that has the potential to release fibres will need to be considered as part of the exposure assessment.

### Air monitoring principles

The following sections outline when various methods may be relevant to the site investigation and management process.

* the purpose of any air sampling should be clearly identified
* the air quality monitoring strategy should be developed by a person experienced in asbestos sampling and exposure assessment (e.g. occupational hygienist[[20]](#footnote-20))
* monitoring for asbestos fibres is not useful in real time for informing management decisions about the effectiveness of controls during asbestos disturbance – other direct measurement of particles may be required (e.g. real time dust sampler).

### Exposure assessment

Exposure monitoring may be undertaken as part of a detailed site investigation incorporating health risk assessment. This may be appropriate where significant levels of airborne asbestos fibres are possible, and or to help allay community concerns regarding previous activities undertaken at a site.

Methods for completing an exposure assessment include:

* qualitative exposure assessment based on investigation and assessment of the site, activities undertaken, potential for particulate/fibre release and expected air concentrations
* task/activity based sampling for activities being undertaken at the site
* simulation of past or future tasks/activities likely to be undertaken at the site (may require additional approval from Worksafe or Worksafe Commission).

A lower reporting limit for any exposure sampling should be considered. Where possible international methods using electron microscopy analysis are preferred for assessment of low-level exposure, especially where the fibre size and identification of fibre type are important and where high analytical sensitivity is required. While many international methods use transmission electron microscopy, scanning electron microscopy allows for direct viewing of a larger area of filter than TEM and is more readily available. The sampling methodology may need to be adapted to relevant site conditions, activities and expected particulate loading on filters. For example, depending on the expected particle load from activities being undertaken, long duration and/or or high volume sampling may be required to collect sufficient volumes of air for lower limits of reporting.

Exposure assessments have been completed in Western Australia based on a modification of *ISO 14966:2002 Ambient air — Determination of numerical concentration of inorganic fibrous particles — Scanning electron microscopy method.*

### Dust/Particulate monitoring

Dust monitoring provides a useful surrogate for assessing the effectiveness of dust management at a site for the following reasons:

* real time dust sampling can be undertaken with alarms/action levels set that provide immediate feedback regarding the effectiveness of dust control measures or changes in conditions that may lead to elevated dust levels
* dust monitoring is commonly used, well known and does not require specific asbestos monitoring expertise
* results are immediately available and easy to interpret and data logging provides evidence that adequate dust management has been employed during remedial/site works.

Dust monitoring equipment should demonstration that particulate levels are kept as low as reasonably possible. The site dust management plan will need to identify triggers used for control actions.

Equipment should be located along the site perimeter at “background” upwind and downwind locations, taking into account local site features and topography. Where there is a well-defined diurnal and seasonal variation in the dominant wind direction, monitoring stations should be located along the key axes. Generally, regional meteorological data will be sufficient to aid planning of fixed dust monitoring stations and portable devices may be repositioned depending on daily conditions. For fixed stations (e.g. Tapered Element Oscillating Microbalance) a detailed log of atypical meteorological conditions may be useful for interpreting results or addressing complaints.

### Quality assurance/Quality control

Quality assurance and quality control (QA/QC) practices should be consistent with guidance provided by the NEPM, which also provides information on the development of Data Quality Objectives (DQO) and on quality control samples.

Relevant considerations particular to asbestos include:

* investigators should have adequate asbestos experience and breadth of knowledge to ensure the quality of recommended visual detection and quantitation methodologies
* sampling and analytical procedures should be justified as to their appropriateness and effectiveness
* GHS labelling and safe sample packaging and transport requirements are to be met
* analytical methods should be consistent and allow results to be reproducible within and between laboratories. Importantly, fibre-counting criteria should be consistent for all sample analyses
* National Association of Testing Authorities (NATA) asbestos accreditation is a standard QA/QC requirement
* wherever there is analytical uncertainty regarding whether fibres in a sample are asbestos, the fibres should be assumed to be asbestos. Re-sampling should be considered to clarify the presence of asbestos at a site
* until an alternative method to identify asbestos in bulk materials (including soil) is developed and validated, the use of the Australian Standard Method for the Qualitative Identification of asbestos in bulk samples (AS4964-2004) is recommended.

The use of duplicates during sampling for asbestos is not a mandatory requirement. However, there may be cases, usually when there may legal positions argued, that a duplicate or triplicate sample may be necessary. In such a case, it would be a division of a single sample rather than an attempt to collect equivalent samples.

