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29 October 2021

Dear Tracy

Re: Proposed revocation of the recovered fines order and exemption and introduction of the recovered soil order and exemption

Thank you for the opportunity to provide feedback on the NSW EPA's proposed revocation of the recovered fines order and exemption and introduction of the recovered soil order and exemption. The Waste Management and Resource Recovery Association of Australia (WMRR) and the Waste Contractors & Recyclers Association of NSW (WCRA) have developed a joint response on behalf of the construction and demolition (C&D) sector, which is the largest recycling sector in state.

WMRR is the national peak body for all stakeholders in the essential $15 billion waste and resource recovery (WARR) industry. We have more than 2,000 members across the nation – with more than 700 in NSW - involved in the breadth and depth of WARR activities, representing a broad range of business organisations, the three (3) tiers of government, universities, and NGOs. WCRA has been representing the NSW waste management sector since May 1948 and is a registered industrial organisation under both the *NSW Industrial Relations Act* 1996 and the *Fair Work (Registered Organisations) Act* 2009. WCRA currently has 212 members who own, operate and/or control the vast majority of assets used in waste management collection, processing, and disposal across NSW and the ACT. Together, WMRR and WCRA represent industry operators who will be most impacted by the proposed revocation of the order and exemption for recovered fines and the introduction of the proposed recovered soils order.

Industry states at the outset that it is categorically opposed to any revocation of this order given the important role that it plays in ensuring construction material is circulated within the NSW economy and environment, and in doing so, reduces the reliance on virgin material while creating jobs and investment in NSW. Industry is of the strong view that this is a quality assurance issue that can be addressed by the EPA continuing the process commenced in 2020 to improve the applicable specification and testing regime, and does not necessitate the closing of this valuable and essential sector.

By way of background, in 2019-20, the C&D sector in NSW was responsible for processing more than 12.5 million tonnes of materials, about 60% of the total waste generated in NSW, representing the highest landfill diversion rate in the state at 76%. The sector employs more than 580 FTEs for mixed waste recycling, 450 FTEs for source-separated recycling, and approximately 750 truck drivers. Further, the sector has a revenue of approximately $580 million a year representing hundreds of millions of dollars' worth of capital and operational investment in Western Sydney.

WMRR and WCRA acknowledge the ongoing and productive discussions between the EPA and industry that commenced in early 2019, following the EPA review of the material produced under this order. These discussions, which included multiple workshops in 2020 and ongoing work on developing an improved testing regime in 2021, focused on the scope of the existing order and approach, and the overarching regulatory framework. In industry's view, this process was to ensure mixed C&D material and skip bin materials could continue to be recycled at a higher and best use; however, in acknowledging that this order had been in existence since 2014, refinements on aspects such as applicable standards, testing, and equipment were required.

Industry stresses (and this is detailed further in our comprehensive submission) that at no point over the last three (3) years was the sector advised or led to believe that a complete revocation of the order was being considered. In fact, on the contrary, there were clear representations made in workshops with industry - on 23 July 2020 for example - that the recovered fines scope would remain with a refinement of levels based on research and a new specification developed to improve consistency, quality, and benefit of fines.

Industry has been at pains to work with the NSW EPA to address concerns that have been held by both government and industry about the testing and sampling regime under this order. To this end, significant consultation and correspondence occurred between industry and EPA up until late August 2021 in an attempt to improve this regime to the satisfaction of both parties, given the desire by all to provide a high quality material back to market that meets relevant levels and limits. As highlighted in the 29 October 2021 enRiskS report, the ambiguity that exists in the 2014 order is arguably one of the major contributors to the variability of testing across industry.

While industry's full submission and substantiating independent reports can be found attached, there are several key issues that WMRR and WCRA would like to highlight.

1. The proposed revocation will have significant **operational and financial impacts** on both the C&D and construction sectors, as well as community in NSW.

   Independent preliminary analysis has shown that more than 400 jobs will be lost as a result of the revocation, with at least 380 of these being in Western Sydney. Meanwhile, the net costs to the NSW community are expected to be $956 million for mixed C&D waste and $129 million for soil cover over a 10-year period at today's discounted value.

   As construction and renovation sites in NSW are not designed to hold multiple skip bins for source separation of materials on-site, predominantly due to the cost of land, the NSW C&D sector was developed to enable the transfer of mixed skip and C&D material to be transferred from construction and renovation sites to a recycling facility for the material to be source separated and recovered. This system has had economic benefits to-date, including keeping NSW construction costs competitive and growing jobs - predominantly in Western Sydney – as well as hundreds of millions of dollars' worth of investment. The recovered material then loops its way back on to new construction sites as construction and/ or landscaping material, driving circularity in the economy.

   The inability of the construction industry to reuse C&D materials, coupled with having to now pay the landfill levy, will significantly increase residential construction costs (amongst other types of construction) by thousands of dollars per lot, which will put additional strain on Western Sydney communities at a time of soaring property prices and collapsing housing affordability.

2. More than 1.2 million more tonnes of material will be **sent to landfill** every year, which goes against the state's environmental objectives. To put things into perspective, a state-wide roll-out of Food Organics Garden Organics (FOGO) collection will reduce waste to landfill by ~400,000t per annum.

3. The EPA's decision to revoke the order and exemption is based on **data that is flawed** as it appears to rely heavily on data and information that preceded the implementation of the 2019 construction facility guidelines, which drove significant action and investment by industry to improve the quality and consistency of this material.

The C&D industry is keen to continue working with the EPA as we believe there are myriad opportunities and pathways that will enable the sector to continue meeting the regulator's human health and environmental objectives. While the Centre for International Economics (CIE), which industry commissioned to understand the effect of the EPA progressing with the revocation of this order, found that "the response developed by NSW EPA to revoke the recovered fines order is effective, in the sense that it would remove any problems related to the use of recovered fines", it also noted that the revocation is "not proportional in the sense that the costs of doing so far outweigh the expected benefits". The CIE's report – Better Regulation Statement for proposed changes to recovered fines and recovered soils can be found at Appendix A.

Please note that industry also commissioned Environmental Risk Sciences (enRiskS) to undertake a stage one (1) assessment of the use of recovered fines compliant with existing resource recovery orders, consideration of the newly proposed resource recovery order for recovered soil and comparison of the regulation of these materials with other recycled materials which are used for similar purposes. Amongst the key findings, which can be found at Appendix C - Independent Review: Reuse of recovered fines in NSW – Stage 1 - is that a comparison of concentration limits in the various resource recovery orders with guidelines based on the protection of human health and ecosystems shows the limits are quite variable and are similar to, or more conservative than the guidelines protective of human health and ecosystems. Importantly, the assessment found that potential for exposure to any chemicals that may be present in recovered fines or recovered soil is likely to be very low for people or the environment, given the nature of permitted uses (i.e., at depth for engineered fill/earthworks).

It is vital to remember that in the vast majority of instances, this is material from construction sites that is being returned for appropriate use on construction sites. The C&D industry does not produce these materials but processes them for reuse by the construction sector. As noted in enRiskS' report, the impacts on people or the environment of foreign materials in recovered fines or recovered soil are likely to be extremely limited given that these materials are already widely present in the environment (i.e., construction materials in buildings etc.).

Industry is very keen to continue working with the EPA to resolve the EPA's concerns and develop potential solutions, a number of which can be found in our submission attached. A complete revocation of the orders is not only a significantly disproportionate response to challenges that can be dealt with, it will wipe out an entire $580 million/year essential industry and impose significant costs

WASTE CONTRACTORS & RECYCLERS ASSOCIATION OF N.S.W

on an even larger construction sector, all of which will ultimately be detrimental to the community and environment.

Please see attached WMRR's and WCRA's comprehensive submission, which is supported by a number of appendixes including stage one (1) reports by CIE and enRiskS. Please note that these reports do not cover the entire scope of issues industry had intended to capture, given the eight (8)-week consultation timeframe. Industry believes further work must be undertaken and will proceed with stage two (2) studies and analyses over the coming weeks; we would like to do this in partnership with the EPA given the significant impact that this proposal has on both the C&D sector and the NSW construction industry.

WMRR and WCRA members have committed a tremendous amount of time, cost and effort in the production of these reports and submission, and we welcome an opportunity for WMRR and WCRA to present and review the findings in these reports to the EPA.

WMRR and WCRA appreciate the ongoing engagement with the EPA and requests that our submission and the substantiating reports are considered in full ahead of the proposed revocation. Please do not hesitate to contact the undersigned if you would like to further discuss our feedback and findings.

Yours sincerely

Gayle Sloan
CEO
WMRR

Tony Khoury
Executive Director
WCRA

Contents

Introduction

This document forms the response from the Waste Management & Resource Recovery Association (WMRR) and the Waste Contractors & Recyclers Association of NSW (WCRA) on behalf of the Construction and Demolition (C&D) waste management sector, to the New South Wales (NSW) Environment Protection Authority's (EPA) request for submissions on its proposed revocation of the Recovered Fines (Continuous and Batch) Resource Recovery Orders and Exemptions and a draft new Recovered Soils Order.

Background

WMRR is the national peak body for the $15bn waste and resource recovery industry. WMRR membership covers the C&D waste sector along with the entire range of waste and resource recovery industries including landfill, recycling and resource recovery, energy from waste and the e-waste, organics, commercial and industrial, hazardous and biohazardous waste sectors. WMRR has over 2040 members nationally (718 in NSW), representing almost 500 companies.

WCRA has been representing the NSW waste management sector since May 1948. WCRA is a registered industrial organisation under both the *NSW Industrial Relations Act* 1996 and the *Fair Work (Registered Organisations) Act* 2009. WCRA currently has 212 members who, own, operate and/or control the vast majority of assets used in waste management collection, processing and disposal across NSW and the ACT. WCRA has a number of working groups including C&D waste, liquid & hazardous waste, scrap metal recycling, WHS and the ACT group. WCRA's C&D waste group has long enjoyed a great working relationship with WMRR's C&D waste group and this joint submission represents a strong and united industry position on the NSW EPA's proposal.

WMRR and WCRA represent the industry operators most impacted by the proposed revocation of the orders and exemptions for Recovered Fines and the introduction of the proposed Recovered Soils Order. Furthermore, it should be noted that up to eight (8) resource recovery orders and exemptions apply to the sector demonstrating the significant complexity in which they need to navigate compared with other industries. Having associations such as WMRR and WCRA to support and guide them is critical in improving the sector.

Collaboration between WMRR and WCRA to formally respond to State departments, government policy or regulatory changes is usually rare, however, this joint response demonstrates the serious concerns that the whole industry has in relation to the proposed revocation of the orders and exemptions, and the significant impact these changes will have on both association's memberships.

Across both associations, more than 100 organisations will be directly impacted by the revocation of the order and exemption. This includes both large recycling businesses and small to medium enterprises (SMEs) and local government. There are also many smaller businesses that provide skip bin services to residential and commercial building sites across the state. These small-scale operators will be significantly impacted by the proposed changes. The impacted business process approximately 2.85 million tonnes per annum (tpa) of C&D waste and 1.24 million tpa of recovered fines and soils from a range of C&D sources, of varying size, scale and complexity from simple residential renovations through to large civil and commercial infrastructure projects. As a result, the industry is worth around $500 million to the NSW State economy employing 580 FTEs for mixed waste recycling and 450 FTEs for source separated recycling. As many as 380 of these jobs are in western Sydney particularly in areas where high unemployment rates are common, as well as being the area most affected by recent Covid 19 restrictions.

The construction sector in NSW is the fourth largest contributor to NSW GSP at $15 billion, this industry providing an important component of the building and construction supply chain. A particularly critical function during a period of growth within NSW where there has been significant recent development both in infrastructure and in State policy to drive sustainable development and resource recovery. The industry will play a key role in achieving the desired targets and outcomes from the State government's *Waste and Sustainable Materials Strategy (WaSMS)*, the accompanying infrastructure needs analysis and the EPA's draft *Waste Delivery Plan.* Without a fully functioning and viable C&D recycling sector the State government's plans are in jeopardy.

It is WMRR's, WCRA's and their respective members' strong view that the proposed revocation of the order and exemption and the changes that would result from the proposed recovered soils order will significantly reduce recycling of mixed C&D waste, increase landfilling, economically impact the industry and jobs and increase the costs for the building and construction industry (commercial, industrial, infrastructure, residential) and households.

This submission is structured as follows:

- EPA consultation
- Industry background;
- Importance of C&D waste to the circular economy;
- Concerns, issues and implications;
- Implications of the proposed changes;
- The proposed new Recovered Soils Order;
- Alternative solutions for discussion;
- Proposed transition pathway; and
- Conclusion.

EPA Consultation

On 1 May 2019 the EPA wrote to licensed facilities that produced recovered fines under the 2014 resource recovery order seeking data for the period 1 January 2017 to 31 December 2018. This data included the total amount of fines produced, customers and sampling results.

Importantly, the data provided and then analysed by the EPA was for the period prior to the commencement of the *Standards for Managing Construction Waste in NSW* (the Standards) which began on 15 May 2019. Industry worked closely with EPA to finalise these standards which are aimed at implementing appropriate processes and procedures to manage risks associated with receiving contaminants in material delivered to recycling facilities and improve industry and community confidence in the quality of recycled resources recovered from construction and demolition wastes.

In November 2019, the EPA presented the findings from the review of facility data, outlined the results from inspections and sampling that the EPA undertook and provided detail regarding the possible amendments to the order and exemption based on the findings. The EPA concluded that compliance and sampling practices where not robust enough to provide certainty regarding the quality of products produced through the exemptions and orders and that this presented potential risks associated with the land application of recovered fines, including:

- the presence of asbestos;
- the presence of microplastics, chemically treated timbers and synthetic mineral fibres (SMF);

- failure to meet a chemical or attribute limit at least once in the two years of data reviewed;
- failure in an aspect of required testing, and in some instances, failure to meet the testing frequency;
- failure to notify the EPA of non-compliances, and evidence of continued retesting of non-compliant samples; and
- that sampling for recovered fines on a "continuous" basis was inadequate as it did not provide a reliable representation of the waste and the product being supplied to the community.

As a result, the EPA outlined suggestions to improve practices such as introducing asbestos sampling/testing, batch sampling and QA/QC procedures. There was no suggestion or recommendation to revoke, or consider revoking, the orders and exemptions, rather clear representations (via EPA presentations) were made that the orders would continue. During the time the EPA took to undertake its investigation and provide the results, the industry and the EPA developed the Standards which has since improved the management of C&D waste at processing facilities. These improvements are in accordance with several of the EPA's suggestions from the November 2019 presentation to industry.

A series of online workshops, initiated by the NSW EPA and facilitated by Elton Consulting, were held with the C&D industry in 2020. The purpose of Workshop 1, which was held on 19 May 2020 and was attended by 16 industry stakeholders, was to discuss the issues associated with the receival of waste at facilities. The purpose of Workshop 2, which was held on 23 July 2020 and was attended by 12 industry stakeholders, was to discuss improved processing of recovered fines. The third and final workshop, Workshop 3, was held on 15 October 2020 and was attended by 16 industry stakeholders. The purpose of this workshop was to discuss the proposed amendments to the recovered order and exemption.

Prior to Workshop 3, attendees were provided an overview of the draft proposed amendments to the order and exemption, including amendments to:

- The definitions;
- Land application uses;
- The batch/continuous process;
- Sampling and testing; and
- Retesting practices.

At the conclusion of Workshop 3, participants were advised that draft amendments to the recovered fines order and exemption would be presented to industry first before broader consultation. However, almost 12 months later without prior forewarning, on 2 September 2021 the EPA announced that it intends to revoke both the Batch Process and Continuous Process Recovered Fines (skip bin fines) Orders and Exemptions. The EPA agreed to an extension of the short initial period of consultation to the end of October 2021, whereafter it intends at some point to revoke the orders and exemptions.

The industry worked in good faith with the EPA over this period, in particular to develop improved processes for the production and testing/ sampling of recovered fines. The industry is concerned that the EPA intends to revoke the order, at short notice, and with no indication throughout the engagement that it was moving towards this outcome. In fact, the position presented to the industry in workshops by the EPA was that the recovered fines batch order would remain albeit with proposed changes to some of the parameters. Throughout the consultation the focus has been on revising the existing order and ensuring robust and clear processes in place for industry to comply with so that the ambiguity in the current requirements was addressed and requirements were clear. Instead, the EPA now proposes to revoke the recovered fines orders and exemptions without substantiating why this is necessary, how this decision has been reached or what costs and benefits it will have. In the absence of this advice the industry has commissioned its own Better Regulation Statement by the Centre for International Economics (CIE) to assess the impacts of the proposed action and the alternative recovered soils order (**Appendix A**). The better regulation principles are in summary:

Principle 1 – establish the need for government action to only occur where benefits outweigh costs.

Principle 2 – the objective of the government action should be clear.

Principle 3 – impacts should be properly understood, and a range of options considered.

Principle 4 – the government action should be effective and proportional.

Principle 5 – consultation should inform regulatory action.

Principle 6 – simplification and reform should be considered, not just repeal.

Principle 7 – regulation should be periodically reviewed and reformed to improve efficiency and effectiveness.

In our view the EPA has failed to meet the requirements of the NSW government's better regulation principles and we are not aware of specific work the EPA has done to address these principles in forming its proposal to revoke the recovered fines orders and exemptions. This submission and the supporting economic and scientific studies by independent experts attached as appendices here is evidence that the EPA proposed action does not reflect better regulation as amongst other issues, costs clearly outweigh benefits, the action is not proportional, the objectives are unclear and other options have not been properly assessed.

Industry Background

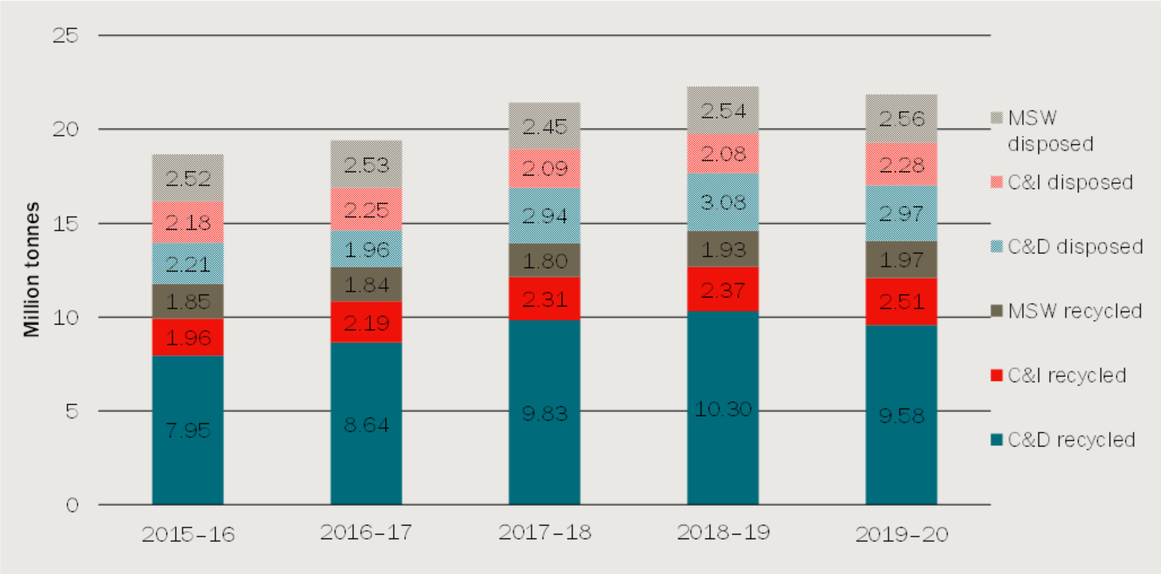
C&D Waste Management

NSW C&D recycling is the largest recycling sector within the NSW recycling industry, with an annual revenue in the order of ~ $500 million per year[1]. The industry employs over 580 full time equivalents (FTEs) for mixed waste recycling and 450 FTEs for source-separated recycling.

Using EPA data, recent years have been characterised by significant increases in the generation of C&D waste from 10.1 million tonnes in 2015/16 to over 13.4 million tonnes in 2018-19, prior to a slight decrease to 12.55 million tonnes in 2019/20 . Significant increases have also been seen in the recycling of C&D waste between 2015/16 and 2018/19, with an increase from 8 million tonnes to 10.3 million tonnes, prior to a slight decrease in 2019/20, while other waste streams remained static (chart 1.1).

[1] CIE 2021, Better Regulation Statement for proposed changes to recovered fines and recovered soils

1.1 Waste recycled and disposed, by waste stream

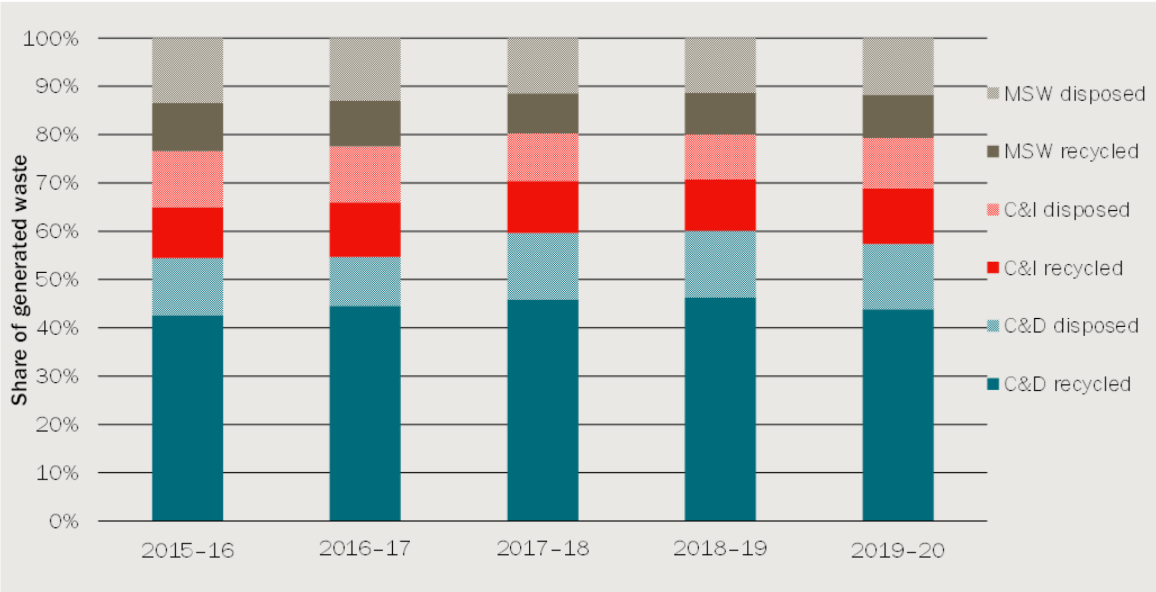


Note: C&D (construction and demolition), C&I (commercial and industrial), MSW (municipal solid waste)

Source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

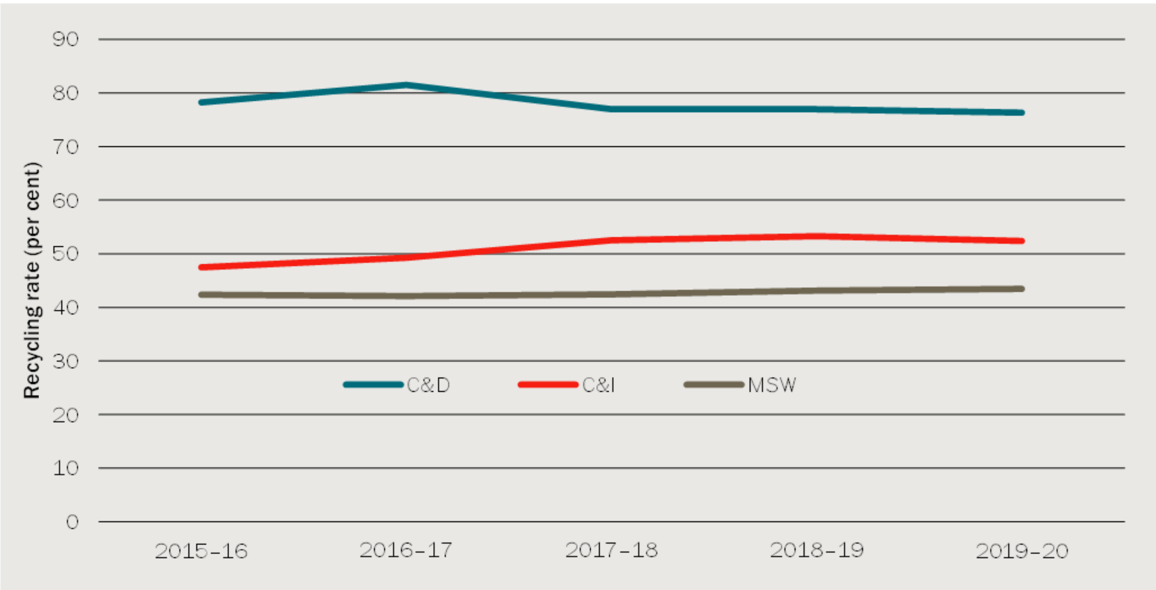
C&D waste accounts for almost 60% of the total waste generated in NSW and has a recovery rate above 75%, the highest recovery rate of all waste streams. This is 24 percentage points and 33 percentage points higher than the C&I and MSW recycling sector, respectively (chart 1.2 and 1.3).

1.2 Share of total annual waste generation



Note: C&D (construction and demolition), C&I (commercial and industrial), MSW (municipal solid waste)
Source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

1.3 Recycling rate, by waste stream



Data source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

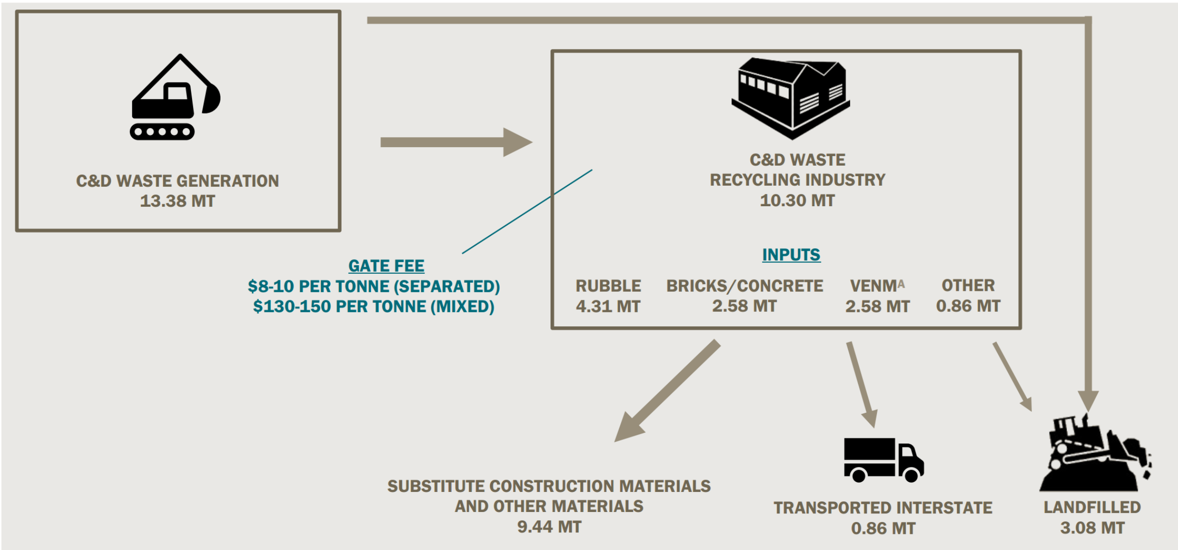
The C&D recycling sector was the only recycling sector close to achieving the NSW EPA targets set out in the previous WARR Strategy and was likely to be the only sector close to achieving the targets of the recently released WaSMS.

The C&D recycling covered within this response is not all C&D recycling, as some materials such as metals will go to other recyclers, and some materials have in the past been sent interstate. The data provided by the C&D recycling industry used in this response equates to approximately 7.4 million tonnes of waste per year, of which:

- 4.5 million tonnes or 61 % is source-separated, and
- 2.9 million tonnes or 39 % is mixed waste.

Industry assessment is that the recovery rates are 99% (source separated) and 80% (mixed waste), for material that is sent to the recycling facilities.

1.4 2018/19 NSW C&D waste industry overview



A Virgin Excavated Natural Material (excavated material surplus from civil construction projects, e.g., tunnel spoil)

Note: MT is mega tonnes; Totals may not sum due to rounding.

Source: National Waste Database 2020, https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data, NSW EPA (2020), Data Quality Statement, https://www.qld.gov.au/__data/assets/pdf_file/0033/129669/recycling-waste-report-2019.pdf

Skip Bins

Mixed C&D waste from construction sites is delivered to processors comes in large part from skip bin collections. It is one of the more challenging C&D waste material streams to manage for recycling. Some operators estimate excavated material and fines make up around 30% of the volume in mixed waste C&D skip bins (Construction & Demolition Waste Status Report Australian Government, 2011). Skip bins are utilised on building projects where there are space constraints and/or time constraints and/or insufficient volumes of different waste streams to justify the investment in multiple bin systems that would be required to source separate all C&D materials on site. This is especially the case for the vast majority of residential building sites. The degree to which source separation of materials within the bin hire industry is currently occurring is difficult to know. However, where there is the space and the facilities to do so, the market and waste levy drive the financial incentives to sort and recover high value materials such as metals, concrete and soils and avoid the cost of landfill disposal.

Supply Chain

Recycling Facilities

C&D waste recycling streams received by processing facilities are generally:

- Mixed waste including demolition materials, building site clean-up waste and skip bin collected waste;
- Source separated concrete, brick, asphalt, timber and plasterboard; and
- Excavated soils and aggregate.

When **C&D mixed waste** material arrives at the processing facility it is generally separated into different material using specialised purpose-built sorting plant and equipment which rely on sorting, shredding, screening and density separation. The aim is to separate the waste into the following:

- Clean masonry fraction to meet the requirements of the Recovered Aggregates Resource Recovery Order;
- Clean soil to meet the Recovered Fines Resource Recovery Order;
- Ferrous and non-ferrous metals to be recycled by others;
- Wood suitable for reuse complying with the Compost or Mulch Resource Recovery Order or as use as alternative fuels in approved facilities;
- Other materials such as plasterboard, garden organics and cardboard for recycling by others;
- Mixed waste for further processing at other facilities or for landfill.

The typical percentage split of material produced from C&D mixed waste recycling process is:

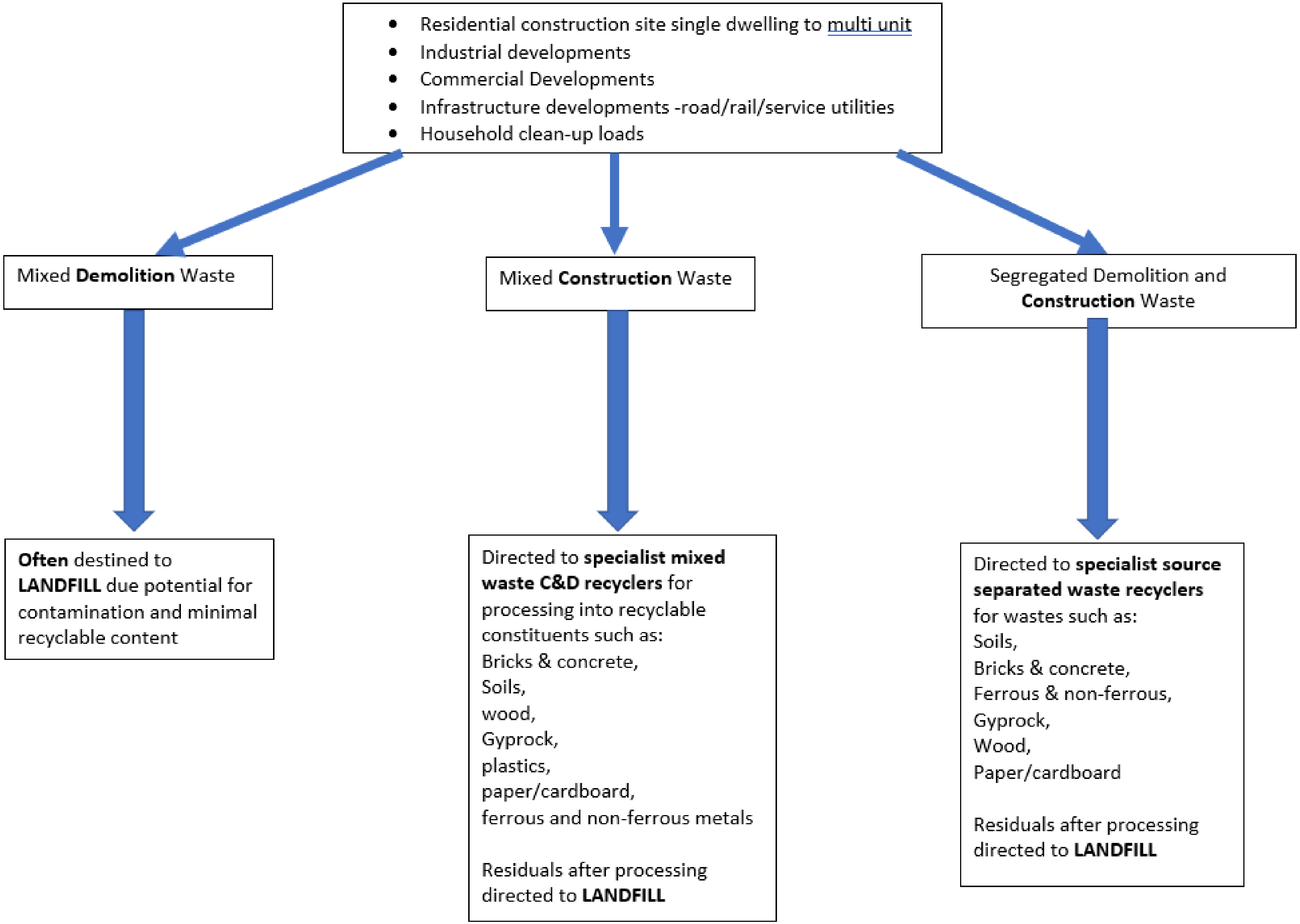
- 35-45% soil;
- 20-30% masonry;
- 10-15% wood;
- 3-5% ferrous and non-ferrous metals;
- 1-2% other; and
- 15-25% residual waste destined for landfill.

Source separated concrete, brick and asphalt material is recycled using crushing and screening equipment and the products produced are manufactured to the relevant Resource Recovery Orders. Ferrous and non-ferrous metal is produced for recycling by others during this process. Only a very small percentage of residual waste is produced when processing source separated concrete and brick (<0.1%).

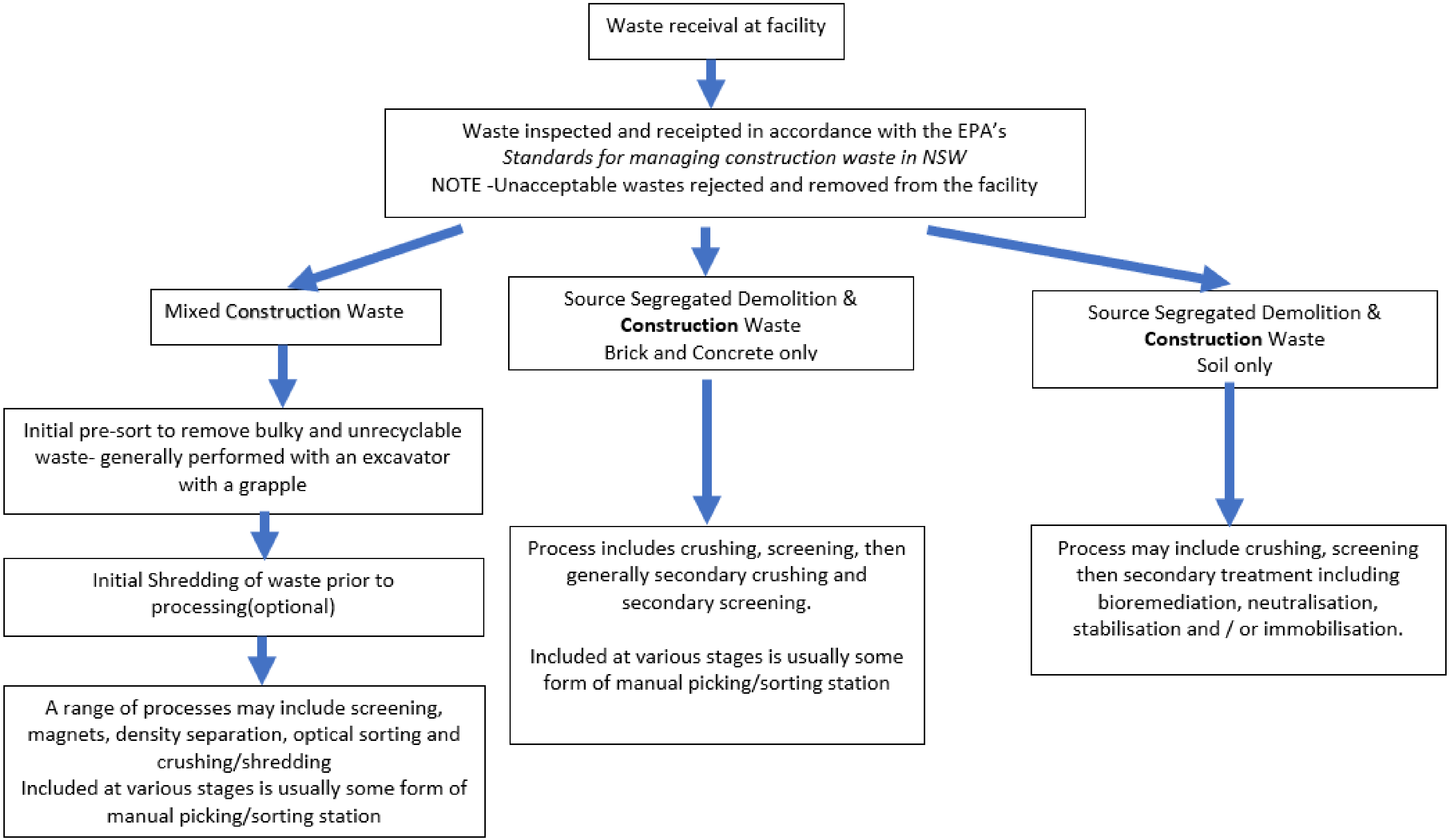
The products produced are used in drainage works, behind retaining walls, electrical trenches, temporary ground cover on building sites, under concrete slabs, pipe backfill and in various landscaping applications. Many products are additionally manufactured to comply with specifications for Transport for NSW, Sydney Water Corporation, electricity supply utilities and local councils and as such are extensively used in road construction.

Excavated soils are typically processed at C&D recycling facilities via screening to produce recovered fines, masonry for subsequent crushing and screening to make recovered aggregates, and residual waste. Products include turf underlay, gardening mix, road base, engineered fill and void remediation for quarries and landfill sites.

The existing typical C&D recycling waste flows from waste generating sites to C&D recycling facilities is shown in the following figure along with the typical recycling process flows within recycling facilities themselves.



Residential construction site single dwelling to multi unit
Industrial developments
Commercial Developments
Infrastructure developments -road/rail/service utilities
Household clean-up loads
Mixed Demolition Waste
Mixed Construction Waste
Segregated Demolition and Construction Waste
Often destined to LANDFILL due potential for contamination and minimal recyclable content
Directed to specialist mixed waste C&D recyclers for processing into recyclable constituents such as:
Bricks & concrete,
Soils,
wood,
Gyprock,
plastics,
paper/cardboard,
ferrous and non-ferrous metals
Residuals after processing directed to LANDFILL
Directed to specialist source separated waste recyclers for wastes such as:
Soils,
Bricks & concrete,
Ferrous & non-ferrous,
Gyprock,
Wood,
Paper/cardboard
Residuals after processing directed to LANDFILL


Waste receival at facility
Waste inspected and receipted in accordance with the EPA's
Standards for managing construction waste in NSW
NOTE -Unacceptable wastes rejected and removed from the facility
Mixed Construction Waste
Source Segregated Demolition & **Construction** Waste
Brick and Concrete only
Source Segregated Demolition & **Construction** Waste
Soil only
Initial pre-sort to remove bulky and unrecyclable waste- generally performed with an excavator with a grapple
Initial Shredding of waste prior to processing(optional)
A range of processes may include screening, magnets, density separation, optical sorting and crushing/shredding
Included at various stages is usually some form of manual picking/sorting station
Process includes crushing, screening, then generally secondary crushing and secondary screening.
Included at various stages is usually some form of manual picking/sorting station
Process may include crushing, screening then secondary treatment including bioremediation, neutralisation, stabilisation and / or immobilisation.

Products
Products from C&D waste processing facilities include:

- Crushed brick and/or concrete aggregates – used mainly for drainage type applications as well as temporary and access surfaces replacing virgin quarry products;
- Crushed brick and/or concrete sands and road bases – used for pipe laying backfill, bedding sands, paving bases and road construction sub-base and base course layers replacing virgin quarry products; and
- Treated contaminated soils for use as engineering fill.

Products from Mixed C&D waste processing facilities include:

- Soils/fines for use as turf underlay, subbase or fill;
- Timber for mulch and composting;
- Timber for alternate fuel (WWDF);
- Processed engineered fuels (RDF);
- Masonry for further processing by crushing into sands and aggregates as per the Segregated waste stream above;
- Gyprock for soil amendments; and
- Metals for further reprocessing.

Recovered Fines Sector

Material that is processed under the Recovered Fines Order, or that would be impacted by the proposed Recovered Soils Order includes:

- the fine material that is one output from mixed C&D recycling facilities, such as soil and sand substitute material;
- bulk excavated soils that require some processing and hence are not classified as excavated natural material, and which are being processed under the recovered fines orders currently; and
- contaminated/hazardous soils that are processed under site specific arrangements, which would likely be aligned to the proposed recovered soils order.

We note the EPA estimates that 1.2 million tonnes of recovered fines were processed in 2017/18. Based on previous data provided to the CIE by industry, waste facilities processed 2.9 million tonnes of C&D waste material. Through consultation with major mixed waste processors CIE estimates that recovered fines comprise 31% of input material on average, which results in the production of approximately 900,000 tonnes of recovered fines.

The quantity of soils processed under the recovered fines order is harder to determine, as some soil does not need to be processed, therefore is classified as Excavated Natural Material (ENM). It is estimated that 300,000 tonnes of soil are currently processed under the recovered fines order and a further 25,000 tonnes of contaminated soils is processed under site specific arrangements.

The ability to receive this material from construction sites across NSW and make recycled products for use in construction and landscaping is an important practice that has been integral to managing Sydney's construction costs and reduce reliance on diminishing scarce virgin materials (such as topsoil) in NSW. It has also enabled recovery rates within the C&D sector to remain at over 75% in NSW.

Typically, recovered fines from the processing of mixed C&D waste and soil are used in applications by the processor or sold to retailers by the processor. Recovered fines are primarily used in the following applications:

- Turf underlay: this is the most common application of recovered fines. Turf underlay consisting of recovered fines is typically marketed as a lower-cost form of underlay.
- Road base: Combined with recovered aggregates to form a road base. This requires specific particle size mixes.
- Gardening mix: gardening mix is a less common application for recovered fines, and typically only where the level of chemical contamination and inclusions is relatively low. Gardening mix can be used for growing plants other than turf, such as in garden beds.
- Engineered fill: an uncommon application for recovered fines due to the potential compactability of timber and other inclusions.
- Quarry and other void remediation: rehabilitation of former quarry or landfill sites can make use of recovered fines as a fill.

Importance of C&D Waste to the circular economy

C&D waste, and the industry that processes it, play a significant role in the circular economy.

Substitute for Virgin Materials

Materials produced by the C&D waste recycling industry provide substitutes for extracted materials through the reuse of for example, tunnel and basement excavation spoil and recycled aggregate, concrete, bricks and tiles. In a report commissioned by the then NSW Department of Planning and Environment, *Construction materials for Sydney Region* (April 2019) these substitute construction materials are estimated to meet 46% of the industry's demand for sand and crushed rock products for subbase, road base and engineered fill. In 2018 the total demand in the Greater Sydney Region for construction related materials was 36.2Mt. Of this total, extractive materials equalled 19.5Mt and substitute materials equalled 16.7Mt. The report also predicted a continuation of the rising demand (36% from 2012-2018) for these materials due to increased demand in all sectors – housing, non-residential buildings, roads and other infrastructure. The majority of extractive sites are located outside the Sydney Region (all crushed rock and two thirds of sand facilities). In 2018 there were on average nearly 2,000 truckloads of extracted materials delivered in Sydney every day. The forecasted demand for substitute construction materials over 2018-2036 was 326Mt.

There is no reason to suggest that the demand trend will not continue and most likely increase, especially with post Covid 19 government stimulus and the State's infrastructure program. A significant consequence of the proposed revocation will be the unavailability of some substitute construction materials and the resulting shortfall leading to the need for further extraction of natural materials. This will be compounded by the increased truck movement from outside the greater Sydney region. There are also likely to be significant increases in cost for these materials due to scarcity, as well as the higher production and transportation costs from outside Sydney.

Economy

The annual revenue based on the data for source separated and mixed C&D processing facilities, i.e., only the recycling operations and not the collections/transport component of the value chain, is ~$500 million per year. This covers less material volumes than data on C&D published by NSW EPA, as EPA figures include virgin excavated natural material (VENM) and some C&D recycling would go to other facilities (such as metal recyclers or interstate).

The continued production of recovered fines is integral not only to the viability of the C&D recycling sector, but also the construction sector in NSW, which currently generates over $15 billion a year for the NSW economy.

Markets

The C&D recycling sector produces a suite of products for varying applications and as such has several markets for product sale and utilisation. The key markets include:

- Construction industry where recycled C&D materials are used for:
  - drainage;
  - temporary and access surfaces;
  - pipe laying backfill;
  - bedding sands;
  - paving bases;
  - road construction sub-base and base course layers; and
  - engineering fill.
- Landscaping industry where recovered fines are predominately used for turf underlay but also some of the above;
- Organics recycling industry providing timber for mulch and composting;
- Energy production industry:
  - Timber for substitute or supplementary fuel
  - Processed engineered fuels such as Refuse Derived Fuels
- Metals recycling industry;
- Retail landscape industry; and
- Horticulture industry via recycled gyprock for soil amendments.

In particular, the C&D recycled products are utilised by the construction industry as a substitute for virgin materials in road construction and subbase. As previously outlined, 16.7Mt of substitute construction materials were utilised by the construction industry in 2018. Of this 85% was utilised in road construction and major infrastructure projects. The Tier 1 contractors who construct NSW's major road networks and large infrastructure are, and will continue to be, a major market for the C&D recycling industry. Without cheaper substitute construction products from the C&D recycling industry located in closer proximity to the construction itself (as opposed to more distant mines and quarries), these large civil and infrastructure projects would cost more, take longer to construct and result in increased costs to the community.

Recycling Rates and Landfill Diversion Targets

The C&D recycling sector processes almost 60% of the total waste generated in NSW with a recycling rate of 76%. This demonstrates the importance of the industry in achieving the State government's 10 year diversion target of 80% for all waste streams (as outlined below), when both MSW (46%) and C&I (56%) waste diversion lag significantly behind C&D waste recycling.

Source: NSW Waste and Sustainable Materials Strategy 2041

By reducing the ability of the C&D recycling industry to achieve higher diversion targets through the revocation of the recovered fines orders and exemptions, it is highly unlikely the diversion targets will be achieved. In fact, CIE has predicted the following outcomes:

- C&D mixed waste recovery rate will fall from 75% to 38%
- C&D waste recovery rate will fall from 76% to 65%
- The state-wide recovery rate will fall from 64% to 58%

To put the size of the impact in perspective, the initiatives and programmes proposed to achieve the state-wide reduction in Food Organics and Garden Organics (FOGO) being disposed to landfill are expected to recover around 400,000 tpa of organics. This diversion from landfill will be more than offset by increased C&D waste being disposed to landfill, which will be over 1 million tpa.

Concerns, Issues and Implications

Timing

Usefulness of Data Sources

The EPA intends to revoke the recovered fines orders and exemptions due to its concerns about compliance with the orders, sampling practices, contaminants in process outputs and concerns that the material presents a risk. Whilst the industry accepts that non-compliance has occurred, the EPA's investigation predated the introduction of the Standards and commensurate industry performance improvements and therefore is not an accurate assessment of current industry performance or the products it produces. Further, the risk has not been properly communicated by the EPA (See Risk section below).

There have been several process changes made by C&D recycling facilities since the introduction of the Standards. These include:

- A significant increase in receival inspection procedures resulting from the introduction of the Standards;
- The Standards have resulted in better source site controls due to non-compliant loads being rejected at receival facilities; and
- Facilities have also increased their processing equipment investment resulting in a better-quality recycled product produced for market.

The industry has implemented significant improvements in operations and infrastructure therefore, data utilised by the EPA to facilitate its decision to revoke the recovered fines orders and exemptions is based on outdated information and is not representative of the current practices of C&D recycling facilities.

Announcement and allocated time for response

The industry's view is that the timing of the announcement and allocated time for response is unreasonable. The EPA has been reviewing the performance of the orders for 2.5 years and has given the industry eight (8) weeks to respond. We note that this is in contrast to the consultation period (many months) and engagement with the Alternative Waste Treatment (AWT) industry and local government on the alternatives to producing Mixed Waste Organic Outputs (MWOO) and a transitional support package following the revocation of that order and exemption.

The C&D waste industry has been engaging with the EPA in good faith and doing the work necessary to better understand the issues through quantitative analysis and assessment. For example, we have commissioned a number of reports including:

- Better Regulation Statement for proposed changes to recovered fines and recovered soils – Stage 1, The Centre for International Economics (CIE) (October 2021);
- Independent review: Reuse of recovered fines in NSW – Stage 1, Environmental Risks Sciences (EnRiskS) (October 2021);
- Economic and community impacts of asbestos regulations for construction and demolition recycling - The Centre for International Economics (CIE) (May 2021); and
- Independent review: Asbestos in Construction and Demolition Recycling (Prepared for: Beatty Legal Pty Limited) – Environmental Risks Sciences (EnRiskS) (October 2020).

As well as actively engaging developing solutions for a more effective regulatory approach:

- Proposed an alternative waste classification approach;
- Developed a guideline for unexplained asbestos finds;
- Engaged in workshops with the EPA and separately across the industry; and
- Contributed to actions arising from those workshops.

See Appendices and Additional Documents for the full list.

We have previously asked the EPA to await finalisation of some of the more recent reports commissioned by the industry so that any subsequent decision is informed by proper assessment of impacts, costs, benefits and potential alternatives. Deferring a decision until the end of the year in order to properly consider these reports and their robust analyses will not have an immediate or detrimental effect, especially given the time it has taken to get to this point and will provide the time necessary to more clearly understand the problem and develop practical alternative approaches that will be less impactful on the C&D waste management industry and the building and construction industry whilst maintaining an essential service. It will also provide the necessary time for the second stage of this work and we are open to doing this in partnership with the EPA.

We also note the stated intention of the EPA to review the resource recovery orders and exemptions framework over the next two (2) years. Revoking the recovered fines orders and implementing a new recovered soils order would be very premature in this context. Industry agrees the framework is overdue for a root and branch review as it is cumbersome and not meeting its intended purpose i.e., to beneficially reuse waste within a circular economy whilst being protective of human health and the environment.

***Summary Statement:* The EPA investigation predated the introduction of the *Standards for managing construction waste in NSW*. The industry has significantly invested in technology and equipment, changed practices and improved performance. Information used by the EPA on which to base its proposed revocation of the orders is outdated and not representative of current controls, practices and results. Given the stated EPA intention to review the resource recovery framework, it is premature to revoke the recovered fines orders and exemptions now.**

Economic Impact

The industry is of the view that revocation of the orders is both unnecessary and premature and will have a devastating effect on the industry and jobs, especially in western Sydney and other high unemployment areas It will also result in increased costs of $956 million for mixed C&D and $129 million for soil over 10 years to the building and construction sector and households (e.g. due to costs associated with landfill disposal and sourcing alternative products), undermine recycling rates and increase disposal to landfill. Given increased costs to waste generators it is likely to also see an increase in illegal dumping and its attendant environmental impacts and costs to the state and local government to clean up. The economic impact of the proposed changes are details in the table below:

Item	Mixed C&D waste, discounted	Soil, discounted
	$m, present value	$m, present value
NSW Government (waste levy)	1 053	344
C&D recyclers (lost producer surplus)	- 459	- 35
Construction businesses, demolition	-1 378	- 402
Material users	- 125	- 35
Environment/community	- 46	0
Total	**- 956**	**- 129**

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

The above estimates are based on central case assumptions detailed in the CIE Better Regulation Statement (**Appendix A**).

- benefits to the NSW Government of $1,045 million in additional waste levy revenue;
- costs to mixed waste C&D recyclers of $445 million which includes $270 million related to existing stockpiles if transition is undertaken rapidly, This could be avoided with a long transition. It includes a loss of return on facilities and equipment developed to process mixed C&D waste;
- costs to the construction sector of $1,378 million for increased waste costs;
- cost to users of recycled materials of $125 million for higher material costs; and
- costs to the community of $46 million related to the part of waste that is anticipated to be transported to Queensland for processing (including GHG and air emissions, accidents and congestion).

Based on discussions with members of the skip bin industry, the revocation will likely result in a modification to the manner in which skip bin charges are calculated. Charges are currently based on a cubic metre (m^3) basis on the assumption that a portion of the material will be recovered. In order to adequately cover disposal charges, skip bin operators are considering the implementation of a two-stage charging system which includes an initial charge for the bin and transport, and a subsequent charge for disposal, based on actual weight. This will require equipment changes. The industry calculates the cost of retrofitting scales to collection vehicles to be around $7,000 per vehicle. There are an estimated 750 number vehicles involved in skip bin services.

The implementation of weight based charging will significantly and directly impact householders undertaking single home construction and renovations. The industry estimates a 160% increase to the cost of disposing building and construction waste for the average new home build. Due to increases in gate fees and waste levy charges the cost of waste disposal from these types of projects will increase from $1,500 to $3,900 per standard skip bin (refer to **Appendix B**).

The viability of recycling mixed C&D wastes will become unprofitable due to the EPA's proposed changes. This will result in the loss of jobs predominantly in Western Sydney, estimated to be 398. An additional 102 jobs are forecast to be lost across the balance of Greater Sydney, resulting in a total loss of 500 jobs. This is a very poor outcome both in terms of recycling and the economy for NSW and the construction industry.

***Summary Statement:* The revocation of the recovered fines orders and exemptions will have a devastating impact of the C&D waste recycling industry and lead to the loss of 500 jobs. Costs for the building and construction sector and households will increase $956 million for mixed C&D waste and $129 million for soils over 10 years, recycling rates will be undermined, and illegal dumping will increase. The proposed changes will also have a direct effect on costs for new single home builds for households, increasing the average skip bin waste disposal charge by 160%.**

Recycling Rates and Landfill Diversion

NSW has adopted the National Waste Policy Action Plan targets of reducing total waste generated by 10% per person by 2030 and an 80% average recovery rate from all waste streams by 2030. Further to this NSW has an interim target of 80% for C&D waste by 2020 (currently 76%). The revocation of the Recovered Fines orders would seriously undermine the ability to reach these targets and the outcomes would be detrimental to the stated aims and objectives of the recently released *NSW Government Waste and Sustainable Materials Strategy* and proposed *NSW EPA Waste Delivery Plan*. Revoking these orders will effectively diminish NSW's ability to reach the resource recovery targets the government has adopted and before the intended upstream changes to waste generation that will improve the quality and quantity of waste have been introduced. The industry estimates (CIE 2021) that the changes proposed by the EPA will result in

- The resource recovery targets in the recently released *NSW Waste and Sustainable Materials Strategy 2041* will not be met due to a:
    - reduction in the mixed C&D waste recycling rate from 75% to 38%;
    - reduction in the C&D recycling rate from 76% to 65%; and
    - reduction in the overall NSW recycling rate from 64% to 58% – the target is 80 per cent

In other words, the NSW government targets will not be achieved as a direct result of the proposed revocation of the recovered fines orders.

There are a number of new proposed NSW facilities for C&D recycling. These facilities are being approved by councils, DPIE & EPA with conditions that demand recycling rates of ~90%. The revocation of the Recovered Fines Orders will make it impossible for these facilities to comply.

The revocation will also lead to an increase in material disposed to NSW landfills of ~one (1) million tonnes per year. This is in addition to current C&D landfilling of three (3) million tonnes per year in NSW. This is more than twice the tonnes that could be diverted from landfill by rolling out FOGO to households and targeted businesses across NSW. In other words, the efforts to reduce organics disposal will be completely offset by the increase in C&D waste disposal.

Summary Statement: The NSW government targets for resource recovery will not be achieved as a direct result of the proposed revocation of the recovered fines order.

Landfill Capacity

Across NSW, three (3) million tonnes of C&D material is landfilled each year. The EPA's proposed regulatory change would lead to approximately one (1) million additional tonnes of C&D material being landfilled each year This will stretch greater Sydney landfill capacity, which is expected to be reached currently in 2028, and would instead by reached in ~2026. This would increase the risk that new capacity could not be planned and delivered in time, and new capacity would likely be more distant and at higher cost. The increasing scarcity of landfill space will drive up disposal costs, and consequently apply further pressure to more distant landfills, increasing transportation costs and the environmental and social impacts associated with more vehicles on the road for longer distances.

In addition, without the ability to beneficially reuse recovered fines, the viability of recycling mixed C&D wastes is unprofitable. As mentioned above, will result in the loss of jobs predominantly in Western Sydney, estimated to be 398. An additional 102 jobs are forecast to be lost across the balance of Greater Sydney, resulting in a total loss of 500 jobs. This is a very poor outcome both in terms of recycling and the economy for NSW and the construction industry.

Summary Statement: The proposed revocation will result in an estimated additional 1 million tonnes of C&D material landfilled each year and estimated total job loss of 500 and an estimated 398 in Western Sydney.

Illegal Dumping

The increase in gate fees for the disposal of C&D waste associated with the revocation will likely result in an increase in illegal dumping.

In a 2007 study[2], MMA and BDA Group undertook an empirical analysis of illegal dumping in the state of South Australia drawing on a Local Government Association baseline study of illegal dumping incidents. It was estimated that the extent of illegal dumping was sensitive to legal disposal costs, with a cross-price elasticity of around 2. That is, if the price of legal disposal increased by 50 per cent (minimum increase expected for mixed C&D waste), the amount of illegal dumping would double.

MMA and BDA also found that total illegal dumping volume was about one (1) per cent of the landfill amount, and about 10 per cent was C&D waste. If this was similar in NSW, this would imply ~8,000 tonnes more illegal dumping would occur in NSW. Note that it may be higher in NSW given the much higher landfill disposal fees than South Australia and the higher rates of building and infrastructure development currently occurring and planned for the future.

Summary Statement:

Due to increased disposal costs, it is estimated that at least an additional 8,000 tonnes of C&D waste will be illegal dumped in NSW adding costs for state agencies and local government for clean-up and undermining the gains made through Regional Illegal Dumping Squad activities and the EPA's Waste Crime Taskforce in deterring such practices.

Defunct Investment

To implement the Standards the industry has invested in new technology and infrastructure for example smaller screen sizes to produce a finer product and dedicated sorting plants. Improvements have also been made to control systems for load assessments and employee training on asbestos awareness and identification in order to improve the detection of contaminates in material received at processing facilities and undertake actions to address it. The industry has invested around $37

[2] MMA and BDA 2007, *South Australia's Waste Strategy 2005-10: Ex-ante Benefit Cost Assessment*,

million in capital expenditure over the last two (2) years alone to improve performance and achieve the new Standards. These are now sunk costs that cannot be realised if the proposed changes go ahead, and the investment will go to waste if the industry collapses.

Further, many facility operators have invested large amounts of capital based on the existing Resource Recovery Orders and Exemptions, only to have the EPA now propose to move the goal posts. For example, one (1) major company has invested $30 million dollars on a dedicated mixed C&D waste processing facility designed to meet the current recovered fines orders. This entire facility is now in jeopardy. This undermines industry confidence and the incentive to invest in recycling infrastructure in NSW will substantially reduce. This is also counter to the NSW government's stated intention of increasing investment in waste and recycling infrastructure.

Summary Statement: **The industry has in good faith undertaken significant investment in technology, equipment, systems and staff skilling to improve performance and meet the new Standards and the requirements that apply under the current recovered fines orders and exemptions. This investment will still have to be paid for and there is a real likelihood of stranded assets as a result of the proposal to revoke the orders.**

Education and Source Separation

By its proposed action to revoke the resource recovery orders the EPA appears to be addressing its concerns about recovered fines at the wrong point.

Contamination levels in C&D waste that affects processing operators and recycled products is a supply chain issue that needs to be addressed by the construction industry and households. There is a clear role and responsibility for government and the EPA to educate the sector and the community to improve behaviours. It is analogous to organics where government has mandated source separation for householders and some businesses to ensure best practice removal of contaminants and beneficial reuse of a resource. Government is supporting these changes through legislation, education and financial support to reduce contamination, increase reuse of valuable resources and avoid landfilling. A similar approach is needed to improve resource recovery in C&D waste. Given the stated intention to review the resource recovery framework it is important to look at the whole supply chain from waste generation, through processing to end use of recycled materials and a targeted well designed education campaign about the benefits of source separation and contamination reduction, is critical to the review and achieving better environmental and circular economy outcomes.

Summary Statement: **The entire supply chain for recovered mixed C&D waste needs to be the starting point for a review of resource recovery in NSW. Similar to the FOGO initiatives, Government and the EPA have a critical role to play to educate the building sector and households about the value and importance of source separation and contamination reduction of wastes.**

Site Specific Orders

The proposed revocation of the general recovered fines orders and replacing them with more stringent site-specific orders is unlikely to achieve the outcomes the EPA is seeking. The changes will mean most facility operators will not go down this path due to the time and costs involved, and the investment uncertainty that it will create for financing. Even so, some operators may still apply and this will place pressure and resource costs on the EPA to assess them in a timely manner. Something that does not occur currently. Moreover, it seems illogical to require individual site-specific orders and exemptions for what is a standard industry wide activity with known waste streams, similar processing operations and similar output products. A process and products that is exactly of the type a general order would apply to. The lack of transparency into what order is approved for what site also leads to concerns about the regulator intervening in the operations of the market and undermining certainty and creating an uneven playing field, not only for the resource recovery industry but also the construction industry.

Further the scope of the site specific order proposed, precludes skip bin or mixed C&D materials being used, which as mentioned throughout this report is a common and integral practice on construction sites. This means that under the proposed order there will be significant volumes of material that can be recovered and used, being required by the NSW EPA to be landfilled.

Please note that if the site-specific orders were required, then a key consideration would be the impact on competition. The NSW Government's position as stated in the Competition Principles Agreement (which all states and territories have signed up to) is that regulation should not restrict competition unless it can be demonstrated:[3]

- the benefits of the restriction outweigh the costs, and
- the objectives of the legislation can only be achieved by restricting competition.

Further, the NSW Government has separate guidance on assessing regulation against the competition test and has signed up to the Intergovernmental Agreement on Competition and Productivity – Enhancing Reforms which both state that competition should not be restricted unless it can be demonstrated the benefits of a restriction outweigh the costs.[4],[5]

The EPA's site specific option would impose a risk of anti-competitive impacts, and market distortion. Further there are no appeal rights for resource recovery orders meaning arbitrary and impactful decisions can be made by the regulator with severe repercussions on operators with no ability to test or redress this.

The application of site-specific orders will also reduce the level of investment in infrastructure and innovation within the industry. This is due to the lack of permanency or longevity of the site-specific of the orders and the 'bankability' of the uncertainty of this approach and limitations this brings to securing finance.

Summary Statement: **The EPA's suggested alternative of operators applying for site specific orders to treat a reduced amount of C&D waste is counter to its own approach to general resource recovery orders. These are known waste streams, undergoing similar processing steps and leading to similar products produced for reuse. A site specific order approach lacks transparency, creates an unlevel playing field, distorts the market and undermines cost competitiveness without any appeal rights.**

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[3] NSW Government 2019, NSW Government Guide to Better Regulation, NSW Treasury, November, pp. 13-14, https://www.treasury.nsw.gov.au/sites/default/files/2019-01/TPP19-01%20-%20Guide%20to%20Better%20Regulation.pdf

[4] NSW Government 2017, Assessment Against the Competition Test, April, Department of Finance Services & Innovation, p. 7 https://www.productivity.nsw.gov.au/sites/default/files/2018-05/Assessment_Against_the_Competition_Test-April_2017_1.pdf

[5] Intergovernmental agreement on competition and productivity – Enhancing reforms 2016.

Regulatory Framework

Under NSW waste regulations resource recover orders and exemptions can be applied to certain wastes for their beneficial reuse as long as it is:

- genuine and not another means of disposal;
- fit for purpose; and
- will not cause harm to human health or the environment.

There are currently eight (8) resource recovery orders and exemptions that in some part relate to the use of recycled materials for building, landscaping, construction and infrastructure. The recovered fines order and exemptions set the requirements and controls for the processing and use of soil, subbase and fill products that are produced from mixed building and construction waste. Waste processing facilities primarily sell recovered fines to suppliers of such materials who then on-sell for landscaping or construction purposes. In practice, the NSW framework is particularly focussed on controlling the recycling process rather than the circumstances and context within which the end product is intended to be used.

In contrast to NSW, other leading jurisdictions take a risk-based approach that has a greater focus on outcomes rather than process. For example, both Victoria and South Australia have regulatory frameworks that are cognisant of the end use for recycled products and have systems designed to facilitate safe use of recycled materials. Their systems define the material as fill or recycled aggregate and whilst protecting human health and the environment also facilitate the use of a valuable resource, recognising the actual use of this material and the risk involved.

In Victoria fill material is defined in regulations and an authority is provided to use the material in certain settings provided it meets specified contamination limits. Also, a general environmental duty applies to all Victorians requiring the reduction of risk of harm from activities. In South Australia waste from building and construction activities is classified as *clean fill* (includes soils, processed C&D waste and industrial residue) or *intermediate waste soil* used for construction fill purposes.

Summary Statement: The NSW resource recovery framework and the way it is applied by the EPA does not take a proportionate approach to risk as applied in other leading jurisdictions and is overly focussed on process not beneficial recycling outcomes.

EPA Sampling/Testing

The industry is concerned that the EPA's evidence base for this decision is predicated largely on the results of an investigation that has used 2017- 2018 data and site sampling that occurred in October 2019, and that this analysis does not take into consideration the implementation of the Standards and associated investment by facilities from 2019 onwards. The industry has been diligently applying the Standards since they were introduced. The Standards were intended to improve the management of C&D waste at processing facilities and assist with the identification of contaminants of concern, especially Asbestos Containing Material (ACM).

The fine material resulting from the processing of mixed C&D waste will be highly variable given the variability of the inputs. On any given day the material received at processing facilities may have more or less fine soil, small pieces of concrete, plaster and paper.

As the EPA's investigation and sampling predates this improvement in practices, processes and products the industry requests that at a minimum the investigation and sampling is redone before any decision to revoke the orders is made.

Further, as evidenced by the work that was undertaken by industry in consultation with NSW EPA between October 2020 and August 2021, which is also reaffirmed by the EnRiskS 2021 report (**Appendix C**), there is significant ambiguity around the testing and sampling regime that is contained within the current Orders. This includes what is meant by continuous, batch, when re-tests and notification occurs. Industry has demonstrated its genuine commitment in working with the EPA to reach an agreed and satisfactory outcome and we wish for this process to be recommenced. EnRiskS has concluded that the variability in compliance by facilities that the EPA found in its investigation is reflective of the lack of clarity and purpose in the orders, in particular:

- the context for the chemical and physical contaminant limits
- how these limits fit with other regulatory requirements and guidance for example, contaminated sites assessment and other resource recovery orders and exemptions that apply to the C&D waste recycling industry
- how limits were determined and what they are aiming to be protective of
- the lack of connection to and consideration of background levels for key contaminants
- lack of clarity around definitions, for example what is meant by batch process and sampling requirements (densities and methods)

Further as part of this submission we have included a proposal for batch testing, that includes independent testing (**Appendix D**).

Concentration Limits

The industry is unsure what problem the EPA is addressing with the proposed revocation. Our view is that the contamination levels can be and are most often met. Comparisons with the NEPM HIL-A levels (the most stringent) and which are designed to be protective of human health suggests that current contamination levels are not likely to result in significant harm to human health. There are rarely any contaminants in the products that exceed the maximum levels. Thresholds in the proposed recovered soils order are more stringent for almost all contaminants in the existing recovered fines orders, which in turn are stricter than NEPM HIL-A levels. Further, perceived impacts of plastic or other foreign materials entering the environment are not likely given the product's use, incorporation into the soil and lack of opportunity to mobilise given it is mostly subbase and appropriately covered.

EnRiskS has found that for chemical contaminants the limits currently applied to recovered fines and proposed for recovered soils are the same or much lower than the limits applied to:

- backyard soils in contaminated land assessments
- composts, soil conditioners and mulches
- excavated natural material and recovered aggregates
- wastes for disposal to landfills where there is limited engineering

It is noted that in particular the chemical contamination limits applied to contaminated sites assessments are specifically calculated to consider exposure to people who would come into daily contact with the materials during gardening and growing produce as well as for ecosystem impacts.

The evaluation of potential exposure pathways indicates that for all uses of recovered fines materials:

- exposure to people is likely to be limited
- exposure to aquatic organisms is likely to be limited
- exposure to terrestrial organisms is possible but likely to be limited especially if these materials are place at depth

Further it is important to consider background levels when setting limits for chemical such as lead and Benzo(a)pyrene to ensure they are reasonable and achievable. For example, lead will be present in C&D waste because it naturally occurs in soil and rocks, is present in historical fill materials, has historically been deposited from motor vehicle air emissions and chips of paint from demolition materials. This is especially so in urban areas of Sydney. C&D waste that arrives for processing at recycling facilities reflects the built form, location and environment that it is recovered from.

Summary Statement: The EPAs decision to revoke the order is based on data from October 2019. Industry has made improvements to practices since the implementation of the Standards and re-sampling should be undertaken prior to any decision is made to revoke the order. Limits set for chemicals and foreign materials in resource recovery orders and exemptions should be reasonable, achievable and measurable, reflective of background levels and risk of exposure. The current orders lack clarity and context, are difficult to interpret and lead to inconsistencies in application.

Retrospective Impact

The proposed changes will have retrospective impacts as well as those identified in the previous sections of this response. Currently there are stockpiles of processed or partly processed C&D mixed waste on processing facility sites. The waste material continuing to be generated and stored on building and construction sites will grow while the EPA considers the revocation of the orders. Similarly, finished product is likely to be currently stockpiled on consumers sites awaiting use as turf underlay, subbase and fill. This raises a number of questions we presume the EPA has considered but there has been no communication or indication for the industry as to how this will be managed and by whom. For example:

- How does the EPA propose to deal with stockpiles and stored materials if the orders and exemptions are revoked?
- What will be the fate of processed and recycled material that is now or soon will be, in situ?
- How will this be communicated effectively to both ensure compliance and alleviate concerns for all stakeholders?

These are similar issues to those that arose when the EPA revoked the MWOO order that affected the AWT operators and their customers. The EPA established support systems and communications to stakeholders to provide advice and financial support to dispose of the resulting non-compliant material. The EPA should provide a similar response if the recovered fines orders and exemptions are revoked.

Summary Statement: **There may be significant quantities of recovered fines and recycled products stockpiled on building and construction sites, processing facilities and on consumer sites (intermediary and final). If the recovered fines orders and exemptions are revoked what will be the status of these materials and how will they be managed? The EPA at the least should provide assistance and support to manage these stockpiles as it did with MWOO.**

Risk based approach should be used

The concept of defining pollution based on its potential to cause harm is embedded within NSW legislation and guidance that the EPA administers and forms a basis upon which regulatory action is determined.

Any risk assessment should incorporate an understanding of the hazard associated with a substance and knowledge and assessment of any potential exposure pathways. That is, how someone may come into contact with a substance, how frequently and for how long. This is to determine if the dose or exposure is sufficiently elevated to result (or potentially result) in adverse health effects. This relationship is the key to being able to quantify hazards and therefore how the risk should be avoided or ameliorated. Taking into account the fate of products from recycled C&D waste, is necessary to framing the controls in their production and use. Limiting chemicals of concern is obviously critical but limits set in regulatory instruments must reflect the ultimate end use of the product and potential exposure pathways. If recovered fines are processed into products that are used as subbase or engineering fill the exposure pathway is low risk (EnRiskS 2021).

The EPA is concerned about the results of its investigation and has indicated it has identified a risk that it presumably feels is unable to be removed or mitigated. However, it is not clear exactly what risk/s is being referred to, in that there are a number of substances present in the samples taken however it is unclear if they are simply present (eg plastic) or a contaminant of concern (eg asbestos). However, in both instances this risk can be managed depending on the use that the recycled material is being put to. This material in many instances is being used as fill and is not going to have any human contact or likely exposure pathway. Proportionate levels should be set based on the end use of material. It would appear that the NSW EPA is using the same criteria for topsoil as it is for subbase and embankments. This is inappropriate and the orders need to be more nuanced to reflect the nature of the risk and controls needed depending on the end use of the recycled product. For example, the use of a recycled material that contains visible particles of plastic in a buried engineering fill situation does not necessarily mean there is an unacceptable risk to human health or the environment. A risk-based approach would take into consideration the characteristics of the material, how it was being used and the likelihood of mobilisation.

Further, depending on the location that material is excavated from, there may be high background levels of some pollutants (eg Western Sydney and lead). The EPA's approach of simply reducing the concentration limits for certain pollutants without reflecting the source of the material, treatment process or end use is overly simplistic and fails to address risk, intended use of the product or the objectives of resource recovery and a circular economy. This approach is also not in accord with NSW EPA's Principles under its Regulatory Strategy, especially:

- **We apply a risk-based approach to regulation.** This helps us make informed decisions and focus our regulatory activities on the biggest risks to the environment and human health.
- **We use evidence as the basis for our decisions and actions**, and to help solve environmental problems and regulatory challenges. This is informed by sound science – research, environmental monitoring, technical expertise and partnering with other research bodies, the community, government and experts.

The industry has developed an alternative integrated framework and provided it to the EPA for consideration. Our proposed waste classification and reuse framework (**Appendix E**) has a risk-based approach that focusses on the source or generation of the waste material, how it is then classified based on scientific evidence eg VENM, ENM soils, homogenous C&D waste, mixed C&D waste, the processing or treatment it undergoes and its end use eg, topsoil, engineering fill or disposal to landfill.

Note, we are also led to believe that the EPA has a concern about aesthetics, again this can be addressed based on purpose/ use, but also specifying of different size (and therefore equipment) for the materials.

Summary Statement: **There should be an alternative integrated risk-based framework developed for recovered C&D waste materials that focuses on the source or generation of the waste material, how it is then classified based on scientific evidence eg VENM, ENM soils, homogenous C&D waste, mixed C&D waste, the processing or treatment it undergoes and its end use eg, topsoil, engineering fill or disposal to landfill.**

Issues with Compliance

The EPA's investigation did not apply the rigor of its own policies and procedures, for example the Compliance Policy, Compliance Audit Handbook and new Regulatory Strategy. If the principles and approaches in these policies and procedures are applied they provide assurance to both the regulator and regulatee that a systematic, professional and robust process that is evidence based has been followed that provides an opportunity for the regulatee to respond to the findings and the justification for follow up action from the regulator. It also ensures that the process happens in a timely manner and is transparent and defensible.

For example, we are aware that the usual process should be to conduct a planned and systematic investigation/audit, identify non-compliances and good practices, provide an opportunity for feedback on findings of noncompliance or further observations and implement a remediation program to address any non-compliances, typically, where the regulatee holds and Environment Protection Licence (EPL), through Pollution Reduction Programs or other specific licence conditions.

We are not aware of instances where the outcome of a similar investigation or audit has resulted in the revocation of the regulatory instrument against which compliance was assessed. As was the case for the EPA's investigation of recovered fines. Even though the investigation conducted by the EPA was not a formal audit, as a credible regulator following the principles of its own policies it should have followed a similar process and provided the opportunity for the industry to address non-compliances and improve performance. In part, the issues identified by the EPA have been those that were the subject of the work the industry and the regulator were cooperatively engaged in prior to the sudden announcement of the revocation. The EPA appears to be treating Resource Recovery Orders and Exemptions differently from other regulatory instruments it enforces.

Summary Statement: **The EPA did not follow its own policies and procedures for investigation and regulatory decision making for the recovered fines orders and has responded to non-compliances by proposing to revoke the regulatory instrument it administers rather than provide the opportunity for the operators to demonstrate they have improved performance and can produce a product that is protective of human health and the environment.**

Alternative Daily Cover

In its letter to facility operators of 2 September 2021 the EPA suggested that following the revocation of the recovered fines orders and exemptions the resource recovery operators could consider applying for a site-specific order or that material previously produced under the existing orders could be used as Alternative Daily Cover (ADC) at landfills, noting the 75% waste levy concessional discount for this material. Presumably as a way of offsetting the significant costs associated with revocation. Our analysis shows that the ADC suggestion is unrealistic as:

- Supply will clearly outstrip demand for this use;
- Landfill operators are unlikely to see the value in purchasing this material for this purpose as they generally have their own reserves; and

- EPA Regional staff have expressed a view to at least one (1) landfill operator that the EPA is intending to reduce allowable total ADC amounts by 50%.

The EPA's assumptions that recovered fines will be able to be used as alternate daily cover by landfills is flawed. The supply will far outweigh the demand as landfills have access to other forms of cover at more attractive rates. The industry has undertaken an analysis of the amount of landfill area and daily cover required for the whole of NSW and the Sydney metro area. This analysis indicates that even if all ADC was recovered fines, supply is at least an order of magnitude more than demand. As identified earlier in this response, there are 1,200,000 of recovered fines produced annually and our assessment is that between 74,000 to 123,000 tpa of daily cover is required by landfills (refer **Appendix F**) - noting that if recent proposed action by NSW EPA officers to reduce allowable ADC rates is applied to more landfills, this amount will reduce even further. This is unlikely to be a viable alternative for processed and recycled mixed C&D waste. Further this material can be recycled and should be to be used for higher order purpose than landfill.

Summary Statement: **The EPA's suggestion that processed mixed C&D waste can be utilised for daily cover at landfills is unlikely to be a viable alternative use for this material. The industry's analysis indicates that the demand for such material, even if used in all landfills, is exceedingly small compared to the amount of material produced.**

Managing Finds of Asbestos and Asbestos Containing Material (ACM)

"We are all exposed to low levels of asbestos in the air we breathe every day." (enHealth 2013)

There are always a small number of asbestos fibres in the air we are all exposed to. The levels of fibres in the air need to be above background levels to be of concern. However, there are considerable differences in air concentrations across urban, rural or industrial settings and indoors or outdoors. According to SafeWork Australia, the typical environmental background presence in outdoor air is 0.0005 fibres/mL and 0.0002 fibres/mL in indoor air, resulting in 5,500 fibres breathed by an average person per day.

Since around 2007 the C&D waste industry has been working with the NSW EPA to develop improved approaches to identifying and dealing with asbestos finds in C&D waste that is received at waste recycling facilities. To improve our understanding and support a more considered and appropriate response to asbestos that is reflective of the actual risk the industry commissioned two key reports:

- *Independent review: Asbestos in construction and demolition recycling* Environmental Risk Sciences (EnRiskS) October 2020. Prepared for Beatty Legal Pty Ltd (**Appendix G**)
- *Economic and community impacts of asbestos regulations for construction and demolition recycling*, The Centre for International Economics (CIE) May 2021 (**Appendix H**)

As well as these more recent reports the industry also worked with Safework NSW in 2010 to produce the *Management of Asbestos in Recycled Construction and Demolition Waste Guide* and contributed to the development the EPA's 2019 Standards. The industry also worked with the EPA to develop an Unexpected Finds protocol that has yet to be accepted (see Supporting Documents).

The EnriSks 2020 report examines the hazards, exposure and risks associated with asbestos, how this is managed in NSW and in other jurisdictions, the various regulatory definitions and approaches, detection limits (zero tolerance versus trivial levels) and how this is disconnected from other regulations and guidance in NSW. In particular the *Work Health and Safety Regulation 2017* and *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) and the EPA's regulation of air emissions of asbestos from stationary sources. It concludes the requirement for zero asbestos appears to only apply to C&D waste recycling facilities and there appears to be no practical understanding by the EPA of how difficult it is to inspect mixed waste to guarantee that asbestos is not present, especially small fragments (<2-3mm) of ACM and recyclers are bearing the responsibility for asbestos found in waste that has been cleared at source. It also concludes many of the issues can be resolved with a workable Unexpected Finds procedure.

The CIE May 2021 report looked at the impacts on the industry due to its inability to meet the EPA's zero tolerance approach to the presence of asbestos, assessed the economic, social and environmental consequences of three alternative options for managing asbestos in C&D waste, examined the direct impacts on the C&D waste recyclers and construction sector form each, the costs of alternatives to manage unexpected asbestos finds and the economic consequences of increasing costs for the industry and the costs of reduced C&D recycling. It concluded that the EPA's approach to managing asbestos would impose direct costs of $35.1 million for C&D recyclers due to extra costs related to disposal of more material, engaging hygienists more frequently and the disruption to site operations. Conversely, the report provides an alternative approach supported by the industry and estimates the costs at $1.7 million.

It is common for bonded ACM to be treated differently from friable asbestos as it usually poses a very low risk. A recent update from the Western Australian Department of Health noted that site assessments have supported the assumption that bonded ACM fragments pose only a minor risk (EnRiskS 2021).

Asbestos is part of Australia's built environment, reflecting a long history of the use of asbestos as a building material.

It is not surprising that asbestos or ACM may be found in C&D waste delivered to processing facilities for recycling. Asbestos may be present in such waste due to:

- Mixing in of small amounts of bonded asbestos from demolition with materials to be sorted and recycled;
- Being naturally present in the soil where a building is being demolished or constructed; and
- The settling of asbestos fibres present in the atmosphere.

The background presence of asbestos fibres in the air means the concept of zero asbestos or zero asbestos exposure is meaningless. The industry has been working with the NSW EPA for many years to develop an appropriate protocol or procedure to identify the potential for asbestos to be present in C&D waste and how best to manage that during the recycling process.

Different types of asbestos pose different levels of risks to workers and the community. Asbestos in bonded materials eg cement sheeting pose the lowest level of risk whilst loose fibres, such as those present in friable asbestos can move readily into the air and pose the highest level of risk.

For C&D waste material there is a low potential for friable asbestos to be present if the materials are managed correctly at the point of removal from structures or buildings, as per current legislated requirements. The most likely form of asbestos encountered in C&D waste is bonded asbestos which presents a low risk, unless it is mechanically damaged.

The EPA's zero tolerance approach to the regulation of asbestos in C&D waste is not consistent with other NSW settings. For example, the *Work Health and Safety Regulation 2017* does not require zero asbestos post the removal of asbestos and allows for soil to include trace amounts of asbestos, which is defined as <0.01% w/w. For contaminated sites assessment NSW uses the NEPM which has a risk-based assessment approach for the presence of asbestos in soils in different land use settings. The planning framework in NSW including through the provisions of SEPP 55, the Standard LEP and DCP conditions and construction certificates also uses a risk-based approach to assessing the presence of asbestos and managing its safe removal and disposal during demolition and construction activities. The requirement for zero asbestos appears to only apply to C&D waste recycling facilities and their products.

To date, there is no consistent threshold which defines asbestos waste across jurisdictions in Australia. Western Australia is the only state to provide a contamination criterion, of 0.001 per cent (weight for weight), which has been adopted as best practice in Northern Territory and Queensland.

It is important to consider the following when setting limits for asbestos in recycled materials:

- Asbestos is naturally occurring and has been widely used which means it is highly likely that any soil sample could contain a small amount.
- For the recycling of C&D waste to occur the potential for asbestos to be present needs to be controlled at source and properly and professionally removed as is currently required in NSW.

Summary Statement: **Asbestos is ubiquitous in the environment, and we are all exposed to a small amount in the air we breathe. Small amounts are likely to be present in any soil sample but bonded asbestos is likely to pose only a small risk of exposure. Asbestos contamination must be dealt with at source and current NSW requirements for asbestos management, handling and assessment address this. Any limits set for asbestos must properly reflect the risk. The NSW EPA must continue to work with industry to finalise a protocol for managing unexpected finds and/or presence of asbestos that is reflective of the levels of asbestos in the environment.**

New Recovered Soils Order

The NSW EPA has developed a new Recovered Soil Order 2021 for public consultation, that will enable recycling of excavated soil (including but not limited to natural materials such as sandstone, shale, clay and soil) that is processed, and contains at least 98% (by weight) natural material after processing but does not include asbestos, acid sulfate soils (ASS), chlorinated hydrocarbons, organochlorine pesticides (OCPs), polychlorinated bi-phenyls (PCBs) or per- and polyfluoroalkyl substances (PFAS).

Further this material cannot be derived from the processing of building and demolition waste (including residues from the processing of skip bin waste). Recovered soil does not meet the definition of virgin excavated natural material in the POEO Act and does not meet the definition of excavated natural material in the excavated natural material order and exemption 2014 and can only be used for the purpose of engineering fill or earthworks (no landscaping applications).

This Order will affect a significant volume across Sydney of bulk excavation from construction sites, eg during basement and tunnel developments. It is estimated that about six (6) million tonnes per annum will be negatively impacted by this Order. It is highly unlikely that this material will come from skip bins.

Industry has a number of concerns with this proposal, and genuinely believes due to the move to requiring the testing on a building or construction site and unrealistic/unachievable testing criteria when on a licensed site, that this could lead to the material no longer being recovered for beneficial reuse and the closure of industry operations with more jobs lost.

Industry's concerns include:

- The practicality and effectiveness of material assessment and sampling being undertaken on construction sites by either a desktop assessment or detailed site investigation. This could result in:
    - Low quality sampling and testing management (one of the main concerns raised by NSW EPA with the industry is failure to comply with testing requirements)- We question who will oversee this as these will not be licensed sites?
    - Poor classification of this material as clean fill and being used on other sites without sufficient testing;
    - Potential for significant rorting with material being moved between building sites, as witnessed on RMS infrastructure sites, with the risk that this material will not be captured within the regulatory framework at all;
    - Only material that fails to comply will be moved to licensed sites and then only for the purpose of landfilling. This would result in the collapse of the soil recycling industry in NSW (about a six (6) million tpa industry).
- Despite the classification as soil (we note that no definition exists in NSW POEO Act for this), it cannot be used as landscaping material (what would commonly be referred to as soil), rather this material can only be used as the equivalent of *uncontaminated fill*, however the levels that have been set do not bear any resemblance to the risk that this material poses given its allowed use.
    - Note, the EPA also appears by the use of the word soil, confusing the fact that there is no intention with this material to use it for actual soil, rather it is engineered subbase and the approach should reflect the risk associated with this material's purpose.
- The criteria that are proposed for this material are more stringent than the allowable limit for Excavated Natural Material (ENM) and it is unclear as to the basis and determination for these levels. It is also questionable as to whether or not a laboratory can test to these levels. Further, it is not possible to screen to these levels with currently available equipment (2mm and 5mm screens).
    - The approach of the current order with the ability for the basket of materials to reach a certain level (not prescriptive as per this order by item), was preferable given this is a more realistic way to manage material we know has existing levels.
    - The proposed chemical concentration levels will in all likelihood result in all this material going to landfill as they are unachievable. In particular our advice from soil scientists is that those for Benzo(a)pyrene and lead are unworkable.