## Validation sampling

Validation will be necessary for remediation works primarily related to removal of asbestos-contaminated materials and large scale soil screening where the mesh size is greater than 7 mm.

Some removal strategies will be self-validating. For example, removal via handpicking should ensure that the final pass does not identify any ACM. In these cases, the evaluation and reporting of remediation methodology must be adequately recorded through the course of a project.

Any validation sampling should be based on the previously described recommended sampling methods. Sampling may not always be necessary to verify completion of remedial activities. For example, excavation of a disposal or fill area where boundaries of the waste or fill can be visibly distinguished and identified based on the presence of natural (undisturbed) soils or other change in condition indicative of non-impacted soil. The decision making process and visual confirmation of remediation must be recorded.

# Site remediation

The main remediation options include: management in situ, treatment on-site, and removal of the contaminated soil from the site. Consideration may also be given to changing the final intended use, or redesign of development plans (e.g. locations of building, hardstands and open spaces), to better manage the risk in perpetuity.

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| Exposure to asbestos can be adequately managed by preventing the release of airborne asbestos fibres and remediation involving minimal disturbance, such as containment and management in situ, is preferable to large scale removal activities. |

All options for remediation must be considered and presented to the site owner/occupier. Options may include a combination of methods. The preferred option should be supported by strong argument when compared with the others. Although cost, time, convenience and future owner perception will be important considerations, the arguments presented for selection should be primarily stated in terms of public and worker protection.

The main options are discussed in the following sections, and relate primarily to ACM unless FA or AF is specifically referred to. The proponent is free to propose other remediation measures through suitable argument and/or precedent.

All equipment operation, vehicle movements and dust during sampling and monitoring regime and remediation activities need to be carefully managed.

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| Early stakeholder engagement in remediation options is expected. Where, following remediation, the control of the land will pass on to a new owner or entity (e.g. local government) to manage, these parties must be included in the decision making process, especially where there will be long term management obligations on the party involved. |

In addition, site remediation activities will need to comply with any other licences or approvals required by State and local government (e.g. screening activities). Such requirements should be identified in any remediation action plan.

Remediation options that are available for contaminated sites may not be approved for other situations (e.g. treatment of waste stockpiles).

Important considerations for the DOH in assessing the acceptability of any remediation proposal consists of:

* minimisation of contaminated soil disturbance
* minimisation of contaminated material/soil moved to landfill
* written agreement from parties with responsibilities for temporary, interim or ongoing site management.

The object of any remediation strategy and site management approach is to:

* prevent and protect individuals and communities from exposure that could lead to asbestos-related diseases
* provide information to individuals and communities about OSH and public health risks.

Regard should be given to the following Public Health Act 2016 principles.

**PUBLIC HEALTH ACT 2016 - PRINCIPLES**

**Sustainability principle**

Sound public health practices and procedures should be adopted as a basis for sustainability for the benefit of all people and the community today, while consideration is given to the public health, social, economic and environmental needs of future generations.

Public health, social, economic and environmental factors should be considered in decision making, with the objective of improving community wellbeing and the benefit to future generations.

Public health practices and procedures should be cost effective and in proportion to the significance of the public health risks and consequences being addressed.

**Precautionary principle**

If there is a public health risk, lack of scientific certainty should not be used as a reason for postponing measures to prevent, control or abate that risk.

In the application of the precautionary principle, decision making should be guided by —

(a) a careful evaluation to avoid, where practicable, harm to public health; and

(b) an assessment of the risk weighted consequences of the options.

**Principle of proportionality**

Decisions made and actions taken to prevent, control or abate a public health risk should be proportionate to the public health risk sought to be prevented, controlled or abated.

In the application of the principle of proportionality, decision making and action should be guided by the aim that, where measures that adversely impact on an individual’s or business’s activities or a community’s functioning are necessary, measures that have the least adverse impact are taken before measures with a greater adverse impact.

**Principle of intergenerational equity**

The present generation should ensure that public health is maintained or enhanced for the benefit of future generations.

## Presence of other contamination

The presence of other contaminants may affect the approach taken to or the timing of asbestos remediation. The following considerations may be important:

* Do other contaminants present an immediate threat to health or the environment?
* Will the proposed asbestos remediation option mobilise or compromise the other contaminants or vice versa?
* Is a single option or combination of remediation options available that will treat both asbestos and the other contaminants?

## Containment and long term management

On site containment may be considered where:

* asbestos-contaminated material is located reasonably deeply, for example > 1.5 m
* distribution of asbestos is difficult to determine and/or
* proponent does not wish to characterise the level of contamination
* asbestos contamination covers a large area, for example > 2000 m2
* contamination includes significant FA or AF
* site will largely be covered by hardstand
* site is to be covered by clean fill for geotechnical or other purposes
* likely associated requirement for a Memorial on Title (MOT) and implementation of long term management plans is not a concern.

On site containment primarily involves the isolation of the contaminated area with barriers and covers so that it cannot be readily disturbed and therefore will not generate airborne fibres. Potentially affected parties, including current and known future users, should be informed of the contamination and the arrangements in place to protect them, including through a MOT, as discussed in Section 6.3.

Other on site management measures not described in these Guidelines are possible, such as cement injection stabilisation, which effectively encapsulates the asbestos material.

A MOT associated with remediated sites is a common occurrence and should not be regarded from as less acceptable outcome.

The barrier or cover is usually a layer of clean fill (sand or soil). This fill should be demonstrated to be free of contamination. The need for surface water drainage also needs to assessed and included in the remediation plan.

The depth of the clean fill should be sufficient to maintain a depth of cover that prevents access and disturbance of any buried asbestos-containing material. The depth of required fill should consider:

* current and future site use
* the integrity of the final top surface cover (e.g. hardstand, gravel, turf)
* potential for damage/erosion of the cover through human activity, surface water movement or other causes
* ability to inspect/maintain cover over the long term
* access to below ground infrastructure including irrigation systems and service trenches.

Where possible, the depth of cover should be sufficient to address any access to, or future installation of utility and underground services. Alternatively, service trenches may be isolated from other buried contaminated material and back filled with clean fill. The long term management plan for the site should address the need for appropriate precautions during any below ground excavation.

Contamination associated with high concentrations of friable asbestos or free asbestos fibre, for instance > 10% w/w asbestos, may require a greater depth of clean fill or more frequent inspection of cover, depending on site circumstances.

Long term management measures as well as a MOT would also be expected for any asbestos-containing material remaining at site. Information on management of recreational reserves is provided here.

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| Remediation Plans and long term management measures must be agree to and endorsed in writing by the entity that will have in perpetuity control of the site. |

### Separation and/or isolation of contaminated and uncontaminated fill

A geo-textile barrier provides a warning of the presence of underlying soil contamination. Where possible the barrier should be a contrasting colour to the surrounding soils. Specialised or improvised geo-textile fabrics may be used, meeting the following conditions:

* water permeable
* high visibility
* rot-proof and chemically inert
* high tensile strength
* coverage of contaminated area and 0.5 m beyond boundary if practical
* parallel sheets to be fixed together or overlap by 20 cm.

Alternate means of visibly identifying and separating fill may be used, e.g. a layer of crushed rock between clean soils and asbestos-contaminated soils. An Ongoing Site Management Plan (OSMP) is a recommended element whenever a covering barrier is employed. This provides additional assurance that the protective measures will be maintained and that potentially affected parties will be kept informed of possible risks. A full description of the OSMP is provided later in Section 6.5.

The means of isolating and visibly identifying the layers of soils must be well documented in any ongoing site management plan and specific procedures developed for any site works. The expected lifespan of geotextile barriers should also be included in the long-term management plan.

A dense vegetative barrier, such as turf, can be very useful in protecting the clean fill cover from erosion and also from some forms of human disturbance. In certain cases, the site may involve ongoing corporate or communal management which will control what happens with the vegetative barrier, including its maintenance.

The advantages of onsite containment include:

* minimal disturbance of asbestos –contaminated soil
* minimisation of sampling and investigative works required with potentially lower costs, time delays and greater confidence of outcomes.

The disadvantages include:

* asbestos remains on the site and will need to be properly managed
* level of the site may need to be raised
* The site will remain classified with MOT, which could adversely affect purchaser perceptions.

### Excavation and on-site burial

On some sites, the on-site relocation and re-burial of asbestos-contaminated soil within a containment cell will be an option. The burial site is usually required to be in an already asbestos-contaminated area. Approval from DWER will be required to place contaminant cells outside of an already contaminated area of the site.

Use of on-site containment cells can lessen the risks and costs associated with taking the material off-site and disposing of it and can intern the asbestos containing material in an area of the site that allows for suitable long term management, i.e. under buildings or hardstands or within an area of development that is controlled by an entity that can apply institutional controls on a site. This would allow more vulnerable parts of the site (i.e. sensitive land use or low integrity cover) to be remediated. The reburied asbestos would still have to be properly managed in accordance with any restrictions and an OSMP and may allow for an Interest Only Deposited Plan.