EnRiskS advises that the limits proposed are significantly lower than the limits of reporting indicated in the recommended analytical method resulting in significant limitations to determine compliance with the guideline. For foreign materials the limits applied to recovered soils are significantly lower than those applied to foreign materials present in other material types that are used for similar purposes. The groupings of foreign materials are much more specific than for other relevant types of materials and in practice they would be quite difficult to differentiate with confidence between material types and this is not in line with the analytical method recommended.

We note that there is no guidance on the desktop assessment process or how this is to be undertaken or the type of evidence that is required to demonstrate that prohibited substances are not likely to be present in recycled material. Given the ubiquitous nature of some chemicals in the environment at low levels, such as PFAS in soils in urban areas it is not clear what sort of evidence developed from a desktop assessment would be sufficient (EnRiskS 2021).

***Summary Statement:* The proposed recovered soils order and exemption is not workable and there will be increased costs associated with the loss of substitute excavation materials and an increase in the extraction of virgin materials**

Alternative Solutions for discussion

The industry is strongly of the view that there are alternatives to the EPA's proposed revocation of the recovered fines orders and exemptions that will not cause the market disruption, costs to the community, industry and consumers and increased landfilling that will result from revocation. The following alternative solutions are suggested for further discussion and would also be a beneficial starting point for the broader review of resource recovery orders and exemptions the EPA has proposed to undertake. Note that the alternatives are not exclusive of each other and could work together to achieve the shared outcomes both the EPA and the industry are seeking ie, increased resource recovery with fit for purpose products that do not harm the environment or human health.

Consideration of Independent Studies

1. The comprehensive independent scientific and economic analysis reports (**Appendix A & Appendix C**) commissioned by the industry to fully understand the issues with recovered fines and recovered soils orders and the proposed EPA revocation need to be properly considered and the conclusions and recommendations discussed in detail with the EPA. Whilst these reports are finalised and the authors and the industry stand by the results, they represent stage one of a two stage approach. Given the restricted time to respond to the EPA's revocation further work is needed to examine the detail of the alternatives and reforms that are recommended, the requirements that are best reflective of hazards and risks and the costs and benefits of agreed changes. We invite the EPA to be partners in this process so that the assessment of the problem is better understood, and it is based on the most current and up to date information before making a final decision. The industry remains committed to working with the EPA to understand the actual/potential issues and how they can be resolved and expects that with joint commitment this work could be concluded by the end of the year and will also be useful to support the proposed broader review of the resource recovery framework.

Amend Current Orders

2. Instead of revoking, amend the existing orders to reflect the outcomes from the EPA/Industry working group process that commenced in 2020, for example change to batch only, smaller screening sizes, consider limits that take difficulties in analysing physical contaminants and take background levels for chemicals into account, amend sampling regimes/frequency and consider an independent sampler, undertake regular auditing and compliance and enforcement, agree on and implement the industry's previously suggested Unexpected Finds Protocol. Set a period, perhaps two years before review to allow the industry time to put systems and equipment in place and apply the new sampling regimes. Monitor industry compliance closely with the revised order whilst the broader resource recovery orders and exemptions framework review is undertaken. The amended recovered fines order could be grandfathered once the broader review of resource recovery order and exemption framework is completed (See a proposed marked-up recovered fines order at (**Appendix I**).

New Approach

3. Develop a new resource recovery regime for C&D mixed waste that regulates the materials holistically across the whole supply chain using a risk-based approach i.e., from generation, transport, processing, to product use to ensure all aspects of the supply chain are satisfactorily performing and working together to produce a fit for purpose product and outcome. This approach would more accurately reflect and take account of the end use of the product and provide greater certainty to processors and consumers that contamination standards are being met. Such an approach could be underpinned by a general environmental duty (or similar) to protect the environment and human health, it would better reflect circular economy principles and outcomes and be more consistent with other leading jurisdictions.

Regulate via Licencing

4. Along with or instead of changes to the resource recovery orders use existing Environment Protection Licence (EPL) conditions to apply a Pollution Reduction Program that has the elements of No.2 above. This is a more efficient way to ensure operators understand their responsibilities and usual EPA regulatory processes like inspections, annual licence returns, and regular licence reviews will identify non compliances in a more timely and systematic way so that corrective action can be taken. It would also place resource recovery within the risk-based approach that has proven successful for EPLs.

   This would mean that the EPA would not need to establish a specific regulatory approach to compliance for resource recovery orders as it could utilise current practices and procedures. It would also mean the statutory service delivery and appeal processes would be available to the licensee making for a more timely and transparent approach to changes and greater certainty for investment. This approach would facilitate clearer regulatory requirements ensuring that operators understand what is required of them and the EPA can better assess compliance and take appropriate action where necessary. For example, an Unexpected Asbestos Finds Plan could be a licence condition and operate in the same way as the current Pollution Incident Response Management Plans (PIRMP).

   Depending on the desired scope of this approach it could mean that licensing thresholds may need to change to capture smaller waste sorting operations such as those associated with some skip bin services. However, this would accord with the *Waste and Sustainable Materials Strategy* and the draft *EPA Waste Delivery Plan's* indication to strengthen the regulation of illegal dumping and waste crime and extend licensing requirements for waste transporters. It may also require the Resource Recovery Exemption to operate more like the Victorian EPA's Determinations. An outcomes-based approach that takes risk into account by setting the rules for safe recycling products and provides assurance to consumers that there is a robust regulatory framework providing a fit for purpose product as long as it is used as intended.

Transition Pathway

Should the EPA proceed with its proposed approach to revoke the recovered fines orders and exemptions and implement a new recovered soils order and exemption the construction industry, households, the C&D waste industry and the NSW economy will be impacted as previously described. Accordingly, there will need to be an orderly transition to the new regime. Especially as existing contractual arrangements between generators and transporters and processors and consumers may be subject to force majeure. There will also be stockpiles of materials on building sites, processing facility sites and on users' sites that may no longer be able to be collected, processed or used. The fate of these stockpiles will need to be determined. We estimate an orderly transition will take two years and to mitigate impacts and ensure the continuation of critical waste services during transition, the proposed changes would require, at a minimum the following:

1. Waiving of the waste levy for recovered fines for a defined period (we suggest two years would be needed) to allow the waste generators, transporters, processors and consumers to adjust to the changes and increased costs.
2. Providing a subsidy to cover the tipping cost of recovered fines. Many building projects have sold "off-the-plan" and are locked into waste management contracts for up to 3 years.
3. Financial support for the affected parties to transition out of the industry or towards a different business model. This could come potentially from the continuation of WLRM programs or from the new Waste Delivery Plan proposed funding. The industry transition costs are estimated at $270 million but we also note that government will receive an estimated $1,045 billion in increased revenue from the waste levy receipts (CIE 2021).
4. Education and behaviour change program for the construction and home renovation industry to improve understanding of different waste streams and how to undertake better source separation.
5. Commitment to meaningfully engage with the industry on the timely review of the resource recovery order and exemption framework as outlined in the draft EPA Waste Delivery Plan

The above requirements are not dissimilar to the MWOO/AWT transition package. This is reasonable given the similar impacts on the supply chains and consumers for both MWOO and Recovered Fines. Noting that the financial and economic costs of the loss of recovered fines as a product are much more significant.

Conclusion

In conclusion we make the following key points:

- The decision to revoke the recovered fines orders and exemptions is premature, made from a poor evidence base and without the justification required for such impactful regulatory change.
- The C&D waste resource recovery industry has worked in good faith to improve performance and the products it supplies.
- Revocation of the orders and exemptions will be a poor outcome for NSW recycling and resource recovery, will lead to increased landfilling and put added strain on landfill capacity.
- The National and NSW recycling and landfill avoidance targets will not be achieved and major initiatives like FOGO recycling will be seriously undermined.
- The revocation will lead to increased illegal dumping especially as the construction sector increases activity and the C&D waste processing industry contracts. It is likely that a small number of remaining facilities will struggle to service an increasing demand.
- It will be cheaper (and more profitable for some) to dump than dispose of waste to landfill. The proposed changes will undermine the gains made by RID Squads, Councils and EPA in tackling illegal dumping, and will in all likelihood result in increased movement of material to South East Queensland.
- The proposed recovered soils order and exemption is not workable and there will be increased costs associated with the loss of substitute excavation materials and an increase in the extraction of virgin materials.

- There will be significant increases in costs to the waste industry, construction industry, householders and a direct loss of jobs.
- We have provided reasonable, thoughtful and viable alternatives to address the EPA's concerns and seek to enter into further discussions with the EPA about these.
- We share the same desired outcomes and want to continue the dialogue to ensure the best possible outcomes for resource recovery, the environment and human health.

Appendices

Appendix A – Better Regulation Statement for proposed changes to recovered fines and recovered soils, The Centre for International Economics (CIE), October 2021

Appendix B – Cost Impact to Households

Appendix C – Independent Review: Reuse of recovered fines in NSW – Stage 1, Environmental Risks Sciences (EnRisks), October 2021

Appendix D - On-Site Testing and Reform for the Recovered Fines Order, NSW C&D Working Group, June 2021

Appendix E – Proposed Revised Waste Classification/Resource Recovery Response Strategy

Appendix F – Alternative Daily Cover Calculation

Appendix G - Independent review: Asbestos in Construction and Demolition Recycling, EnRiskS, October 2020

Appendix H - Economic and Community Impacts of Asbestos Regulations for Construction and Demolition Recycling, The Centre for International Economics (CIE), May 2021

Appendix I – Marked-up Recovered Soils Order

Supporting Documents

Draft Guideline – Developing an Unexpected Asbestos Finds Plan

Peer Review and Gap Analysis of the Supply and Demand for the Greater Sydney Region, RPS Group, July 2020

APPENDIX A

Better Regulation Statement for proposed changes to recovered fines and recovered soils

CIE, October 2021

COMMERCIAL IN CONFIDENCE

FINAL REPORT

Better Regulation Statement for proposed changes to recovered fines and recovered soils

Stage 1

Prepared for
Waste Contractors and Recyclers Association (WCRA) and Waste Management and Resource Recovery Association of Australia (WMRR)

29 October 2021

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Contents

BOXES, CHARTS AND TABLES

Executive summary

The waste industry through WCRA and WWRR is undertaking a Better Regulation Statement (or Regulation Impact Statement) to provide information on the expected impacts of an alternative regulatory option being considered by NSW EPA for recovered fines. The Better Regulation Statement follows the process set out in NSW Government guidelines that are aimed at ensuring better policy outcomes for the community. This report sets out Stage 1 findings, which focus on the current regulatory arrangements and EPA's proposed regulatory arrangements. The report notes other alternative options, but these have not been assessed in detail.

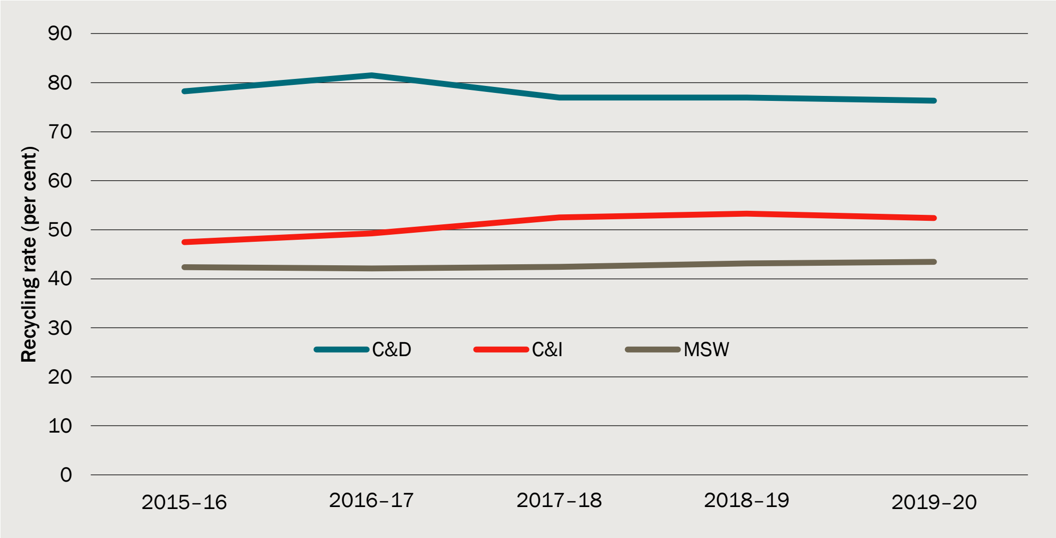
The construction and demolition (C&D) resource recovery sector

NSW C&D recycling is the largest recycling sector within the NSW recycling industry. The annual revenue based on the data for source separated and mixed C&D processing facilities, i.e., only the recycling operations and not the collections/transport component of the value chain, is ~$500 million per year.[1] The C&D recycling industry employs over 580 FTEs for mixed waste recycling and 450 FTEs for source-separated recycling. There are an additional 750 truck drivers employed in collecting skip bins for mixed C&D waste.

The NSW C&D sector has the highest recovery rates for waste streams in NSW, and C&D waste accounts for almost 60 per cent of the total waste generated in NSW. Recovery rates for C&D, commercial and industrial (C&I) and municipal solid waste (MSW) are shown in chart 1.

1 This covers less material volumes than data on C&D published by NSW EPA, as EPA figures include virgin excavated natural material (VENM)[1] and some C&D recycling would go to other facilities (such as metal recyclers or previously interstate).

1 Recycling rate, by waste stream



Data source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

In June 2021, the NSW Government released the *NSW Waste and Sustainable Materials Strategy 2041*.[2] This outlined a target of having an 80 per cent average recovery rate from all waste streams by 2030. Currently, the C&D sector is the only waste stream close to this target. As the Strategy shows, the C&D sector has also been the only one getting close to the previous resource recovery targets set by the NSW Government.[3] C&D recycling is a key part of achieving NSW Government resource recovery targets.

Recovered fines

This Better Regulation Statement is specifically focused on material processed under the recovered fines order, or that would be impacted by the proposed recovered soils order. This material comprises:

- the fine material that is one output from mixed C&D recycling facilities, such as soil and sand substitute material
- bulk excavated soils that require some processing and hence are not classified as excavated natural material, and which are being processed under the recovered fines orders currently
- contaminated/hazardous soils that are processed under site specific arrangements, which would likely be aligned to the proposed recovered soils order.

There are various sources available for the amount of material in these categories. NSW EPA reported a figure of 1.2 million tonnes of recovered fines were being produced in

2 https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0006/385683/NSW-Waste-and-Sustainable-Materials-Strategy-2041.pdf

3 https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/recycling/19p1690-warr-strategy-progress-report-2017-18.pdf

2017 and 2018 — that is 600 000 tonnes per year.[4] For the purposes of the analysis we use the volumes set out in table 2.

- For mixed C&D waste, we use previous CIE estimates of the entire industry volume as the central case, and the weighted average share of fines of 31 per cent. We show a sensitivity with tonnes only for businesses we have directly consulted with for this project, which is similar to the EPA figure of 600 000 tonnes per year.
- For soil, we use the estimate of tonnes for the businesses consulted with for this project as the central case. We know this is not the entire industry, but do not know whether others are recovering soil under the recovered fines order or whether this meets requirements for ENM. As a sensitivity, we use a high case of 50 per cent more volume, noting that this could be considerably higher than we have allowed for.
- For contaminated soil processed under site specific arrangements, we use current volumes from businesses consulted as the central case, and expected future volumes based on capacity expansions being undertaken for the high case.

There are uncertainties about the volume of recovered fines and recovered soil. The two most important are whether recovered fines that are blended with aggregates to form a road base are covered under the recovered fines orders (we have assumed they are) and whether a larger amount of soil is actually covered under the recovered fines orders, rather than the Excavated Natural Material order (we have assumed it is not). Changes in volume will increase or decrease the benefits and costs, but do not impact on conclusions about whether an option has net costs or net benefits.

2 Volumes used for analysis

	Central case	Sensitivity case
	000 tonnes	000 tonnes
Mixed C&D waste processed per year	2 850	1 990
Recovered fines produced from mixed C&D waste	906	616
Soil processed under the recovered fines order	308	462
Contaminated/hazardous soil processed under site specific arrangements	25	80

Source: The CIE, based on consultations with waste businesses.

Better regulation principles

Under NSW Government requirements, a Better Regulation Statement (BRS) is required for significant new and amending bills and a Regulatory Impact Statement for subordinate regulations. This process is simply a formal framework to help policy-makers think through the impacts of regulatory proposals in a disciplined and comprehensive way. This helps to ensure that policy decisions are based on best practice regulatory principles (see box 3) and the best available evidence, resulting in better policy outcomes for the community. For simplicity we refer to the term 'Better Regulation Statement' throughout this report.

4 NSW EPA 2020, Outcomes report for Workshop 1, May.

3 Better Regulation Principles[5]

Principle 1: The need for government action should be established. Government action should only occur where it is in the public interest, that is, where the benefits outweigh the costs.

Principle 2: The objective of government action should be clear.

Principle 3: The impact of government action should be properly understood by considering the costs and benefits (using all available data) of a range of options, including non-regulatory options.

Principle 4: Government action should be effective and proportional.

Principle 5: Consultation with business and the community should inform regulatory development.

Principle 6: The simplification, repeal, reform or consolidation of existing regulation should be considered.

Principle 7: Regulation should be periodically reviewed, and if necessary reformed to ensure its continued efficiency and effectiveness.

The need for and objective of government action

Government regulation occurs in relation to recovered fines to ensure that materials produced from waste do not have negative impacts on the environment and human health. The NSW EPA currently has a set of standards for recovered fines, set out in the *Recovered Fines Order (Batch)* and *Recovered Fines Order (Continuous)*. In 2019 it commenced a review of recovered fines, and found a variety of issues related to compliance with the existing orders. These included that recovered fines that did not meet contamination thresholds, had a range of foreign materials[6] or where testing and sampling compliance was inadequate. The performance was mixed across different recyclers. While it is clear that there had been a lack of compliance with the orders, it is not clear that this had any material human health and environmental impacts.

Based on reviewing current thresholds for recovered fines, proposed thresholds in the recovered soils order and thresholds for site contamination from the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM), referred to as the Health-based Investigation Levels (HILs) for tier A (residential properties with garden/accessible soil), key issues are:

- Current levels of contamination of recovered fines have variable performance across facilities against the maximum average thresholds. There are rarely any contaminants with samples that exceed the absolute maximum thresholds.

5 NSW Government, *NSW Guide to Better Regulation*, October 2016, p. 6.

6 Note that some issues with foreign materials were an issue with the order, rather than with material, as this was not specified in the order.

- Current levels of contamination are significantly below the HIL-A thresholds with the exception of lead for which the maximum sample across all facilities exceeded the threshold by 76.7 per cent, and Chromium for which the maximum sample was almost as high as the threshold. Other contaminants that were relatively close were PCBs (60 per cent of threshold) and benzo(a)pyrene (56.7 per cent).
  - This compares the maximum sample across all facilities to the HIL-A thresholds. The NEPM prescribes that where sufficient data is available and it is appropriate for the exposure being evaluated, the mean should be compared to the HILs. Under a simple comparison of the mean level for each facility against the HIL-A thresholds, levels of contamination are below the HILs for all facilities and all contaminants.
- The thresholds in the new recovered soils order are stricter for almost all contaminants than the existing recovered fines orders, which are in turn more strict than the HIL-A thresholds.

NSW EPA has also cited issues related to plastic pollution entering the environment. The environmental costs associated with foreign material are expected to be very small.

Alternative options to meet objectives

Options to achieve these objectives with respect of recovered fines and recovered soils include:

- the base case — continuation of existing regulatory arrangements currently in place, which detail the uses and contamination requirements for recovered fines, and which are also used for recovered soils
- EPA's proposed option — this is the EPA's proposed option to revoke orders related to recovered fines and to introduce an order related to recovered soils. The EPA has also indicated that it would consider site specific orders but will not allow mixed C&D waste, including material from skip bins to be used as an input in the production of recovered fines.

There are a range of other options outside of these that relate to the standards for material used for different purposes and the approach to compliance and enforcement with standards. There has not been sufficient time to work through these options in detail. However, broadly they could include:

- replacing the recovered fines order with a recovered fill order, which limits the use of material to be in areas with less likelihood of human health or environmental impacts
- variation to the arrangements in place for contamination levels under existing recovered fines orders, such as:
  - aligning to HILA contamination levels, which are typically less stringent than the recovered fines orders
  - including foreign materials
- increased compliance and enforcement of the existing recovered fines order, and increased penalties or revocation of ability to produce for operators that are breaching standards in a way that impacts on human health or the environment

- changes to recovered soils order to the allowed uses and contamination thresholds so that this order could be used
- site specific orders consistent with current recovered fines (white list).

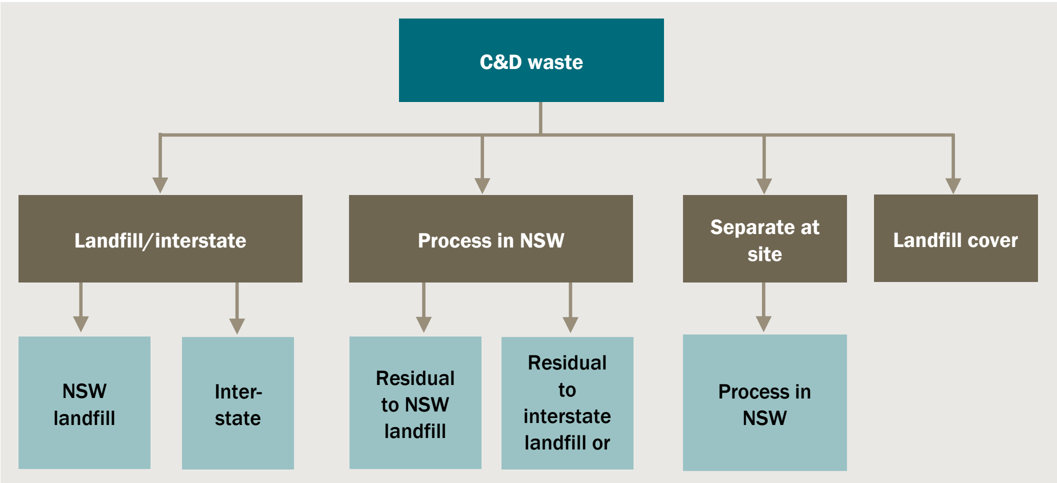
Impacts, costs and benefits of the options

We have examined the NSW EPA proposed option in detail. At this stage there has not been sufficient time to develop and examine other options.

Alternative pathways for recovered fines

Changes to the arrangements for recovered fines and soils could lead to a variety of possible changes, as shown in chart 4.

4 Alternative pathways for mixed C&D waste



Data source: The CIE and consultations with waste businesses.

Based on the analysis of the financial costs of different options and expectations of individual recyclers, we have used the alternative pathways for material shown in table 5.

- For mixed C&D waste, about half of this would be processed and then fines sent to landfill, a further 20 per cent processed and then used as landfill cover, 17 per cent directed straight to landfill, 7 per cent directed interstate and 5 per cent source separated at construction sites.
- For soil, bulk excavated soil would be sent directly to landfill and hazardous soil would be processed and then sent to landfill.

5 Alternative pathways used for central case estimates

Direction	Mixed C&D waste	Soil
	Per cent	Per cent
Straight to landfill	17	92
Processed then fines to landfill	51	8

Direction	Mixed C&D waste	Soil
	Per cent	Per cent
Straight to interstate	7	
Processed then interstate	0	
Source separated at site	5	
Landfill cover	20	
Total	**100**	**100**

Source: The CIE.

Material flows

The expected changes in material volumes to recovery and landfill are shown in table 6. With the current proposed changes, 1.3 million tonnes more material would be destined to landfills in NSW per year. The recovery rate for mixed C&D material currently processed would fall from 75 per cent to 40 per cent. The recovery rates of the C&D sector would fall from 76 per cent to 66 per cent. The NSW state-wide recovery rate would fall from 64 per cent to 58 per cent.

To put this into perspective, a state-wide roll-out of FOGO would reduce waste to landfill by ~400 000 tonnes, compared to 1 million tonnes more into landfill from the proposed changes.[7]

6 Changes in recovery under the EPA's proposed option

Item	Current regulations		EPA proposed regulations		Difference	
	Per year	Over ten years	Per year	Over ten years	Per year	Over ten years
	000 tonnes	000 tonnes	000 tonnes	000 tonnes	000 tonnes	000 tonnes
Mixed C&D waste						
tonnes sent to landfill	713	7 125	1 701	17 012	989	9 887
Soil processed as recovered fines or through site specific exemptions						
tonnes sent to landfill	0	0	333	3 332	333	3 332
	Per cent		Per cent		Per cent	
Resource recovery metrics						
Mixed C&D recovery rate	75.0	na	40.3	na	-34.7	na
C&D recovery rate	76.4	na	65.8	na	-10.5	na
NSW all materials recovery rate	64.3	na	58.2	na	-6.0	na

Note: Based on 2019/20 material generation and recovery rates for the current regulations.
Source: The CIE.

7 Based on NSW red bin audit data suggesting that 41 per cent of waste in red bins is food and garden organics and this drops to 25 per cent in areas where FOGO services are provided. We have estimated FOGO impact as a 16 per cent reduction on total MSW waste going o landfill.

Costs and benefits

The revocation of the recovered fines order and introduction of a new recovered soils order would mean large additional costs for disposal of waste for construction businesses (including related to the NSW waste levy), costs for C&D recyclers who have capital expenditure and sites dedicated to processing of mixed C&D waste and soil and higher costs for raw materials for material users. On the opposite side, the NSW Government would be expected to receive substantial increases in waste levy revenue. The central case distribution of costs and benefits is shown in table 7.

The net costs to the NSW community are expected to be $956 million for mixed C&D waste and $129 million for soil over a ten year period and discounted today's value. To put this into perspective, changes to waste regulations to increase standards for construction waste had a net benefit of $70 million over a ten year period, as reported by NSW EPA.[8] These are very large costs and there are ways to reduce these costs, while continuing to meet human health and environmental objectives.

7 Distribution of costs and benefits of EPA proposed option for mixed C&D waste

Item	Mixed C&D waste, discounted	Soil, discounted
	$m, present value	$m, present value
NSW Government (waste levy)	1 053	344
C&D recyclers (lost producer surplus)	- 459	- 35
Construction businesses, demolition	-1 378	- 402
Material users	- 125	- 35
Environment/community	- 46	0
Total	**- 956**	**- 129**

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

The estimates of costs and benefit presented above are based on central case assumptions. There is uncertainty about a range of factors, which would impact on the benefits and cost. This includes:

- the volume of material impacted
- the pathway for mixed C&D waste if recovered fines could not be used
- the ability of landfills to accommodate additional tonnages in NSW, and what that might do to costs
- the possibility for site specific orders and exemptions
- the social discount rate used.

The cost benefit results (the overall net benefit to the NSW community) is shown under various sensitivities in table 8.

8 NSW EPA 2018, Better Regulation Statement Protection of the Environment Operations Legislation Amendment (Waste) Regulation 2018, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wasteregulation/18p1271-better-regulation-statement.pdf.

- Under the central case assumptions, the net cost is $1085 million covering both mixed C&D waste and soil.
- If volumes impacted are lower — covering only the volumes from businesses that we have specifically consulted with for this project for mixed C&D waste, and not covering hazardous soil that is processed under site specific requirements — the net cost falls to $814 million, and the amount of material diverted to NSW landfills is expected to be 1 million tonnes per year more than currently is the case.
- If volumes are higher for soil — based on expectations for hazardous soil and 50 per cent higher amounts of bulk excavated soil — the net cost is $1179 million
- If all mixed C&D waste goes to landfill, rather than being processed, which is the best economic option as long as landfill capacity can be increased at the cost expected in a timely manner, then the net cost is $675 million. However, the resource recovery outcomes are substantially worse, with 2.47 million tonnes per year going to landfill, almost doubling the annual C&D waste going to landfill currently.
- If all mixed C&D waste is sent interstate — the worst outcome economically — the net cost is over $4 billion. This has the effect of *reducing* the amount of material going to landfill in NSW, because the residual from mixed waste that is currently landfilled in NSW is sent interstate. Note that in reality this would increase landfilling interstate, even though it would lead to an improvement in the stated NSW recovery rates, as interstate movement is counted as recycling. If only the recovered fines are sent interstate the net cost is $1.7 billion.
- If landfill cost can be provided at a lower cost of $50 per tonne, equal to the cost expected by Marsden Jacobs in its analysis for the Better Regulation Statement for changes to C&D waste standards, then the net cost is $866 million. On the other hand, if new landfill capacity is difficult to find, and is more distant, leading to a cost of $90 per tonne (plus the waste levy to estimate gate fees)), the net costs would be $1303 million. Issues around landfill capacity in Greater Sydney will become more imminent — The *NSW Waste and Sustainable Materials Strategy 2041* expected capacity issues to be reached by 2028. This would bring that forward by around 2 years. Given time for planning and approval, this is expected to be problematic.
- The net costs are lower if a higher social discount rate is used of 10 per cent, and lower if a lower social discount rate is used of 3 per cent. These rates are consistent with NSW Treasury guidelines for cost benefit analysis.
- A longer period for implementation, of 2 years plus exemptions for material already delivered to sites where it will be used but has not yet been used, could reduce the net costs to $968 million.

8 Sensitivity analysis of net benefits

	Mixed C&D waste	Soil	Total	Additional tonnes to NSW landfill per year
	$m, present value	$m, present value	$m, present value	mT per year
Central case	- 956	- 129	-1 085	1.32
Lower volumes impacted	- 703	- 111	- 814	1.00

	Mixed C&D waste	Soil	Total	Additional tonnes to NSW landfill per year
	$m, present value	$m, present value	$m, present value	mT per year
Higher volumes impacted	- 956	- 223	-1 179	1.53
All mixed C&D waste to landfill	- 546	- 129	- 675	2.47
All mixed C&D waste interstate	-4 027	- 129	-4 156	-0.38
All mixed C&D processed and recovered fines sent interstate	-1 689	- 129	-1 817	0.33
Lower landfill cost	- 784	- 82	- 866	1.32
Higher landfill cost	-1 128	- 175	-1 303	1.32
10 per cent discount rate	- 857	- 114	- 971	1.32
3 per cent discount rate	-1 124	- 154	-1 278	1.32
No transition costs	- 840	- 129	- 968	1.32

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

Assessment of process for making regulatory changes

Better Regulation Principle 5 is that consultation with business and the community should inform regulatory development. The NSW EPA has undertaken substantial consultation in relation to recovered fines. This included a process of three workshops in 2020 to seek to improve the quality of recovered fines. This raised many possible options to improve recovered fines.

While NSW EPA has conducted considerable consultation in relating to improving recovered fines, there is no information available about how the feedback provided has been used to **inform** consideration of a wide range of possible options for addressing the quality of recovered fines. The option to revoke the recovered fines order is at odds with the presentations made by NSW EPA and the process of holding workshops to improve the quality of recovered fines — this process implies that representations were made that the aim is to continue to produce recovered fines with improved the quality rather than to remove the ability to produce recovered fines at all. It is not clear if NSW EPA has undertaken cost benefit analysis of options in considering alternative regulatory responses intended to reduce the human health and environmental impacts of recovered fines. If so, these are not publicly available.

Better Regulation Principle 4 is that Government action should be effective and proportional. The response developed by NSW EPA to revoke the recovered fines order is effective, in the sense that it would remove any problems related to the use of recovered fines. However, it is not proportional in the sense that the costs of doing so far outweigh the expected benefits. Options that appear to more proportional to the issues uncovered in EPA's review include:

- increased compliance and enforcement, including a cost recovery arrangement for NSW EPA compliance activities related to recovered fines if resourcing is problematic

- the ability to penalise an operator for recovered fines that are systematically breaching conditions that impact on human health and environmental outcomes, and an approach for when an operator would no longer be able to produce recovered fines
- adjustments to standards and/or allowed uses in the recovered fines orders to ensure that these are aligned to human health and environmental outcomes.

1 Introduction

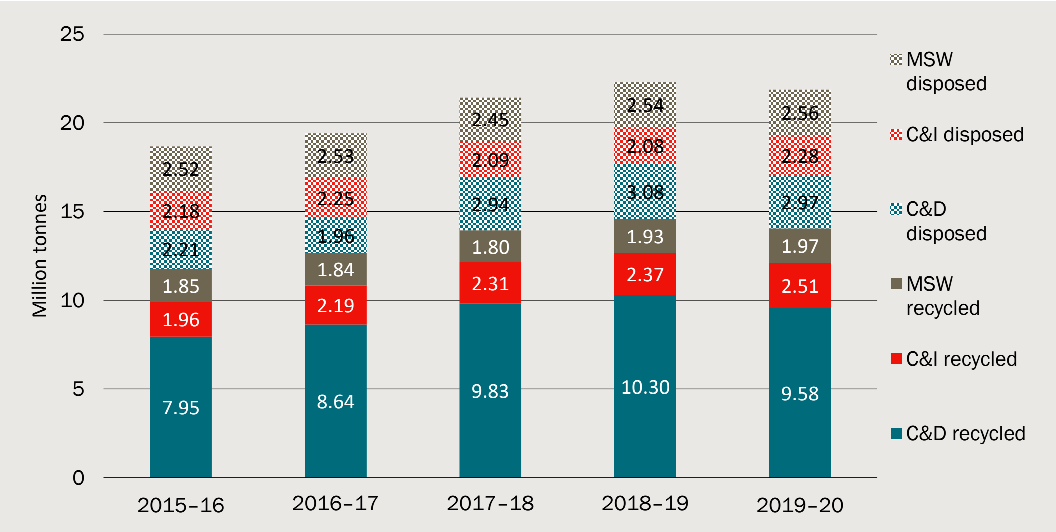
The waste industry through WCRA and WWRR is undertaking a Better Regulation Statement (or Regulation Impact Statement) to provide information on the expected impacts of an alternative regulatory option being considered by NSW EPA for recovered fines. The Better Regulation Statement follows the process set out in NSW Government guidelines that are aimed at ensuring better policy outcomes for the community.

C&D recycling activities

NSW C&D recycling is the largest recycling sector within the NSW recycling industry. The annual revenue based on the data for source separated and mixed C&D processing facilities, i.e., only the recycling operations and not the collections/transport component of the value chain, is ~$500 million per year.[9]

Using EPA data on all C&D waste, recent years have been characterised by significant increases in generated and recycled C&D waste from 2015/16 to 2018/19, before falling in 2019/20 (chart 1.1).

1.1 Waste recycled and disposed, by waste stream



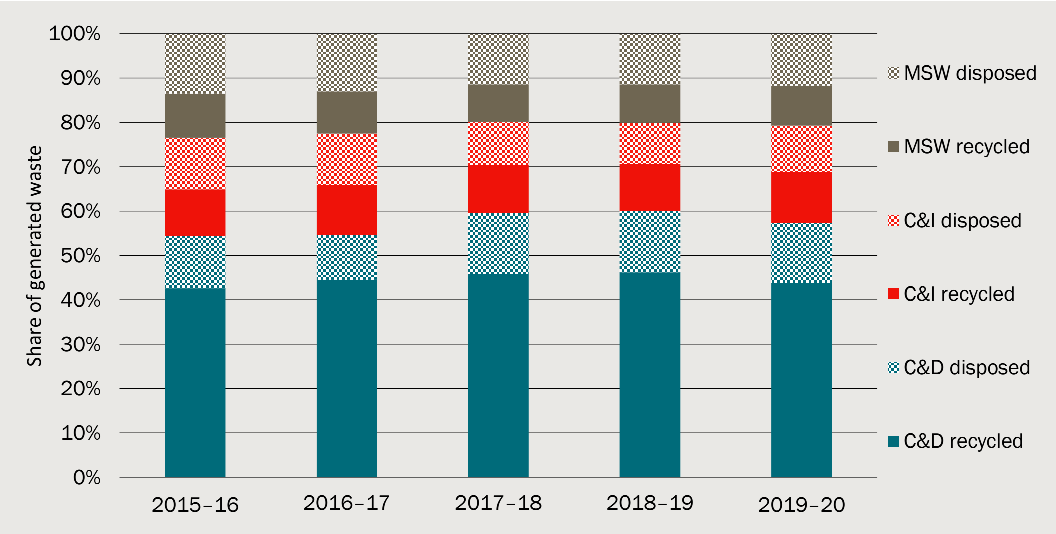
Note: C&D (construction and demolition), C&I (commercial and industrial), MSW (municipal solid waste)

Source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

9 This covers less material volumes than data on C&D published by NSW EPA, as EPA figures include virgin excavated natural material (VENM)[9] and some C&D recycling would go to other facilities (such as metal recyclers or previously interstate).

C&D facilities process almost 60 per cent of the total waste generated in NSW. The sector has a recycling rate above 76 per cent. This is 24 percentage points and 33 percentage points higher than the C&I and MSW recycling sector, respectively (chart 1.2 and 1.3).

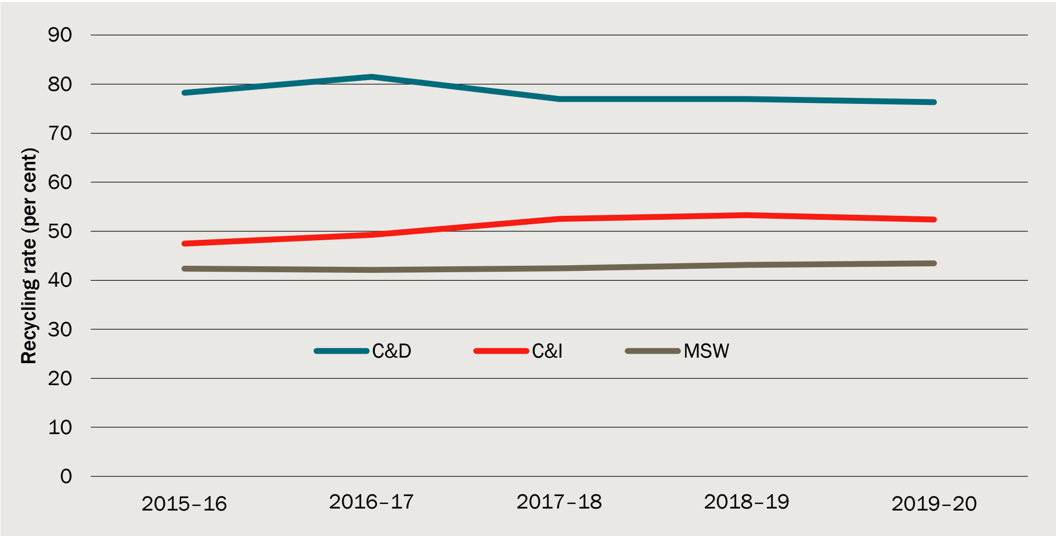
1.2 Share of total annual waste generation



Note: C&D (construction and demolition), C&I (commercial and industrial), MSW (municipal solid waste)

Source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

1.3 Recycling rate, by waste stream



Data source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

In June 2021, the NSW Government released the *NSW Waste and Sustainable Materials Strategy 2041*.[10] This outlined a target of having an 80 per cent average recovery rate from all waste streams by 2030. Currently, the C&D sector is the only waste stream close to

10 https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0006/385683/NSW-Waste-and-Sustainable-Materials-Strategy-2041.pdf

this target. As the Strategy shows, the C&D sector has also been the only one getting close to the previous resource recovery targets set by the NSW Government.[11]

C&D recycling can be broken into different segments based on the material being processed.

- Recycling of source separated materials — this includes masonry materials such as, cement, bricks, concrete, and timbers and Gyprock. Source separated recyclers process approximately 4.5 million tonnes per year, of which 99 per cent is recycled
- Recycling of mixed waste — this includes skip bins or truck loads of mixed C&D waste. Mixed waste recyclers process approximately 2.9 million tonnes per year, of which 75 per cent is recycled.

This does not cover all C&D material that is counted as recycled in NSW EPA data. The gap includes bulk excavated soils (which could be virgin excavated natural material, excavated natural material, soil currently processed as recovered fines and contaminated soils), material sent directly to other recyclers such as metal recyclers and material sent interstate.

The C&D recycling industry employs over 580 FTEs for mixed waste recycling and 450 FTEs for source-separated recycling. This covers those involved in recycling activities. There are a further 750 truck drivers employed in collecting skip bins for mixed C&D waste.

This Better Regulation Statement is specifically focused on material processed under the recovered fines order, or that would be impacted by the proposed recovered soils order. This material comprises:

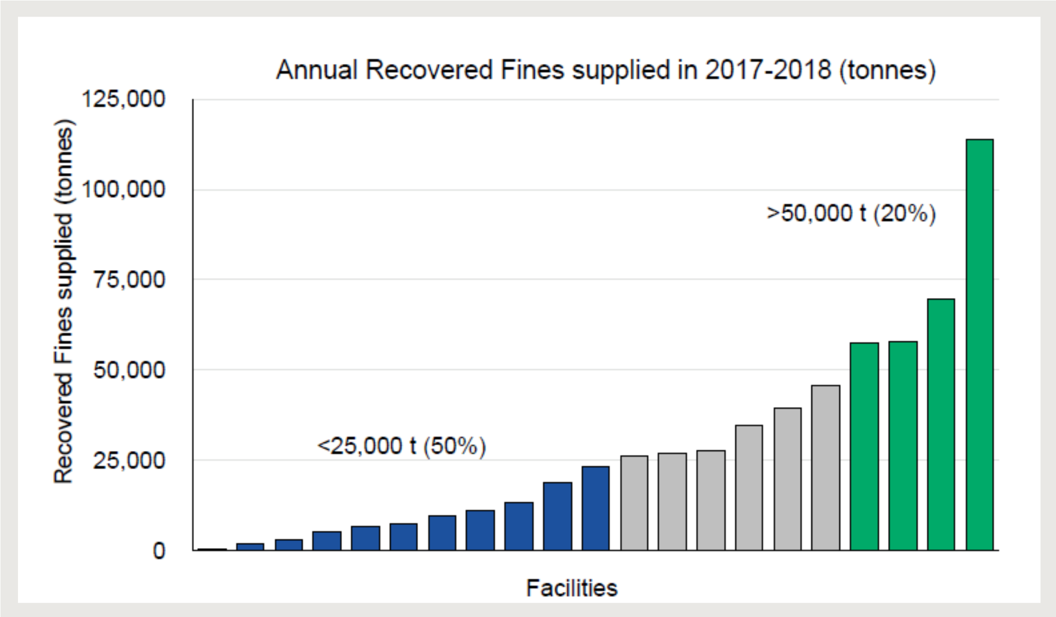
- the fine material that is one output from mixed C&D recycling facilities, such as soil and sand substitute material
- bulk excavated soils that require some processing and hence are not classified as excavated natural material. These are being processed under the recovered fines orders currently
- contaminated soils that are processed under site specific arrangements, which would likely be aligned to the proposed recovered soils order.

There are various sources available for the amount of material in these categories. NSW EPA reported a figure of 1.2 million tonnes of recovered fines were being produced in 2017 and 2018, or around 600 000 tonnes per year (chart 1.4).[12]

11 https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/recycling/19p1690-warr-strategy-progress-report-2017-18.pdf

12 NSW EPA 2020, *Recovered Fines Workshop 1, May 2020: Outcomes Report*.

1.4 NSW EPA recovered fines by facility, 2017/18



Data source: NSW EPA presentation as part of Workshop 1, May 2020.

Previous industry data provided to the CIE indicated mixed waste facilities in total processed 2.9 million tonnes of material. We have consulted with major mixed waste processors as part of this project, and recovered fines are estimated to comprise 31 per cent of input material on average. This implies around 900 000 tonnes of recovered fines are produced. For the businesses consulted for this project, recovered fines produced from mixed C&D waste are around 600 000 tonnes. In some cases, material is currently being stockpiled ready to process in the future into fines, or is being blended in with aggregates. We have assumed that the latter is covered under the recovered fines orders, and could not be undertaken through use of the recovered aggregates order.

Estimates of soil that is processed under the recovered fines order is less certain. This is because some soil does not need to be processed and therefore is classified as Excavated Natural Material. Our best estimate is based on consultations with businesses. This indicated 300 000 tonnes of soil is currently processed under the recovered fines order. A further 25 000 tonnes of contaminated soils processed under site specific arrangements is expected to be impacted by the recovered soils order.

For the purposes of the analysis we use the volumes set out in table 1.5.

- For mixed C&D waste, we use previous estimates of the entire industry volume as the central case, and the weighted average share of fines of 31 per cent. We show a sensitivity with tonnes only for businesses we have directly consulted with for this project.
- For soil, we use the estimate of tonnes for the businesses consulted with for this project as the central case. We know this is not the entire industry, but do not know whether others are recovering soil under the recovered fines order or whether this meets requirements for ENM. As a sensitivity, we use a high case of 50 per cent more volume.

- For contaminated soil processed under site specific arrangements, we use current volumes from businesses consulted as the central case, and expected future volumes based on capacity expansions being undertaken for the high case.

1.5 Volumes used for analysis

	Central case	Sensitivity case
	000 tonnes	000 tonnes
Mixed C&D waste processed per year	2 850	1 990
Recovered fines produced from mixed C&D waste	906	616
Soil processed under the recovered fines order	300	450
Contaminated soil processed under site specific arrangements	25	80

Source: The CIE, based on consultations with waste businesses.

Uses of recovered fines

Recovered fines from processing of mixed C&D waste and soil are typically sold by the processor to retailers or used in applications by the processor themselves. Recovered fines are sometimes blended with other materials, such as Excavated Natural Material (ENM). Recovered fines are primarily used in the following applications:

- **Turf underlay**: this is the most common application of recovered fines. Turf underlay consisting of recovered fines is typically marketed as a lower-cost form of soil underlay, as in the following excerpts from websites of retailers:
  - "As the name suggests, Recycled Turf Underlay is suitable for use as an underlay when laying turf and is a soil that has been reclaimed and recycled from sites. It is screened to 10 mm to remove very large particles, rocks and pebbles and is generally considered a popular and economical underlay. Each project has its own considerations, but where you have invested a lot of money on a premium turf, such as Sir Walter, we would recommend that you not skimp on the soil you would choose to underlay it. Go for the 80/20 mix in such a case."[13]
  - "Recycled Turf Underlay is a budget recycled underlay which is predominantly used for fill. It is often compacted, before a top layer of sandy soil is applied. It is not suitable or recommended for most types of turf to be directly laid upon, however turf such as Kikuyu can survive on a thick layer of Recycled Turf Underlay."[14]
- **Gardening mix**: gardening mix is a less common application for recovered fines, and typically only where the quality (i.e. level of chemical contamination and inclusions)

13 https://www.turtlenursery.com.au/soil-supplies/recycled-turf-underlay/ accessed on 13 October 2021

14 https://parkleasandsoil.com.au/portfolio/recycled-turf-underlay/ accessed on 13 October 2021

is relatively low. Gardening mix can be used for growing plants other than turf, such as in garden beds.

- **Road base:** Combined with recovered aggregates to form a road base. This requires particular particle size mixes
- **Engineered fill**: an uncommon application for recovered fines due to the potential compactability of timber and other inclusions. This application is very broadly defined, with Hanson (a supplier of engineering fill) defining it as "fills engineered to maintain project-specific specifications and deliver a stable base by minimising water erosion"[15].
  - NSW EPA have a specification for 'Select Fill', which is material placed directly on the subgrade of pavements, and state that Select Fill can be used as engineered fill to raise site levels. For this application, engineered fill must meet requirements for strength measured based on the ability of the fill to resist a standardised penetration test.[16]
- **Quarry and other void remediation**: rehabilitation of former quarry or landfill sites can make use of recovered fines as a fill.

Better regulation principles

Under NSW Government requirements, a Better Regulation Statement (BRS) is required for significant new and amending bills and a Regulatory Impact Statement for subordinate regulations. This process is simply a formal framework to help policy-makers think through the impacts of regulatory proposals in a disciplined and comprehensive way. This helps to ensure that policy decisions are based on best practice regulatory principles (see box 1.6) and the best available evidence, resulting in better policy outcomes for the community.

1.6 Better Regulation Principles[17]

Principle 1: The need for government action should be established. Government action should only occur where it is in the public interest, that is, where the benefits outweigh the costs.

Principle 2: The objective of government action should be clear.

Principle 3: The impact of government action should be properly understood by considering the costs and benefits (using all available data) of a range of options, including non-regulatory options.

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15 https://www.hanson.com.au/products/aggregates-sand/fills-bedding/engineered-fill/

16 The California Bearing Ratio (CBR) measures the strength of the subgrade of a road or other paved area. See: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/waste/100004-supply-recycled-material.pdf?la=en&hash=7BDBD041B1287DFCEA8C399BBEB328B922C88C9E

17 NSW Government, *NSW Guide to Better Regulation*, October 2016, p. 6.

Principle 4: Government action should be effective and proportional.

Principle 5: Consultation with business and the community should inform regulatory development.

Principle 6: The simplification, repeal, reform or consolidation of existing regulation should be considered.

Principle 7: Regulation should be periodically reviewed, and if necessary reformed to ensure its continued efficiency and effectiveness.

Quantifying the benefits and costs of a regulatory proposal is a key element of the RIS process. Although the benefits and costs of regulatory proposals can be difficult to quantify precisely, quantification is nevertheless desirable to help policy-makers to better understand the complex trade-offs between environmental and social benefits and economic costs. Quantification forces critical assumptions and uncertainties to be explicitly identified meaning decisions are made with regard to maximum amounts of information. The alternative is that critical assumptions and uncertainties are implied but not identified nor understood.

The quantification of benefits and costs needs to be undertaken in a systematic framework that seeks to trace through how policy changes flow through the economy and interact with other existing (or new) policies to deliver outcomes for the community.

The BRS process can also help to engage and educate the community on complex policy issues. It can help to weigh up competing arguments and, therefore, shift the public debate beyond unsubstantiated assertions onto evidence.

2 Problem that regulation is addressing

For government regulation, a problem is defined by a 'market failure'. There are two sources of market failure relating to recovered fines:

- human health or environmental impacts related to the use of recovered fines and soil that are not taken into account by those processing and using these products
- buyers of products being unable to easily observe some types of contamination, giving rise to issues of information asymmetry.

For the purpose of understanding the problems associated with recovered fines, we distinguish between contamination and what we refer to as inclusions. Inclusions in recovered fines are material in recovered fines other than soil, bricks, concrete, and ceramics. This includes glass, asphalt, bitumen, slag, plaster, textiles, paint, engineered timber, rubber, polystyrene, soft plastics and rigid plastics. These materials are also referred to as 'foreign materials' by NSW EPA.[18]

These problems give rise to the objective of regulations relating to C&D waste. These are to protect the environment and reduce risks to human health in New South Wales, aligned to the objectives of the Protection of the Environment Operations Act 1997 (POEO Act).

Risk to human health and the environment from contamination

There are a range of risks caused by different types of contamination in soil. These costs include:

- Human diseases or other health impacts, such as lung cancer due to Chromium VI exposure[19] or biological and neurological damage from lead exposure.[20] These harms to health can lead to a range of health system costs, productivity losses, or even impact crime rates.[21]
- Harm to ecosystems, such as arsenic pollution leading to harm to nearby aquatic ecosystems.[22]

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18 NSW EPA, 2020, *Recovered Fines Workshop 2 – 23 July 2020: Outcomes Report*, October 2020, p.24.

19 https://www.epa.gov/sites/default/files/2016-09/documents/chromium-compounds.pdf

20 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2717145/

21 Childhood lead poisoning was found to be associated with $1.7 billion direct costs of crime in the USA by Gould (2009): https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2717145/

22 https://www.tandfonline.com/doi/full/10.1080/23311843.2019.1650630

- Impact on crops and domestic plants (e.g. turf), such as reduced yields in acidic soil[23] or soil containing microplastics affecting earthworms, produce and in turn becoming detectable in food.[24]

Impacts on human health and ecosystems are borne by the community, and not necessarily by the person applying recovered fines to their land. For example, recovered fines may be used as turf underlay at a home, which is then rented, and residents of the home may be affected by contamination in that underlay. Accordingly, these costs are referred to as externalities, because they are borne by people other than the consumer of the product.

Impacts on crops are not necessarily externalities, with impacts of soil contamination on turf growth usually being borne by the person who applied the soil to land.

In the market for recovered fines, there is a market failure in that the level of contamination of recovered fines will be greater than optimal, because buyers and sellers do not have a sufficient incentive to reduce the external costs of contamination. In the absence of regulation of the contamination of recovered fines, the product will be more contaminated than optimal.

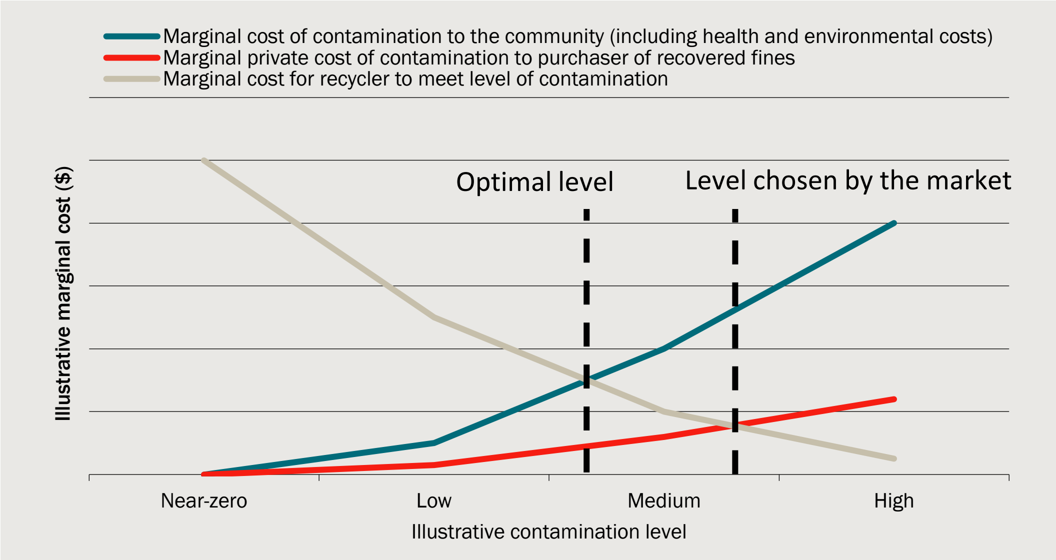
In the market for soil, buyers and sellers of soil and recovered fines will trade-off costs of reducing contamination with the costs of that contamination to consumers. In the long run, we would expect that the level of contamination will be reduced to a level where the cost of delivering a marginal reduction in contamination (the marginal cost) will be equal to the benefit to the consumer of such a reduction (the marginal private benefit).

However, if there are also public costs, such as environmental and human health costs, then this private benefit is below the total societal benefit of reducing contamination. Accordingly, the level of contamination delivered by the market will be higher than is optimal (chart 2.1).

23 https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/167209/soil-acidity-liming.pdf

24 https://www.ehn.org/plastic-in-farm-soil-and-food-2647384684/passing-through-plant-and-human-tissue

2.1 Marginal cost of contamination and meeting contamination thresholds



Note: The level of costs and benefits and shape of these curves are illustrative only.

Data source: The CIE.

Level of contamination of recovered fines

Recovered fines currently produced by C&D recyclers have varying contamination levels. The recovered fines orders specify thresholds for contamination and inclusions that must be met by recovered fines products. Audit data from EPA suggests that some recovered fines are breaching some of these thresholds. Table 2.4 provides a summary of:

- thresholds for contamination and inclusions of recovered fines,
- thresholds proposed by EPA in the new Recovered Soils Order , which are significantly lower than the existing recovered fines orders,[25]
- thresholds for site contamination from the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM), referred to as the Health-based Investigation Levels (HILs) for tier A (residential properties with garden/accessible soil),
- current levels of contamination of recovered fines based on the audit data supplied by NSW to WCRA, and
- the performance of current levels against selected thresholds.

This table does not include asbestos contamination, which is required to be zero under the existing and new orders.

Key takeaways from this comparison include the following:

25 The new order has some differences in classification of contaminants and inclusions, such as separate thresholds for a range of individual inclusions, as opposed to the broader groupings in the existing orders. For simplicity, we have sought to align the new order thresholds to the existing order and the audit data for comparison.

- The thresholds in the new recovered soils order are more strict for almost all contaminants than the existing recovered fines orders, which are in turn more strict than the HIL-A thresholds.
- Current levels of contamination of recovered fines have variable performance across facilities against the maximum average thresholds. There are rarely any contaminants with samples that exceed the absolute maximum thresholds.
- Current levels of contamination are significantly below the HIL-A thresholds with the exception of lead for which the maximum sample exceeded the threshold by 76.7 per cent, and Chromium for which the maximum sample was almost as high as the threshold. Other contaminants that were relatively close were PCBs (60 per cent of threshold) and benzo(a)pyrene (56.7 per cent).
  – Note, however, that we are comparing the maximum sample to the HIL-A thresholds. However, the NEPM prescribes that where sufficient data is available and it is appropriate for the exposure being evaluated, the mean should be compared to the HILs. Under such a comparison, the levels of contamination of each contaminant is below the HILs for all facilities.

The HIL thresholds may change in future years if supported by new evidence. Accordingly, it may be appropriate to apply a buffer to the thresholds for recovered fines/soil orders such that they are, say, 50 per cent below the HIL-A thresholds. Such a buffer would ensure that material being applied to land is unlikely to fail a future standard for site contamination, and therefore require investigation and potentially remediation.

2.2 Current levels of contaminants and comparison to thresholds

Chemicals and other attributes	Existing recovered fines orders (RFOs)		New recovered soils order (RSO)		NEPM	Current levels				Performance against RFO		Relative to HIL-A
	Maximum average conc. for characterisation	Absolute maximum conc.	Maximum average conc. for characterisation	Maximum average conc. for routine testing	Health-based investigation levels (HIL-A) [b]	Median sample	Average sample	Maximum average by facility	Maximum sample	Maximum average in any facility under RFO threshold?	Absolute maximum conc. in any sample under RFO threshold?	Ratio of maximum sample to HIL-A threshold
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	per cent
1. Mercury	0.5	1.5	0.5	1.0	50	0.1	0.1	0.2	0.3	Yes	Yes	0.6
2. Cadmium	0.5	1.5	0.5	1.0	20	0.3	0.3	0.5	1.6	No	Yes	8.0
3. Lead	100	250	75.0	150.0	300	61	67	153	530	No	Yes	176.7
4. Arsenic	20	40	20.0	40.0	100	4	4	5	12	Yes	Yes	12.0
5. Chromium (total)	60	150	10.0	20.0	100	10	11	14	99	Yes	Yes	99.0
6. Copper	70	200	100.0	250.0	6000	27	27	58	200	Yes	Yes	3.3
7. Nickel	40	80	40.0	80.0	400	7	7	15	20	Yes	Yes	5.0
8. Zinc	250	600	150.0	400.0	7400	113	119	199	490	Yes	Yes	6.6
9. Total Organic Carbon	5%	10%	0.0	0.0	N/A	0%	0%	0%	0%	Yes	Yes	N/A
10. Electrical Conductivity	2.5 dS/m	3.5 dS/m	1.5 dS/m	3.0 dS/m	N/A	2.0	1.5	2.5	2.5	Yes	Yes	N/A
11. pH *	7.5 - 9	7.0 - 10	5.0-9.0	4.5-10.0	N/A	8.7	8.7	9.5	9.9	No	Yes	N/A
12. Total Polycyclic Aromatic Hydrocarbons (PAHs)	20	80	20.0	50.0	300	4	6	18	30	Yes	Yes	10.0
13. Benzo(a)pyrene	1	6	1.0	2.0	3	0	1	2	2	No	Yes	56.7
14. Total Petroleum Hydrocarbons (TPHs) C6-C9	80	150	N/A [a]	N/A [a]	N/A	20	21	24	40	Yes	Yes	N/A
15. Total Petroleum Hydrocarbons (TPHs) C10-C36	800	1600	N/A [a]	N/A [a]	N/A	295	307	873	1 250	No	Yes	N/A
16. Individual Chlorinated Hydrocarbons	N/A	1	N/A	N/A	N/A	0.20	0.19	0.20	1.00	N/A	Yes	N/A

Chemicals and other attributes	Existing recovered fines orders (RFOs)		New recovered soils order (RSO)		NEPM	Current levels				Performance against RFO		Relative to HIL-A
	Maximum average conc. for character-isation	Absolute maximu m conc.	Maximum average conc. for character-isation	Maximum average conc .for routine testing	Health-based investigat-ion levels (HIL-A) [b]	Median sample	Average sample	Maximum average by facility	Maximum sample	Maximum average in any facility under RFO threshold?	Absolute maximum conc. in any sample under RFO threshold?	Ratio of maximum sample to HIL-A threshold
17. Individual Organochlorine Pesticides	N/A	1	N/A	N/A	N/A	0.20	0.20	0.22	0.30	N/A	Yes	N/A
18. Individual Polychlorinated Biphenyls (PCBs)	N/A	1	N/A	N/A	1	0.20	0.21	0.28	0.60	N/A	Yes	60.0
19. Glass, metal and rigid plastics	0.1%	0.3%	N/A	0.01%	N/A	0.13%	0.18%	0.70%	1.50%	No	No	N/A
20. Plastics - light flexible film	0.05%	0.10%	N/A	0.0	N/A	0.10%	0.11%	0.17%	0.20%	No	No	N/A
21. Proportion (by weight) retained on a 0.425 mm sieve	80%	90%	N/A	0.0	N/A	N/A	N/A	N/A	N/A	Yes	Yes	N/A
22. Proportion (by weight) retained on a 9.5 mm sieve	N/A	5%	N/A	0.0	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A
23. Proportion (by weight) retained on a 26.5 mm sieve	N/A	0%	N/A	0.0	N/A	N/A	N/A	N/A	N/A	N/A	Yes	N/A

[a] These values are not applicable only because the new order prescribes levels of Total Recoverable Hydrocarbons (TRHs) rather than Total Petroleum Hydrocarbons (TPHs) and because of the thresholds used for different fractions (e.g. C6-C10 vs C6-C9). This makes the thresholds not directly comparable.

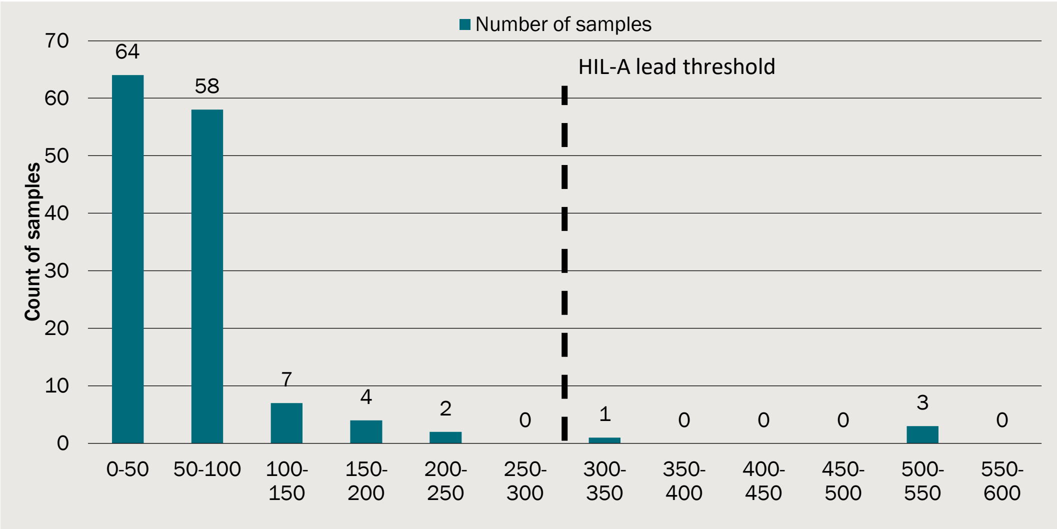
[a] As a minimum, the maximum or 95% UCL should be compared to the HILs. However, where there is sufficient data and it is appropriate for the exposure being evaluated, the arithmetic mean (or geometric mean in the case of a log normal distribution) should also be compared to the HILs.

Note: mg/km is dry weight unless otherwise specified. 'Conc.' denotes concentration. N/A for a column showing thresholds means that the threshold is not regulated under that framework (e.g. proportion of glass, metal and rigid plastics is not specified as part of the HIL-A). N/A for a column showing

Source: NSW EPA Audit data supplied by WCRA, *National Environment Protection (Assessment of Site Contamination) Measure 1999* Schedule B7 'Derivation of Health-based Investigation Levels', available at: https://www.legislation.gov.au/Details/F2013C00288

The concentration of lead in EPA audit samples is generally below 100. However, 4 samples (2.8 per cent) exceeded the HIL-A threshold for lead.

2.3 Distribution of lead concentration among EPA audit samples



Data source: NSW EPA audit data, CIE.

Comparison to the Health-based investigation levels (HILs)

The HILs provide a useful comparison for the current levels of contamination and thresholds in the new and proposed orders. The NEPM states that "each HIL should embody a margin of safety such that there is no appreciable risk for exposures for the relevant scenarios".[26]

The HILs are set for a few tiers of sites (shown in Appendix B), which are as follows:[27]

- HIL A (chart 2.4): Residential with garden/accessible soil (home-grown produce <10% fruit and vegetable intake), also includes childcare centres, preschools and primary schools
- HIL B: Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments
- HIL C: Public open space such as parks, playgrounds, playing fields, secondary schools and footpaths. This does not include areas of undeveloped open space
- HIL D: Commercial/industrial such as shops, offices, factories and industrial sites.

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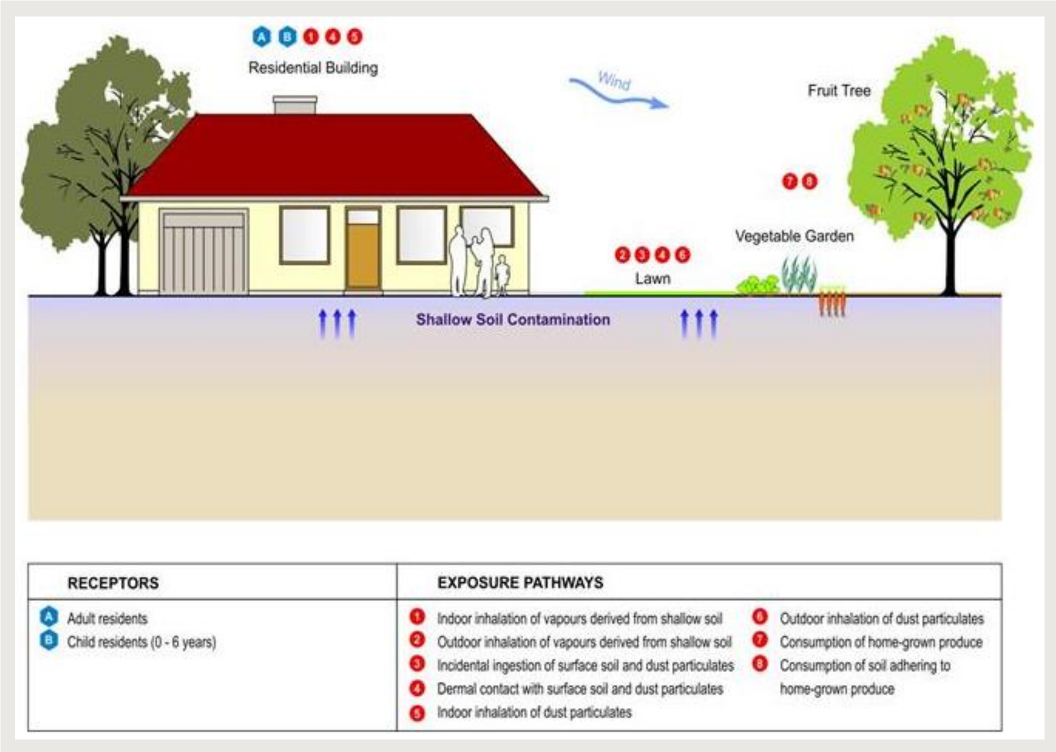
26 *National Environment Protection (Assessment of Site Contamination) Measure 1999* Schedule B7 'Derivation of Health-based Investigation Levels', available at: https://www.legislation.gov.au/Details/F2013C00288

27 These definitions are extracted from the NEPM.

2.4 Residential site aligning to HIL-A thresholds



Data source: National Environment Protection (Assessment of Site Contamination) Measure 1999 Schedule B7 'Derivation of Health-based Investigation Levels', available at: https://www.legislation.gov.au/Details/F2013C00288

However, comparison to the HILs are subject to a few key limitations, extracted verbatim from the NEPM in (Box 2.5). We believe these levels provide an appropriate comparator to assess whether the current levels of contamination are leading to health risks. These standards were stated to generally be very conservative according to NSW EPA in 2015.[28] Comparison to these levels suggests that the current levels of contamination are not likely to be resulting in significant harms to human health.

28 https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/epa/150308-nepms.ashx

2.5 Objectives, approach and limitations of the HILs

- "The HILs (including interim HILs) are scientific, risk-based guidance levels (or Tier 1 criteria) designed to be used in the first stage of an assessment of potential risks to human health from chronic exposure to contaminants."
- "HILs are defined as the concentration of a contaminant above which further appropriate investigation and evaluation will be required. Levels in excess of the HILs do not imply unacceptability or that a significant health risk is likely to be present. Similarly, levels below the HILs do not necessarily imply acceptability or that a health risk is not likely to be present, particularly if more sensitive populations are present or the assumptions for land use scenarios are not appropriate."
- "The HILs have been designed to be protective of the health of most people who could potentially be exposed to soil contaminants under four broad land use categories. For people within sensitive populations; for example, the immunosuppressed, those with pre-existing illness, or those with pica behaviour, the HILs may not be sufficiently protective of health. These issues would need to be addressed in a site-specific assessment."
- "each HIL should embody a margin of safety such that there is no appreciable risk for exposures for the relevant scenarios, A–D. This has been undertaken on the basis of available scientific information to March 2012 (including toxicity reference values that are generally based on the known most sensitive significant toxicological effects)."
- "The generic land use scenarios used in the development of the HILs will be unlikely to accurately reflect all of the conditions present at an individual site. As the HILs are intended to represent a 'reasonable worst case' for each land use, provided that the site land use is broadly equivalent to one of the HIL scenarios, the HILs will provide for a health protective Tier 1 screening assessment. There are some limitations to the use of HILs, as described previously."

Source: *National Environment Protection (Assessment of Site Contamination) Measure 1999* Schedule B7 'Derivation of Health-based Investigation Levels', available at: https://www.legislation.gov.au/Details/F2013C00288

A key issue is higher-risk populations, specifically immune-compromised people and children with pica (eating items without nutritional value, such as soil), which may still have toxic effects from levels of soil contamination below the thresholds. There is not a great deal of evidence about prevalence of pica among children (see box 2.6) or about the costs of resultant health and other issues caused by soil ingestion.

2.6 Prevalence of soil pica behaviour among children

Prevalence of soil pica among children is uncertain, and there is little data to support estimation of the share of children with ingestion behaviour

- EPA assumes 95 per cent ingest 200mg soil/day or less, but some children can consume up to 25-60g of soil in a single day. This level of ingestion could result in doses that would be fatal from soil that meets EPA's 'conservative' acceptable contamination thresholds[29]
- Observational data (fecal samples) from 20 institutionalised children in Jamaica in 1988, suggests that 20.8 per cent of children aged 1-6 had at least one soil pica incident (at least 1g in a day), and 10.5 per cent had at least 1g/day ingestion rate over a four month period. However, there are a range of limitations with this study and inference about pica prevalence in other settings/countries, due to behavioural differences (children were institutionalised), the uniformly warm climate of Jamaica which might influence time spent outside, and the relatively low extent of grass cover in the Jamaican setting.[30]
- One out of 64 children in 'Calabrese, Pastides and Barnes (1989) displayed soil pica behaviour. This child had soil ingestion of 5-8 grams per day. This study used a mass balance approach, which compared to a fecal audit approach (such as in Wong, 1988) results in lower but more accurate estimates of ingestion. It foundthat median soil consumption among the remaining 63 children was 9-40mg per day.
- More recent data based on parental interviews suggests that 38 per cent of children put soil in their mouths (mouthing or ingestion) at least monthly, 24 per cent at least weekly and 11 per cent daily.[31]
- However, it is difficult for parents to identify high-soil ingesters, with Calabrese, Stanek and Barnes (2008) finding that among 12 children identified as high ingesters, one displayed high soil ingestion (0.5-3.05g/day), while the median ingestion among the other 11 children being comparable to typical soil ingestion among children not assumed or observed to have soil ingestion behaviour.[32]

29 https://ehp.niehs.nih.gov/doi/abs/10.1289/ehp.971051354

30 https://www.umass.edu/metasoil/no_password/reference/Soil%20pica%20not%20a%20rare%20event.PDF

31 https://www.tandfonline.com/doi/abs/10.1080/10588339891334249

32 https://www.tandfonline.com/doi/abs/10.1080/15320389709383565

Risk of asbestos exposure and asbestos-related diseases (ARDs)[33]

Asbestos contamination was identified by NSW EPA in 57 per cent of samples of recovered fines assessed as part of the review of the recovered fines order.[34]

Asbestos fibres are hazardous and can cause mesothelioma, lung cancer, pleural disease and asbestosis when inhaled. The fibres can be released into the air when asbestos products are incorrectly handled, stored or transported for disposal.

Asbestos-contaminated soil can create risks of exposure to airborne fibres, such as through lawnmowing or other processes that disturb the soil. A SafeWork NSW guide for managing asbestos in or on soil prescribes practices for removal of asbestos in the top 10cm of soil stratum.[35] The SafeWork Guide also states that ‘where non-friable or friable asbestos is present in soil at depth greater than 0.5 metres, it should not be disturbed except for site remediation, redevelopment or management. For intermediate depths, a site-specific assessment should be undertaken. This indicates that the risks of fibres becoming airborne are related to the depth of asbestos-containing soil.

Under the current criteria for asbestos waste classification in NSW, a contamination below NEPM levels (0.1 g/kg or 0.01 per cent) can nonetheless deem the tested material or stockpile as asbestos waste.

In 2015, there were an estimated 4 152 deaths in Australia due to asbestos-related diseases, and 10 444 prevalent cases of disease. This accounts for mesothelioma in addition to a broader range of ARDs such as lung cancer. While the majority of these cases are due to past occupational exposure, there remains a significant number of people living with disease that have not had any workplace contact with asbestos.

Hospital and primary healthcare costs associated treating ARDs are estimated at $190 million for 2015.[36] Furthermore, living with an ARD compromises an individual’s ability to participate in the paid and unpaid workforce. Productivity losses also flow through to carers who are no longer able to participate in work and the community as they otherwise would. These indirect effects are estimated at $321 million in 2015. Most losses (85 per cent) are due to disease caused by occupational exposure, with losses evenly shared between paid and unpaid work.

Chart 2.7 presents estimates of the health system and productivity costs of ARD in 2015.

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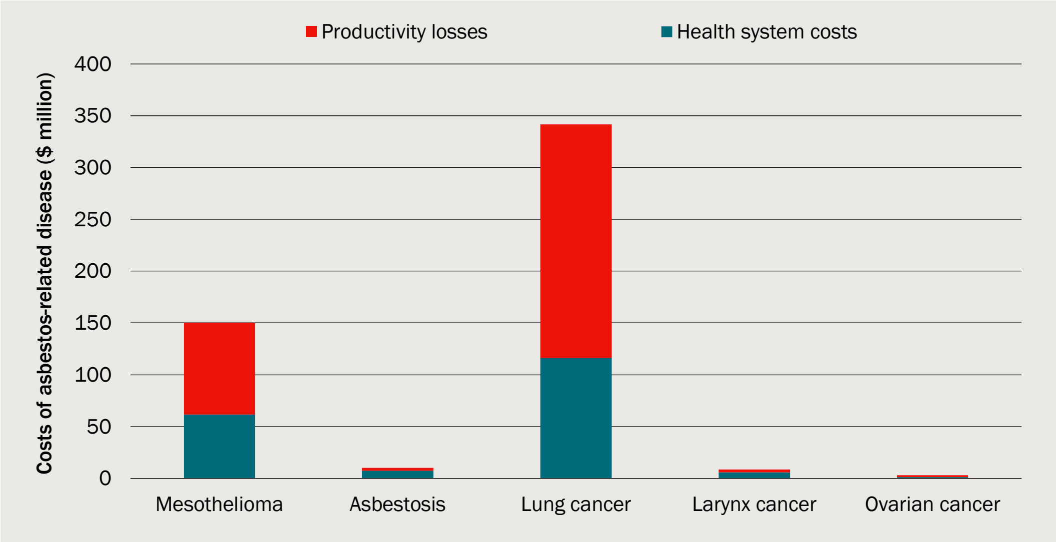
33 The CIE conducted a comprehensive costing study of the economic burden of asbestos-related disease for the Asbestos Safety and Eradication Agency in 2017, https://www.asbestossafety.gov.au/sites/default/files/documents/2018-07/ASE-2274%20CIE%20Executive%20Summary.pdf

34 NSW EPA, 2020, *Recovered fines workshop 3: Outcomes report*, October 2020, p.15.

35 https://www.safework.nsw.gov.au/resource-library/asbestos-publications/managing-asbestos-in-or-on-soil

36 This includes cost for hospital admissions ($53.7M), GPs ($21.5M), specialist and other health practitioners ($48.4M), an pharmaceuticals ($59M).

2.7 Summary of health system costs and productivity losses



Note: This chart does not show our estimates of the monetary value of lost quality-of-life because these estimates should not be added to estimates of the value of lost productivity.

Source: The CIE.

The majority of current cases are likely related to occupational exposure in workplaces that occurred before modern occupational asbestos regulations and practices came into effect.[37] Furthermore, management of waste or recycling does not appear as an occupation of specific interest in studies of occupation-related cases of mesothelioma, indicating a rather low risk for exposure.[38]

Further, any asbestos risks associated with recovered fines would be associated with non-compliance, since there is no difference between the level of tolerable asbestos contamination between the existing and proposed orders.

Possibility of environmental impacts at contamination levels below HIL-A

While HIL-A is a useful comparator to assess the health-based risk associated with contamination of soil, it is not necessarily a good guide as to the environmental risk associated with contamination. Recovered fines could potentially be associated with leachate once applied to land, and NSW EPA has also cited risks of plastics entering marine ecosystems (chart 2.8).[39] If this led to impacts on animals (such as extinction of endangered species) or impacts on plants/ecological communities, then these could be costly environmental impacts.

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37 AIHW (2020), *Mesothelioma in Australia 2019,* https://www.aihw.gov.au/getmedia/558c0b6d-e872-4a0f-953d-23ae6afab3b0/aihw-can-134.pdf.aspx?inline=true

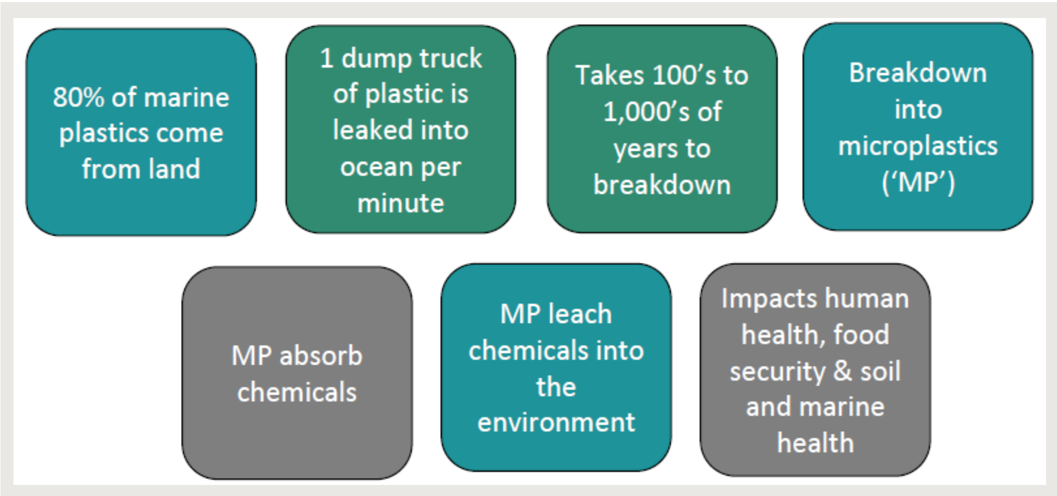
38 Finity Consulting, 2016, *The Third Wave: Australian mesothelioma analysis and proje*ction, pg. 69, available at: http://www.finity.com.au/publication/the-third-wave-australian-mesothelioma-analysis-projection

39 NSW EPA, 2020, *Recovered Fines Workshop 2 – 23 July 2020: Outcomes report*, October 2020, slide 24 in workshop presentation.

It is difficult to value the costs associated with terrestrial deposits of plastics and other materials that are relevant for recovered fines. This is often because of lacking evidence about the effect of these materials when present in the marine or terrestrial environments on animals or plants. For example, Wang et al (2019) states that while microplastic pollution is present in Chinese coastal environments, the impact of this pollution remains to be made clear, and further risk assessment is needed.

The environmental costs associated with foreign inclusions in recovered fines such as plastics are likely to be extremely small. The recovered fines audit data suggests a simple average plastic concentration of 0.04 per cent across the 14 facilities that were sampled. Based on 906 000 tonnes of recovered fines produced each year, this implies 362.4 tonnes of plastics being applied to land. Only a very small fraction of this material, if any, would be expected to enter the marine environment, particularly where soil is applied to land that is not close to coastal or inland waterways. For comparison, an estimated 26 150 tonnes of plastic litter may be entering the ocean each year.[40] Given that such a small volume of plastic material in recovered fines would enter waterways, this suggests that the risk of environmental harms from plastics in recovered fines is negligible.

2.8 NSW EPA rationale for risk associated with plastic in recovered fines



Data source: NSW EPA, 2020, *Recovered Fines Workshop 2 – 23 July 2020: Outcomes report*, October 2020, slide 24 in workshop presentation.

Information asymmetries for private costs of contamination and inclusions

There are unlikely to be information asymmetries associated with inclusions. This is because inclusions are more likely to be visible, such as polystyrene beads. Marketing of products such as turf underlay appears to position the product as a cheaper alternative to others, which would appropriately reflect their level of inclusions.

40 Based on global estimate of 8 million tonnes of plastics entering ocean (see https://www.marineconservation.org.au/ocean-plastic-pollution) and Australia's share of plastics emitted to the ocean, estimated as 0.003 per cent.

NSW EPA, in a workshop presentation relating to recovered fines, reported consumer feedback about inclusions in soil material which stated:

> "I have experienced 'turf underlay' or recovered fines from landscape suppliers who supply a product littered with plastic and saw dust which has no benefits for quality plant or turf growth"

This feedback suggests that inclusions such as plastics, saw dust, and likely others are apparent to customers. These physical inclusions can be differentiated from chemical contaminants which aren't apparent upon visual inspection of the material, and costly testing is required to assess chemical contamination levels.

Findings of EPA review of recovered fines

As noted above, NSW EPA conducted a review of recovered fines in 2019, based on two previous years of data. It found potential issues and risks including:

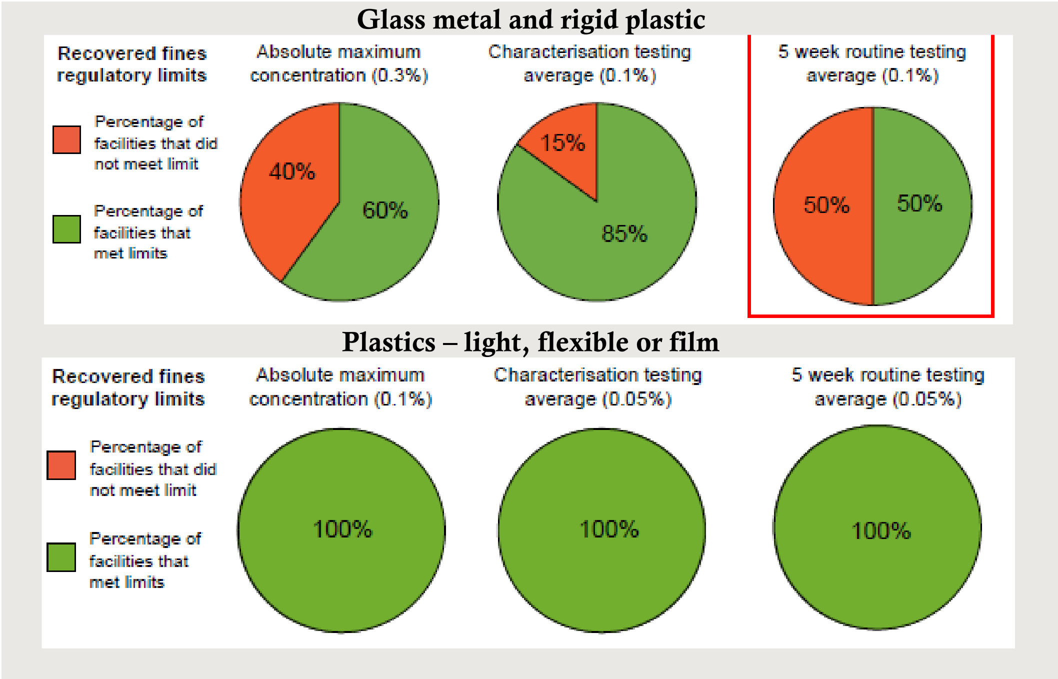
- the presence of asbestos in recovered fines
- the presence of microplastics, chemically treated timbers and synthetic mineral fibres (SMF) in recovered fines
- failure to meet a chemical or attribute limit at least once in the 2 years of data reviewed
- failure in an aspect of required testing, and in some, failure to meet the testing frequency
- failure to notify the EPA of non-compliances, and evidence of continued retesting of noncompliant samples, and
- that sampling for recovered fines on a "continuous" basis was inadequate as it did not provide a reliable representation of the waste being supplied to the community.[41]

In workshops with industry participants aimed at improving the quality of recovered fines in 2020, NSW EPA also outlined its findings from data and key concerns. While it found that in its sampling, most contaminants met the chemical limits in the RF order, it considered there to be high levels of foreign material in some fines (chart 2.9).[42] It also found that many samples had some level of asbestos. The level of performance against standards across facilities was mixed.

41 NSW EPA 2021, Letter to facilities, 2 September 2021, https://asbg.net.au/attachments/article/559/Letter%20to%20recovered%20fines%20facilities%20re%20regulatory%20response.pdf.

42 NSW EPA 2020, Workshop 2 Outcomes Report, May

2.9 NSW EPA Assessment of foreign materials



Data source: NSW EPA 220, Workshop 2 Outcomes Report, May.

These issues highlight a compliance concern with respect to the existing recovered fines orders.