The boundaries of the area from which excavated soil was taken should include an extra 1 m laterally and an additional 30 cm depth to account for any uncertainty in the contamination delineation and removal process or be validated as uncontaminated.

## Treatment on-site

Where contamination is main associated with non-friable sources of asbestos and the need to avoid MOT is important, treatment on site may be an option.

Treatment on-site is taken here to mean undertaking some physical treatment or manipulation of the contaminated soil on-site, specifically collecting ACM or asbestos-contaminated soil, raking, tilling, screening or excavation of asbestos contaminated soil and re-burial within a nominated containment area.

### Collecting ACM

Guidance on hand-picking or “emu-bob” of surface ACM is provided in Section 5.1.1. This technique can sometimes be used to remediate as well as to estimate the level of contamination associated with surface soils.

Remediation is possible where collecting visible material results in removal of the contamination present at the site. This may be only possible if it is proven that the impacts are confined to the immediately accessible top surface soils and that contamination has been substantially removed. Evidence of the depth of penetration will be required, either by sampling and/or the desktop study.

Some types of FA material located on the surface may also be readily collected and removed, although additional work should be undertaken to assess and manage less visible free-fibres associated with it.

For the ACM remediation of surface and accessible sub-surface (default of 10 cm) removal process to be adequately validated, the DOH requires at least two passes (and then as many as required) until a final validation pass does not find any contamination over the area.

A manual or mechanical rake can be used to assist the collection of matter capable of probing to the level of surface contamination. Raking may only be effective with sandy soils. The spacing between the rake teeth should be such that the ACM present is able to be captured by the rake, allowing uncontaminated soil to pass through. Field work has shown that custom rakes are no more effective in removing asbestos cement fragments (the most common ACM encountered) than commercially available rakes. However, consideration should be given to scraping soils (e.g. with a shovel) vs raking where “hot spots” of very small pieces of ACM may be present. Very small fragments may be evidence that the material has been crushed, smashed or pulverised and collection via surface scrape of the visible material and immediately surrounding impacted surface soil would include remove any associated AF that may have been created from any mechanical action that has occurred, eliminating the need for AF sampling and verification.

The picking and raking and scraping of surface soils should be conducted on a grid by grid basis for large surface area impacts.

When using collection methods, the ACM content should be weighed and its source location noted. If the third or higher final pass across the impacted area results in no visible ACM being found then the soil can be considered effectively remediated of ACM.

For collection to be effectively validated, it may be necessary to remove any covering vegetation, whilst ensuring that the vegetation is clean of ACM before disposal. Prior to vegetation clearing, consideration should be given as to the need for a Clearing Permit to be obtained from DWER under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

### Tilling

Tilling using mechanical means may be an acceptable methodology, for instance to reveal ACM contamination that is no deeper than the tines. The desktop study and sampling may help to support such an approach. Tilling is expected to be used together with hand-picking and will require initial removal of surface vegetation. A grid approach should again be used with a similar spotting, locating, weighing and calculation approach used as outlined for hand-picking. Again, the top readily accessible soil surface (default 10 cm) must be free of visible asbestos for the site to be considered remediated.

### Screening

Mechanical screening can be used where concentrations are above or below the soil investigation criteria. It is most suitable for minor asbestos cement fragment impact in sandy soils. However, this process requires a comprehensive dust management plan (including air sampling) and community consultation process.

If undertaken with the appropriate controls, screening can be an effective tool for separating ACM from soil to limit material being disposed to landfill.

A screen of effective final mesh size of less than or equal to 7 x 7 mm should be used to ensure that fragments of ACM panels do not pass through lengthways. Based on the amount of ACM retrieved for a given volume of soil screened, the percentage of asbestos w/w can be calculated. If the levels of small fragments are high, or a larger screening size is used, sampling of the resulting stockpiles will be required to confirm that screening is effective.

Dust management and air quality monitoring are particularly important during screening procedures because they have the potential to release considerable amounts of dust and possibly free asbestos fibre.

Consideration of the above on-site treatment options should take account of the following factors:

* Advantages
  + no contaminated soil needs to be moved off-site for disposal; MOT is avoided
  + sampling can be combined with remediation;
  + risk is removed and no more management is required.
* Disadvantages
  + not suitable for high levels of contamination
  + may not be suitable if there is considerable additional demolition debris
  + may not be suitable for compacted soils or soils with high clay content
  + in some cases, has potential to generate considerable dust which requires management and monitoring to ensure there are no off-site impacts
  + may require additional controls (eg. enclosure) where a sufficient buffer from sensitive land uses is unavailable.