3 *Alternative options*

The objective of regulations relating to C&D waste is related to the objectives of the Protection of the Environment Operations Act 1997 (POEO Act), including to protect the environment and reduce risks to human health in New South Wales.

Options to achieve these objectives with respect of recovered fines and recovered soils include:

- the base case — continuation of existing regulatory arrangements currently in place, which detail the uses and contamination requirements for recovered fines
- EPA's proposed option — this is the EPA's proposed option to revoke orders related to recovered fines and to introduce an order related to recovered soils. The EPA has also indicated that it would consider site specific orders but not related to mixed C&D waste.

There are a range of other options outside of these that relate to the standards for material used for different purposes and the approach to compliance and enforcement with standards. There has not been sufficient time to work through these options in detail. Some of these are set out in broad terms below as well.

The sections below expand on these alternative options.

The base case

The current regulatory arrangements for recovered fines allow for fine material from mixed C&D waste to be used for construction or landscaping. This is used by the waste industry to cover:

- mixed C&D waste collected in skip bins and then processed to different types of material. This includes a recovered fines product. Some businesses also mix recovered fines with recovered aggregates to produce road base
- waste that is predominantly soil but still requires some processing and hence cannot be classified as excavated natural material (ENM). This also includes soil that would not meet the contamination requirements of ENM.

There are also some businesses that treat contaminated soil under site specific arrangements. This is not covered under the recovered fines order.

The EPA currently has two orders — continuous and batch — which differ in their sampling and processing arrangements. Essentially, a batch process is one where a particular load is processed individually, while a continuous process has lots of different loads continuously being added. The latter means that there is more mixing of loads of different types.

Under the base case businesses continue to process mixed C&D waste and soil as part of the recovered fines order.

EPA proposed option

The EPA has indicated that it is proposing to revoke the recovered fines order. It will at the same time introduce a recovered soils order. The recovered soils order would allow for the processing of excavated material and soil for use as earthworks and engineering fill.

This option would mean:

- fine material from processing of building and demolition waste would not be able to be applied to land in its current arrangements (for landscaping and construction). We consider that fine material from mixed C&D waste could also not be blended in with aggregate to make road base through use of the recovered aggregate order, because that order does not specify soil as an input material
- soils currently processed through the recovered fines order could now be processed through the recovered soils order. However:
  - the contamination thresholds are specified as being lower which will mean some soil would not be able to be processed to meet the proposed recovered soil order
  - the foreign material concentrations are proposed to be limited to microscopic levels, which will not allow for much material if any to be recycled
  - the set of uses also appears more restrictive, in that landscaping is not included. We expect that this means that this material could not be used for turf underlay, which is one of the major current uses.

We also understand that under this proposal facilities that have site specific arrangements for processing of contaminated soils would have their standards aligned to the recovered soils order.

We have not examined in detail what the impacts would be if similar standards for contamination were extended to other resource recovery orders such as aggregates. This would be expected to have larger impacts than for mixed C&D waste, as the recovery of source separated materials is more economic than mixed C&D waste, and the quantity of materials is larger.

Other alternative options

There has not been sufficient time to work through the alternative options in detail. However, broadly they could include:

- replacing the recovered fines order with a recovered fill order, which limits the use of material to be in areas with less likelihood of human health or environmental impacts
- variation to the arrangements in place for contamination and foreign material levels under existing recovered fines orders, such as:

  - aligning to HIL-A contamination levels, which are typically less stringent than the recovered fines orders
  - aligning to the HIL-B (Residential with minimal opportunities for soil access; e.g. high-rise buildings and apartments), HIL C: (Public open space such as parks and footpaths) or HIL D:(Commercial/industrial) thresholds
  - not imposing restrictions on inclusions/foreign materials, but retaining strict chemical contamination thresholds
  - applying restrictions on individual inclusions/foreign materials to apply to groups of like density foreign materials to ensure that commercial labs are able to consistently analyse materials
- increased compliance and enforcement of the existing recovered fines order, and increased penalties or revocation of ability to produce for operators that are breaching standards in a way that impacts on human health or the environment
- changes to recovered soils to make the order apply to a larger share of material, such as alterations to the contamination/foreign material inclusion thresholds
- site specific orders consistent with current recovered fines (white list)
- use of recovered fines in construction applications but not in landscaping applications
  - it is a little unclear from interstate regulations where recovered fines would sit, but appears that this would have similarities with the approach taken in Victoria (see Appendix C)

Further analysis of these options is recommended by NSW EPA.

4 Impacts of alternative options

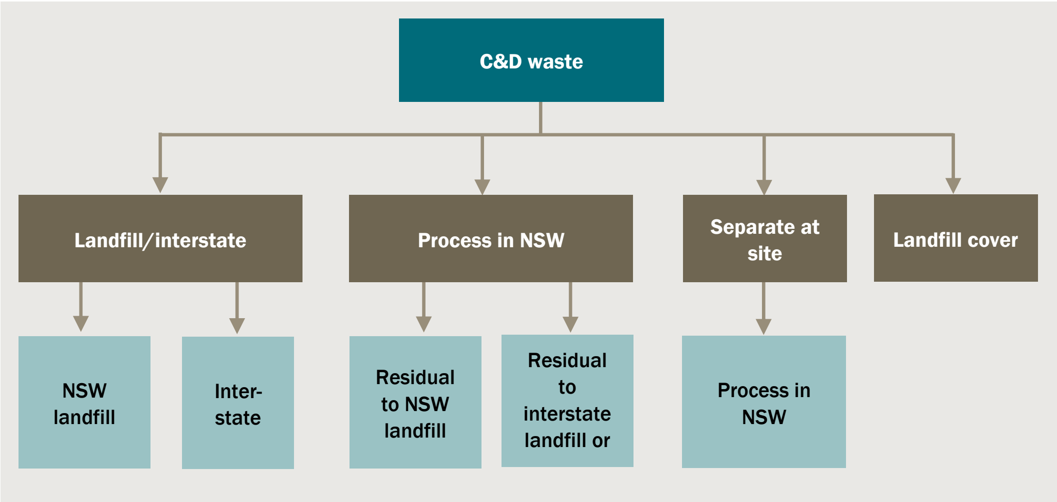
Businesses within the resource recovery and construction industries will respond differently to the regulatory options depending on factors such as:

- the characteristics of the material that they receive as inputs — material with a higher share of fine material but that cannot be covered under the recovered soils order will be most impacted
- the ability of the construction site to accommodate multiple bins that allow for separation of soil and other materials at site
- the assets owned by the resource recovery business, their ability to repurpose these to alternative activities and the incremental costs to them of different alternatives. For example, a resource recovery business with its own truck fleet may use excess capacity to move material into other states, while a business with its own landfill will direct material there. A business that has ageing processing infrastructure will be more likely to move away from processing mixed waste, while one with new infrastructure will be more likely to continue processing mixed waste
- the expectations of the resource recovery business and its customers around resource recovery. For example, customers that are seeking to achieve higher resource recovery as part of their sustainability commitments will be more likely to pay a premium to do so, leading to continued recycling of mixed C&D waste even if the fines cannot be recovered.

Mixed C&D waste

For mixed C&D waste, we can envisage six possible alternative pathways for material (chart 4.1). The different pathways impact on the economic and financial costs, as well as the achievement of government objectives related to resource recovery. For example, moving mixed waste directly to landfill will mean large amounts of material are not recovered, but will avoid costs related to processing of mixed C&D waste. Alternatively, if mixed C&D waste is processed, then it will only be the fine component that is directed to landfill.

4.1 Alternative pathways for mixed C&D waste

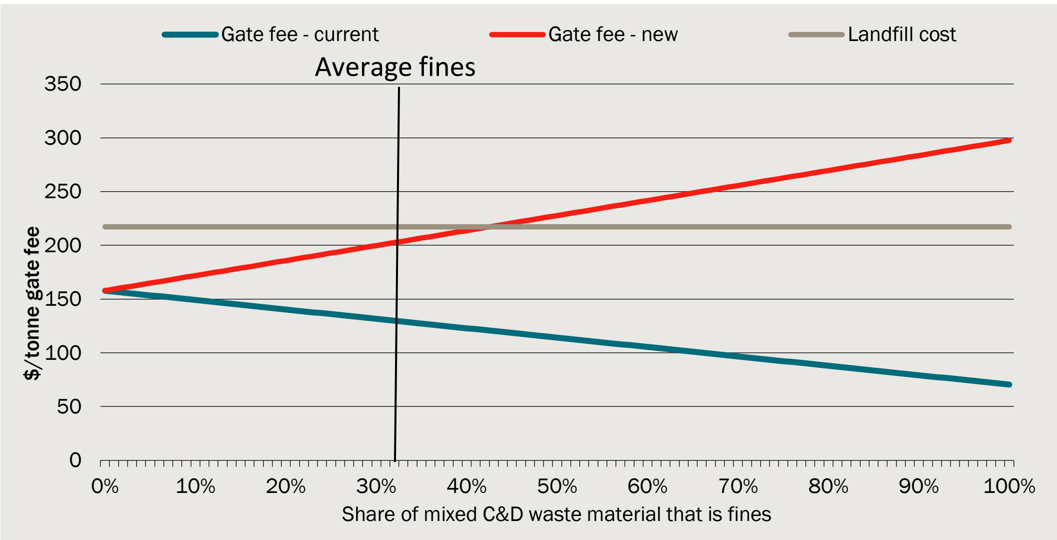


Data source: The CIE and consultations with waste businesses.

Financially, the pathways will be dependent on the type of mixed waste load. In chart 4.2 we show gate fees for recycling under the current regulations versus with no use of recovered fines. Currently, a higher share of fines leads to a lower gate fee — and an average gate fee is ~$130 per tonne. Without being able to use recovered fines, a higher share of waste that is fines will lead to higher gate fees. At about 40 per cent of material being fines, the gate fee offered for mixed C&D recycling would be about the same as landfill.

Note that these calculations maintain shares for other materials. There is wide variety in other materials, such as metals, concrete and bricks, wood and plastic, which also impacts on the gate fee for material.

4.2 Mixed C&D waste gate fees with alternative load types



Data source: The CIE.

To understand the alternative directions for mixed C&D waste we have:

- estimated the financial costs for disposal under each alternative option, which will provide a guide as to which option is likely to be chosen where least cost disposal is being sought by the construction and waste disposal businesses. The financial costs are estimated for an average load. Different loads will have different cost implications, and will lead to different waste mixes moving in different directions
- consulted with the major mixed C&D waste recyclers to understand what they expect to do in the absence of the ability to use recovered fines as a product. This was then weighted with their current tonnages to derive industry wide shares to each alternative pathway.

The assessment has focused on legal pathways for material. The removal of the recovered fines orders may lead to a range of other possible directions that are grey areas or are not legal. This could include:

- processing soils through the recovered aggregates order, because this order does not specify a minimum particle size
- processing bulk excavated soil through the ENM resource recovery order — strictly ENM is for material that is not processed
- illegal dumping of material — higher gate fees is a financial incentive for increased illegal dumping (box 4.3), which then has costs associated with clean-up.

4.3 Price incentives and illegal dumping

In a 2007 study[43], MMA and BDA Group undertook an empirical analysis of illegal dumping in the state of South Australia drawing on a Local Government Association baseline study of illegal dumping incidents. It was estimated that the extent of illegal dumping was sensitive to legal disposal costs, with a cross-price elasticity of around 2. That is, if the price of legal disposal increased by 50 per cent (minimum increase expected for mixed C&D waste), the amount of illegal dumping would double.

Another study by Kinnaman (2009),[44] analysing illegal dumping data for South Korea, estimated a cross-price elasticity of 3. This represents a very sensitive response.

We therefore assume the medium dumping elasticity of 2, and a high and a low elasticity of 3 and 1.5 respectively.

We do not have data on the current volume of C&D material that is illegally dumped. In its 2007 study, MMA and BDA study that total illegal dumping volume was about one per cent of landfill amount, and about 10 per cent was C&D. If this was similar in NSW, this would imply ~8000 tonnes more illegal dumping in NSW. Note that it may be higher in NSW given the much higher landfill disposal fees than South Australia.

43 MMA and BDA 2007, *South Australia's Waste Strategy 2005-10: Ex-ante Benefit Cost Assessment*,

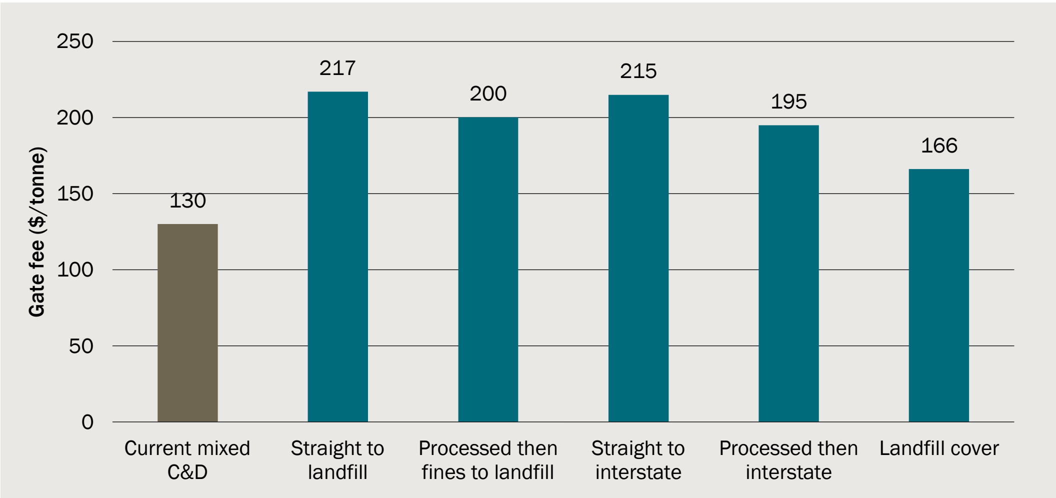
44 Kinnaman, Thomas C. 2009, "The Economics of Solid Waste Management", *Waste Management*, 29, p.2615-2617.

Financial costs of alternative pathways

We can estimate the financial costs of alternative pathways for mixed C&D waste through understanding the costs of processing and the prices of the outputs of mixed C&D waste. For a typical load, the estimated gate fees are shown in chart 4.4 for the current gate fee and for a range of alternative disposal options.

- All pathways would lead to gate fees much higher than the current gate fee for mixed C&D waste. This would in turn be expected to be passed on to those generating material.
- Whether or not mixed C&D material is processed, and then fines go to landfill, or the whole mixed C&D load goes to landfill, and whether it is sent interstate, all lead to fairly close gate fees, ranging from $195 per tonne to $217 per tonne. This suggests material will go to different destinations depending on the specific circumstances of the business and characteristics of the waste.
- Use of recovered fines as landfill cover would lead to a lower gate fee for mixed C&D waste of $166 per tonne. This is based on recovered fines avoiding 75 per cent of the waste levy. However, as noted below the market for this is likely to be somewhat limited.

4.4 Gate fees without ability to recover fines for mixed C&D waste



Data source: The CIE.

The financial costs for source separation will vary across construction sites, and it is not possible to give a single figure for this. Some construction sites already undertake a degree of source separation where this can assist in reducing their costs and meeting their resource recovery targets. This would be further incentivised if recovered fines cannot be recycled. However, consultations indicated this would only be likely for a small share of sites (at most 5 per cent of current mixed waste), given the additional land requirements and additional other site and skip bin costs.

The financial costs for use of recovered fines as landfill cover would reduce the disposal cost of processed recovered fines and be an attractive option if recovered fines cannot be used elsewhere. Currently, landfills use a range of approaches for daily cover, including:

- material won on-site, for which no levy is paid
- material brought to site, such as VENM, for which there is a levy liability
- tarpaulin covers or other covers that can be removed at the start of each day
- spray covers (eg ConCover), and
- recovered fines.

The materials able to be used are set out in the licences for each landfill. Recovered fines can be used if approved for the particular landfill and these meet the conditions of the Recovered Fines Alternative Daily Cover specifications.[45] In this case they attract a waste levy equal to one quarter of the full waste levy.

We would expect that using fines as alternative daily cover would be a very attractive option when landfill is the only alternative, and only limited by the size of the market. Exact estimates of the amount of recovered fines that could be diverted to alternate daily cover are not available. EPA has previously noted that “Each facility will only be able to receive a limited quantity of recovered fines for land application as daily cover per annum to ensure that the discounted levy rate does not become a mechanism for waste levy avoidance.”[46] It is understood following consultations with C&D landfill operators that landfills sited that are approved to use recovered fines as Alternate Daily Cover are limited to approximately 15 000 tonnes per annum. The Better Regulation Statement related to introducing the levy exemption for recovered fines did not detail what amount of use was expected and formed the basis for the estimated costs and benefits associated with this change.[47] We have held discussions with landfills on the likely magnitude of daily cover, but given this appears to be limited by EPA we do not have a robust figure on this.

For the purposes of the analysis, we have applied a high estimate of 20 per cent of recovered fines from mixed C&D waste material being used for alternative daily cover. Under the central case recovered fines volumes, this would mean ~200 000 tonnes per year. WCRA and WMAA are also in the process of developing estimated of the market for ADC, and initial results suggest 100 0000 tonnes may be possible.

Business consultations

Waste business consultations indicated a variety of expected responses if recovered fines could not be reused. Weighted by tonnes:

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45 https://www.epa.nsw.gov.au/your-environment/waste/waste-levy/levy-regulated-area-and-levy-rates

46 NSW EPA 2018, Better Regulation Statement Protection of the Environment Operations Legislation Amendment (Waste) Regulation 2018, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wasteregulation/18p1271-better-regulation-statement.pdf.

47 NSW EPA 2018, Better Regulation Statement Protection of the Environment Operations Legislation Amendment (Waste) Regulation 2018, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wasteregulation/18p1271-better-regulation-statement.pdf.

- 23 per cent of mixed C&D waste would go directly to a NSW landfill
- 62 per cent of mixed C&D waste would be processed and fines would become part of the residual sent to landfill
- 9 per cent would be sent interstate as mixed C&D loads
- no recovered fines would be sent interstate, and
- a small amount of material would be source separated (we allow for 5 per cent)
- some material may be used as alternative daily cover. However, expectations are that this would be small as this market was already saturated.

This aligns to expectations from the financial analysis that there would be a range of alternatives pursued. The major difference is that the financial analysis suggested that the least financial cost option would be to process mixed C&D waste in NSW and then send the recovered fines interstate. This was not considered an option by any business. Potentially this is because this would be inconsistent with the Proximity Principle, because material sent interstate (QLD) would likely be landfilled. Businesses were yet to investigate in detail whether their processed fines would be suitable for interstate markets for use rather than landfill. We expect that if recovered fines could be sent interstate for use, then this would be financially the best option for waste businesses, as it would avoid levies imposed on waste disposed of to landfills.

Note that businesses also anticipated regulatory responses if large quantities of material were sent interstate.

Bulk excavated soil

For bulk excavated soils that are currently processed under the recovered fines orders, or that are processed under site specific arrangements that would be aligned to the proposed recovered soils order, alternatives were derived from consultations.

- Based on the current recovered soils order, very little if any of the material currently processed could be recovered and used in a way currently allowed. This is because landscaping is not allowed as a use and contamination thresholds proposed are not achievable.
  - In this case all material would be landfilled
- With changes to the recovered soils order all soil could potentially be recovered. This would require changes to the proposed contamination thresholds and foreign material thresholds. We model the proposed order as currently specified, under which we expect no soil to be able to be processed, as businesses have indicated that the current thresholds are not achievable on a consistent basis, leading to too little commercial incentive to process for the time when material is meeting thresholds.
- Contaminated soil processed under site specific requirements would also be landfilled as these arrangements were made consistent with the recovered soils order. However, it would continue to be processed so that it could be landfilled in a non-hazardous landfill.

Estimates used for alternative pathways

Based on the discussion above, we have used the alternative pathways for material shown in table 4.5.

- For mixed C&D waste, about half of this (by tonnes) would be processed and then fines sent to landfill, a further 20 per cent processed and then used as landfill cover, 17 per cent directed straight to landfill, 7 per cent directed interstate and 5 per cent source separated at construction sites.
  - for alternate daily cover (ADC) for landfills, we have applied a high estimate of 20 per cent of recovered fines from mixed C&D waste material being used for alternative daily cover. Under the central case recovered fines volumes, this would mean ~200 000 tonnes per year. WCRA and WMAA are also in the process of developing estimated of the market for ADC, and initial results suggest 100 0000 tonnes may be the upper end of this market. If the market for ADC is smaller then more recovered fines would go into landfill not as cover and less mixed C&D waste would be processed
- For soil, bulk excavated soil would be sent directly to landfill and hazardous soil would be processed and then sent to landfill.

4.5 Alternative pathways used for central case estimates

Direction	Mixed C&D waste	Soil
	Per cent of tonnes	Per cent of tonnes
Straight to landfill	17	92
Processed then fines to landfill	51	8
Straight to interstate	7	
Processed then interstate	0	
Source separated at site	5	
Landfill cover	20	
Total	**100**	**100**

Source: The CIE.

Expected changes in material flows under the options

The expected changes in material volumes to recovery and landfill are shown in table 4.6. With the current proposed changes, an additional 1 million tonnes of material per year would be destined to landfills in NSW. The recovery rate for mixed C&D material currently processed would fall from 75 per cent to 38 per cent. The recovery rates of the C&D sector would fall from 76 per cent to 65 per cent. The NSW state-wide recovery rate would fall from 64 per cent to 58 per cent.

To put this into perspective, a state-wide roll-out of FOGO would reduce waste to landfill by ~400 000 tonnes, compared to 1 million tonnes more into landfill from the proposed changes.[48]

4.6 Changes in recovery under the EPA's proposed option

Item	Current regulations		EPA proposed regulations		Difference	
	Per year	Over ten years	Per year	Over ten years	Per year	Over ten years
	000 tonnes	000 tonnes	000 tonnes	000 tonnes	000 tonnes	000 tonnes
Mixed C&D waste						
tonnes generated	2 850	28 500	2 850	28 500	0	0
tonnes processed	2 850	28 500	2 154	21 537	- 696	-6 963
tonnes sent to landfill	713	7 125	1 701	17 012	989	9 887
tonnes recovered	2 138	21 375	1 149	11 488	- 989	-9 887
Soil processed as recovered fines or through site specific exemptions						
tonnes generated	333	3 332	333	3 332	0	0
tonnes processed	333	3 332	25	250	- 308	-3 082
tonnes sent to landfill	0	0	333	3 332	333	3 332
tonnes recovered	333	3 332	0	0	- 333	-3 332
	Per cent		Per cent		Per cent	
Resource recovery metrics						
Mixed C&D recovery rate	75.0	na	40.3	na	-34.7	na
C&D recovery rate	76.4	na	65.8	na	-10.5	na
NSW all materials recovery rate	64.3	na	58.2	na	-6.0	na

Note: Based on 2019/20 material generation and recovery rates for the current regulations.
Source: The CIE.

As noted above, the alternative regulatory options have not at this stage been thoroughly explored. It appears that:

- changes to the proposed recovered soils order could be made that would allow for this material to be able to be recovered, including:
  - expanding the set of uses to include landscaping
  - increasing thresholds for foreign materials
  - increasing chemical thresholds to levels consistent with no human health impacts
- changes could be made to allow for mixed C&D waste to have some alternative use other than landfill with minimal risk to human health and the environment. This could include:

48 Based on NSW red bin audit data suggesting that 41 per cent of waste in red bins is food and garden organics and this drops to 25 per cent in areas where FOGO services are provided. We have estimated FOGO impact as a 16 per cent reduction on total MSW waste going o landfill.

– an adjusted order, such as a recovered fill order, that would allow material to be used as fill. Consultations have indicated that this would not be engineered fill, because engineered fill requires different compaction properties than recovered fines
– continuation or minor adjustment to the existing order but with higher levels of enforcement, possibly linked to a cost recovery arrangement for compliance and enforcement activity.

5 Costs and benefits of NSW EPA's proposed option

Revoking recovered fines orders and introducing a recovered soils order have a range of costs and benefits, set out in table 5.1.

5.1 Types of costs and benefits of revoking recovered fines orders and a new recovered soil order

Benefit/cost	Pathway					
	Send direct to landfill	Process and landfill fines	Straight to interstate	Processed then interstate	Source separated at site	Landfill cover
Benefits						
Reduced costs for processing mixed C&D waste	✓		✓		✓	
Reduced costs for disposal of material produced from processing mixed C&D waste	✓	✓	✓	✓	✓	✓
Reduced environmental impacts from use of recovered fines	✓	✓	✓	✓	✓	✓
Costs						
Increased costs from disposal of C&D waste at NSW landfill (landfill resource costs)	✓	✓			✓	✓
Increased costs from disposal of waste interstate			✓	✓		
Additional economic, social and environmental costs for transport interstate			✓	✓		
Increased costs for source separating					✓	
Additional cost for raw materials currently supplied from mixed C&D	✓	✓	✓	✓		

Source: The CIE.

These costs and benefits will not be constant over time, and we categorise in three ways:

- Long term costs and benefits — in this case all the costs associated with processing can be avoided, such as costs related to capital equipment and sites. This would be expected to be most relevant for a 5-10 year period

- Short to medium term costs and benefits — in this case costs related to operational aspects of processing can be avoided. However, capital is already sunk and cannot be avoided.
- Transition costs — these costs relate to managing a change in regulations and include costs related to disposing of existing stockpiles, contract renegotiation costs, costs to install equipment required to change pricing (one business that charges by the cubic metre would need to install weighbridges to charge by the tonne). These costs could be minimised with a long transition time.

Aside from the timing of costs, the other important aspect is the difference between financial costs and economic costs. A cost benefit analysis if focused on economic costs. However, the waste businesses and companies involved in the waste sector are concerned with financial costs. The key differences are set out in box 5.2.

5.2 Economic versus financial costs and benefits

A cost benefit analysis is concerned with the costs and benefits to the NSW community as a whole. Some costs and benefits are relevant for this calculation, and others represent a transfer from one group to another. In the waste industry, the key financial cost that is not an economic cost is the waste levy. This means that the financial cost of landfilling may be $220 per tonne, but the underlying economic cost is only about $70 per tonne.

There are other costs and benefits that are economic costs but are not financial costs. These include environmental and human health impacts related to the use or landfilling of material and the social and environmental costs related to interstate transport (such a additional congestion and air and GHG emissions).

Process for estimating costs and benefits

To estimate costs and benefits, we:

- estimate the costs and benefits for each possible pathway for waste in the short-term and in the long term, for mixed C&D and soil separately
- apply shares to each pathway based on the expected share of material moving into each
- apply a timing to estimates where the first year of the cost benefit analysis uses short-term estimates, and then gradually move from short-term to long term estimates
- add the transition-related costs in year 1, and
- present results for costs and benefits and how these are distributed, and
- undertake sensitivity of results to alternative assumptions.

Mixed C&D waste

Key assumptions for estimating costs and benefits

Key assumptions for estimating costs and benefits are shown in table 5.3. We note that different businesses have different compositions of their waste inputs and have variation within their customers (such as discounts for scale), and these figures reflect a weighted average across businesses and customers.

5.3 Key assumptions for mixed C&D waste

Item	Estimate	Basis for estimate
Current gate fees for mixed C&D waste	$130 per tonne	Consultation with waste businesses. Note that there was a wide range, and some charged by cubic metre currently
Short-term operating costs for mixed C&D waste	$20 per tonne	Industry consultations
Material shares and prices		
▪ Recovered fines	Share: 31 per cent, Price: -$5/tonne	Industry consultations
▪ Brick/concrete/rubble	Share: 32 per cent Price: $0/tonne	Industry consultations
▪ Wood	Share: 10 per cent Price: -$90/tonne	Industry consultations
▪ Metal	Share: 2 per cent Price: $200/tonne	Industry consultations
▪ Landfill (including cartage)	Share: 25 per cent Price: -$232/tonne	Industry consultations
▪ Weighted average material value	-$65/tonne	CIE calculations based on above
Long term cost for processing	$65 oer tonne	CIE calculation, based on difference between gate fee and weighted average material value
Landfill resource cost	$70 per tonne	CIE assumption based on current gate fees, less levy. EPA 2018 noted landfill resource cost as $50 per tonne CIE 2020 noted new landfill resource costs of $100 per tonne
Interstate costs – resource	$95.9 per tonne	CIE Waste Transport Cost Model, for road transport Sydney to South East QLD
Interstate costs – social	$17.3 per tonne	CIE Waste Transport Cost Model, for road transport Sydney to South East QLD. Reflects congestion and accident costs
Interstate costs – environmental	$15.7 per tonne	CIE Waste Transport Cost Model, for road transport Sydney to South East QLD. Reflects GHG emissions and air and water pollution

Item	Estimate	Basis for estimate
Interstate gate fee for mixed C&D material and recovered fines	$115 per tonne	This includes the QLD waste levy. From the perspective of the NSW community this is an economic cost.
Raw material costs relative to recycled materials from mixed C&D waste	$15 per tonne	Industry consultation indicated this could be as high as $40 per tonne. ENM prices expected to be $5-10 per tonne, which is $15 more than recovered fines

Notes: NSW EPA 2018, Better Regulation Statement Protection of the Environment Operations Legislation Amendment (Waste) Regulation 2018, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wasteregulation/18p1271-better-regulation-statement.pdf; CIE 2020, Economic and community impacts of asbestos regulations for construction and demolition recycling, prepared for WCRA.

Source: As noted in table.

There may be environmental impacts from the use of recovered fines and the landfilling of recovered fines. As set out in chapter 2, our best estimate is that the value of human health and environmental impacts for use of recovered fines is zero. Similarly, we expect no health and environmental impacts from the landfilling of mixed C&D waste or the recovered fines portion of mixed C&D waste (see Appendix A).

Costs and benefits by pathway

Using the assumptions above, the estimated economic costs and benefits in the short-term and long term are shown in table 5.4 and table 5.5 respectively. To understand what these numbers mean, take the option of processing fines and then diverting to landfill, which is the option that most mixed C&D waste is likely to go to:

- the waste recycler avoids the small cost they currently face to dispose recovered fines through sale, of $5 per tonne applied to 31 per cent of material, which equals a $2 avoided cost
- however, they now have to dispose of this material to landfill, which has a resource cost of $85 per tonne for the 31 per cent of material ($70 for the landfill and $15 for transport). This gives an additional cost of $26 per tonne
- users of recovered fines now cannot access these and instead have to access other material, which has a resource cost of $15 per tonne compared to using recycled materials. Applied to the 31 per cent, this gives a $5 per tonne of mixed C&D waste cost.

The most damaging option from an economic perspective is for mixed C&D waste to be transported to Queensland. In this case, a very large transport cost is incurred. Further existing waste levy transfers to the NSW Government for residual from mixed C&D waste are instead shifted to Queensland. This is a cost to the NSW community.

Source separation is also a very costly option economically, because the financial incentives in place with the waste levy would lead to inefficient levels of on-site sorting.

The use of material as landfill cover is the best economic option where it can be used. We have assumed that 20 per cent of material could be diverted to this use — this is higher than expected by businesses at this stage. However, the financial incentives are well aligned to this occurring where possible.

5.4 Cost and benefits for mixed C&D waste pathways — short-term

	Straight to landfill	Processed then fines to landfill	Straight to interstate	Processed then interstate	Source separated at site	Landfill cover	Total
Share of material to each option	17%	51%	7%	0%	5%	20%	100%
	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D
Reduced recycling costs	20		20		20		6
Reduced material disposal costs	28	2	28	2	2	2	8
Additional landfilling/disposal cost	-70	-26	-115	-36	-26	-26	-40
Additional interstate transport cost			-129	-40			-9
Additional cost for raw materials	-15	-5	-15	-5	-5	0	-6
Additional costs for source separation					-101		
Overall net benefit	**-37**	**-29**	**-211**	**-79**	**-110**	**-25**	**-47**

Source: The CIE.

In the long term, reduced recycling costs are higher for those options that remove the need for material to be processed, such as sending mixed C&D waste directly to landfill, interstate or source separating. The avoided cost increases from $20 per tonne to $65 per tonne. This reflects being able to avoid costs related to equipment and sites, which are fixed in the short-term.

Moving mixed C&D waste directly to landfill has a net benefit relative to current arrangements in the long term. This is because of the large avoided recycling costs. Note that financially it is much worse because the levy impacts are very large for this option. It is also the worst option by a substantial margin in terms of reported resource recovery outcomes. All other pathways have net costs relative to current mixed C&D waste arrangements.

5.5 Cost and benefits for mixed C&D waste pathways — long term

	Straight to landfill	Processed then fines to landfill	Straight to interstate	Processed then interstate	Source separated at site	Landfill cover	Total
Share of material to each option	17%	51%	7%	0%	5%	20%	100%
	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D
Reduced recycling costs	65		65		65		19
Reduced material disposal costs	28	2	28	2	2	2	8
Additional landfilling/disposal cost	-70	-26	-115	-36	-26	-26	-40
Additional interstate transport cost			-129	-40			-9
Additional cost for raw materials	-15	-5	-15	-5	-5	0	-6
Additional costs for source separation					-101		
Overall net benefit	**8**	**-29**	**-166**	**-79**	**-65**	**-25**	**-33**

Source: The CIE.

The expected impact per tonne of mixed C&D waste is a net cost of $47 per tonne in the short-term falling to $33 per tonne in the long term. Applied to total mixed C&D waste, this gives a net cost of $133 million per year in the short-term, falling to $95 million per year in the long term.

The distribution of costs and benefits is shown in table 5.6 and table 5.7. Under all pathways the construction sector is the main group negatively impacted, because it will face higher gate fees for material, or higher costs for on-site source separation. C&D recyclers face negative impacts for pathways where they no longer process. If they continue processing there are no negative impacts, because it is assumed that they will increase their gate fees. Whether costs end up being imposed on construction or waste businesses will reflect the negotiations that occur. In the longer term impacts on the waste businesses are assumed to be zero, because they will by assumption set gate fees to recover their costs.

The main beneficiary of the alternative pathways (except when material goes interstate) in the NSW Government, who gains in increased waste levy revenue.

5.6 Distribution of cost and benefits for mixed C&D waste pathways — short-term

	Straight to landfill	Processed then fines to landfill	Straight to interstate	Processed then interstate	Source separated at site	Landfill cover	Total
Share of material to each option	17%	51%	7%	0%	5%	20%	100%
	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D
NSW Government (waste levy)	110	45	-37	0	45	11	44
C&D recyclers (lost producer surplus)	-45	0	-45	0	-45	0	-13
Construction businesses, demolition	-87	-70	-81	-64	-105	-36	-69
Material users	-15	-5	-15	-5	-5	0	-6
Environment/community			-33	-10			-2
Total	**-37**	**-29**	**-211**	**-68**	**-110**	**-25**	**-47**

Source: The CIE.

5.7 Distribution of cost and benefits for mixed C&D waste pathways — long term

	Straight to landfill	Processed then fines to landfill	Straight to interstate	Processed then interstate	Source separated at site	Landfill cover	Total
Share of material to each option	17%	51%	7%	0%	5%	20%	100%
	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D
NSW Government (waste levy)	110	45	-37	0	45	11	44
C&D recyclers (lost producer surplus)	0	0	0	0	0	0	0
Construction businesses, demolition	-87	-70	-81	-64	-105	-36	-69
Material users	-15	-5	-15	-5	-5	0	-6

	Straight to landfill	Processed then fines to landfill	Straight to interstate	Processed then interstate	Source separated at site	Landfill cover	Total
	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D	$/tonne mixed C&D
Environment/community			-33	-10			-2
Total	**8**	**-29**	**-166**	**-68**	**-65**	**-25**	**-33**

Source: The CIE.

Transition costs to a new regulatory arrangement

The transition to a new regulatory arrangement would impose net costs, as well as change who costs are incurred by. The extent of costs will depend on the transition time allowed, and decisions made about material already on site or already processed, but not yet applied to land.

- The major net costs would occur for stockpiles of material. This includes stockpiles of mixed C&D waste to be processed, and stockpiles of recovered fines at the processor, as well as stockpiles of recovered fines on sites where this would be used but has not yet been used. If all existing stockpiles are not allowed to be used, then this would amount to an additional economic cost of $117 million, and a financial cost to the waste businesses of $284 million (table 5.8). We would expect some facilities to be bankrupt with this level of impact.
- There are also stockpiles in skip bins currently out at sites. With a very rapid transition, skip bins companies would also face significant financial impacts, because they have sold skip bins at a price that is no longer achievable.
- One business consulted would face a cost to install weighbridges, which would ~$0.25 million.
- There will also be net costs from transactional issues. For example, longer term contracts (which would typically extend less than 2 years) would need to be renegotiated requiring time for lawyers and executives. There are also resource recovery requirements in contracts which would not be able to be met, such as for building seeking green certification or infrastructure seeking ISCA certification.[49] How this impacts on the sector will depend on the specifics of each contract, but would involve time for lawyers on both sides to renegotiate arrangements.

5.8 Costs related to stockpiles

Type of stockpile	Tonnes	Economic cost	Economic cost	Financial cost	Financial cost
		$/tonne	$m	$/tonne	$m
Stockpiles of mixed C&D	250 000	-29	-7	-70	-18
Stockpiles of processed fines	400 000	-95	-38	-232	-93

49 https://new.gbca.org.au/construction-and-demolition-waste/; https://www.iscouncil.org/is-ratings/.

Type of stockpile	Tonnes	Economic cost	Economic cost	Financial cost	Financial cost
		$/tonne	$m	$/tonne	$m
Fines at sites where they will be used but not applied	750 000	-95	-71	-232	-174
Total	1 400 000	NA	-117	NA	-284

Source: The CIE, based on industry consultations.

Transitional costs and potential liabilities could be reduced to zero with a long lead time of around 2 years from announcing a policy change to the date of implementation. The only exception could be stockpiles of recovered fines already brought to major use sites, but not yet applied. This would need site specific exemptions to ensure that the material could continue to be used, or a longer transition period than 2 years.

There may also be longer term impacts related to sites that have historically used recovered fines. One issue raised is that any subsequent excavations from sites that have used recovered fines would be considered non-recyclable, due to the soil's inclusion of recovered fines. It is not clear to us if this is the case, and this may need clarifying in any changes to the regulatory arrangements.

Timing of costs and benefits

Transition and short-term benefits and costs occur in the years immediately after the regulatory arrangements have changed. By a period of about ten years, we expect that the long term costs and benefits are most relevant. How impacts change in the intermediate period reflects the age of the capital invested in recovered fines, and its economic life, as well as the time periods to adjust sites to undertake different activities.

We do not have complete information on the economic life of the assets used to produced recovered fines. From the information available, over the past 2 years, there has been capital expenditure of $37 million specifically related to recovered fines with the commencement of the *Standards for managing construction waste in NSW* 2019. This does not include substantial expenditure made for general mixed C&D waste processing, such as the $90 million for the MPC2 facility at Bingo's Eastern Creek site, which is part of its Recycling Ecology Park.[50] This suggests substantial recent expenditure on assets, which is sunk and cannot be avoided if decisions are made to halt mixed C&D recycling. The most significant of these are the Paton's Lane resource recovery centre and MPC2 noted above.[51]

Consultations suggested that economic lives vary considerably across assets, but major components of processing equipment would be expected to last at least 10 years.

Based on this, we allow for short-term impacts to occur for the first three years, and then gradually moving to long term impacts at the end of the ten-year evaluation period.

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50 Bingo 2021, 1st half 2021 investor presentation, https://www.bingoindustries.com.au/getattachment/3bf9f0e2-5b84-47e3-95dc-a3c94333f53c/bin_1h_fy21_investor_presentation.pdf.

51 https://patonslane.com.au/about/about-us/

Overall costs and benefits

Overall, the proposed EPA option is expected to have a net cost of $956 million in discounted terms over a ten-year period. The cost and benefit items are shown in table 5.9.

5.9 Costs and benefits of EPA proposed option for mixed C&D waste

Item	Undiscounted	Discounted
	$m	$m, present value
Reduced recycling costs	326	211
Reduced material disposal costs	227	159
Additional landfilling/disposal cost	-1 143	- 803
Additional interstate transport cost	- 257	- 181
Additional cost for raw materials	- 178	- 125
Additional costs for more bins and site	- 143	- 101
Transition costs	- 117	- 117
Overall net benefit	-1 286	- 956

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

Distribution of costs and benefits

The distribution of costs and benefits are shown in table 5.10. The big beneficiary is the NSW Government, who receives $1.053 billion more in waste levy revenue (in discounted terms). The waste sector has substantial net costs, as does the construction sector. The waste sector's costs are particularly large related to transition ($284 million). To the extent that a more orderly transition is made then these costs could be avoided.

5.10 Distribution of costs and benefits of EPA proposed option for mixed C&D waste

Item	Undiscounted	Discounted
	$m	$m, present value
NSW Government (waste levy)	1 428	1 053
C&D recyclers (lost producer surplus)	- 507	- 459
Construction businesses, demolition	-1 962	-1 378
Material users	- 178	- 125
Environment/community	- 66	- 46
Total	**-1 286**	**- 956**

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

Soil

Key assumptions for estimating costs and benefits

The alternative for soils that cannot be processed under the recovered fines or recovered soils order is that this material is landfilled. This occurs as follows:

- hazardous soil continues to be treated, but following treatment is landfilled at a resource cost of $70 per tonne plus $15 per tonne for transport
- bulk excavated soil is no longer processed and is sent directly to landfill. This avoids processing costs of $25 per tonne in the short-term, $50 per tonne in the long term and leads to additional landfill resource costs of $70 per tonne.

Overall costs and benefits

The same cost timing is used as with mixed C&D waste. Applying this to the 333 000 tonnes per year of soil, the proposed changes would lead to a net cost of $129 million in present value terms over ten years (table 5.11

5.11 Costs and benefits of EPA proposed option for recovered soils

Item	Undiscounted	Discounted
	$m	$m, present value
Reduced recycling costs	109	73
Reduced material disposal costs	0	0
Additional landfilling/disposal cost	- 237	- 166
Additional interstate transport cost	0	0
Additional cost for raw materials	- 50	- 35
Overall net benefit	- 178	- 129

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

Distribution of costs and benefits

The pattern of costs and benefits is similar to mixed C&D waste. Construction businesses would be most impacted negatively and the NSW Government would be most impacted positively through additional waste levy income (table 5.12).

5.12 Distribution of costs and benefits of EPA proposed option for soil

Item	Undiscounted	Discounted
	$m	$m, present value
NSW Government (waste levy)	490	344
C&D recyclers (lost producer surplus)	- 45	- 35
Construction businesses, demolition	- 573	- 402
Material users	- 50	- 35

Item	Undiscounted	Discounted
	$m	$m, present value
Environment/community	0	0
Total	**- 178**	**- 129**

Note: Over a ten year period using a discount rate of 7 per cent.
Source: The CIE.

The distribution of impacts is where these impacts will initially be felt. All impacts are eventually felt by households. For example, increased construction costs will be paid for in higher costs for construction projects.

Sensitivity analysis for mixed C&D waste

The estimates of costs and benefit presented above are based on central case assumptions. There is uncertainty about a range of factors, which would impact on the benefits and cost. This includes:

- the volume of material impacted
- the pathway for mixed C&D waste if recovered fines could not be used
- the ability of landfills to accommodate additional tonnages in NSW, and what that might do to costs
- the possibility for site specific orders and exemptions
- the social discount rate used.

The cost benefit results (the overall net benefit to the NSW community) is shown under various sensitivities in table 5.13.

- Under the central case assumptions, the net cost is $1085 million covering both mixed C&D waste and soil.
- If volumes impacted are lower — covering only the volumes from businesses that we have specifically consulted with for this project for mixed C&D waste, and not covering hazardous soil that is processed under site specific requirements — the net cost falls to $814 million, and the amount of material diverted to NSW landfills is expected to be 1 million tonnes per year more than currently is the case.
- If volumes are higher for soil — based on expectations for hazardous soil and 50 per cent higher amounts of bulk excavated soil — the net cost is $1179 million
- If all mixed C&D waste goes to landfill, rather than being processed, which is the best economic option as long as landfill capacity can be increased at the cost expected in a timely manner, then the net cost is $675 million. However, the resource recovery outcomes are substantially worse, with 2.47 million tonnes per year going to landfill, almost doubling the annual C&D waste going to landfill currently.
- If all mixed C&D waste is sent interstate — the worst outcome economically — the net cost is over $4 billion. This has the effect of *reducing* the amount of material going to landfill in NSW, because the residual from mixed waste that is currently landfilled in NSW is sent interstate. Note that in reality this would increase landfilling interstate, even though it would lead to an improvement in the stated NSW recovery rates, as

interstate movement is counted as recycling. If only the recovered fines are sent interstate the net cost is $1.7 billion.

- If landfill cost can be provided at a lower cost of $50 per tonne, equal to the cost expected by Marsden Jacobs in its analysis for the Better Regulation Statement for changes to C&D waste standards, then the net cost is $866 million. On the other hand, if new landfill capacity is difficult to find, and is more distant, leading to a cost of $90 per tonne (excluding the waste levy), the net costs would be $1303 million.
- The net costs are lower if a higher social discount rate is used of 10 per cent, and lower if a lower social discount rate is used of 3 per cent. These rates are consistent with NSW Treasury guidelines for cost benefit analysis.
- A longer period for implementation, of 2 years plus exemptions for material already delivered to sites where it will be used but has not yet been used, could reduce the net costs to $968 million.

5.13 Sensitivity analysis of net benefits

	Mixed C&D waste	Soil	Total	Additional tonnes to NSW landfill per year
	$m, present value	$m, present value	$m, present value	mT per year
Central case	- 956	- 129	-1 085	1.32
Lower volumes impacted	- 703	- 111	- 814	1.00
Higher volumes impacted	- 956	- 223	-1 179	1.53
All mixed C&D waste to landfill	- 546	- 129	- 675	2.47
All mixed C&D waste interstate	-4 027	- 129	-4 156	-0.38
All mixed C&D processed and recovered fines sent interstate	-1 689	- 129	-1 817	0.33
Lower landfill cost	- 784	- 82	- 866	1.32
Higher landfill cost	-1 128	- 175	-1 303	1.32
10 per cent discount rate	- 857	- 114	- 971	1.32
3 per cent discount rate	-1 124	- 154	-1 278	1.32
No transition costs	- 840	- 129	- 968	1.32

Note: Over a ten year period using a discount rate of 7 per cent unless otherwise noted.
Source: The CIE.

Key issues relevant for these sensitivity tests, and other variances to results, are set out below.

Landfill capacity

The central case estimates are based on mixed C&D waste and recovered fines that go to landfill having a resource cost of $70 per tonne. There is the potential for this to be higher if it is difficult or costly to develop new landfill capacity, or this has to happen at further distances from where material is generated, which increases transport costs. The NSW Waste Strategy has indicated that new non-putrescible landfill capacity would be required by 2028 for Greater Sydney.[52] Across NSW 3 million tonnes of C&D material is landfilled each year. EPA's proposed regulatory change would lead to ~1 million tonnes more being landfilled each year, which would bring forward the date for new landfill capacity to ~2026.

While there is probably some headroom in the 2028 capacity assessment, the proposed change will materially bring forward required landfill capacity. It will also likely increase landfilling costs.

The alternative optimistic scenario is than landfill costs are lower than allowed for. Landfill resource costs can be lower than $70 per tonne for non-putrescible landfills, as is evidence by low gate fees in South East Queensland. Marsden Jacobs used an assumption of ~$50 per tonne for NSW in relation to the NSW construction standards.[53] We have chosen a higher figure as we expect that the magnitude of the changes will lead to higher landfill costs. As a sensitivity, we also show the results at $50 per tonne.

Site specific orders and exemptions

NSW EPA may provide site specific exemptions for processing of recovered fines. This would provide a 'white list' approach to allowing particular facilities to produce recovered fines. At this stage, this would have no impact on mixed C&D recycling, because EPA has indicated these would only ever apply to source separated material.[54]

If the site-specific requirements were expanded to cover mixed C&D waste, then a key consideration would be the impact on competition. The NSW Government's position as stated in the Competition Principles Agreement (which all states and territories have signed up to) is that regulation should not restrict competition unless it can be demonstrated:[55]

- the benefits of the restriction outweigh the costs, and
- the objectives of the legislation can only be achieved by restricting competition.

Further, the NSW Government has separate guidance on assessing regulation against the competition test and has signed up to the Intergovernmental Agreement on Competition and Productivity – Enhancing Reforms which both state that competition should not be restricted unless it can be demonstrated the benefits of a restriction outweigh the

52 NSW Government 2021, *NSW Waste and Sustainable Materials Strategy 2041,* https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0006/385683/NSW-Waste-and-Sustainable-Materials-Strategy-2041.pdf

53 NSW EPA 2018, Better Regulation Statement Protection of the Environment Operations Legislation Amendment (Waste) Regulation 2018, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wasteregulation/18p1271-better-regulation-statement.pdf.

54 NSW EPA 2021, Letter to facilities, 2 September 2021, https://asbg.net.au/attachments/article/559/Letter%20to%20recovered%20fines%20facilities%20re%20regulatory%20response.pdf.

55 NSW Government 2019, NSW Government Guide to Better Regulation, NSW Treasury, November, pp. 13-14, https://www.treasury.nsw.gov.au/sites/default/files/2019-01/TPP19-01%20-%20Guide%20to%20Better%20Regulation.pdf

costs.[56][57] For options that focused on site specific arrangements, which would impose a risk of anti-competitive impacts, the benefits of this would need to be established to meet these requirements.

The other significant issues with site specific orders and exemptions are their lack of transparency and lack of long-term certainty. Site Specific Orders are easily revoked and/or amended by the NSW EPA without consultation. This lack of regulatory certainty makes the use of these orders speculative, and very difficult to fund with traditional funding sources. Without a transparent and certain regulatory framework, businesses cannot fund and therefore invest in the required infrastructure to produce material under a site specific order.

Costs and benefits of other options

As noted in chapter 3, there are a wide range of other options that could be given further consideration but are not currently developed in as much detail as the current regulatory approach and NSW EPA's proposed changes. We have not formally undertaken CBA of these options given time limitations and the need to develop these in greater detail.

Key areas that would provide better outcomes for the NSW community that can be drawn from the discussion of the problem in chapter 2 and from the analysis of impacts of NSW EPA's proposed option are as follows:

- The thresholds and uses in the proposed recovered soils order are currently much more strict than is suggested by impacts on human health and the environment. The set of proposed uses is also not aligned with current uses for some recovered soil, which is used as landscaping. Revisions to the soil contamination arrangements and allowing this to be used for landscaping could lead to all soil continuing to be recovered and used for its highest value uses.
- Further consideration should be given to uses of recovered fines with thresholds that are achievable, that would have minimal risk to human health and the environment, rather than removing the orders completely. The current predominant uses are turf underlay and mixing in with aggregates to create road base. This could mean considering specific areas of the current recovered fines order uses that could be restricted if there are human health or environmental impacts. A much clearer rationale for what impacts are currently a problem is required to ensure that adjustments can be made.
- Compliance and enforcement activities are an important part of ensuring that standards are met. This may mean the need to revise the compliance and enforcement activities, penalties and cost recovery arrangements if there is insufficient funding for compliance and enforcement.

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56 NSW Government 2017, Assessment Against the Competition Test, April, Department of Finance Services & Innovation, p. 7 https://www.productivity.nsw.gov.au/sites/default/files/2018-05/Assessment_Against_the_Competition_Test-April_2017_1.pdf

57 Intergovernmental agreement on competition and productivity – Enhancing reforms 2016.

- The wase industry has proposed a number of issues related to the quality of inputs that are received as part of workshops with NSW EPA. These may be able to reduce the contamination issues and could be further tested and analysed.

6 Process in making decisions

Consultation undertaken in developing regulatory options

Better Regulation Principle 5: Consultation with business and the community should inform regulatory development.

The EPA has been considering recovered fines over a number of years. Based on publicly available documents and workshop notes provided in consultations with waste businesses, we note the following.

- In 2016, the EPA released a Consultation paper on *New minimum standards for managing construction and demolition waste in NSW*.[58] This paper indicated that the NSW EPA was proposing to remove the orders for recovered fines and to allow this material to be used as daily cover for landfills.
- In 2017, NSW EPA released a *Consultation report on the changes to the regulation of waste in NSW*.[59] This paper indicated that NSW EPA was proposing to remove the orders for recovered fines and to allow this material to be used as daily cover for landfills. Specific orders and exemptions would be required for the use of recovered fines for land application.
- In 2019, the NSW EPA released *Standards for managing construction waste in NSW*.[60] This did not indicate any changes to use of recovered fines. These standards aimed to improve the management of construction waste through improved inspections and additional training.
- In 2019, NSW EPA also commenced a review of the recovered fines order and exemption. This involved NSW EPA collecting 2 years of records and data, as well as undertaking site visits and sampling of recovered fines produced by industry.
- In 2020, NSW EPA conducted three workshops with industry to share the results of its review and develop options with industry to improve the standard of recovered fines.

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58 NSW EPA 2016, New Minimum standards for managing construction and demolition waste in NSW, Consultation paper, https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/wasteregulation/nsw-managing-construction-demolition-waste-minimum-standards-160545.ashx.

59 NSW EPA 2017, Consultation report on the changes to the regulation of waste in NSW, https://www.epa.nsw.gov.au/publications/wasteregulation/17p0314-waste-reg-consultation-report.

60 NSW EPA 2019, Standards for managing construction waste in NSW, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/waste/19p1542-standards-for-managing-construction-waste-in-nsw.pdf.

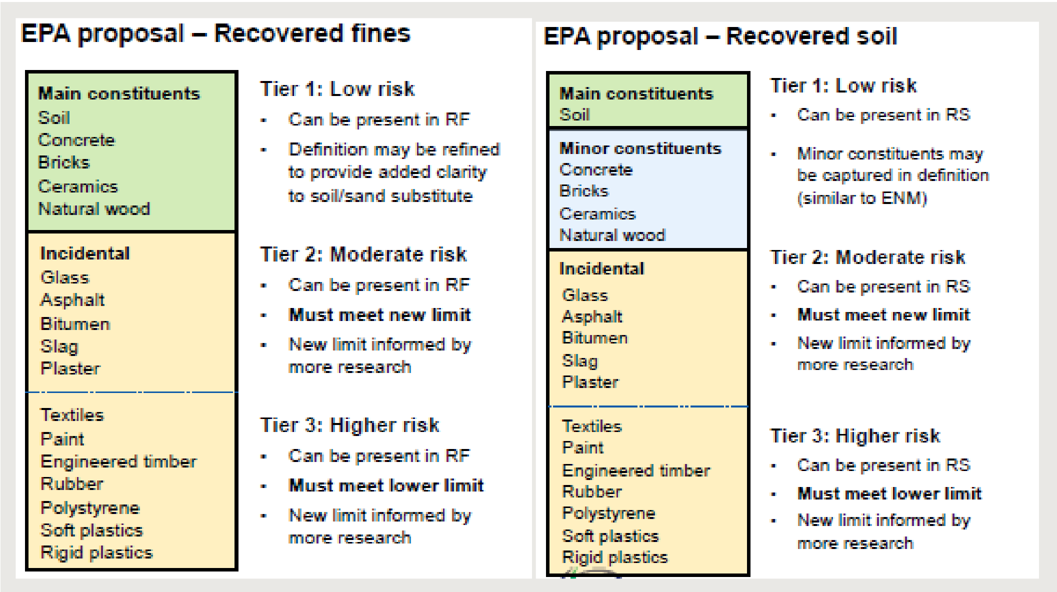
- In 2021, NSW EPA announced that it was going to revoke the recovered fines orders and exemptions, and also sought feedback on a proposed recovered soil order.

The consultation process, particularly the three workshops, provided a wide range of options to improve the quality of recovered fines. For example, EPA's proposed options from Workshop 2 are shown in chart 6.1 Similarly, Workshop 3 proposed new definitions for recovered soils and recovered fines. The workshop reports noted the following as the main outcomes.

- Workshop 1 found the main priorities for EPA to consider were:
  - waste tracking system
  - rejected loads register
  - initial DA waste assessment report / planning conditions
  - standardise testing, sampling and reporting requirements in WCR (including a standard template for WCR)
  - consultant accreditation
  - improved asbestos training and education for householders and smaller building operators.
- Workshop 2 provided the following feedback:
  - the EPA should focus on outcomes-based requirements, rather than being too prescriptive about the type of materials facilities can process
  - additional focus is required on improved source separation and tracking of materials before they enter the waste processing facilities
  - there is some merit in defining recovered soils to separate it from recovered fines.
  - there should be no materials specifically excluded from recovered fines. EPA should focus on identifying limits for contaminants based on limiting environmental harm rather than banning any outright
  - the EPA should not specify to industry what equipment it uses to process recovered fine materials. Noting that "There are many variables dependant on waste composition and scale of processing that will impact what processing equipment is effective and financially viable."
  - all sellers and resellers should be required to declare that the material incorporates recycled material with improved supply chain accountability and responsibility for accurately informing consumers of product composition, and
  - too strict requirements have the potential to destroy the recovered fines industry and the EPA should, instead, focus on improved enforcement and policing of rogue operators at both the front and back end of the waste chain.
- Workshop 3 provided the following conclusions:
  - a key problem for industry is that they are receiving poor quality waste from upstream waste generators
  - there is a lack of tracking and testing of waste materials prior to it being received by facilities
  - asbestos sampling requirements will likely identify asbestos in the waste and may render the processing of recovered fines unviable

– batch testing will be difficult for industry to implement due to space and time constraints, and
– the most appropriate method of testing stockpiles needs to be further considered.

6.1 EPA proposals from workshop 2, July 2020



Data source: NSW EPA 2020, Outcomes report Workshop 2, July.

We conclude that NSW EPA has conducted considerable consultation in relating to improving recovered fines. However, there is no information available about how the feedback provided has been used to **inform** consideration of a wide range of possible options for addressing the quality of recovered fines.

The option to revoke the recovered fines order is at odds with the presentations made by NSW EPA and the process of holding workshops to improve the quality of recovered fines. This process implies that the aim is to improve the quality rather than to remove the ability to produce recovered fines at all.

It is not clear if NSW EPA has undertaken cost benefit analysis of options in considering alternative regulatory responses intended to reduce the human health and environmental impacts of recovered fines. If so, these are not publicly available.

Effective and proportional response

Better Regulation Principle 4: 'Government action should be effective and proportional'.

NSW EPA has observed considerable compliance issues with respect to the recovered fines orders in place, as part of its 2019 review. These included recovered fines that did not meet contamination thresholds, had a range of foreign materials[61] or where testing

61 Note that some issues with foreign materials were an issue with the order, rather than with material, as this was not specified in the order.

and sampling compliance was inadequate. NSW EPA did not establish that there were any material human health or environmental impacts arising from the issues uncovered. A discussion of the evidence related to these impacts is set out in chapter 2.

The response to revoke the recovered fines order is effective, in the sense that it would remove any problems related to the use of recovered fines. However, it is not proportional in the sense that the costs of doing so far outweigh the expected benefits.

Options that appear to more proportional to the issues uncovered include:

- increased compliance and enforcement, including a cost recovery arrangement for NSW EPA compliance activities related to recovered fines
- the ability to penalise an operator for recovered fines that are systematically breaching conditions that impact on human health and environmental outcomes, and an approach for when an operator would no longer be able to produce recovered fines
- adjustments to standards and/or allowed uses in the recovered fines orders to ensure that these are aligned to human health and environmental outcomes.

A External costs of landfills

Landfilling of inert waste has much lower and potentially insignificant environmental costs. This is because the definition of non-putrescible waste ensures that there is little decomposition of material. Decomposition is the cause of most leachate and emissions at landfills, which are the key environmental costs of putrescible landfills. Leachate can also arise due to dissolved solids, sometimes metals and other pollutants. Non-putrescible landfills do still require liners and must meet other requirements as per the landfill design guidelines.[62]

General solid waste may only be classified as non-putrescible if:[63]

- "it does not readily decay under standard conditions, does not emit offensive odours and
- "does not attract vermin or other vectors (such as flies, birds and rodents), or
- "it has a specific oxygen uptake of less than 1.5 milligrams O_2 per hour per gram of total
- "organic solids at 20 degrees Celsius, or
- "it is such that, during composting (for the purpose of stabilisation), the mass of volatile solids in the organic waste has been reduced by at least 38%, or
- "it has been treated by composting for at least 14 days, during which time the temperature of the organic waste must have been greater than 40 degrees Celsius and the average temperature greater than 45 degrees Celsius."

BDA Group (2009) states that "inert landfills are taking inert wastes and do not have significant air emissions or leachate impacts".[64] Their analysis, focussed on putrescible landfills, identifies a range of environmental impacts of landfills studied in the literature (table A.1).

Comparing the set of externalities from landfill and the definition of non-putrescible/inert waste suggests that this material will not have external costs from landfill.

62 NSW EPA, 2016, *Environmental Guidelines — Solid waste landfills*, available at: https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/waste/solid-waste-landfill-guidelines-160259.ashx

63 https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/wasteregulation/140796-classify-waste.ashx

64 BDA Group, 2009, *The full cost of landfill disposal in Australia*, p.44, available at: https://www.environment.gov.au/system/files/resources/2e935b70-a32c-48ca-a0ee-2aa1a19286f5/files/landfill-cost.pdf

A.1 Non-market costs of landfill disposal

Category	Applies to putrescible landfills?	Applies to inert landfills
Emissions of greenhouse gases	✓	×
Emissions of other air pollutants	✓	×
Leachate emissions	✓	×
Amenity impacts	✓	×
Transport impacts	✓	✓
Pollution displacement	✓	×

Source: BDA Group (2009), CIE.

B Thresholds for soil contamination

B.1 Health-based investigation levels

Chemical	A	B	C	D
	mg/kg	mg/kg	mg/kg	mg/kg
Metals and inorganics				
arsenic[2]	100	500	300	3 000
beryllium	60	90	90	500
boron	4 500	40 000	20 000	300 000
cadmium	20	150	90	900
chromium (VI)	100	500	300	3 600
cobalt	100	600	300	4 000
copper	6 000	30 000	17 000	240 000
lead[3]	300	1 200	600	1 500
manganese	3 800	14 000	19 000	60 000
mercury (inorganic)	40	120	80	730
methyl mercury	10	30	13	180
nickel	400	1 200	1 200	6 000
selenium	200	1 400	700	10 000
zinc	7 400	60 000	30 000	400 000
cyanide (free)	250	300	240	1 500
Polycyclic aromatic hydrocarbons (PAHs)				
benzo(a)pyrene TEF[5]	3	4	3	40
Total PAHs[6]	300	400	300	4 000
Phenols				
phenol	3 000	45 000	40 000	240 000
pentachlorophenol	100	130	120	660
cresols	400	4 700	4 000	25 000
Organochlorine pesticides				
DDT+DDE+DDD	240	600	400	3 600
aldrin and dieldrin	6	10	10	45
chlordane	50	90	70	530
endosulfan	270	400	340	2 000
endrin	10	20	20	100
heptachlor	6	10	10	50
HCB	10	15	10	80

Chemical	A	B	C	D
	mg/kg	mg/kg	mg/kg	mg/kg
methoxychlor	300	500	400	2 500
mirex	10	20	20	100
toxaphene	20	30	30	160
Phenoxyacetic acid herbicides				
2,4,5-T	600	900	800	5 000
2,4-D	900	1 600	1 300	9 000
MCPA	600	900	800	5 000
MCPB	600	900	800	5 000
mecoprop	600	900	800	5 000
picloram	4 500	6 600	5 700	35 000
Other pesticides				
atrazine	320	470	400	2 500
chlorpyrifos	160	340	250	2 000
bifenthrin	600	840	730	4 500
Other organics				
PCBs	1	1	1	7
PBDE flame retardants (Br1- Br9)	1	2	2	10

Source: National Environment Protection (Assessment of Site Contamination) Measure 1999 Schedule B7 'Derivation of Health-based Investigation Levels', available at: https://www.legislation.gov.au/Details/F2013C00288

C Recovered fines in other jurisdictions

Victoria, Queensland and South Australia also appear to have arrangements for recycling of the fraction of soil and similar fine material extracted from mixed C&D waste (table C.1). However, it is difficult to assess the extent to which regulatory arrangements align to NSW due to definitional and terminology differences. For example, the term 'fines' is rarely used in other jurisdictions, but 'clean fill' is a commonly used term. This material may refer to a product similar to the 'recovered soil' or ENM products in NSW, or recovered fines, but the details are unclear.

C.1 Recovered fines and clean fill in other jurisdictions

Jurisdiction	Definition, applications and limitations	Tonnages
Victoria	The *Environment Protection Regulations 2021* provide specifications for authority to receive 'fill material'. This material is defined in the regulations to be industrial waste that is soil including clay, silt and sand, and does not contain asbestos or exceed specified contamination thresholds. Fill material is sourced from soil mixtures below the topsoil layer, which means that fill material contains less organic matter. Organic matter still must be screened from fill material since decomposition of organic matter can create voids in fill leading to subsidence. Similarly, industrial waste items such as brick and tiles must be removed, or waste with such material may need to be disposed at landfill. Excavated soils can be mixed with industrial wastes such as bricks, rubble and concrete, but these must be screened, removed, and the soil assessed for contamination. EPA Victoria stated in 2016 that "screened fines from pcoessing have historically been used in various applications. EPA will work with this industry sector to provide further guidance on this material", however, more recent guidance has not been able to be identified. Such material still seems to be used, with Delta Group Recycling stating that 'Screened fines from crushed brick and excavation rock … is used for pipe bedding, under slab preparation, and under pavers', with 7mm brick dust and 5mm rock dust products available. [e] Applications for this material include landscaping, filling pools and engineering fill. We have not identified any use of recovered fill from mixed C&D sources in garden mix, turf underlay or similar applications. There are also specifications for recycled aggregates, but we do not understand this material to overlap with the NSW definition of recovered fines, but rather fall under the NSW recovered aggregates classification.	Approximately 1 million tonnes output annually [a]

Jurisdiction	Definition, applications and limitations	Tonnages
South Australia	Waste-derived fill ('clean fill') includes waste soil for direct reuse, processed C&D waste and a homogenous mineral-basd industrial residue. EPA SA specifies a range of chemical contamination criteria for this material, and requires it to be similar in composition to virgin solid mineralogical materials in the soil profile (e.g. inert soil, rock, sand and silt). This material appears to be used for landfill rehabilitation, urban regeneration, and likely other applications. Separately from waste-derived fill, there is also a category for 'intermediate waste soil', which indicates minor contamination. This can only be used for construction fill purposes.	1.14 million tonnes output annually of 'separately reported material and clean fill' (including soil, sand and rubble). This is mostly (0.874 million tonnes) clean fill, with the remainder being intermediate waste soil. [b]
Queensland	'Clean fill' is mentioned in the *Waste reduction and recycling regulation 2011*, which states that it is exempt from the waste levy if it is separate from other waste when delivered to a waste levyable waste disposal site. There appears to be a market for clean fill from C&D sites, which is then used primarily in C&D projects to fill holes and build ground elevation. [d]	C&D recyclers reported there was 177 000 tonnes of residual material producted in 2018/19, and recovered fines/soil do not appear to be included in resource recovery totals for C&D waste.[c]

[a] *Recycling Victoria*, p.33, available at: https://www.vic.gov.au/sites/default/files/2020-02/Recycling%20Victoria%20A%20new%20economy.pdf

[c] Categories of C&D recycling include: concrete, asphalt, bricks and tiles, fibre cement, plasterboard, timber, non-packaging glass, non-packaging plastic, ferrous scrap metal, non-ferrous scrap metal, and Other C&D not elsewhere classified. This last residual category may include material similar to recovered fines, and this tonne accounted for 165 457 tonnes in 2018/19. See *Recycling and waste in Queensland Report 2019*, p.6, available at: https://www.qld.gov.au/__data/assets/pdf_file/0033/129669/recycling-waste-report-2019.pdf

[d] https://www.boodlesconcrete.com.au/quarry-supplies/clean-fill

[e] http://www.deltagroup.com.au/wp-content/uploads/Delta-Group-Core-Services-Brochure-Recycling.pdf

Source: Recycling Victoria, *Recycling and waste in Queensland Report 2019*, https://www.epa.vic.gov.au/-/media/epa/files/publications/1624.pdf , and the CIE.

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APPENDIX B

Cost Impact to Households

WASTE CONTRACTORS & RECYCLERS ASSOCIATION OF N.S.W

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26th October 2021

Waste management costs - new house in greater Sydney

Based on an average 2 storey, 390 square metre home-:

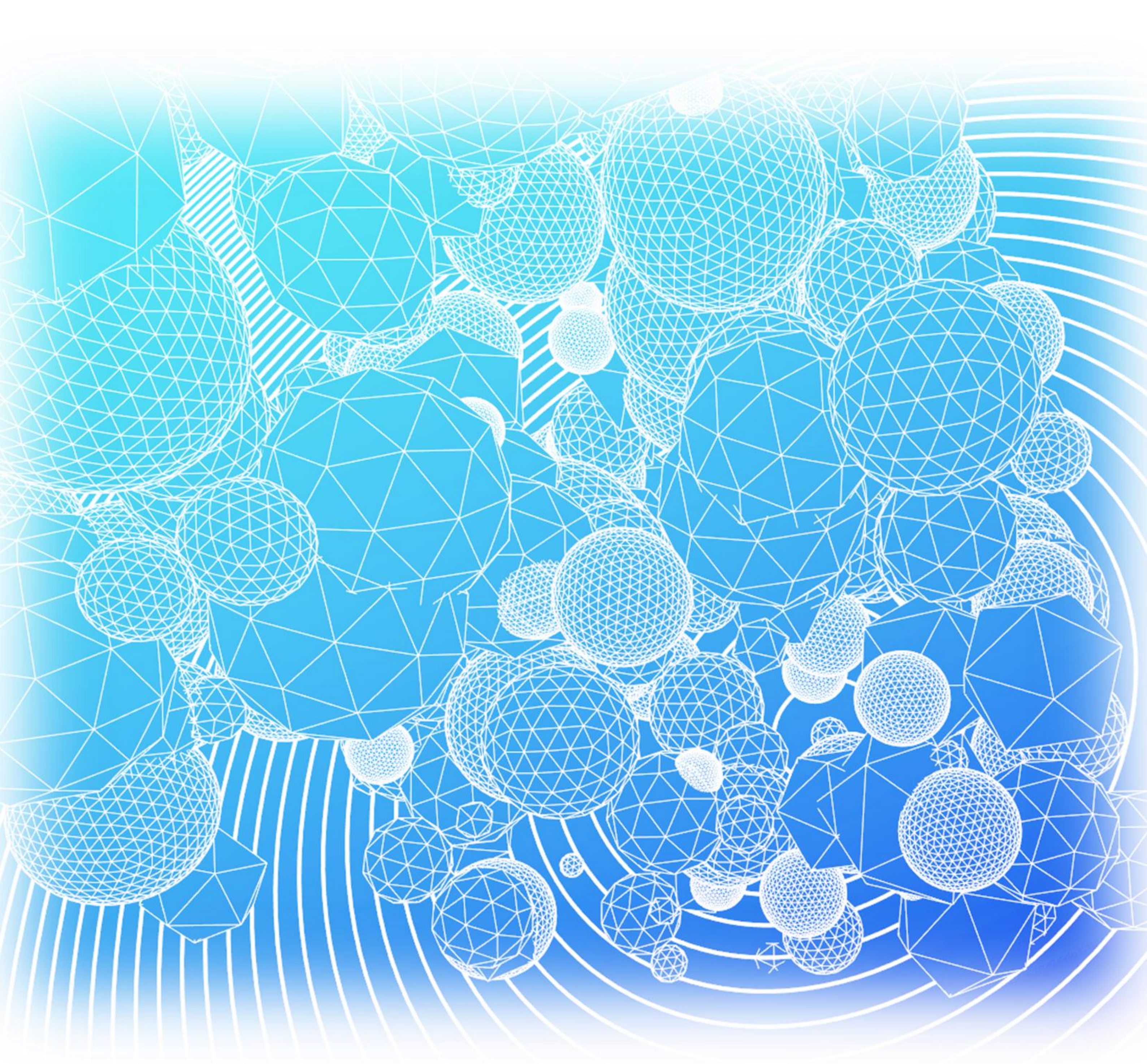
- A C&D waste contractor will undertake on average four (4) site collections and site cleans over the duration of the construction.
- Approx. 27 cubic metres of mixed C&D waste is collected, including soil, sand, rubble, bricks, tiles, plastic, metal, timber, glass, etc.
- Based on an analysis of recycling tipping dockets, 27 cubic metres is generated (approx. 13 tonnes)
- The current waste management cost of these 27 cubic metres is $1,500 (or $55.50 per metre)
- This is currently classed as a heavy load and C&D recyclers want heavy bins as the products are all currently recyclable.
- If the EPA revokes the RRO for recovered fines, recyclers will not want heavy loads.
- This material will be priced at a tonnage rate (recycler needs to cover the cost of tip fee and the waste levy of $147.10)
- Average tip fee of $300 per tonne, the cost will escalate to $3,900
- This change of regulation by the EPA will result in an increased waste management bill of $2,400 in the construction of an average sized 2 storey

Tony Khoury
Executive Director

APPENDIX C

Independent Review: Reuse of recovered fines in NSW – Stage 1,

Environmental Risks Sciences (EnRisks), October 2021



Independent review: Reuse of recovered fines in NSW – Stage 1

Prepared for: Waste Contractors and Recyclers Association of NSW

29 October 2021

Document History and Status

Report Reference	WCRA/21/FINE001
Revision	C – Stage 1 Final
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Limitations

Environmental Risk Sciences has prepared this report for the use of the Waste Contractors and Recyclers Association of NSW in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in the **Section 1** of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports provided for use in this assessment was false.

This report was prepared in October 2021 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Table of contents

Glossary of terms

Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).
Exposure Assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure Pathway	The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as chemical leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
Guideline Value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the NSW Department of Environment and Conservation (DEC) or institutions such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organisation (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter- and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines will have different names, such as investigation level, trigger value, ambient guideline etc.
HHRA	Human Health Risk Assessment
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure).
Inhalation	The act of breathing. A hazardous substance can enter the body this way (see route of exposure).
Point of Exposure	The place where someone can come into contact with a substance present in the environment (see exposure pathway).
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Receptor Population	People who could come into contact with hazardous substances (see exposure pathway).
Risk	The probability that something will cause injury or harm.
Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin (dermal contact)
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicology	The study of the harmful effects of substances on humans or animals.

Executive Summary

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by the Waste Contractors and Recyclers Association of NSW (WCRA) to undertake an assessment of the use of recovered fines compliant with existing resource recovery orders, consideration of the newly proposed resource recovery order for recovered soil and comparison of the regulation of these materials with other recycled materials which are used for similar purposes.

This review forms stage 1 of the work and provides consideration of the resource recovery orders and the potential for environmental impacts from recovered fines produced in line with the current regulatory framework. It focuses in more detail on some key contaminants and issues with sampling and analytical methods and interpretation of the orders.

Stage 2 of this work could involve development of detailed exposure scenarios for the permitted uses of recovered fines or recovered soils to allow calculation of risk based criteria that could inform revision of the orders. A discussion of background levels for relevant chemicals and other technical or policy matters which are relevant in targeting calculations for risk based criteria would also be included.

Review outcomes

The review has identified a number of key outcomes including:

- Ambiguities in both of the resource recovery orders for recovered fines make it difficult to be confident as to what is required to be in compliance.
- Comparison of concentration limits in the various resource recovery orders with guidelines based on the protection of human health and ecosystems shows the limits are quite variable and are similar to or more conservative than the guidelines protective of human health and ecosystems.
- The draft recovered soil order is ambiguous in what sort of soil could be considered for reuse due to the difference in legal definitions for terms that are normally used interchangeably – building and demolition waste vs construction waste.
- Potential for exposure to any chemicals that may be present in recovered fines or recovered soil is likely to be very low for people or the environment, given the nature of permitted uses (i.e. at depth for engineered fill/earthworks).
- Difficulties/lack of clarity with the sampling and analysis methods specified in the various orders.
- Background levels of some chemical parameters do not appear to have been considered in determining limits for the orders, as some limits are below average background concentrations in soil in Australia.
- Impacts on people or the environment of foreign materials in recovered fines or recovered soil are likely to be extremely limited given that these materials are already widely present in

the environment (i.e. construction materials in buildings etc) and, in addition, the permitted uses limit the potential for visual impacts.

- The resource recovery orders for recovered fines have been in place for a significant time period (i.e. since 2008) but the recent NSW EPA audit is the first that has occurred.

More detail on these findings include:

- There is a lack of clarity in the specifications of the resource recovery orders for recovered fines which makes it difficult to ensure compliance. Issues where there is ambiguity in the recovered fines orders include:
    - definitions for batch and continuous processing
    - acceptability or not of resampling
    - variability in the required number of samples to be collected for analysis in the 2 orders.

- Comparing the absolute maximum limits for the 2 recovered fines orders and the draft recovered soil order with limits for other recycled materials and national guidelines for soils that are calculated to be protective for human health and ecosystems has shown:
    - the limits for recovered fines are similar to those for other recycled materials
    - the limits for recovered soil (draft) are lower than those for other recycled materials and it is not clear why this is the case nor whether background levels in Australian soils have been considered in the development of the lower limits. Achieving some of these lower limits will be difficult given background levels in soil in a range of areas/sources
    - the limits in all orders are lower than the national guidelines for soil that are protective of human health and the environment.

- There are sampling and analysis issues that impact on demonstrating compliance with the limits in these orders including:
    - highly variable sampling rates in all the orders evaluated in this assessment and there is a lack of transparency on why there is such a difference
    - requirements for limits of reporting that are not in line with the recommended standard analysis method and/or are difficult to achieve.

- Limited information on sampling rates in the waste classification guidance compared to the more significant requirements under the various resource recovery orders provides a disconnect in this process. Receivers/processors of waste may have little or insufficient information on the material from the classification process, but they are required to have confidence that they will be able to produce a product that will comply with the limits in the relevant order. This is particularly problematic for asbestos but is relevant for most parameters.

- Looking at some of the chemical contaminants in more detail:
    - lead
        - the limits in all the orders are well below the national guidelines for soil protective of human health or ecosystems

- the limits in the recovered fines orders are similar to average background levels of lead in soil in Australia
- the NSW EPA sampling indicates that the average concentration of lead in recovered fines is below background levels in Australian soils
- the limits in the recovered soil order are below average background levels of lead in soil in Australia
- requiring these recycled products to have lower levels than present on average in general/background soil is problematic given that these products include soil from many sources.

- benzo[a]pyrene
    - the limits in all the recovered fines orders are similar to or lower than background levels of this chemical (and those related to it)
    - the NSW EPA sampling indicates that the average concentration of benzo[a]pyrene in recovered fines is similar to likely background levels in Australian soils
    - the limits are also similar to the national soil guidelines protective of human health and the environment
    - requiring these recycled products to meet even lower limits (as proposed in the draft recovered soil order) is problematic, again, given the background levels in soil and the issues with routinely available limits of reporting when considering BaP TEQs.

- Looking at some of the physical contaminants in more detail:
    - Asbestos
        - no data was available on the presence or level of asbestos in recovered fines
        - asbestos is a naturally occurring mineral so has the potential to be present in any soil or recycled material regardless of source
        - there are significant limitations in the ability of the analysis to demonstrate complete absence of fibres.

    - Foreign materials
        - presence of foreign materials in these recycled products is predominantly a visual issue
        - these products are generally placed at depth, so the potential for impact based on amenity is limited
        - other products (e.g. composts, mulches) that are definitely used at the ground surface are allowed to contain higher levels of these foreign materials which may have visual impacts
        - there are also significant limitations in the robustness of the analytical method.

Review recommendations

There are a number of recommendations that have been made through this assessment including:

- Retention of the recovered fines orders with some revision including:

- clarified definitions (batch, continuous, characterisation sampling, routine sampling etc)
  - consideration of limits of reporting that take into account the relevant difficulties in analysis for physical contaminants
  - consideration of background levels of relevant chemical contaminants when determining limits in an order
  - consideration of including a requirement for an independent person to be used to undertake sampling
  - consideration of including a requirement for a suitably accredited auditor to audit the sampling and analysis undertaken at a site on a regular basis (6 monthly or yearly) to ensure compliance with the relevant order.

- Revision of the draft recovered soil order before finalisation including:
  - clarified definitions and guidance on the nature of the desktop assessment for prohibited items
  - consideration of limits of reporting that take into account the relevant difficulties in analysis for physical contaminants
  - consideration of background levels of relevant chemical contaminants when determining limits in an order
  - consideration of including a requirement for an independent person to be used to undertake sampling
  - consideration of including a requirement for a suitably accredited auditor to audit the sampling and analysis undertaken at a site on a regular basis (6 monthly or yearly) to ensure compliance with the relevant order.

- Potential for asbestos to be present needs to be controlled at the source not at the processors of these waste materials. This means all asbestos containing materials need to be removed by an appropriately qualified asbestos professional prior to any demolition occurring at all sites. This is already a requirement in NSW, however additional compliance checks to ensure this happens would be useful as would requiring clearance certificates for all sites supplying wastes to processors.

- Consideration of how there could be better alignment of how sampling is undertaken for waste classification with sampling required under the resource recovery orders would be useful. Currently, it appears less sampling is required for waste classification (which defines the quality of material to waste processors) than is needed to define the quality of the recovered materials produced by the waste processors. The potential variability in recycled materials makes this lack of alignment problematic.

- There is a need to improve the confidence that processors can have that they will be able to produce compliant products because they can better understand the nature of their source materials.

Section 1. Introduction

1.1 General

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by the Waste Contractors and Recyclers Association of NSW (WCRA) to undertake an assessment of the use of recovered fines compliant with existing resource recovery orders, consideration of the newly proposed resource recovery order for recovered soil and compares the regulation of these materials with other recycled materials which are used for similar purposes.

Recovered fines is a component of mixed construction and demolition waste that is collected for reuse by a range of producers in NSW. The reuse of these materials is currently regulated by a number of regulatory instruments including:

- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The "continuous process" recovered fines order 2014 (NSW EPA 2014j)
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The "continuous process" recovered fines order 2014 (NSW EPA 2014a)
- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The "batch process" recovered fines order 2014 (NSW EPA 2014b)
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The "batch process" recovered fines order 2014 (NSW EPA 2014c).

The orders cover the sampling and testing requirements to manage the quality of the materials and notification and record keeping/recording requirements to ensure relevant information is kept by processors. The orders also include criteria for the chemical components of the recovered fines and the test methods to be used to demonstrate that the material complies with the criteria. The exemptions include conditions that must be complied with in order to have an exemption from the relevant parts of the POEO Act and Regulations as discussed in **Section 2.**

The NSW EPA has been reviewing the reuse of this material and the adequacy of these resource recovery orders/exemptions over the last few years. The review has included auditing sites and record keeping across 2017/18 and sampling of recovered fines across all processors in 2018/19. Workshops with processors were held in 2020 to discuss issues arising from the results of the audits and the sampling and analysis.

Recent advice to WCRA has indicated that the NSW EPA is proposing to make the following changes as a result of this review:

- revoking both the "batch" and "continuous" general recovered fines orders and exemptions to prevent recovered fines being applied to land
- consideration of site-specific orders and exemptions for specific individual facilities that can demonstrate they can make high quality recovered fines

- development of a new general order and exemption for recovered soil (which has been provided in draft form for comment). This new order appears to specifically exclude fines generated from most of the waste types currently used in the generation of recovered fines. In addition, the uses to which this recovered soil can be put are quite limited.

These steps will require significant changes in how this industry operates and may limit viability.

This review forms stage 1 of the work and provides consideration of the resource recovery orders and the potential for environmental impacts from recovered fines produced in line with the current regulatory framework. It focuses in more detail on some key contaminants and issues with sampling and analytical methods and interpretation of the orders.

Stage 2 of this work could involve development of detailed exposure scenarios for the permitted uses of recovered fines or recovered soils to allow calculation of risk based criteria that could inform revision of the orders. A discussion of background levels for relevant chemicals and other technical or policy matters which are relevant in targeting calculations for risk based criteria would also be included.

1.2 Objectives

The objectives of this assessment are:

- Establishing a conceptual model for the assessment by explaining:
    - what types of waste are used as sources of recovered fines
    - how these wastes are processed to generate recovered fines and how this has changed since 2019
    - types of activities where the recovered fines are used to allow development of an understanding of how chemicals/inclusions that may be present in the fines could reach people or ecosystems via particular exposure pathways.
- Consideration of the data collected by NSW EPA in 2019, and provide an assessment of potential risk due to the presence of benzo[a]pyrene (and related polycyclic aromatic hydrocarbons (PAHs)), lead, asbestos and foreign materials/inclusions (i.e. plastic, glass, metal etc) in the recovered fines.
- Discussion of analytical method, limits of reporting and guidelines for asbestos in soil to identify how the limit of reporting is different within different guidance documents even though the method appears to be the same.
- Discussion of analytical methods to be used for foreign materials including discussion of robustness of the limits of reporting in comparison to the proposed thresholds.
- Discussion of waste classification standards in comparison to thresholds in the recovered soils order.

This review has not considered data for parameters other than those listed above.

This review was limited due to timing requirements for comments on the proposed changes by the NSW EPA. Further work is intended to be undertaken including development of detailed exposure scenarios for the use patterns for these materials and calculation of proposed limits for all parameters listed in the recovered fines orders using those exposure scenarios.

1.3 Approach

The approach taken for the assessment of potential risks is in accordance with guidelines / protocols endorsed by Australian regulators, including:

- enHealth (2012a) Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards
- enHealth (2012b) Australian Exposure Factor Guide
- National Waste Policy (2018)
- NSW Waste Avoidance and Resource Recovery Strategy (2014-2021)
- ASC NEPM (1999 amended 2013) National Environmental Protection Measure – Assessment of Site Contamination including:
    - Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013a)
    - Schedule B4 Guideline on Health Risk Assessment Methodology (NEPC 1999 amended 2013b)
    - Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013c)
- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The “continuous process” recovered fines order 2014
- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The “batch process” recovered fines order 2014
- https://www.standards.org.au/standards-catalogue/sa-snz/consumer/cs-037/as--4454-2012
- https://www.epa.nsw.gov.au/your-environment/recycling-and-reuse/resource-recovery-framework/current-orders-and-exemption/resource-recovery-biosolids

Where required, additional guidance will be obtained from relevant Australian and International guidance consistent with current industry best practice, such as that available from the US Environmental Protection Agency (USEPA) and the World Health Organisation (WHO). Where these other guidelines have been adopted in the preparation of this report are referenced throughout this report.

Following this guidance, this review has been undertaken to include the following:

- Introductory description of the NSW waste management framework and the resource recovery system in NSW (**Section 2**)
- Review of chemical and foreign material limits in the resource recovery orders for recovered fines or recovered soil and comparison of those limits with limits for other materials used in similar fashion and guidelines designed to be protective of human health and ecosystems (**Section 3**).
- Consideration of sampling and analysis issues in demonstrating compliance with limits (**Section 4**)
- Exposure scenarios relevant for the use patterns relevant for recovered fines or recovered soil (**Section 5**)
- Review of key issues for these materials including lead, benzo[a]pyrene, asbestos and foreign materials (**Section 6**)
- Outcomes of the review (**Section 7**).

Section 2. Regulatory framework for recovered fines

2.1 General

This section provides an introduction to the overall waste management framework in NSW and explains what recovered fines consist of, and how the recovered fines orders fit into the overall framework.

2.2 NSW waste management framework

Resource recovery orders form part of the overall framework for managing waste in NSW. The structure of this framework and where these orders fit is described below.

In NSW, wastes, as with many other aspects of pollution control, are managed under the Protection of the Environment (Operations) Act (POEO) 1997 and its supporting regulations.

The Act includes the following key aspects in relation to waste:

Definitions:

> ***Waste*** *includes -*
>
> *(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment, or*
>
> *(b) any discarded, rejected, unwanted, surplus or abandoned substance, or*
>
> *(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance, or*
>
> *(d) any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations, or*
>
> *(e) any substance prescribed by the regulations to be waste.*
>
> *A substance is not precluded from being waste for the purposes of this Act merely because it is or may be processed, recycled, re-used or recovered.*
>
> ***Waste facility*** *means any premises used for the storage, treatment, processing, sorting or disposal of waste (except as provided by the regulations).*
>
> ***Building and demolition waste*** *means unsegregated material (other than material containing asbestos waste or liquid waste) that results from—*
>
> *(a) the demolition, erection, construction, refurbishment or alteration of buildings other than -*
>
> > *(i) chemical works, or*

(ii) mineral processing works, or

(iii) container reconditioning works, or

(iv) waste treatment facilities, or

(b) the construction, replacement, repair or alteration of infrastructure development such as roads, tunnels, sewage, water, electricity, telecommunications and airports, and includes materials such as -

(i) bricks, concrete, paper, plastics, glass and metal, and

(ii) timber, including unsegregated timber, that may contain timber treated with chemicals such as copper chrome arsenate (CCA), high temperature creosote (HTC), pigmented emulsified creosote (PEC) and light organic solvent preservative (LOSP),

but does not include excavated soil (for example, soil excavated to level off a site prior to construction or to enable foundations to be laid or infrastructure to be constructed).

Under the POEO Act, it is an offence to:

- Pollute land which is defined as:

land pollution or pollution of land *means placing in or on, or otherwise introducing into or onto, the land (whether through an act or omission) any matter, whether solid, liquid or gaseous—*

(a) that causes or is likely to cause degradation of the land, resulting in actual or potential harm to the health or safety of human beings, animals or other terrestrial life or ecosystems, or actual or potential loss or property damage, that is not trivial, or

(b) that is of a prescribed nature, description or class or that does not comply with any standard prescribed in respect of that matter,

but does not include placing in or on, or otherwise introducing into or onto, land any substance excluded from this definition by the regulations.

This definition would include the application of recovered fines to land for construction or landscaping purposes or of recovered soil for engineered fill or for earthworks.

The fact that this is an offence under the POEO Act is why a system is required – the resource recovery order/exemption system – to actually allow application of recycled materials to land where it is considered that there would be benefit and that there would not be harm to people or the environment.

Development of resource recovery orders/exemptions requires consideration of all matters that would not normally be permitted to occur under NSW law that may be relevant for a potential reuse opportunity. The orders/exemptions then need to include relevant legal exemptions for matters that are not normally permitted and/or requirements to be applied to ensure that such legal exemptions do not result in harm to people or the environment.

Protection of the Environment Operations (Waste) Regulation 2014

The NSW *Protection of the Environment Operations (Waste) Regulation 2014* includes (by definition) any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is intended to be applied to land or used as a fuel.

The resource recovery system has been developed under Clauses 92/93 of this regulation. This regulation provides the NSW EPA with powers to exempt certain wastes from some of the normal requirements of the POEO Act and Regulations, where such material will be reused as long as that reuse:

- is genuine, rather than being an alternate means of waste disposal
- is beneficial or fit-for-purpose
- will not cause harm to human health or the environment.

Development of resource recovery orders and exemptions by NSW EPA provides a process for consideration of these matters to ensure reuse of such material is genuine resource recovery. If NSW EPA considers that a reuse situation is genuine resource recovery, then an order and exemption are prepared detailing the limitations on how such reuse can occur and what processing of the waste material being reused is required before reuse is permitted.

The orders and exemptions relevant for recovered fines include:

- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The “continuous process” recovered fines order 2014
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The “continuous process” recovered fines order 2014
- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The “batch process” recovered fines order 2014
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The “batch process” recovered fines order 2014

POEO Amendment (Waste) Regulation 2018

The *POEO Amendment (Waste) Regulation 2018* includes the following key aspects:

Part 8A is specific to construction and demolition waste facilities where the following definition is provided:

> ***construction waste*** *means:*
>
> *(a) material that results from the construction of buildings or infrastructure (such as roads, tunnels, airports and infrastructure for sewage, water, electricity and telecommunications) and includes materials such as:*

(i) bricks, concrete, paper, plastics, glass and metal, and (ii) timber, including unsegregated timber, that may contain timber treated with chemicals, and

(iii) soil or other excavated material (but not virgin excavated natural material within the meaning of Schedule 1 to the Act), and

Note. Construction waste includes all building and demolition waste within the meaning of Schedule 1 to the Act.

(b) material processed from any material to which paragraph (a) applies,

(c) waste that contains any material to which paragraph (a) or (b) applies.

It is a condition of an environment protection licence for a scheduled waste facility that is a construction and demolition waste facility that the requirements set out in the Standard on managing construction waste in NSW are complied with at the facility.

NSW EPA Standard on managing construction waste (NSW EPA 2019)

The NSW EPA Standard on managing construction waste (NSW EPA 2019) requires each load of construction waste that enters a C&D waste facility to undergo inspection.

This requires visual inspections at 2 points:

- Inspection point 1 – top of load in truck from an elevated location or using a video camera
- Inspection point 2 – tip and spread in an inspection area, with inspection by trained personnel (visual inspection).

The Standard requires rejection of the entire load where asbestos waste or other prohibited wastes are identified as present in the load at either of the inspection points.

More information about the requirements for handling construction and demolition waste is provided at https://www.epa.nsw.gov.au/your-environment/waste/industrial-waste/construction-demolition .

2.3 Description of recovered fines

2.3.1 Background

Recovered fines are a soil or sand substitute that has a typical maximum particle size of 9.5 mm. It is derived from processing mixed construction and demolition waste including residues from skip bin waste. These materials can be prepared via a batch process or a continuous process under the 2 resource recovery orders.

A soil or sand substitute means material that can be used in place of soil or sand – i.e. has same/similar characteristics. It does not mean that it must be made of soil or sand.

The reason for allowing the use of these materials as a soil/sand substitute is to:

- minimise the need to generate virgin soil or sand from natural sources
- maximise recovery of these materials from waste/minimise the amounts of this material ending up in landfill.

Recovered fines are materials that are less than, at least, 9.5 mm in size. The resource recovery order requirements mean that most of the recovered fines are much smaller as 80% on average needs to be less than 0.425 mm in size. This means recovered fines are extremely fine materials that will usually need to be mixed with other materials like soil or sand and or placed at depth to ensure the materials are not subject to wind erosion or disturbances from other activities at the ground surface.

These recovered fines are currently used in the following ways:

- soil substitute for under-turf landscaping and landscaping blends in applications, where deemed suitable
- soil substitute for engineered fill, where deemed suitable.

The waste processors produce these recovered fines from mixed construction and demolition wastes and primarily sell it to suppliers of such material who then on sell (often after blending with other materials) for landscaping or construction purposes.

The mixed construction and demolition waste consists of waste materials generated during construction of buildings or infrastructure or generated during the demolition of buildings or infrastructure. Such waste materials consist of bricks, cement, timber, paper/cardboard, plasterboard, plastics, metals and soil.

The fine material resulting from the processing of these wastes will be heterogeneous – i.e. highly variable. Some days the material may have more fine soil, other days it may have more small pieces of broken concrete, and other days it may have more plaster or small pieces of paper. This is because it depends on what mix of building materials is actually present in the material brought to the waste processing facility.

Processing of the wastes to generate the full range of recycled products including recovered fines is shown in **Figures 1** and **2**.

Figure 1 shows that a range of recycled material products are generated from the processing of these mixed construction and demolition wastes. Recovered fines is the fine material that is left at the end of the process that is of an appropriate size for use as a soil/sand substitute.

Figure 2 shows the type of processes used to separate materials from this mixed waste stream into the various products which can then be recycled/reused.

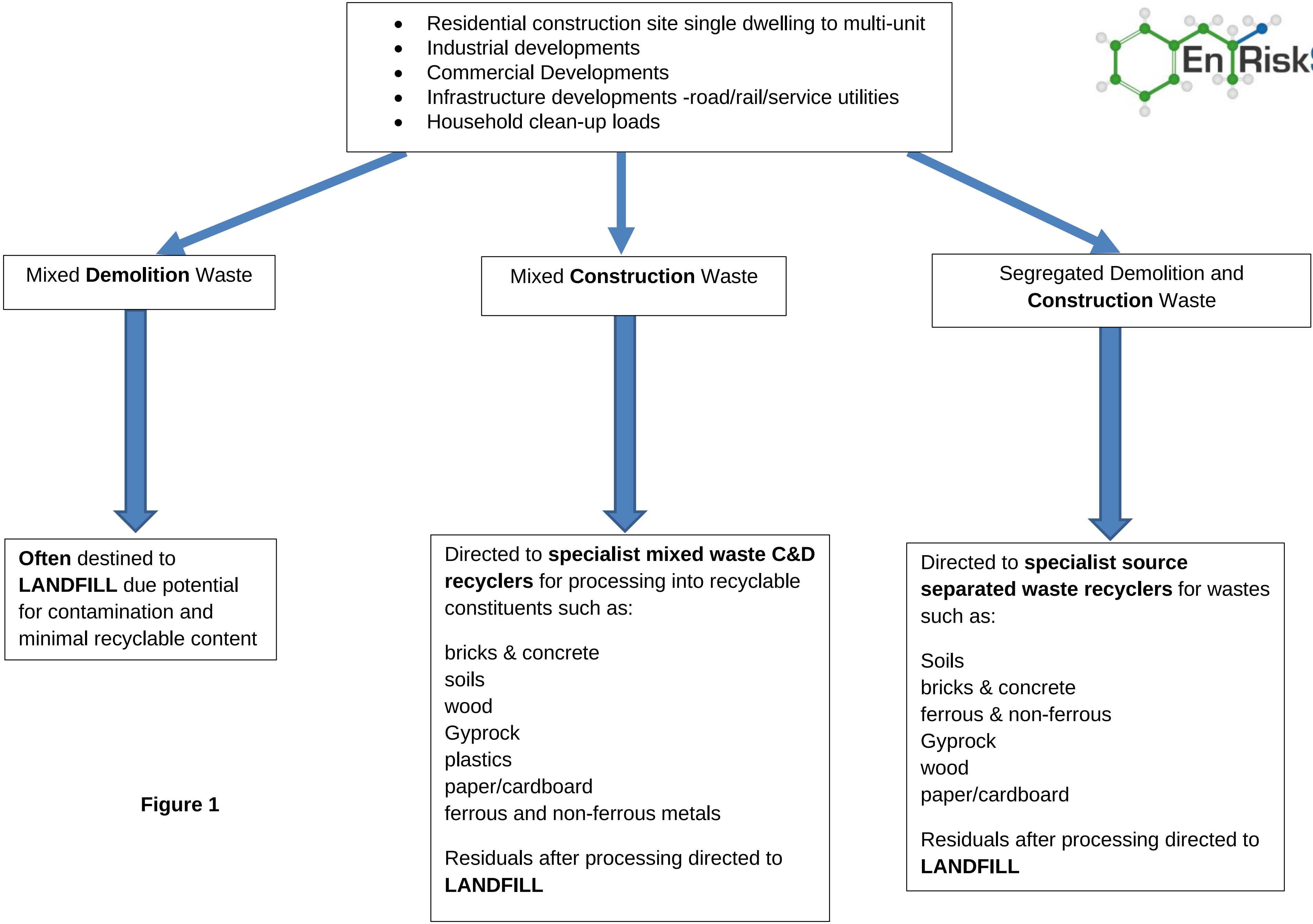
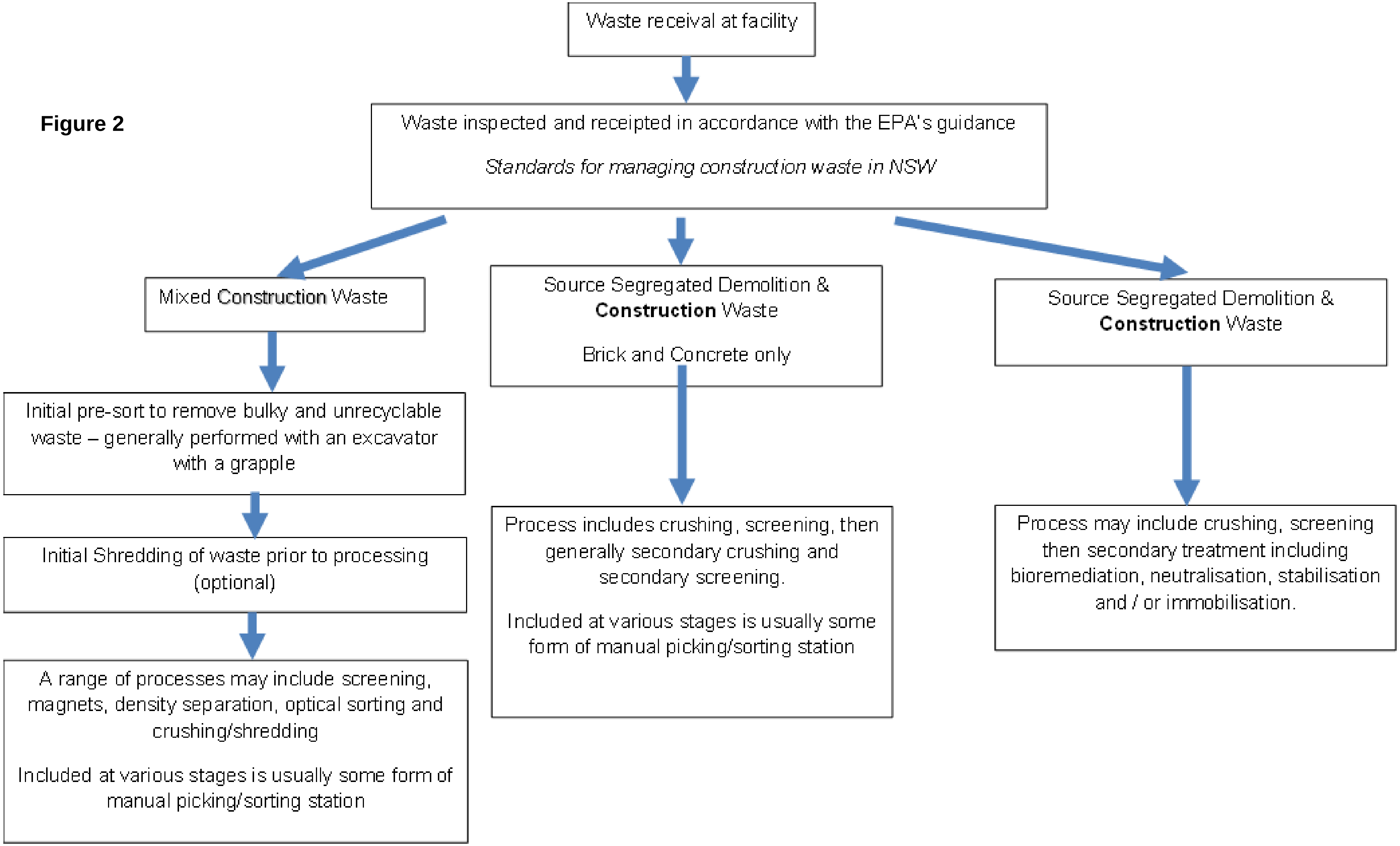

Residential construction site single dwelling to multi-unit
Industrial developments
Commercial Developments
Infrastructure developments -road/rail/service utilities
Household clean-up loads
Mixed Demolition Waste
Mixed Construction Waste
Segregated Demolition and Construction Waste
Often destined to LANDFILL due potential for contamination and minimal recyclable content
Directed to specialist mixed waste C&D recyclers for processing into recyclable constituents such as:
bricks & concrete
soils
wood
Gyprock
plastics
paper/cardboard
ferrous and non-ferrous metals
Residuals after processing directed to LANDFILL
Directed to specialist source separated waste recyclers for wastes such as:
Soils
bricks & concrete
ferrous & non-ferrous
Gyprock
wood
paper/cardboard
Residuals after processing directed to LANDFILL

Figure 1

Figure 2



Waste receival at facility
Waste inspected and receipted in accordance with the EPA's guidance
Standards for managing construction waste in NSW
Mixed Construction Waste
Source Segregated Demolition & **Construction** Waste
Brick and Concrete only
Source Segregated Demolition & **Construction** Waste
Initial pre-sort to remove bulky and unrecyclable waste – generally performed with an excavator with a grapple
Initial Shredding of waste prior to processing (optional)
A range of processes may include screening, magnets, density separation, optical sorting and crushing/shredding
Included at various stages is usually some form of manual picking/sorting station
Process includes crushing, screening, then generally secondary crushing and secondary screening.
Included at various stages is usually some form of manual picking/sorting station
Process may include crushing, screening then secondary treatment including bioremediation, neutralisation, stabilisation and / or immobilisation.

More specific details for the recovered fines part of the process are outlined in the resource recovery orders.

2.3.2 Batch process

The recovered fines order for material produced using a batch process requires the following:

- Written sampling plan must be prepared prior to any batch processing of mixed construction/demolition waste to produce fines (i.e. material less than 9.5 mm)
- Sampling of the fines must be undertaken in accordance with the plan and the relevant Australian Standard (AS 1141.3.1 (2012))
- Each batch must be sampled by taking 10 composite samples from every 400 tonnes of waste processed (composite sample is defined here as a sample where 5 samples taken through the entire batch are combined in equal part into a single sample for analysis)
- These samples must be tested for the parameters listed in the relevant table and results must be in line with the requirements listed in the relevant table (see **Table 1**)
- The recovered fines cannot be supplied to anyone if the concentrations do not comply with the values listed
- Analysis must be undertaken using the various methods listed in the order for the different types of parameters and the analysis must be undertaken by a NATA accredited laboratory (or equivalent)
- Each batch of fines must be supplied with a written statement certifying all requirements of the order have been met and including a link to the resource recovery order and exemption
- Records must be kept by the processor including the sampling plan, the test results, the amount of fines supplied to each purchaser and the name and address of each purchaser or, at least, the registration details for the vehicle used to transport the fines from the processor's site
- Such records must be able to be supplied if requested
- NSW EPA must be notified within 7 days if any part of these requirements are not complied with.

Table 1: Parameters required to be analysed and the relevant limits (batch process)

Parameter	Maximum average concentration for one-off concentration (mg/kg dry weight unless otherwise specified)	Absolute maximum concentration for one-off concentration (mg/kg dry weight unless otherwise specified)
Mercury	0.5	1.5
Cadmium	0.5	1.5
Lead	100	250
Arsenic	20	40
Chromium (total)	60	150
Copper	70	200
Nickel	40	80
Zinc	250	600
Total organic carbon (TOC)	5%	10%
Electrical conductivity	2.5 dS/m	3.5 dS/m
pH	7.5-9	7-10
Total polycyclic aromatic hydrocarbons (PAHs)[1]	20	80
Benzo[a]pyrene	1	6

Parameter	Maximum average concentration for one-off concentration (mg/kg dry weight unless otherwise specified)	Absolute maximum concentration for one-off concentration (mg/kg dry weight unless otherwise specified)
Total petroleum hydrocarbons (C6-C9)	80	150
Total petroleum hydrocarbons (C10-C36)	800	1,600
Individual chlorinated hydrocarbons[2]	Not applicable	1
Individual organochlorine pesticides[3]	Not applicable	1
Individual polychlorinated biphenyls (PCBs)[4]	Not applicable	1
Glass, metal and rigid plastics	0.1%	0.3%
Plastics – light flexible film	0.05%	0.1%
Proportion (by weight) retained on a 0.425 mm sieve	80%	90%
Proportion (by weight) retained on a 9.5 mm sieve	Not applicable	5%
Proportion (by weight) retained on a 26.5 mm sieve	Not applicable	0%

Notes:

1 Polyaromatic hydrocarbons include naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b,k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[g,h,i]perylene

2 Chlorinated hydrocarbons include carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichlorothene, dichloromethane (methylene chloride), 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, vinyl chloride and hexachlorobutadiene

3 Organochlorine pesticides include aldrin, alpha BHC, beta BHC, gamma BHC (lindane), delta BHC, chlordane, DDT, DDD, DDE, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor and endosulfan (includes endosulfan I, endosulfan II and endosulfan sulfate).

4 Polychlorinated biphenyls includes: Aroclor 1016 (CAS Registry No. 12674-11-2), Aroclor 1221 (CAS Registry No. 11104-28-2), Aroclor 1232 (CAS Registry No. 11141-16-5), Aroclor 1242 (CAS Registry No. 53469-21-9), Aroclor 1248 (CAS Registry No. 12672-29-6), Aroclor 1254 (CAS Registry No. 11097-69-1), Aroclor 1260 (CAS Registry No. 11096-82-5).

No definition is provided in the resource recovery order about what is meant by a batch process. There is also no information provided in this order to indicate how the limits listed in **Table 1** were determined or what they are designed to protect.

It is assumed that the absolute maximum concentration limits apply to the results for any single composite sample from a particular batch, but no definition is provided in the order.

It is assumed that the maximum average concentration limits apply to the average concentration for all samples from a single batch. The definition provided in 4.4.2 is not completely clear.

An example of how this requirement would operate is that a facility that processes 80,000 tonnes per year using a batch process would need to take 10 composite samples per 400 tonnes which is approximately equivalent to 30-35 samples per 1,500 tonnes of processed waste (i.e. processed material per week).

In addition to the resource recovery order, there is a resource recovery exemption. The exemption indicates what parts of standard legislation in NSW for waste management do not apply for the purposes of this resource recovery process. It also indicates how the recovered fines may be used.

Materials produced under this resource recovery order/exemption are exempt from:

- Section 48 of the POEO Act in respect of the scheduled activities described in clauses 39 of Schedule 1 of the POEO Act (this section requires a site to have an environment protection licence if relevant scheduled activities are conducted on the site, clause 39 of Schedule 1 indicates that application of waste to land for the purposes of disposal is a scheduled activity – compliance with this order/exemption means that when recovered fines are applied to land no licence is required)
- Section 88 of the POEO Act (this section covers requirements for payment of the waste levy – compliance with this order/exemption means that no payment of the waste levy is required)
- Part 4 of the Waste Regulation (this part of the regulation relates to payment of the waste levy – compliance with this order/exemption means that no payment of the waste levy is required)
- Clause 109 and 110 of the Waste Regulation (these clauses relate to reporting requirements for sites which could be defined as new landfills/waste facilities – compliance with this order/exemption means that a site where recovered fines are applied is not defined as a new landfill or waste facility).

The conditions of the exemption include:

- Recovered fines must comply with all the relevant limits provided in the order (and listed in **Table 1** above)
- Recovered fines can only be applied to land for the purposes of construction or landscaping
- Recovered fines cannot be used for:
    - Construction of dams or related water storage infrastructure
    - Mine site rehabilitation
    - Quarry rehabilitation
    - Sand dredge pond rehabilitation
    - Back-filling of quarry voids
    - Raising or reshaping of land used for agricultural purposes
    - Construction of roads on private land unless certain conditions are in met (use is minimised, it's for a road for which there is a development consent, it's for a road that provides access to a development that has a development consent or the works are either an exempt or complying development)
- Recovered fines can only be applied to land for the purposes of construction or landscaping where the works comply with a development consent and the material is not applied in or beneath surface water or groundwater
- Users of the recovered fines must keep a written record of the use for 6 years (quantity used and name and address of supplier) and these records must be available for NSW EPA officers on request
- Recovered fines must be applied to land for the purposes of construction or landscaping within a reasonable period of time after receipt (i.e. cannot be stored on-site for an extended period).

2.3.3 Continuous process

The recovered fines order for material produced using a continuous process requires the following:

- Written sampling plan must be prepared prior to any continuous processing of mixed construction/demolition waste to produce fines (i.e. material less than 9.5 mm)
- Sampling of the fines must be undertaken in accordance with the plan and the relevant Australian Standard (AS 1141.3.1 (2012))
- The fines generated using the continuous process must be initially characterised by collecting 1 composite sample per fortnight (composite sample is defined here as a sample where 5 samples taken through the material are combined in equal part into a single sample for analysis)
- Routine sampling of the continuous output must include 1 composite sample per week
- These samples must be tested for the parameters listed in the relevant table and results must be in line with the requirements listed in the relevant table (see **Table 2**)
- The recovered fines cannot be supplied to anyone if the concentrations do not comply with the values listed
- Analysis must be undertaken using the various methods listed in the order for the different types of parameters and the analysis must be undertaken by a NATA accredited laboratory (or equivalent)
- Each batch of fines must be supplied with a written statement certifying all requirements of the order have been met and include a link to the resource recovery order and exemption
- Records must be kept by the processor including the sampling plan, the test results, the amount of fines supplied to each purchaser and the name and address of each purchaser or, at least, the registration details for the vehicle used to transport the fines from the processor's site
- Such records must be able to be supplied if requested
- NSW EPA must be notified within 7 days if any part of these requirements are not complied with.

Table 2: Parameters required to be analysed and the relevant limits (continuous process)

Parameter	Maximum average concentration for characterisation (mg/kg dry weight unless otherwise specified)	Maximum average concentration for routine testing (mg/kg dry weight unless otherwise specified)	Absolute maximum concentration for one-off concentration (mg/kg dry weight unless otherwise specified)
Mercury	0.5	No testing required	1.5
Cadmium	0.5	No testing required	1.5
Lead	100	100	250
Arsenic	20	No testing required	40
Chromium (total)	60	60	150
Copper	70	70	200
Nickel	40	No testing required	80
Zinc	250	250	600
Total organic carbon (TOC)	5%	No testing required	10%
Electrical conductivity	2.5 dS/m	2.5 dS/m	3.5 dS/m

Parameter	Maximum average concentration for characterisation (mg/kg dry weight unless otherwise specified)	Maximum average concentration for routine testing (mg/kg dry weight unless otherwise specified)	Absolute maximum concentration for one-off concentration (mg/kg dry weight unless otherwise specified)
pH	7.5-9	7.5-9	7-10
Total polycyclic aromatic hydrocarbons (PAHs)[1]	20	No testing required	80
Benzo[a]pyrene	1	No testing required	6
Total petroleum hydrocarbons (C6-C9)	80	No testing required	150
Total petroleum hydrocarbons (C10-C36)	800	No testing required	1,600
Individual chlorinated hydrocarbons[2]	Not applicable	No testing required	1
Individual organochlorine pesticides[3]	Not applicable	No testing required	1
Individual polychlorinated biphenyls (PCBs)[4]	Not applicable	No testing required	1
Glass, metal and rigid plastics	0.1%	0.1%	0.3%
Plastics – light flexible film	0.05%	0.05%	0.1%
Proportion (by weight) retained on a 0.425 mm sieve	80%	No testing required	90%
Proportion (by weight) retained on a 9.5 mm sieve	Not applicable	No testing required	5%
Proportion (by weight) retained on a 26.5 mm sieve	Not applicable	No testing required	0%

Notes:

1 Polyaromatic hydrocarbons include naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b,k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[g,h,i]perylene

2 Chlorinated hydrocarbons include carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichlorothene, dichloromethane (methylene chloride), 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, vinyl chloride and hexachlorobutadiene

3 Organochlorine pesticides include aldrin, alpha BHC, beta BHC, gamma BHC (lindane), delta BHC, chlordane, DDT, DDD, DDE, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor and endosulfan (includes endosulfan I, endosulfan II and endosulfan sulfate).

4 Polychlorinated biphenyls includes: Aroclor 1016 (CAS Registry No. 12674-11-2), Aroclor 1221 (CAS Registry No. 11104-28-2), Aroclor 1232 (CAS Registry No. 11141-16-5), Aroclor 1242 (CAS Registry No. 53469-21-9), Aroclor 1248 (CAS Registry No. 12672-29-6), Aroclor 1254 (CAS Registry No. 11097-69-1), Aroclor 1260 (CAS Registry No. 11096-82-5).

No definition is provided in the resource recovery order about what is meant by a continuous process. There is also no information provided in this order to indicate how the limits in **Table 2** were determined or what they are designed to protect.

It is assumed that the absolute maximum concentration limits apply to the results for any single composite sample taken during characterisation or routine testing, but the definition is not entirely clear.

In regard to the maximum average concentration limits, the order indicates that:

- Arithmetic mean of as few as 1 sample is required to compare to the limits when considering the characterisation testing – which is not an appropriate indication of average (Clause 4.2.1 does not indicate the time period for characterisation testing so it appears there could be 1 sample taken in the initial fortnight of processing a new source of relevant material and Clause 4.3.2 just requires that the arithmetic mean of the characterisation testing samples should be determined and compared to the maximum average limits).

- Arithmetic mean of 5 composite samples over 5 weeks is required for comparison with the maximum average limits for routine testing.

The order, also, does not make clear how it is to be determined when characterisation testing is required nor does it indicate what would trigger re-characterisation after some time period.

An example of how this requirement would operate is that a facility that processes 80,000 tonnes per year using a continuous process would need to take at least 1 composite sample to be collected each week which is approximately equivalent to 1 sample per 1,500 tonnes of processed waste. It is also noted that only a limited list of parameters needs to be measured in the samples collected under the routine testing requirement.

In addition to the resource recovery order, there is a resource recovery exemption. The exemption indicates what parts of standard legislation in NSW for waste management do not apply for the purposes of this resource recovery process. It also indicates how the recovered fines may be used.

Materials produced under this resource recovery order/exemption are exempt from (as discussed above):

- Section 48 of the POEO Act in respect of the scheduled activities described in clauses 39 of Schedule 1 of the POEO Act
- Part 4 of the Waste Regulation
- Section 88 of the POEO Act
- Clause 109 and 110 of the Waste Regulation.

The conditions of the exemption include:

- Recovered fines must comply with all the relevant limits provided in the order (and listed in **Table 2** above)
- Recovered fines can only be applied to land for the purposes of construction or landscaping
- Recovered fines cannot be used for:
    - Construction of dams or related water storage infrastructure
    - Mine site rehabilitation
    - Quarry rehabilitation
    - Sand dredge pond rehabilitation
    - Back-filling of quarry voids
    - Raising or reshaping of land used for agricultural purposes
    - Construction of roads on private land unless certain conditions are in met (use is minimised, its for a road for which there is a development consent, its for a road that provides access to a development that has a development consent or the works are either an exempt or complying development)
- Recovered fines can only be applied to land for the purposes of construction or landscaping where the works comply with a development consent and the material is not applied in or beneath surface water or groundwater
- User of the recovered fines must keep a written record of the use for 6 years (quantity used and name and address of supplier) and these records must be available for NSW EPA officers on request

- Recovered fines must be applied to land for the purposes of construction or landscaping within a reasonable period of time after receipt (i.e. cannot be stored on-site for an extended period).

2.3.4 Differences between the orders

While both orders provide some detail on what constitutes acceptable material, there are some key aspects that are not included or are unclear that make unambiguous and consistent interpretation and application of the orders difficult.

The orders do not define what is meant by the term “batch” or “continuous” process which makes it difficult to determine what processing qualifies a facility as preparing materials based on one or other of the orders. Given the significant difference in the sampling procedures listed in the two orders, it seems that it would be important that these terms be better defined.

The orders have significant differences in the amount of sampling that is required (**Section 4.2**). The characteristics of the materials, regardless of whether these are generated from a batch or continuous process would be the same due to consistent sources of material types (i.e. bricks, concrete, plasterboard, etc), but there will always be different proportions of each type and the mix would change over each hour, each day or each week.

There are, also, some differences in the values for the average limits but the absolute maximum limits are the same for both orders (**Tables 1** and **2**).

2.4 Proposed recovered soil order

In addition to the existing resource recovery orders and exemptions for recovered fines, the NSW EPA is considering the possibility of introducing a new order for a new category – recovered soil. The draft order and exemption have been provided for comment.

Recovered soil is only exempt from normal environment protection legislation where it complies with all requirements of the draft order and is only applied to land for the purposes of engineering fill (i.e. used to support structures or pavements for which engineering properties must be controlled) or earthworks (i.e. for raising the level of a site or raising/shaping the topography of a site).

The definition of recovered soil in the draft order is:

> *excavated soil (including but not limited to natural materials such as sandstone, shale, clay or soil) that must be processed and contain at least 98% natural materials after processing.*

Soil to be used for recovered soil must not be derived from the processing of building and demolition waste. The definition for such waste in the POEO Act is:

> ***Building and demolition waste*** *means unsegregated material (other than material containing asbestos waste or liquid waste) that results from—*
>
> *(a) the demolition, erection, construction, refurbishment or alteration of buildings other than -*
> *(i) chemical works, or*
> *(ii) mineral processing works, or*
> *(iii) container reconditioning works, or*

(iv) waste treatment facilities, or

(b) the construction, replacement, repair or alteration of infrastructure development such as roads, tunnels, sewage, water, electricity, telecommunications and airports, and includes materials such as -

(i) bricks, concrete, paper, plastics, glass and metal, and

(ii) timber, including unsegregated timber, that may contain timber treated with chemicals such as copper chrome arsenate (CCA), high temperature creosote (HTC), pigmented emulsified creosote (PEC) and light organic solvent preservative (LOSP),

but does not include excavated soil (for example, soil excavated to level off a site prior to construction or to enable foundations to be laid or infrastructure to be constructed).

This means the draft order can only be applied to soil generated from soil excavated to level a site prior to construction or to enable foundations to be laid etc.

It is also noted that there is a definition of construction waste in the POEO (Waste) Regulation. This definition states the following:

construction waste *means:*

(a) material that results from the construction of buildings or infrastructure (such as roads, tunnels, airports and infrastructure for sewage, water, electricity and telecommunications) and includes materials such as:

(i) bricks, concrete, paper, plastics, glass and metal, and (ii) timber, including unsegregated timber, that may contain timber treated with chemicals, and

(iii) soil or other excavated material (but not virgin excavated natural material within the meaning of Schedule 1 to the Act), and

Note. Construction waste includes all building and demolition waste within the meaning of Schedule 1 to the Act.

(b) material processed from any material to which paragraph (a) applies,

(c) waste that contains any material to which paragraph (a) or (b) applies.

This definition means that soil excavated for the purposes listed above would not be acceptable for inclusion in recovered soil. This mix of definitions makes it quite difficult to be confident as to what material could actually be used to generate recovered soil in compliance with the draft order.

The draft order also notes that the relevant soil for this purpose would not be expected to meet the definitions of virgin excavated natural material or excavated natural material.

The definition of ***virgin excavated natural material*** is:

natural material (such as clay, gravel, sand, soil or rock fines):

(a) that has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities and

(b) that does not contain any sulfidic ores or soils or any other waste

and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.

The definition of ***excavated natural material*** is specified in the resource recovery order for excavated natural material as follows:

> *excavated natural material means naturally occurring rock and soil (including but not limited to materials such as sandstone, shale, clay and soil) that has:*
>
> > *a) been excavated from the ground, and*
> > *b) contains at least 98% (by weight) natural material, and*
> > *c) does not meet the definition of Virgin Excavated Natural Material in the Act.*
>
> *Excavated natural material does not include material located in a hotspot; that has been processed; or that contains asbestos, Acid Sulfate Soils (ASS), Potential Acid Sulfate soils (PASS) or sulfidic ores.*

The definition of excavated natural material is almost the same as the definition of recovered soil. The only difference is that the recovered soil may contain small amounts (less than 2%) of materials other than naturally occurring ones (where naturally occurring ones are materials such as sandstone, shale, clay or soil). The recovered soil may also be processed in some way.

The draft order states that recovered soil cannot contain asbestos, acid sulfate soils, chlorinated hydrocarbons, organochlorine pesticides, polychlorinated biphenyls or per/poly fluoroalkyl substances (PFAS).

Asbestos matters are discussed in **Sections 4.4 and 6.4**.

It is important to note that soil, particularly soil in urban areas, will usually contain small amounts of one or more of these groups.

- Acid sulfate soils are a particular geology present in coastal areas in NSW. The areas where such soils are present have been mapped which should allow such materials to be avoided for the purposes of this order.
- Chlorinated hydrocarbons are chemicals that are unlikely to be present in most soils due to their volatility. There would be contaminated sites where they might be present at detectable levels, but this would be identified during a site investigation. It is unlikely that recovered soil would be generated at a known contaminated site.
- Organochlorine pesticides were used for many decades for termite control around homes especially around concrete slabs. These chemicals are long lived so it is possible that small levels would remain in soil under or close to building slabs. Most site investigations do not identify that these chemicals are above the limits of reporting (specified as 0.02 mg/kg for each individual pesticide in the draft order).
- Polychlorinated biphenyls are chemicals that were present in transformer oils but have been banned for such use for decades. These chemicals are also long lived and so it is possible that small amounts could remain in soil in urban areas. Most site investigations do not identify that these chemicals are above the limits of reporting using the analytical method specified in the order (specified as 0.2 mg/kg for each Arochlor in the draft order).
- Per and poly fluoroalkyl substances (PFAS) are chemicals found in fire fighting foams and a wide range of other products used around the home and commercial premises that have resulted in widespread low levels in urban areas. Many site investigations identify that these chemicals may be present in urban areas above the limits of reporting (specified as 0.005 mg/kg for PFOS+PFHxS+PFOA in the draft order).

A desktop assessment of whether a source of recovered soil could contain any of these prohibited groups of chemicals is required for each site where such material may be generated. If the desktop assessment indicates that one or more of these groups could be present, then the recovered soil cannot be classified as recovered soil and cannot be processed for use as recovered soil. It is noted that there is no guidance provided in the draft order as to how to undertake such a desktop assessment or what type of evidence is likely to be sufficient to demonstrate that these prohibited groups are not likely to be present in material to be recycled.

Given the ubiquitous nature (at low levels) of chemicals like PFAS in soils in urban areas, it is not clear what sort of evidence developed from a desktop assessment could be sufficient.

Requirements for sampling of the recovered soil after it has been processed are based on a table in the draft order which indicates the number of samples per batch of recovered soil. **Table 3** shows the requirements.

Table 3: Sampling requirements under draft recovered soil order

Stockpile size (tonnes)	Number of discrete samples
<250	5
250-500	6
500-1,000	8
1,000-1,500	9
1,500-2,000	10

It is noted that composite samples are no longer required. Instead, discrete samples are to be collected. Discrete samples are likely to have more variability than composite samples as per the previous orders. For a stockpile of 250 tonnes, 5-6 samples are required. Each sample is 6-8 kg. So, a total of 48 kg of recovered soil is to be collected to indicate the quality of 250,000 kg.

The draft order also requires the preparation of a sampling plan as is required in the recovered fines orders.

The draft order provides a list of parameters which must be measured in the samples of recovered soil and limits for each parameter type. These parameters and limits are listed in **Table 4**.

Table 4: Parameters required to be analysed and the relevant limits (draft order for recovered soil)

Parameter	Maximum average concentration for one-off characterisation (mg/kg dry weight unless otherwise specified)	Absolute maximum concentration for one-off characterisation (mg/kg dry weight unless otherwise specified)
Mercury	0.5	1
Cadmium	0.5	1
Lead	75	150
Arsenic	20	40
Chromium (VI)	10	20
Copper	100	250
Nickel	40	80
Zinc	150	400
Electrical conductivity	1.5 dS/m	3 dS/m
pH	5-9	4.5-10

Parameter	Maximum average concentration for one-off characterisation (mg/kg dry weight unless otherwise specified)	Absolute maximum concentration for one-off characterisation (mg/kg dry weight unless otherwise specified)
Total polycyclic aromatic hydrocarbons (PAHs)[1]	20	50
Benzo[a]pyrene TEQ[2]	1	2
Naphthalene	1	2
Benzene	Not applicable	0.5
Toluene	Not applicable	65
Ethylbenzene	Not applicable	25
Xylenes	Not applicable	15
Total recoverable hydrocarbons (C6-C10) (F1)[4]	25	30
Total recoverable hydrocarbons (>C10-C16) (F2)[3,5]	60	80
Total recoverable hydrocarbons (>C16-C34) (F3)[3]	100	150
Total recoverable hydrocarbons (>C34-C40) (F4)[3]	250	450
Asbestos fines/fibrous asbestos	Not applicable	No asbestos present
Rubber	Not applicable	0.01%
Plastic	Not applicable	0.01%
Paper/cardboard	Not applicable	0.01%
Asphalt	Not applicable	0.01%
Cloth	Not applicable	0.01%
Paint	Not applicable	0.01%
Glass	Not applicable	0.01%
Metal	Not applicable	0.01%
Wood	Not applicable	0.01%

Notes:

1 Polyaromatic hydrocarbons include sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b+j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[g,h,i]perylene.

2 Benzo[a]pyrene TEQ includes benzo[a]anthracene, chrysene, benzo[b+j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenzo[a,h]anthracene, benzo[g,h,i]perylene multiplied by their relevant toxicity equivalence factors as per ASC NEPM Schedule B1 (NEPC 1999 amended 2013a).

3 Total recoverable hydrocarbon analysis can include silica gel cleanup (relevant for F2, F3 and F4 only).

4 F1 fraction includes total recoverable hydrocarbons (C6-C10) minus the sum of concentrations for benzene, toluene, ethylbenzene and xylenes.

5 F2 fraction includes total recoverable hydrocarbons (>C10-C16) minus the concentration of naphthalene.

There is no information provided in this order to indicate how the limits were determined or what they are designed to protect.

There are a number of differences between the parameters and limits listed in **Table 4** and those in **Tables 1** and **2** including:

- No limits for chlorinated hydrocarbons, organochlorine pesticides and polychlorinated biphenyls as these are prohibited from being present – based on a desktop assessment
- Parameters and limits for petroleum hydrocarbons have been updated based on latest national guidance for contaminated sites assessment – the ASC NEPM – it is noted that the limits listed for both average and absolute maximum are very close to the common limits of reporting for these chemical groupings (common LORs are 20 mg/kg for F1, 50 mg/kg for F2, 100 mg/kg for F3, 100 mg/kg for F4)
- The limit for benzo[a]pyrene has been applied to the group of chemicals making up benzo[a]pyrene equivalents which is in line with national and international practice – this

group of chemicals all contribute to the same effect as benzo[a]pyrene but with different potencies which are accounted for in the equivalency factors that are applied to calculate the benzo[a]pyrene equivalents

- Specific limits for a wide range of materials that might be visible in recovered soil and could have a visual or amenity impact when this material is placed at the ground surface (when placed at depth there is no need to consider visual/amenity impacts) including limits for cloth, glass, metal, wood, rubber, plastic etc
- A limit for asbestos has also been included.

Section 3. Comparison of limits

3.1 General

This section provides a comparison of the limits specified to define acceptable quality of recovered fines and recovered soil with those that indicate the classification requirements for waste or acceptable quality of low density residential soil (as per ASC NEPM), compost, soils etc (AS 4454), excavated natural material and recovered aggregate (relevant resource recovery order), as well as specifications for recycled materials used for pavements, earthworks and drainage (NSW DECCW guidance document).

3.2 Sources of guidance

There are many sources of guidelines from state and national guidance which specify the quality of materials to be used as soil or as soil substitute as well as those that define how wastes should be classified.

3.2.1 Contaminated land guidelines – human health

The National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM) provides guidelines for soil for 4 generic scenarios (NEPC 1999 amended 2013a, 1999 amended 2013d). The scenarios include:

- Low density residential
- High density residential
- Parkland/open space
- Commercial/industrial

Guidelines have been developed for each scenario and these are called health investigation levels or HILs.

These guidelines are established under Commonwealth legislation in cooperation with the states and territories (i.e. all jurisdictions need to be consulted and sign off on any NEPM). It is relatively cumbersome to undertake any update to a NEPM such as the site contamination one, so they do not get updated very often.

In recent times, a different approach has been adopted for contaminated sites assessment.

The class of chemicals known as PFAS were not covered at all within the existing ASC NEPM, but guidance was needed for the assessment of a large number of sites that were being identified with these chemicals. The new approach adopted was for the formation of a Heads of EPA committee which has then published guidance material for this groups of chemicals in the form of a national environmental management plan (NEMP). The NEMP document has followed all the principles of the ASC NEPM but is focused solely on the PFAS group. The NEMP includes guidelines for PFAS for application at contaminated sites that have been calculated using the same general approach as that used for all other health investigation levels.

This approach may be used in the future for updating health investigation levels where this may be required. It is important to note that undertaking any update/review of these guidelines needs to be approved by all states/territories and the commonwealth and any change to these guidelines also must be approved by all these jurisdictions.

The significant work that was undertaken during the update of the ASC NEPM in 2013 to define the exposure scenarios and get agreement across all jurisdictions means that it is unlikely that these scenarios will be changed in any review/update. However, a guideline for a particular chemical could change in a review/update, if the understanding of its toxicity was to change significantly from that used in the 2013 update. In addition, additional guidelines may be added for chemicals which do not have any guidelines at present, if required, such as has been done for the PFAS group in the NEMP published by the Heads of EPA committee.

As already noted, these guidelines (HILs) are based on human health protection and make assumptions about a specific way people may be exposed for each land use type. The assumptions describe what is considered to be a conservative scenario for how someone might be exposed to chemicals in soil and the scenarios are different for each of the 4 land use types because how people may interact with a site will be different depending on their activities.

The scenario for calculating the HIL-A guidelines for low density residential assumes people have backyards, gardens and potentially vegetable gardens. It is specifically assumed that a person is exposed to the contaminants in soil through:

- incidental ingestion of 50 mg soil and indoor dust per day for adults and 100 mg per day for children every day of the year for 29 years for adults and 6 years for children
- soil will come into contact with 1/3 of the skin surface area for adults and almost half of the skin surface area for children every day of the year for 29 years for adults and 6 years for children – the calculations assume the soil stays on the skin all day
- inhalation of dust occurs indoors for 20 hours and outside for 4 hours every day of the year for 29 years for adults and 6 years for children
- consumption of home grown produce grown in relevant soil which contributes 10% of daily intake of fruit and vegetables.

The calculations for the HIL-A guidelines are generally based on children being exposed as this generates lower (more stringent) guidelines than using adult based parameter values.

The scenario for calculating the HIL-B guidelines for high density residential land use that there may be small garden areas around an apartment building where some people may garden or play. This scenario specifically assumes people are exposed to the contaminants in soil through:

- incidental ingestion of 12.5 mg soil or indoor dust per day for adults and 25 mg per day for children every day of the year for 29 years for adults and 6 years for children
- soil coming into contact with 1/3 of the skin surface area for adults and almost half of the skin surface area for children every day of the year for 29 years for adults and 6 years for children – the calculations assume the soil stays on the skin all day
- inhalation of dust occurs indoors for 20 hours and outside for 1 hours every day of the year for 29 years for adults and 6 years for children.

The calculations for the HIL-B guidelines are generally based on children being exposed as this generates lower (more stringent) guidelines than using adult based parameter values.

The scenario for calculating the HIL-C guidelines for public open space assumes that such parklands may be used in similar ways to a backyard for people who live in an apartment building and have a park nearby. It is assumed this type of exposure will be higher than exposure for people who use public open space for sporting activities, so these guidelines cover all relevant uses for public open space. The scenario specifically assumes people are exposed to the contaminants in soil through:

- incidental ingestion of 25 mg soil per day for adults and 50 mg per day for children every day of the year for 29 years for adults and 6 years for children (assumes that soil from the area is not tracked inside a home – so does not contribute to exposure as indoor dust)
- soil coming into contact with 1/3 of the skin surface area for adults and almost half of the skin surface area for children every day of the year for 29 years for adults and 6 years for children – the calculations assume the soil stays on the skin all day
- Inhalation of dust while outside for 2 hours every day of the year for 29 years for adults and 6 years for children.

The calculations for the HIL-C guidelines are generally based on children being exposed as this generates lower (more stringent) guidelines than using adult based parameter values.

The scenario for calculating the HIL-D guidelines for commercial/industrial land use assumes there are some outdoor areas at a work site or an office building where people may relax or undertake activities. The scenario specifically assumes people at these types of sites are exposed to the contaminants in soil through:

- incidental ingestion of 25 mg soil or indoor dust per day for adults every working day of the year for 30 years
- soil coming into contact with 1/5 of the skin surface area for adults every working day of the year for 30 years – the calculations assume the soil stays on the skin all day
- inhalation of dust indoors for 8 hours and outside for 1 hour every working day of the year for 30 years.

The calculations for the HIL-D guidelines use adult based parameter values.

These scenarios are designed to be conservative – i.e. overestimating likely exposures.

The HIL-A guideline applies to soil that is acceptable for use in backyards where people relax, play, garden and grow fruit and vegetables without the need for any special controls. This guideline has been used for comparison in this assessment with the limits proposed for recovered soil and the limits currently in place for recovered fines. The HIL-A guidelines are the most conservative of all the ASC NEPM guidelines. As noted above, this guideline does assume daily contact with the material and consumption of fruit and vegetables grown in the material.

It is not permissible to use recovered fines or recovered soil for locations where produce may be grown, so this guideline is particularly conservative for evaluating the quality of recovered fines or recovered soil.

The HIL-A guidelines are listed in **Table 5** for comparison with the limits for recovered fines and recovered soil, even though the scenario used in their derivation does not match the use patterns for these materials. In addition, the HIL-D guidelines have also been listed. These guidelines apply to commercial/industrial sites and the scenario used to calculate these values is more relevant to the use patterns for recovered fines – usually for engineered fill etc where material is placed at depth and covered.

3.2.2 Contaminated land guidelines – ecological

Another aspect of the contaminated land guidelines are those for the protection of ecological systems. There are ecological investigation levels as part of the ASC NEPM for a small number of chemicals including ones relevant to the lists used in the various resource recovery orders relevant to this assessment (NEPC 1999 amended 2013a). Other guidelines designed to be protective of ecosystems are those from the Canadian Council of Ministers of the Environment (CCME 2020) and these have been used to supplement the Australian ecological investigation levels.

The EIL values are designed to be protective for plants and animals in land used for residential purposes or as parkland. This means they should be protective for soil dwelling organisms, gardens, grasses, trees etc.

Most of the EILs from the ASC NEPM are provided as added contaminant limits. These values are designed to be added to a relevant value for background concentrations rather than used directly. The actual EIL is the added contaminant limit plus the background concentration. Using them "as is" (i.e. added contaminant limits only for the most sensitive value based on recovered fines/ recovered soil pH) means that the levels listed in this assessment are lower than necessary to be protective of ecosystems.

It is also noted that for many of the metals the added contaminant limits vary depending on soil conditions, particularly pH. The values chosen for use in this assessment are the most conservative values assuming the materials comply with the pH range listed. In most cases, this means that relevant added contaminant limit for soils of pH 4.5 or the lower of all values listed where information on the critical parameter was not available (e.g. cation exchange capacity, clay content etc).

The values listed in **Table 5** are the added contaminant levels (where relevant) or ecological investigation levels for residential/parkland uses for comparison with the limits for recovered fines and recovered soil. The relevant guidelines for commercial/industrial land uses have also been included in this table for comparison with the limits in the relevant orders.

3.2.3 Excavated natural materials

Excavated natural materials are another resource recovery product. There is a resource recovery order and exemption:

- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The excavated natural material order 2014 (NSW EPA 2014d)
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The excavated natural material exemption 2014 (NSW EPA 2014i)

The definition of excavated natural material is specified as follows:

> *excavated natural material means naturally occurring rock and soil (including but not limited to materials such as sandstone, shale, clay and soil) that has:*
>
> > *a) been excavated from the ground, and*
> > *b) contains at least 98% (by weight) natural material, and*
> > *c) does not meet the definition of Virgin Excavated Natural Material in the Act.*
>
> *Excavated natural material does not include material located in a hotspot; that has been processed; or that contains asbestos, Acid Sulfate Soils (ASS), Potential Acid Sulfate soils (PASS) or sulfidic ores.*

The resource recovery exemption indicates that the only permissible uses of materials complying with the order are application to land as engineering fill or for use in earthworks.

Just as for the recovered fines orders (and the draft recovered soil order), there are limits specified in the order which define the acceptable quality of material complying with the excavated natural materials order. The limits in the order indicate material of an appropriate quality for the same purposes as are relevant for recovered fines and/or recovered soil (draft order). There is no information provided in the ENM order to indicate how the limits were determined or what they are designed to protect.

The values listed as the absolute maximum concentration limits have been listed in **Table 5** for comparison with the limits for recovered fines and recovered soil.

3.2.4 Recycled materials for pavements, earthworks and drainage/ Recovered aggregate

There are a range of other resource recovery orders which govern the reuse of a wide range of materials. There are a number which regulate materials for end uses similar to that for recovered fines or recovered soil. One of those is the resource recovery order for recovered aggregate which has been included here for comparison with the orders being reviewed.

The resource recovery order and exemption for recovered aggregate are as follows:

- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The recovered aggregate order 2014 (NSW EPA 2014h)
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The recovered aggregate exemption 2014 (NSW EPA 2014g)

The definition of recovered aggregate is specified as follows:

> *material comprising of concrete, brick, ceramics, natural rock and asphalt processed into an engineered material*

The resource recovery exemption indicates that the only permitted uses include application to land for road making activities, building, landscaping and construction works.

- Recovered aggregate cannot be used for:
  - Construction of dams or related water storage infrastructure
  - Mine site rehabilitation
  - Quarry rehabilitation
  - Sand dredge pond rehabilitation
  - Back-filling of quarry voids
  - Raising or reshaping of land used for agricultural purposes
  - Construction of roads on private land unless certain conditions are in met (use is minimised, it's for a road for which there is a development consent, it's for a road that provides access to a development that has a development consent or the works are either an exempt or complying development)

Just as for the recovered fines orders (and the draft recovered soil order), there are limits specified in the order which define the acceptable quality of material complying with the recovered aggregate order. The limits in the order indicate material of an appropriate quality for the same purposes as are relevant for recovered fines and/or recovered soil (draft order). There is no information provided in the recovered aggregate order to indicate how the limits were determined or what they are designed to protect.

The same limits are provided in the NSW DECCW report "Specification for supply of recycled material for pavements, earthworks and drainage" from 2010 (DECCW 2010).

The values listed as the absolute maximum concentration limits have been listed in **Table 5** for comparison with the limits for recovered fines and recovered soil.

3.2.5 Compost, soil conditioners and mulches

Australian Standard 4454-2012 provides guidance on the acceptable quality of composts, soil conditioners and mulches (Australian Standard 2012).

The scope of the standard is as follows:

> *This Standard specifies requirements for organic products and mixtures of organic products that are to be used to amend the physical and chemical properties of natural or artificial soils and growing media. It specifies physical, chemical, biological and labelling requirements for composts, mulches, soil conditioners and related products that have been derived largely from compostable organic materials and which meet the minimum requirements as set out in this Standard. It covers products marketed or distributed both in bags and in bulk in an unrestricted manner in all market sectors including domestic use, urban landscaping, agriculture and land rehabilitation.*

The guidance in this standard is designed to ensure that the materials are of a suitable quality for domestic use where no controls can be assumed to be present. This means the chemical characteristics are designed to be protective for both human health and ecological systems for uses that are more sensitive than the uses permitted for recovered fines or recovered soil (draft order).

There is no information provided in the standard to indicate how the limits were determined or what they are designed to protect.

The values listed as the absolute maximum concentration limits have been listed in **Table 5** for comparison with the limits for recovered fines and recovered soil.

3.2.6 Waste classification limits

NSW EPA has issued guidance about the limits relevant to determining the quality of material that can be disposed to landfills including landfills with limited engineering (NSW EPA 2014f). These criteria indicate the maximum amounts of various chemicals that can be present in material being disposed to landfill.

The values for the CT1 limits have been listed in **Table 5** for comparison with the limits for recovered fines and recovered soil.

3.3 Comparison

The limits derived from each of the sources listed in **Section 3.2** have been compared with the limits for recovered fines and recovered soil (draft) in **Table 5**.

Table 5: Comparison of limits/guidelines published in Australia relevant to soil and soil like materials

Parameter	Absolute maximum (recovered fines – batch)	Absolute maximum (recovered fines – continuous)	Absolute maximum (draft recovered soil)	ASC NEPM HIL-A	ASC NEPM ecological guidelines – A	ASC NEPM HIL-D	ASC NEPM ecological guidelines – D	Absolute maximum (ENM)	Absolute maximum (Recovered aggregate)	Composts, soil conditioner, mulches	Waste classification (CT1)
	mg/kg										
Mercury	1.5	1.5	1	40	6.6 (CCME)	730	NA	1	1	1	4
Cadmium	1.5	1.5	1	20	10 (CCME)	900	NA	1	1.5	1	20
Lead	250	250	150	300	1,100 (ACL)	1,500	1,800 (ACL)	100	150	150	100
Arsenic	40	40	40	100	100	3,000	160	40	40	20	100
Chromium (total)	150	150	NA	NA	190 (ACL)	NA	310 (ACL)	150	120	100	NA
Chromium (VI)	NA	NA	20	100	0.4 (CCME)	3,600	NA	NA	NA	NA	100
Copper	200	200	250	6,000	60 (ACL)	240,000	85 (ACL)	200	150	150	NA
Nickel	80	80	80	400	30 (ACL)	6,000	55 (ACL)	60	80	60	40
Zinc	600	600	400	7,400	100 (ACL)	400,000	150 (ACL)	300	350	300	NA
Boron	NA	NA	NA	NA	NA	300,000	NA	NA	NA	100	NA
Selenium	NA	NA	NA	NA	NA	10,000	NA	NA	NA	5	20
Total organic carbon (TOC)	10%	10%	NA	NA	NA	NA	NA	NA	NA	≥20%	NA
Electrical conductivity	3.5 dS/m	3.5 dS/m	3 dS/m	NA	NA	NA	NA	3 dS/m	3 dS/m	10 dS/m	NA
pH	7-10	7-10	4.5-10	NA	NA	NA	NA	4.5-10		5-8	NA
Total polycyclic aromatic hydrocarbons (PAHs)[1]	80	80	50	300	NA	4,000	NA	40	NA	NA	200
Benzo[a]pyrene	6	6	NA	NA	1.4 (NEPM note)[1]	NA	1.4 (NEPM note)[1]	1	NA	NA	0.8
Benzo[a]pyrene TEQ	NA	NA	2	3	NA	40	NA	NA	NA	NA	NA
Naphthalene	NA	NA	2	3	170	NL	370	NA	NA	NA	NA
Benzene	NA	NA	0.5	0.5	50	3	75	0.5	NA	NA	10
Toluene	NA	NA	65	160	85	NL	135	65	NA	NA	288

Parameter	Absolute maximum (recovered fines – batch)	Absolute maximum (recovered fines – continuous)	Absolute maximum (draft recovered soil)	ASC NEPM HIL-A	ASC NEPM ecological guidelines – A	ASC NEPM HIL-D	ASC NEPM ecological guidelines – D	Absolute maximum (ENM)	Absolute maximum (Recovered aggregate)	Composts, soil conditioner, mulches	Waste classification (CT1)
	mg/kg										
Ethylbenzene	NA	NA	25	55	70	NL	165	25	NA	NA	600
Xylenes	NA	NA	15	40	45	230	95	15	NA	NA	1,000
Total petroleum hydrocarbons (C6-C9)	150	150	NA	NA	NA	NA	NA	NA	NA	NA	650
TRH F1	NA	NA	30	45	120	260	170	NA	NA	NA	NA
Total petroleum hydrocarbons (C10-C36)	1,600	1,600	NA	NA	NA	NA	NA	NA	NA	NA	10,000
TRH F2	NA	NA	50	110	120	NL	170	NA	NA	NA	NA
TRH F3	NA	NA	150	2,500	300	3,500	1,700	NA	NA	NA	NA
TRH F4	NA	NA	450	10,000	2,800	10,000	3,300	NA	NA	NA	NA
Individual chlorinated hydrocarbons[2]	1	1	NA	NA	NA	NA	NA	NA	NA	NA	10-2,000 (depending on chemical)
Individual organochlorine pesticides[3]	1	1	NA	6-300 (depending on chemical)	180 (DDTs)	45-3,600 (depending on chemical)	640 (DDTs)	NA	NA	0.5	50 (sum of organochlorine pesticides)
Individual polychlorinated biphenyls (PCBs)[4]	1	1	NA	1	NA	7	NA	NA	NA	Not detected (LOR 0.2)	50
Proportion (by weight) retained on a 0.425 mm sieve	90%	90%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Proportion (by weight) retained on a 9.5 mm sieve	5%	5%	NA	NA	NA	NA	NA	NA	NA	NA	NA
Proportion (by weight) retained on a 26.5 mm sieve	0%	0%	NA	NA	NA	NA	NA	NA	NA	NA	NA

Parameter	Absolute maximum (recovered fines – batch)	Absolute maximum (recovered fines – continuous)	Absolute maximum (draft recovered soil)	ASC NEPM HIL-A	ASC NEPM ecological guidelines – A	ASC NEPM HIL-D	ASC NEPM ecological guidelines – D	Absolute maximum (ENM)	Absolute maximum (Recovered aggregate)	Composts, soil conditioner, mulches	Waste classification (CT1)
	mg/kg										
Asbestos fines/fibrous asbestos	NA	NA	No asbestos present	0.01% (bonded ACM) 0.001% (FA/AF)	NA	0.05% (bonded ACM) 0.001% (FA/AF)	NA	NA	NA	NA	Special waste
Glass, metal and rigid plastics	0.3%	0.3%	NA	NA	NA	NA	NA	NA	NA	0.5%	NA
Rubber, plastic, bitumen, paper, cloth, paint and wood	NA	NA	NA	NA	NA	NA	NA	0.1%	NA	NA	NA
Rubber, plastic, paper, cloth, paint, wood and other vegetable matter	NA	NA	NA	NA	NA	NA	NA	NA	0.3%	NA	NA
Plastics – light flexible film	0.1%	0.1%	NA	NA	NA	NA	NA	NA	NA	0.05%	NA
Rubber	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Plastic	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Paper/cardboard	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Asphalt	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Cloth	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Paint	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Glass	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Metal	NA	NA	0.01%	NA	NA	NA	NA	NA	2%	NA	NA
Wood	NA	NA	0.01%	NA	NA	NA	NA	NA	NA	NA	NA
Plaster	NA	NA	NA	NA	NA	NA	NA	NA	0.5%	NA	NA

Notes:

1 A note provided in the ASC NEPM states that the information available detailing the ecotoxicity of benzo[a]pyrene to soil organisms is limited. The note also outlines that a guideline of 88 mg/kg may actually be relevant for the protection of soil organisms. A lower, more stringent value (as listed) has been determined based on consideration of accumulation in the food chain but such accumulation (and potentially direct effects on soil organisms) are not relevant for the locations where these materials are

permitted to be used. If these materials are placed at depth, there is little potential for accumulation in soil organisms which may be consumed by birds or mammals. Use of the value of 88 mg/kg is usually considered more relevant for sites used for commercial/industrial purposes or where material is to be placed at depth.

Review of **Table 5** indicates the following:

- For chemical contaminants, the limits currently applied to recovered fines and proposed to be applied to recovered soil are the same or much lower than limits applied to:
    - backyard soil in contaminated land assessments for either human health or ecosystem protection
    - composts, soil conditioners and mulches relevant for human health or ecosystem protection in this type of scenario
    - excavated natural material and recovered aggregate both of which are used in the same type of exposure situations
    - wastes for disposal in landfill in landfills with limited engineering.
- The chemical contaminant limits applied for contaminated sites assessment are specifically calculated to consider relevant high end exposure to people who would come into daily contact with the materials during gardening and growing produce as well as ecosystem impacts based on appropriate ecotoxicological data for the residential/backyard land use (HIL-A) and for commercial/industrial land use (HIL-D).
- For foreign materials, the limits currently applied to recovered fines are similar to or lower than those applied to foreign materials present in other material types that are used for similar purposes (usually at depth) and for composts/mulches which are placed at the ground surface.
- The groupings for foreign materials used for recovered fines are similar to those used for other relevant material types and limit the impact of the analytical difficulties (i.e. differentiating between material types when they are weathered).
- The limits applied in the existing recovered fines orders are also in line with the limits of reporting indicated in the recommended analytical method so avoid the difficulty in being able to confidently/reliably determine if the amount of a particular grouping is above or below a limit.
- For foreign materials, the limits proposed to be applied to recovered soil in the draft order are significantly lower than those applied to foreign materials present in other material types that are used for similar purposes (usually at depth) and for composts/mulches which are placed at the ground surface.
- The groupings for foreign materials proposed for use for recovered soil are much more specific than used for other relevant material types. The analytical difficulties are likely to make demonstrating compliance quite difficult (i.e. differentiating between material types when they are weathered). It also requires use of an approach not recommended in the specified analytical method.
- The limits to be applied in the proposed recovered soil order are significantly lower than the limits of reporting indicated in the recommended analytical method so there will be significant limitations in being able to confidently/reliably determine if the amount of a particular grouping is above or below a guideline.

Section 4. Sampling and analysis issues

4.1 General

This section provides discussion of issues related to the analytical methods for asbestos and for foreign materials (i.e. plastic, rubber, glass, metal, paper, etc) that might be present in recovered fines or soil.

4.2 Sampling rates

4.2.1 Recovered fines/soil

Another aspect of the orders which is somewhat confusing are the various sampling rates required for the different material types.

The recovered fines order recommends the following rate of sampling for material produced using a batch process:

- Each batch must be sampled by taking 10 composite samples from every 400 tonnes of waste processed (composite sample is defined here as a sample where 5 samples are combined in equal part into a single sample for analysis)

This means, for a facility that processes 80,000 tonnes per year using a batch process (for example), the order appears to require 10 composite samples to be collected per 400 tonnes which is approximately equivalent to 30-35 samples per 1,500 tonnes of processed waste (i.e. processed material per week).

The recovered fines order recommends the following rate of sampling for material produced using a continuous process:

- The fines generated using the continuous process must be initially characterised by collecting 1 composite sample per fortnight (composite sample is defined here as a sample where 5 samples are combined in equal part into a single sample for analysis)
- Routine sampling of the continuous output must include 1 composite sample per week

For a facility that processes 80,000 tonnes per year using a continuous process (for example), the order appears to require 1 composite sample to be collected each week for routine testing or each fortnight for initial characterisation testing. The rate for routine testing is approximately equivalent to 1 sample per 1,500 tonnes of processed waste. It is also noted that only a limited list of parameters needs to be measured in the samples collected under the routine testing requirement.

The draft order for recovered soil indicates sampling rates based on the size of stockpile of finished material ready for sale as recovered soil. This makes it difficult to compare with the recovered fines requirements as those are based on total waste processed rather than the volume or weight of the finished product. The sampling rates detailed in this draft order are shown in **Table 6**.

Table 6: Sampling requirements under draft recovered soil order

Stockpile size (tonnes)	Number of discrete samples
<250	5
250-500	6
500-1,000	8
1,000-1,500	9
1,500-2,000	10

Other resource recovery orders as well as the waste classification guidelines and guidance in the ASC NEPM also provide guidance on sampling rates.

4.2.2 Excavated natural material (resource recovery order) (NSW EPA 2014e)

The resource recovery order for excavated natural material indicates sampling rates based on the size of stockpile of finished material ready for sale/use. The sampling rates are shown in **Table 7**.

Table 7: Sampling requirements

Stockpile size (tonnes)	Number of samples
<500	3
500-1,000	4
1,000-2,000	5
2,000-3,000	7
3,000-4,000	10

In this order, it is specified that, when analysing metals, pH and foreign materials, composite samples should be used (i.e. composite sample is defined here as a sample where 5 samples are combined in equal part into a single sample for analysis). For the organic contaminants specified in the order discrete samples should be used.

4.2.3 Recovered aggregate (resource recovery order) (NSW EPA 2014h)

The order specifies that such material should be first characterised using 20 composite samples to show that it can comply with the limits in the order where this material is produced using a continuous process. Characterisation testing must be undertaken each calendar year. Once the material has been characterised, routine testing rates apply. The routine testing requirement is for 5 composite samples to be taken from every 4,000 tonnes (or part) or every 3 months of production (whichever is lesser).

Where the material is produced using a batch process, the sampling requirements are 10 composite samples to be taken for every 4,000 tonnes or part thereof.

4.2.4 Compost, soil conditioners and mulches (Australian Standard 2012)

Australian Standard 4454 appendix A indicates how many samples should be taken to indicate that a compost, soil conditioner or mulch is in compliance with the requirements of the standard. The sampling rate is shown in **Table 8**. The values listed in brackets are the approximate mass of the volume listed assuming a bulk density of these materials of 1,500 kg/m^3.

Table 8: Sampling requirements

Stockpile size (m^3)	Number of discrete samples
<575 (approximate 860 tonnes)	12
1,000 (approximate 1,500 tonnes)	16
2,000 (approximate 3,000 tonnes)	23
3,000 (approximate 4,500 tonnes)	28
>3,600 (approximate 5,400 tonnes)	30

4.2.5 Contaminated land assessments (NEPC 1999 amended 2013e)

Schedule B2 of the national guidance for assessing contaminated sites provides 2 types of guidance on sampling rates. Guidance for the number of samples that should be collected across a site under investigation is based on Australian Standard 4482-1 and is listed in **Table 9**. This is based on the size of the site and provides recommended minimum numbers of samples per unit area not volume. However, if surface soil is being assessed and is assumed to constitute the top 10 cm, then the sample volumes equivalent to these surface areas are provided in brackets in this table.

Table 9: Sampling requirements

Size of site (m^2) (i.e. surface area not volume)	Number of composite/discrete samples
500 (50 m^3)	5
1,000 (100 m^3)	6
2,000 (200 m^3)	7
3,000 (300 m^3)	9
4,000 (400 m^3)	11
5,000 (500 m^3)	13
6,000 (600 m^3)	15
7,000 (700 m^3)	17
8,000 (800 m^3)	19
9,000 (900 m^3)	20
10,000 (i.e. 1 hectare) (1,000 m^3)	21

The ASC NEPM also provides guidance on sampling from stockpiles of potentially contaminated soil. The sampling rate for stockpiles is provided in **Table 10**. The values listed in brackets are the approximate mass of the volume listed assuming a bulk density of these materials of 1,500 kg/m^3.

Table 10: Sampling requirements

Stockpile size (m^3)	Number of composite/discrete samples
<75 (approximate 113 tonnes)	3
75-100 (approximate 113-150 tonnes)	4
100-125 (approximate 150-188 tonnes)	5
125-150 (approximate 188-225 tonnes)	6
150-175 (approximate 225-263 tonnes)	7
175->200 (approximate 263-300 tonnes)	8

These sampling rates are designed to apply to stockpiles of homogeneous soils suspected of contamination.

EPA Victoria have some more specific guidance on soil sampling (EPA Victoria 2009). They recommend sampling stockpiles at a rate of 1 sample per 25 m^3 for lower volumes of material. This is the same as the table above taken from the ASC NEPM.

Further advice is provided by EPA Victoria, however, on how to vary that rate when large volumes of material are being assessed (EPA Victoria 2009). This guidance indicates that 10 samples can be collected and analysed as this is the recommended minimum value to calculate the 95% upper confidence limit of the mean (i.e. 95%UCL). This statistic gives a worst case estimate of the average concentration. If this value is below the relevant guideline, then no further samples are required. There is a limit to the application of this advice – the sampling rate should never be larger than 1 sample per 250 m^3. This means, if a stockpile is bigger than 2,500 m^3, then more than the minimum 10 samples are required.

4.2.6 Waste classification requirements (NSW EPA 2014f)

Sampling and analysis are required for parameters that could be expected to be present in a waste based on site activities, site history or the processes producing a waste. This means that not all chemicals, for which classification limits are listed, need to be analysed in a particular type of waste material. The parameters measured in a waste sample in order to classify the material need to be justified based on relevant information and/or sampling/analysis and records to support the choice need to be maintained by the waste generator. If chemicals not listed in the waste classification guidelines are known to be present in a waste material, then they must be tested for, and advice sought from NSW EPA as to what limits might be applied to classify the waste.

The guidance on sampling rates is provided in Appendix 1 of the waste classification guidance. This appendix refers to 2 Australian Standard documents

- AS 1199.0–2003: Sampling Procedures for Inspection by Attributes – Introduction to the ISO2859 Attribute Sampling System (Standards Australia 2003)
- AS 1141.3.1–2012: Methods for sampling and testing aggregates – Sampling – Aggregates (Standards Australia 2012a)

These standards (and the information in Appendix 1 of NSW EPA guidance) provide very detailed information on the issues that influence sampling design to demonstrate compliance with the relevant criteria for the classification of the waste material and how to ensure the sampling design addresses these issues.

The primary issues that need to be considered when designing a sampling program for waste are the volume and source of the waste and the variability in the quality of the waste. Professional judgement is then applied, when those issues are sufficiently understood for a particular type of waste, to determine the number of samples to take to be sufficient for classification. Information describing the basis of the sampling design must be included in the classification report supplied to the waste facility when disposing the waste.

A range of rules of thumb are commonly used in the industry from 1 sample per 25 m^3 through to 1 sample per 250 m^3 when time available for sampling design is short or information on the waste material is limited.

These rules of thumb are similar to the recommendations in the EPA Victoria document discussed in **Section 4.2.5**. That document applies to stockpiles of industrial wastes as well as contaminated soils.

4.2.7 Sampling rates comparison

These rates appear quite variable although many of these materials are used for quite similar uses and/or have similar sources and likely variability in quality.

An attempt has been made to compare the sampling rates in **Table 11**. It is noted that the rates specified in the recovered fines orders are based on the total amount of material processed to produce this product while all the other guidance documents have sampling rates that apply to the amount of product ready for use.

The comparison has been based on how many samples are required to demonstrate compliance for 1,500 m^3 of material – i.e. 2,250 tonnes (assuming 1,500 kg/m^3).

Table 11: Comparison of sampling requirements

Guidance source	Sampling rate for 1,500 m^3
Recovered fines (batch)	38
Recovered fines (continuous)	1-2
Recovered soil (draft)	9
Excavated natural materials	5
Recovered aggregate	20 (characterisation) 5 (routine)
AS 4454 (compost, soil conditioner, mulch)	20
ASC NEPM – site investigation	32
ASC NEPM – stockpile sampling	60 (may be adjusted using statistical analysis)
NSW waste classification	Variable – professional judgement (6-60 based on rules of thumb discussed in **Section 4.2.6**)

This table emphasises that the numbers of samples required under the different guidance documents to demonstrate compliance are highly variable.

The limited information on sampling rates in the waste classification guidance compared to the more significant requirements under the various resource recovery orders are problematic as the receivers/processors of waste may have little information on the material from the classification results but need to have confidence that they will be able to produce a product that will comply with the limits in the relevant order.

These documents do not include information as to how these sampling rates were determined so the assumptions about volumes, sources and variability are not transparent. This makes it difficult to compare the adequacy of the sampling rates to demonstrate that the various materials are in compliance with the relevant requirements.

For many of these guidance documents, this comparison is made more difficult due to the lack of clarity in regard to:

- What is meant by batch or continuous processes for recovered fines
- How to calculate the relevant value to compare to the maximum average concentration limits, where relevant

A useful improvement for sampling may be the introduction of the use of independent samplers in addition to independent laboratories undertaking the analyses. In addition, the use of auditors to review data, sampling program designs and compliance with a relevant auditor may also assist in ensuring the quality of recycled materials.

4.3 Analysis of foreign materials

The recovered fines orders and the draft recovered soil order require the use of a method provided by NSW Roads and Traffic Authority to determine foreign materials content in recycled crushed concrete[1].

The method statement in this document involves the following steps:

- supply of a sample of at least 6 kg
- dry the test sample at 50-60ºC (to constant mass)
- divide up the test sample to ensure the sieve is not overloaded
- test sample is then sieved through a 4.75 mm sieve (i.e. collecting pieces larger than 4.75 mm in the sieve while allowing smaller materials to flow through)
- sieving should occur for not less than 2 minutes and agitation should be used (often done with a mechanical shaker)
- once sieving of a portion is complete, weigh the material collected in the sieve (i.e. >4.75 mm) and record the weight
- sort all of the collected material into 3 types as follows:
    - Type I – metal, glass, asphalt, stone, ceramics and slag
    - Type II – plaster, clay lumps and other friable material (i.e. easily crumbled)
    - Type III – rubber, plastic, bitumen, paper, cloth, paint, wood and other vegetable matter
- weigh the materials in each group and record (i.e. Type I, II, III)
- repeat for all portions of the whole sample – i.e. the whole 6 kg of sample needs to be put through the sieve and the collected material sorted
- combine the information for each portion of the whole sample
- calculate the percentage for each material type as a proportion of the mass of the original test sample (i.e. the whole 6 kg sample)
- the limit of reporting for this test method is 0.1% for each grouping of materials – i.e. Type I, II and III.

[1] https://rms.nsw.gov.au/business-industry/partners-suppliers/documents/test-methods/t276.pdf

This means the test method is essentially a size separation exercise followed by visual identification of the type of material for each piece present in the sieve.

There are a number of limitations with this method that need to be considered as described below.

Size

This test method requires the use of a 4.75 mm sieve (or 0.475 cm, conforming to the Australian standard for such devices – AS 1152 (1993)). This means the pieces in the sieve are likely to be at least 0.5 cm in size. If recovered soil is processed by sieving to be less than 9.5 mm (0.95cm), then the pieces relevant for this method will be between 0.5 and 0.9 cm in size. Pieces of this size would be somewhat visible (depending on what they are made of) if the recovered soil could be placed at the ground surface.

The method specified in the recovered fines orders and the draft recovered soil order require the use of a 2 mm (0.2 cm) sieve instead of a 4.75 mm (0.475 cm) sieve. It is assumed, but not stated anywhere, that this smaller sieve must also conform to the relevant Australian standard – AS 1152 (1993).

Using this smaller sieve size, the pieces collected will be as small as 0.2 cm in size. This means pieces could be as small as a pinhead. Pieces of material the size of a pinhead would not be visible in material used for engineering fill or earthworks even if placed at ground surface.

Identification of specific material types

The method statement considers it may be difficult to confidently identify whether a small piece is a specific material type especially when the materials are weathered. To address this, the method groups material types that are likely to look similar. The method specifies 3 different groupings (type I, II and III) in the dot points listed above. The method requires these 3 groupings to be measured, not the individual material types that make up each of the groupings. It is noted that this approach to dealing with the different material types when pieces are weathered was based on pieces of between 0.5 and 0.9 cm not pieces as small as 0.2 cm, which would be even more difficult to identify confidently.

For the recovered fines orders, the groupings provided in the method are also those required for these orders.

For the method to be applied to the recovered soil in accordance with the draft order, the pieces to be identified will be down to the size of a pinhead. In addition, the draft recovered soil order is requiring that all the individual material types be identified not just the 3 groupings. Trying to distinguish weathered material types with confidence at this very small size will be extremely difficult.

Limits of reporting

The limit of reporting specified in this method is 0.1% based on weight of collected material on the sieve compared to the original weight of the test sample. The large original weight of the test sample places limitations on the sensitivity of this test method.

The recovered fines orders use the limit of reporting specified in the method statement, so this already accounts for trying to find a small amount of material in a relatively large sample.

The starting weight of the test sample is approximately 6 kg. It is not possible to weigh a 6 kg sample on a particularly sensitive scale as such a heavy sample would harm the scale. It would be normal to weigh such a sample on a scale that is accurate to 1 g (or perhaps 0.1 g).

As an example, an individual 6 kg field sample may be weighed at the laboratory upon receipt and the weight may be recorded as 6,030 g (i.e. example). If a sample is broken into portions to allow the use of a more sensitive balance, the sum of the individual portion weights will have a greater measurement error due to the multiple weighing occasions each with their measurement error. These errors accumulate as the portion weights are added together, so this is unlikely to provide the weight of the whole sample to more significant figures with any confidence.

Using this example weight (i.e. 6,030 g), a limit of reporting of 0.1% would mean that the amount collected on the sieve would be 6.03 g at the limit of reporting.

If a limit of reporting of 0.01% was to be achieved, then the amount collected would be 0.603 g.

This mass can be readily measured by balances usually available in a laboratory to an appropriate accuracy. However, the reliability of such a measurement depends strongly on how well the material in the sieve is transferred into a container for weighing. Missing one piece the size of a pinhead would potentially change the weight by something like 0.1 g (i.e. 100 mg) or even more. This is a small amount of material and could be easily missed.

A small variation in the laboratory procedure could easily make this difference. This could occur due to a sample being processed at the end of a day versus the beginning of a day or if samples were assessed by 2 different analysts who have slightly different habits.

A change of 0.1 g in a total mass of 0.603 g (i.e. the example weight) is approximately 20% different when aiming for a limit of reporting of 0.01%. However, it this small change in mass occurred (i.e. $\pm$ 0.1 g) when the limit of reporting was 0.1% (i.e. targeted a total mass of the material of interest of 6 g), this would only make a 2% difference in the measurement which is within the normal measurement error. A 2% difference in a result is much less likely to be the difference between a compliant sample versus a non-compliant sample.

Aiming for this lower limit of reporting makes this analysis less robust for the following reasons:

- it is not in line with the requirements of the recommended method so the change in measurement error has probably not been considered
- it will be more difficult to get reproducible/reliable results when levels of these foreign materials are close to the limit of reporting
- a quite small change in procedure at the laboratory could easily result in samples being determined to be compliant or non-compliant due to the impact of a small change in weight of the foreign material.

Material density

Another aspect that hasn't been considered in the existing orders for recovered fines or the draft order for recovered soil is the differences in density for different types of foreign materials. For example, 0.01% by weight of metals would be a small number of small pieces which may not even be particularly visible when the product is used, while 0.01% by weight of light film plastics could be a lot more pieces and would potentially be more visible.

It may be more appropriate to consider the use of different values for the limits, which take this aspect into consideration, for the different material types.

Summary

The method recommended for use for identifying potential foreign materials is not designed to be used in the fashion required by the draft order for recovered soil.

It is a simple method in philosophy, so the changes are not unreasonable and do not vary the basic overall approach, however, the changes are difficult to implement with any confidence. The issues that are most problematic include:

- Requiring the use of a smaller sieve size which results in individual pieces of the various foreign material types down to the size of a pinhead being relevant for visual inspection to determine their classification.
- Requiring the identification/measurement of all listed foreign material types rather than the 3 groupings specified in the method document. This is further complicated by the smaller size and probability that the materials will be weathered and difficult to classify with confidence.
- Assuming that a more sensitive limit of reporting can be applied even though the starting sample is of a size that is difficult to measure to more significant figures and the likely variability in the transfer of each material type from the sieve to the balance due to their small size which could make a material difference to the result. This means results around 0.01% could be highly variable and result in potential failures for batches based on a single sample that was assessed slightly differently to the rest of the sample for a stockpile, given that the limits for these material types are absolute maximum values which apply to the highest value measured for any sample from a stockpile. This is especially difficult, given the limits in the draft recovered soil order are absolute maximum values only.
- It may also be more appropriate to consider the use of different values for the limits, which take the density of the different types of foreign materials into consideration. This would limit the potential for visible amounts of material that is very light.

4.4 Analysis of asbestos

A limit for asbestos is being introduced in the proposed recovered soil order.

Information about the presence and assessment of asbestos in soil is provided in the following documents:

- ASC NEPM (NEPC 1999 amended 2013a)

- Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia (2021) (WA DOH 2021).

The WA guidelines from 2021 are the most recently updated in Australia and the original version of the same guidance from WA (WA DOH 2009) was used as the basis for the current guidance in the national ASC NEPM.

Asbestos is a naturally occurring mineral. It comes in a range of forms including:

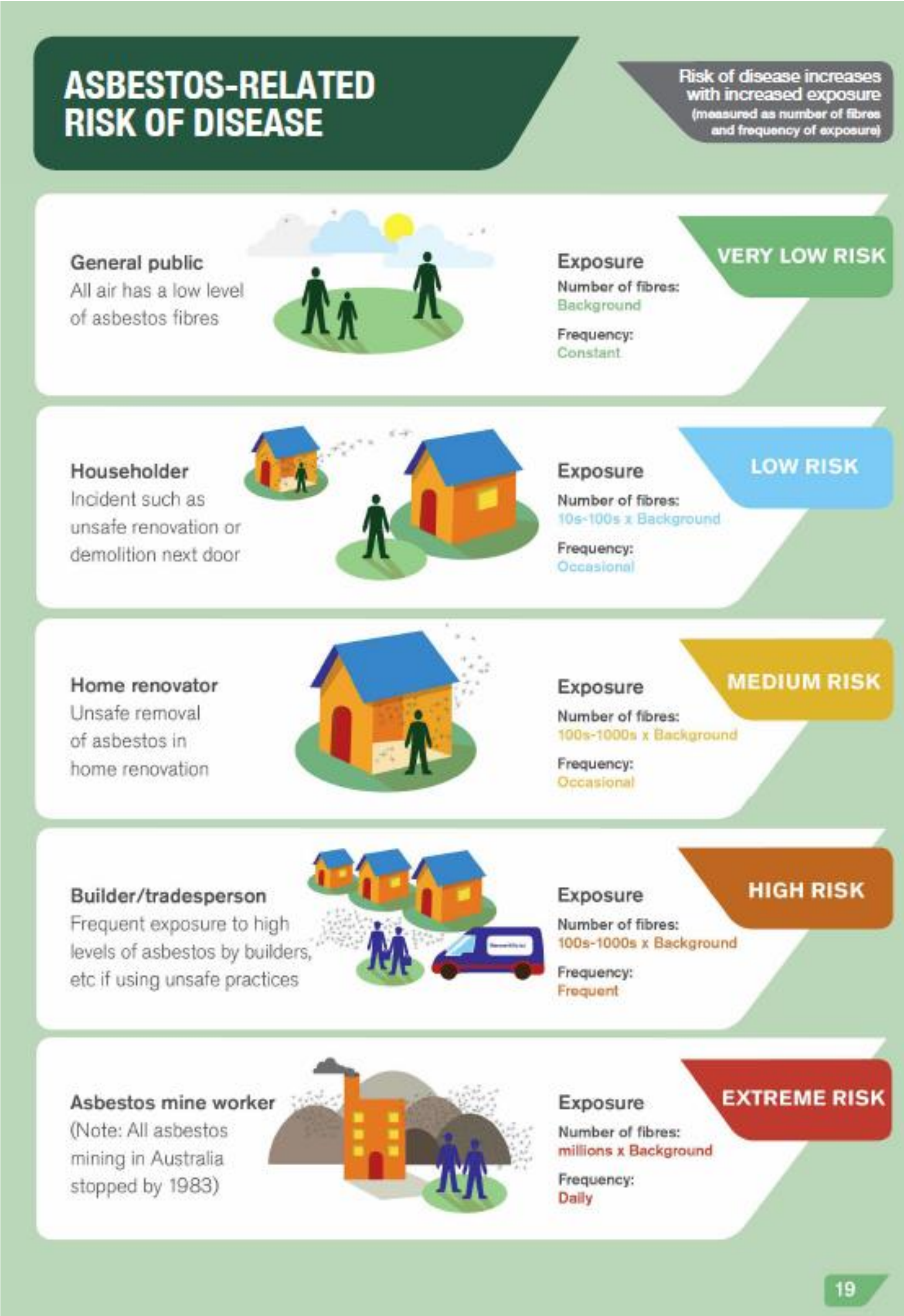
- Bonded asbestos containing material (bonded ACM) which is cement sheeting or "fibro" which contains asbestos fibres within cement panelling – it is usual to assume that such bonded ACM contains 15% asbestos based on guidance in the ASC NEPM and WA DOH.
- Fibrous asbestos (FA) is any material containing asbestos that is wholly or in part friable (i.e. can be broken or crumbled by hand pressure).
- Asbestos fines (AF) are materials that may contain asbestos in small pieces or bundles (smaller than 7 mm x 7 mm) present within a soil sample (WA DOH 2021).