## Removal off-Site

Removal off site is an option for asbestos-contamination that is not buried deeply, cannot be contained on site or where the extent of contamination evident and well delineated.

Opportunistic removal may be undertaken where excavations are be required as part of site development.

Removal off site may be required where it is important to avoid a MOT. Since DOH considers minimising public risk, soil disturbance and off-site disposal as priorities, this remediation method should be considered only when all other options are unsuitable. However, “dig and dump” has been widely practiced and in certain cases may be appropriate, for instance, when unexpected “hotspots” are found during site development.

For excavation of any asbestos contaminated soil, it is recommended that additional material is removed in all directions beyond the measured lateral boundary of the contaminated area until natural soils or validated uncontaminated soils are present. The surfaces exposed by the excavation will need to be validated in regard to asbestos contamination as outlined in Section 5.9 Validation.

Excavated contaminated material should be transported and disposed in accordance with the Environmental (Controlled Waste) Regulations.

Complete excavation and removal will remove the potential for any future exposure and does not require any ongoing management. The disadvantages associated with this option is the need to control removal and transport and the occupation of landfill space and costs of disposal.

### Management of remediation activities

Some of the investigative procedures and especially the remediation measures have the potential to generate significant amounts of dust including airborne asbestos fibre.

Possible dust-generating activities include the mechanical screening of soil and major earth excavations and vehicle movement. Effective dust management controls are required and air quality monitoring needs to be included.

A Dust Management Plan (DMP) should be developed and implemented for all activities undertaken at a site. The level of detail will depend on the nature and extent of the contamination and the type and magnitude of disturbing activities.

A DMP should include sections on: dust control measures, air quality monitoring, personnel protection and training, and action levels and responses.

Available dust control measures include but are not limited to:

* wetting with an agent specifically designed to suppress the release of particulates/fibres
* using dust suppressants or covers on soil stockpiles
* installing wind barriers of a suitable height
* using sheltered areas wherever possible
* full enclosure structures around dust generating activities
* monitoring meteorological conditions and modifying or stopping work when they are adverse
* regulating the activities at a site and/or speed of vehicles
* restricting or minimising access to contaminated areas, especially by vehicles
* implementing a community dust complaint and response system.

All persons involved in remediation works must be adequately trained. The site-specific training must include:

* asbestos awareness training
* understanding of the nature and extent of site-specific asbestos contamination
* controls and notifications to be followed
* how to prevent exposure to contamination, including
  + dust control measures
  + handling and disposal procedures
  + selection and use of personal protective equipment and clothing
  + personal and equipment decontamination procedures
  + emergency procedures.

## Ongoing Management

Ongoing management refers to proper control of any asbestos contamination remaining at the site and the communication of relevant information to site owners/occupiers, users and persons who may encounter asbestos contaminated material as part of future site works.

Adequate characterisation of contamination aids in planning development and future management in such a way that areas with asbestos contamination are not or at least minimally disturbed.

Ongoing management should aim to alert and protect any future workers or site users to the presence of asbestos to protect themselves from exposure to airborne fibres. Depending on organisation arrangements, it may be possible to include areas requiring ongoing management into existing asbestos registers and asbestos management programs.

Note that, depending on DWER and DOH review of site risks, a site that has only implemented interim measures may retain a classification for requiring remediation until the long term measures have been confirmed to be in place.

Risk based assessment requires site-specific action levels based on air concentrations. An accurate exposure assessment can only be determined through airborne sampling. Asbestos is not uniformly distributed in soil. Extensive activity based sampling studies undertaken by the USEPA indicate that weight/weight soil concentration cannot adequately predict inhalation exposure. A management plan will need to be developed and implemented on a long-term basis. The following elements should be considered in establishing such a plan:

* agreement from all parties involved regarding the remediation plan and ongoing management arrangements proposed for the site
* agreed timeline for implementation of long term management solutions to ensure interim measures are not extended beyond their ability to prevent future exposure.
* description of engineering or institutional controls for any asbestos contamination remaining in situ
* integration with any existing corporate asbestos management plans used by the organisation and with any:
* authorisation / permit to work process
* existing procedures associated with inspection of cover materials (e.g. turf management)
* proof of arrangements to maintain the integrity of the covering barrier of the contaminated area if there is any possibility of it being disrupted, for instance if the barrier is in the form of a vegetative cover, scheduling surface inspections following periods of heavy rainfall
* surface water run off that may erode cover, particular after heavy rainfall
* arrangements for personnel associated with any future work (including regular inspections) on the site to be warned and guided in regard to the impacted area, including safe working practices and repairing any damage to the barrier
* development of an information and communication strategy for existing or prospective owners, occupiers and users of the site
* where needed, procedures for how to deal with asbestos that may be encountered by various persons using or working at the site
* the ongoing review and audit of management provisions and stakeholder engagement to ensure in perpetuity management of the asbestos contamination.

The stakeholder communication/training should include details of:

* results of site investigations
* restrictions on site use to protect from exposure
* any responsibilities they hold with regard to the management arrangements
* where additional information may be obtained.

Where ACM remains on the site and is managed, the land will be classified accordingly and a memorial put on the title. The final classification is likely to be “Remediated for restricted use”. The restricted use would consist of a warning that asbestos remains on site and the precautions required to prevent exposure.

Where asbestos contamination has been, or remains buried at a site, site specific procedures will be required to address the following and be outlined in the OSMP in practical terms:

* authorisation for any ground disturbance/site works
* occupational safety and health provisions for workers
* dust control measures and air quality monitoring requirements
* reinstatement of cover and verification of the integrity of controls restored to previous or equivalent level of safety
* update of any site plans, procedures or management documents following the works.

# Reporting

All asbestos-related reports should be presented primarily as outlined in the Contaminated sites guidelines: Assessment and management of contaminated sites, (December 2014). The reports should also reflect the guidance provided in relevant chapters of these Guidelines. Specifically, the following information, that is often omitted, must be included in reports :

* each report should provide an outline the relevant training and experience of at least the supervising environmental consultant (not full CV)
* if an approach varies from these Guidelines, it should be fully detailed and justified, including by providing information on precedents or any validation of methods used
* all reports should be as comprehensive as possible in regard to information, process and decisions, to avoid misinterpretation
* each report should be normally “stand-alone” and should not rely on other documents for contextual information or for interpretation
* each report should investigate, outline and take account of any changes to site-associated conditions that might affect the management process
* where asbestos is not the only contaminant, any reporting relating to it should be clearly identified and preferably discretely handled
* a specific plan and/or site specific procedure for managing asbestos contamination (separate to other contaminants) may be required that incorporates control of all sources of asbestos at a location and complies with OSH legislation
* for the PSI visual inspection it is critical to comment specifically **on the presence or absence of asbestos material and on the inspection method**
* if a DSI is conducted, its report should include a statement as to why it was necessary as part of the remediation and management process
* if a site is subject to a Mandatory Auditors Report, that report should comment on the compliance with these Guidelines of the relevant site investigation and management activities
* the Site Remediation and Validation Report should include documentation arising from the disposal of removed asbestos or asbestos containing material at a suitable landfill
* in the case of an OSMP, evidence will need to be included that the responsible party (and any nominated responsible persons) will manage the site into perpetuity
* incorporate photographs of field investigation, remediation and validation inspections in reports since asbestos is often identified visually
* provide example of how calculations against criteria have been made
* include field records for air monitoring data and analytical reports.

## Soil Investigations

The details of the process and rationale associated with site investigations, walkover inspections, site sampling, analysis and validation, and how the results are interpreted must be reported.

The soil investigation methodology needs to be clear and comprehensive, especially for sites that are complicated or lack good historical information. The report should:

* include the full raw data, including soil logs and laboratory results in appendices.
* incorporate tables and diagrams to help summarise and interpret the data.
* show asbestos concentration calculations.

## Reporting of sampling results

Unlike other contaminants, sampling often relies on field sampling and visual identification of ACM and FA. Reports will benefit from the annotation of summary information on a suitable site inspection diagram. Useful information may include:

* the various types and forms of asbestos contamination encountered
* average and range of sizes observed
* locations where samples of suspect material were taken for identification or AF analysis
* locations where photographs were taken including direction of the shot.

Field technicians need to demonstrate that they have been adequately trained to identify the range of asbestos containing materials that may be present in soils and how to assess their condition. As a minimum they will need to have attended the “title seminar” held by DOH.