The draft recovered soil order is the only order of those for similar materials that requires assessment for asbestos. The focus required in this draft order is asbestos fines and fibrous asbestos – i.e. very small fragments of mineralised material or highly weathered/old sheeting.

Potential for exposure to asbestos is important to assess for people. It is not normally required to assess the potential for such exposure to ecosystems.

Effects in people from exposure to asbestos arise from inhalation exposure of fibres that can be inhaled into the lungs (i.e. fibres of an appropriate size). The likelihood of effects is related to exposure to asbestos fibres in air. When asbestos fibres may be present in soil, the issue of concern is whether there are enough fibres present in soil to provide enough when blown up and mixed into the atmosphere. This requires them to be easily picked up by the wind from the ground surface or during works that disturb the soil. This requires soil to be quite dry and easily ruffled by the wind for situations where the ground surface is remaining in place and no actual earthworks are occurring. For situations where earthworks are occurring, it may be easier for the fibres to be blown into the atmosphere but, again, there need to be enough fibres in the soil for enough to transfer into the air (WA DOH 2021).

Australian health authorities have provided the following visual explanation of exposure to asbestos fibres in air (enHealth 2013).



This figure shows that there are always a small number of fibres in air to which we are all exposed – background levels. The levels of fibres in air need to be above background levels to be of concern.

It is common for bonded ACM to be treated differently from FA/AF as has occurred in the draft recovered soil order. No limit or requirement for testing has been applied to bonded ACM. This material usually poses a very low risk because it is difficult for the fibres to escape from the cement panelling into the atmosphere unless the panelling is broken into many small pieces and is highly weathered. The recent update from WA Department of Health noted that site assessments in WA, since their original guidance from 2009 was implemented, have supported the assumption that bonded ACM fragments pose only a minor risk (WA DOH 2021).

The ASC NEPM and WA DOH (2021) includes guidelines for asbestos in soil as listed in **Table 12**.

Table 12: ASC NEPM health investigation levels for asbestos in soil

Guideline type	Value
Bonded ACM	
HIL-A	0.01% (100 mg/kg) by weight asbestos
HIL-B	0.04% (400 mg/kg) by weight asbestos
HIL-C	0.02% (200 mg/kg) by weight asbestos
HIL-D	0.05% (500 mg/kg) by weight asbestos
FA/AF	
HIL-A	0.001% (10 mg/kg) by weight asbestos
HIL-B	
HIL-C	
HIL-D	

These guidelines are based on the assessment undertaken by WA Department of Health in 2009. Research indicated that a soil level of 0.01% for friable asbestos (i.e. 0.1 g asbestos/kg soil) should result in fibre levels in air below 0.001 fibres per mL and probably around 0.0001 fibres per mL. These levels in air are related to a lifetime risk around $1x10^{-5}$ to 1×10^{-6} based on WHO guidance and this lifetime risk is considered to be negligible by Australian health authorities (i.e. indistinguishable from background). This research was used in the Netherlands to derive guidelines for soil of 0.01% for FA/AF and 0.1% for bonded ACM (ten fold factor due to lower levels of fibre release from the cement sheeting). The WA team applied an additional 10 fold factor to both these guidelines from The Netherlands, given that WA soils are generally drier soils than soils in Europe and because it is easier for fibres to be blown into the air if the soil is drier. This gave the guidelines listed in **Table 12** (NEPC 1999 amended 2013e).

It is possible to measure fibres in air and this is commonly done for occupational studies but for contaminated sites assessment or for determining the quality of a material like these recovered soils testing for asbestos in the solid material is preferred.

The Australian test method for assessing fibres in air has a limit of reporting of 0.01 fibre per mL and this is considered sufficient for assessing potential for health effects. This means the potential concentration of fibres in air from soil containing 0.001% FA/AF (the value considered to pose a negligible risk) will be well below detectable levels (fibres/mL for 0.001% FA/AF should be 0.0001 or lower based on the research used for the Australian guidelines) and this will also be below levels that could cause effects (enHealth 2005; NEPC 1999 amended 2013e).

The draft order indicates analysis of asbestos fines and fibrous asbestos is to be undertaken using Australian Standard AS4964-2004, *Method for the qualitative identification of asbestos in bulk samples* (Australian Standards 2004). This is the method also recommended in the ASC NEPM

(NEPC 1999 amended 2013a) and Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia (2021) (WA DOH 2021).

This method is designed for the qualitative identification of the presence of asbestos (including identification as to whether fibres of the different asbestos minerals – amosite, crocidolite and chrysotile). The method involves the use of polarised light microscopy and dispersion staining to identify the presence of amosite, crocidolite and chrysotile mineral fibres in bulk samples such as soils.

The procedure provided in the method includes the following steps:

- Screen the entire sample using a stereomicroscope/magnifying lens to determine if it is homogeneous or not.

Soil samples are likely to be non-homogeneous and there is a separate discussion specific for soil samples. The method for soil is as follows:

- if the soil contains a significant quantity of larger sized particles (i.e. >10 mm in diameter) the soil can be screened – this is not a relevant step for recovered soil if the processing for recovered soil includes screening through a 9.5 mm sieve (i.e. it has already been done to produce the final product)
- screen the recovered soil product through a 2 mm sieve and examine the material retained in the sieve using low power stereomicroscope
- extract any visible fibrous material for later assessment
- for the material that passed through the 2 mm sieve (i.e. <2 mm in size) spread out the entire sample to a thickness of no more than 1-3 mm
- examine with a combination of low and high powers on a stereomicroscope to locate fibrous material/fibre bundles
- extract the fibrous material/fibre bundles for further examination
- weigh or measure the dimensions of all asbestos containing matter (approximate)
- weigh any asbestos bundles or estimate the dimensions (length along the fibre and width when the fibres in a bundle are squeezed together)
- once the fibrous material/fibre bundles have been extracted they are then prepared for polarised light microscopy which then allows identification as to whether the fibres are mineral ones that could be asbestos related or if they could be made of some organic material or other types of mineral fibres.

As noted, the Australian Standard is for a qualitative method and it does not provide guidance about how to calculate the concentration of fibrous materials in soil.

The draft recovered soil order addresses the following additional matters which assist in quantitation:

- each sample must be at least 1 kg
- bonded ACM is determined by sieving the 1 kg sample through a 7 mm sieve rather than the 10 mm sieve discussed above
- bonded ACM is considered to be cement sheeting pieces larger than 7 mm x 7 mm

- the calculation of concentration of bonded ACM involves dividing the weight of material identified as bonded ACM retained on the 7 mm sieve by the total weight of the sample with the assumption that bonded ACM is 15% asbestos by weight
- there does not appear to be a requirement to measure bonded ACM in recovered soil in the rest of the draft order nor is there any limit for bonded ACM in the table of parameters and limits
- FA/AF is the material that could pass through or be retained on a 2 mm sieve (after material has been subject to the 7 mm sieve)
- the calculation of the concentration of FA/AF involves dividing the weight of FA/AF identified by the total weight of the sample with the assumption that FA/AF is 100% asbestos
- identification of the fibres is required to be undertaken as per the AS method using polarised light microscopy.

The ASC NEPM also indicates that:

- If no FA/AF is found in the material retained on a 2 mm sieve, then a trace analysis is required on the material that passed through the 2 mm sieve. The method for trace analysis is specified in the AS4964.

These additional matters are similar to the additional requirements for such sampling at contaminated sites described in the ASC NEPM except that samples of 10 L and 500 mL are required depending on the target analyte and the stage of the investigation. It is noted that a 500 mL sample would be of a similar size or slightly larger than a 1 kg sample required in the draft recovered soil order (due to the density of soil).

The limit of reporting for this method is determined by the ability to measure the weight of the relevant material retained on the various sieves and also the ability to measure the weight of the total sample to an appropriate accuracy. The same issue about the limits of reporting discussed in **Section 4.3** is relevant here.

The 1 kg sample can be measured to the nearest gram or perhaps the nearest 0.1 g depending on the balance used. If the limit of reporting is 0.001%, that means the amount of material retained on the 2 mm sieve and extracted as fibrous material/fibre bundles is around 0.01 g or 10 mg from a 1 kg sample. This is quite a small amount and, again, the accuracy of the method (and the LOR) depends on how reliably the material in the sieve is transferred into a container for weighing. It is noted that the weighing needs to occur before all fibrous material is confirmed as asbestos using the microscope and that, if some material is found not to be asbestos, it can no longer be reweighed due to process for microscopy.

It would be quite easy for there to be some variability in the measurement of weights as small as 10 mg, especially when some of the material included in the weight may not actually be the material of interest. This means results close to the limit of reporting will have relatively large measurement errors which could cause a detect instead of a non-detect result. Should a sample have a significant amount of FA/AF, then these measurement issues are not important as they would make a negligible change to the result, but these issues are critically important where concentrations are around the limit of reporting.

Section 5. Exposure scenarios for recovered fines and recovered soil

5.1 General

This section discusses how people or the environment might be exposed to the recovered fines when used for construction or landscaping purposes.

5.2 Background

As discussed in **Section 2**, any reuse opportunity that can be considered resource recovery must comply with the following:

- reuse is genuine, rather than being an alternate means of waste disposal
- reuse is beneficial or fit-for-purpose
- reuse will not cause harm to human health or the environment.

Recovered fines are a soil or sand substitute that has a typical maximum particle size of 9.5 mm. It is derived from processing mixed construction and demolition waste including residues from skip bin waste. These materials can be prepared via a batch process or a continuous process under the 2 resource recovery orders.

A soil or sand substitute means material that can be used in place of soil or sand – i.e. has same/similar characteristics. It does not mean that it must be made of soil or sand. The resource recovery orders/exemptions indicate that this material can be used for construction or landscaping purposes – presumably wherever soil or sand would normally be used.

It is noted that commonly the recovered fines are used in the following ways:

- soil substitute for under-turf landscaping and landscaping blends in applications, where deemed suitable
- soil substitute for engineered fill, where deemed suitable.

5.3 Exposure pathways – recovered fines

5.3.1 Potential sources of contamination

The recovered fines are made up of the fine material that is generated when mixed building and demolition waste is transported in a skip bin or other container to a waste facility where the physical shaking/knocking together during transport may generate final materials. The fine material may also be generated during processing of these wastes at a waste facility.

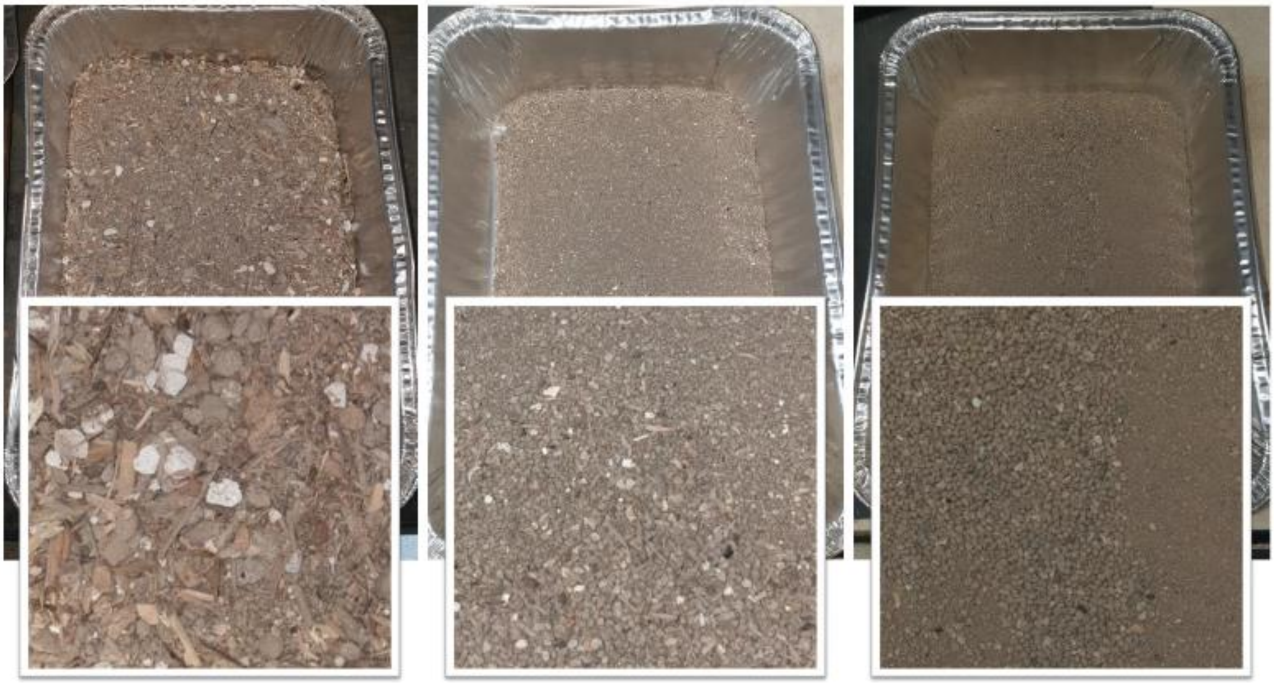
This fine material is made up of:

- soil
- sand
- brick dust
- cement dust
- ceramic dust/chips from broken tiles
- small chips of wood

- small pieces of paper/cardboard
- small chips of plastic
- metal fragments
- plaster dust from plasterboard.

Some fines will have more soil and sand due to being generated from waste that consists primarily of soil and sand, while other types of fines will have more of a mix of materials due to being generated from skip bin waste from building projects predominantly.

Some photos of recovered fines from a range of processors are provided below from the presentations to industry by NSW EPA in 2020.



Photos taken by NSW EPA and discussed in Workshop 1 in 2020.

These recovered fines are purchased by suppliers of landscaping materials or fill materials. They are mixed with soil and other materials to form the final product that is provided for sale.

As noted, there are 3 main uses of recovered fines:

- under-turf landscaping materials
- other landscaping blends
- engineered fill.

There are 2 permitted uses listed in the draft recovered soil order:

- engineered fill
- earthworks.

The potential pathways of exposure for each of these uses are discussed in the following sections.

5.3.2 Under turf landscaping materials

Table 13 presents a summary of the potential receptors and exposure pathways relevant to the use of recovered fines as an underlay when preparing an area for applying turf. This use pattern involves bringing landscaping material to a site. This material is comprised of recovered fines and other materials and is spread across the site to provide a level base for turf to be laid. The recovered fines are mixed in with other materials including soil and covered by turf.

The covering of the underlay by turf limits how people may come into contact with these materials and also mitigates some of the ways various ecosystems may be exposed.

It is also noted that the recovered fines are sourced from materials that are normally present in outdoor areas. Materials like bricks, cement, tiles, plastic, wood are already present and widely distributed in our built environment. This means these materials are already subject to the effects of rain, wind and sunlight which results in the chemicals that make up these materials moving from buildings into soil and water.

Table 13: Exposure pathways and receptors – under turf landscaping materials

Receptors	Exposure pathways				Comments
	Inhalation of dust	Ingestion of recovered fines	Dermal contact with recovered fines	Leaching from recovered fines	
People					
Workers using the turf underlay landscaping material	✓	✓	✓		Workers have potential to come into direct contact with the material during the placement of the under turf landscaping material at a site ready for turf placement. Contact may also occur for those who lay the turf, although given the way rolls of turf are placed and unrolled, it is likely that direct contact with the underlay will be minimal. Where direct contact can occur, this means a worker may incidentally ingest some recovered fines and/or their skin may come into contact. In addition, where the underlay is dry, there may be some inhalation of dust until the turf is put in place.
General public				✓	It is highly unlikely that the general public and/or a householder with newly laid turf would be able to come into direct contact with the underlay material unless they laid the turf themselves, in which case, their exposure would be as described by the exposure scenario above. Leaching of chemicals from the recovered fines to surface water or into groundwater which may then eventually reach surface waters to which people may be exposed is a possibility. Given the source of the materials in the recovered fines, it is not expected that such leaching would result in levels in groundwater or surface water significantly different than commonly found. This is because such chemicals also leach every time it rains from the bricks, cement, wood, ceramics, plastics etc used to construct the outdoor surfaces of

Receptors	Inhalation of dust	Ingestion of recovered fines	Dermal contact with recovered fines	Leaching from recovered fines	Comments
					buildings and infrastructure. In addition, a range of chemicals also leach from outdoor furniture and other plastics that are used in outdoor areas. It is possible that some contaminated soil could occasionally be mixed into the source material or that building materials that have come into contact with contaminated products could be part of the recovered fines in the turf underlay which may result in unusual chemicals leaching from the underlay. However, it would be expected that such chemicals would be present in such materials in small amounts.
Ecosystems					
Aquatic				✓	Aquatic organisms may be exposed to chemicals present in the recovered fines should they leach from the material during rain and there is enough rain to take that water to surface water bodies nearby or into groundwater that may eventually discharge to a surface water body. The comment above that anything that leaches from these materials would be commonly found in the environment due to washing off buildings etc would also apply here.
Terrestrial		✓	✓		Terrestrial organisms may be exposed to the recovered fines when they live or grow in close contact with the material.

5.3.3 Landscaping blends

Table 14 presents a summary of the potential receptors and exposure pathways relevant to the use of recovered fines in general blends of landscaping material. This use pattern involves bringing landscaping material to a site that is comprised of recovered fines and other materials. Such materials are then used in garden beds and other areas around a site. The recovered fines are mixed in with other materials including soil. Such blends may be placed at depth within a garden bed or at the surface.

Where these materials are placed at depth with other products covering this would limit how people may come into contact with these materials and also some of the ways various ecosystems may be exposed.

It is also noted that the recovered fines are sourced from materials that are normally present in outdoor areas. Materials like bricks, cement, tiles, plastic, wood are already present and widely distributed in our built environment. This means these materials are already subject to the effects of rain, wind and sunlight which results in the chemicals that make up these materials moving from buildings into soil and water.

Table 14: Exposure pathways and receptors – landscaping blends

Receptors	Exposure pathways: Inhalation of dust	Exposure pathways: Ingestion of recovered fines	Exposure pathways: Dermal contact with recovered fines	Exposure pathways: Leaching from recovered fines	Comments
People					
Workers using the landscaping blend material	✓	✓	✓		Workers have potential to come into direct contact with the material during the use of such blends of landscaping material at a site in garden beds etc. Where direct contact can occur, this means a worker may incidentally ingest some recovered fines and/or their skin may come into contact with these materials. In addition, where these materials are placed at the ground surface and they remain dry, there may be some inhalation of dust. Given that these materials are used in garden beds etc, it is unlikely that they will remain dry for an extended period.
General public				✓	A householder may come into contact with such landscaping materials when they maintain their gardens after they have been constructed (or while they are constructing them). Such contact could result in incidental ingestion and/or skin contact as described above. The general public is only likely to come into direct contact with these materials if they undertake gardening activities at a park where these materials have been placed (or other activities which involve working with landscaped areas. Leaching of chemicals from the recovered fines to surface water or into groundwater which may then eventually reach surface waters to which people may be exposed is a possibility. Given the source of the materials in the recovered fines, it is not expected that such leaching would result in levels in groundwater or surface water significantly different than commonly found. This is because such chemicals also leach every time it rains from the bricks, cement, wood, ceramics, plastics etc used to construct the outdoor surfaces of buildings and infrastructure. In addition, a range of chemicals also leach from outdoor furniture and other plastics that are used in outdoor areas. It is possible that some contaminated soil could occasionally be mixed into the source material or that building materials that have come into contact with contaminated products could be part of the recovered fines which may result in unusual chemicals leaching from the landscaping blend. However, it would be expected that such chemicals would be present in such materials in small amounts.
Ecosystems					
Aquatic				✓	Aquatic organisms may be exposed to chemicals present in the recovered fines should they leach from the material during rain and there is enough rain to take that water to surface water bodies nearby or into groundwater that may eventually discharge to a surface water body. The comment above that anything that leaches from these materials would be commonly

Receptors	Exposure pathways				Comments
	Inhalation of dust	Ingestion of recovered fines	Dermal contact with recovered fines	Leaching from recovered fines	
					found in the environment due to washing off buildings would also apply here.
Terrestrial		✓	✓		Terrestrial organisms may be exposed to the recovered fines when they live or grow in close contact with the material.

5.3.4 Engineered fill

Table 15 presents a summary of the potential receptors and exposure pathways relevant to the use of recovered fines as part of engineered fill. Such fill is used in places like retaining walls, embankments and road and rail construction. This use pattern involves forming the fill material into the relevant areas. Such materials will usually be placed at depth and it is possible for such fill to be strongly compacted especially if the fill is used in an infrastructure project. This compaction will limit how much water can move through the material due to the limited porosity remaining in the filled area.

It is also noted that the recovered fines are sourced from materials that are normally present in outdoor areas. Materials like bricks, cement, tiles, plastic, wood are already present and widely distributed in our built environment. This means these materials are already subject to the effects of rain, wind and sunlight which results in the chemicals that make up these materials moving from buildings into soil and water.

Table 15: Exposure pathways and receptors – engineered fill

Receptors	Exposure pathways				Comments
	Inhalation of dust	Ingestion of recovered fines	Dermal contact with recovered fines	Leaching from recovered fines	
People					
Workers using the engineered fill	✓	✓	✓		Workers have potential to come into direct contact with the material during the placement of the engineered fill. Where direct contact can occur, this means a worker may incidentally ingest some recovered fines and/or their skin may come into contact. In addition, where the fill is dry there may be some inhalation of dust until overlying material is put in place or vegetation establishes.

Receptors	Exposure pathways: Inhalation of dust	Exposure pathways: Ingestion of recovered fines	Exposure pathways: Dermal contact with recovered fines	Exposure pathways: Leaching from recovered fines	Comments
General public				✓	A householder may come into contact with such fill while they are constructing a retaining wall/embankment or filling an area or when they are maintaining such areas. Such contact could result in incidental ingestion and/or skin contact as described above. The general public is only likely to come into direct contact with these materials if they come into close contact with a filled area and if the recovered fines material is in the surface of the filled area. Leaching of chemicals from the recovered fines to surface water or into groundwater which may then eventually reach surface waters to which people may be exposed is a possibility. Given the source of the materials in the recovered fines, it is not expected that such leaching would result in levels in groundwater or surface water significantly different than commonly found. This is because such chemicals also leach every time it rains from the bricks, cement, wood, ceramics, plastics etc used to construct the outdoor surfaces of buildings and infrastructure. In addition, a range of chemicals also leach from outdoor furniture and other plastics that are used in outdoor areas. It is possible that some contaminated soil could occasionally be mixed into the source material or that building materials that have come into contact with contaminated products could be part of the recovered fines in the engineered fill which may result in unusual chemicals leaching from the fill. However, it would be expected that such chemicals would be present in such materials in small amounts.
Ecosystems					
Aquatic				✓	Aquatic organisms may be exposed to chemicals present in the recovered fines should they leach from the material during rain and there is enough rain to take that water to surface water bodies nearby or into groundwater that may eventually discharge to a surface water body. The comment above that anything that leaches from these materials would be commonly found in the environment would also apply here.
Terrestrial		✓	✓		Terrestrial organisms may be exposed to the recovered fines when they live or grow in close contact with the material.

5.3.5 Summary

These evaluations of potential exposure pathways indicate that for all uses of these materials:

- exposure to people is likely to be limited
- exposure to aquatic organisms is likely to be limited
- exposure to terrestrial organisms is possible but likely to be limited especially if these materials are placed at depth.

5.4 Exposure pathways – recovered soil

5.4.1 Engineered fill

Table 16 presents a summary of the potential receptors and exposure pathways relevant to the proposed use of recovered soil as engineering fill (i.e. used to support structures or pavements for which engineering properties must be controlled).

Such fill is used in places like retaining walls, embankments and road and rail construction. This use pattern involves forming the fill material into the relevant areas. Such materials will usually be placed at depth and covered. It is also possible that such fill will need to be strongly compacted especially if used in an infrastructure project. This compaction will limit how much water can move through the material due to the limited porosity remaining in the filled area which limits the potential for leaching of chemicals from the fill (should various chemical contaminants be present).

It is also noted that the proposed recovered soil is made predominantly from materials that are normally present in outdoor areas. This order requires that the product be at least 98% natural materials and that it not be derived from building and construction waste. This means the chemicals that could be derived from recovered soil will be ones already present in the environment due to the effects of rain, wind and sunlight washing them from soils and related materials.

Table 16: Exposure pathways and receptors – engineering fill

Receptors	Exposure pathways				Comments
	Inhalation of dust	Ingestion of recovered fines	Dermal contact with recovered fines	Leaching from recovered fines	
People					
Workers using the engineering fill	✓	✓	✓		Workers have potential to come into direct contact with the material during the placement of the fill. Where direct contact can occur, this means a worker may incidentally ingest some recovered fines and/or their skin may come into contact. In addition, where the fill is dry there may be some inhalation of dust until overlying material is put in place or vegetation establishes.

Receptors	Exposure pathways: Inhalation of dust	Exposure pathways: Ingestion of recovered fines	Exposure pathways: Dermal contact with recovered fines	Exposure pathways: Leaching from recovered fines	Comments
General public				✓	A householder may come into contact with such fill while they are constructing a retaining wall/embankment or filling an area or when they are maintaining such areas. Such contact could result in incidental ingestion and/or skin contact as described above. The general public is only likely to come into direct contact with these materials if they come into close contact with a filled area and if the recovered soil is in the surface of the filled area. Leaching of chemicals from the recovered soil to surface water or into groundwater which may then eventually reach surface waters to which people may be exposed is a possibility. Given the source of the materials in the recovered soil, it is not expected that such leaching would result in levels in groundwater or surface water significantly different than commonly found. The fact that the recovered soil is required to be at least 98% natural materials any chemicals present will be ones that already leach every time it rains from these natural materials and are widespread in the environment.
Ecosystems					
Aquatic				✓	Aquatic organisms may be exposed to chemicals present in the recovered soil should they leach from the material during rain and there is enough rain to take that water to surface water bodies nearby or into groundwater that may eventually discharge to a surface water body. The comment above that anything that leaches from these materials would be commonly found in the environment would also apply here.
Terrestrial		✓	✓		Terrestrial organisms may be exposed to the recovered soil when they live or grow in close contact with the material.

5.4.2 Earthworks

Table 17 presents a summary of the potential receptors and exposure pathways relevant to the proposed use of recovered soil for earthworks (i.e. for raising the level of a site or raising/shaping the topography of a site).

This use pattern involves forming the material into the relevant areas to raise the level of a site or to change the topography of a site. Such materials will usually be placed at depth and covered. It is also possible that such material will need to be strongly compacted especially if used in and around an infrastructure project. This compaction will limit how much water can move through the material due to the limited porosity remaining in the filled area which limits the potential for leaching of chemicals from the fill (should various chemical contaminants be present).

It is also noted that the proposed recovered soil is made predominantly from materials that are normally present in outdoor areas. This order requires that the product be at least 98% natural materials and that it not be derived from building and construction waste. This means the chemicals that could be derived from recovered soil will be ones already present in the environment due to the effects of rain, wind and sunlight washing them from soils and related materials.

Table 17: Exposure pathways and receptors – earthworks

Receptors	Exposure pathways				Comments
	Inhalation of dust	Ingestion of recovered fines	Dermal contact with recovered fines	Leaching from recovered fines	
People					
Workers using the engineering fill	✓	✓	✓		Workers have potential to come into direct contact with the material during placement to fill a site or an area. Where direct contact can occur, this means a worker may incidentally ingest some recovered fines and/or their skin may come into contact. In addition, where the fill is dry there may be some inhalation of dust until overlying material is put in place or vegetation establishes.
General public				✓	A householder may come into contact with such material while they are undertaking the earthworks (if they are doing the work themselves). Such contact could result in incidental ingestion and/or skin contact as described above. The general public is only likely to come into direct contact with these materials if they come into close contact with a filled area and if the recovered soil is in the surface of the filled area. Leaching of chemicals from the recovered soil to surface water or into groundwater which may then eventually reach surface waters to which people may be exposed is a possibility. Given the source of the materials in the recovered soil, it is not expected that such leaching would result in levels in groundwater or surface water significantly different than commonly found. The fact that the recovered soil is required to be at least 98% natural materials any chemicals present will be ones that already leach every time it rains from these natural materials and are widespread in the environment.
Ecosystems					
Aquatic				✓	Aquatic organisms may be exposed to chemicals present in the recovered soil should they leach from the material during rain and there is enough rain to take that water to surface water bodies nearby or into groundwater that may eventually discharge to a surface water body. The comment above that anything that leaches from these materials would be commonly found in the environment would also apply here.
Terrestrial		✓	✓		Terrestrial organisms may be exposed to the recovered soil when they live or grow in close contact with the material.

5.4.3 Summary

These evaluations of potential exposure pathways indicate that for all uses proposed for recovered soil:

- exposure to people is likely to be limited
- exposure to aquatic organisms is likely to be limited
- exposure to terrestrial organisms is possible but likely to be limited especially if these materials are placed at depth.

Section 6. Discussion of key issues

6.1 General

This section of the assessment includes a discussion of the results from the sampling and analysis undertaken by NSW EPA in 2019 and an evaluation of the risks posed for a subset of parameters identified as most relevant.

It is understood that the audit undertaken in 2017/18 and sampling undertaken in 2019 by the NSW EPA is the first time such work has been undertaken by the regulator since the processing of recovered fines began in 2008.

The sampling undertaken by NSW EPA involved the collection of 10 samples from recovered fines product at each of the sites processing construction and demolition waste (including skip bins) and producing recovered fines.

The information provided for this assessment was just a table of results, no information has been provided on sampling or analytical methods or limits of reporting. It is also not clear whether there are results that are less than the limit of reporting although it is expected that some of the results were non-detect.

This section provides more specific assessment of the data and risks relevant to the presence of lead, carcinogenic PAHs as BaP TEQ, asbestos and foreign materials in recovered fines.

6.2 Lead

Lead is one of the parameters for which limits have been set for both processing methods for recovered fines and in the draft order for recovered soils. The limits are:

- Recovered fines – batch process – absolute maximum concentration of 250 mg/kg
- Recovered fines – batch process – maximum average concentration of 150 mg/kg
- Recovered fines – continuous process – absolute maximum concentration of 250 mg/kg
- Recovered fines – continuous process – maximum average concentration of 100 mg/kg
- Recovered soil (proposed) – absolute maximum concentration of 150 mg/kg
- Recovered soil (proposed) – maximum average concentration of 75 mg/kg

Lead will be present in soil or construction and demolition waste because it is:

- naturally occurring in soil and rocks
- present in fill materials (predominantly ash from former power stations) commonly historically used in many urban areas prior to development
- deposited from air onto soil surfaces (or building surfaces) from combustion sources (especially leaded petrol, noted to no longer be relevant, but is a source of former contamination that may remain in construction and demolition waste)
- chips of paint that have fallen from a wall onto the ground in areas where leaded paints have been used historically.

If chips of old paint are present in a sample, then it is likely that an elevated concentration of lead will be measured in soil containing such a chip, as some older paints contained very high levels of lead.

Information provided within the ASC NEPM indicates background concentrations of lead in Australian soils for various states are as listed in **Table 18**. The study used to source information on background levels collected samples in 4 states and targeted urban areas that had well established suburbs and more newly established suburbs as well as areas that were near major road and heavy traffic areas and locations that were in low traffic areas (Olszowy et al. 1995). The comparison of older and newer suburbs provided information on areas affected by lead paint and leaded petrol compared to areas not affected by these sources. The comparison of higher traffic areas and lower traffic areas provided information on the impact of leaded petrol only as a source. The study avoided known contaminated locations.

Table 18: Background concentrations of lead in Australian soils (Olszowy et al. 1995)

State	Soil descriptor	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)
New South Wales	old suburbs/high traffic	123	1,429	379
	old suburbs/low traffic	41	1,465	303
	new suburbs/high traffic	12	192	55
	new suburbs/low traffic	13	44	23
Queensland	old suburbs/high traffic	10	666	271
	old suburbs/low traffic	5	819	170
	new suburbs/high traffic	7	83	38
	new suburbs/low traffic	3	28	9
South Australia	old suburbs/high traffic	31	441	181
	old suburbs/low traffic	8	354	83
	new suburbs/high traffic	5	144	43
	new suburbs/low traffic	6	51	17
Victoria	old suburbs/high traffic	25	450	149
	old suburbs/low traffic	25	1,300	247
	new suburbs/high traffic	5	60	26
	new suburbs/low traffic	10	35	17

The overall mean background soil concentration in Australian soils from **Table 18** is around 120 mg/kg. The range for lead concentrations in soils collected in this study was 5 mg/kg (likely at limit of reporting) to more than 1,400 mg/kg.

The concentrations in the recovered fines sampled by NSW EPA (8 to 530 mg/kg) were well within this range from soils sampled around urban areas in Australia. The average concentration of lead across all of the recovered fines samples (67 mg/kg) was also well below the average concentration in these soil samples.

Applying a limit of 75 mg/kg for average lead concentrations, as specified in the proposed recovered soil order, means that the new order is requiring average levels in recovered soil to be lower than the average levels in background soil in Australia in urban areas. Given that the recovered soil is at least 98% natural soil, it seems that this is problematic.

There are also mineralised areas in rural and remote areas. The average concentrations in these locations are also likely to be well above 75 mg/kg.

The soil guideline that applies to soil in a normal low density residential backyard is 300 mg/kg for lead. As already indicated, this guideline is protective for human health where a child is exposed to soil directly during play every day of the year and consumes home grown fruit and vegetables. The HIL-A guideline was developed using the USEPA model for estimating blood lead concentrations from exposure. This means it is even more targeted at ensuring the effect of most concern remains within acceptable values than most other HIL values.

It is also noted that the HIL-A (and all the HILs) assume that the lead in soil is 100% bioavailable. This means all lead in a soil will dissolve in the stomach or will move through the skin when in contact with skin or will move from a soil particle across membranes in the lung when inhaled. Because lead can be chemically bound within a soil particle (or other particle type), this 100% bioavailability assumption is likely to overestimate how much lead actually gets into the body. This is a recognised conservative assumption in the HILs because there will be some situations where contamination may be 100% bioavailable (depending on the source) and these national guidelines are designed to be conservative to ensure all situations where detailed assessment is required are identified.

However, for lead in recovered fines or recovered soil from building demolition sites, it will be common that the lead is due to the historical use of ash for fill in inner urban areas of Sydney or due to deposition of particles from air due to combustion of leaded petrol up until such use was cease. The lead in these types of material has been shown to be quite bound into particles and little is bioavailable. Other lead sources like mineral ores will also have quite low bioavailability.

This means a soil concentration of 300 mg/kg is considered to be a conservative estimate of a value that will be protective of human health, given the conservative assumptions built into the exposure scenarios.

The limits for both recovered fines and recovered soil are well below this value.

It is acknowledged, however, that the limits for recovered fines or recovered soil are, in part, designed to minimise the likelihood that the use of these materials could result in a site, where these materials have been used, having levels of any particular chemical parameter approaching levels close to the contaminated land guidelines or the waste classification guidelines.

It is also acknowledged that the ASC NEPM Schedule B1 (Section 2.1.2) states:

- Investigation and screening levels are not clean-up or response levels nor are they desirable soil quality criteria.
- The use of these levels in regulating emissions and application of wastes to soil is inappropriate.

It is not ideal if the use of these recycled materials could result in a contaminated site if assessed in the future for some more sensitive use nor is it appropriate to allow material to be placed at a site that will result in pollution up to the limit based on protection of human health.

Consequently, the use of limits for these materials that are below the HIL values is reasonable and limits below the HIL-A value will definitely be protective of both human and ecological health.

However, it is important to consider background levels of lead when setting such limits to ensure the limits are reasonable and achievable.

6.3 Benzo[a]pyrene equivalents

Benzo[a]pyrene is a polycyclic aromatic hydrocarbon (PAHs). This is a group of chemicals that are generated whenever materials are burnt. They are present in air due to combustion of petrol in cars, bushfires, house fires, barbeques, fire pits, power stations, gas stoves etc. They are also present in food due to all forms of cooking including BBQs. This means people are exposed to these chemicals all day every day.

There are many chemicals that form this group but analysis and regulation focus on a group of 16 which are considered the most important. Of these 7 are considered to be very similar in how they cause health effects and are now combined as benzo[a]pyrene equivalents (or BaP TEQs).

The concentration of benzo[a]pyrene alone or as TEQs is one of the parameters for which limits have been set for both processing methods for recovered fines and in the draft order for recovered soils. The limits are:

- Recovered fines – batch process – absolute maximum concentration of 6 mg/kg (BaP only)
- Recovered fines – batch process – maximum average concentration of 1 mg/kg (BaP only)
- Recovered fines – continuous process – absolute maximum concentration of 6 mg/kg (BaP only)
- Recovered fines – continuous process – maximum average concentration of 1 mg/kg (BaP only)
- Recovered soil (proposed) – absolute maximum concentration of 2 mg/kg (BaP TEQs)
- Recovered soil (proposed) – maximum average concentration of 1 mg/kg (BaP TEQs)

Unlike the information available for lead in Australian soils, there is no detailed information about background levels of BaP or PAHs in Australian soils. However, given that these are naturally occurring chemicals, consideration of background concentrations is relevant.

The Massachusetts Department of Environmental Protection has undertaken a detailed review of soil data to provide guidance on background levels of metals and PAHs for use in site contamination assessments [2] (MDEP 2002). Levels higher than the listed concentrations are relevant for more detailed assessment in this US state. The values identified as background for PAHs/BaP were based on more than 750 soil samples collected across the state.

The concentration of BaP alone relevant for natural soils recommended for use was 2 mg/kg (MDEP 2002). The concentration of BaP TEQs was not calculated in this document but all the relevant values for each of the 7 relevant chemicals were provided so the TEQ concentration has been calculated and is 3.1 mg/kg. These are considered background values. All limits in the orders for recovered fines or soil are below these values (i.e. more stringent). In Massachusetts, if soil concentrations are below these background levels no additional investigation of a site is required in relation to these chemicals.

[2] https://www.mass.gov/lists/chemical-research-standards#polycylic-aromatic-hydrocarbons-(pahs)-

The guidance also lists values for natural soil which may have received ash (MDEP 2002). For BaP alone, this value was 7 mg/kg and, for BaP TEQs, it was 10.5 mg/kg. These values show the significant difference that can result if even small amounts of ash might be present at a site due to historic filling, bushfires, house fires, or disposal of ash around a residential lot (such as from a fire pit or internal fireplace/combustion stove).

Yang et al. (1991) provides concentrations of these chemicals from soils taken from roadsides in Australia. The average concentration of BaP was 0.4 mg/kg and, for BaP TEQs, the average concentration was 0.5 mg/kg (Yang et al. 1991).

Morillo et al. (2007) investigated soil concentrations in 3 European cities (Glasgow, Ljubljana and Torino). This study used ultra-trace limits of reporting. The mean concentrations of BaP alone were 0.971 mg/kg for Glasgow, 0.0768 mg/kg for Ljubljana and 0.229 mg/kg for Torino. The mean concentrations of BaP TEQs were 1.4 mg/kg for Glasgow, 0.1 mg/kg for Ljubljana and 0.3 mg/kg for Torino.

The concentrations in the recovered fines sampled by NSW EPA ranged from 0.1 to 1.7 mg/kg and were well within the range from soils sampled around urban areas in Australia and in European cities. They were also below what is considered background in Massachusetts.

The average concentration of benzo[a]pyrene across all of the recovered fines samples (0.5 mg/kg) was also well below the average concentration in these studies in Australia, Europe or Massachusetts.

The values available from the NSW EPA data appear to be for benzo[a]pyrene only not BaP TEQs and the limit of reporting appears to be 0.1 mg/kg.

The limit of reporting for BaP alone commonly available at commercial laboratories is around 0.5 mg/kg. Some laboratories may do better than this for routine analysis and some may offer ultra-trace analysis with a limit of reporting around 0.05 mg/kg, however, this is provided at a higher cost than routine analysis.

What limits of reporting are available on a routine basis from the commercial laboratories in Australia is important when considering the potential change of parameter from BaP alone to BaP TEQs and what limit value can validly be applied to such results.

For BaP TEQs, the concentration is the sum of 7 individual chemical concentrations (where each of the chemical concentrations are adjusted for their potency to act like BaP). If all 7 chemicals are present below a limit of reporting of 0.5 mg/kg, then the limit of reporting for BaP TEQs is 1.2 mg/kg (based on each of the 7 chemicals being assumed to be present at 0.5 mg/kg and then each chemical being adjusted using the relevant factor). If it is assumed that each chemical not detected at the limit of reporting is present at half the limit of reporting, then the BaP TEQs sum will be 0.6 mg/kg. These values for the sums are essentially the same as the maximum average values being applied in the draft recovered soil order so this means any detection of these chemicals in a sample will likely result in a failure.

There is no consideration of this methodological limitation in the draft order nor is there guidance in the draft order as to how to calculate BaP TEQs when some or all of the relevant chemicals are not detected. This lack of clarity will limit the confidence any supplier can have when determining if their product is likely to be able to comply with the draft order. It is noted that these are naturally occurring chemicals that are widespread in our environment. It is also noted that it would be possible for a recovered soil product to fail the limits specified just due to the inclusion of soil from a backyard where dumping of some ash in a garden bed occurred where that ash came from a BBQ or an indoor fireplace.

The HIL-A value for benzo[a]pyrene TEQs is 3 mg/kg. This is only slightly higher than proposed in these orders, but it does give some room, given the limitations of the analytical methods and the summing process.

Another aspect that introduces conservatism into the HIL-A values is assuming chemicals are 100% bioavailable. The bioavailability of these chemicals within the human body varies depending on their source.

If the PAHs are present in ash materials (i.e. from burning), then they are strongly chemically bound inside the ash particles. In such situations, they have been shown to not be bioavailable to a significant extent. Other sources of such chemicals (like coal tar) are much more bioavailable. Given the sources of materials used to produce recovered fines or recovered soil, it is likely that any PAHs will be present due to ash in the mix rather than as a result of contact with coal tars or other similar materials. Consequently, assuming 100% bioavailability will be highly conservative.

There are 2 resource recovery orders for ash materials – one for ash from burning biomass (i.e. vegetation) and one for coal ash[3]. For both of these orders, there are relevant chemical contaminant limits for a range of chemicals, but no limit has been included for PAHs. It is presumed this is due to these chemicals being strongly bound within the ash and being confident that they are not bioavailable to any significant extent. This confirms the conclusion that 100% bioavailability is extremely conservative.

It is noted that the order for coal ash allows the use of this material for engineered fill and other uses similar to recovered fines or recovered ash but also permits its use as a soil amendment for the growing of vegetation. This also supports the conclusion that NSW EPA has assumed the PAHs (including BaP) in coal ash have very low bioavailability. Given that the PAHs (including BaP) present in recovered fines or recovered soil are also likely to be related to the presence of ash, it is likely that these chemicals also have very low bioavailability in these recycled materials.

The limits for both recovered fines and recovered soil are similar to background levels expected for BaP and the guidelines for the protection of human health. The guidelines for the protection of human health assume 100% bioavailability so they are likely to be extremely conservative for these products and their permitted uses.

It is acknowledged, however, that the limits for recovered fines or recovered soil are, in part, designed to minimise the likelihood that the use of these materials could result in a site, where these

[3] https://www.epa.nsw.gov.au/your-environment/recycling-and-reuse/resource-recovery-framework/current-orders-and-exemption

materials have been used, having levels of any particular chemical parameter approaching levels close to the contaminated land guidelines or the waste classification guidelines.

It is also acknowledged that the ASC NEPM Schedule B1 (Section 2.1.2) states:

- Investigation and screening levels are not clean-up or response levels nor are they desirable soil quality criteria.
- The use of these levels in regulating emissions and application of wastes to soil is inappropriate.

It is, therefore, not ideal if the use of these recycled materials could result in a contaminated site if a site where these materials have been used were to be assessed in the future for some more sensitive use. It is also not appropriate to allow material to be placed at a site that will result in pollution up to the limit based on protection of human health.

Consequently, the use of limits for these materials that are similar to background levels and the HIL-A value is reasonable and achievable and will definitely be protective of both human and ecological health.

6.4 Asbestos

Asbestos is the generic name given to the fibrous variety of six naturally occurring minerals. These minerals have been used in a wide range of commercial products. The minerals are hydrated silicates including a serpentine mineral (*chrysotile*) (also known as 'white asbestos'), and five amphibole minerals (*actinolite, amosite* (also known as 'brown asbestos'), *anthophyllite, crocidolite* (also known as 'blue asbestos'), and *tremolite*) (enHealth 2005, 2013; IARC 1973; USGS 2001).

A detailed assessment of issues related to the potential presence of asbestos in recycled materials is provided in:

- enRiskS (2020) Independent review: Asbestos in Construction and Demolition Recycling. Dated 20 October 2020.

A short summary is provided below.

Asbestos is one of the parameters for which limits have been set in the draft order for recovered soils. The limits are:

- Recovered soil (proposed) – absolute maximum concentration – no FA/AF reported
- Recovered soil (proposed) – maximum average concentration – no limit specified

This means that any detection of fibrous asbestos/asbestos fibres will result in material being failed. Given that these are naturally occurring minerals, requiring no detections ever is problematic.

It is important to understand natural sources of asbestos when considering potential for such material to be present in recovered fines or recovered soil. Asbestos minerals are widely spread throughout the earth's crust and are not restricted to the few mineable deposits. In particular, chrysotile is present in most serpentine rock formations.

Emissions of asbestos fibres from natural sources occur due to natural weathering. In addition, emissions of such fibres from these natural geologies can be enhanced by man's activities, such as quarrying or street building. Very little, however, is known about the overall load emitted from natural sources (WHO 2000). Man-made emissions originate from activities in the following categories:

a) mining and milling
b) manufacture of products
c) construction activities
d) transport and use of asbestos-containing products
e) disposal.

Indoor asbestos fibre concentrations can be considerably higher than outdoor concentrations.

Asbestos fibres normally constitute only a relatively small fraction of the total number of fibres in ambient air. Other fibres can be present from fungi or other microorganisms, synthetic mineral fibres, other biological material, synthetic fibres from textiles etc.

The biologically more important so-called "critical" fibres for asbestos minerals are those equal to or longer than 5 µm and having diameters up to 3 µm with an aspect ratio equal to or greater than 3:1 (WHO 2000) (i.e. long and thin).

Table 19 presents a summary of the available data on background levels of asbestos in air in urban, rural and industrial areas. In addition, the table includes calculated lifetime burdens, i.e. the number of asbestos fibres inhaled over a lifetime in urban and rural areas compared with workplace exposures.

This shows that all members of the population are always exposed to asbestos in air, with significant (1 million to many millions) numbers of fibres inhaled over a lifetime, even where no exposure occurs in a workplace or to a contaminated area.

In spite of this, the general population (non-occupationally exposed population) does not contract asbestos related disease in any significant numbers. The background rate of mesothelioma is noted to be less than 1.5 per million per year.

Table 19: Summary of background levels of asbestos reported in the environment

Exposure	Concentrations reported (f/cm^3 = f/mL)	Reference
Urban air (typically 10 times higher than rural)	0.000003 to 0.0198 for multiple countries 0.00004 to 0.05 (0.0011 mean) in US 0.0016 to 0.0037 (0.0016 mean) for 1990's US 0.0001 to 0.001 lowest background	(Krakowiak et al. 2009) (Abelmann et al. 2015) (ASCC 2008) (WHO 2000) (IARC 2012)
Rural air	0.0003 to 0.0218 for multiple countries 0.0000048 to 0.013 (0.00039 mean) in US 0.000014 to 0.000092 (0.000018 mean) in 2000's in US 0.00001 to <0.0001 lowest background	(Krakowiak et al. 2009) (Abelmann et al. 2015) (ASCC 2008) (WHO 2000) (IARC 2012)
Industrial air	<0.0006 to 91.4	(Krakowiak et al. 2009)
Heavy traffic road crossing or freeway	0.0009 to 0.0033	(WHO 2000)
Indoors	<0.001 buildings with no ACM <0.001 to 0.01 buildings with friable asbestos 0.00003 to 0.006 in homes, schools etc 0.00012 (mean) in US	(WHO 2000) (WHO 2000) (IARC 2012) (ATSDR 2001) (Lee & Van Orden 2008)

Exposure	Concentrations reported (f/cm^3 = f/mL)	Reference
Outdoor ambient levels or background	0.00003 to 0.0047 in the US	(Glynn et al. 2018)
Lifetime burdens	**Urban population** exposed to 0.00003 to 0.0002 f/cm^3, exposure for 70 years = ~1.5 x 10^7 to 10^8 accumulated fibres	(WHO 2000)
	Rural population exposed to 0.00001 f/cm^3, exposure for 70 years = 10^5 to 10^6 accumulated fibres	(WHO 2000)
	Asbestos workers exposed to 0.1 to 1 f/cm^3 Exposure for 50 years = 10^{10} to 10^{11} fibres Exposure for 0.7 year (incidental exposure) = 5x10^7 fibres	(WHO 2000)

No data for asbestos was provided within the NSW EPA data set which is why no discussion of results is included here.

There are a number of important points to consider when considering relevant limits for asbestos in these recycled materials:

- Asbestos is naturally occurring in soil and has been widely used. This means that it is highly likely any soil sample could contain a small amount of asbestos material
- To enable recycling of building and demolition waste or construction waste to occur, the potential for asbestos to be present needs to be controlled at source. This means all asbestos containing materials need to be removed by an appropriately qualified asbestos professional prior to any demolition occurring – already required in NSW regulation. Additional compliance checks to ensure this happens would be useful as would requirement for clearance certificates.

6.5 Foreign materials

These products – recovered soil/recovered fines – are recycled. This means that it is possible that some low levels of foreign materials could be present. The processing of the waste used to make these products includes sieving to ensure only small pieces of such materials are present. The current resource recovery orders require that the levels of such material be low – less than 1-2%.

These foreign materials include:

- Material types that are normally present in the ground including wood, components of plaster dust, metals
- Material types that are readily degradable including paper/cardboard, cloth
- Material types that are commonly present in the ground around construction sites or infrastructure including plastic, bricks, glass, paint, metal, plaster, asphalt

All of these materials are commonly encountered by people or ecosystems as they are the construction materials for buildings and infrastructure. All of these types of materials will be present in the environment from human activities.

The potential for effects on people or ecosystems is limited for the following reasons:

- Only small amounts are permitted to be present in these products

- The various material types are manufactured (or naturally occur) in a way that limits the potential for leaching of the various chemicals that make up these materials
- People and ecosystems are already exposed to these materials in a widespread fashion and no significant effects have been shown to occur adjacent to buildings or infrastructure where concentrations would be expected to be highest
- The common uses of recovered fines or recovered soil are as engineered fill or for earthworks or for underlay for turf and other landscaping uses. These uses mean that the material is predominantly buried or, at least, covered by vegetation like turf.

It is possible that consumers of these products may be concerned about how these products look when (and if) they are placed at the surface, if a small number of pinhead sized pieces of plastic or metal or glass could be observed. However, given the permitted uses of these products, it is unlikely that this will occur frequently as they will be quickly covered over at most locations.

It is noted that the Australian Standard 4454 covers composts, soil conditioners and mulches. These materials are much more likely to be placed at the ground surface and are available for domestic use (i.e. much lower level of control). There are limits on foreign materials in these products. For the grouping of glass, metal and rigid plastics, the absolute maximum limit is 0.5% and for plastics (light film) the absolute maximum limit is 0.05%. These limits are higher than those in the recovered fines order (for glass, metal and rigid plastics) or in the draft recovered soil order (for both groupings). This means there is potential for more visible foreign materials to be present in products sold to the domestic market for use in home gardens at the ground surface than for such materials to be present in recovered fines or recovered soil as defined by these orders.

Section 7. Outcomes

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by the Waste Contractors and Recyclers Association of NSW (WCRA) to undertake an assessment of the use of recovered fines compliant with existing resource recovery orders, consideration of the newly proposed resource recovery order for recovered soil and compares the regulation of these materials with other recycled materials which are used for similar purposes.

The review has identified a number of key outcomes including:

- Ambiguities in both of the resource recovery orders for recovered fines make it difficult to be confident as to what is required to be in compliance.
- Comparison of concentration limits in the various resource recovery orders with guidelines based on the protection of human health and ecosystems shows the limits are quite variable and are similar to or more conservative than the guidelines protective of human health and ecosystems.
- The draft recovered soil order is ambiguous in what sort of soil could be considered for reuse due to the difference in legal definitions for terms that are normally used interchangeably – building and demolition waste vs construction waste.
- Potential for exposure to any chemicals that may be present in recovered fines or recovered soil is likely to be very low for people or the environment, given the nature of permitted uses (i.e. at depth for engineered fill/earthworks).
- Difficulties/lack of clarity with the sampling and analysis methods specified in the various orders.
- Background levels of some chemical parameters do not appear to have been considered in determining limits for the orders, as some limits are below average background concentrations in soil in Australia.
- Impacts on people or the environment of foreign materials in recovered fines or recovered soil are likely to be extremely limited given that these materials are already widely present in the environment (i.e. construction materials in buildings etc) and, in addition, the permitted uses limit the potential for visual impacts.
- The resource recovery orders for recovered fines have been in place for a significant time period (i.e. since 2008) but the recent NSW EPA audit is the first that has occurred.

More detail on these findings include:

- There is a lack of clarity in the specifications of the resource recovery orders for recovered fines which makes it difficult to ensure compliance. Issues where there is ambiguity in the recovered fines orders include:
  - definitions for batch and continuous processing
  - acceptability or not of resampling

- variability in the required number of samples to be collected for analysis in the 2 orders.

- Comparing the absolute maximum limits for the 2 recovered fines orders and the draft recovered soil order with limits for other recycled materials and national guidelines for soils that are calculated to be protective for human health and ecosystems has shown:
  - the limits for recovered fines are similar to those for other recycled materials
  - the limits for recovered soil (draft) are lower than those for other recycled materials and it is not clear why this is the case nor whether background levels in Australian soils have been considered in the development of the lower limits. Achieving some of these lower limits will be difficult given background levels in soil in a range of areas/sources
  - the limits in all orders are lower than the national guidelines for soil that are protective of human health and the environment.

- There are sampling and analysis issues that impact on demonstrating compliance with the limits in these orders including:
  - highly variable sampling rates in all the orders evaluated in this assessment and there is a lack of transparency on why there is such a difference
  - requirements for limits of reporting that are not in line with the recommended standard analysis method and/or are difficult to achieve.

- Limited information on sampling rates in the waste classification guidance compared to the more significant requirements under the various resource recovery orders provides a disconnect in this process. Receivers/processors of waste may have little or insufficient information on the material from the classification process, but they are required to have confidence that they will be able to produce a product that will comply with the limits in the relevant order. This is particularly problematic for asbestos but is relevant for most parameters.

- Looking at some of the chemical contaminants in more detail:
  - lead
    - the limits in all the orders are well below the national guidelines for soil protective of human health or ecosystems
    - the limits in the recovered fines orders are similar to average background levels of lead in soil in Australia
    - the NSW EPA sampling indicates that the average concentration of lead in recovered fines is below background levels in Australian soils
    - the limits in the recovered soil order are below average background levels of lead in soil in Australia
    - requiring these recycled products to have lower levels than present on average in general/background soil is problematic given that these products include soil from many sources.

  - benzo[a]pyrene
    - the limits in all the recovered fines orders are similar to or lower than background levels of this chemical (and those related to it)

- the NSW EPA sampling indicates that the average concentration of benzo[a]pyrene in recovered fines is similar to likely background levels in Australian soils
- the limits are also similar to the national soil guidelines protective of human health and the environment
- requiring these recycled products to meet even lower limits (as proposed in the draft recovered soil order) is problematic, again, given the background levels in soil and the issues with routinely available limits of reporting when considering BaP TEQs.

- Looking at some of the physical contaminants in more detail:
  - Asbestos
    - no data was available on the presence or level of asbestos in recovered fines
    - asbestos is a naturally occurring mineral so has the potential to be present in any soil or recycled material regardless of source
    - there are significant limitations in the ability of the analysis to demonstrate complete absence of fibres.
  - Foreign materials
    - presence of foreign materials in these recycled products is predominantly a visual issue
    - these products are generally placed at depth, so the potential for impact based on amenity is limited
    - other products (e.g. composts, mulches) that are definitely used at the ground surface are allowed to contain higher levels of these foreign materials which may have visual impacts
    - there are also significant limitations in the robustness of the analytical method.

Section 8. Recommendations

There are a number of recommendations that have been made through this assessment including:

- Retention of the recovered fines orders with some revision including:
  - clarified definitions (batch, continuous, characterisation sampling, routine sampling etc)
  - consideration of limits of reporting that take into account the relevant difficulties in analysis for physical contaminants
  - consideration of background levels of relevant chemical contaminants when determining limits in an order
  - consideration of including a requirement for an independent person to be used to undertake sampling
  - consideration of including a requirement for a suitably accredited auditor to audit the sampling and analysis undertaken at a site on a regular basis (6 monthly or yearly) to ensure compliance with the relevant order.
- Revision of the draft recovered soil order before finalisation including:
  - clarified definitions and guidance on the nature of the desktop assessment for prohibited items
  - consideration of limits of reporting that take into account the relevant difficulties in analysis for physical contaminants
  - consideration of background levels of relevant chemical contaminants when determining limits in an order
  - consideration of including a requirement for an independent person to be used to undertake sampling
  - consideration of including a requirement for a suitably accredited auditor to audit the sampling and analysis undertaken at a site on a regular basis (6 monthly or yearly) to ensure compliance with the relevant order.
- Potential for asbestos to be present needs to be controlled at the source not at the processors of these waste materials. This means all asbestos containing materials need to be removed by an appropriately qualified asbestos professional prior to any demolition occurring at all sites. This is already a requirement in NSW, however additional compliance checks to ensure this happens would be useful as would requiring clearance certificates for all sites supplying wastes to processors.
- Consideration of how there could be better alignment of how sampling is undertaken for waste classification with sampling required under the resource recovery orders would be useful. Currently, it appears less sampling is required for waste classification (which defines the quality of material to waste processors) than is needed to define the quality of the recovered materials produced by the waste processors. The potential variability in recycled materials makes this lack of alignment problematic.
- There is a need to improve the confidence that processors can have that they will be able to produce compliant products because they can better understand the nature of their source materials.

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APPENDIX D

On-Site Testing and Reform for the Recovered Fines Order
NSW C&D Working Group, June 2021

On-Site Testing and Reform of the Recovered Fines Order

Proposal for EPA consideration

Executive summary

Conversation with EPA on reform of the Recovered Fines Order has been constructive. We believe that, following Workshop 3, there were several issues still to be resolved. In this submission, we have attempted to propose solutions to those issues.

Central to the reform, the NSW EPA has indicated they wish to revise the 'Batch Process' Recovered Fines Order and discontinue the 'Continuous Process' Recovered Fines Order. The primary basis for this is EPA concern that under the current Continuous Process Order, analytical data for the material is generally not received until some time <u>after</u> the material has left the Site. This could theoretically present significant issues in the event of non-complying analytical results and may present an unacceptable risk to human health and the environment.

We acknowledge that the distribution of uncertified material tested under a 'Continuous Process' may lead to undesirable outcomes. In the event that a facility is not able to hold recovered fines tested under this 'Continuous Process' RRO until the material is confirmed to meet the order, we would like to propose an alternate method of certification. This alternative would allow industry to continue producing material in an uninterrupted fashion, but would give EPA confidence that producers will have robust, precise, actionable characterisation data on hand, <u>before</u> the material leaves the site.

Our proposal is based around the following elements:

1. A sampling density that scales with batch size;
2. Analysis via conventional off-site laboratory, or via a robust On-Site Testing process, which provides accurate and instantaneous data on material quality;
3. Quality assurance and quality control;
4. A structured and consistent approach to confirmatory analysis ('re-testing'); and
5. A structured and consistent approach to managing failures and non-compliant material.

These elements are discussed in detail in this document.

We are seeking from the EPA:

1. A meeting to discuss our submission further, prior to any draft revised Order being circulated;
2. In-principle support of our proposal for on-site testing;
    a. This will allow the industry group to invest in demonstrating the performance of the proposed alternative methods, in accordance with USEPA method 301 "Field Validation of Pollutant Measurement Methods". We note that various documents, including the NEPM and existing NSW EPA documents (i.e. Waste Classification Guidelines) allow for alternative methods and non-NATA methods to be used, following consultation with the EPA.
3. Feedback regarding our proposed methods for confirmatory analysis and hotspot removal.
4. Feedback on the proposed changes to contaminant limits and confirmation of the laboratory method to which asbestos is to be tested to (i.e. Australian Standard 4964-2004, NEPM, etc).

We thank you for considering our proposal and we look forward to receiving your feedback and meeting with you soon.

1. Introduction

- NSW EPA has indicated that it believes that it is necessary to discontinue the 'continuous process' Recovered Fines Order.
- The primary reason for its discontinuation is that the existing arrangements for continuous process Resource Recovery Orders (**RRO**) allow material to leave a site for beneficial re-use elsewhere, prior to any characterisation data for that material being obtained.
- NSW EPA have suggested batch testing is the way forward.
- Industry has stated that a large number of sites producing Recovered Fines do not have the physical space to stockpile and test batches using external laboratories, at a rate that achieves acceptable economy of scale and speed under the current Batch Process Order. There are however some operations that are able to, and do hold material until this material has been confirmed to meet the order.
- Industry is putting forward an alternative approach, which would achieve the outcomes of batch testing (i.e. material is characterized before leaving the Site), whilst ensuring that it remains viable for both large and small sites to continue to recycle and produce fines.
- Our proposal is based around the following elements:
  - A sampling density that scales with batch size;
  - Analysis via conventional off-site laboratory, or via a robust On-Site Testing process, which provides accurate and instantaneous data on material quality;
  - Quality assurance and quality control;
  - A structured and consistent approach to confirmatory analysis ('re-testing'); and
  - A structured and consistent approach to managing failures and non-compliant material.

A flow chart of the proposed process to be captured in the revised Order is provided at Attachment A.

2. Sampling density and regime

- We propose a sample regime that scales with batch size.
- A sampling plan appropriate to the Site will be developed, the Sampling Plan must be designed in a manner that ensures the samples obtained will be representative of the material produced and encompassed in the batch.
  - The sampling method detailed in the Sampling Plan will be consistent with Australian Standard 1141.3.1-2012 Methods for Sampling and Testing Aggregates – Sampling – Aggregates (or equivalent) and should be prepared by a suitably qualified and experienced person.
- The sampling density is based on the estimated weight of the batch (where 1 m3 is taken to be 1.5 tonnes); It is based on the EPA's suggestion of 1.5 x the ENM Order. If batches are larger than 4,000 T, additional samples must be taken based on the number required for any tonnage over and above that amount.

Tonnes encompassed by batch	Number of samples
250	3
500	5
1000	6
2000	8
3000	11
4000	15

The samples obtained may be composite samples, as defined in the current Order.

3. On-Site Testing

On-Site Testing is a process by which analytical data are obtained for samples, either via conventional techniques (where they can be deployed in the field), or comparable alternatives. On-Site Testing is based on portable analytical technologies and based on a procedure that provides results instantaneously.

Although On-Site Testing has benefits when compared to conventional laboratory testing, we consider On-Site Testing to be a complementary approach that allows greater amounts of high-quality data to be obtained instantaneously, allowing management decisions to be made more quickly. The ongoing performance and precision of On-Site Testing methods would be checked via regular QA analysis at off-site, NATA accredited laboratories.

A standardised On-Site Testing methodology will be used, that is proven to achieve results that are equivalent in precision and repeatability to the current standard laboratory methods.

The methodology would need to be published so that organisations are free to implement it internally and can be accessed by third parties to ensure competition and cost control through market forces.

The EPA may perhaps wish to publish an 'Approved Methods for On-Site Testing' document for the relevant analytes, or specify the method(s) in the Order itself.

QA/QC

The On-Site Testing methodology will have appropriate QA/QC controls in place to ensure repeatability of the field method. We also propose for a regular QA process whereby a duplicate sample (or the same sample analysed onsite) is analysed by a NATA accredited laboratory. The results are compared to ensure the On-site method is performing as expected.

On-Site Testing sampling quality control will be to the same standard and accuracy as expected for sampling for a NATA laboratory assessment. This includes implementation of standard soil sampling QA and decontamination procedures (i.e. disposable nitrile gloves, cleaning sampling equipment). Holding times to be defined and complied with. Chain of custody for validation samples etc.

Blanks, spikes and duplicates can be analysed (for most contaminants) via On-Site Testing, at the required rate.

A standard data form (including field sheets and digital files for photo attachment etc.) is to be prepared and included with the Order for those facilities that wish to utilise On-Site Testing. This ensures that the record-keeping requirements for all facilities is clear and standardised.

EPA may wish to consider other controls as appropriate, such as photograph requirements at defined points, video recording the process, periodic third party audits of the process, proof of regular calibration of testing equipment, etc.

Sample preparation

Appropriate sample preparation will be carried out for certain analyses (i.e. for non-volatiles). The specific details are to be confirmed and may include particle size reduction (i.e. pulverising) and homogenization.

On-Site Testing analytical regime

Analyte	Proposed field method(s) used to assess	Sample retention	Comments
pH and EC	pH: 1:5 dilution AS1289.4.3.1-1997. EC: 1:5 dilution method 104 NEPM (B3).	Destructive	Field method expected to be implemented in an identical manner to laboratory method. Settling time may be reduced (to < 1 hour).
Foreign material and particle size distribution	RMS Test Method T276 (2.36 mm sieve) (field). OR Hydro sieving (2.36 mm sieve)	Non-destructive	Field method expected to be implemented in an identical manner to laboratory method. The drying step may be removed.
8 priority heavy metals	Analysis of metals via portable X-Ray Fluorescence analysis.	Non-destructive	XRF analysis to be conducted on both bagged samples and samples prepared as analysis discs or in sample 'cups'.
Asbestos (ACM, FA, AF>2mm)	NEPM Screening to 7mm and 2mm (stereomicroscope assisted inspection) and subsequent confirmation of ACM via Microphazir NIR spectrometer.	Non-destructive	The process of AS 4964-2004 will be followed to the extent possible, with confirmation of ACM via repeat NIR rather than PLM and Dispersion staining. The sub 2 mm fraction is not proposed to be routinely analysed – this is supported by EPA data which did not exhibit any positive detections above the limit of reporting in the sub 2mm fraction. Sample preparation for PACM may include dilute H_2SO_4 bath or other surface preparations to reduce the risk of matrix interference.
BTEX and vTRH (C6-C9)	Presence/Absence or broad quantification via Photoionisation detector.	Non-destructive	A response curve is proposed to be developed based on BTEX spike sample data. Alternatively, BTEX and vTRH can be analysed with the Site-Lab, but this is a destructive method.
TRH C10-C40	Solvent extraction and Site-Lab Ultraviolet spectroscopy	Destructive	Field deployable equivalent to USEPA SW-846 method 8100.
PAH	Solvent extraction and Site-Lab Ultraviolet spectroscopy	Destructive	Field deployable equivalent to USEPA SW-846 method 8100.
Total Organic Carbon	Potential autoanalyzer comparison/oxidation analysis	Destructive	Not a contaminant and not proposed to be analysed via On-Site Testing. TOC analysis (Walkley Black) will remain a requirement for off-site laboratory analysis.
OCP/PCBs/Chlorinated Hydrocarbons	NA	NA	These analytes have been flagged by the EPA for removal from the Order. Not proposed to be analysed via On-Site Testing.

Table 1. On-Site Testing methods.

Note that other processes required to allow analysis (i.e. moisture determination, drying, crushing/homogenising etc.) are also achievable on site and methods for these steps would also be specified.

NATA Laboratory analysis

The Order could be written in a manner that allows producers to choose between two types of assessment. One option is to utilise On-Site Testing (with regular laboratory QA), or to carry on having all analyses done via an analytical laboratory (see the flow chart at **Attachment A**).

If On-Site Testing is utilised in any given fortnight:

- One sample within the fortnight analysed via the On-Site Testing process will be validated by an off-site, NATA accredited laboratory, using the current accepted laboratory test method.
- Where field tests are non-destructive, the laboratory will analyse the SAME sample as analysed by the laboratory. Where tests are destructive, a DUPLICATE sample (taken from homogenised material where appropriate) will be analysed.
- NATA laboratory data will be compared to On-Site Testing data and RPDs calculated. If RPDs are violated, a process of continued validation is triggered, until performance standards are shown to be equivalent again (i.e. 2 consecutive QA samples pass).

4. Confirmatory analysis ('re-testing')

Solid samples occur in a defined three-dimensional structure. This restricts the ability of particles to move freely within the matrix. This is an issue for solid samples that is not generally observed in fluid (water and gas) samples. In heterogenous natural solid mixtures (i.e. soils), this property causes 'spatial heterogeneity' WITHIN samples. Spatial heterogeneity is a primary source of data uncertainty.

The sample preparation procedures of laboratories are not specified in Orders. This allows laboratories to prepare samples for analysis in the way they see fit. For example, some labs crush and homogenise, some homogenise, some sift and some simply scoop material from a part of the sample container (say, from the top of the jar). This inconsistency between labs and the lack of transparency (sample preparation is not described in analytical reports) creates uncertainty about how representative a primary analysis may be of the sample as a whole. We regularly see this where RPDs of duplicates are outside of the acceptable range, but they are generally explained away as being caused by 'sample heterogeneity' rather than an inaccuracy in the analytical method, or occasionally assessed further through triplicate analysis.

Unless the EPA specifies sample preparation and homogenisation steps in the Order, we believe that confirmatory analysis (or 're-testing' as it has been colloquially referred) must be permitted.

Confirmatory analysis could be carried out regardless of whether the analysis is done via On-Site Testing methods, or conventional laboratory methods. Confirmatory analysis would work as follows:

- Where a primary analysis for a sample fails against the limit for a particular contaminant, the sample is re-run for that contaminant another four times (at a minimum). The confirmatory analysis must be ordered within the holding time for the analysis and the sample must not be removed from the laboratory (or field test) and re-submitted.
- The mean is then calculated, based on the results for all analyses for that sample.
- If the mean of the results is still non-compliant with the relevant limit, assess whether the mean is influenced by an outlier.
    - Calculate the quartiles for the data and the inter-quartile range (IQR). Multiply the IQR by 1.5. Subtract this value from the first quartile and add this value to the third quartile. If a result falls outside the resulting range, then it is an outlier and may be excluded from the dataset.
- Re-calculate the mean of the data, with outlier(s) excluded.
    - If the mean is compliant with the relevant limit, the sample is taken to be compliant and the mean is used as the representative value for that sample in further statistical analyses among other samples, for the batch as a whole.

- If the mean is non-compliant with the relevant limit, then the sample has failed and is referred to as a 'hotspot'. The batch may be taken as non-compliant, or the producer may choose to carry out hotspot delineation and removal, as per the procedure below.

Examples – using lead with a sample absolute maximum of 150 mg/kg

- Example 1: Primary Lead result is 160 mg/kg. Lead is run four more times, with results 44, 60, 101 and 90. The mean of all results is 91, which is taken to be the representative value for the sample and is compliant with the relevant limit.
- Example 2: Primary Lead result is 420 mg/kg. Lead is run another five times, with results 150, 105, 100, 89 and 67. The mean of all results is 155, which is non-compliant with the limit. In this dataset, the IQR is 61 and 1.5x the IQR is 91.5. The third quartile is 150. The Third quartile plus 1.5xIQR = (150 + 91.5) = 241.5. Therefore the result of 420 is an outlier of the dataset and may be discarded. There are no low outliers to remove, as the First quartile minus 1.5xIQR is a negative number. With that outlier removed, the mean of the dataset is 102.2 which is compliant.
- Example 3: Primary Lead result is 1,200 mg/kg. Lead is run another four times, with results 900, 70, 750, 1000. The mean of all results is 784, which is non-compliant with the limit. In this dataset, the IQR is 690 and 1.5 x the IQR is 1035. The first quartile is 410 and the third quartile is 1100. When 1.5xIQR is subtracted from the first quartile and added to the third, it confirms all results are within the relevant range and no results can be discarded as outliers. Therefore, the mean of 784 stands and the sample is non-compliant.

5. What to do in the event of 'failures'

There are two types of failures that may occur, assuming the revised Order continues to use an 'absolute maximum' limit for each sample and an 'average' limit for the batch as a whole.

In the event of a failure of the batch average, additional samples may be taken from the batch and analysed. The Order should not place a limit on the number of additional samples, as the practicality of additional sampling will be determined by the producer on a case by case basis, taking into account time, cost etc. If additional samples bring the average into compliance, then the batch is compliant with the Order.

In the event of failure on the sample absolute maximum (regardless of whether confirmatory analysis and outlier assessment has been completed as per the previous section), hotspot removal may be carried out, if the following parameters have been met:

- The Sampling Plan and sampling carried out clearly identifies where each sample was taken. Ideally, physical markers are used to identify sample locations. At a minimum, an accurate diagram should be used to identify sample locations, along with photos taken of samples in situ at the time of sampling.
- The composition and location of the batch and samples at the time of sampling have been maintained (i.e. material has not been moved, added to, or taken from it).

If these parameters have not been met, then hotspot removal cannot take place and the entire batch is taken to have failed the analysis and must be disposed of.

If the parameters are met, then the following process may be undertaken to deal with non-compliant samples:

Option 1 (remove non-compliant material and validate):

1. A minimum of 1 m^3 of material is to be removed around the location of the non-compliant sample. This material is to be removed from the batch and disposed of.
2. Take a photo showing the area that material has been removed from. This photo must be retained along with the records for the batch, as per the requirements of the Order.
3. From all 'sides' of the void created by removing the material, collect a sample to be analysed for the analyte that resulted in the failure.

   a. For example, if the material was taken from the middle of a stockpile, 5 validation points are required (four sides and the base). If the material was taken from the edge of a stockpile, then 4 validation points are required (three sides and the base). If the material is removed all the way to ground level, then no base sample is required.
   b. Regarding the validation analyte(s), only the analyte(s) causing the failure must be tested. For example, if the initial sample failed due to Lead, only Lead needs to be analysed in the validation samples.

4. Analyse the validation samples. If the validation samples are all compliant, the batch is taken to be compliant. No further action is needed to clear the batch.
5. If any of the validation samples are non-compliant on the primary analysis, confirmatory analysis detailed above may be carried out on the validation sample. If, after the confirmatory analysis process, the validation sample is still non-compliant, then an additional minimum of 1 m^3 of material is to be taken from the side(s) with the failing validation sample(s).
   a. The process of validation is to be repeated, starting again at point 1 above, until no failures occur in the validation samples.
   b. This process of hotspot removal may be repeated up to a maximum of five times. If on the fifth attempt, the validation samples are non-compliant, then removal of the relevant section must occur, as per Option 2 below.

Option 2 (remove non-compliant material on the basis of next complying result):

1. Material may be removed from the entire 'area' of a batch between a failing sample and the next closest compliant sample.
   a. For example, say a producer has a 500 t batch with 5 samples (which should be evenly distributed throughout the stockpile) and one non-compliant sample. The producer would be permitted to remove the section of the stockpile around the non-compliant sample, with the section stopping at the next closes compliant samples. This should result in removal of approximately 20% of the stockpile volume/mass.

      If it was a 2,000 t stockpile with 8 samples (evenly distributed), including one non-compliant sample, you would expect 12.5% of the stockpile volume/mass to be removed.
2. The material removed must be disposed of.
3. If this method is followed, no further validation sampling is required. The batch is taken to be compliant once the non-conforming material has been removed.

Important note regarding confirmatory analysis and hotspot removal

The options discussed above are likely to be most effective where decisions can be made in real time, for example, via on-site testing. Confirmatory analysis, additional sampling and hotspot removal (Option 1) may be difficult if using conventional off-site laboratory analysis for samples, due to the timing/logistics of sample collection and transport and lead time for analysis. It is not to say these options cannot be done with off-site laboratory analysis, just that doing so will require batches to be held on site for longer periods of time. This may restrict the ability for sites with space constraints to implement these options if they use off-site laboratory testing. This should be considered and addressed in the individual producer's sampling plan.

At all times, the entirety of a batch is to remain on site, until the analysis process for the batch is complete.

6. Proposed changes to analyte limits and addition of asbestos analysis

We note that based on the EPA's review of Recovered Fines material, ICH, OCP and PCB are proposed to be removed from the analyte list. We support this change.

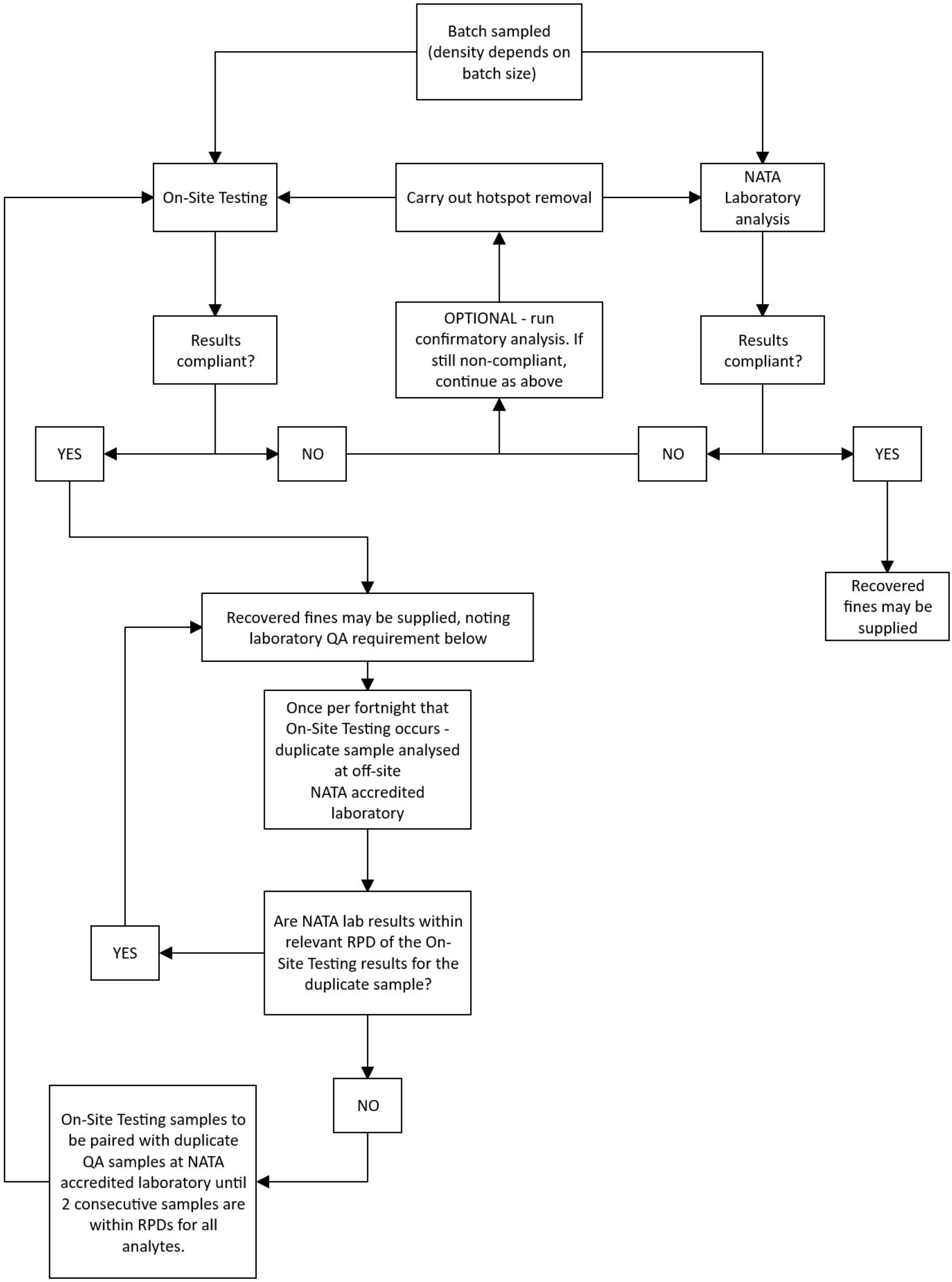
We also propose the following changes to analyte limits:

- Glass: We propose that glass is removed from the foreign material list. Glass is not a contaminant, it is inert and insoluble. In fact, glass sand is an appropriate product for re-use by land application. In the event that glass is retained in the list, it should be listed individually, with a tolerance limit of 5% (average) and 10% (maximum).
- Metal: We propose that metal is removed from the foreign material list. Metal is not a contaminant and metal is permitted in higher concentrations in other similar resource recovered material (i.e. ENM allows up to 2% and Recovered Aggregate allows up to 1%). In the event that metal is retained in the list, it should be listed individually, with a tolerance limit of 1% (average) and 2% (maximum).
- Lead – we propose an increase in the average to 150 mg/kg and the maximum to 250 mg/kg. The EPA's data from the Recovered Fines review indicates the background levels of lead in Sydney materials are above 100 mg/kg. This is supported by other sources in the scientific literature, grey literature and citizen science projects. Generally, lead concentrations up to 300 mg/kg are still considered safe in an Australian context, even in land use scenarios where edible plants are grown and there is direct contact between soil and receptors. We consider 150 mg/kg to be a reasonable compromise which addresses these two issues.

We would welcome the opportunity to discuss this further with the NSW EPA.

Regarding asbestos, we propose a method in Section 3 of this document for an On-Site Testing method for Asbestos that involves a greater degree of analysis than the WA DOH (and NEPM) field method, but does not involve laboratory PLM and DS microscopy methods. The proposed method would be robust and adequate for identification of asbestos to 2 mm. **Importantly, we note that in almost 100 representative samples across the EPA's sampling program for Recovered Fines, there were no asbestos finds above the limit of reporting in the < 2 mm size fraction**.

If the producer carries out testing via an off-site laboratory only, we propose that Australian Standard 4964-2004 asbestos analysis (50 g grab sample) is obtained for each sample point.

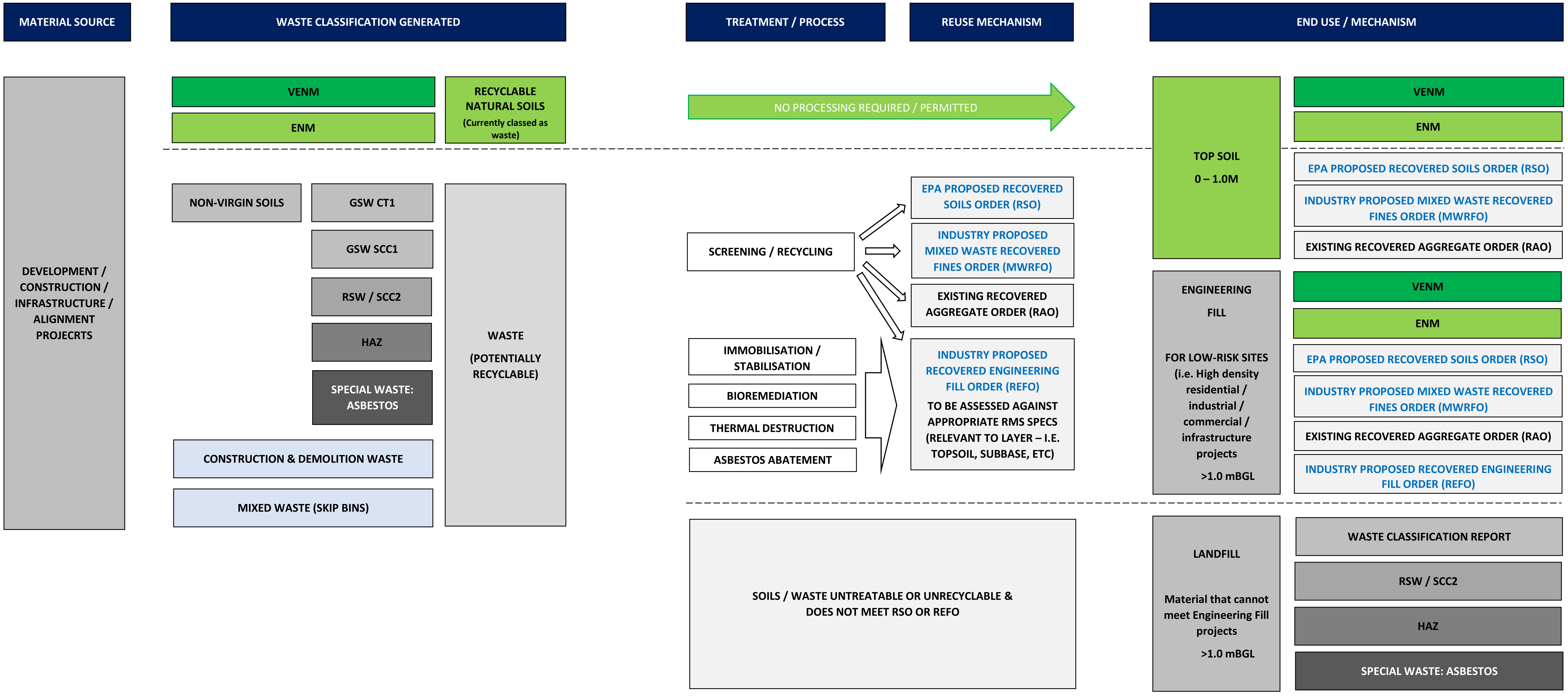


Batch sampled (density depends on batch size)
On-Site Testing
Carry out hotspot removal
NATA Laboratory analysis
Results compliant?
OPTIONAL - run confirmatory analysis. If still non-compliant, continue as above
Results compliant?
YES
NO
NO
YES
Recovered fines may be supplied
Recovered fines may be supplied, noting laboratory QA requirement below
Once per fortnight that On-Site Testing occurs - duplicate sample analysed at off-site NATA accredited laboratory
Are NATA lab results within relevant RPD of the On-Site Testing results for the duplicate sample?
YES
NO
On-Site Testing samples to be paired with duplicate QA samples at NATA accredited laboratory until 2 consecutive samples are within RPDs for all analytes.

APPENDIX E

Proposed Revised Waste Classification/Resource Recovery Response Strategy

PROPOSED REVISED WASTE CLASSIFCATION / RESOURCE RECOVERY RESPONSE STRATEGY



FOLLOWING RESOURCE RECOVERY ORDERS REPLACED BY RECOVERED SOILS ORDER AND RECOVERED ENGINEERING FILL ORDER:

RECOVERED FINES ORDER (CONTINUOUS)

EXCAVATED PUBLIC ROAD MATERIAL ORDER

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

APPENDIX F

Alternative Daily Cover Calculation

Data from NSW local govement waste and resouce recovery data report 2019-2020				20Y strategy
	Unit	2019-2020	Per day	
NSW **household** residual waste generation	t	2,240,000	6,137	This two numbers are only the household generation, not incluidng C&I so potentially doubled
Sydney Metor area **household** waste generation	t	1,880,000	5,151	

Recovered fine mass production each	t	1,200,000	3,288

General assumptions		
Density of recovered fine (From calculation in EPA letter)	t/m^3	1.1
Density of waste in landfill after compaction	t/m^3	1
Landfill tip lift height	m	3
		5
daily cover thickness requirment	m	0.15

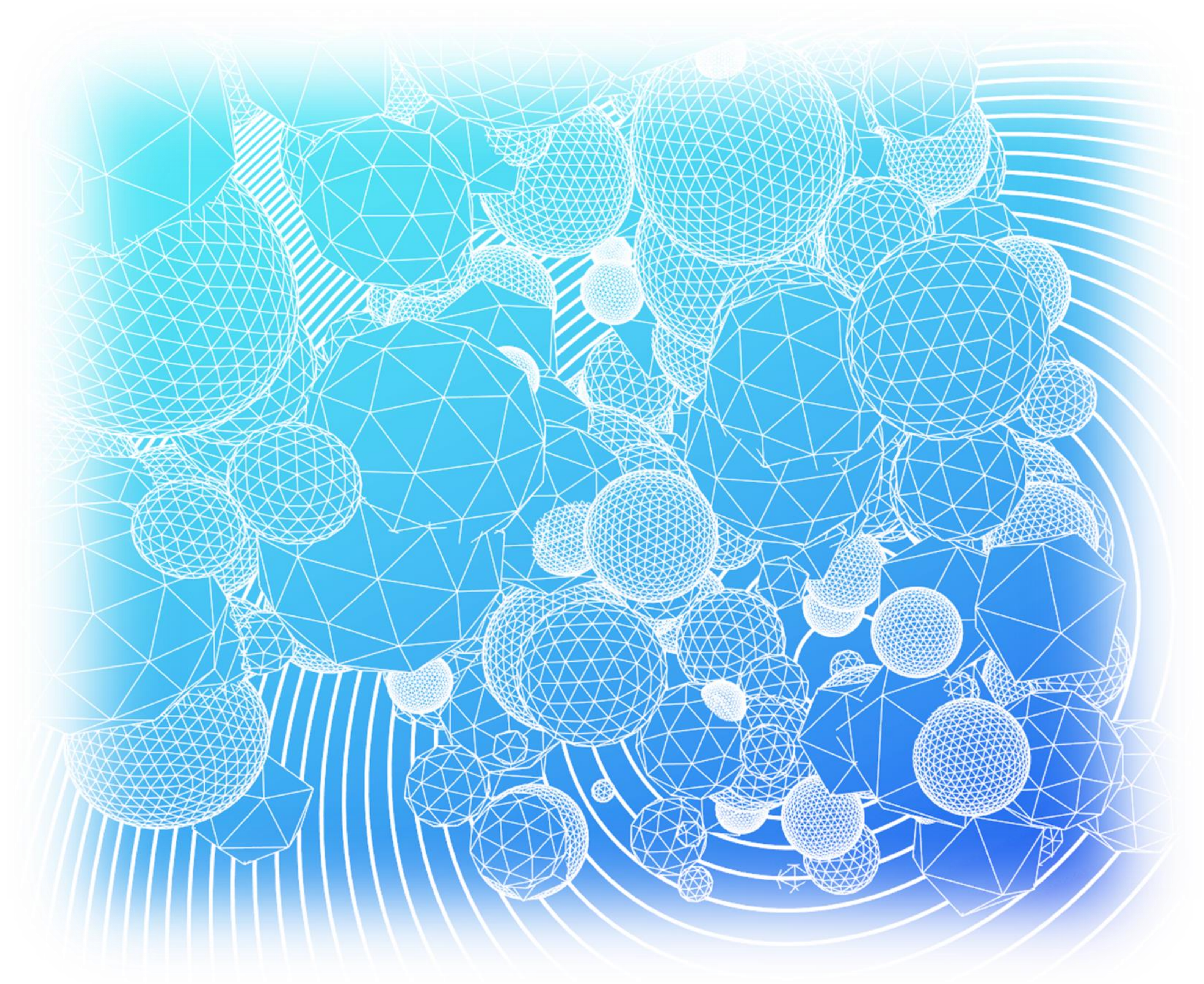
Calculations based on the actual demand of daily cover material						
		Whole NSW			Sydney Metor area	
Volume of waste occupied in landfill every day	m^3	6,137			5,151	
Active tipping surface areas need to be covered daily	m^2	3 m tipping lift	5 m tipping lift		3 m tipping lift	5 m tipping lift
		2,046	1,227		1,717	1,030
Volume requirement for daily cover material	m^3	307	184		258	155
Tonnage of recovered fine required for dailty cover	tons per day	338	203		283	170
	tons per annum	123,200	73,920		103,400	62,040

Calculation based on using all the recovered fine as ADC			
Total volume of recovered fine per annum	m^3	1,090,909	
Surface areas can be covered if use all recovered fine as ADC per annum	m^2	7,272,727	
		3 m tipping lift	5 m tipping lift
Volume of waste in landfill can be coverd by recovered fine per annum	m^3	21,818,182	36,363,636
Mass of waste in landfill can be coverd by recovered fine per annum	t	21,818,182	36,363,636

APPENDIX G

Independent review: Asbestos in Construction and Demolition Recycling
EnRiskS, October 2020

PRIVILEGED AND CONFIDENTIAL



Independent review: Asbestos in Construction and Demolition Recycling

Prepared for: Beatty Legal Pty Limited

20 October 2020

EnRiskS

Document History and Status

Report Reference	BL/20/CDRR001
Revision	C – Final
Date	20 October 2020
Previous Revisions	A – Draft issued on 17 July 2020 B – Revised Draft issued on 14 September 2020

Limitations

Environmental Risk Sciences has prepared this report for the use of Beatty Legal Pty Limited in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in the **Section 1** of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports provided for use in this assessment was false.

This report was prepared between June and October 2020 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Table of contents

Glossary of terms

Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).
Exposure Assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure Pathway	The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as chemical leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
Guideline Value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the NSW Department of Environment and Conservation (DEC) or institutions such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organisation (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter- and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines will have different names, such as investigation level, trigger value, ambient guideline etc.
HHRA	Human Health Risk Assessment
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure).
Inhalation	The act of breathing. A hazardous substance can enter the body this way (see route of exposure).
Point of Exposure	The place where someone can come into contact with a substance present in the environment (see exposure pathway).
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Receptor Population	People who could come into contact with hazardous substances (see exposure pathway).
Risk	The probability that something will cause injury or harm.
Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin (dermal contact)
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicology	The study of the harmful effects of substances on humans or animals.

Executive summary

ES.1 Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Beatty Legal Pty Limited to undertake an independent review of the technical information around the potential presence and risks posed by asbestos that may be present in construction and demolition (C&D) waste to be recycled.

As noted by enHealth in 2013 (enHealth 2013)

"We are all exposed to low levels of asbestos in the air we breathe every day."

Consequently, it is no surprise that it is possible that asbestos may be found in C&D waste being brought in for recycling. Asbestos may be present in such waste due to:

- mixing in of small amounts of bonded asbestos from demolition with concrete for recycling or
- it being naturally occurring in the soil on which a building is being demolished or constructed (i.e. soil containing asbestos gets mixed into the waste) or
- settling of asbestos fibres generally present in the atmosphere (i.e. source of fibres is off-site).

Since around 2007, the C&D recycling industry has been working with the NSW EPA to develop an appropriate protocol/procedure for understanding the issues arising from the potential for asbestos to be present in construction and demolition waste and how best to manage that during the recycling process. This procedure has not yet been finalised.

In 2019 a court case changed the understanding of the law in NSW around asbestos containing wastes (Environment Protection Authority v Grafil Pty Ltd)**.** The court case determined that 1 fibre of asbestos in a stockpile makes the stockpile asbestos waste.

This change in understanding has the real potential to affect the viability of the C&D recycling industry which would have significant impacts on the amount of waste that requires landfilling. Given the limited landfilling volume available in NSW, this matter requires serious consideration.

To better understand the health and environmental risks of asbestos in C&D recycling, a detailed independent technical review has been undertaken and presented in this report.

ES.2 Objectives

The objectives of the review presented in this report are:

- Undertake independent review and provide a summary document detailing:
    - what is asbestos (where it comes from; how it is present in our environment; how it moves around the environment)
    - general technical basis for managing asbestos including toxicology, risk assessment, sampling and analysis and ambient levels

  - hazard based versus risk based guidelines
  - management frameworks for other chemicals in wastes in Australian jurisdictions – similarities and differences for asbestos
  - management frameworks for asbestos containing waste in NSW and other jurisdictions including international jurisdictions. This will include information about the basis for these frameworks [i.e. risk based], where available, and the situations where these get applied (e.g. WHS or contaminated land or waste)
  - concept of trivial versus non-trivial when assessing environmental changes
  - general description of C&D recycling process including products produced and where they are used
  - current issues with the existing system for the management of asbestos in this industry
  - definitions in relation to asbestos containing wastes (existing and changes due to court case in 2019) including what is technically feasible to measure (including sampling methods)
  - technical basis of asbestos guidelines used for waste and for other industries (like contaminated land)
- Based on the review undertaken, outline a best practice approach to managing asbestos within C&D recycling processes, noting where these measures may require additional work, or revision or changes to current guidelines, policy or regulation.

ES.3 Outcomes

The review presented in this report has identified a number of key outcomes which are summarised below:

Hazards posed by asbestos

- It is clear that there are a range of hazards posed by the potential presence of asbestos in any environment. The key hazards relate to asbestos fibres that are of biological concern, i.e. those equal to or longer than 5 μm and having diameters up to 3 μm with an aspect ratio equal to or greater than 3:1, that can move into the air and be inhaled. When assessing asbestos, there are a range of different methods that can be used to quantify asbestos fibres, some of which enable characterisation of the fibres with characteristics that have the potential to pose hazards to human health when inhaled. The selection of the quantification method is important as each will report different aspects in relation to asbestos exposure and risk. Hence guidelines are often tied to specific analytical methods.
- Different types of asbestos pose different levels of risk to workers and the community. Asbestos that is bonded in materials (or cement sheeting) poses the lowest risk, while loose fibres, such as those present in friable asbestos, that can easily move into the air pose the highest risk.
- In relation to potential risks posed by C&D waste:
  - There is a low potential for friable asbestos to be present in C&D waste where these materials are effectively managed at the point of removal from buildings and structures (i.e. upstream)

- The most likely form of asbestos is bonded asbestos, which is of low risk, except where the bonded material is mechanically damaged. When this occurs, there is the potential for some fibres to be released to air, where exposure may occur. This material can be more easily identified and managed in waste materials. The most effective way to manage the potential for this damage to occur is for it to be effectively removed upstream or identified at the gate.
- The background presence of asbestos fibres in air, which is relevant to all members of the community in urban and rural areas means that the concept of zero asbestos or zero asbestos exposure is meaningless.
- While it is accepted that zero tolerance is part of NSW asbestos waste regulations and community expectations, the concept is meaningless in technical terms. Everyone is exposed to fibres from natural sources. Such sources are not targeted for management by regulation or policy. In addition, the concept of 'zero' for anything that requires any form of measurement is meaningless as its detection depends on the reporting limit of the method. It is never possible to determine "zero", only that something cannot be detected.

Definition of asbestos

- The definition of asbestos in the POEO Act, which is adopted throughout all of the NSW regulations and is consistent with the definitions adopted in other states is very general. In addition, the definition of asbestos waste is very general and appears to have resulted in the zero-tolerance approach adopted in NSW, where the concept of any asbestos means it is an asbestos waste.
- The use of such a general definition does not enable risk to be considered, nor the characteristics of asbestos, namely fibres of a particular length and width that are of importance to the hazards that asbestos poses. In addition the definition does not allow any distinction between risks posed by ACM that are likely to be visible (i.e. bonded or in products), which are low risk, and asbestos fibres that can easily move into the air, which are high risk.
- This lack of regulatory definition, and link with the characteristics of asbestos that are hazardous, results in misunderstanding and misinformation that the hazards relate to the general term asbestos, and how these relate (or not) to the toxicological studies.

Current asbestos guidance

Current guidance on asbestos in NSW is mixed and is the cause of many of the issues identified by the C&D recycling industry. There is a requirement for this industry to have "zero" asbestos in waste received and managed at a facility, and "zero" tolerance on the presence of asbestos in recycled products produced.

While the concept of "zero" asbestos is meaningless, the requirement is also disconnected from other regulations and guidance in NSW:

- The key disconnect relates to the *WHS Regulation 2017*, that relates to the requirements for removing and managing asbestos from buildings and structures prior to demolition (the process that produces the waste received by a C&D facility). The *WHS Regulation 2017* does not require "zero asbestos" post asbestos removal and allows for soil to include trace levels of asbestos, which is defined as <0.01% w/w. In addition, removal of small amounts of ACM (<10 m^2) poses the greatest risk of being present in such wastes.

- NSW utilises the NEPM (NEPC 1999 amended 2013a) for the assessment and management of contaminated soil, where risk-based guidelines for the presence of asbestos that may remain in soil in different land use settings is defined.
- NSW allows for emissions to air of asbestos from stationary sources (NSW EPA 2016a), at levels that may result in significant airborne asbestos exposures within the community, well above background levels and well above WHO air guidelines.

The requirement for "zero" asbestos appears to only apply to the C&D recycling facilities. Such a requirement is not workable where the waste being delivered does not have a requirement to have "zero" asbestos when it leaves the place where such waste was produced. This places the onus and liability (of prosecution) of managing asbestos to a zero-tolerance level on the operators of the C&D facilities alone and not onto the producers of the waste being recycled.

Current NSW EPA Standard (EPA 2019)

These documents relate to visual identification of ACM.

- ACM, where bonded in materials which would be visible is considered to be low risk in terms of health and can be easily removed from soil or waste using an emu-picking approach (noted to be permitted in the 2010 Worksafe guidance, but not in 2019).
- The greatest risk, however, relates to loose asbestos fibres. As discussed in **Sections 2, 3** and **4**, the key risk for workers and the community (including consumers) relates to the inhalation of fibres. The potential for friable asbestos to be present in C&D waste is low, and the release of any fibres from bonded asbestos can be minimised by the effective removal of these materials prior to mechanical damage.

Other Australian States

- South Australia and Queensland are silent on the management of asbestos in C&D waste.
- Victoria and Western Australia provide a definition of an acceptable level of asbestos, as measurable fibres, in waste that is consistent with risk-based guidance in the ASC NEPM. The criteria of 0.001% is also consistent with the detection limits that may be achievable for the analysis. This guidance includes the requirement to analyse for fibres addressed the key risk related to asbestos – the inhalation of fibres that are not visible so cannot be addressed by current control measures. The WA guidance also allows for the removal of visible ACM by emu-picking, which provides a workable approach to dealing with low risk asbestos in these materials.

International approaches

- Most international jurisdictions are clear that the removal of asbestos at a site, prior to demolition is key to managing asbestos in C&D waste. Some jurisdictions adopt the concept of zero asbestos in waste.
- The UK and Canada go further and allow for trace amounts of asbestos to remain. The UK adopts the reporting limit for the detection of fibres (using a specified method). Canada

provides a definition of trace levels that is higher than in the UK. Ontario references the term trivial but does not define trivial.
- Canada also provides a definition of zero asbestos in air, which is essentially the reporting limit of the method (with the analysis method stated).
- The concept of zero asbestos is meaningless, as we are all exposed to background levels of asbestos all of the time, and with anything that requires measurement, a non-detection never means zero.
- Being able to define what is meant by "zero" or allowing consideration of trivial levels of asbestos and defining what is trivial enables these concepts to be better understood by industry and the community.

Trivial

- The concept of defining pollution based on its potential to cause harm and whether or not it is non-trivial is already within NSW legislation and guidance. The concept of non-trivial, however, is not defined particularly in terms of asbestos, where it gets caught up in the definitions of asbestos in the POEO Regulation which effectively mean zero-tolerance.
- The SA EPA also adopts the concept of trivial and has included consideration of background, which is important for asbestos. They reference the health based guidelines on asbestos in the ASC NEPM to assist in understanding what is considered trivial.
- Where background exposures to dust and asbestos are considered, adopting a soil or waste guideline of 0.001% w/w for friable asbestos (which is consistent with NEPC guidance on contaminated land, and also consistent with the criteria for asbestos in C&D waste in Victoria and Western Australia) would result in inhalation exposures that are below background in urban and rural areas, and could be considered to be trivial.
- Given the concept of trivial is already relevant in NSW, it would be appropriate to provide a definition of what is non-trivial in terms of asbestos in C&D recycling industry.

ES.4 Recommendations

To be able to effectively manage asbestos contamination that may be present in C&D materials taken to facilities for the purpose of recycling, there are some fundamental aspects of legislation and policy in NSW that have to be changed, including:

- Changes to the *WHS Regulation* to ensure that waste generated from the demolition of structures with asbestos (friable and non-friable) adopt the same threshold or definition of "zero" asbestos as required to be adopted by the C&D recycling industry. Only where requirements in relation to the presence (or otherwise) of asbestos is the same for the generators of the waste and the C&D recycling industry can future protocols relating to "unexpected finds" be relevant and applicable.
- Rework the definition of asbestos, so that it is better linked with the characteristics of asbestos that pose hazards to human health, and can be matched with measurement methods.
- Providing a definition of zero asbestos in the context of measurement (i.e. reporting limits for methods) and background or non-trivial exposures and risks.

- Allowing for the hand-picking or emu-picking of visible ACM prior to transport to a facility, and at receipt at a facility as this is the material most likely to be present in C&D waste and this material is of low risk. There are numerous examples of procedures that can be used to ensure this is done effectively and safely.

Without the above legislative changes, it will be very difficult to establish a workable protocol or procedure for C&D waste recycling that does not result in significant liabilities remaining with the owners of these facilities in relation to the presence of asbestos.

Section 1. Introduction

1.1 General

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Beatty Legal Pty Limited to undertake an independent review of the technical information around the potential presence and risks posed by asbestos that may be present in construction and demolition (C&D) waste to be recycled.

As noted by enHealth in 2013 (enHealth 2013)

"We are all exposed to low levels of asbestos in the air we breathe every day."

Consequently, it is no surprise that it is possible that asbestos may be found in C&D waste being brought in for recycling. Asbestos may be present in such waste due to:

- mixing in of small amounts of bonded asbestos from demolition with concrete for recycling or
- it being naturally occurring in the soil on which a building is being demolished or constructed (i.e. soil containing asbestos gets mixed into the waste) or
- settling of asbestos fibres generally present in the atmosphere (i.e. source of fibres is off-site).

Since around 2007, the C&D recycling industry has been working with the NSW EPA to develop an appropriate protocol/procedure for understanding the issues arising from the potential for asbestos to be present in construction and demolition waste and how best to manage that during the recycling process. This procedure has not yet been finalised.

In 2019 a court case changed the understanding of the law in NSW around asbestos containing wastes (Environment Protection Authority v Grafil Pty Ltd). The court case determined that 1 fibre of asbestos in a stockpile makes the stockpile asbestos waste.

This change in understanding has the real potential to affect the viability of the C&D recycling industry which would have significant impacts on the amount of waste that requires landfilling. Given the limited landfilling volume available in NSW, this matter requires serious consideration.

To better understand the health and environmental risks of asbestos in C&D recycling, a detailed independent technical review has been undertaken and presented in this report. This review presents the technical background for asbestos (including information about the toxicology and risks posed by different types of asbestos, the analysis of asbestos as well as background levels of asbestos (ambient levels) commonly present in air that the community is exposed to); description of the C&D recycling process, how asbestos might be present and how it asbestos is currently managed; a description of how other jurisdictions manage asbestos containing wastes; and proposing a practical, technically feasible framework for managing asbestos containing wastes into the future.

This document could then be used in discussions with NSW EPA and other relevant stakeholders and the general public (or interested groups).

1.2 Objectives

The objectives of the review presented in this report are:

- Undertake independent review and provide a summary document detailing:
  - what is asbestos (where it comes from; how it is present in our environment; how it moves around the environment)
  - general technical basis for managing asbestos including toxicology, risk assessment, sampling and analysis and ambient levels
  - hazard based versus risk based guidelines
  - management frameworks for other chemicals in wastes in Australian jurisdictions – similarities and differences for asbestos
  - management frameworks for asbestos containing waste in NSW and other jurisdictions including international jurisdictions. This will include information about the basis for these frameworks [i.e. risk based], where available, and the situations where these get applied (e.g. WHS or contaminated land or waste)
  - concept of trivial versus non-trivial when assessing environmental changes
  - general description of C&D recycling process including products produced and where they are used
  - current issues with the existing system for the management of asbestos in this industry
  - definitions in relation to asbestos containing wastes (existing and changes due to court case in 2019) including what is technically feasible to measure (including sampling methods)
  - technical basis of asbestos guidelines used for waste and for other industries (like contaminated land)
- Based on the review undertaken, outline a best practice approach to managing asbestos within C&D recycling processes, noting where these measures may require additional work, or revision or changes to current guidelines, policy or regulation.

1.3 Approach

The approach taken for the assessment of potential risks to human health is in accordance with guidelines / protocols endorsed by Australian regulators, including:

- enHealth, Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a);
- enHealth, Australian Exposure Factor Guide (enHealth 2012b);
- NEPM (1999 amended 2013) National Environmental Protection Measure – Assessment of Site Contamination including:
  - Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013a)
  - Schedule B4 Guideline on Health Risk Assessment Methodology(NEPC 1999 amended 2013c)
  - Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013d)

    - Toolbox Note – Key principles for the remediation and management of contaminated sites
- Relevant Standard Methods including:
    - Australian Standard 2004, Method for the qualitative identification of asbestos in bulk samples, Method No. 4964 (Standards Australia 2004);
    - NOHSC 2005, Guidance note on the membrane filter method for estimating airborne asbestos fibres, 2nd Edition, National Occupational Health and Safety Commission (NOHSC 2005)
- Environmental Health Standing Committee (enHealth), Asbestos: A guide for householders and the general public, Australian Health Protection Principal Committee, Canberra, 2013 (enHealth 2013);
- Environmental Health Standing Committee (enHealth), Management of asbestos in the non-occupational environment, Australian Health Protection Principal Committee, Canberra, 2005 (enHealth 2005);
- NSW Approved Methods for Modelling and Assessment of Air Pollutants in NSW (NSW EPA 2016a);
- National Waste Policy (2018);
- NSW Waste Avoidance and Resource Recovery Strategy (2014-2021); and
- SafeWork Australia and SafeWork NSW guidance on asbestos in the workplace and asbestos in and on soil.

Other guidelines adopted in the preparation of this report are referenced throughout this report.

Section 2. Hazards: Asbestos

2.1 General

This section provides a summary of the properties and hazard of asbestos.

Hazard identification examines the capacity of an agent to cause adverse health effects in humans and other animals. It is a qualitative description based on the type and quality of data, complementary information (such as structure-activity analysis, genetic toxicity and pharmacokinetics) and the weight of evidence from these various sources (enHealth 2012a). The hazard assessment can also consider the available data and determine a dose-response relationship that can be used to define quantitative guidelines or toxicity reference values for use in a risk assessment. The dose-response relationship is key to being able to quantify hazards and therefore risks.

The presence of a hazard does not, by itself, automatically result in adverse health effects. It is the dose or level of exposure that is important to making decisions about the potential for health effects (i.e. the risks).

Risk assessment incorporates the understanding of hazard with information related to exposure to determine if the dose or exposure is sufficiently elevated to result (or potentially result) in adverse health effects.

2.2 What is asbestos

Asbestos is the generic name given to the fibrous variety of six naturally occurring minerals. These minerals have been used in a wide range of commercial products. The minerals are hydrated silicates including a serpentine mineral (*chrysotile*) (also known as 'white asbestos'), and five amphibole minerals (*actinolite, amosite* (also known as 'brown asbestos'), *anthophyllite, crocidolite* (also known as 'blue asbestos'), and *tremolite*) (enHealth 2005, 2013; IARC 1973; USGS 2001).

The structure of these silicate minerals depends on the conditions under which they were formed. They may be long, thin fibres or they may take a range of other shapes. It is when they are in the form of the long, thin fibres that they are of most concern. The terms 'asbestos' or 'asbestiform minerals' refer only to those silicate minerals that occur in these long, thin fibres and as polyfilamentous bundles. The bundles are composed of extremely flexible fibres with a relatively small diameter and a large length. These fibre bundles have splaying ends, and the fibres are easily separated from one another (HSE 2005; USGS 2001).

Most asbestos used for commercial purposes was the serpentine mineral – chrysotile. Chrysotile is the only one of the three principal serpentine silicate minerals that can present in a fibrous form. Of the amphibole silicate minerals, amosite and crocidolite occur only in the asbestiform habit, while tremolite, actinolite and anthophyllite occur in both asbestiform and non-asbestiform habits (i.e. as fibres and as other shapes which do not require the same sort of evaluation) (enHealth 2005, 2013; HSE 2005; NTP 2005; USGS 2001).

Asbestos fibres are strong (e.g. high tensile strength, wear and friction characteristics), flexible (e.g. the ability to be woven), heat resistant (e.g. heat stability; thermal, electrical and acoustic insulation) and they have insulating properties and they are resistant to chemical, thermal and biological degradation (enHealth 2005, 2013; HSE 2005; NTP 2005; USGS 2001).

The fibres are light and their shape means they do not settle out onto surfaces very quickly unlike larger particles or particles of different shapes so they remain airborne for some time (enHealth 2013).

2.3 Sources of asbestos

Asbestos is widely distributed in the Earth's crust, and chrysotile, which accounts for more than 95% of global mining and use, occurs in virtually all serpentine minerals. Asbestos deposits have served as commercial sources in more than 40 countries, but the largest natural deposits are located in Canada, South Africa, China, and Russia. Amosite and crocidolite have been mined from South Africa, while crocidolite was once mined in Western Australia.

Asbestos fibres are basically chemically inert. They do not evaporate, dissolve, burn, or biodegrade, making them environmentally stable and cumulative. Asbestos fibres can be released into the air as a result of mechanical and natural disruption of asbestos containing materials (ACM) during use and disposal. Because of the widespread use of asbestos and their natural occurrence, the fibres are ubiquitous in the environment. Asbestos-containing materials that do not result in respirable fibres pose virtually no risk to health similar to other inert materials.

Asbestos fibres are present in normal urban air. Such fibres are present due to historic uses including in brake pads in cars. They are also present because this is a naturally occurring material, where fibres can be disturbed from rocks containing the mineral deposits (enHealth 2013).

Man-made asbestos containing products (ACM) can be divided into two types – bonded and friable asbestos. In good condition, bonded asbestos products such as asbestos cement sheet do not pose a risk because the asbestos fibres are bound together in solid cement. Friable asbestos products produce airborne fibres and so do pose a risk. It should be noted that bonded asbestos products can be damaged to become friable (enHealth 2013).

2.4 Health effects associated with asbestos exposure

2.4.1 General

Although the link between occupational exposure to asbestos and lung diseases such as mesothelioma was suspected over a century ago, it wasn't until the 1960's that the link was well established. Most evidence of the adverse health effects of asbestos (IARC 2012) comes from epidemiological studies of groups with known occupational exposures to asbestos such as those employed in the asbestos mining, processing or production industries or in the building trade. However, it is also clear that environmental (e.g. living near an asbestos mine) or para-occupational exposures (e.g. household contact with exposed workers) can result in asbestos related diseases.

Additionally, the background level of asbestos related disease may be related to the ubiquity of this naturally occurring mineral fibre. The annual mesothelioma rate in adults with no history of asbestos exposure is about 1.5 per million people (McDonald, J. & McDonald 1977; Peto 1984). This is considered low. The etiology (i.e. the cause) of these cases is unknown. Low-level environmental exposure to asbestos and asbestiform minerals has been postulated as a factor in these cases

(Omenn GS 1986). Berry et al (Berry, GR, AJ. Pooley, FD. 1989) reported that the lung burden of amosite and crocidolite fibres in 37 'unexposed' mesothelioma cases ranged up to 8.1 million fibres per gram of dry lung tissue (median 0.31). In summary, asbestos fibres are widespread in the environment, but the incidence of asbestos-related disease is extremely low, except in cases of high occupational or para-occupational exposure. This means everyone breathes in asbestos fibres during their lifetime. The small burden of fibres resulting from this background exposure appears to be tolerated.

Extensive epidemiological research on asbestos shows clear associations between asbestos exposure and asbestosis, lung cancer, and mesothelioma. The epidemiological evidence for other types of cancer is less extensive than it is for lung cancer and mesothelioma, but is still considerable for some. Epidemiological evidence shows a high incidence of lung cancer among workers exposed to chrysotile, amosite, anthophyllite, and with mixed fibres containing crocidolite, and tremolite. Pleural and peritoneal mesotheliomas were reported to be associated with occupational exposures to crocidolite, amosite, and chrysotile. Gastrointestinal tract cancers were reported to have been demonstrated in groups occupationally exposed to amosite, chrysotile or mixed fibres containing chrysotile. An excess of cancer of the larynx in occupationally exposed individuals has also been noted. In summary, all types of commercially available asbestos are well known to cause fibrosis of the lung and pleura as well as cancer of the lung, mesothelium and possibly the gastrointestinal tract in humans (IARC 2012).

Asbestos-related health effects result primarily from chronic exposures to asbestos, but relatively brief, high-level and low-level neighbourhood exposures in the vicinity of a crocidolite mine or mill, can also cause these diseases. The increased risk of mesothelioma is dose-dependent (enHealth 2005). Short-term exposures to low concentrations of airborne asbestos are likely to be associated with very low health risks (i.e. unlikely to result in disease) (enHealth 2005).

The four main asbestos-related conditions are pleural plaques, asbestosis, lung cancer and mesothelioma (HACA 2016):

- Pleural plaques are areas of white, smooth, raised scar tissue on the outer lining of the lung, internal chest wall and diaphragm. Pleural plaques are uncommon, and their occurrence is usually associated with exposure to asbestos. Most people with pleural plaques have no symptoms. Refer to **Section 2.4.2** for further discussion.
- Asbestosis is a chronic lung disease caused by inflammation or scarring in the lungs. It is associated with asbestos exposure and causes breathlessness, coughing, and permanent lung damage. Refer to **Section 2.4.2** for further discussion.
- Lung cancer is a tumour that develops in the lungs. People who are exposed to asbestos and smoke or have pre-existing lung disease have a higher chance of developing lung cancer. Refer to **Section 2.4.3** for further discussion.
- Mesothelioma is a cancer of the tissue that lines the body cavities, particularly the chest and abdominal cavities. It is almost exclusively caused by exposure to asbestos and usually takes a very long time to develop. Refer to **Section 2.4.4** for further discussion.

Asbestos-related diseases can take a long time to develop. Asbestosis can take 10 to 20 years to develop after initial exposure, whereas mesothelioma may take 30 to 45 years to develop (HACA 2016).

2.4.2 Asbestosis and pleural disease

Asbestosis and asbestos pleural disease are non-malignant asbestos diseases (i.e. not cancer) that are slowly progressive.

Asbestosis is a chronic inflammatory and fibrotic medical condition affecting the parenchymal tissue of the lungs caused by the inhalation and retention of asbestos fibres. Sufferers may experience severe dyspnoea (shortness of breath) and are at an increased risk for certain malignancies, including lung cancer but especially mesothelioma. The characteristic pulmonary function finding in asbestosis is a reduction in lung volumes, particularly the vital capacity (VC) and total lung capacity (TLC). In the more severe cases, the drastic reduction in lung function due to the stiffening of the lungs and reduced TLC may induce right-sided heart failure.

The onset of visible fibrosis rarely occurs earlier than 15–20 years from first exposure to high concentrations of respirable fibres. Not all individuals exposed to high levels of asbestos fibre develop asbestosis. There may be a threshold for asbestosis development of between 25 to 100 fibres-years/mL, effectively a high exposure. This compares to the current occupational time weighted average (TWA) exposure for asbestos fibres of 0.1 fibres/mL (which would require 10 years exposure at 0.1 fibres/mL to equate to 1 fibre-year/mL) (enHealth 2005).

In a review of the epidemiologic evidence for an asbestosis exposure response relationship, the World Health Organization Task Group on Environmental Criteria for Chrysotile Asbestos (WHO 1998) concluded that “the risk at lower exposure levels is not known.” There is evidence of an increased incidence of asbestosis in smokers which may be due to a number of issues such as smoking effects on lung function and defence mechanisms, however, no specific ‘dose’ of tobacco that caused this enhanced incidence could be determined (ATSDR 2001). Lung fibre retention is expected to play a role in the development of asbestosis with trapped asbestos fibres having a prolonged lung residence time. Therefore, the progression of asbestosis may continue for many years after exposure (ATSDR 2001).

Asbestos pleural disease is a non-malignant disease caused by inhalation of asbestos fibres that scar the pleura. The pleura is the thin membrane lining the lung and chest cavity. If the scarring is diffuse and extends along the chest wall, it is called pleural thickening. If the scarring is more focused and well defined, it is called pleural plaques. Asbestos pleural disease results in a similar scarring process as the one that occurs inside the lung with asbestosis; however, it occurs in the lining of the lungs rather than in the lungs themselves (ATSDR 2001). In regards to pleural plaques, enHealth (2005) provides the following:

> *The relationship between dose and response for pleural plaques is much weaker than for asbestosis. A good correlation has been shown between pleural plaques and asbestos fibres in the lungs; however, there is large variation.*

As these diseases generally occur only after heavy industrial exposure they are of limited relevance to this review and have not been specifically discussed further.

2.4.3 Lung cancer

National and international health agencies have classified asbestos as a known human carcinogen. This includes classifications available from IARC (IARC 2012) and the USEPA (USEPA 2020).

Asbestos, by itself or acting synergistically with tobacco smoke, causes lung cancer. Lung cancer can occur many years after initial exposure (10–40 years). Lung cancer has been identified in people exposed to respirable asbestos in occupational environments and has been associated with exposure to both amphibole and chrysotile asbestos (ATSDR 2001). The causal association between asbestos exposure and lung cancer is generally well recognised, but there are still substantial controversies on how the risk might vary by exposure to different fibre types and sizes, and whether there is a risk at low levels of exposure (i.e. environmental/community exposures).

There is some evidence that chrysotile asbestos may be less potent for the induction of lung cancer than the amphibole forms of asbestos (e.g. crocidolite, amosite and tremolite). This “amphibole hypothesis” (Cullen 1996; McDonald, JC. 1998; Stayner, Dankovic & Lemen 1996) is based on the observation from experimental studies that chrysotile asbestos is less biopersistent (i.e. has a shorter half-life) in the lung than the amphiboles. IARC (IARC 2012) noted that the lower biopersistence of chrysotile in the lung does not necessarily imply that it would be less potent than amphiboles for lung cancer.

2.4.4 Mesothelioma

Mesothelioma is a cancer of the lining of the chest cavity (the pleura) or, less commonly, the lining of the abdominal cavity (the peritoneum).

It is generally, but not always, associated with continued occupational or other high exposure to respirable asbestos. Fairly consistent and strong epidemiological evidence indicates that approximately 70% to 90% of mesothelioma cases can be related to asbestos exposure (Youakim 2005), and hence it is commonly accepted that asbestos exposure is the cause.

The ability to link asbestos exposure to the development of mesothelioma is subject to sufficient time elapsing since the exposure occurred, to permit the disease to have initiated and developed. Mesothelioma generally does not occur until 20–50 years after exposure. Mesothelioma has been associated with all types of asbestos. However, the evidence for causality is strongest for amphiboles. Unlike lung cancer, mesothelioma occurrence does not appear to be affected by smoking history.

Mesothelioma can occur with low asbestos exposure; however, very low background environmental/community exposures carry only an extremely low risk. The dose necessary for effect appears to be lower for asbestos-induced mesothelioma than for pulmonary asbestosis or lung cancer (ATSDR 2001).

The incidence rates of malignant mesothelioma have been increasing in Australia since 1965 and it is clear that these rates of mesothelioma are related to the use and production of asbestos in Australia in previous decades. There is no indication of when the incidence rates of mesothelioma will start to decline although a recent update of Wittenoom workers stated that by the end of 2008, the number of mesothelioma deaths related to direct exposure at Wittenoom had reached 4.7% for all the male workers and 3.1% for the females and predicted that about another 60 to 70 deaths with mesothelioma may occur in men by 2020 (Berry, G et al. 2012).

The link between asbestos exposure and the incidence of lung cancer and mesothelioma has been assessed in more than 20 epidemiological studies of occupational exposure in traditional asbestos industries. There is much less evidence of a link between non-occupational or para-occupational exposures and asbestos related disease. In the first published study to show exposure-response relationships between incidence of mesothelioma and environmental/community exposure to any form of asbestos, the incidence rate of mesothelioma for Wittenoom residents with household contact with crocidolite miners or neighbourhood exposure to crocidolite tailings has been estimated to be 260 per million person-years (Hansen et al. 1998). The incidence of mesothelioma increased significantly with increasing time following first residence at Wittenoom and with increased level of exposure to crocidolite. The incidence of mesothelioma increased from about 210 per million person-years (pmpy) at 20–29 years since first exposure, to over 1,600 pmpy at 40 or more years from first exposure. This rate is substantially higher than the 1998 Western Australian rate of 50 pmpy for men and 8 pmpy for women. The corresponding figures for the Wittenoom workers' cohort were approximately 900 and 7,000 pmpy. (Hansen et al. 1998).

The background incidence rate of mesothelioma in people without occupational, domestic or neighbourhood exposure to asbestos and with normal lung fibre content is about one or two annual deaths per million of population, which translates broadly to a lifetime risk of 8 to 16 per 100,000 for either sex although recent data indicates this could be as high as 25 per 100,000. Whether this background level is in fact caused by naturally occurring asbestos, or asbestos-like materials in the natural environment, by other causes or by a mixture of causes, is not known (WATCH 2002-2012).

2.5 Asbestos mode/mechanism of action

2.5.1 General

The quantitative assessment of potential risks to human health for any chemical requires the consideration of the health end-points and, where carcinogenicity is identified; the mechanism of action needs to be understood. The IARC (IARC 2012) review concluded that "*The mechanistic basis for asbestos carcinogenicity is a complex interaction between crystalline mineral fibres and target cells in vivo. The most important physicochemical properties of asbestos fibres related to pathogenicity are surface chemistry and reactivity, surface area, fibre dimensions, and biopersistence*."

In addition to the degree of exposure (magnitude or intensity, frequency and duration), the physical properties of the fibres, including fibre type, size and shape are important determinants of asbestos related diseases. The physical and chemical properties, persistence in the lungs and capacity to translocate across membranes are factors that underpin the intrinsic toxicity of the various asbestos types.

2.5.2 Fibre dimensions

Fibre dimension determines the likelihood that a fibre will enter the body insofar as the size and shape influence the respirability and clearance of the fibres as well as the potential for translocation across cells and biological membranes. In terms of shape, fibres >8 μm long and <0.25 μm diameter, with an aspect ratio (length/width) ≥10 appear to be most dangerous. In terms of length, fibres >20 μm and <100 μm long tend to be more carcinogenic. Fibres >100 μm long are not respirable (cannot reach the lungs) and hence do not pose a risk, unless they are first broken down into shorter fibres.

Asbestosis has been associated with fibres longer than 2 μm, mesothelioma with fibres longer than 5 μm, and lung cancer with fibres longer than 10 μm (Lippmann 1988, 1990). Fibres <5 μm are considered to be much less potent than longer fibres, however, in typical occupational environments, fibres shorter than 5 μm outnumber the longer fibres by a factor of 10 or more (Dement & Wallingford 1990). As noted, studies report that longer thinner fibres are more carcinogenic but do not identify a precise fibre length that did not have biological activity (Berman & Krump 2008; Stanton & Wrench 1972). Studies looking at human tissues have also found that the majority of asbestos fibres in mesothelial tissues were shorter than 5 μm in length, thus indicating the ability of the shorter fibres to reach the tumour site, remain there, and have an unspecified role in the etiology of disease (Dodson, Ronald F et al. 2001; Suzuki & Yuen 2002). There is clear evidence that short fibres predominate in the lung, thoracic lymph nodes and mesothelial tissue following asbestos exposure (Dodson, Ronald F. et al. 2003). Furthermore, short fibres appear to more readily migrate to the pleura and are present in substantial amounts in pleural plaques, pleural fibrotic tissue and mesotheliomas.

2.5.3 Fibre respirability

Fibre diameter is an important determinant of carcinogenic potency, as it influences fibres' aerodynamic diameter, a contributing factor for pulmonary deposition. Specifically, the diameter of fibres impacts their deposition rate and clearance rate from the lungs and the body overall, and thus the amount of time they have to interact with biological systems.

The following general conclusions can be made about particle respirability (USEPA 2003):

- Fibres that are deposited in the lung are usually thinner than approximately 0.7 μm and are almost always thinner than 1 μm.
- Long, thin fibres are deposited in the lung with greater efficiency.
- Because of physical/chemical differences, short, thick chrysotile structures will be deposited more efficiently in the lung than corresponding (i.e., short, thick) amphibole structures and longer, thinner amphibole structures are typically deposited more efficiently than corresponding chrysotile structures.
- Curly chrysotile structures are less likely to reach the lung than are straight amphibole (or chrysotile) structures.

2.5.4 Fibre clearance

Once inhaled, asbestos fibres can be removed from their site of deposition (WHO 2000) by:

- Mucociliary clearance
- Translocation within alveolar macrophages
- Uptake by epithelial cells.

These mechanisms usually remove 95-98% of deposited fibres, as most of the fibres have lengths less than <5 μm. Fibres less than 15 μm are often engulfed by macrophages. Longer fibres may be more pathogenic because they are harder to clear from the lungs. Most reports have shown that fibre accumulation is proportional to measured exposure for amphiboles, but this is not generally true for chrysotile. For amosite and crocidolite, estimated clearance half-times are measured in years to decades, whereas for chrysotile, the available, rather indirect, data suggest that the vast majority of fibres are cleared within months, although some fibres may be sequestered and only cleared very slowly. Although both chrysotile and amphibole asbestos are generally insoluble, within the lungs, chrysotile fibres can subdivide into constituent fibrils that will partially dissolve and those that don't dissolve at all. Overall, these studies suggest that the differences between amphibole and chrysotile fibre burdens in man reflect much faster clearance of chrysotile fibres, rather than a failure of chrysotile deposition.

Clearance rates partially determine biopersistence, that is, the degree to which fibres remain or persist in the body. Biopersistence is influenced by fibre size which in turn dictates respirability, deposition, as well as clearance from the lung. Chrysotile has been shown to be rapidly removed from the lung following inhalation exposure in experimental animals (Bernstein, Chevalier & Smith 2005), while lung analyses from humans (Albin et al. 1994) who were primarily exposed to chrysotile fibres show low levels of chrysotile compared to amphibole fibres even when amphibole exposure represented a trace impurity of overall exposure (Rowlands, Gibbs & McDonald 1982).

In summary, there is clear support for the view that the epidemiological literature and mechanistic animal studies show a strong correlation between fibre length and carcinogenic potency for asbestos (ATSDR 2001). Risk assessments should thus give greater importance to fibres greater than 10 μm in length while accepting that shorter fibres may also play a role in asbestos cancer etiology.

2.5.5 Fibre type

There is some uncertainty around the types or severity of illness attributable to the different mineralogical types of commonly encountered asbestos. The asbestos industry has supported research and published various studies claiming that chrysotile is much less toxic than the amphibole forms such as crocidolite and amosite.

For example, arguments have been presented that:

- mesothelioma incidence associated with chrysotile exposure is actually attributable to relatively low concentrations of other asbestos fibre types
- chrysotile is less potent than other asbestos fibres in the induction of asbestosis and lung cancer based upon observed differences in fibre persistence, morphology, composition and lung fibre burdens
- there is a threshold for chrysotile fibre exposure below which pathological effects will not occur or will be undetectable in epidemiological studies.

However, strong experimental support for reduced chrysotile toxicity on a mechanistic basis remains lacking. WHO (WHO 2014) states that: *'The scientific evidence is clear. The firm conclusion of the WHO and IARC assessments is that chrysotile causes cancer of the lung, larynx and ovary, mesothelioma and asbestosis, whether or not it is less potent than amphibole types of asbestos in doing so. Assertions about differing physicochemical properties, the question of whether or not historical epidemiological studies may have been dealing with chrysotile contaminated with* *amphibole types of asbestos, and the physical containment of chrysotile in modern high-density cement (at the time of manufacture) do not alter this finding.'*

The WA Rationale states that *'While it is reasonable to anticipate differences in toxicity according to the mineralogy and dimensions of asbestos fibres, current scientific knowledge is not yet able to provide meaningful distinction. In addition, it is evident that the influence of confounding environmental exposure factors on asbestos toxicity may be significant, particularly in non-occupational settings. From a regulatory perspective, the assumption that the potential health impacts posed by different asbestos fibre types and dimensions are equivalent is therefore considered both conservative and reasonable.'*

Based on the existing data, most regulators adopt different risk levels for the different types of asbestos based on some large meta-analyses (Berman & Krump 2008; Hodgson, J & Darnton 2000). Some of these risk levels have recently been re-appraised. (Hodgson, JT & Darnton 2010) updated their meta-analysis of the potency of chrysotile asbestos fibres to cause mesothelioma and revised their potency estimate upward (i.e. higher risk).

2.5.6 Human susceptibility to asbestos-related disease

Studies have also demonstrated that not all people are similarly affected by exposure to the same levels of asbestos as is the case for many diseases. Multiple diseases are associated with asbestos exposure and other environmental or genetic factors may interact e.g. there is a synergistic effect between cigarette smoking and lung cancer.

Several populations that may be unusually susceptible to asbestos exposure have been identified (ATSDR 2001). The long-term retention of asbestos fibres in the lung and the long latency period for the onset of asbestos related disease suggests that those exposed earlier in life (as children) may be at greater risk. Early developmental differences may also lead to increased childhood susceptibility. An association has been noted between certain genotypes and increased risks of mesothelioma, cancers and non-malignant respiratory disease (Neri et al. 2008). In Cappadocia, Turkey, certain families in specific villages show an autosomal dominant susceptibility to developing mesothelioma after exposure to erionite, a naturally occurring mineral that shares the same structure as asbestos (Ascoli et al. 1998; Huncharek, Klassen & Christlani 1995).

Animal studies suggest that those who are immunologically deficient may experience increased severity of pulmonary lesions in response to asbestos exposure. Further studies indicate that genetic differences in immunological capabilities may be a predisposing factor for asbestos related disease. Some human studies have suggested that individuals infected with Simian Virus 40 may be at increased risk of developing mesothelioma.

2.5.7 Mode of action

Fibres that persist within the lung or the mesothelium are capable of producing fibrogenic and tumorigenic effects in these tissues. Although the precise mechanisms by which asbestos fibres cause toxic injury have not been determined, there are several proposed modes of action including both direct interaction between fibres and cellular components and induced cell-mediated pathways (ATSDR 2001).

- *Direct action*: Asbestos fibres can adsorb to a variety of cellular macromolecules (e.g., proteins, membrane lipids, RNA, DNA), an interaction mediated by surface charge. Fibres can also bind to fibronectin, a glycoprotein found in abundance in the alveolar lining fluid. Fibre binding can alter protein shape, stiffen membranes and interfere with chromosome segregation.
- *Active oxygen mechanism:* In response to asbestos fibres, alveolar macrophages produce reactive oxygen species in an attempt to digest the fibre. The reactive oxygen species include hydrogen peroxide and superoxide radical anion which can interact to produce potent hydroxyl radicals. Cell membrane lipids have been shown to undergo peroxidation, resulting in increased membrane permeability in rat lung fibroblasts cultured with asbestos. Overall, cytotoxic and oxidative responses indicative of oxidative stress in a variety of lung tissues have been observed following asbestos exposure.
- *Other Cell-Mediated Mechanisms*: In addition to the release of active oxygen species, alveolar macrophages and other cells, including pleural mesothelial and lung cells, release a number of cellular factors in response to asbestos exposure. These factors are mediators of a number of cellular reactions including inflammation, macrophage recruitment and cell proliferation.

2.6 Quantification of hazard

Asbestos is considered to act with a non-threshold dose response relationship (WHO 2000, 2014). This means that there is no safe dose for asbestos exposure, however, the risk of asbestos-related disease increases with increasing dose or exposure.

The WHO (2000) provides unit risk values relevant to the assessment of asbestos exposure, and mesothelioma, based on data from a number of studies. The WHO best estimate (which notes a number of uncertainties) is a risk of $2x10^{-5}$ for exposure to 100 f/m^3. This assessment has been used in the derivation of the NEPM guidelines for asbestos in soil (NEPC 1999 amended 2013a; WA DOH 2009)

The WHO (WHO 2000) further indicates that, with a lifetime exposure to 1000 f/m^3 (0.0005 f/ml or 500 f/m^3, optically measured) in a population of whom 30% are smokers, the excess risk due to lung cancer would be in the order of 10^{-6}–10^{-5}. For the same lifetime exposure, the mesothelioma risk for the general population would be in the range 10^{-5}–10^{-4}.

The USEPA currently adopts an inhalation unit risk of 0.23 (f/mL)$^{-1}$ and the most recent review (USEPA 2020) has proposed an inhalation unit risk of 0.16 (f/mL)$^{-1}$ for chrysotile asbestos exposures.

2.7 Asbestos fibre measurement

The inhalation of micron-scale asbestos fibres is the major exposure pathway for this material. Consequently, the determination of risk and occupational exposure limits is based, in large part, on the accurate determination of fibre concentrations in the air. However, all measurement procedures are complicated by the considerable variation in physical structure and chemical composition that are found with the different forms of asbestos.

Regulatory definitions specify mineral species identification based on chemistry and crystal structure, but can also specify physical parameters, such as length and width, which apply to and define particles that meet specific counting rules. This is frequently done by identifying approved analytical methods, such as ISO 10312 (ISO 2019) or NIOSH 7400 (NIOSH 2019), that clearly define for the analyst which particles should and should not be counted.

Historically, the most commonly used definitions (e.g., those used by the Occupational Safety and Health Administration [OSHA], National Institute for Occupational Safety and Health [NIOSH], and World Health Organization [WHO]) for a regulated form of “asbestos” are limited to those structures longer than 5 μm and with a defined length-to-width (aspect) ratio of 3:1 or sometimes 5:1; rarer definitions (e.g., AHERA as used by the U.S. Environmental Protection Agency [EPA]) include different length parameters.

Most regulations are based on numbers of countable particles per unit volume of air. Generally, the regulatory definitions have evolved historically for practical reasons related to the analytical sensitivities of the instruments used in regulatory measurements. As such, they may include categories that do not produce health effects or, conversely, may exclude some that do (Case et al 2011).

Three main forms of microscopy have been used for measuring asbestos: ordinary light microscopy (OLM); phase contrast microscopy (PCM); and transmission electron microscopy (TEM).

Ordinary light microscopy **(OLM)** is the most limited method as there can be no distinction made between mineralogies or morphologies. OLM is generally limited to detecting particles that are much larger than those detected using phase contrast and electron microscopy, which makes it the least useful of the readily available methods.

In the 1980s, the USEPA developed an approach for assessing asbestos risks (USEPA 1986) which assumes no differences between the potencies of different asbestos types (amphibole and chrysotile). At the time, the most likely analytical method used for asbestos analysis was Phase contrast microscopy (PCM).

Phase contrast microscopy **(PCM)** using the membrane filter method has been used for many years as the standard procedure for the determination of asbestos fibres in air in Australia. The Australian National Occupational Health and Safety Commission (NOHSC) has published a Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres (2nd. Ed.) (NOHSC 2005).

“Countable fibres” are defined as any fibrous objects having a maximum width less than 3 μm, a length greater than 5 μm and a length/width ratio greater than 3:1. These guidelines do not place a requirement on the quantification of fibres below 5 μm in length in occupational settings even though the available evidence indicates that such fibres represent the majority of fibres released from asbestos building materials (Spurny 1989; Teichert 1986b).

The detection limit of this method is 0.01 f/mL level. Laboratories are present in Australia that are NATA accredited for analysis using PCM.

This methodology has been adapted from occupational hygiene practice in the asbestos industries in the 1970's and 1980's and has been adapted for use on sites involving asbestos removal from the 1980's. The PCM methodology is somewhat limited in all but high public risk situations because almost all data are recorded as below detection limit (e.g. <0.01 f/mL or <10,000 fibres per cubic metre of air). The method does not provide an air quality dataset that may be able to be used on a daily basis to understand emerging changes in risk during site remediation and identify any warning signs that elevated levels could occur.

Unlike OLM, PCM is able to measure smaller asbestos structures and also determine their shape. However, PCM can only measure particles greater than 0.25 μm in diameter and 0.5 μm in length. This can result in underestimation of narrow asbestos particles, which may be important for accurately quantifying asbestos cancer risk (Berman, D & Crump, K 2008; Berman, DW & Crump, KS 2008). It has been shown in previous studies that PCM significantly underestimates asbestos fibre concentration in air when compared to TEM, primarily because of poor resolution (Perry 2004). Other limitations of PCM include the inability to distinguish between particle mineralogy and, in some instances, the inability to distinguish between asbestiform and non-asbestiform particles. Depending on the sample matrix, this inability to clearly identify only asbestos fibres could potentially result in overestimation of the concentration of asbestos present on a filter. The possibility of either underestimation from poor resolution, or overestimation from misidentification of non-asbestiform particles, causes PCM to be an inaccurate method for estimation of asbestos concentrations.

Transmission electron microscopy **(TEM) or scanning electron microscopy (SEM)** – Analytical Method 7402 –Asbestos measured by TEM (Baron & Platek 1990) quantifies the asbestos fibre fraction of all fibres in air samples when there is any uncertainty as to the composition of the samples. Unlike other analytical techniques used for asbestos analysis, TEM/SEM is able to distinguish different fibre mineralogies. TEM is able to reveal fibres that are less than 0.01 μm in diameter and SEM is able to reveal fibres down to 0.05 μm in diameter. As a consequence, different fibre size classes of both amphibole and chrysotile asbestos can be differentiated. TEM is slower and more expensive and may be able to achieve lower detection limits than PCM. It is noted, however, that the detection limit is affected by the small portion of the sample that can be observed under high magnification.

In general, there is a lack of standardised methods for TEM/SEM and an absence of proficiency testing. Few laboratories have been identified in Australia that can conduct TEM/SEM analysis. Review of the NATA website indicates that only one laboratory in Australia is NATA accredited for asbestos and inorganic fibre identification using SEM.

Overall

PCM is the predominant method used in all workplace determinations principally because of its relative ease of use and cost advantage. There are limitations with each of these procedures. For example, PCM may underestimate the concentration of relevant fibres as this visual procedure cannot accurately determine fibres below 0.2 μm in diameter. Importantly, all of the asbestos types can produce fibres below this size which cannot be easily determined by optical resolution (Brown 2000). In addition, PCM procedures routinely count only fibres longer than 5 μm in length. The conventional PCM method is adequate for monitoring the breathing zone of workers (wearing respiratory protection) so that the level of protection to workers near asbestos sources are quantitatively monitored. Static asbestos-in-air monitoring at the boundary of sites undergoing remediation etc. using the conventional membrane filter method will typically produce ‘below limit of detection’ data.

PCM techniques are not able in some situations to accurately distinguish morphologically non-asbestos fibres from asbestos fibres. Fibres below 5 μm in length may still be very relevant to asbestos mediated health effects in humans (Suzuki, Yuen & Ashley 2005; Tossavainen, Karjalainen & Karhunen 1994) and are best evaluated using electron microscopy methods. However, the more sensitive analytical methods utilizing electron microscopy are time and labour intensive and suffer from standardisation problems between laboratories (Wagner 2002).

Currently, environmental laboratories offering asbestos in soil analysis can provide a variety of methods, some of which are accredited and some are not:

- Gross visual screen, often performed as soils are mixed and weighed out for other analyses – this will only detect ACM – no quantification
- Detailed screen using a x10 – x40 standard optical microscope – this will detect ACM and most free fibres – no quantification
- Identification of asbestos type by Phase Contrast Optical Microscopy (PCOM) or Polarised Light Microscopy (PLM) – no quantification
- Quantification by gravimetric measurement – visible pieces or large bundles are picked out manually and weighed – this will only detect ACM to 0.1%
- Quantification by sedimentation and fibre measurement using PCOM or PLM (fibres) – this will detect fibres to 0.001%
- Quantification and identification by Transmission Electron Microscopy – this is a high resolution method which will detect fibres to 0.0001%, but the equipment is extremely expensive and only available in a very small number of laboratories

Comments on hazards and measurement

It is clear that there are a range of hazards posed by the potential presence of asbestos in any environment. The key hazards relate to asbestos fibres that are of biological concern, i.e. those equal to or longer than 5 μm and having diameters up to 3 μm with an aspect ratio equal to or greater than 3:1, that can move into the air and be inhaled.

Asbestos is naturally occurring in many areas and is also present as a result of historical uses of asbestos materials, hence asbestos is expected to always be present in the environment.

When assessing asbestos, there are a range of different methods that can be used to quantify asbestos fibres, some of which enable characterisation of the fibres with characteristics that have the potential to pose hazards to human health when inhaled. The selection of the quantification method is important as each will report different aspects in relation to asbestos exposure and risk. Hence guidelines are often tied to specific analytical methods.

Section 3. Asbestos exposure and risk

3.1 General

Breathing in asbestos fibres is the main pathway linked to risk of developing an asbestos related disease. This risk is increased with the number of fibres breathed in (i.e. the dose) and the length of time of exposure. This is illustrated in **Figure 3.1**, that illustrates the risk factors relevant to asbestos (enHealth 2013). Touching the fibres or eating them has not been linked to disease.

Every Australian is exposed to very low levels of asbestos in the air we breathe every day. There are usually between 10 and 200 asbestos fibres in every 1000 litres of air. This means we breathe in up to 3000 asbestos fibres a day (also refer to **Section 3.4** for additional discussion in background exposures). Despite this very few people experience ill effects from such exposure (HACA 2016).

Most people who have developed asbestos related diseases in Australia have had exposure to much higher levels of asbestos fibres through working directly with asbestos or asbestos products. Family members of these workers have also been known to develop asbestos-related diseases because the workers carried asbestos fibres home on their clothing, skin and hair (HACA 2016).

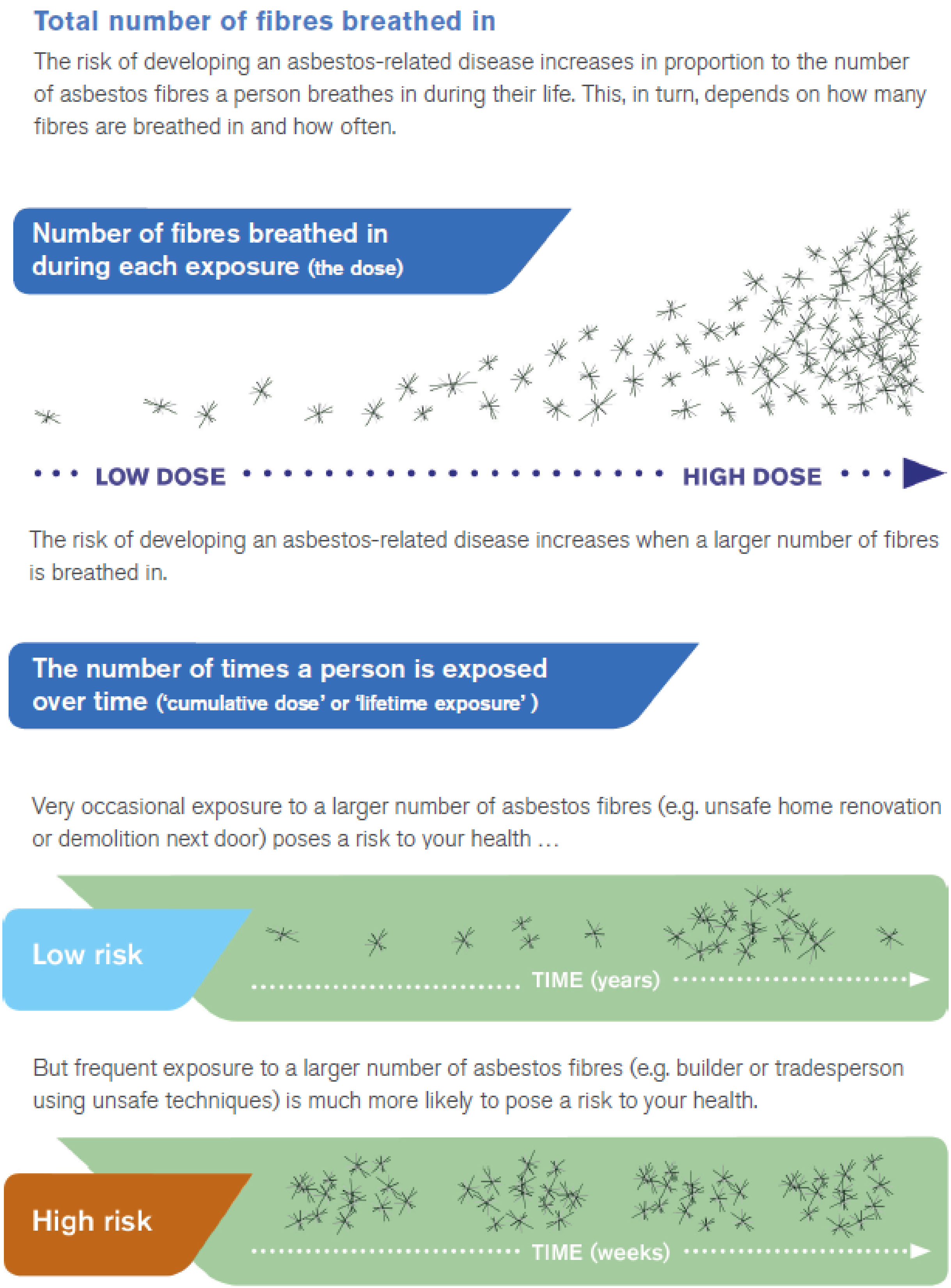


Figure 3.1: Risk factors in developing asbestos-related disease (enHealth 2013)

3.2 Risks posed by asbestos

The hazards associated with exposure to asbestos relate to the inhalation of small fibres (refer to **Section 2**) (enHealth 2013). Hence risks posed by the presence of asbestos materials depends on the nature and condition of the material and the potential for asbestos fibres to be released to air.

The common forms of asbestos include (enHealth 2005, 2013):

- Bonded products, where asbestos is bound into solid products with asbestos comprising around 10% to 15%. The materials are solid, rigid and non-friable and the fibres are not often released to air. These materials are commonly referred to as 'fibro', 'asbestos cement' and 'AC sheeting'. Bonded ACM is visible. **Where intact, these materials are considered very low risk. Where damaged or badly weathered, the materials may become friable and the risk is increased in such situations**. Further discussion on the potential for asbestos fibres to be released to air from weathering and mechanical damage is provided in **Section 3.3**.

- Friable products are generally soft and loose and crumble into fine material or dust with light pressure. Such products contain a high levels of asbestos (up to 100%) and the fibres can easily be released to air. **These materials pose the highest risk**. Unless present in complete products, once disturbed or crushed the fibres are not visible.

  In the demolition of structures in NSW (and Australia), all friable asbestos (including any building that has fire damaged asbestos materials) is required to be properly removed by a suitably licenced person. Where this process is properly undertaken, there should be no friable asbestos present in demolition materials removed from the site (post asbestos removal).

Figure 3.2 produced by enHealth graphically displays this risk information (enHealth 2013). The risk terms outlined by enHealth, as presented in this figure, have been used in this assessment with the following contextualisation relevant to this assessment:

- A '**very low risk**' is considered to relate to concentrations of asbestos fibres indistinguishable from background ranges and estimated not to exceed 0.01 f/mL in concentration.
- A '**low risk**' is considered to relate to concentrations of asbestos fibres slightly above background for a short period of time. These slightly increased concentrations are very unlikely to exceed 0.01 f/mL and are estimated to not exceed the occupational guideline of 0.1 f/mL.

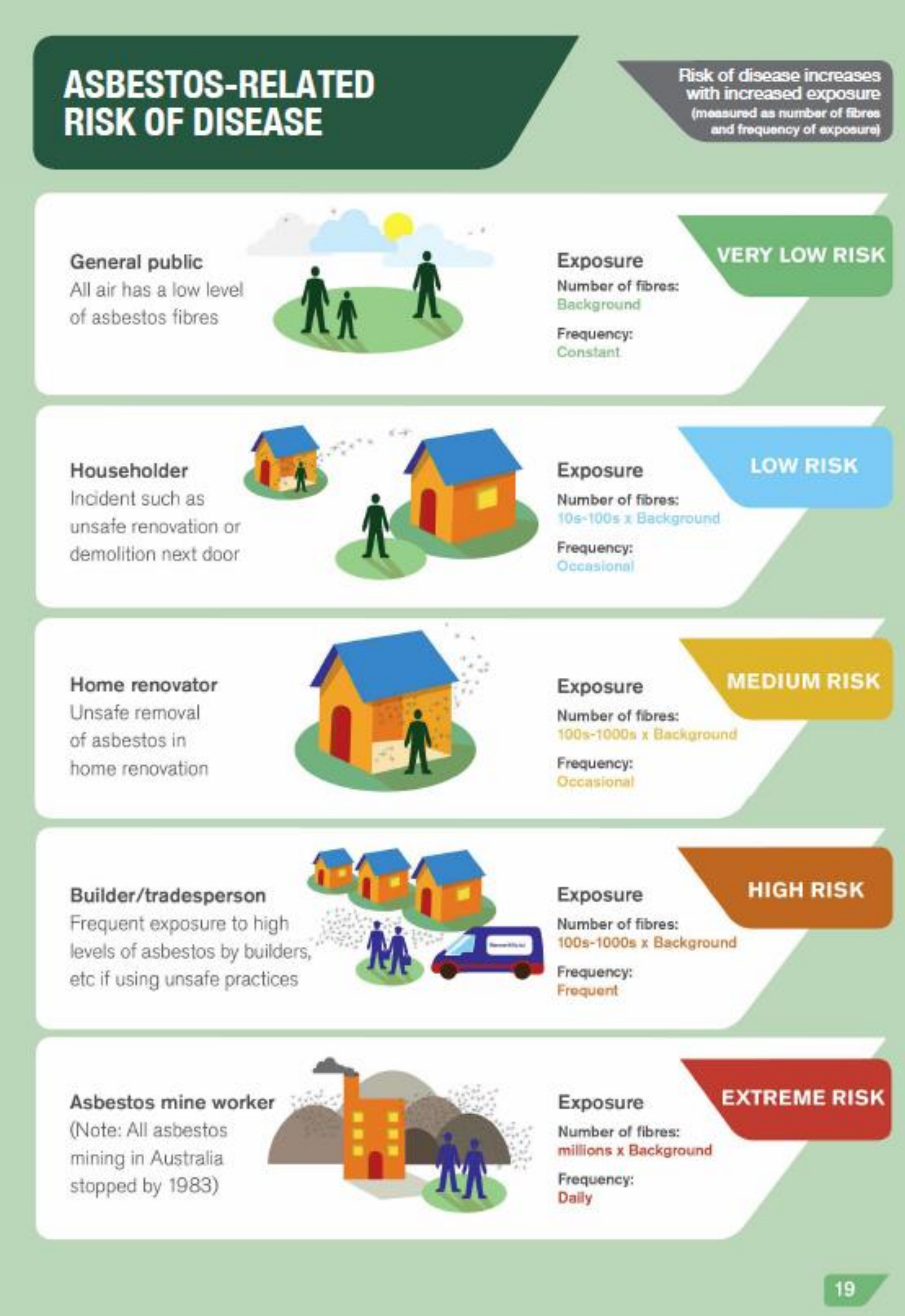


Figure 3.2: Asbestos related risk guide developed by enHealth (2013)

3.3 Effects of weathering and damage of asbestos in cement materials

The performance of asbestos cement (AC) materials requires that the cement matrix adheres to the outside of the asbestos fibres and fibre bundles so that the high tensile strength of the fibres is used to create a stronger product, than if just cement alone was used. The asbestos is added to the cement and wet mixed before being formed, compressed and cured to produce the end product.

In the asbestos cement, which contains approximately 10% – 15% of asbestos by weight, the larger asbestos bundles may be visible by eye especially at newly fractured edges. Any physical breaking and cracking of AC material exerts high mechanical forces to the fracture surface and tends to pull out asbestos fibres and bundles, thus making them more able to become airborne. Fires and very high temperatures cause the hydrated cement to release water vapour and the cement sheet to expand internally, leading to explosive failure where the sheet will crack and spall extensively, leaving areas of pulled-out fibres. A proportion of the fibres disturbed during mechanical breakage will be made airborne at the time. Mechanical attrition of the cement will also lead to release of airborne asbestos fibres and cutting of the cement sheets with saws and angle grinders are particularly able to release fibres from inside the AC. Similarly, mechanical cleaning of dry surfaces of AC sheets are also known to release substantial numbers of airborne asbestos fibres (Burdett 2007).

A typical example of a chrysotile bundle present in a sample of AC material following breakage is shown in **Figure 3.3**. Although the matrix material will 'cement' particles together, and some of the exposed fibres will have cement particles adhered to the fibres, the bundles of chrysotile fibre contain many fibres and fibrils, which are not in direct contact with the cement matrix and may not have cement fragments adhered to the surface (Burdett 2007).

Primarily, the weathering of an AC sheet is based on its major component (90% cement). As it weathers the more resistant asbestos is left increasingly free of the cement matrix. Therefore, weathered asbestos cement often has the potential to release more fibres from the surface than unweathered asbestos cement due to the much greater numbers of loosely bound fibres exposed on the surface. In more extreme cases, weathering may cause the surface to flake or crack, giving an even greater area from which asbestos may be released into the air (Burdett 2007).

Asbestos fibres are typically resistant to weathering, however, the AC product is expected to be affected by weathering. The nature of the weathering may affect the potential for loose asbestos fibres to be present that may move into the air. Where materials have undergone significant weathering from water or acidic materials (or leaching) there is the potential for asbestos fibres to be exposed and remain on the surface of the AC material (refer to **Figure 3.4**) (Campopiano et al. 2009). Other forms of weathering may result in asbestos fibres and bundles being exposed (refer to **Figures 3.5 and 3.6**), some of which may include particles of concrete adhered to the fibres, but there may be some fibres where no concrete is adhered (Burdett 2007; Campopiano et al. 2009).

More detailed review of the asbestos fibres from these weathered AC materials indicates some have a coating (mainly calcium) and many of the individual fibres have attached cement particles, while others do not (Burdett 2007). These are further illustrated in **Figure 3.7**.

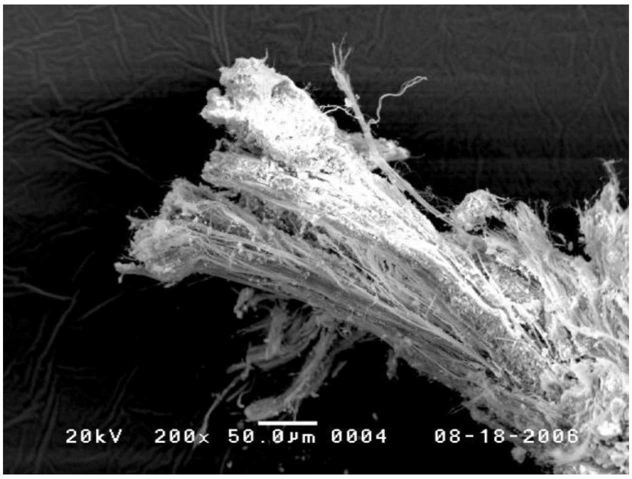


Figure 3.3: Chrysotile fibre bundle projecting from broken section of AC material (scanning electron microscopy [SEM] image at approx. x 200) (Burdett 2007)

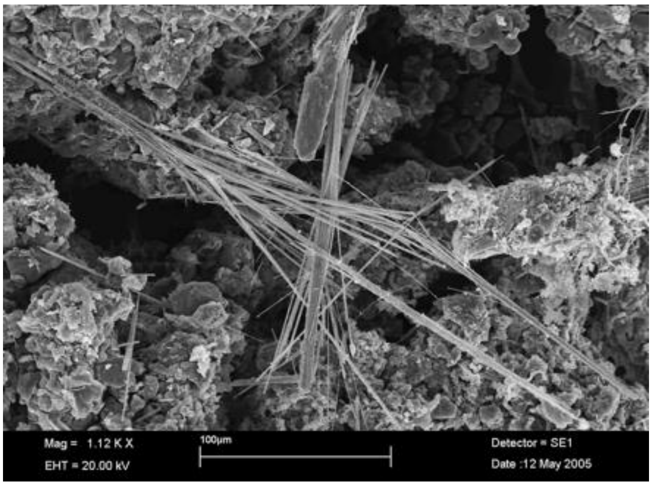


Figure 3.4: Amosite fibres exposed or detached from cement sheeting following weathering (SEM image) (Campopiano et al. 2009)

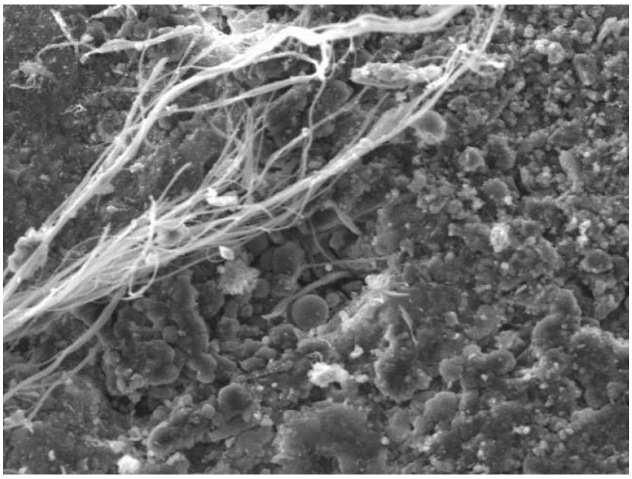


Figure 3.5: Chrysotile fibres exposed on the surface of weathered AC material (SEM image at approx. x 600) (Burdett 2007)

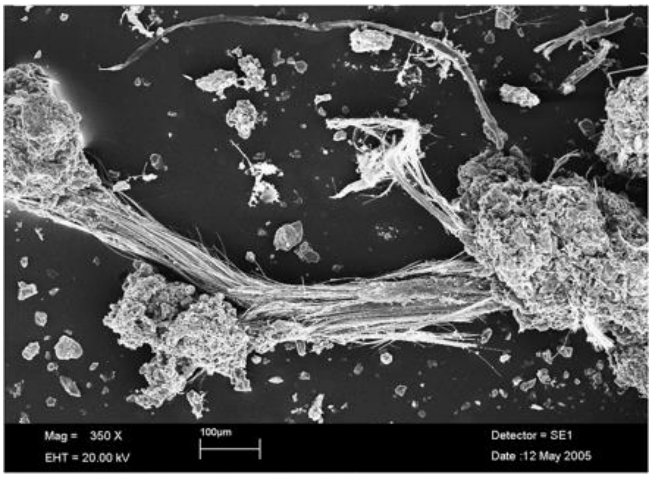
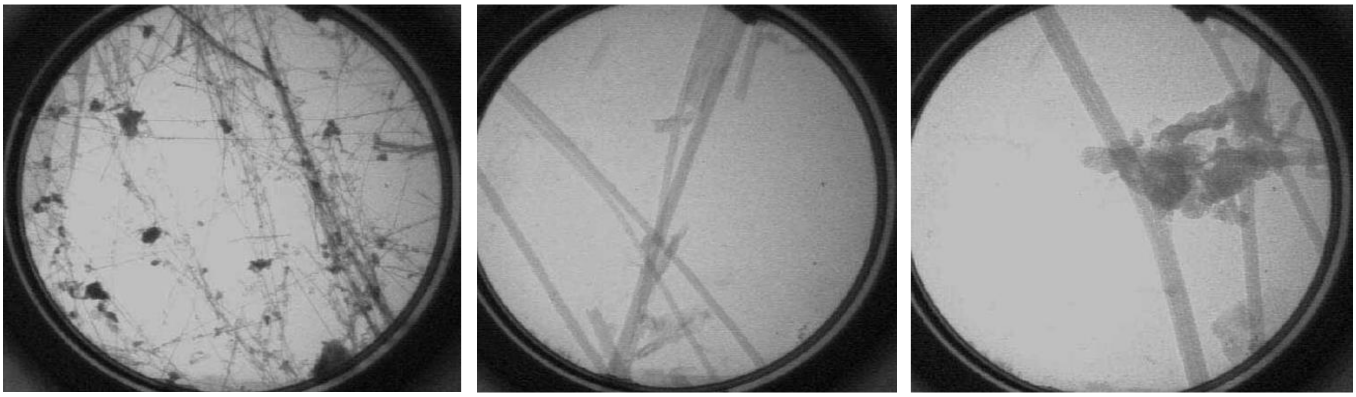


Figure 3.6: Chrysotile fibres detached from weathered AC material (SEM image)



A **B** **C**

Figure 3.7: Chrysotile fibres from weathered AC material, A: showing small cement particles attached to the fibres, B: Fibres at high magnification showing no evidence of coating or many attached particles, C: High magnification example of particle attached to fibre (Burdett 2007)

Overall, it appears that the vast majority of fibres are uncoated and there is no evidence to support the claim that all the chrysotile has been chemically or structurally altered (Burdett 2007).

Further review of asbestos fibres in air (derived from these weathered materials) identified that the fibres had only a few small particles of cement attached or were free of any coating or particles, as illustrated in **Figure 3.8**. This may suggest that the presence of cement particles on asbestos in weathered material may reduce the potential for asbestos fibres to be present in air, with only fibres with small amounts of cement particles or no cement particles moving into the air phase.

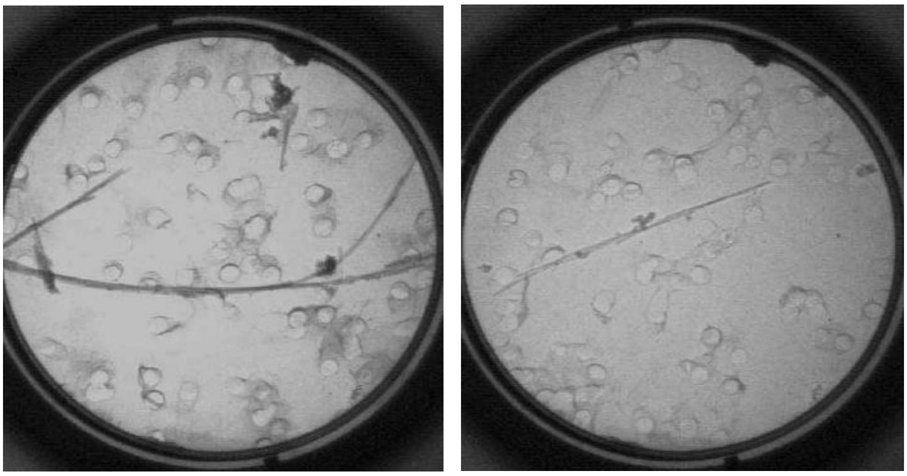


Figure 3.8: Examples of magnified airborne chrysotile fibres from weathered AC material, showing a few small particles attached to fibres and fibres free of particles (Burdett 2007)

The fibres found in the air samples essentially showed no significant alteration and would be able to be distinguished as asbestos fibres using standard methods (Burdett 2007).

In relation to the inhalation of asbestos fibres derived from the weathering or damage to AC materials, there are no differences in the carcinogenic potencies between 20 year old weathered chrysotile asbestos fibres from the surface of AC sheets and friable chrysotile asbestos fibres (Spurny 1989; Tilkes & Beck 1989).

Human epidemiology has shown that chrysotile asbestos cement manufacture is low risk compared to other asbestos products. The low risk is largely due to the lower levels of fibre emissions in the manufacturing industry, as much of the asbestos production is carried out using wet processes and when dry the asbestos is locked into a resilient cement matrix. There was also increasing use of dust controls in western production plants (Burdett 2007).

Teichert (Teichert 1986b, 1986a) concluded that despite evidence of “considerable erosion”, only “very low” (i.e. in most cases undetectable) asbestos fibre emissions were observed from AC roofing. A strength of this work was that fibre concentrations were related to the prevailing weather conditions at the time of measurement. The proportion of released fibres in the external air that were asbestos in nature were reported to be very low at 1.1 % for shorter fibres of 2.5 µm to 5.0 µm in length and less than 0.2% for fibres greater than or equal to 5.0 µm in length (Teichert 1986b).

In a review of their previous work Spurny (Spurny 1989) concludes that AC corrodes in response to “aggressive” atmospheric pollution (e.g. to acids arising for sulfur dioxide and other industrial gases). The extent of corrosion is dependent on several factors including the concentrations of these pollutant gases, the relative time of exposure and the prevailing weather conditions. Spurny (1989) indicates, however, that only about 20% of free asbestos is released into the air. The remaining 80% is hypothesised to be removed by rain. It is not known if these northern European findings can be directly related to the drier conditions found in Australia (ASCC 2008).

Overall, the broad consensus from the available information is that the release of asbestos fibres is exceedingly small from non-friable asbestos materials (AC) as a result of aging, weathering and/or corrosion (ASCC 2008; Burdett 2007). This is partly due to:

- The relatively lower amount of asbestos used in this product compared to others; and
- The hard resistant nature of the cement matrix which makes it more difficult to release airborne fibres (as noted above);

AC is considered non-friable and has a low hazard except when physically damaged or handled (e.g. by using power tools and other machinery). Where released to air, fibres from these materials are no less hazardous than those released from friable asbestos.

3.4 Background exposure

Natural sources are important, because asbestos minerals are widely spread throughout the earth's crust and are not restricted to the few mineable deposits. In particular, chrysotile is present in most serpentine rock formations. Emissions from these sources are due to natural weathering and can be enhanced by man's activities, such as quarrying or street building. Very little, however, is known about the amounts emitted from natural sources (WHO 2000). Man-made emissions originate from activities in the following categories:

a) mining and milling
b) manufacture of products
c) construction activities
d) transport and use of asbestos-containing products
e) disposal.

Indoor asbestos fibre concentrations can be considerably higher than outdoor concentrations.

Asbestos fibres normally constitute only a relatively small fraction of the total number of fibres in ambient air. The biologically more important so-called "critical" fibres are those equal to or longer than 5 µm and having diameters up to 3 µm with an aspect ratio equal to or greater than 3:1 (WHO 2000) as already discussed.

Table 3.1 presents a summary of the available data on background levels of asbestos in air in urban, rural and industrial areas. In addition, the table includes calculated lifetime burdens, i.e. the number of asbestos fibres inhaled over a lifetime in urban and rural areas compared with workplace exposures. This shows that all members of the population are always exposed to asbestos in air, with significant (a million to many millions) numbers of fibres inhaled over a lifetime, even where no exposure occurs in a workplace. In spite of this, the general population (non-occupationally exposed population) does not contract asbestos related disease in any significant numbers. The background rate of mesothelioma is noted to be less than 1.5 per million per year.

Table 3.1 Summary of background levels of asbestos reported in the environment

Exposure	Concentrations reported (f/cm^3 = f/mL)	Reference
Urban air (typically 10 times higher than rural)	0.000003 to 0.0198 for multiple countries 0.00004 to 0.05 (0.0011 mean) in US 0.0016 to 0.0037 (0.0016 mean) for 1990's US 0.0001 to 0.001 lowest background	(Krakowiak et al. 2009) (Abelmann et al. 2015) (ASCC 2008) (WHO 2000) (IARC 2012)
Rural air	0.0003 to 0.0218 for multiple countries 0.0000048 to 0.013 (0.00039 mean) in US 0.000014 to 0.000092 (0.000018 mean) in 2000's in US 0.00001 to <0.0001 lowest background	(Krakowiak et al. 2009) (Abelmann et al. 2015) (ASCC 2008) (WHO 2000) (IARC 2012)
Industrial air	<0.0006 to 91.4	(Krakowiak et al. 2009)
Heavy traffic road crossing or freeway	0.0009 to 0.0033	(WHO 2000)
Indoors	<0.001 buildings with no ACM <0.001 to 0.01 buildings with friable asbestos 0.00003 to 0.006 in homes, schools etc 0.00012 (mean) in US	(WHO 2000) (IARC 2012) (ATSDR 2001) (Lee & Van Orden 2008)
Outdoor ambient levels or background	0.00003 to 0.0047 in the US	(Glynn et al. 2018)

Exposure	Concentrations reported (f/cm^3 = f/mL)	Reference
Lifetime burdens	**Urban population** exposed to 0.00003 to 0.0002 f/cm^3, exposure for 70 years = ~1.5 x 10^7 to 10^8 accumulated fibres	(WHO 2000)
	Rural population exposed to 0.00001 f/cm^3, exposure for 70 years = 10^5 to 10^6 accumulated fibres	(WHO 2000)
	Asbestos workers exposed to 0.1 to 1 f/cm^3 Exposure for 50 years = 10^{10} to 10^{11} fibres Exposure for 0.7 year (incidental exposure) = 5x10^7 fibres	(WHO 2000)

Comments on exposure and risk

Different types of asbestos pose different levels of risk to workers and the community. The level of risk posed by asbestos will depend on the nature of the materials in which asbestos is present, and the nature and duration of exposure.

High Risks – This relates to asbestos that may be present as friable asbestos, that can easily move into air where exposure may occur. The greater the duration of exposure to scenarios where these fibres are present in air in elevated numbers, the greater the risk. The presence of friable asbestos in building and demolition waste is expected to be negligible where these materials are properly removed in accordance with existing regulatory requirements and guidelines that require these materials to be removed by a licenced contractor prior to any demolition.

Low Risk – This relates to asbestos that remains bound or bonded in products, where there is a very low potential for asbestos fibres to be released to air, even where weathering may have occurred.

Risks may be increased where these materials are heavily weathered or mechanically damaged, and asbestos fibres may be available to move into the air. The movement of asbestos to air may be more limited from these materials. However, once in air, the hazards posed by airborne asbestos fibres remain unchanged.

The background presence of asbestos, relevant to all members of the community in urban and rural areas means that the concept of zero asbestos or zero asbestos exposure and risk is meaningless.

While it is accepted that zero tolerance is part of NSW asbestos waste regulations and community expectations, the concept is meaningless in technical terms. Everyone is exposed to fibres from natural sources. Such sources are not targeted for management by regulation or policy.

These background exposures have been further considered in relation to the concept of trivial in **Section 6**.

Section 4. Asbestos guidelines – Australia

4.1 General

There is scientific uncertainty regarding the dose–response relationships for asbestos – i.e. how many fibres are needed to cause the various effects. There is also considerable public concern about unwilling exposure to asbestos fibres. As a consequence, regulators typically adopt a conservative approach to policy and guidelines in relation to asbestos.