## Reporting of Screening or Tilling Sampling

For these types of sampling, a site diagram should be provided denoting on a grid basis the investigation area(s), the direction of each pass, the collected weight of asbestos, and calculated soil asbestos concentrations, all on a per pas basis. In the case of screening, the effective screen mesh size should be stated, and the results for the different strata should be differentiated.

The discussion of results should include trends observed across the sequence of investigation passes, including variability and change in asbestos concentrations, and delineation of areas where asbestos contamination is more pronounced.

## Reporting of Sampling – Soil Bores, Test Pits and Trenches

This type of sampling may often also involve discretionary and follow-up sampling. The different types of sampling should all be differentiated and a rationale provided as to why and where they occurred. The following components should be considered for inclusion in the site investigation diagram:

* depth of strata sampled for asbestos
* soil asbestos concentrations at each position for each strata sampled; Size of sample screening mesh used
* highlighted locations if free asbestos fibres are identified.

## Air Quality Monitoring

Reporting elements for air-quality monitoring should include:

* rationale for air-quality monitoring conducted and any corrective action levels adopted
* the data and time of the sampling
* the names of the people conducting the sampling and analysis
* sampling instrument used, its accessories and the method of analysis
* flow rates, pre and post flow checks
* any deviations from standard protocols
* static sampling locations
* the activities and location of any person wearing a sampling device
* relevant information on engineering controls, weather conditions and protective clothing and equipment.
* any exceedances of adopted corrective action levels;

Some of the information may be provided as part of other reported information or in appendices within analytical reports and field records. However, a summary cross-referencing the relevant information would be of benefit.

The discussion on air quality monitoring should provide an evaluation of potential causes of exceedances, the prevailing meteorological conditions and the effectiveness of corrective actions implemented and include a statement of the potential exposure of human receptors to asbestos fibres and of the adequacy of site management measures implemented.

### Material Tracking and Disposal

Complete documentation of the remediation works need to be available in the final report including:

* description of all field operations or daily longs
* containment areas
* maps showing excavation profiles
* maps showing location of asbestos contamination left in situ
* vehicle/load tracking information
* disposal weights and receipts

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# Glossary

**AQM** Air-quality monitoring

**Asbestos** The asbestiform varieties of mineral silicates belonging to the serpentine and amphibole groups of rock-forming minerals, including actinolite, amosite (brown asbestos), anthophyllite, crocidolite (blue asbestos), chrysotile (white), tremolite, or any mixture of these.

**Asbestos-Containing Material (ACM)** For the purpose of these guidelines, these are materials that contain asbestos in an inert bound matrix such as cement or resin. Related to non -friable material greater than 7 x 7 mm.

**Asbestos Fines (AF)** Includes all asbestos or asbestos containing materials, including free fibres, small fibre bundles and fragments and pieces of non-friable material that are smaller than 7 x 7 mm.

**Asbestos Removalist (Licensed)** A removalist registered, licensed or otherwise authorised, under Western Australian State legislation to perform asbestos removal and maintenance work.

**Brownfield Site** Any previously developed land that is not currently in use, whether contaminated or not.

**CS Act** Contaminated Sites Act 2003

**DWER** Department of Water and Environmental Regulation

**DOH** Department of Health (WA)

**DSI** Detailed Site Investigation

**“emu-Bob” or “emu-Pick”** The manual collection or hand-picking usually of visible fragments or pieces of suspect materials using a systematic process of visual inspection across the surface of a site.

**exposure Pathway** The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site.

**f/mL** Fibres per millilitre.

**Fibril** The smallest discrete constituent which can be physically separated from a bundle of asbestos, representing a single microscopic or sub- microscopic crystal.

**Fibrous Asbestos (FA)** Friable asbestos means loose friable material, such as insulation products and other asbestos products that have become severely degraded or damaged such that they have become friable.

**Free Fibres** Mineral fibres released from ACM or other asbestos sources due to deterioration, demolition or disturbance.

**Friable** Material which is crumbled or reduced to powder by hand pressure. Asbestos in this form is especially hazardous due to potential for fibres to become airborne.

**Hardstand Area** An area that is covered by impervious construction material such as asphalt, concrete or brick.

**Hazard** The capacity of an agent to produce a particular type of adverse health or environmental effect, (e.g., asbestos to cause mesothelioma).

**Health Risk Assessment** The process of estimating the potential impact of a chemical, biological, physical or social agent on a specified human population system under a specific set of conditions and for a certain time-frame.

**Memorial on Title (MOT)** A statement registered on the site certificate of title by the Registrar of Titles, Landgate, documenting information relevant to the status of site contamination and relevant restrictions on site use.