4.2 Regulation of asbestos in Australia

Exposures to asbestos in the past were very high in some Australian industries and occupations. For example, there has been as much as 25 million particles per cubic foot (150 fibres/mL) in asbestos pulverisers and disintegrators in the asbestos cement industry (Roberts and Whaite, 1952 quoted in Leigh et. al. (Leigh et al. 2002)), and up to 600 fibres/mL in baggers at Wittenoom (Major, 1968 in Leigh et.al. 2002). However, the recognition of the associated health risks led to a series of regulations being adopted nationally in the late 1970s. Exposure limits of 0.1 fibres/mL for crocidolite and amosite; and 1.0 fibres/mL for chrysotile were imposed. In July 2003, a revised national exposure standard for chrysotile asbestos of 0.1 fibres/mL was declared by the National Occupational Health and Safety Commission (NOHSC).

The asbestos air-quality limit for protecting the public around contaminated sites is 0.01 fibres per millilitre (f/mL) (using the membrane filter method) as endorsed by the enHealth Council (enHealth 2005; NOHSC 2005).

In 2001 NOHSC declared a prohibition on all uses of chrysotile asbestos from 31 December 2003, subject to a very limited range of exemptions, and confirmed earlier prohibitions on the use of amosite and crocidolite asbestos. The prohibition of chrysotile was adopted simultaneously under regulations in each Australian OHS jurisdiction, as well as Australian Customs, on 31 December 2003. The prohibition does not extend to ACMs that were in situ at the time prohibition took effect (i.e. part of existing buildings) and is subject to a very limited range of exemptions. Since 1988, NOHSC and then the ASCC, has provided detailed guidance material to minimise occupational exposures to asbestos. This material was revised in 2005, and most recently in 2018 and 2020 and includes national codes of practice for the safe removal of asbestos (Safe Work Australia 2018) and for the management and control of asbestos in the workplace (Safe Work Australia 2020). It also includes a Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres 2nd Edition [NOHSC:3003(2005) (NOHSC 2005)].

4.3 Australian guidelines for asbestos in contaminated sites

The ASC NEPM (NEPC 1999 amended 2013a) sets out soil levels for asbestos for different site uses below which no effects would be expected. These are derived from guidance developed by the Western Australian Department of Health (WA DOH 2009).

The asbestos in soil guideline values have been based on preventing the entrainment of asbestos fibres into the breathing zone of sensitive receptors from normal activities relevant to different long-term uses of land. In the derivation of soil guidelines, the WA Department of Health and the NEPM (Assessment of Site Contamination) use a risk-based and, where necessary, conservative approach to the uncertainties associated with protecting the public from asbestos-contaminated sites and employ the following general contamination criteria:

- The investigation criterion or clean-up goal is 0.001% asbestos in soil on a weight for weight basis (w/w) for free fibre-related materials including fibrous asbestos and free fibre itself. It should be noted that this criteria is 10 times lower than the original criteria (0.01%) derived by the Dutch (Swartjes & Tromp 2008) to account, in part, for the drier Western Australian soil;
- Depending on site use, at least a 10-fold higher criteria is applied to asbestos-containing materials (ACM) (i.e. bonded) in sound condition, such as commonly found asbestos cement fragments, since these pose much lower risks to human health; (NEPC 1999 amended 2013a; WA DOH 2009).

The derived health screening levels for asbestos in soil, as adopted in the ASC NEPM are listed in **Table 4.1** (NEPC 1999 amended 2013a).

Table 4.1: Summary of NEPM screening levels for asbestos in soil (NEPC 1999 amended 2013a)

Health Screening Levels for Relevant Land use Settings (w/w)				
Form of asbestos	**Residential A[1]**	**Residential B[2]**	**Recreational C[3]**	**Commercial/ Industrial D[4]**
Bonded ACM	0.01%	0.04%	0.02%	0.05%
FA and AF[5] (friable asbestos)	0.001%			
All forms of asbestos	No visible asbestos for surface soil			

Notes:
1. Residential A with garden/accessible soil also includes children's day care centres, preschools and primary schools.
2. Residential B with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.
3. Recreational C includes public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and unpaved footpaths.
4. Commercial/industrial D includes premises such as shops, offices, factories and industrial sites.
5. The screening level of 0.001% w/w asbestos in soil for FA and AF (i.e. non-bonded/friable asbestos) only applies where the FA and AF are able to be quantified by gravimetric procedures. This screening level is not applicable to free fibres.

The available soil criteria detailed above are based on the protection of human health (all workers and members of the public) associated with long-term (chronic[1]) exposure for commonly undertaken activities for the various land uses (NEPC 1999 amended 2013a).

It is noted that the ability of National Association of Testing Authorities (NATA) accredited laboratories, using Polarized Light Microscopy (PLM) as specified in available methods, to quantify asbestos in such low concentrations in bulk soil samples is limited to a reporting limit of 0.01% (w/w)

[1] Chronic exposure refers to exposures that may occur over at least a year. Within the NEPM chronic exposures relates to exposures over 25 years for residents and users of public open space areas and 30 years for workers

(Standards Australia 2004). Regulators may request that an attempt is made to quantify asbestos contamination at levels below 0.01% (w/w) but this is technically difficult.

4.4 Air guidelines

There are currently no ambient air quality criteria for asbestos in any state in Australia. It is noted that the WA DoH guidelines for asbestos in soil (which has been utilised in the development of the soil guideline discussed in **Section 4.3**) adopts the WHO air quality guideline value of 0.001 f/mL.

Lifetime exposure to asbestos-in-air at 0.0001 f/mL of air (>5 microns in length) has been estimated to produce about 2–4 excess cancer deaths (lung cancer plus mesothelioma) per 100,000 people.

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA 2016b) provides methods for the assessment of air pollutants from stationary sources[2] in NSW. This applies to new as well as existing facilities where there are emissions to air. The document includes guidance on the interpretation of the modelling results and includes assessment criteria for air pollutants that should not be exceeded at or beyond the site boundary. This guidance includes assessment criteria for asbestos in air as: 0.18 mg/m^3 over a 1 hour averaging period (refer to Table 7.2a of NSW EPA 2016a). This means that asbestos can be lawfully released directly to air from new and existing stationary sources in NSW provided the concentration in air at or beyond the site boundary is below the assessment criteria.

It is noted that the NSW assessment criteria for asbestos is presented in mg/m^3, which is not comparable with other data and guidelines. Based on the most common measurement technique (phase contrast light microscope) the conversion adopted in this assessment is 30 f/ml per mg/m^3 (NRC 1984; USEPA 1986). Using this conversion, the assessment criteria is 5.4 f/ml as a 1 hour average concentration. If this criteria is converted to a long-term average (i.e. an annual average) (Ontario MfE 2004) the assessment criteria would be 0.43 f/ml. This is a long-term air criteria that is significantly elevated (by many orders of magnitude) above the WHO health based air guidelines and background levels (as detailed in **Section 3.4**).

The above essentially means that NSW guidance currently allows for significant emissions to air of asbestos from new and existing stationary sources at levels that would be considered to pose a significantly elevated (and arguably unacceptable) risk to community health.

4.5 NSW asbestos regulation

Asbestos is regulated in NSW by SafeWork NSW, the Environment Protection Authority (EPA), councils, emergency service organisations and the NSW Department of Planning and Environment (DPE).

The Heads of Asbestos Coordination Authorities (HACA) was established in 2011 to ensure that NSW government agencies and councils effectively coordinate the safe management of asbestos to help reduce the incidence of asbestos related diseases in NSW. The HACA is chaired by SafeWork NSW with senior representatives from: Department of Industry, Department of Planning and

[2] Stationary sources are defined (NSW EPA 2016a) as “any premises-based activity; does not include motor vehicles”.

Environment, Dust Diseases Authority, Environment Protection Authority, Local Government NSW, Ministry of Health, Office of Emergency Management, Office of Local Government.

HACA published an Asbestos Blueprint in 2011. The Blueprint was updated most recently in 2017 (SafeWork NSW 2017). The Asbestos Blueprint is designed to provide clarity and improved coordination of asbestos regulation in NSW, leading to better protection of the health and wellbeing of the community and workers. Improved coordination of regulatory services also leads to better services for the public. The Blueprint also provides the public with a clear description of the regulatory landscape.

Figure 4.1 provides an overview of the complex inter-governmental agency interactions and responsibilities in relation to all phases of asbestos management in NSW. **Table 4.2** provides a summary of asbestos legislation and regulations in NSW. These are taken from the Asbestos Blueprint (SafeWork NSW 2017).

In the ground	Naturally occurring asbestos	DPE/Councils
	Mineral extraction, abandoned mines	DPE
	Declared contaminated land	EPA
	Non-declared contaminated public land	EPA/Councils
	Non-declared contaminated non-workplace land	EPA/Councils
	Non-declared workplace - contaminated land	SafeWork NSW
	Asbestos remediation work	SafeWork NSW
	Illegal dumping	EPA
Supply	Illegal import/export	SafeWork NSW through DIBP
	Illegal supply	SafeWork NSW
Buildings and vehicles	Licensed asbestos assessors	SafeWork NSW
	At workplaces	SafeWork NSW
	At non-workplaces	Councils
Removal	Licensed removal work and asbestos assessors	SafeWork NSW
	At workplace not requiring a licensed removalist	SafeWork NSW
	At all locations by a PCBU or worker	SafeWork NSW
	At non-workplaces — all other cases	Councils
Emergencies	Response to emergency incidents	Fire & Rescue NSW (HAZMAT)
	Major recovery operations	Fire & Rescue NSW (HAZMAT)
	Routine recovery operations	Councils
	Waste export	EPA through DIBP
Transport and disposal	Transport by vehicle	EPA
	Landfill facilities	EPA
	Scheduled waste storage and disposal facilities	EPA
	Waste transport — interstate	EPA
	Temporary on-site waste storage — workplaces	SafeWork NSW
	Laundering facilities	SafeWork NSW

Figure 4.1: Regulatory responsibilities based on asbestos mineral life cycle (SafeWork NSW 2017)

Table 4.2: Asbestos Legislation and Regulations in NSW (SafeWork NSW 2017)

Topic	Legislation
Work health and safety	*Work Health and Safety Act 2011 (WHS Act 2011)* *Work Health and Safety Regulation 2017 (WHS Regulation 2017)* *Work Health and Safety (Mines and Petroleum Sites) Act 2013* *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*
Environmental protection	*Protection of the Environment Operations Act 1997* *Protection of the Environment Operations (General) Regulation 2009* *Protection of the Environment Operations (Waste) Regulation 2014* *Contaminated Land Management Act 1997* *Environmental Trust Act 1998* *Dangerous Goods (Road and Rail Transport) Regulation 2009*
Planning	*Environmental Planning and Assessment Act 1979* *Environmental Planning and Assessment Regulation 2000* *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008* *State Environmental Planning Policy (Infrastructure) 2007* *State Environmental Planning Policy (State and Regional Development) 2011* *State Environmental Planning Policy No 55 – Remediation of Land*
Local government	*Local Government Act 1993*
Consumer safety	*Fair Trading Act 1987* *Property, Stock and Business Agents Act 2002* *Home Building Act 1989* (For LFAI) *Conveyancing (Sale of Land) Regulation 2017* (for LFAI) *Residential Tenancies Regulation 2010* (for LFAI)
International trade	*Customs Act 1901* *Customs (Prohibited Imports) Regulations 1956* *Customs (Prohibited Exports) Regulations 1958* *Hazardous Waste (Regulation of Exports and Imports) Act 1989* *Industrial Chemicals (Notification and Assessment) Act 1989* *Industrial Chemicals (Notification and Assessment Regulations 1990*
Emergency response	*State Emergency and Rescue Management Act 1989* *Fire Brigade Act 1989*
Compensation	*Workers' Compensation (Dust Diseases) Act 1942* *Dust Diseases Tribunal Act 1989* *Dust Diseases Tribunal Regulation 2007* *Dust Diseases Regulations 2006* *Dust Diseases Tribunal (Standard Presumptions – Apportionment) Order 2007* *James Hardie (Civil Penalty Compensation Release) Act 2005* *James Hardie Former Subsidiaries (Winding up and Administration) Act 2005* *James Hardie Former Subsidiaries (Winding up and Administration) Amendment Act 2009* *James Hardie Former Subsidiaries (Winding up and Administration) Regulation 2007* *James Hardie (Civil Liability) Act 2006*

4.6 Workplaces

The control of asbestos in the workplace is regulated under the *WHS Act* and the *WHS Regulation*. SafeWork NSW administers the legislation for all workplaces with the exception of mine and petroleum sites which are administered by the Department of Industry (SafeWork NSW 2017). The asbestos requirements specified in these regulations apply to all workplaces, including workplaces at waste disposal sites or sites where temporary storage of materials is required.

Some of the key aspects of the *WHS Regulation 2017* that relate to asbestos are as follows (also refer to **Section 7.2** for further discussion):

- All asbestos or ACM at the workplace must be identified by a competent person. If the material cannot be identified, it must be assumed that the material is asbestos
- If asbestos is identified at the workplace, the person with management or control of a workplace must ensure that an asbestos register and asbestos management plan are prepared.
- A person conducting a business or undertaking (PCBU)/licensed asbestos removalist (holding a licence suitable for the removal of friable and/or non-friable asbestos) must ensure that asbestos waste is contained and labelled before the waste is removed from an asbestos work area, and disposed of as soon as practicable at a site authorised to accept asbestos waste.
- The licensed asbestos removalist must ensure that when the licensed asbestos removal work is completed, a clearance inspection of the asbestos removal area is carried out by a competent person or licensed asbestos assessor, and the person must issue a clearance certificate before the asbestos removal area at the workplace is re-occupied.
- A licence is not required for the removal of small volumes (<10 m^2) of non-friable asbestos (ACM) and there are significantly fewer controls on this work, with no requirements for reporting or the conduct of a clearance inspection and certification.

4.7 Waste

Where asbestos is transported or disposed, this is regulated by the NSW EPA.

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* No 156 (POEO Act) includes the following key aspects in relation to asbestos and waste:

<u>Definitions:</u>

> ***Waste*** *includes -*
>
> *(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment, or*
>
> *(b) any discarded, rejected, unwanted, surplus or abandoned substance, or*
>
> *(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance, or*
>
> *(d) any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations, or*
>
> *(e) any substance prescribed by the regulations to be waste.*
>
> *A substance is not precluded from being waste for the purposes of this Act merely because it is or may be processed, recycled, re-used or recovered.*

__waste facility__ means any premises used for the storage, treatment, processing, sorting or disposal of waste (except as provided by the regulations).

__Asbestos__ means the fibrous form of those mineral silicates that belong to the serpentine or amphibole groups of rock-forming minerals, including actinolite, amosite (brown asbestos), anthophyllite, chrysotile (white asbestos), crocidolite (blue asbestos) and tremolite.

__Asbestos waste__ means any waste that contains asbestos.

__Building and demolition waste__ means unsegregated material (other than material containing asbestos waste or liquid waste) that results from—

(a) the demolition, erection, construction, refurbishment or alteration of buildings other than -

(i) chemical works, or

(ii) mineral processing works, or

(iii) container reconditioning works, or

(iv) waste treatment facilities, or

(b) the construction, replacement, repair or alteration of infrastructure development such as roads, tunnels, sewage, water, electricity, telecommunications and airports, and includes materials such as -

(i) bricks, concrete, paper, plastics, glass and metal, and

(ii) timber, including unsegregated timber, that may contain timber treated with chemicals such as copper chrome arsenate (CCA), high temperature creosote (HTC), pigmented emulsified creosote (PEC) and light organic solvent preservative (LOSP),

but does not include excavated soil (for example, soil excavated to level off a site prior to construction or to enable foundations to be laid or infrastructure to be constructed).

Section 144AAB - Re-use and recycling of asbestos waste prohibited. A person must not cause or permit asbestos waste in any form to be re-used or recycled (with penalties outlined).

The POEO Act provide penalties for the unlawful disposal of asbestos.

Protection of the Environment Operations (Waste) Regulation 2014

The NSW *Protection of the Environment Operations (Waste) Regulation 2014* includes (by definition) any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is intended to be applied to land or used as a fuel. Part 7 specifically relates to the transportation and management of asbestos waste.

POEO Amendment (Waste) Regulation 2018

The *POEO Amendment (Waste) Regulation 2018* includes the following key aspects:

Provides requirements for the transport and disposal (to landfill) of asbestos waste.

Part 8A is specific to C&D waste facilities where the following definition is provided:

> ***construction waste*** *means:*
>
> *(a) material that results from the construction of buildings or infrastructure (such as roads, tunnels, airports and infrastructure for sewage, water, electricity and telecommunications) and includes materials such as:*
>
> > *(i) bricks, concrete, paper, plastics, glass and metal, and (ii) timber, including unsegregated timber, that may contain timber treated with chemicals, and*
> >
> > *(iii) soil or other excavated material (but not virgin excavated natural material within the meaning of Schedule 1 to the Act), and*
> >
> > *Note. Construction waste includes all building and demolition waste within the meaning of Schedule 1 to the Act.*
>
> *(b) material processed from any material to which paragraph (a) applies,*
>
> *(c) waste that contains any material to which paragraph (a) or (b) applies.*

It is a condition of an environment protection licence for a scheduled waste facility that is a construction and demolition waste facility that the requirements set out in the Standards for managing construction waste in NSW are complied with at the facility.

The NSW EPA Standard on managing construction waste (EPA 2019) requires each load of construction waste that enters a C&D waste facility to undergo inspection. This requires visual inspections at 2 points:

- Inspection point 1 – top of load in truck from an elevated location or using a video camera
- Inspection point 2 – tip and spread in an inspection area, with inspection by trained personnel (visual inspection).

The Standard requires rejection of the entire load where asbestos waste is identified at either of the inspection points.

This standard does not include further risk assessment or testing for friable asbestos fibres. Such fibres are not visible so the inspection process as outlined would not detect these. The standard also does not include any additional definitions of asbestos or asbestos waste.

Dangerous Goods (Road and Rail Transport) Regulation 2014

The *Dangerous Goods (Road and Rail Transport) Regulation 2014* adopts uniform national requirements for the transport of dangerous goods including the requirements of the Australian Dangerous Goods Code ('the Code'). Asbestos is categorised by the Code as a Class 9 dangerous good; however, most asbestos waste is subject to special provision 168.

Special provision 168 – exemptions from the dangerous goods code:

> *Asbestos which is immersed or fixed in a natural or artificial binder (such as cement, plastics, asphalt, resins or mineral ore) in such a way that no escape of hazardous quantities of respirable asbestos fibres can occur during transport is not subject to this Code. Manufactured articles containing asbestos and not meeting this provision are nevertheless not subject to this Code when packed so that no escape of hazardous quantities of respirable asbestos fibres can occur during transport.*

The tracking threshold is 100 kg or 10 m^2 for “transporters of asbestos”.

Comments on the definition of asbestos

The definition of asbestos in the POEO Act, which is adopted throughout all of the NSW regulations and is consistent with the definitions adopted in other states (refer to **Section 4.11**) is very general. Similarly, the definition of asbestos waste is very general and appears to have resulted in the zero-tolerance approach adopted in NSW, where the concept of any asbestos means it is an asbestos waste.

The use of such a general definition does not enable risk to be considered, nor the characteristics of asbestos, namely fibres of a particular length and width that are of importance to the hazards that asbestos poses (refer to **Section 2**). In addition, the definition does not allow any distinction between risks posed by ACM (i.e. likely to be visible (i.e. bonded or in products)), which are low risk, and asbestos fibres that can easily move into the air, which are high risk (refer to **Section 3**).

This lack of regulatory definition, and link with the characteristics of asbestos that are hazardous, results in misunderstanding and misinformation that the hazards relate to the general term asbestos, and how these relate (or not) to the toxicological studies (Case et al. 2011).

Without clarity on the definition of asbestos waste, any facility operating in NSW would carry significant liabilities when dealing with any product, as asbestos may be present in any material from background sources, in addition to being derived from some waste materials.

Further this definition of asbestos is at odds with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA 2016b), that establishes guidelines that allow for new and existing stationary sources to release asbestos to air at and beyond their site boundary at levels that would pose a risk to community health.

4.8 Local Councils

Local councils are responsible for managing asbestos in the community through educating residents, regulating land use and development, and managing waste disposal.

Specifically, this relates to the following (SafeWork NSW 2017):

- Contaminated land:
    - Record known asbestos site contamination on Section 149 certificates where practicable and, for council workplaces, record on council’s asbestos register.

- Regulate asbestos contaminated land that is not declared 'significantly contaminated' under the *CLM Act 1997* (excluding oversight of removal or remediation work which is the role of SafeWork NSW).

- Demolition:
  - Approve demolition under the *EP&A Act*.
  - Council certifiers may approve development as complying development under the *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*.
- Residential premises:
  - Respond to any public health risks (risks to council workers and wider public) relating to the removal of asbestos containing materials or asbestos work at residential properties that does not involve a business or undertaking.
  - Respond to complaints about unsafe development activities at a residential property.
  - Respond to public health risks posed by derelict properties or asbestos materials in residential settings.
  - Include properties listed on the Loose-fill Asbestos Insulation Register on section 149 (2) planning certificates.
  - In areas where loose-fill asbestos insulation has been identified, include a notation on all section 149(5) planning certificates regarding the potential for loose-fill asbestos insulation in properties that are not listed on the Register.
- Waste:
  - Manage waste facilities in accordance with environmental protection legislation.
  - Respond to illegal storage, illegal dumping and orphan waste.
  - Regulate transport and disposal of asbestos containing materials

4.9 Department of Planning and Environment

The Department of Planning and Environment's (DPE) primary role in the management of asbestos relates to administration of State Environmental Planning Policies, and the *EP&A Act* (and associated Regulation).

While the DPE does not have an operational role in the management of asbestos, it has a regulatory function and provides policy support relating to asbestos and development. In assessing proposals for development under the *EP&A Act*, consent authorities are required to consider the suitability of the subject land for the proposed development. This includes consideration of the presence of asbestos and its environmental impact (SafeWork NSW 2017).

Where asbestos represents contamination of the land (i.e. it is present in excess of naturally occurring levels), *State Environmental Planning Policy No. 55 — Remediation of Land* imposes obligations on developers and consent authorities in relation to remediation of the land and the assessment and monitoring of its effectiveness.

The *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008* enables exempt and complying development across the state. While this includes demolition and the removal of asbestos, the *EP&A Regulation* specifies particular conditions that must be contained in a complying development certificate in relation to the handling and lawful disposal of both friable and non-friable asbestos material under the *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*.

4.10 NSW guidance on construction and demolition waste recycling 2010

Asbestos contamination in construction and demolition materials for recycling has been recognised as an issue for a long period of time.

In 2010, WorkCover NSW published a guide on the management of asbestos in recycled construction and demolition waste (WorkCover NSW 2010). This guidance clearly stated that products containing asbestos containing materials (ACM) are prohibited from being sold or used as recycling materials.

The guidance was intended to provide practical assistance to the construction and demolition waste recycling industry to minimise the potential risk of asbestos contamination in recycled C&D materials – e.g. concrete and brick.

It outlines the procedures to manage ACM that may enter a recycling facility. This guide covers the receipt, processing and management of construction and demolition (C&D) materials at construction and demolition (C&D) facilities.

The guidance links with regulatory obligations for the management, control and removal of asbestos.

This guidance provides for the following:

- The definition of asbestos is consistent with that provided in the POEO Act (refer to **Section 4.7** above)
- Site required to advise suppliers that asbestos and ACM will not be accepted, incorporate "no asbestos" clause in contracts, visible signs, trained staff.
- The primary control point for the removal of asbestos is prior to demolition (i.e. not at the waste facility). Buildings and structures normally undergo regulated and comprehensive asbestos removal programs and stringent clearance inspections before they are demolished. If licensed demolishers conduct the demolition, and the waste has ACM removed and separated at the source, the probability of ACM being present should be low.
- However, it is not unusual for mixed waste from unknown sources, or from small-scale demolition or refurbishment activities that place their waste into skip bins, to contain amounts of ACM waste. These sources should be considered high risk.
- An inspection process should be implemented when waste materials are received at the C&D facility. It should be a two-stage process undertaken by trained personnel.
- The first stage takes place on receipt of the load, the second when the load is tipped out (and before it is included in a mass stockpile).
- If friable asbestos is detected, the load should be immediately rejected.
- If bonded ACM is detected, it should be removed in accordance with the *Code of practice for the safe removal of asbestos* and stored appropriately for later disposal. If friable ACM is detected, the load must be isolated and kept wet during the course of further inspection.

- If ACM is detected, the load should be either:
    - assessed by an occupational hygienist
    - rejected and reloaded onto the delivery truck
    - isolated until removal is arranged.

The process is summarised in **Figure 4.2**.

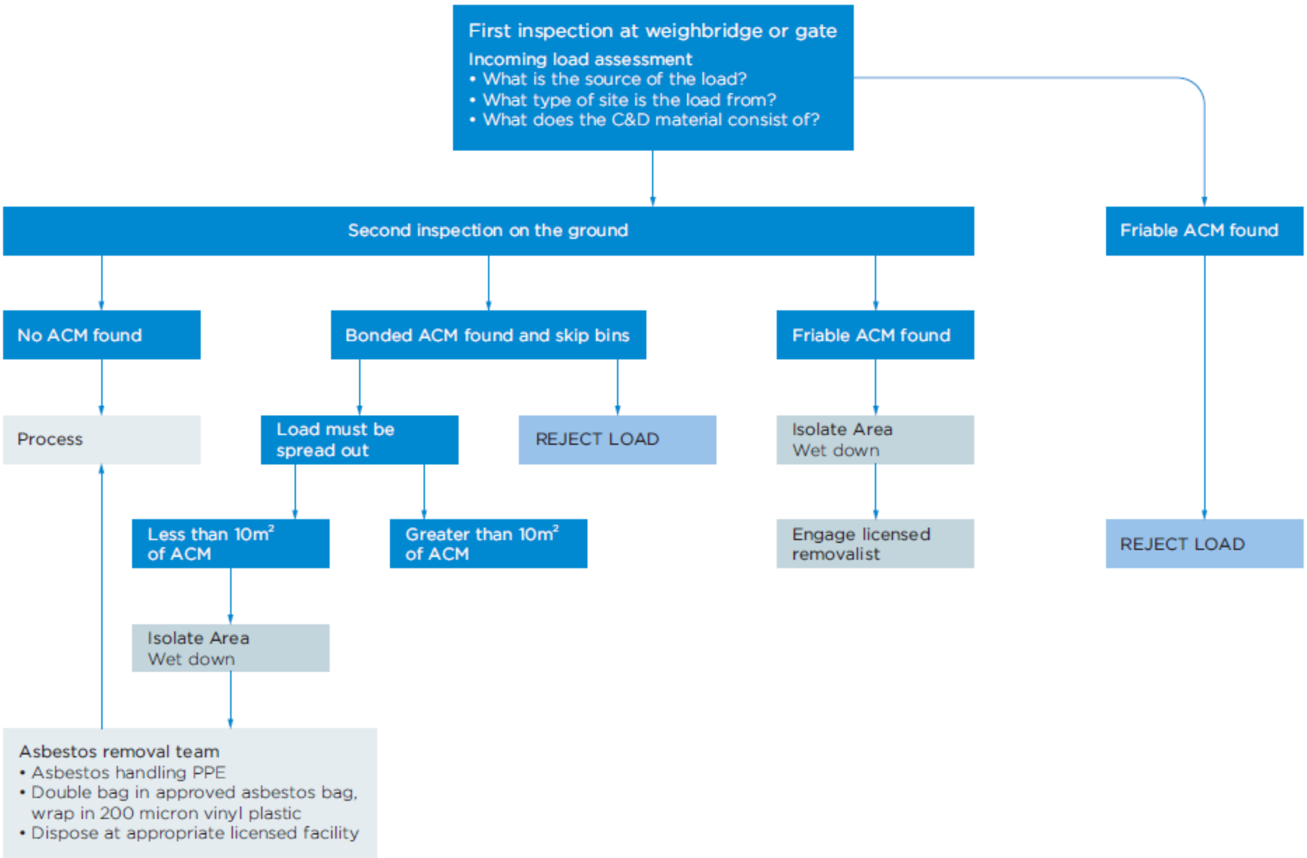


Figure 4.2: ACM inspection process from 2010 guidance (WorkCover NSW 2010)

2014

In 2014, the NSW EPA (NSW EPA 2014) provided a draft protocol on the management of asbestos during resource recovery for C&D waste.

The document states that the protocol has been developed by NSW EPA and WorkCover NSW, in consultation with industry, to:

- prevent asbestos entering a recycling facility
- improve workplace safety at recycling facilities

- outline the management requirements for asbestos where it is discovered in waste, whether unprocessed, processed or supplied to a third party.

The protocol provides practical procedures for verifying that ACM does not contaminate material intended for resource recovery and thereby meets construction industry and community expectations.

The definition of asbestos is consistent with that provided in the POEO Act (refer to **Section 4.7** above).

The protocol follows a similar process as detailed in 2010, with inspection required at the gate (preliminary inspection) and following tipping and inspection (detailed inspection)

Following completion of the detailed inspection:

- Where no asbestos, or suspected asbestos, is observed, the waste can be moved into the storage/processing area or stockpile.
- Where asbestos is sighted or suspected, the entire waste load must be rejected and details of the load entered into the Rejected Load Register.

If asbestos is observed, the load should be immediately wetted down.

The recycling facility operator must maintain an Asbestos Inspection Register where the details of each load of waste inspected in the designated inspection area are recorded.

Where suspected asbestos is observed in a waste stockpile at a recycling facility or in waste-derived materials supplied to a third party or off site, and the facility can satisfy the EPA that it has complied with the requirements of the protocol, a risk-based approach to assessing the waste can be permitted. This means that the waste must be sampled, classified and managed in accordance with this protocol by an occupational hygienist or qualified professional approved by the EPA or WorkCover NSW. The final regulatory decision is a matter for the EPA.

Removal of asbestos, or suspected asbestos, from stockpiles or waste-derived materials supplied to a third party by ‘emu-picking’ or processing of any other kind is not permitted.

Where asbestos is observed in a waste stockpile at a recycling facility or in waste-derived materials supplied to a third party, and the facility cannot demonstrate compliance with the requirements of the protocol to the satisfaction of the EPA, all of the waste material involved is required to be classified and removed to a facility that can lawfully receive it.

Figure 4.3 provides a summary of the steps required in the draft Protocol.

The 2014 draft protocol has never been finalised, and it is understood that the draft document was withdrawn by the EPA in 2019.

Appendix I: Steps for sampling and removing asbestos waste from stockpiles and supplied waste-derived materials

Note: Handling, storage, transport and disposal of asbestos waste must be in accord with the requirements of the Protection of the Environment Operations (Waste) Regulation 2005.

Scenario
One or more pieces of ACM (or suspected ACM) is identified in a stockpile or supplied waste-derived materials

Step 1
Immediately cease adding to or removing from the stockpile or supplied waste-derived material (except in line with the steps below) and manage as per Section 6.1 of the protocol, including notifying the EPA on 131 555. Where approved by the EPA, remove from the stockpile or waste-derived material each piece of ACM and one cubic metre of the stockpile surrounding it. This cubic metre is deemed to have a minimum waste classification of Special Waste (asbestos waste) (or any higher class as determined in accord with the EPA *Waste Classification Guidelines*) and must be disposed of to a landfill that can lawfully receive that waste.*, **

Step 2
Segregate from the stockpile or supplied waste-derived material the 20 cubic metres immediately adjacent to and surrounding each cubic metre removed in Step 1. Move this 20 cubic metres to an area that is not contaminated with asbestos, divide it into four separate 5-cubic metre sections and spread them to a height of not more than 100 mm, ideally on a hardstand (such as a concrete pad) and inspect for visible ACM.

No visible ACM detected

Step 3a
Regroup the 20-cubic metre section of waste into a single separate pile and collect one 10-litre sample for analysis. The sample must be sent to an accredited NATA laboratory and analysed for asbestos in accord with the requirements of AS4964-2004: *Method for the qualitative identification of asbestos in bulk samples.*

Visible ACM detected

Step 3b
The separated 20 cubic metres is deemed to have a minimum waste classification of Special Waste (asbestos waste) (or any higher class as determined in line with the EPA *Waste Classification Guidelines*) and must be disposed of to a landfill that can lawfully receive that waste.*, **

Asbestos not detected

Step 4a
The 20 cubic metres of waste can lawfully be managed in accord with its usual waste classification. It can be returned to the original stockpile once Steps 1–3 have been followed for all pieces of ACM identified in the original stockpile.
The entire stockpile of waste or supplied waste-derived materials can now lawfully be managed in accordance with its usual waste classification.

Asbestos detected by lab analysis

Step 4b
40 cubic metres of the stockpile or supplied waste-derived materials surrounding and immediately adjacent to this 20 cubic metres must be tested and managed as in Steps 2 and 3a or 3b.

Step 4c
If ACM and/or asbestos is detected in the 40 cubic metres separated for visual assessment and testing in Step 4b, repeat that step on 40-cubic-metre quantities until it can be demonstrated that the waste material is free of asbestos or ACM.

* In accord with Section 6.2 of the protocol, submit an Asbestos Survey and Sampling Report to the EPA prior to the removal of any Special Waste (asbestos waste) from the facility.
** Within seven days of the disposal of the waste, submit an Asbestos Disposal Report to the EPA which meets all of the requirements of Section 6.3 of the protocol.

Figure 4.3: Procedures for managing asbestos in C&D materials as per Draft Protocol (NSW EPA 2014)

2020

It is understood that the NSW EPA is developing a new or updated Asbestos Unexpected Find Procedure which aims to provide an approach to managing what is termed “unexpected finds” at resource recovery facilities. This procedure is being developed in consultation with industry and it is understood that the basis of the procedure remains the concept of zero tolerance.

4.11 Guidance in other Australian states and territories

Victoria

Key legislation in relation to C&D waste includes:

- *Environment Protection Act 1970* (The Act)
- *Environment Protection (Industrial Waste Resource) Regulations 2009* (IWR Regs)
- *Environment Protection (Scheduled Premises and Exemption) Regulations 2007* (Sched. Prem. Regs)
- State Environment Protection Policy (Prevention and Management of Contamination of Land) (PMCD SEPP)
- National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM).

The definition of asbestos adopted in Victoria is consistent with that used in NSW.

Guidance on recycling C&D material in Victoria is provided in a WorkSafe Victoria document (WorkSafe Victoria 2007).

This guidance material provides information to assist industry to meet its obligations under the *Occupational Health and Safety (Asbestos) Regulations 2003* (the Asbestos Regulations). The guidance material describes an auditable procedure to verify that asbestos-containing material has been removed from C&D materials prior to recycling.

The Asbestos Regulations require that a licensed asbestos removalist be engaged to remove asbestos from workplaces, other than in a few very limited circumstances. Following removal of the asbestos, the person who commissioned the removal work must obtain a Clearance Certificate from an independent person prior to the site being re-occupied. This is not required where the asbestos-containing material removed was non-friable and less than 10 square metres.

The guidance uses a risk based approach to classifying C&D waste. The guidance requires inspection at the gate, with a Material Risk Classification Matrix used to classify the materials. Where asbestos is sighted the load should be rejected. Inspection is also required when unloading with the type of inspection dependent on the risk level relevant to the load. This may include sampling of the waste.

This remains consistent with the approach outlined in the EPA Victoria toolkit for C&D waste (EPA Victoria 2017).

The *Occupational Health and Safety Regulations 2007* note that regulations around asbestos handling “do not apply to construction and demolition material -

a) produced in accordance with an auditable process, determined by the Authority, to verify that asbestos-containing material has been removed from that material; and
b) of which less than 0·001% is asbestos-containing material measured using a method determined by the Authority."

This allows for the use of a definition of asbestos in C&D waste.

Queensland

Queensland has no specific guidance on the potential presence of asbestos in the C&D waste recycling industry.

Sections 452 and 453 of the *Work Health and Safety Regulation 2011* require asbestos to be removed before demolition commences so far as reasonably practicable.

The tracking threshold for asbestos is 175 kg non-friable for transport in Queensland.

Queensland does not track asbestos-contaminated soils (or other contaminated soils). However, it does define where waste is asbestos waste to be regulated (>0.01% w/w) based on the contaminated land criteria.

South Australia

South Australia has no specific guidance on the potential presence of asbestos in the C&D waste recycling industry. However, it did conduct a review of the re-use and recycling of clean fill and building and demolition waste (SA EPA 2001). Guidance is available on wastes containing asbestos (SA EPA 2017). A Standard for the production and use of waste derived fill (WDF) includes requirements in relation to asbestos (SA EPA 2013) and includes C&D waste. The following relates to asbestos in these materials:

- The EPA supports the removal of asbestos from the environment and expects that, to the maximum extent possible, persons involved in construction, demolition and recycling take specific measures to ensure that no asbestos is incorporated into WDF. This position is based on the precautionary principle for best practice waste management. This approach aims to continue to reduce the overall risk of exposure to asbestos by preventing pollution and continually removing it from the environment and ensuring its secure and safe disposal at authorised facilities. The EPA does not endorse any safe level of asbestos for use in WDF.
- Any waste proposed for use as WDF that is derived from materials potentially containing asbestos, must be subject to representative analysis in order to demonstrate the material is free of asbestos if it is to be considered as meeting the waste fill criteria.
- If the proponent believes there is a suitable beneficial use that will not pose any risks to human health or the environment, use as fill may be possible at specific sites and under specific conditions. These include:
    - remove all asbestos from the fill to the maximum extent possible and achievable
    - conduct a thorough, scientifically sound and robust quantitative human health risk assessment (refer to information below)

- submit a site management plan endorsed by a site contamination auditor, engaged for that purpose in accordance with EPA requirements, in which the auditor provides the opinion that, based on the knowledge available at the time including appropriate assessment of the site, the WDF is suitable for use, will not pose an unacceptable risk of causing harm and the land will be suitable for its proposed use at the completion of the project. An audit report for the destination of the WDF containing asbestos (ACM) in this regard must be produced at the completion of the project and must be attached to the title of the land in accordance with questions under Form 1 as required by section 7 of the LBSC Regulations
- adhere to all conditions of the site management plan and audit report
- not use the WDF at a destination with a sensitive use.

Any risk assessment would need to comply with the ASC NEPM.

South Australia acknowledges that asbestos waste can be a concern in C&D Wastes, and refers to the above as well as the NSW Draft guidance (NSW EPA 2014) for additional information.

Western Australia

Western Australia have guidelines on the recycling of C&D waste (DEC 2012). These guidelines note the following:

- Recycling C&D waste is important for reducing the demand for virgin materials, diverting waste from landfill and salvaging valuable resources.
- Asbestos is a hazardous material.
- While regulations and procedures are in place to identify and remove asbestos and asbestos-containing materials (ACM) from buildings prior to demolition, there is still a small risk that some asbestos or ACM will be contained in C&D waste that is directed to recycling facilities.
- The operation of C&D waste recycling facilities and landfills accepting asbestos waste are regulated under Part V of the Environmental Protection Act 1986 (the Act).
- The objectives of these guidelines are to document the procedures DEC expects C&D waste recyclers to implement to:
  1. Minimise the risk of asbestos being received and processed at the premises;
  2. Minimise the potential risk of asbestos in emissions within and from their recycling premises; and
  3. Minimise the potential risk of asbestos contamination in recycled construction and demolition (C&D) materials and products.

The procedures outlined in the guidance are summarised as follows:

- If suspect FA or AF are detected, the load must be isolated, kept wet and once appropriately contained and redirected to an appropriately authorised disposal facility.
- Where suspect ACM is identified within a load and is not capable of being easily removed by hand, the load must be rejected and should be isolated, kept wet and once appropriately contained, and redirected to an appropriately authorised disposal facility.

- Where suspected ACM fragments capable of being easily removed by hand are identified in a load, the suspect ACM must be removed from the load and either:
  1. Appropriately isolated and covered for asbestos testing. If testing of representative samples confirms the material is ACM, it must be redirected to an appropriately authorised disposal facility. If testing confirms the material is not ACM, the waste can be added to the stockpile awaiting further processing; or
  2. Assumed to be ACM and redirected to an appropriately authorised disposal facility.
- ACM and FA are subject to visual inspection and sampling procedures since they are larger in size (>7 mm). AF (<7 mm) is assessed by submitting samples for laboratory analysis.
- Each sample collected must be at least 10 litres in volume and then be divided into 2 size fractions (>7 mm and <7 mm) in the field by sieving though a 7 mm screen or spread out for inspection on a contrasting colour fabric. The >7 mm fraction should be examined for any suspect asbestos material and this should be retained to calculate the level of contamination. The <7 mm fraction will need to be a minimum 500 mL, be wetted, and submitted for laboratory analysis. This sample size is considered necessary to improve the limit of detection for asbestos in the analysis procedure.

Sample Analysis Method >7 mm sample fractions as follows:

- Asbestos concentrations (for ACM and FA) should be calculated in accordance with the methods detailed in section 4.1.7 of Department of Health (DoH), 2009, Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia.
- As detailed in the DoH Guidelines, averaging asbestos levels across the stockpile is not appropriate and asbestos levels within each sample should be reported.
- Each <7 mm sample fraction must be analysed for FA and AF. Asbestos analysis must be undertaken by an independent NATA certified laboratory and comply with Australian Standard Method for the Qualitative Identification of asbestos in bulk samples (AS4964–2004) or be demonstrated to be able to achieve the equivalent level of results to this Australian Standard. AS4964-2004 is currently the only method in Australia that has NATA certification and the practicable level of detection for this standard polarized light microscopy method (PLM) and dispersion staining (DS) is 0.01% w/w. It is possible, however, to measure asbestos contamination at or lower than 0.001% w/w where an increased sample size is used, however, DEC recognises that any reporting of concentrations below 0.01% w/w will be outside the conditions set by NATA.
- Therefore, to determine whether recycled products meet the product specification for asbestos content, samples must be a minimum of 500 mL in size. Proponents must adopt one of the following analytical approaches:
  - Detected/non-detected – where any quantity of asbestos is detected by the PLM method it must be assumed, without further analysis, to be in concentrations above the product specification limit of 0.001%w/w. A weight of evidence approach may be adopted i.e. the frequency and occurrence of other positive results in the stockpile can be taken into account, to determine whether the stockpile being assessed is considered to meet the product specification or not; or

- Where any quantity of asbestos is detected by the PLM method, the sample is subject to further testing in the form of a semi-quantitative method with a lower level of detection for asbestos.

- A number of laboratories have developed such semi-quantitative methods for the analysis of low levels of asbestos. Techniques include:
  - The extraction and weighing of fibre bundles or fibre cement material from the total sample; and
  - Measuring the width and length (i.e. volume) of individual fibre by Phase Contrast Microscopy (PCM) and calculating the weight of fibres in the extracted sub-sample.

If the visual inspection, sieve sample or analytical results identify asbestos above or possibly above the 0.001% w/w criteria then that stockpile or product process should be deemed potentially contaminated and considered for off-site disposal as asbestos waste, or subject to further actions to remediate it or to demonstrate its acceptability by further assessment. A record should be made of the decision making and action taken e.g. off-site disposal, further assessment undertaken etc, in relation to that stockpile.

The WA guidelines allow for the hand-picking or emu-picking of ACM materials from the waste (with details provided on how this can be done effectively).

4.12 Australian review

A report was completed in 2011 which included a review of issues relating to C&D waste across Australia (Hyder 2011). The following is a summary of the key findings from that review:

> *Asbestos contamination is a critical issue in C&D recycling, and Federal intervention may be required to produce a workable solution for all stakeholders. Best Practice Guidelines for screening incoming loads to minimise contamination risk, coupled with adoption of a small allowable limit of <0.001% contamination in end products, may provide a solution.*
>
> *Due to the widespread use of asbestos material over many years, resource recovery operators who adopt the most stringent acceptance and testing regimes cannot fully guarantee there are no asbestos fibres in materials coming into their sites and in their final products. In some jurisdictions there is a zero tolerance approach to asbestos, while others have allowable limits of < 0.001% of asbestos in products.*
>
> *In NSW, consultation for this review has highlighted that the presence of asbestos contamination presents one of the most problematic issues for the C&D waste recovery market. Due to widespread use of asbestos material in the NSW construction market over many years, even resource recovery operators who adopt the most stringent testing regimes and make all possible effort to avoid any asbestos coming onto their sites cannot fully guarantee there is no asbestos fibres in their final products. However, the NSW regulator currently has zero tolerance of asbestos in recovered materials.*
>
> *The current situation is extremely problematic, with the potential to completely destroy the C&D resource recovery sector. So long as there is zero allowable limit of asbestos in end products, and no way for even the most diligent operators to guarantee this outcome, all*

> *operators carry continual risk of being in breach of legal requirements. All stakeholders expressed a view that the current situation is unsustainable.*
>
> *One example provided in the review concerned a recent project where 600 tonnes of recycled material was supplied to a client at around $20/tonne (total value approximately $12,000), and a small amount of asbestos material was found in the material (less than 1 kg). The cost for the company to remove all material and clean up the site was estimated at more than $150,000.*
>
> *Industry participants point to the adoption of allowable levels of asbestos in Victoria and WA as a workable solution to this potentially debilitating issue. The allowable limit adopted in Victoria and WA is <0.001% (as discussed in* ***Section 4.11****). While this is a very small percentage, it should be noted that, due to the high volumes of end products coming out of the C&D recycling sector, this could equate to a considerable amount of asbestos being legally allowed into the marketplace. In the example above involving 600 tonnes of products, an allowable limit of 0.001% could equate to 6 kg of asbestos at the project site.*
>
> *An alternative solution that has been discussed by some industry operators is to close their operations altogether and cease attempting to recover resources from C&D waste streams. While wholesale abandonment of existing operations by established and profitable organisations is certainly an extremely unlikely outcome, it should be noted that the issue of asbestos does have the potential to completely close down the C&D resource recovery market in NSW.*
>
> *WorkCover NSW produced a guide for the Management of asbestos in recycled construction and demolition waste (SafeWork NSW 2010). The document was produced in consultation with industry, and is considered a best practice guide to minimising the risk of asbestos contamination in recovered C&D material. The use of this guide, combined with the adoption of some very small allowable limit of asbestos in C&D products, as implemented in Victoria and WA, is worthy of serious consideration. However, the human health, environmental, legislative and political complexities surrounding asbestos in NSW mean that and any change to the government's approach on this issue would require careful management.*
>
> *The management of asbestos in C&D waste recovery and recycling will require the engagement of the State's WorkCover Authority or health department. In Victoria, this approach was taken in collaboration with environmental agencies and the unions representing employee interests, to achieve an outcome that was satisfactory to all parties.*
>
> *Asbestos contamination is one of the most critical issues in the NSW market. Victoria and WA have adopted small allowable limits of asbestos to solve this issue. NSW is unlikely to independently progress toward a similar solution.*

The recycling of wastes, in particular C&D waste, is acknowledged by the Australian Government to be hampered by cross-contamination, with asbestos identified as a well documented problem (NSW EPA 2014).

A national Asbestos Safety and Eradication Agency (ASEA) was established under the Asbestos Safety and Eradication Agency Act 2013 to administer the National Strategic Plan (ASEA 2019) which aims to prevent exposure to asbestos fibres in order to eliminate asbestos-related disease in Australia. Website: https://www.asbestossafety.gov.au/

A review commissioned by the Asbestos Safety and Eradication Agency (ASEA) (ASEA 2016; Blue Environment 2017) identified that the management of asbestos varies across the states of Australia. This includes differences in the definitions of asbestos waste.

There is no threshold for asbestos in waste (i.e. any concentration of asbestos is classified as asbestos waste) in NSW, ACT, NT, QLD, SA.

The *Occupational Health and Safety Regulations 2007* note that regulations around asbestos handling "do not apply to construction and demolition material – (b) of which less than 0.001% is asbestos containing material measured using a method determined by the Authority".

The WA *Environmental Protection (Controlled Waste) Regulations 2004* define material containing asbestos as "material which contains 0.001% or more of asbestos fibres weight/weight". This is likely to dictate thresholds in asbestos waste.

Different states also have different threshold requirements for tracking asbestos waste.

- NSW, Vic, Qld and SA track ACM through waste generator, transporter and receiver to ensure it is disposed of in a facility that will appropriately manage the risks posed by asbestos waste to human health
- SA and Vic both require the tracking of asbestos waste by commercial asbestos waste companies for any amount of asbestos, but do not require tracking of domestic self-haul regardless of the tonnage. SA does not record the fate of the waste asbestos – only the name of the receiving facility.
- The ACT, NT, Tas, and WA do not track asbestos transport for either commercial asbestos companies or domestic self-haul asbestos transport.

For asbestos contaminated wastes (asbestos contaminated soils, C&D wastes):

- Vic, SA, track asbestos contaminated wastes.
- ACT, NSW, NT, Tas, WA do not track asbestos contaminated wastes.
- Qld does not track asbestos contaminated soils under their hazardous waste tracking system, but does have another permitting system for contaminated soils movements.

Comments on approaches adopted in other states

Victoria and Western Australia provide a definition of an acceptable level of asbestos, as measurable fibres, in waste that is consistent with risk-based guidance in the ASC NEPM. The criteria of 0.001% is also consistent with the detection limits that may be achievable for the analysis. Including the requirement to analyse for fibres addressed the key risk related to asbestos – the inhalation of fibres that are not visible so cannot be addressed by current control measures. The WA guidance also allows for the removal of visible ACM by emu-picking, which provides a workable approach to dealing with low risk asbestos in these materials.

South Australia and Queensland are largely silent on an acceptable level of asbestos in C&D waste.

Section 5. International approaches to asbestos in C&D recycling

5.1 General

This section provides an overview of guidelines available in other countries that specifically relate to the C&D industry.

5.2 UK

Asbestos waste is "Hazardous Waste" when it contains more than 0.1% asbestos – definition adopted in England and Wales, with the same criteria for "Special Waste" as adopted in Scotland. It is not permitted to mix asbestos waste with other waste to get below 0.1%.

CL:AIRE CAR-SOIL™ , Control of Asbestos Regulations 2012, Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance (CL:AIRE 2016), where the following is noted:

> *The aim of the guidance is to set out what is good practice for assessing and managing risks from asbestos in soil and C&D materials.*
>
> *'Asbestos' is the general term used for the fibrous silicates listed in regulation 2(1) of CAR 2012. Guidance provided in ACoP L143 states, in respect of the determination of asbestos in bulk materials, that any mixture containing one or more of these fibrous silicates at more than "**trace**" amounts, as defined in Appendix 2 of the first edition of HSG248, Asbestos: The analysts' guide for sampling, analysis and clearance procedures ('The Analysts' Guide'), is within the definition.*
>
> *HSG248 provides a definition for 'trace' amounts of asbestos in bulk samples, below which the Regulations do not apply. It is important for the purpose of this guidance to define what an 'asbestos-containing material' is in the context of soil and/or C&D materials that may have been contaminated by asbestos and, therefore, the point at which the Regulations will apply*
>
> *For representative bulk samples of fragments of suspect materials thought to contain asbestos and submitted for asbestos identification analysis, HSG248 recommends that 'asbestos not detected' is reported when no asbestos fibres are found after careful searching of the sample under the stereo microscope for 10 minutes and searching a minimum of two preparations mounted in suitable Refractive Index (RI) liquid at high magnification by Phase Light Microscopy (PLM)/Phase Contract Microscopy (PCM) for a further 5 minutes.*
>
> *HSG248 goes on to say that if during the search only one or two fibres are seen and identified as asbestos, the term "**asbestos [fibres] identified at the limit of detection**" may be used. This is taken to be the equivalent of 'trace' asbestos, for bulk materials.*
>
> *A 'Blue Book' method describes the quantification of the mass of asbestos in soil, construction materials and products, or associated materials, using a gravimetric method for ACM and fibre bundles, plus dispersion and fibre counting for free fibres using Phase*

Contrast Microscopy (PCM), including calculations for the concentration of Total Fibres and Regulatory Fibres as counted using Annex 1 of HSG248, as appropriate.

Analysis of soil and/or C&D materials in accordance with the 'Blue Book' method requires prior identification analysis by the asbestos identification method described in HSG248. The Limit of Quantification of the 'Blue Book' method is given as 0.001% w/w, based on a practical Limit of Detection of 0.0001%.

*For samples of soil and C&D materials where no fragments of ACMs are isolated and fewer than three asbestos fibres are identified during detailed and extended identification and gravimetric analysis procedures combined, the mass concentration of asbestos fibre is likely to be many orders of magnitude below the 0.0001% w/w Limit of Detection; this generally will be taken to mean '**trace**' asbestos fibre contamination.*

In such circumstances, therefore, on the basis that the potential risk from exposure to such trivial concentrations of asbestos in the external environment is likely to be very low to negligible, it is practical to conclude that such material, whilst containing very few isolated asbestos fibres, is not strictly an ACM that falls under the definition of asbestos in the Regulations.

Prohibitions on the manufacture, supply and use of asbestos and asbestos-containing articles and materials are not contained in CAR 2012. They can be found in direct-acting EU legislation, the Registration, Evaluation, Authorisation & Restriction of Chemicals Regulations (REACH), which applies in the UK and other EU Member States. For the convenience of the reader some information on REACH and its application to asbestos-containing aggregate materials is presented below.

*REACH prohibits the manufacture, placing on the market and use of any article or product to which asbestos has been **intentionally added.***

Recycled aggregates, which fall under the definition of 'articles' under REACH, where asbestos is found to be present are deemed to have had asbestos intentionally added, "subject to evidence to the contrary being adduced in any proceedings.

Caution must be exercised, therefore, to ensure that the mixing of asbestos and inert demolition wastes does not occur if asbestos and/or ACMs have not first been removed from a building prior to its demolition.

5.3 EU

The EU recognises that contamination with asbestos of C&D materials to be recycled is an issue due to the nature of the materials being managed. This is noted to be a key risk to the C&D waste recycling industry (EC 2018).

Asbestos cannot be readily isolated from other components in the mineral fraction of demolition waste. For this reason, the only practical means of guaranteeing the absence of asbestos is to ensure thorough removal prior to demolition, and this, in turn, requires a comprehensive survey of the fabric of the structure to identify occurrences of this material.

The EU has a C&D waste management protocol. This outlines the need for proper removal of asbestos so that it does not contaminate materials for reuse and recycling. Hazardous C&D waste is defined as containing asbestos-based materials in the form of breathable fibres (EC 2016). Hazardous C&D waste is required to be separated from other waste and disposed to an appropriate facility. No more specific detail is provided on the management of asbestos within the protocol.

The EU Council Decision of 19 December 2002 established criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (2003/33/EC). This states that construction materials containing asbestos and other suitable asbestos waste may be landfilled at landfills for non-hazardous waste without testing.

The EU Commission Decision of 16 January 2001 amending Decision 2000/532/EC as regards the list of wastes (2001/118/EC) defines that construction materials containing asbestos were classified as hazardous waste. **Asbestos waste is any waste which contains more than 0.1% w/w asbestos**.

The Nordic Council of Ministers have end-of-waste guidance for C&D waste (Norden 2016) which provides criteria under which specified waste fractions are no longer considered to be waste. The criteria include values for a range of metals and other chemicals but do not include a value for asbestos. The Nordic countries (Denmark, Finland, Norway and Sweden) already have procedures for selective demolition, depollution of buildings and on-site sorting of C&D waste/concrete that, if they are followed and properly inspected, probably will be sufficient to ensure a good quality input material. This includes procedures to effectively reduce contamination from asbestos. Most Nordic countries state that there is a total ban on asbestos in C&D materials.

5.4 United States

Asbestos and ACM is required to be removed during demolition and renovations by an approved contractor and must be properly disposed as asbestos waste.

In the US, most C&D waste is regulated at the state level, with around half the states applying specific C&D regulations. However, when C&D waste contains hazardous materials such as lead-based paint, asbestos, or elements such as lead, mercury, cadmium, PCBs and arsenic, disposal is regulated under the Federal Resource Conservation and Recovery Act (RCRA).

Some states and cities have implemented policies to encourage C&D recycling, including the following:

- Demolition contractors are required to pay a deposit in order to receive a building permit – the deposit is refunded if the contractor can demonstrate that the C&D waste was taken to a certified recovery facility.
- Contractors are required to produce a complete site plan prior to receiving a building permit – the site plan must detail recycling of rubble (concrete/asphalt), land-clearing debris, corrugated cardboard, metals and wood.
- State solid waste legislation specifies recycling goals for counties, and a certain amount of C&D waste is allowed to count toward those goals.

The USEPA provides a document on the characterisation of building-related C&D debris in the US (USEPA 1998). This provides a summary of various state waste requirements. Most do not accept any asbestos materials in C&D debris or waste.

5.5 Canada

Canada provides the following definitions of asbestos[3]:

Airborne asbestos fibre: Asbestos fibres that are longer than 5 µm (micrometres) with an aspect ratio equal to or greater than 3:1 and that are carried by the air.

Asbestos: actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite in their fibrous form.

Asbestos-containing material (ACM): means

- Any article that is manufactured and contains 1% or more asbestos by weight at the time of manufacture or that contains a concentration of 1% or more asbestos as determined in accordance with Method 9002 set out in the document entitled NIOSH Manual of Analytical Methods published by the National Institute for Occupational Safety and Health, as amended from time to time, or in accordance with a scientifically proven method used to collect and analyse a representative sample of the material; and
- Any material that contains a concentration of 1% or more asbestos as determined in accordance with Method 9002 set out in the document entitled NIOSH Manual of Analytical Methods published by the National Institute for Occupational Safety and Health, as amended from time to time, or in accordance with a scientifically proven method used to collect and analyse a representative sample of the material.

Zero airborne asbestos concentration: The concentration of “zero” airborne asbestos fibres in COHSR 10.19 (1.1, 3) corresponds to a recognized asbestos analytical method, such as NIOSH Method 7400 or NIOSH Method 7402, used to analyse an asbestos sample that returns a result that is below the limit of detection (LOD) of the analytical method. The LOD of NIOSH Method 7400 and of NIOSH Method 7402 is less than 0.01 f/mL (cm^3). After a qualified person conducts asbestos air sampling, when a result is below the limit of detection for that method, the asbestos sample can be effectively considered to be “none detected” or “zero”. The specific value of the LOD is set by the technological limits of the analytical equipment required in the analytical method, rather than being chosen by a person.

In relation to consumer products (which would be expected to include recycled products), Canada has regulations that prohibit the import, sale and use of processed asbestos fibres. Asbestos is a commercial term applied to six different varieties of minerals: chrysotile, amosite, crocidolite, anthophyllite, tremolite and actinolite. Based on current scientific data, human health risks associated with exposure to trace amounts of naturally occurring asbestos are expected to be low.

[3] https://www.canada.ca/en/employment-social-development/services/health-safety/reports/asbestos-exposure-management-programs.html

Hence Environment and Climate Change Canada and Health Canada have defined what are considered to be **trace amounts of asbestos**, as follows[4]:

- Trace amounts of asbestos are those below 0.1% when measured using a suitable standard analytical method with polarized light microscopy (PLM).
- At present, test results identifying asbestos at 0.1% or more, with fibres that demonstrate both of the following characteristics, will be considered by Environment and Climate Change Canada and Health Canada as evidence of the presence of asbestos in more than a trace amount:
    - Fibres longer than 5 µm, with a mean aspect ratio greater than 3:1. Aspect ratios should be determined for fibres, not bundles.
    - Very thin fibrils, less than 3 µm in width.

Ontario laws in relation to C&D waste (R.R.O. 1990, Regulation 347[5]), define asbestos waste as follows:

"**asbestos waste**" means the following solid or liquid waste that contains asbestos in more than a **trivial** amount:

1. Waste that results from the removal of asbestos-containing construction or insulation materials.
2. Waste that results from the manufacture of asbestos-containing products.
3. Waste that results from the removal of asbestos-containing components from a motor vehicle.
4. Waste that results from the removal or handling of waste or materials described in paragraphs 1, 2 and 3, including personal protective equipment, tools that cannot be decontaminated and cleaning materials.

The law does not define "trivial", but Section 17 includes details on the management of asbestos waste.

[4] https://www.canada.ca/en/environment-climate-change/services/management-toxic-substances/list-canadian-environmental-protection-act/asbestos/trace-asbestos-consumer-products-guidance.html

[5] https://www.ontario.ca/laws/regulation/900347

Comments on international approaches

Most international jurisdictions are clear that the effective and complete removal of asbestos at a site, prior to demolition is key to managing asbestos in C&D waste. Some jurisdictions adopt the concept of zero asbestos in waste.

The UK and Canada go further and allow for trace amounts of asbestos to remain. The UK adopts the reporting limit for the detection of fibres (using a specified method). Canada provides a definition of trace levels that is higher than in the UK. Ontario references the term trivial but does not define trivial. Further discussion on trivial is provided in **Section 6**.

Canada also provides a definition of zero asbestos in air, which is essentially the reporting limit of the method (with the analysis method stated).

The concept of zero asbestos is meaningless (refer to **Section 3**), as we are all exposed to background levels of asbestos all of the time, and with anything that requires measurement, a non-detection never means zero.

Being able to define what is meant by “zero” or allowing consideration of trivial levels of asbestos and defining what is trivial enables these concepts to be better understood by industry and the community.

Section 6. Contamination: Trivial or not

In Australia (referent to **Section 4**), the definitions of asbestos are very general. In addition, with the exception of Victoria and Western Australia, there are not quantitative amounts of asbestos that may be present in waste for recycling in C&D waste. Where states such as NSW have a "zero tolerance" approach, there is no definition of what "zero" means. Internationally, there are a number of jurisdictions where the concept of trivial or trace levels are permitted and defined, with Canada also providing a definition of what is meant by "zero". Most of these levels or definitions relate to the detection limit for a particular method (with the method specified).

Whenever something is measured, the concept of zero is meaningless as it depends on the measurement method used, which has a unique detection limit or practical quantitation limit. There is no way to measure zero for any chemical. The ASC NEPM (NEPC 1999 amended 2013e) indicates that the term non-detect should be used rather than zero or not present when reporting results in relation to contamination.

The concept of trivial levels of contamination or pollution is used in NSW legislation.

The NSW EPA does not use licensing to regulate every potential pollutant that could be contained in a discharge or activity. This is because some pollutants are present at such low levels in a discharge that they are highly unlikely to pose a reasonable risk of harm to human health or the environment. Also, some activities are conducted in such a way that discharges to the environment are avoided – such as where an intensive agricultural activity uses an engineered runoff retention basin.

The POEO Act 1997 (Part 5.7, Section 147) in relation to duty to notify pollution incidents defines that "*harm to the environment is material if – (i) it involves actual or potential harm to the health or safety of human beings or to ecosystems that is **not trivial***,".

In addition, "***land pollution** or **pollution of land** means placing in or on, or otherwise introducing into or onto, the land (whether through an act or omission) any matter, whether solid, liquid or gaseous - (a) that causes or is likely to cause degradation of the land, resulting in actual or potential harm to the health or safety of human beings, animals or other terrestrial life or ecosystems, or actual or potential loss or property damage, that is **not trivial**,"*

In relation to pollution of water, the NSW EPA licencing fact sheet[6] states that:

- It is the responsibility of licence holders to:
  - be aware of the pollutants that are discharged to waters from their premises
  - be aware of the environmental impacts that pollutants discharged from their premises have on the environment
  - ensure that their licence specifically regulates the discharge from their premises of all those pollutants that pose a risk of **non-trivial** harm to human health or the

[6] https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/epa/130119eplswater.ashx

environment – where the premises discharges a pollutant that is not regulated by the licence, the licence holder does not have a defence against the pollution of waters offence for the discharge of that pollutant.

- Licence holders are unlikely to be complying with their licence or the POEO Act if a discharge from their premises:
  - does not comply with the concentration limits for each pollutant specified in condition L3.3 of the licence, or
  - contains pollutants other than those specified in condition L3.3 of the licence and those pollutants are at levels that are **not trivial** – '**trivial**' here relates to both the concentration of the pollutant as well as its risk to the environment.
- The EPA Prosecution Guidelines set out how the EPA decides what regulatory action to take, ensuring that all relevant matters are considered, and the action is proportional to the offence (the **EPA does not act on trivial matters**).

The concept of trivial is also adopted by SA EPA (SA EPA 2008, 2019) in the *Environment Protection Act 1993* (*EP Act*) in relation to site contamination – Section 5B:

> *(1) For the purposes of this Act, site contamination exists at a site if— (a) chemical substances are present on or below the surface of the site in concentrations above the background concentrations (if any); and (b) the chemical substances have, at least in part, come to be present there as a result of an activity at the site or elsewhere; and (c) the presence of the chemical substances in those concentrations has resulted in— (i) actual or potential harm to the health or safety of human beings that is **not trivial**, taking into account current or proposed land uses; or (ii) actual or potential harm to water that is **not trivial**; or (iii) other actual or potential environmental harm that is **not trivial**, taking into account current or proposed land uses.*

To assist in determining 'actual or potential harm' and 'not trivial', as stated in each point of section 5B(1)(c) of the EP Act, the application and use of published investigation criteria or trigger levels is considered appropriate. In assisting consultants and auditors to make consistent determinations of the existence of site contamination, the SA EPA has reviewed available national and international guidance and adopted published criteria. Those that are recognised as appropriate criteria by the EPA are specified in Appendix 2 of the site contamination guideline (SA EPA 2019). Appendix 2 includes the ASC NEPM health screening levels for asbestos contamination in soil.

The description of trivial also includes the concept of background (SA EPA 2008) – **concentrations consistent with background are considered trivial**.

Comments on trivial

The concept of defining pollution based on its potential to cause harm and whether or not it is non-trivial is already within NSW legislation and guidance. The concept of non-trivial, however, is not defined, particularly in terms of asbestos, where it gets caught up in the definitions of asbestos in the POEO Regulation which effectively mean zero-tolerance.

The SA EPA also adopts the concept of trivial and has included consideration of background, which is important for asbestos (refer to **Section 3**) and references the health based guidelines on asbestos in the ASC NEPM to assist in understanding what is considered trivial.

Given the concept of trivial is already relevant in NSW, it would be appropriate to provide a definition of what is non-trivial in terms of asbestos in C&D recycling industry. Defining such levels could be undertaken such that it reflects the reporting limits for asbestos (refer to **Section 4.10**) and the level of risk posed by the materials likely to be present in C&D waste (refer to **Section 3**) and require management.

To further evaluate the concept of trivial, the background concentrations of asbestos in air presented in **Section 3.2** have been further considered.

Based on a background outdoor dust concentration of 0.039 mg/m^3 (NEPC 1999 amended 2013b), and an assumption of 0.0001 f/mL background level of asbestos in air (low value for urban air and reasonable for rural air as per **Table 3.1**), this relates to a soil concentration of 0.0077% w/w, calculated using the following equation.

$$\text{Soil criterion} = \frac{\text{Asbestos in air x mass}}{\text{Dust concentration}} \qquad \text{(mg asbestos/mg soil)}$$

where:
Air concentration = 0.0001 f//mL
Mass of an asbestos fibre = 3 x 10^{-8} mg/f (USEPA 1986)[1]
Dust concentration = Concentration of soil (dust) in the air (mg/mL = mg/m^{3}x10^{-6})

This is higher than the asbestos guideline for friable asbestos in soil adopted in the NEPM (**Section 4.3**) and, also, higher than the guideline adopted for asbestos in C&D recycling in Victoria and Western Australia (**Section 4.11**). The soil concentration that relates to an air concentration is dependent in the level of dust generated, however, the above is presented to illustrate that achieving a 0.001% w/w criteria in soil or waste results in air or exposure concentrations of asbestos below background.

Where background exposures are considered, the value of 0.001% could be considered trivial (refer to **Section 6**).

Section 7. Current C&D recycling processes in NSW

7.1 General

This section provides a description of the current C&D recycling processes, including the procedures adopted to identify and manage asbestos. This section also provides a list of the current issues with the existing regulatory system for the management of asbestos. Some of the information presented in this section has been provided by the C&D industry.

7.2 General description of the C&D recycling process

C&D recycling can be broken down into three distinct waste streams:

1. Mixed waste such as demolition materials, building site clean-up waste and skip bin collected waste;
2. Source separated concrete, brick, and asphalt; and
3. Unprocessed soils.

There are other C&D waste streams such as source separated timber and plasterboard but these are not included in this report.

It must be emphasised that the first and key phase of managing asbestos materials in C&D waste occurs "upstream" well before materials leave a site and may be transported as C&D waste. NSW, along with all other states and territories, require the removal of asbestos waste at the source – i.e. at the building, prior to demolition or other works. In NSW, these requirements are detailed in Chapter 8 of the *Work Health and Safety Regulation 2017 (WHS Regulation 2017)*.

Friable asbestos, and any fire damaged asbestos material, is required to be removed by a licenced[7] asbestos removalist, prior to demolition or any other works. The requirement to use a licenced asbestos contractor for these materials reflects the level of risk these materials pose to workers and the public, should they not be removed and disposed properly. Where this process is undertaken properly, then no friable asbestos or fire damaged asbestos, would be present in C&D waste.

Small quantities (up to 10 m^2) of non-friable asbestos are permitted to be disposed by householders and contractors with no asbestos licence. This is the source of waste that poses the greatest risk for C&D waste in terms of the potential presence of asbestos.

The removal of more than 10 m^2 of non-friable asbestos[7] is required to be undertaken by a licenced asbestos removalist.

There are a range of requirements detailed in the *WHS Regulation 2017* that must be followed for the removal of asbestos by a licenced removalist, including completion of a clearance inspection and issuing a clearance certificate. The clearance requires no visible asbestos residue from

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[7] The contractor must hold a Class A licence that permits the removal of any amount of friable asbestos. A Class B licence does not permit removal of friable asbestos but allows for the removal of any quantity of non-friable asbestos. Refer to NSW *WHS Regulation 2017* and SafeWork Australia guidance for further detail.

asbestos removal work in the area, or in the vicinity of the area and airborne fibre levels less than 0.01 f/ml.

It is noted that the *WHS Regulation 2017* requirements in relation to asbestos do not apply to soil where (Clause 419 (5)):

i. there is no visible ACM or friable asbestos, or
ii. if friable asbestos is visible – does not contain more than trace levels of asbestos determined in accordance with AS 4964:2004.

AS4964:2004 details the method for qualitative identification of asbestos in bulk samples and includes a method for determining trace levels, which uses polarised light microscopy. This method has a detection limit of 1 in 10000 parts by weight or 0.1 g/kg or 0.01% w/w. This means it is permitted for waste to contain trace amounts of asbestos when it leaves a demolition/construction site.

Processes and procedures at C&D waste recycling facilities

The procedures at the facilities include:

1. The mixed waste streams use specialised purpose-built sorting plants that separate the different waste materials generally by shredding, screening and density separation. The aim is to separate the waste into the following:
   - Clean masonry fraction to meet the requirements of the Recovered Aggregates Resource Recovery Order
   - Clean soil to meet the Recovered Fines Resource Recovery Order
   - Steel for recycling by others
   - Non-ferrous for recycling by others
   - Wood suitable for reuse complying with the Compost or Mulch Resource Recovery Orders or as alternate fuels in approved facilities
   - Other materials such as plasterboard, green waste, and cardboard for recycling by others
   - Residual waste either for further processing at other facilities or for landfill.
   - A typical percentage split of materials produced from the mixed C&D waste recycling process is:
     - Soil = 35-45%
     - Masonry =20-30%
     - Wood =10-15%
     - Ferrous & Non-Ferrous metal = 3-5%
     - Other = 1-2%
     - Residual waste = 15-25%
2. Source separated concrete, brick and asphalt material is recycled using crushing and screening equipment and the products produced are manufactured to the relevant Resource Recovery Orders. Ferrous and non-ferrous metal is produced for recycling by others during this process. Only a very small percentage of residual waste is produced when processing source separated concrete and brick (<0.1%).

The products produced are used in drainage works, behind retaining walls, electrical trenches, temporary ground cover on building sites, under concrete slabs, pipe backfill and in various landscaping applications. Many products are additionally manufactured to comply with specifications from the Transport for NSW, Sydney Water Corporation, electricity supply utilities and local councils and as such are extensively used in road construction.

3. Soils are typically processed at C&D recycling facilities via screening to produce recovered fines, masonry for subsequent crushing and screening to make recovered aggregates, and residual waste.

7.3 Current processes/procedures used to identify and manage asbestos

Under current EPA legislation, a C&D recycling facility must comply with the requirements set out in the EPA's document "*Standards for managing construction waste in NSW".*

This Standard imposes minimum procedures including various stages of inspection during the receival and processing stages.

The requirement of the Standard is to undertake **visual** inspections at the weighbridge, upon discharge of the load and upon spreading of the load prior to it being incorporated into a stockpile for processing. Visual inspections are also required of product stockpiles after processing and prior to despatch from the premises.

The important fact here is that the inspections required are visual only and consequently only pieces of asbestos containing material (ACM) will be observed as asbestos fibres are not visible to the naked eye.

Many facility operators have equipped their facilities with a "Micro Phazir" (or similar) portable asbestos analysis device to assist in the identification of material as ACM. It is noted that these devices are not NATA certifiable or 100% accurate in the detection of ACM. In addition, these devices cannot identify if any fibres may be present in waste.

Under the current Standard, any load of waste that has even a single piece of ACM (regardless of size) MUST be rejected by the facility and the details recorded in a register as per the Standard.

7.4 Current issues with the existing system for the management of asbestos in this industry

By way of background, the long-term recycling facilities in the Sydney waste industry have been managing asbestos through inspection of incoming loads since the early 2000's. These facilities have their own written procedures that they follow. In 2010 Workcover produced a Guide titled *'Management of asbestos in recycled construction and demolition waste'.* The industry groups WMRR (formerly WMAA) and WCRA contributed to this document by aggregating their members inspection procedures. This document was extensively adopted by Workcover in their Guide.

In 2019 the EPA released their document "*Standards for managing construction waste in NSW"*. The fundamentals are the same as the Workcover Guide, however, its more prescriptive regarding how to manage stockpiles.

These new Standards mandate the inspection and rejection protocols, however, make it extremely onerous when a piece of asbestos is found in a stockpile of material that has previously been inspected and cleared.

The EPA (some staff, as noted by industry) appear to be of the view that the Standards will totally prevent ACM being found at a recycling facility but this is not achievable due to the nature of the waste received and the range of possible sizes of ACM.

The current situation is that, if ACM is observed at a facility, then the facility will likely be put into a lockdown situation and much investigation work required to resolve the issue prior to reopening the facility, invariably with significant time delays and costs. This will be triggered primarily due to waste materials from sites that had only small quantities of ACM which were permitted to be managed by non-licensed people. For wastes from sites that had large amounts of ACM, the strict requirements for occupational hygienists/licenced removalists should ensure that it is unlikely that such waste will contain visible pieces of ACM.

It is understood that the EPA is currently working with the industry to develop a procedure to manage an “unexpected find” of ACM so that it does not place undue/unnecessary strain on the facility both for its continued operation and financially risking its continued operation. This is a logical approach provided requirements for removing ACM at the point of demolition is undertaken to the same standard as required to be met at the waste facility, and then any ACM find should truly be an “unexpected find”.

The following provides a list of issues identified by the industry with the existing system:

- There appears to be no practical understanding of how difficult it is to inspect mixed waste to be able to guarantee there is no ACM present. If there is a large quantity of ACM in the load it will be obvious. It’s not possible, however, to see small fragments of ACM (say < 2-3 mm in size) mixed in with a variety of wastes such as plastic, plasterboard, timber, cardboard, soils etc.
- There is no understanding that ACM may be stuck to the underside of concrete or encapsulated in the concrete. This material cannot be found easily through visual inspection.
- Most large demolitions have asbestos clearances prior to the demolition of the walls and slabs. These are visual inspections and it is entirely possible for small pieces or fibres to remain mixed with the waste. This then becomes the responsibility of the recycler if these small amounts are found in products.
- Asbestos clearances are allowed to be issued even though trace amounts of asbestos material may remain in the waste which means the waste recyclers bear responsibility for material that has been passed as appropriate in another section of the industry
- Currently the EPA is proposing that when ACM is found in stockpiles or processing plants, that the facility stops operating and engages a hygienist to determine the way forward. This would include removing a quantity of stockpiled material to landfill as asbestos waste. Emu picking ACM out of stockpiles is not permitted by the EPA. This is not viable as the hygienist is not always immediately available and the facility may be closed for a number of days until the matter is finalised. Emu picking is allowed by other states in Australia once appropriately risk assessed e.g. QLD and WA.

- If ACM is found in recycled products supplied to a building site, the EPA provides no guidance other than to say any waste containing asbestos is asbestos waste and asbestos can't be recycled. This leaves the site in the difficult position as to what to do with the ACM material/recycled product. If they have one piece of ACM in 1 tonne it is easy to take it all to landfill. If there are 10 pieces found on the surface of a road where 1000 t has been supplied placed and compacted that's a more difficult problem to determine what to do.
- The regulatory framework as it relates to asbestos and the lack of a due diligence defence for facility operators. This is a critical driver as to whether businesses choose to continue operating within a 'system' that has such exposure to prosecution.

Many of these issues can be solved with a workable "Unexpected Finds' procedure that is robust and does not pose unacceptable environmental or health risks. There is a need to develop a sensible solution to ensure the viability of the C&D waste recycling industry.

Comments on the current processes

The current processes in NSW place all onus on the C&D facility to ensure there is “zero” asbestos, with these operators taking on significant legal risk in receiving waste from various sources.

The *WHS Regulation 2017* details requirements for the removal of asbestos “upstream” of the C&D recycling facility. It is entirely reasonable that an operator of a C&D recycling facility should be able to rely on works being undertaken in accordance with this regulation to ensure asbestos is removed from the waste being delivered. The key issues identified in that process are as follows:

- The removal of asbestos from buildings and structures as detailed in the *WHS Regulation 2017* does NOT require achieving and demonstrating “zero” asbestos. The *WHS Regulation 2017* has guidance on what comprises clearance (following asbestos removal) and allows for trace levels to remain in soil/waste. Neither of these requirements are consistent with “zero” asbestos. In fact, the definition of trace levels in relation to soil results in the use of detection limits that are consistent with the NEPM criteria (NEPC 1999 amended 2013a) for ACM for residential land use, but higher than the criteria for friable asbestos.
- The *WHS Regulation 2017* (and associated SafeWork Australia guidance) allows for the removal and disposal of up to 10 m^2 of non-friable ACM by individuals with no asbestos licence. The *WHS Regulation 2017* requires such materials be removed by a competent person, however, there are no requirements for clearance inspections to occur or certificates to be issued. This aspect poses the greatest risk to C&D recycling facilities as the proper removal and disposal of up to 10 m^2 does not require reporting or verification. Hence waste sent to C&D recycling facilities may include ACM from these sites.

As the processes currently applied to upstream generators of waste do not and cannot result in “zero” asbestos in the waste, the onus to achieve “zero” asbestos in waste being received at a waste facility appears to fall on the operator of the facility, at the gate. This is a significant disconnect or inconsistency.

If the C&D recycling facility can only receive waste with “zero” asbestos and the waste they receive must be cleared by people licenced by SafeWork NSW, then they should be able to rely on the procedures in the upstream waste generation stream to achieve that goal. So the on-site procedures should be sufficient to produce waste containing trivial or zero asbestos

To further compound the disconnect/inconsistency, other aspects of waste regulated in NSW, specifically contaminated soil and air emissions, certainly do not require “zero” asbestos as they allow for asbestos to be present at some level. In the case of air emissions, significant levels of asbestos in air can be lawfully discharged from a stationary source (refer to **Section 4.4**).

Many international jurisdictions make it clear that it is the responsibility of upstream waste generators to ensure that asbestos is removed from waste being delivered to C&D recycling facilities (refer to **Section 5**).

The current procedures do not appear to have any flexibility in allowing the facility to adopt appropriate practices for the identification and management of asbestos, utilising qualified asbestos experts and enabling risk-based decisions to be made in relation to the likely nature of asbestos that may be present, and how to manage those materials. This appears to result in the classification of large amounts of waste and recycled product (at times) as asbestos waste (as defined under the POEO Act). It also appears that the operator of such a facility is required to bear the cost and liability of this waste and the consequences of the waste containing "any asbestos" (or not achieving "zero asbestos") as is currently the situation even though they have no control over the production of the material for recycling and regulations exist to ensure such producers of waste for recycling provide appropriate materials. In addition, asbestos can also be present in such waste due to it being naturally present in soils – i.e. not due to any human activities.

The likelihood of friable asbestos being present in C&D waste is low. The form of asbestos most likely to be present in C&D waste is non-friable ACM which is of low risk in relation to worker and community health (refer to **Section 3.2**). To ensure this material remains low risk, procedures to remove this material prior to any significant mechanical disturbance (the key process by which fibres may be released) should be adopted. This would be at the point of removal (i.e. upstream) and upon receipt at a facility.

Section 8. Outcomes

This review has focused on understanding the complexities of dealing with asbestos contamination in waste that is accepted, handled and managed in the C&D recycling industry in NSW. The recycling of waste, including C&D waste is a key aspect of the waste management system in NSW, to reduce the volume of waste sent to landfill.

This review has considered the current legislation and guidance in NSW as well as approaches adopted in other states of Australia and Internationally, on the identification and management of asbestos contamination in these materials. The C&D recycling industry has identified a range of issues related to the way in which asbestos is managed at recycling facilities that have posed significant difficulties.

The review has identified a number of key outcomes which are summarised below:

Hazards posed by asbestos

- It is clear that there are a range of hazards posed by the potential presence of asbestos in any environment. The key hazards relate to asbestos fibres that are of biological concern, i.e. those equal to or longer than 5 μm and having diameters up to 3 μm with an aspect ratio equal to or greater than 3:1, that can move into the air and be inhaled. When assessing asbestos, there are a range of different methods that can be used to quantify asbestos fibres, some of which enable characterisation of the fibres with characteristics that have the potential to pose hazards to human health when inhaled. The selection of the quantification method is important as each will report different aspects in relation to asbestos exposure and risk. Hence guidelines are often tied to specific analytical methods.
- Different types of asbestos pose different levels of risk to workers and the community. Asbestos that is bonded in materials (or cement sheeting) poses the lowest risk, while loose fibres, such as those present in friable asbestos, that can easily move into the air pose the highest risk.
- In relation to potential risks posed by C&D waste:
    - There is a low potential for friable asbestos to be present in C&D waste where these materials are effectively managed at the point of removal from buildings and structures (i.e. upstream)
    - The most likely form of asbestos is bonded asbestos, which is of low risk, except where the bonded material is mechanically damaged. When this occurs, there is the potential for some fibres to be released to air, where exposure may occur. This material can be more easily identified and managed in waste materials. The most effective way to manage the potential for this damage to occur is for it to be effectively removed upstream or identified at the gate.
- The background presence of asbestos fibres in air, which is relevant to all members of the community in urban and rural areas means that the concept of zero asbestos or zero asbestos exposure is meaningless.
- While it is accepted that zero tolerance is part of NSW asbestos waste regulations and community expectations, the concept is meaningless in technical terms. Everyone is exposed to fibres from natural sources. Such sources are not targeted for management by

regulation or policy. In addition, the concept of 'zero' for anything that requires any form of measurement is meaningless as its detection depends on the reporting limit of the method. It is never possible to determine "zero", only that something cannot be detected.

Definition of asbestos

- The definition of asbestos in the POEO Act, which is adopted throughout all of the NSW regulations and is consistent with the definitions adopted in other states is very general. In addition, the definition of asbestos waste is very general and appears to have resulted in the zero-tolerance approach adopted in NSW, where the concept of any asbestos means it is an asbestos waste.
- The use of such a general definition does not enable risk to be considered, nor the characteristics of asbestos, namely fibres of a particular length and width that are of importance to the hazards that asbestos poses (refer to **Section 2**). In addition the definition does not allow any distinction between risks posed by ACM likely to be visible (i.e. bonded or in products), which are low risk, and asbestos fibres that can easily move into the air, which are high risk.
- This lack of regulatory definition, and link with the characteristics of asbestos that are hazardous, results in misunderstanding and misinformation that the hazards relate to the general term asbestos, and how these relate (or not) to the toxicological studies

Current asbestos guidance

Current guidance on asbestos in NSW is mixed and is the cause of many of the issues identified by the C&D recycling industry. There is a requirement for this industry to have "zero" asbestos in waste received and managed at a facility, and "zero" tolerance on the presence of asbestos in recycled products produced.

While the concept of "zero" asbestos is meaningless, the requirement is also disconnected from other regulations and guidance in NSW:

- The key disconnect relates to the *WHS Regulation 2017*, that relates to the requirements for removing and managing asbestos from buildings and structures prior to demolition (the process that produces the waste received by a C&D facility). The *WHS Regulation 2017* does not require "zero asbestos" post asbestos removal and allows for soil to include trace levels of asbestos, which is defined as <0.01% w/w. In addition, removal of small amounts of ACM (<10 m^2) poses the greatest risk of being present in such wastes.
- NSW utilises the NEPM (NEPC 1999 amended 2013a) for the assessment and management of contaminated soil, where risk-based guidelines for the presence of asbestos that may remain in soil in different land use settings is defined.
- NSW allows for emissions to air of asbestos from stationary sources (NSW EPA 2016a), at levels that may result in significant airborne asbestos exposures within the community, well above background levels and well above WHO air guidelines.

The requirement for "zero" asbestos appears to only apply to the C&D recycling facilities. Such a requirement is not workable where the waste being delivered does not have a requirement to have "zero" asbestos when it leaves the place where such waste was produced. This places the onus and liability (of prosecution) of managing asbestos to a zero-tolerance level on the operators of the C&D facilities alone and not onto the producers of the waste being recycled.

Current NSW EPA Standard (EPA 2019)

These documents relate to visual identification of ACM.

- ACM, where bonded in materials which would be visible is considered to be low risk in terms of health and can be easily removed from soil or waste using an emu-picking approach (noted to be permitted in the 2010 Worksafe guidance, but not in 2019).
- The greatest risk, however, relates to loose asbestos fibres. As discussed in **Sections 2, 3** and **4**, the key risk for workers and the community (including consumers) relates to the inhalation of fibres. The potential for friable asbestos to be present in C&D waste is low, and the release of any fibres from bonded asbestos can be minimised by the effective removal of these materials prior to mechanical damage.

Other Australian States

- South Australia and Queensland are silent on the management of asbestos in C&D waste.
- Victoria and Western Australia provide a definition of an acceptable level of asbestos, as measurable fibres, in waste that is consistent with risk-based guidance in the ASC NEPM. The criteria of 0.001% is also consistent with the detection limits that may be achievable for the analysis. This guidance includes the requirement to analyse for fibres addressed the key risk related to asbestos – the inhalation of fibres that are not visible so cannot be addressed by current control measures. The WA guidance also allows for the removal of visible ACM by emu-picking, which provides a workable approach to dealing with low risk asbestos in these materials.

International approaches

- Most international jurisdictions are clear that the removal of asbestos at a site, prior to demolition is key to managing asbestos in C&D waste. Some jurisdictions adopt the concept of zero asbestos in waste.
- The UK and Canada go further and allow for trace amounts of asbestos to remain. The UK adopts the reporting limit for the detection of fibres (using a specified method). Canada provides a definition of trace levels that is higher than in the UK. Ontario references the term trivial but does not define trivial.
- Canada also provides a definition of zero asbestos in air, which is essentially the reporting limit of the method (with the analysis method stated).
- The concept of zero asbestos is meaningless, as we are all exposed to background levels of asbestos all of the time, and with anything that requires measurement, a non-detection never means zero.
- Being able to define what is meant by “zero” or allowing consideration of trivial levels of asbestos and defining what is trivial enables these concepts to be better understood by industry and the community.