**NATA** National Association of Testing Authorities

**NePM** National Environment Protection Measure

**NOA** Naturally Occurring Asbestos

**PM10** Particulate matter with an equivalent aerodynamic diameter of 10 µm or less

**Polarised Light Microscopy (PLM)** Polarised light microscopy with dispersion staining which allows simple optical characterisation of asbestos fibres to 0.2 µm.

**PSI** Preliminary Site Investigation

**Risk** The probability that, in a certain timeframe, an adverse outcome will occur in a person, group of people, plants, animals and/or ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent.

**SAP** Sampling and Analysis Plan

**Sensitive Receptor** Any individual who may be at greater risk than the general public of suffering detrimental effects from exposure to asbestos. Land-uses such as schools and residences where such individuals are located may also be considered sensitive receptors.

**Structure** Includes inter alia any industrial plant, edifice, wall, chimney, or fence.

**Uncontrolled Fill** Any form of fill material located on site, whether resulting from waste disposal, land-scaping practices, or other process, for which the composition cannot be reliably ascertained. This includes construction and demolition material, ‘inert’ waste, and municipal waste.

**Visible/visual** Refers to visible observations made during site inspections and field sampling. The verb “examine” is used in this document to refer to laboratory observations by eye.

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1. Revised guidance materials are under review and will be published together with the final version of these guidelines [↑](#footnote-ref-1)
2. [↑](#footnote-ref-2)
3. asbestos-contaminated dust or debris (ACD) is defined in Model Work Health and Safety Regulations (January 2019) as dust or debris that has settled within a workplace and is, or is assumed to be, contaminated with asbestos. [↑](#footnote-ref-3)
4. May be a licensed asbestos assessor in other jurisdictions [↑](#footnote-ref-4)
5. See glossary [↑](#footnote-ref-5)
6. Term used in Contaminated Sites Guidelines: Identification, reporting and classification of contaminated sites in Western Australia [↑](#footnote-ref-6)
7. Knowledge should include ability to identify asbestos building products and commercial/industrial materials, such as gaskets and seals, textiles, insulation products and coatings, etc. [↑](#footnote-ref-7)
8. The DOH will continue to provide an advisory, as well as regulatory approach to application of the guidelines. An annual half-day workshop is intended to be provided for interested parties, e.g. local government and industry, on the application of these Guidelines. It would be expected that any persons undertaking investigations attend at least once. [↑](#footnote-ref-8)
9. Some items will have supplementary guidance that will be linked into the final document [↑](#footnote-ref-9)
10. See glossary [↑](#footnote-ref-10)
11. Pictures have been compressed for consultation draft. High quality pictures will be available in the final document. [↑](#footnote-ref-11)
12. Currently 0.1% (on the basis that establishment of site specific criteria provides the same level of control of current screening criteria, ie. exposure to airborne asbestos expected to be around reported ambient levels (WHO 2000). Note that consultation for adoption of the Model WHS legislation is currently underway and the 2019 WHS Model Regulation 419 (5) (a) has a specific exception for soil that differs from the determination of contamination as outlined in these guidelines. For further information, or if you wish to make comment, see [https://www.commerce.wa.gov.au/worksafe/review-process-summary-develop-work-health-and-safety-regulations-western-australia](https://www.commerce.wa.gov.au/worksafe/review-process-summary-develop-work-health-and-safety-regulations-western-australia%20) [↑](#footnote-ref-12)
13. Comments invited on the use of modifying factors (<10) may be made for where not all three conditions apply [↑](#footnote-ref-13)
14. Comments invited on use of default values vs professional judgement. [↑](#footnote-ref-14)
15. DOH has allowed SCA “Blue Book” fibre dispersion methodology [↑](#footnote-ref-15)
16. While manufacturing of many building products containing asbestos ended earlier, using 1990 provides a buffer for use of stock and construction time. [↑](#footnote-ref-16)
17. The DoH prefers that a greater amount of time is spent examining a small number samples that are representative of suspect heavier AF concentrations rather than “routine” (i.e. without associate analytical data objectives) submission of a larger number of samples. [↑](#footnote-ref-17)
18. Use appropriate safety precautions. [↑](#footnote-ref-18)
19. The alternate assumption, i.e. that “like” suspect material does not contain asbestos, is not recommended. [↑](#footnote-ref-19)
20. Note: other jurisdictions may have/require licensed asbestos assessors. [↑](#footnote-ref-20)