Trivial

- The concept of defining pollution based on its potential to cause harm and whether or not it is non-trivial is already within NSW legislation and guidance. The concept of non-trivial, however, is not defined particularly in terms of asbestos, where it gets caught up in the definitions of asbestos in the POEO Regulation which effectively mean zero-tolerance.
- The SA EPA also adopts the concept of trivial and has included consideration of background, which is important for asbestos. They reference the health based guidelines on asbestos in the ASC NEPM to assist in understanding what is considered trivial.
- Where background exposures to dust and asbestos are considered, adopting a soil or waste guideline of 0.001% w/w for friable asbestos (which is consistent with NEPC guidance on contaminated land, and also consistent with the criteria for asbestos in C&D waste in Victoria and Western Australia) would result in inhalation exposures that are below background in urban and rural areas, and could be considered to be trivial.
- Given the concept of trivial is already relevant in NSW, it would be appropriate to provide a definition of what is non-trivial in terms of asbestos in C&D recycling industry.

To be able to effectively manage asbestos contamination that may be present in C&D materials taken to facilities for the purpose of recycling, there are some fundamental aspects of legislation and policy in NSW that have to be changed, including:

- Changes to the *WHS Regulation* to ensure that waste generated from the demolition of structures with asbestos (friable and non-friable) adopt the same threshold or definition of “zero” asbestos as required to be adopted by the C&D recycling industry. Only where requirements in relation to the presence (or otherwise) of asbestos is the same for the generators of the waste and the C&D recycling industry can future protocols relating to “unexpected finds” be relevant and applicable.
- Rework the definition of asbestos, so that it is better linked with the characteristics of asbestos that pose hazards to human health, and can be matched with measurement methods.
- Providing a definition of zero asbestos in the context of measurement (i.e. reporting limits for methods) and background or non-trivial exposures and risks.
- Allowing for the hand-picking or emu-picking of visible ACM prior to transport to a facility, and at receipt at a facility as this is the material most likely to be present in C&D waste and this material is of low risk. There are numerous examples of procedures that can be used to ensure this is done effectively and safely.

Without the above legislative changes, it will be very difficult to establish a workable protocol or procedure for C&D waste recycling that does not result in significant liabilities remaining with the owners of these facilities in relation to the presence of asbestos.

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APPENDIX H

Economic and Community Impacts of Asbestos Regulations for Construction and Demolition Recycling
CIE, May 2021

COMMERCIAL IN CONFIDENCE

FINAL REPORT

Economic and community impacts of asbestos regulations for construction and demolition recycling

Prepared for
WCRA and WMRR

25 May 2021

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Contents

BOXES, CHARTS AND TABLES

Executive summary

The CIE has been commissioned by the Waste Contractors and Recyclers Association (WCRA) and the Waste Management and Resource Recovery Association (WMRR) to assess the economic, social and environmental consequences of three alternative options for managing asbestos waste in construction and demolition (C&D) material.

This is due to the concern that NSW industry operators have in relation to the inability to meet the zero tolerance to asbestos presence approach in the current NSW regulatory framework (including recent case law), and the concern that in the absence of a realistic, agreed framework for managing unexpected finds of asbestos by construction and demolition (C&D) recyclers, operators will not be able to continue to operate in NSW. These industry concerns are further exacerbated by the indefensible liabilities imposed on the recycling sector in 2018.

The C&D processing and recycling sector is the largest waste sector in NSW, responsible for processing over 13.4 Million Tonnes of waste in 2018/19. This is approximately 60 per cent of the total waste generated in NSW. Furthermore, the sector achieves the highest diversion rates, and is the only sector achieving the current NSW EPA recycling target of 80%.

For the specific set of C&D recycling activities covered by this report, i.e., only the recycling operations on licensed sites and not the collections/transport component of the value chain, they input around 7 Million Tonnes of material each year, covering revenue of over $500 Million and employment ~1000 FTEs. This covers less material volumes than data on C&D published by NSW EPA, as EPA figures include virgin excavated natural material (VENM)[1] and some C&D recycling would go to other facilities (such as metal recyclers or previously interstate).

As will be evidenced in this report, the C&D recycling sector is highly efficient at recycling, offering substantially better disposal prices as compared to landfilling, and better prices for materials produced than compared to virgin materials. The sector is integral to keeping valuable materials out of landfill, maximising the life of NSW quarries, keeping NSW construction costs competitive nationally, as well as a myriad of environmental and social benefits — not the least of which being jobs and investment in NSW within both the waste and resource recovery (WARR) and construction sectors.

This report aims to provide a robust evidence base to understand the impacts of different options for asbestos management at construction and demolition (C&D) recycling facilities, and end users of C&D products. To do this, we have considered three Scenarios for asbestos management in NSW:

1 In 2018/19 this amounted to ~2.6 Million Tonnes.

- Scenario one (Worst case scenario) — the current legislative framework[2] including the *Protection of the Environment Operations Amendment (Asbestos Waste) Act* 2018[3] and common law (Grafil)[4] scenario with no presence of asbestos allowed and large penalties. This results in the C&D recycling industry operators considering the risks too high as legislative requirements cannot be met, and discontinuing recycling operations.
- Scenario two (EPA scenario) — based on the EPA's proposed guidelines issued to industry dated October 2019, to assist with asbestos management when there is an unexpected finds at C&D recyclers and end users of materials produced from recycled products. This scenario also assumes that the EPA amends the regulations to abandon the "presence test" introduced in 2018 and reverts to a risk-based approach.
- Scenario three (Industry Scenario) — this reflects the industry's recommended approach for asbestos management, applied to unexpected finds at C&D recyclers and end users of materials produced from recycled products. The industry approach uses visual inspection following an unexpected find, and laboratory testing if further asbestos is discovered. This scenario assumes that the EPA also amends the regulations to abandon the "presence test" and reverts to a risk-based approach.

Scenario 1 highlights the enormous risks if an unexpected finds procedure is not developed, with the regulation not amended and the industry finds itself continuing to be subject to a requirement for zero presence of asbestos, which is cannot mee. This report quantifies the effect (economic and environmental) of industry ceasing as a result.

Scenario 2 and Scenario 3 are alternative variants of methods to manage asbestos, with the main implication being how much it costs for C&D recyclers and end users.

Direct impacts of the three scenarios on C&D recyclers and the construction sector

The different approaches to managing asbestos have cost and risk implications for C&D recyclers and the construction sector.

- In the worst case, the industry considers that there is too much risk given the recent legal interpretation by the NSW Court of Criminal Appeal in Environment Protection Authority v Grafil Pty Ltd, and cannot continue to lawfully recycle C&D materials. That interpretation enshrined the concept that the mere presence of any asbestos, even a single (unseen) fibre in a stockpile could potentially deem the entire stockpile to be now asbestos waste and therefore must be landfilled. The cost of this decision, if enforced by EPA, to the construction industry are in the billions of dollars, mainly for higher costs of disposing of waste C&D material

2 Protection of the Environment Operations Act 1997, available at: https://legislation.nsw.gov.au/view/html/inforce/current/act-1997-156

3 Protection of the Environment Operations Amendment (Asbestos Waste) Act 2018 No 80, available at: https://legislation.nsw.gov.au/view/html/inforce/current/act-2018-080

4 https://nswlr.com.au/view/2019-101-NSWLR-245

- The EPA proposed approach would impose costs directly on C&D recyclers, related to having to dispose of more material, hire hygienists and disruption to sites. Much of this could be avoided by the industry proposed approach, with the EPA proposed approach estimated to cost an additional $35.1 Million per year for C&D recyclers, compared to $1.7 Million for the industry proposal;
  – the costs for managing asbestos are high for end user sites, indicating that a procedure would have to be applied to both C&D recyclers and the end user of their products to minimise costs;
  – the costs for managing asbestos are greater for mixed waste as compared to source -separated wastes such as concrete.

A summary of direct costs of the different scenarios is shown in table 1.

1 Summary of direct impacts of alternative scenarios

Measure	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
	$m/year	$m/year	$m/year
Additional cost imposed on C&D recycling sector	38.5	35.1	1.7
Additional costs of disposal for construction sector	1431.0	0.0	0.0
Additional cost of sourcing virgin materials for the construction sector	232.3	0.7	0.1

Note: The cost imposed on the C&D recycling sector in Scenario 3 is the lost value of specific and intangible capital.
Source: The CIE, based on scenarios developed by industry stakeholders.

Impacts of the three scenarios on the NSW economy

As evidenced above, the requirements for managing asbestos that are required in NSW result in additional costs, that will have impacts along the supply chain and will largely be passed on to the rest of the NSW economy. The main long-term impact of higher costs is that NSW becomes less competitive, and businesses (construction in particular) and resources shift to other states and territories. These impacts have been measured using a computable general equilibrium model of the Australian, and state and territory, economies.

The impacts of the scenarios, relative to there being no additional costs related to managing asbestos or risk to the industry, are set out in table 2.

- The costs arising from the industry proposed approach would reduce employment by 29 people across NSW, and reduce the size of the NSW economy by $6 Million.
- The costs arising from the EPA approach are several multiples of the industry proposed approach, with a reduction in NSW employment of 556 people, and a reduction in the size of the NSW economy of $115 Million relative to what it would otherwise have been.

- The costs imposed by the collapse of the C&D recycling sector in total are many multiples of the other scenarios. If this occurred, this would reduce NSW employment by 10 602 full time equivalents, and reduce the size of the NSW economy by over $2 Billion per year. Annual investment would be more than $200 Million lower across the NSW economy.

2 Impacts on the NSW economy

Indicator	Unit	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
NSW Gross State Product	$m/year	-2 112	- 115	- 6
NSW investment	$m/year	- 219	- 13	- 1
NSW household consumption	$m/year	-1 075	- 58	- 3
NSW employment	FTE	-10 602	- 556	- 29

Source: The CIE.

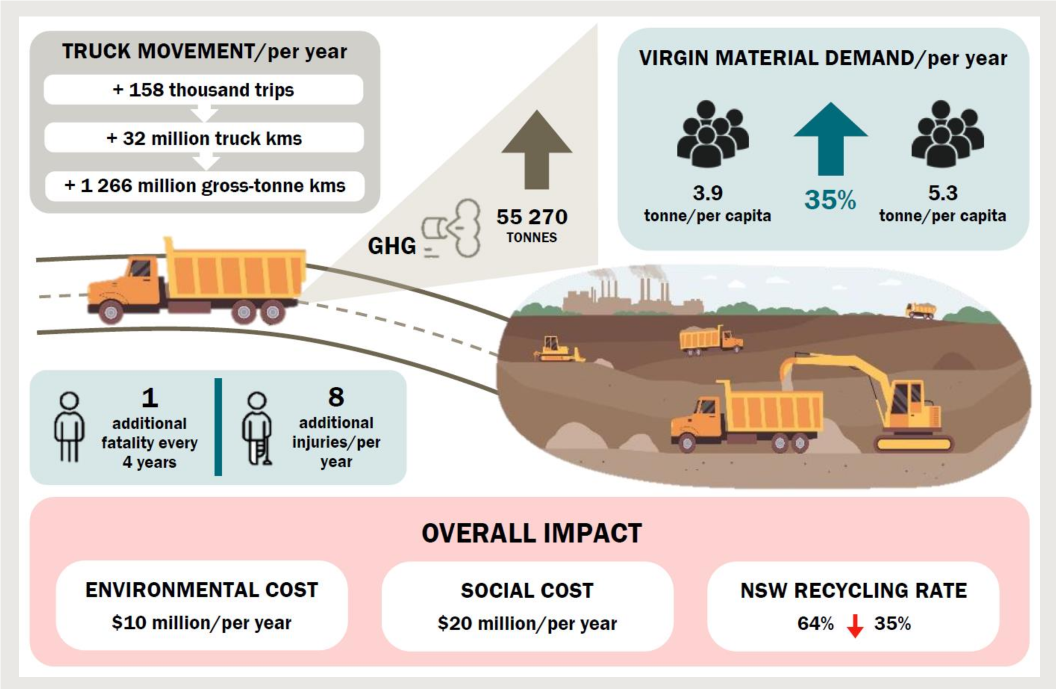
Social, health and environmental impacts

Factors that impact the construction and demolition recycling sector, will also have broader social, health and environmental consequences, in addition to the economic consequences set out above.

These impacts include:

- large reduction in the NSW recycling rate from 64 to 35 per cent;
- substantial increases in transportation of virgin quarried materials into Greater Sydney, with associated GHG emissions, air pollution and other environmental, congestion and safety impacts that this entails. In monetary terms, these impacts are costed at over $10 Million per annum for environmental impacts and $20 Million per annum for social impacts.
- more landfilling demand than the landfill sector can accommodate:
  - NSW landfills are already under high pressure as some large non-putrescible landfills run out of capacity in the next years,
  - if Queensland landfills were used as an alternative there would be much larger social and environmental impacts amounting to over $86 Million per year, as well as significant safety impacts. There would also be large losses in levy revenue compared to if landfilling occurred in NSW
- increasing the risk of illegal dumping and interstate movement of waste, and
- overall increase in public health risks associated with increased illegal dumping, landfilling, and transportation task (chart 3 and table 3).

3 Environmental and social impact of a C&D recycling industry collapse (Scenario 1)



Note: Virgin material demand reflects the total production of crushed rock products and natural sand for Greater Sydney Region in 2017/18.

Data source: The CIE.

4 Qualitative impacts on the NSW economy

Indicator	Collapse of C&D recycling	EPA proposed approach	Industry proposed approach
	Scenario 1	Scenario 2	Scenario 3
Sufficient landfill capacities	No	Yes	Yes
Risk of illegal dumping	Yes	No	No
Risk of increased interstate movement	Yes	No	No
Public health benefit	No	No change	No change

Source: The CIE.

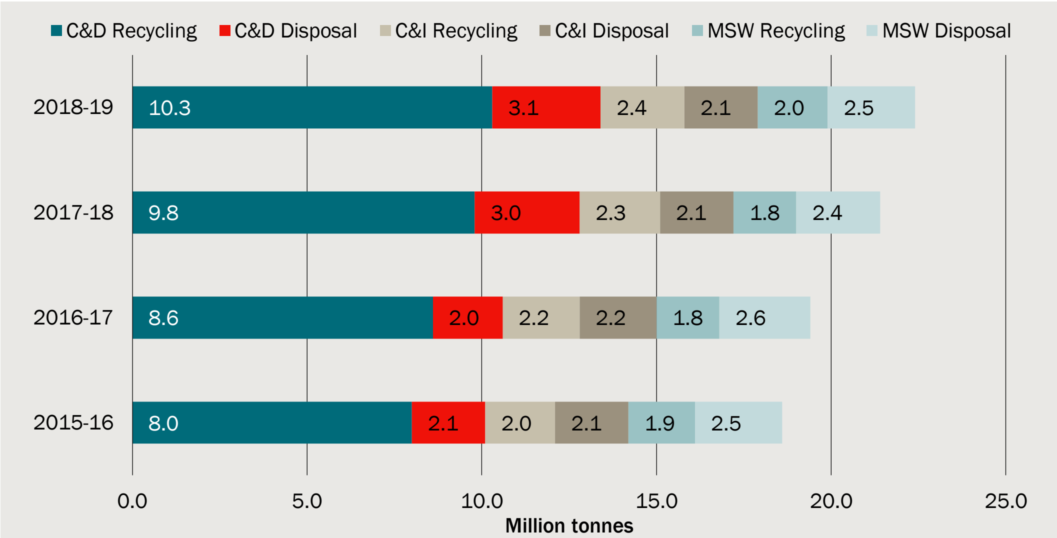
1 The NSW C&D recycling industry

NSW's C&D recycling industry

NSW C&D recycling is the largest recycling sector within the NSW recycling industry. The annual revenue based on the data for source separated and mixed C&D processing facilities, i.e., only the recycling operations and not the collections/transport component of the value chain, covered by this study is ~$500 Million per year. This covers less material volumes than data on C&D published by NSW EPA, as EPA figures include virgin excavated natural material (VENM)[5] and some C&D recycling would go to other facilities (such as metal recyclers or previously interstate).

Using EPA data on all C&D waste, recent years have been characterised by significant increases in generated waste from 10.1 Million tonnes in 2015/16 to over 13.4 Million Tonnes in 2018-19, and also large increases in recycling, while other waste streams remained more static (chart 1.1).

1.1 Waste recycled and disposed, by waste stream



Note: C&D (construction and demolition), C&I (commercial and industrial), MSW (municipal solid waste)

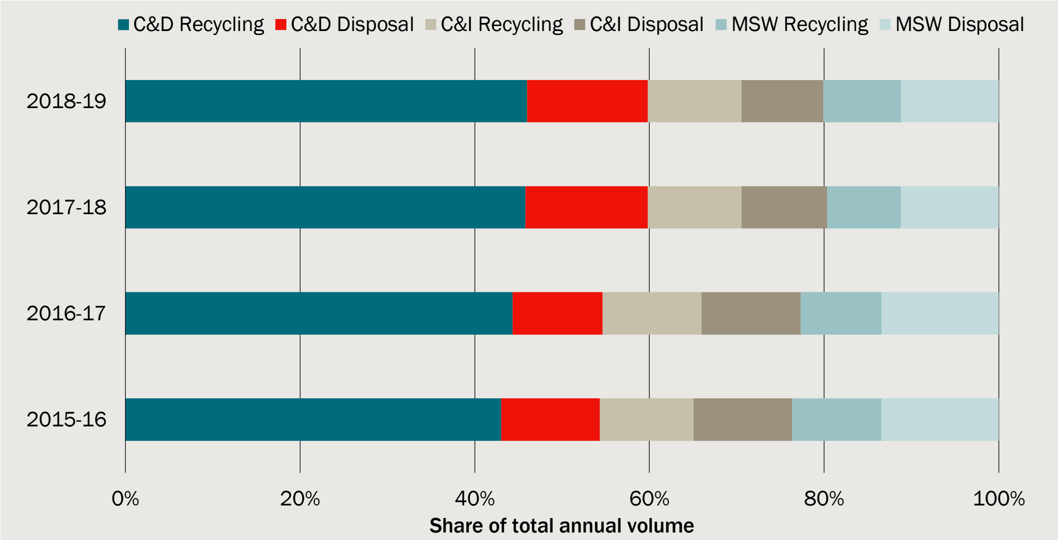
Source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

C&D facilities process almost 60 per cent of the total waste generated in NSW. They have a recycling rate close to 80 per cent. This is 24 percentage points and 34 percentage points higher than the C&I and MSW recycling sector, respectively (chart 1.2 and 1.3).

5 In 2018/19 this amounted to ~2.6 Million Tonnes.

The C&D recycling sector is the only recycling sector achieving the WARR Strategy targets of NSW EPA.[6]

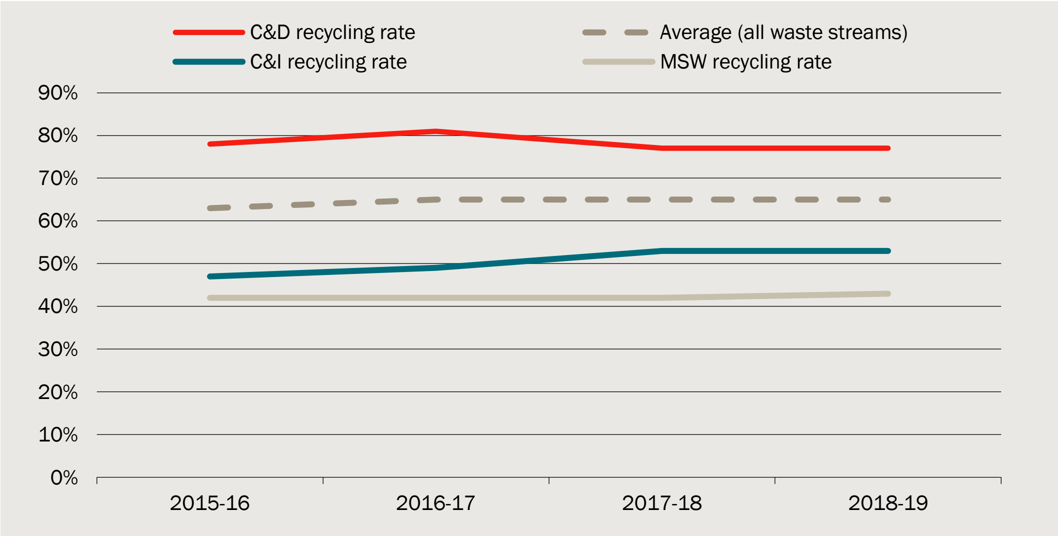
1.2 Share of total annual waste generation



Note: C&D (construction and demolition), C&I (commercial and industrial), MSW (municipal solid waste)

Source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

1.3 Recycling rate, by waste stream



Data source: https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data

The C&D recycling covered by this study is not all C&D recycling, as some materials such as metals will go to other recyclers, and some materials have in the past been sent

6 https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/recycling/19p1690-warr-strategy-progress-report-2017-18.pdf

interstate. The data provided by the C&D waste recycling industry used in this analysis equates to approximately 7.4 Million Tonnes of waste[7] per year, of which:

- 4.5 Million or 61 per cent is source-separated[8], and
- 2.9 Million or 39 per cent is mixed waste[9].

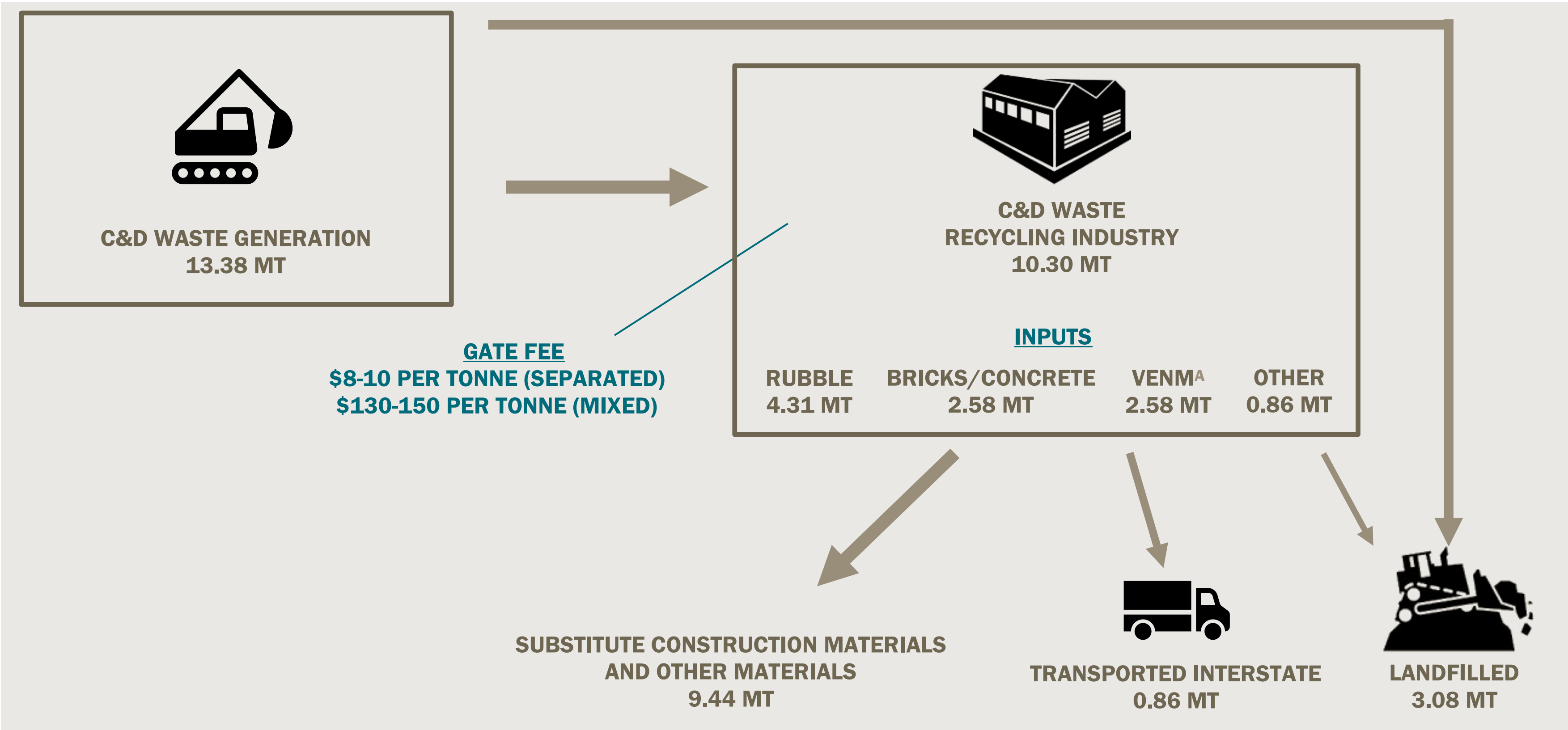
According to the industry, the recovery rates are 99 per cent and 80 per cent, respectively, for material that is sent to these recycling facilities. The industry employs over 580 FTEs for the mixed waste recycling and 450 FTEs for the source-separated recycling.

7 I.e., the total volume that was accepted and inspected at the gate. On average 1 per cent of all incoming loads are rejected.

8 This includes masonry materials such as, cement, bricks, concrete, and timbers and Gyprock.

9 Mixed waste consists of up to 40 per cent fines, 30 per cent masonry, 15 per cent timber, and residual waste (e.g, plastic). (CIE Consultations)

1.4 2018/19 NSW C&D waste industry overview



[A] Virgin Excavated Natural Material (excavated material surplus from civil construction projects, e.g., tunnel spoil)

Note: MT is mega tonnes; Totals may not sum due to rounding.

Source: National Waste Database 2020, https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-performance-data, NSW EPA (2020), Data Quality Statement, https://www.qld.gov.au/__data/assets/pdf_file/0033/129669/recycling-waste-report-2019.pdf

2 Managing asbestos waste in C&D recycling

General

Asbestos is part of Australia's built environment, reflecting a long history of the use of asbestos as a building material.

There are different types of asbestos, i.e., bonded and friable, with different levels of risk for workers and the community. Hereby, friable asbestos or loose fibres pose the highest risks as it can be airborne and inhaled, increasing the risk of asbestos related diseases (ARDs), whereas asbestos bonded in materials has a lower potential for friable asbestos.

A review of asbestos in the construction and demolition recycling found in relation to the potential hazard:[10]

- a low potential for friable asbestos to be present in C&D waste where these materials are effectively managed at the point of removal from buildings and structures (i.e. upstream),
- the most likely form of asbestos is bonded asbestos, which is of low risk, except where the bonded material is mechanically damaged. When this occurs, there is the potential for some fibres to be released to air, where exposure may occur. This material can be more easily identified and managed in waste materials, and
- a background presence of asbestos fibres in air, which is relevant to all members of the community in urban and rural areas.

There exist various estimates on the concentrations of asbestos fibres in the air ranging between 0.00001 to 0.05 fibres/mL. Hereby, the background presence is mainly due to the breakdown of asbestos products, such as asbestos-cement sheets and disturbances from a variety of building materials like insulation, ceiling, tiles, and floor tiles.[11]

There are considerable differences across urban, rural or industrial and indoor or outdoor air concentrations. According to SafeWork Australia, the typical environmental background presence in outdoor air is 0.0005 fibres/mL and 0.0002 fibres/mL in indoor air, which means 5,500 fibres are breathed by an average person per day.[12] However the

[10] Environmental Risk Sciences (2020), *Independent review: Asbestos in Construction and Demolition Recycling,* pp. 2-3

[11] SafeWork Australia, *Hazardous chemicals requiring health monitoring,* https://www.safeworkaustralia.gov.au/system/files/documents/1702/hazardous-chemicals-requiring-health-monitoring.docx

[12] According to SafeWork Australia, "The typical environmental background in outdoor air is 0.0005 fibres/ml and 0.0002 fibres/ml in indoor air. The daily inhalation volume for an

reality is that asbestos is present throughout the environment, and we are all exposed to low levels of asbestos in the air we breathe. (enHealth 2013)

Health system and productivity costs of asbestos-related diseases (ARDs)[13]

In 2015, there were an estimated 4 152 deaths in Australia due to asbestos-related diseases, and 10 444 prevalent cases of disease.[14] This accounts for mesothelioma in addition to a broader range of ARDs such as lung cancer. While the majority of these cases are due to past occupational exposure, there remains a significant number of people living with disease that have not had any workplace contact with asbestos.

Hospital and primary healthcare costs associated treating ARDs are estimated at $190 million for 2015.[15]

Furthermore, living with an ARD compromises an individual's ability to participate in the paid and unpaid workforce. Productivity losses also flow through to carers who are no longer able to participate in work and the community as they otherwise would. These indirect effects are estimated at $321 million in 2015. Most losses (85 per cent) are due to disease caused by occupational exposure, with losses evenly shared between paid and unpaid work. Overwhelming, these costs arise due to the premature death of a person, rather than their disability.

Chart 2.1 presents estimates of the health system and productivity costs of ARD in 2015.

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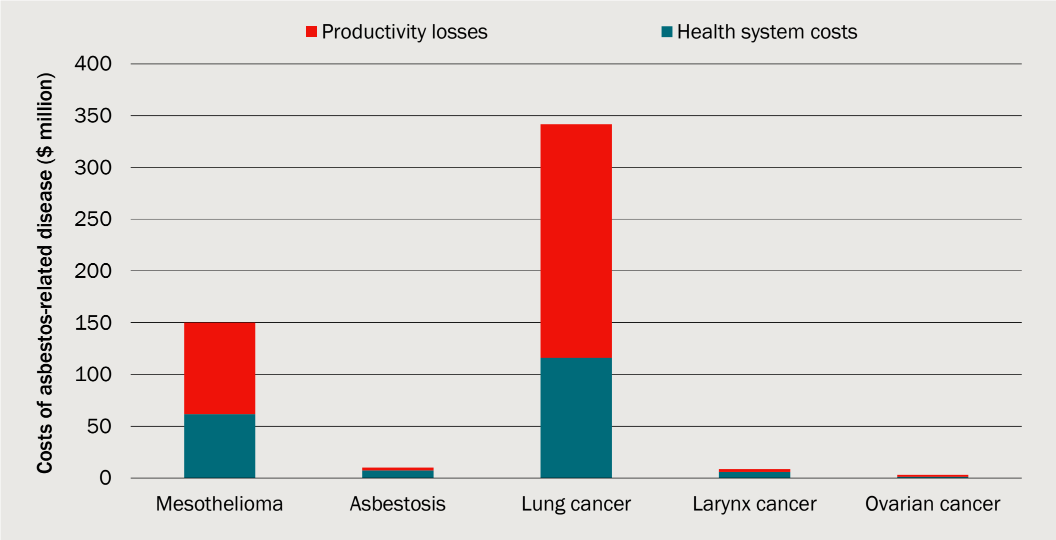
average adult is 22 m^3 or 22,000 litres. This means 5,500 fibres are breathed/day by the average person (proportion of time spent indoors = 20 hours/day)." (*Hazardous chemicals requiring health monitoring,* https://www.safeworkaustralia.gov.au/system/files/documents/1702/hazardous-chemicals-requiring-health-monitoring.docx)

13 The CIE conducted a comprehensive costing study of the economic burden of asbestos-related disease for the Asbestos Safety and Eradication Agency in 2017, https://www.asbestossafety.gov.au/sites/default/files/documents/2018-07/ASE-2274%20CIE%20Executive%20Summary.pdf

14 CIE analysis using GBD data. See Appendix A of the CIE costing study for an explanation of the methodology for estimating the number of deaths due to lung cancer associated with asbestos exposure and mesothelioma based on data from the Global Burden of Disease Study: Institute for Health Metrics and Evaluation (IHME). GBD Compare Data Visualization. Seattle, WA: IHME, University of Washington, 2016. Available from http://vizhub.healthdata.org/gbd-compare.

15 This includes cost for hospital admissions ($53.7M), GPs ($21.5M), specialist and other health practitioners ($48.4M), an pharmaceuticals ($59M).

2.1 Summary of health system costs and productivity losses



Note: This chart does not show our estimates of the monetary value of lost quality-of-life because these estimates should not be added to estimates of the value of lost productivity.

Source: The CIE.

The majority of current cases are likely related to occupational exposure in workplaces that occurred before modern occupational asbestos regulations and practices came into effect.[16] Furthermore, management of waste or recycling does not appear as an occupation of specific interest in studies of occupation-related cases of mesothelioma, indicating a rather low risk for exposure.[17]

The current regulation in NSW

Asbestos fibres are hazardous and can cause mesothelioma, lung cancer, pleural disease and asbestosis when inhaled. The fibres can be released into the air when asbestos products are incorrectly handled, stored or transported for disposal. A broad regulatory framework has evolved over past decades to improve practices relating to the handling, storage, transportation and disposal of asbestos materials.

How is asbestos waste defined?

To date, there is no consistent threshold which defines asbestos waste across jurisdictions in Australia. Western Australia is the only state to provide a contamination criterion, of 0.001 per cent (weight for weight), which has been adopted as best practice in Northern Territory and Queensland. ACT, NSW, SA, and Victoria do not provide any indication

16 AIHW (2020), *Mesothelioma in Australia 2019,* https://www.aihw.gov.au/getmedia/558c0b6d-e872-4a0f-953d-23ae6afab3b0/aihw-can-134.pdf.aspx?inline=true

17 Finity Consulting, 2016, *The Third Wave: Australian mesothelioma analysis and proje*ction, pg. 69, available at: http://www.finity.com.au/publication/the-third-wave-australian-mesothelioma-analysis-projection

of a quantitative threshold, which suggests that any contamination of asbestos found is considered to be asbestos waste (table 2.2).

2.2 Classification of waste containing asbestos

Jurisdiction	Jurisdiction
ACT, SA, Vic, NSW	Asbestos Waste (N220)
WA, NT, Qld	Contaminated Waste/Soil (N120, N121)
Tas	Unknown

Source: Blue environment (2016), Best practice governance of waste asbestos transport, storage and disposal – a discussion paper prepared for Asbestos Safety and Eradication Agency.

Products and waste which are suspected to contain asbestos have to be tested for contamination before further processing or selling. Therefore, samples must be analysed by a laboratory accredited[18] for asbestos identification. Independent of the jurisdiction the Australian Standard method AS 4964-2004 is promulgated as the reference method for asbestos testing under the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) ("the NEPM"), both identification and quantification.

While AS4964-2004 was only intended for a qualitative identification (table 2.3), i.e., a binary result ("Yes" or "No"," the presence test") is reported based on the limit of reporting, laboratories are routinely requested to apply AS4964 to quantity asbestos (table 2.4).[19]

2.3 AS4964-2004 Identification by AS4964

	Result	Limit of reporting	Unit
Asbestos	Yes/No	0.1	g/kg
Asbestos	Dry weight	0.01	g
Asbestos (trace)	Yes/No	5	fibres

Source: ALS Global (2017), *ALS Asbestos Reporting Procedures.*

2.4 Asbestos Quantification under the NEPM

	Result	Limit of reporting	Unit
Asbestos (fines/fibrous)	Dry weight	0.0005	g
Asbestos (fines/fibrous)	Percentage	0.001	%(w/w)
Asbestos containing material	Dry weight	0.1	g
Asbestos containing material	Percentage	0.01	%(w/w)

Source: ALS Global (2017), *ALS Asbestos Reporting Procedures.*

18 Those laboratories must be NATA (National Association of Testing Authorities) accredited.

19 ALS Global (2017), *ALS Asbestos Reporting Procedures*

NSW EPA requires for suspected *bonded* asbestos contamination the qualitative identification and for suspected *non-bonded / friable* asbestos both identification and quantification.[20]

Under the current criteria for asbestos waste classification in NSW, a contamination below NEPM levels (0.1 g/kg or 0.01 per cent) can nonetheless deem the tested material or stockpile as asbestos waste.

Current regulation

The regulation of asbestos is divided into two components relating to the management of asbestos in the workplace and in the environment (as a pollutant and public health risk).

Asbestos in the Workplace

The handling and storage of asbestos waste at worksites is regulated by SafeWork NSW under the current provisions of the Work Health and Safety Regulation 2011 and 2017. In this instance, the 'worksite' could include, for example, the place where an asbestos removalist is working (i.e., on demolition sites).

Current work health and safety (WHS) laws commenced on 1 January 2012 and were remade on 1 September 2017. Under the new WHS laws asbestos removal work continues to be licensed. A licence for friable asbestos removal work is now a 'Class A' asbestos removal licence and a licence for bonded asbestos removal work is now a 'Class B' asbestos removal work licence under the Work Health and Safety Regulation 2017. Existing asbestos removal work licences are being converted to the equivalent asbestos removal licence class on renewal. Asbestos licences are valid for 5 years.[21]

Under the WHS laws, removal of bonded asbestos materials of less than 10 square metres can be undertaken by an unlicensed person.[22] If workers, other than licensed removalists, are likely to be required to undertake work involving asbestos, employers must provide appropriate training in the identification and safe handling of asbestos. Current Work Health and Safety regulations require workplaces to maintain an Asbestos Register detailing the location of all asbestos on site.

Asbestos in the environment

The principal environmental protection legislation for NSW is the Protection of the Environment Operations Act 1997 (POEO Act), which defines waste and establishes management and licensing requirements for waste.[23]

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20 NSW EPA, *Draft Guideline - Developing an Unexpected Asbestos Finds Plan,* unpublished

21 SafeWork NSW, https://www.safework.nsw.gov.au/licences-and-registrations/licences/asbestos

22 Part 8.7 and 8.9 *Work Health and Safety Regulation 2017*

23 NSW EPA, https://www.epa.nsw.gov.au/your-environment/waste/waste-overview/waste-regulations

The storage, transport and disposal of asbestos once it leaves a domestic premise or worksite is governed by the EPA and local councils under Part 4 the Protection of the Environment Operations (Waste) Regulation 2005 and 2014. These revised regulatory requirements for managing asbestos waste were made under the Protection of the Environment Operations Amendment (Schedule Activities and Waste) Regulation 2008. The amendments introduced the following requirements.

- Waste must be stored on the premises in an environmentally safe manner.
- Bonded asbestos material must be securely packaged at all times.
- Friable asbestos material must be kept in a sealed container.
- Asbestos-contaminated soils must be wetted down.
- All asbestos waste must be transported in a covered, leak-proof vehicle.
- Asbestos waste must be disposed of at a landfill site that can lawfully receive this waste.
- Requirements for asbestos transporters to track loads within NSW of asbestos greater than 100 kilograms, or 10 square metres.
- It is illegal to dispose of asbestos waste in domestic garbage bins.
- It is also illegal to re-use, recycle or illegally dump asbestos products.

Schedule 1 of the POEO Act generally requires waste disposal facilities that receive asbestos to be licensed.[24] Transporters of friable asbestos waste materials are not required to be licensed under the POEO Act. Any transporters of asbestos waste must package the waste in accordance with the requirements of the Dangerous Goods Code (as implemented through the POEO Amendment Regulation 2008). Other general provisions of the Act also apply such as the imposition of the waste levy to any asbestos received at a licensed waste disposal facility and penalties for illegal dumping.

The regulation does not allow the use, reuse or sale of any asbestos product.

EPA v Grafil Pty Ltd

While the current laws and regulations have been in place since 2014, the zero-tolerance or presence-based approach (classification of waste as asbestos waste even below NEPM levels) was recently confirmed by the NSW Court of Criminal Appeal (CCA) in Environment Protection Authority v Grafil Pty Ltd.

The CCA overturned a decision of the NSW Land and Environment Court (LEC) that the definition of asbestos waste, being "any waste that contains asbestos", does not depend on the absolute or proportionate amount of asbestos contained.[25]

This means that given the omnipresence of asbestos fibres in the air as well as asbestos in the built environment's soils, any incoming waste received into a recycling facility

24 Clause 139(f) of Schedule 1 enables unlicensed regional landfills that receive less than 5 000 tonnes per year (and were in existence prior to 2008) to receive asbestos waste for disposal.

25 NSW Court of Criminal Appeal Supreme Court (2019), *Environment Protection Authority v Grafil Pty Ltd; Environment Protection Authority v Mackenzie [2019], NSWCCA 174*

potentially is likely to contain trace (but detectable) amounts of asbestos, even at levels that are not visible to the human eye but are detectable at a laboratory. It stands to reason that very fine contamination, such as a fibre, is likely to remain entrained in the subsequently produced recycled products. This puts the recycler in an invidious position from an enforcement perspective as according to the industry there are no processing technologies available to remove asbestos with a high degree of certainty.

The Grafil decision implies a stricter inspection and compliance burden for the C&D recycling waste industry, but also users of recycled and excavated materials.

How big is the 'asbestos problem' in NSW C&D recycling?

Today, the main source of exposure to asbestos is from the renovation or demolition of old buildings, exposing tradesmen, engineers, plumbers, electricians, and construction workers the most.[26] Asbestos poses a hazard if it is airborne, whilst most of the C&D waste receipted and processed at recycling facilities is solid. There are concerns within industry that the current presence-based approach being that, *any presence of asbestos* means that it is asbestos waste (as enshrined by the most recent Court of Criminal Appeal decision in EPA v Grafil) may actually increase overall health risks, in contrast to a risk-based approach, by resulting in:[27]

- higher compliance and disposal costs divert efforts away from other risk areas and leads to less clean-up due to less available funds,
- higher incentives for illegal dumping, and
- less recycling and disposal options.

Standards for managing construction waste in NSW

In line with Part 8A of the Protection of the Environment Operations (Waste) Regulation the EPA has published the "Standards for managing construction waste in NSW". These standards represent the legislative requirements for an environment protection licence and also define inspection requirements and obligations for the C&D waste facilities:

- Initial inspection of the entire top of each incoming load for asbestos,
- Inspection at a tip and spread area of the visible surface area for any asbestos waste, and

26 Safe Work Australia (2014), *Asbestos-related Disease Indicators,* https://www.safeworkaustralia.gov.au/system/files/documents/1702/asbestos_related_disease_indicators_2014.pdf

27 Australian Sustainable Business Group (ASBG) (2018), *Submission on Protection of the Environment Operations Amendment (Asbestos Waste) Bill 2018,* http://www.asbg.net.au/attachments/article/475/ASBG%20Submission%20on%20Asbestos%20Waste%20Bill%20-%202018.pdf

- for any identified asbestos waste, the entire load must be rejected, and the incident recorded in a rejected load register.[28]

Once a load is accepted the liability lies with the C&D waste recycler. Since the re-use and recycling of asbestos waste is prohibited, recyclers can face high penalties for processing asbestos contaminated materials.

As described in the above section, there is a background presence of asbestos fibres in the air. Visual identification of small pieces of asbestos contaminated materials or asbestos fibres during these inspections is very difficult or impossible in the absence of laboratory testing.

Approaches to managing unexpected asbestos finds

The scope of this analysis is the management of *unexpected* asbestos finds at end-user (customer) sites and in waste streams received at C&D waste recycling facilities. In all scenarios, C&D recycling facilities follow the 'Standards for Managing Construction Waste in NSW', i.e., the initial tip and spread processing of waste and monitoring at point of entry onto site.

There are different approaches that can be taken to managing unexpected asbestos finds in waste in C&D recycling facilities, and for end users of the products produced by these facilities. In this study we examine three (3) scenarios for the management of unexpected finds of asbestos in waste:

1. Scenario 1 — The current legislative scenario (Grafil and current regulation), with no unexpected finds procedure in place.
2. Scenario 2 — based on the EPA's proposed guidelines dated October 2019 (provided to the C&D recycling industry for comment for asbestos management, applied to unexpected finds at C&D recyclers and end users of materials produced from recycled products. This is assumed by industry that the EPA also amends the regulations to abandon the "presence test" and reverts to a risk-based approach.
3. Scenario 3 — based on the industry's recommended approach for asbestos management, applied to unexpected finds at C&D recyclers and end users of materials produced from recycled products. This is assumed by industry that the EPA also amends the regulations to abandon the "presence test" and reverts to a risk based approach.

In this chapter we set out these scenarios, and the nature of the problem that they are seeking to address.

28 NSW EPA (2019), *Standards for managing construction waste in NSW*, https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/waste/19p1542-standards-for-managing-construction-waste-in-nsw.pdf

Scenario 1: Strict interpretation of existing laws, including case law

NSW EPA follows the path of a presence-based approach rather than a risk-based approach (see EPA v Grafil). For clarity, this means that a stockpile is tested and a fibre or a tiny fragment is observed that under a microscope is identified as asbestos , that would then designate that stockpile as asbestos waste and require it to be immediately removed for landfill disposal. As asbestos presence in the air is ubiquitous[29], testing stockpiles for asbestos fibres could lead to up to 100 per cent positive results. Industry consultations consider that it is not possible for recyclers to be 100 per cent confident that there is no asbestos in product received and processed, given that in many instances it can only be identified under a microscope.

Scenario 1, assumes that a complete shutdown of the C&D recycling industry will result to guarantee 100 per cent certainty of no asbestos contamination in recycled materials. This means that there will be no C&D waste recycling and thus no recycled quarry substitute materials. This scenario reflects recent developments (Grafil) which significantly increase the risk of recycling and processing C&D waste and therefore the potential financial risk:

- liability of directors even if their businesses diligently conducted visible inspections for ACM and they have complied with the EPA *Standards for managing construction waste in NSW*
- Court of Criminal Appeal NSW (EPA v Grafil Pty Ltd.) ruling:
  - Definition that "any waste that contains asbestos" is to be declared as asbestos waste is independent of the relative or absolute amount
  - Single asbestos fibres are enough to declare waste as asbestos waste (presence-based approach)
  - An inability for C&D recyclers to use a due diligence defence.

As a result of this current regulation, to be absolutely compliant the total C&D waste stream would be disposed of to landfill and the total demand of recovered aggregates and of recovered fines-based topsoil blends must be substituted by virgin quarry materials.

In practice, the risk appetite of companies will be different. Companies that are willing to operate within grey areas would be more likely to continue to operate. Larger, more established operators will be unlikely to continue to operate in this regulatory environment.

Scenario 2: NSW EPA proposed guideline - Developing an Unexpected Asbestos Finds Plan

The proposed EPA guideline for unexpected asbestos finds is applicable for

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29 According to SafeWork Australia, "The typical environmental background in outdoor air is 0.0005 fibres/ml and 0.0002 fibres/ml in indoor air. The daily inhalation volume for an average adult is 22 m^3 or 22000 litres. This means 5500 fibres are breathed/day by the average person (proportion of time spent indoors = 20 hours/day)." (*Hazardous chemicals requiring health monitoring,* https://www.safeworkaustralia.gov.au/system/files/documents/1702/hazardous-chemicals-requiring-health-monitoring.docx)

- all C&D waste facilities that have implemented the C&D standards, and
- only before further processing.

The following steps must be carried out if asbestos is found:

1 Discontinue processing in adjacent area

1 Notification of EPA

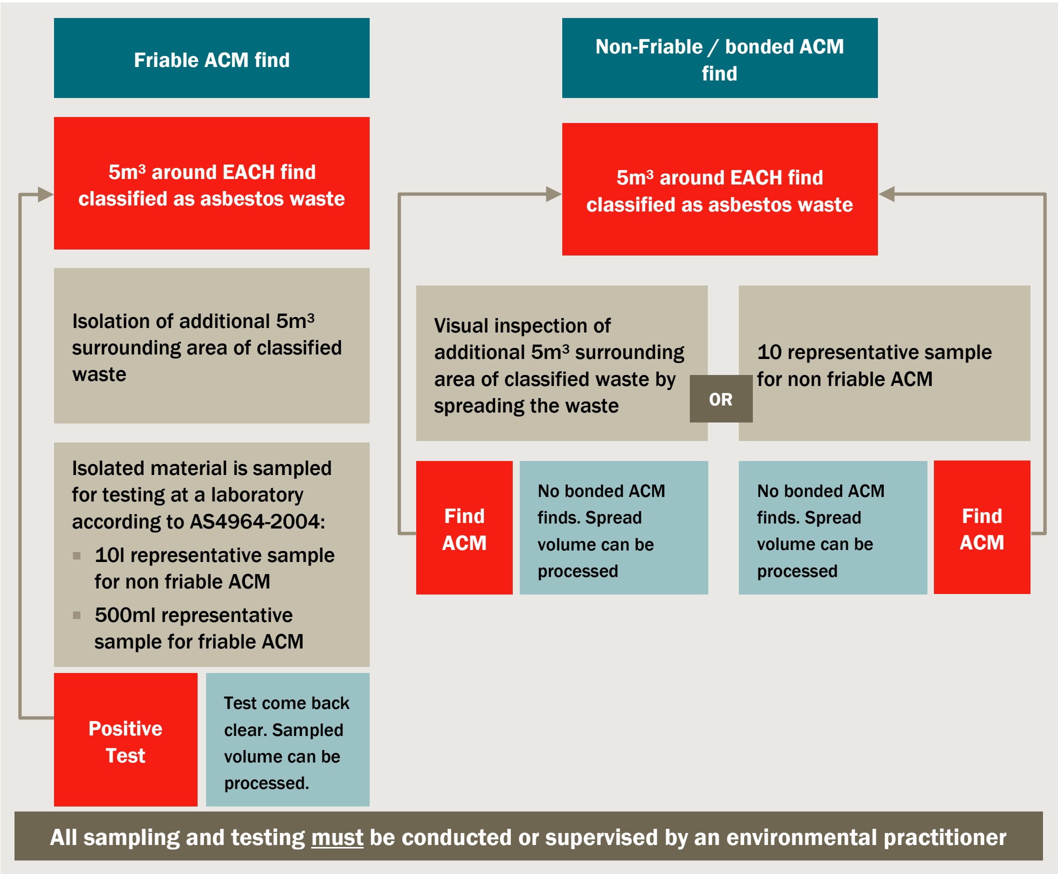
2 Documentation of location and description of type of ACM

3 Site Notification (staff etc.)

4 Isolate all stockpiles and adjacent areas to the ACM find (including signage, barriers, wet down, and reduce risk)

5 Segregate, inspect, sampling and testing (chart 1).

2.5 EPA guideline procedure for unexpected friable/no-friable ACM find



Note: Isolating, testing and sampling is an iterative process until no ACM can be found. According to consultations, recycling facilities isolate multiple 5m3-volumes surrounding the find to reduce sampling time.

Data source: NEW_Draft Guideline - Developing an Unexpected Asbestos Finds Plan (EPA proposed approach).docx.

For the analysis of costs, we assume:

- after an unexpected find no additional asbestos is found in a visual inspection in the surrounding area. Therefore, 5 cubic metre or 6.5 tonnes of material are disposed for every asbestos find

- intensive testing and engagement of an occupational hygienist is necessary for each find, and site delays amount to 2 days
- this approach would apply to C&D recyclers and to end users (customers of recycled products).

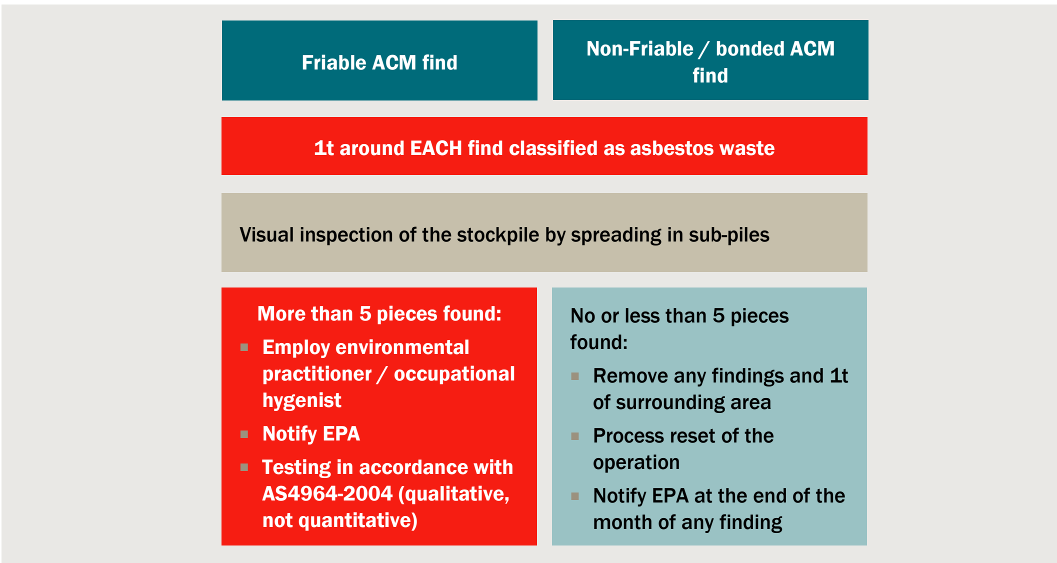
Scenario 3: Industry proposed unexpected finds procedure for Asbestos Containing Materials (ACM)

Scenario 3 above is based on the industry proposed procedure to handle unexpected asbestos finds. The industry advocates for a risk-based approach using visual inspections to determine asbestos contamination risk. Instead of disposing 6.5 Tonnes, the procedure suggests the disposal of 1 Tonne and a visual inspection of the surrounding area. However, if more than five contaminants (that are likely to be asbestos) are identified, an occupational hygienist will be engaged. Scenario 3 assumes like scenario 2 that no further asbestos is found in the surrounding area. Thus, no engagement of a hygienist is required.

The following steps must be carried out if suspected ACM is found:

1 Discontinue processing in adjacent area
2 Notification of EPA and engagement of occupational hygienist only if more than *five* pieces are found
3 Documentation of location and description of type of ACM
4 Site Notification (staff etc.)
5 Isolate all stockpiles and adjacent areas to the ACM find (including signage, barriers, wet down, and reduce risk)
6 Segregate, inspect, if more than five pieces, sampling and testing (chart 2).

2.6 Industry proposed procedure for unexpected friable/no-friable ACM find



Data source: CIE Consultations.

For the analysis of costs, we assume:

- after an unexpected find no additional asbestos is found in the surrounding area. Therefore, 1 Tonne of material is disposed of for every asbestos find
- intensive testing and engagement of an occupational hygienist is not necessary for each find, and site delays amount to1 hour
- this approach would apply to C&D recyclers and to end user (customer) sites.

3 Direct costs to C&D recyclers and the construction industry of alternative approaches to the management of unexpected asbestos finds

The different approaches to managing unexpected asbestos finds have cost and risk implications for C&D recyclers and the construction sector.

- The EPA proposed approach (Scenario 2) would impose costs directly on C&D recyclers, related to having to dispose of more material, hire hygienists and disruption to sites, whilst still allowing the EPA to require landfill disposal for even the discovery of a single fibre. Much of this could be avoided by the industry proposed approach.
  - the costs are prominent for end user sites, indicating that a unexpected finds procedure would have to be applied to both C&D recyclers and the end user of their facilities to minimise cleanup costs
  - higher costs are more likely for recycled products produced from mixed waste as compared to from source separated wastes like concrete or bricks as more complex machinery and personnel are required
- The lack of any EPA-recognised unexpected finds guideline could be substantially worse. In the worst case (Scenario 3), the industry sees too much risk because of the legal interpretation in *Environment Protection Authority v Grafil Pty Ltd*, and cannot continue to recycle C&D materials without risk of non-compliance. The cost of this to the construction industry are in the billions of dollars, mainly for higher costs of disposing of waste C&D material and higher costs to use virgin quarry products, usually sourced from outside the Sydney region.

A summary of costs is shown in table 3.1.

3.1 Summary of direct impacts of alternative scenarios

Measure	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
	$m/year	$m/year	$m/year
Additional cost imposed on C&D recycling sector	38.5	35.1	1.7
Additional costs of disposal for construction sector	1 431.0	0.0	0.0
Additional cost of sourcing virgin materials for the construction sector	232.3	0.7	0.1

Note: The cost imposed on the C&D recycling sector in Scenario 3 is the lost value of specific and intangible capital.
Source: The CIE, based on scenarios developed by industry stakeholders.

Costs that are incurred in the construction industry, as well as the sector will largely be passed on to the rest of the economy, and these economy-wide impacts are set out in the next chapter.

In this chapter we set out the nature and magnitude of direct impacts on C&D recyclers and the construction sector from the three scenarios. These estimates have largely been developed with industry stakeholders, using their knowledge of the likelihood and consequences of finding asbestos under different regulatory approaches.

The chapter is structured as follows:

- the expected likelihood of unexpected asbestos finds at C&D recyclers and end user sites
- the impact of each scenario on materials disposed of
- the impact of each scenario on the C&D recycling industry
- the impact of each scenario on the construction sector.

Likelihood of unexpected asbestos finds

The cost of regulations related to asbestos management will depend on how likely it is that there is an unexpected asbestos find, both at the C&D recycler and at the end user. This will not be impacted by the regulatory approach taken.

The likelihood of finding asbestos has been provided by industry stakeholders based on their experience (table 3.2). This has been provided as the number of finds per week for a facility processing one million tonnes of material per year. Hence a facility processing 100,000 Tonnes per year will have one tenth of the number of finds.

- For a C&D recycler, industry experience indicates that there will be on average two visual finds per week in their stockpiles for a source separated facility processing one Million Tonnes per year. For a facility processing mixed waste, there would be 8 asbestos finds per week per Million Tonnes processed
  - across the entire industry this indicates 465 finds at source separated recyclers and 951 at mixed recyclers
- There is also a likelihood of finding asbestos in material that has been recycled and is either on-site in stockpiles at a C&D facility or has been transported to an end user site.
  - across the entire industry, experience suggests 232 finds for end users from source separated (like bricks and concrete) material and 951 for end user from material from mixed C&D waste recyclers.
  - at all times it must be noted that the recyclers have not sought this material, rather it has been transported to them from construction sites, without identification or advice that the material contains asbestos.

3.2 Unexpected finds by location and type of waste

		Number of unexpected finds	Number of unexpected finds per year across industry
		Finds/week/million tonnes processed	Finds/year
C&D recycler	Source separated	2	465
	Mixed	8	951
End user site	Source separated	1	232
	Mixed	8	951

Source: C&D waste recycling industry.

While the likelihood of finding asbestos will not be impacted by the unexpected finds procedure for managing it, the consequences related to each find will be.

- Under the EPA procedure (scenario 2), a minimum of 6.5 Tonnes of material will be disposed of for each find (5 cubic metres). This assumes no asbestos found around the initial find (or that this is considered as a new find)
- Under the industry unexpected finds procedure, one tonne would be disposed of for each find.

While the procedure would be focused on the C&D recycling site, we also assume that this would be followed through at an end user site.

The total amount of material disposed under the two different unexpected finds of asbestos management procedures is shown in table 3.3, both in tonnes and as a percentage of total material processed.

3.3 Tonnes and per cent of material disposed because of asbestos finds

Location	Type of waste	Scenario 2 (EPA)		Scenario 3 (industry)	
		Tonnes disposed	Share of material disposed	Tonnes disposed	Share of material disposed
		Tonnes/year	Per cent	Tonnes/year	Per cent
C&D facility	Source-Separated	2 925	0.065%	450	0.010%
	Mixed	7 410	0.260%	1 140	0.040%
End-user site	Source-Separated	1 448	0.033%	223	0.005%
	Mixed	5 928	0.260%	912	0.040%

Note: Probabilities are based on 6.5t removed for Sc2 and 1t for Sc3 for each find per week. One year is assumed to have 50 weeks.
Source: C&D waste recycling industry.

The likelihood of finding asbestos for Scenario 1 is irrelevant as it is predicted that this approach will result in no recycling activity being undertaken due to high cost and risk and all C&D waste is directly disposed at landfills.

Cost impacts on C&D recyclers

C&D waste recycling facilities face costs in addressing unexpected asbestos finds. Those differ by location and waste type. Finds at end-users (recycled product customer) sites are in general more costly, as the work on site is disrupted.

There are three major costs associated with unexpected asbestos finds:

- direct costs of addressing asbestos contamination (e.g., occupational hygienist and laboratory testing, and site delays at end-user sites),
- site delays and disruptions for end user sites and smaller C&D recyclers that would not have enough space to operate while asbestos contamination was being addressed, and
- disposal cost of material classified as asbestos waste.

Those direct costs are only relevant for the scenarios 2 and 3 as C&D recycling activity is non-existent in scenario 1.

Direct costs of addressing asbestos contamination

Under the current EPA draft guideline any sampling and testing must be conducted or supervised by an environmental practitioner. In addition, on average ten samples are sent to a NATA certified laboratory for each incident.

The proposed industry unexpected finds procedure advocates a risk-based approach, based on visual inspections. However, if more than five visible pieces of suspected asbestos are found an environmental practitioner must be engaged and laboratory testing takes place. Based on industry experience, it is unlikely that in the industry scenario there will be enough additional findings in many cases, and hence there will be no engagement of a hygienist or testing procedures in scenario 3.

For the purposes of the analysis, we have developed costs per tonne affected for each scenario, based on industry case studies and cost estimates for required activities.

- For the end user costs for the EPA Scenario (Scenario 2), this is based on a customer case study where the hygienist method was applied (box 3.4). This is applied relatively conservatively, as the total cost in this example of a find was $110,800. Under the EPA proposed procedure, less tonnes would be removed (6.5 as compared to 30 in the case study) and we have adjusted costs down proportionately. That is, the EPA procedure is much less expensive than the historical case study.
- For the end user costs for the industry scenario, the industry procedure has been applied to the end user case study. Under the industry procedure, there would have been site delays of 0.1 days at $9,000 per day and no other direct costs, plus disposal costs (which are included separately below). One tonne of material would have been disposed of. This gives a cost of $900 per tonne.
- For a C&D recycling facility, under the EPA procedure, there would be estimated costs of a hygienist of $1,500 and testing costs of $150 per sample for ten samples. Divided by an assumed 6.5 Tonnes of material disposed per find, gives a cost of $462 per Tonne disposed.

- For a C&D recycling facility, under the industry unexpected finds procedure, there would be no estimated direct costs.

3.4 Customer case study for end user contamination costs

In this case study, 1500 Tonnes of product was delivered to a customer. A 50mm piece of asbestos was found within the worksite, and the hygienist method was applied.

The hygienist ordered the site to be shut for 9 days. 30 Tonnes of material within proximity to the asbestos find was removed. Testing was conducted over the entire worksite and no other asbestos detected. The total estimated costs were:

- $81,000 in site delays, based on stand-down costs
- $12,000 in testing costs (sampling and laboratory costs)
- $10,000 in hygienist costs
- $7,800 in disposal costs for tonnes removed.

The total costs of the find were $110,800, for a removal of 30 Tonnes of material. This gives $3,700 per Tonne disposed including disposal.

We do not expect there to be any cost differences in regards to the waste stream (mixed versus source separated).

Table 3.5 summarises the cost per tonne for each waste stream and for recyclers and end users. Note that costs for end-user sites already include site disruption cost, as this was included in the case study work by industry, and represent a typical cost from past experience for the EPA scenario. Site disruptions costs at C&D facilities are not included in *direct* costs of addressing asbestos contamination – these are assessed in the next section.

3.5 Direct costs of addressing asbestos find per tonne (not including disposal costs)

Location	Waste type	Collapse of C&D recycling	EPA proposed approach	Industry proposed approach
		Scenario 1	Scenario 2	Scenario 3
		$/t	$/t	$/t
End-user site	B+D	Na	3 443	900
	Mixed	Na	3 443	900
C&D facility	B+D	Na	462	0
	Mixed	Na	462	0

Note: Assumes that under Sc2 6.5t of material are disposed for each unexpected find.

Source: C&D waste recycling.

Site disruption to C&D recyclers

Any unexpected asbestos finds come along with site disruptions, both at end-user and C&D recycling facilities. Site disruption costs at end-user sites are already factored in the *direct* cost of addressing asbestos.

According to the recycling industry, unexpected finds under the proposed EPA guideline will result in quarantining whole stockpiles or sub-stockpiles which must be tested for asbestos contamination. Irrespective of their size recycling facilities do not have a sufficient operating area to continue to process materials while putting in place the unexpected find management plan required by the EPA guideline.[30] Stakeholder stated this means that their sites will stop operating and they cannot receive any additional material nor sell products. Consultations suggested that the average site delay is for up to four days, dependent on the laboratory. The industry proposed unexpected finds procedure estimates a site delay of 1 hour for the visual inspection and removal of the contaminated material.

The costs for an individual facility that has to halt operations can be large, as many costs will continue to be incurred, without any revenue coming in. Depending on the size of the facility total lost revenue varies considerably. Based on industry data we estimate the total weighted average for daily throughput at 1,131 tonnes for source-separated waste and 1,540 for mixed waste facilities (table 3.6).[31]

3.6 Daily throughput and market share, by waste type and facility size

Waste type	Size	Daily throughput	Market share
		tonnes / day	per cent
B+D	Large	2 000	45
	Small	420	55
Mixed	Large	1 962	75
	Small	274	25

Source: C&D waste recycling. The CIE.

For the industry as a whole, the costs will likely be smaller to some degree, as material is diverted to these other facilities.

Because we are taking an overall industry perspective, rather than the perspective of an individual facility, we have estimated the impact of site disruption as the overall expansion of the industry's capacity required to continue to process all materials. For example, if the industry can currently process 4 Million Tonnes per year, but on any

30 Draft Guideline - Developing an Unexpected Asbestos Finds Plan (unpublished)

31 The weighted average is based on the daily throughput for large and small facilities and teir respective market share. Data on daily throughput for source-separated waste facilities and the market share of large and small facilities was provided by the industry. For mixed waste facilities data we received annual throughput of the largest processors. We used a threshold of 150 000 tonnes per annum to distinguish between small and large facilities.

given day 1 per cent of capacity is disrupted by asbestos contamination, then it would need to expand capacity to process 4.04 Million Tonnes per year.

We estimate the cost of the expansion of capacity based on the fixed costs of the industry divided by the tonnes processed. These differ by the type of waste which is processed.

Fixed costs are calculated as a total revenue (gate fee and sales) less average variable costs less disposal costs. For source separated waste we estimate this as $10 per Tonne. For mixed waste we estimate this as $38 per Tonne.

3.7 Site disruption costs for small facilities (Sc1 and Sc2)

Waste type	Collapse of C&D recycling	EPA proposed approach	Industry proposed approach
	Scenario 1	Scenario 2	Scenario 3
	$/tonne	$/tonne	$/tonne
B+D	Na	10	10
Mixed	Na	38	38

Source: C&D waste recycling.

In Scenario 1, where the C&D recycling sector shuts down, there would also be a form of site disruption costs. That is, the value built up in C&D businesses through their specific capital (equipment) and intangible capital would be lost. Other capital, such as land, would be reused in other sectors. The amount of economic loss from this is difficult to determine. It will be somewhere between zero and the fixed cost estimates above. We assume this is 25 per cent, although given the enormous costs from a complete industry shut-down for the construction sector, this is only a small part of the costs that arise from the scenario.

Disposal costs

In Scenarios 2 and 3, material that has been in contact with asbestos and the area surrounding the asbestos find is classified as asbestos waste and as such disposed. As mentioned, we assume that after the initial find no additional asbestos is found, i.e., in scenario 2, 5 cubic metres or ~6.5 Tonnes and in scenario 3 only 1 Tonne of surrounding material is disposed.

For the disposal cost for C&D recyclers, this is:

- the cost to transport material to landfill and pay landfill fees ($250 per Tonne)
- plus the lost revenue from being unable to sell material, less
- the costs avoided from not having to process material.

These costs are shown in table 3.8.

For the disposal costs for end users, this is included at the cost to transport material to landfill and pay landfill fees ($250 per Tonne).

Net disposal costs per Tonne are the same in both scenarios and differ only by waste type.

3.8 Net disposal cost, by waste type and scenario

Waste type	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
	$/t	$/t	$/t
Source separated	Na	255	255
Mixed	Na	211	211

Source: C&D waste recycling.

Total cost impact for C&D recycling industry

Table 3.9 and chart 3.10 summarise total costs and losses for each scenario for the C&D recycling industry. Note that we have assumed that any end user costs will be borne by C&D recyclers in these estimates. As discussed in the next section, from an economywide perspective costs will be passed on along the supply chain.

Under the EPA proposed guideline (Scenario 2), (and assuming that the EPA also amends the current regulation to align with the proposed EPA Draft guideline[32]) recycling facilities face costs of $35.1 Million per year, compared to $1.7 Million for the proposed industry unexpected finds procedure.

Those costs will be eventually passed on to the construction sector and to the whole economy.

3.9 Total costs for C&D recycling industry, by location, and cost and waste type

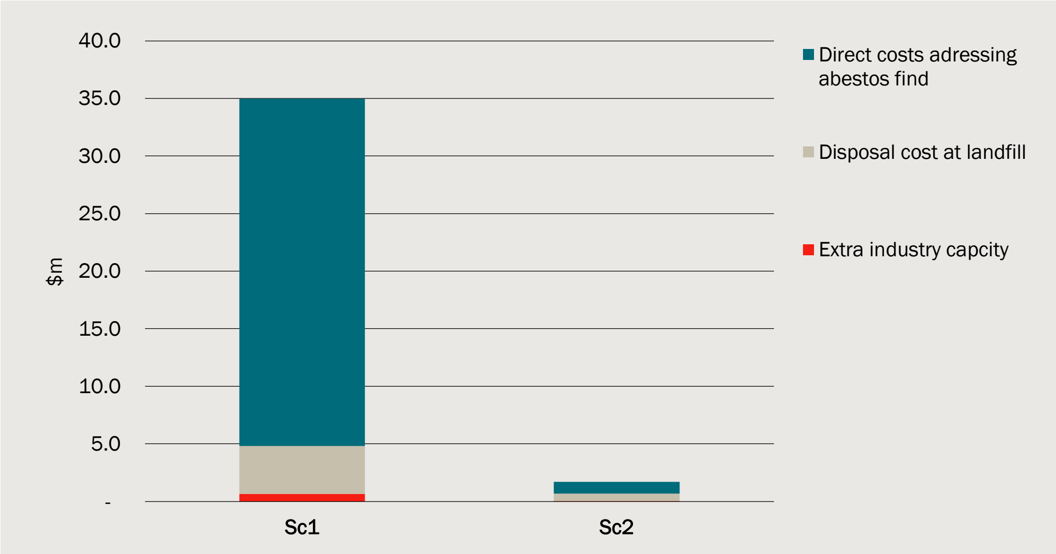
Type of cost	Location	Waste type	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
			$m	$m	$m
Direct Costs addressing ACM find	End-user site	Source-separated	Na	5.0	0.2
		Mixed	Na	20.4	0.8
	C&D Facility	Source-separated	Na	1.4	0.0
		Mixed	Na	3.4	0.0
Disposal cost at landfill	End-user site	Source-separated	Na	0.4	0.1
		Mixed	Na	0.7	0.2
	C&D Facility	Source-separated	Na	0.7	0.1
		Mixed	Na	1.5	0.2
Extra capacity (Sc2/Sc3)	End-user site	Source-separated	Na	0.0	0.0
		Mixed	Na	0.0	0.0

32 Draft Guideline - Developing an Unexpected Asbestos Finds Plan (unpublished)

Type of cost	Location	Waste type	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
			$m	$m	$m
	C&D Facility	Source-separated	Na	0.1	0.0
		Mixed	Na	0.7	0.0
Subtotal		**Source-separated**	Na	**7.6**	**0.4**
Subtotal		**Mixed**	Na	**27.5**	**1.3**
Grand total			**Na**	**35.1**	**1.7**

Source: CIE.

3.10 Total costs for C&D recycling industry, by scenario



Data source: The CIE.

Scenario 1 — where the industry shuts down imposes a different type of cost on C&D recyclers. That is, as they cannot operate any more they will lose all revenue, avoid all costs, with the net loss being the value of capital that cannot be repurposed and intangible business value. We have estimated this as **$38.5 Million per year**.

Impact on the construction sector

The construction sector is directly impacted by the arrangements for asbestos management in two ways, outside of what impacts are passed through from C&D recycling:

- the construction sector has to substitute recovered aggregates with virgin materials, and
- the construction sector will face higher disposal costs where the C&D recycling sector is not available and material has to be diverted to landfill.

Cost of alternative sourcing

In 2017/18, the construction sector used ~40 Million Tonnes of construction material in the Greater Sydney Region (GSR):

- 13.6 Million Tonnes of crushed rock products,
- 5.6 Million Tonnes of natural sand,
- 16.7 Million Tonnes of substitutes (i.e., virgin excavated natural mineral, tunnel spoil, crushed sandstone, recycled C&D waste), and
- 3.6 Million Tonnes of cement and supplementary cementitious materials.[33]

Therefore, 42 per cent of the used construction material non-virgin substitutes.

The C&D waste recycling industry alone provides at least 6.7 Million Tonnes of recovered aggregates (~17 per cent of total) to the construction sector. However, we assume that the recovered products are primarily used as a substitute for crushed rock products; here the share makes up almost 50 per cent.

The advantage of recovered aggregates lies in the price incentive, due to lower transport cost (i.e., most recycling facilities are based in GSR) and lower purchasing price compared to virgin materials.

Transportation makes up 30 per cent of the final good price, and for heavy materials this can amount to up to 50 per cent. Currently, the average distance from a quarry to a construction site is 64km which equals approximately $13 per Tonne, and this distance and price is expected to increase to 100km and $20 per Tonne, respectively.[34]

Increased disposal of materials which could have been potentially processed to recovered aggregates leads to higher demand for virgin materials. Net substitution costs per Tonne is the price for virgin materials including transport minus the price that would have been paid for recovered aggregates.

- For the construction sector, material that has arrived at the end user site and is subsequently disposed would require an alternative material. Industry has indicated the typical price for an alternative virgin material is $50 per Tonne (including transport to site).[35]
- Where material has been removed from a C&D recycler, the construction sector will face a cost of $50 less the cost it would have paid for the recycled material ($10 per Tonne).

The net costs applied are shown in table 3.8.

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33 R.W. Corkery & Co (2019), *Supply and Demand Profile of Geological Construction Materials for the Greater Sydney Region*, p. xv

34 CCAA (2018), https://www.ccaa.com.au/imis_prod/documents/CCAA_Submission_Freight_and_Ports_Plan_March_2018.pdf

35 This price is a conservative estimate. According to the R.W. Corkery & Co (2019) Supply and Demand Study prepared for DPIE, the prices range between $45 to $80 including transport cost of $25 per tonne.

3.11 Net cost of virgin materials, by location and scenario

Location	Collapse of C&D recycling	EPA proposed approach	Industry proposed approach
	Scenario 1	Scenario 2	Scenario 3
	$/tonne	$/tonne	$/tonne
End-user site	40	50	50
C&D facility	40	40	40

Source: C&D waste recycling.

Cost associated with recycling facilities disruptions

The construction sector transports demolition waste to and recovered aggregates from C&D recycling facilities, which are mainly in the Greater Sydney Area (GSA). If there are disruptions to C&D recyclers, material will be transported to another facility. As most of the facilities are GSA-based, additional costs per Tonne will be relatively small, and are not measured in this study.

Of critical importance is the change in disposal costs for the construction sector in the industry shutdown scenario (Scenario 1). In this Scenario, the construction sector will pay disposal costs of $250 per Tonne for landfilling compared to $130 per Tonne for mixed C&D waste C&D and less than $10 per Tonne for source separated C&D waste.

Total cost impact for construction sector

Total cost impact in Scenarios 2 and 3 for the construction sector is shown in table 3.12. If there is an agreed unexpected finds procedure, the direct costs to the construction sector are relatively small, and the main impacts will arise from direct impacts on C&D recyclers being passed on. However, for Scenario 1 (industry shutdown), the construction sector will face dramatic increases in costs, of well over $1.5 Billion per year. This is largely from higher disposal costs for material, but also includes substantially higher costs for sourcing virgin quarry materials compared to their recycled equivalents.

3.12 Total costs for the construction sector

Sector	Type	Collapse of C&D recycling	EPA proposed approach	Industry proposed approach
		Scenario 1	Scenario 2	Scenario 3
		$m	$m	$m
Sourcing virgin materials	Source-separated	142.2	0.2	0.0
	Mixed	90.1	0.5	0.1
Alternative disposal of materials	Source-separated	1 089.0	0.0	0.0
	Mixed	342.0	0.0	0.0
Total C&D Sector		**1 663.3**	**0.7**	**0.1**

Source: The CIE.

4 Economic consequences of increasing costs for C&D recycling

Increased enforcement of the existing regulations and case law for managing asbestos for C&D recyclers will either:

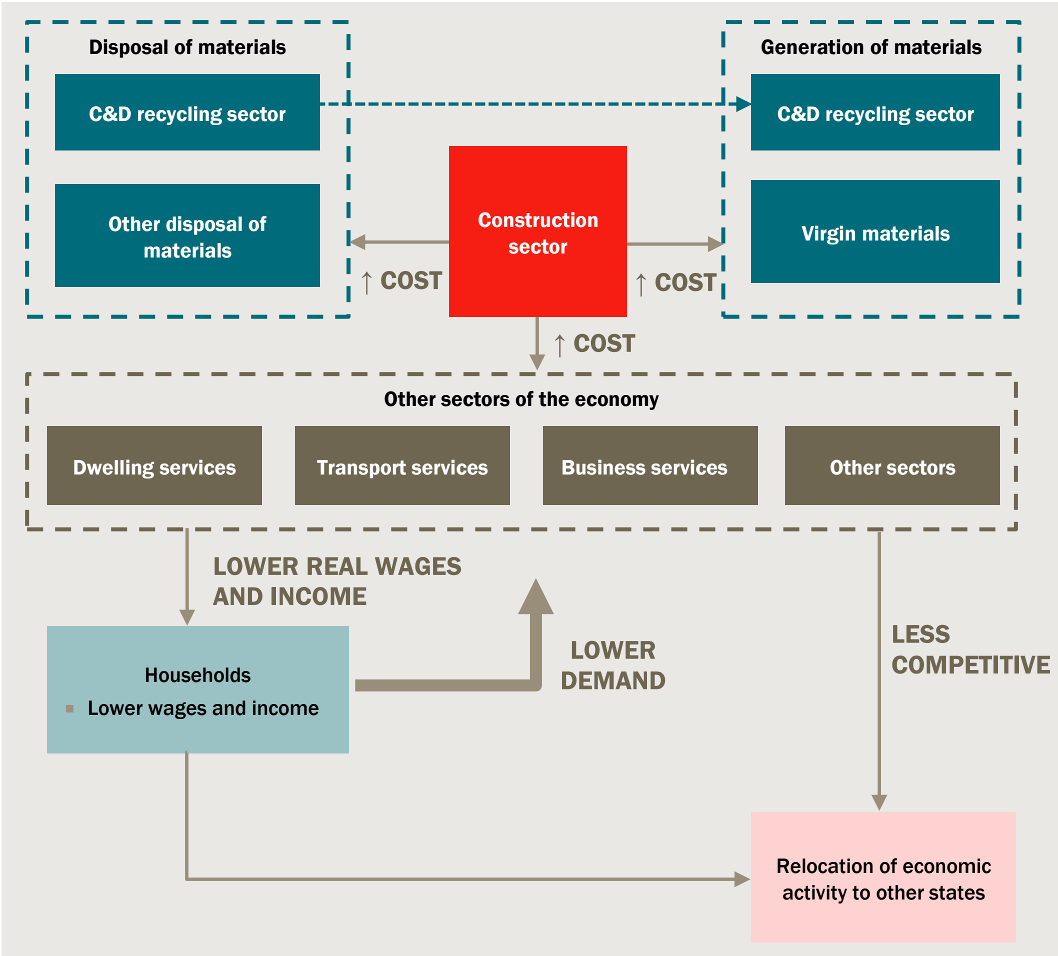
- lead to increases in the cost and a reduction in the productivity of the C&D recycling industry — that is, the industry can produce far less with the same amount of labour and other inputs
- lead to the closure of the C&D recycling sector, because it is unable to meet the theoretical-based regulatory requirements for asbestos.

The pattern of impacts from these two changes is similar, but the magnitude of the second is many times larger. The pattern of impacts is shown in chart 4.1. Essentially, the direct impacts on the sector flow through to the economy, and particularly the construction sector by:

- increasing the cost of removing waste materials for the construction sector, because:
  - higher costs for C&D recyclers will mean higher gate fees for disposal at C&D recycling facilities
  - an inability to recycle material at all will mean the construction sector will face disposal costs at landfills, which are substantially higher than the disposal costs for recycling
- increasing the cost of materials required for construction, because construction will have to use only virgin materials, which are more expensive than their recycled equivalents.

These direct impacts on the construction sector increase the cost of construction to the NSW sectors that undertake construction activities, which is almost all sectors across the economy. In turn, this makes NSW businesses less competitive, NSW wages lower and leads to a reallocation of economic activity to other parts of Australia. These impacts have been quantified using the CIE Regions computable general equilibrium model, as discussed in this chapter.

4.1 Economic impacts of increasing costs for C&D recyclers



Source: The CIE.

While for most sectors and for the NSW economy as a whole, the impacts will be negative, there will be some sectors and businesses that will face increased demand as a result of higher costs or closure of C&D recycling:

- providers of virgin quarry materials will have increased demand, higher output and most likely higher prices (which will be borne by the construction sector)
- providers of landfills will have increased demand, higher output and most likely higher prices (which will also be borne by the construction sector). This means that the landfill sector may actually expands in size as a result of restricting C&D recycling, and more resources are directed into managing waste that could otherwise be used elsewhere in the economy.

The magnitude of the economic impacts will reflect, to some extent, the ability of these other sectors to respond. In the short term, response to changes as large as the complete closure of the C&D recycling sector would be very difficult, because this would mean very large increases in landfill demand and moderate increases in quarry material demand. Economically, this would result in larger increases in prices for landfills and virgin materials, and larger cost increases for construction, in the short term as compared to the longer term.

Measuring the economic impacts

To measure these economic impacts, we have used the CIE Regions model. This models each state and territory economy across 58 sectors. This allows for the complex interlinkages across sectors to be evaluated, and impacts such as how economic activity shifts across regions as a result of changes in productivity to be measured. Information on the CIE Regions model is set out in Appendix A.

The CIE Regions model takes the direct impacts of the scenarios as inputs, and then traces how these impacts move through the NSW (and Australian) economies. The direct impacts used in the model are:

- the change in the demand for and cost of quarry materials from the construction sector, for a given amount of construction — the quarry sector is the other non-metal mineral products sector in the CIE Regions model
- the change in the cost of the waste sector, for a given amount of materials disposed of. This includes the change in costs for C&D recyclers where material is recycled and costs for landfills where material is not disposed of.

The economic modelling is conducted on the basis that the economy has moved back to a new equilibrium. In particular, the economy is back to full employment — Australia-wide employment is not changed and NSW employment is reduced only to the extent that employment shifts to other states and territories.

Overall impacts on the NSW economy and households

The impacts of the scenarios, relative to there being no costs related to managing asbestos or risk to the industry, are set out in table 4.2.

- The costs imposed by the industry proposed approach would reduce employment by 29 people across NSW, and reduce the size of the NSW economy by $6 Million.
- The costs imposed by the EPA approach are several multiples of the industry proposed approach, with a reduction in NSW employment of 556 people, and a reduction in the size of the NSW economy of $115 Million relative to what it would otherwise have been.
- The costs imposed by the collapse of the C&D recycling sector in total are many multiples of the other scenarios. If this occurred, this would reduce NSW employment by 10 602 full time equivalents, and reduce the size of the NSW economy by over $2 Billion per year. Annual investment would be more than $200 Million lower across the NSW economy.

4.2 Impacts on the NSW economy

Indicator	Unit	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
NSW Gross State Product	$m/year	-2 112	- 115	- 6
NSW investment	$m/year	- 219	- 13	- 1

Indicator	Unit	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
NSW consumption	$m/year	-1 075	- 58	- 3
NSW Employment	FTE	-10 602	- 556	- 29
NSW inflation	Per cent	0.20	0.01	0.00
NSW real wage	Per cent	-0.20	-0.01	0.00

Source: The CIE.

These impacts are based on the NSW landfilling sector being able to effectively take up the additional materials diverted. As a consequence, the NSW Government receives a fairly substantial increase in tax revenues (landfill levy) of ~$1 Billion per year in Scenario 1. However, in this scenario it may well not be possible in the short to medium term for NSW landfills to accommodate the very large increase in landfilling. As a sensitivity test, we consider the costs if interstate landfills are instead used, and therefore no levy money flows to the NSW Government (table 4.3).

- In this scenario, the impacts on the NSW economy are a reduction in GSP of $5.5 Billion, more than twice the impact compared to material being landfilled in NSW.
- The employment reduction across NSW would be more than 25,000 full time equivalent jobs.

4.3 Impacts on the NSW economy for industry shutdown (Scenario 1) with interstate landfilling

Indicator	Unit	NSW landfill Scenario 1	Queensland landfill Scenario 1
NSW Gross State Product	$m/year	-2 112	-5 534
NSW investment	$m/year	- 219	- 601
NSW consumption	$m/year	-1 075	-2 802
NSW Employment	FTE	-10 602	-27 123
NSW inflation	Per cent	0.20	0.55
NSW real wage	Per cent	-0.20	-0.52

Source: The CIE.

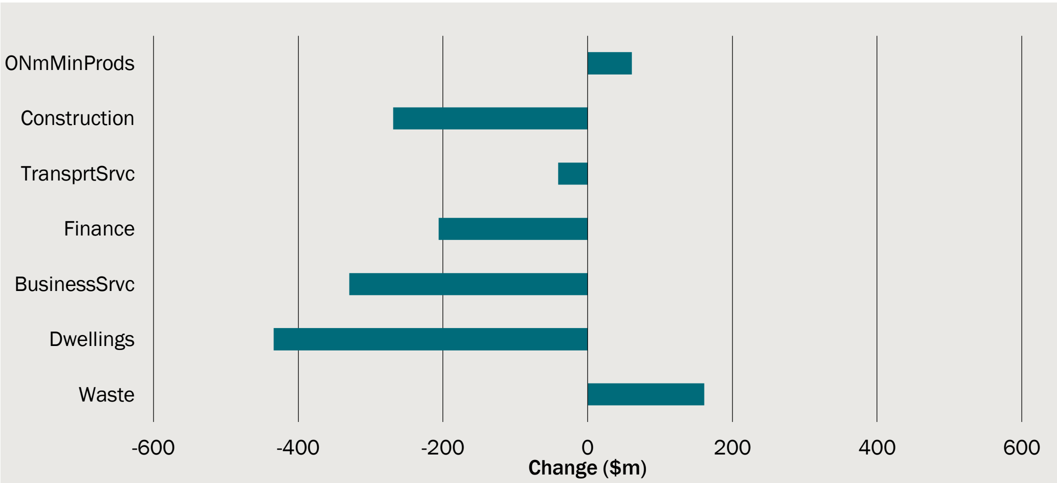
Sectoral impacts of the scenarios

The sectoral impacts of Scenario 2 and Scenario 3 are relatively modest, with the largest impacts being in the construction sector, and dwelling services, which is a heavy user of construction.

The sectoral impacts for Scenario 1 are much larger, and are generally negative across most sectors of the economy. Results are shown as $M changes in value added for selected sectors (chart 4.4) and as a percentage change in value added (chart 4.5).

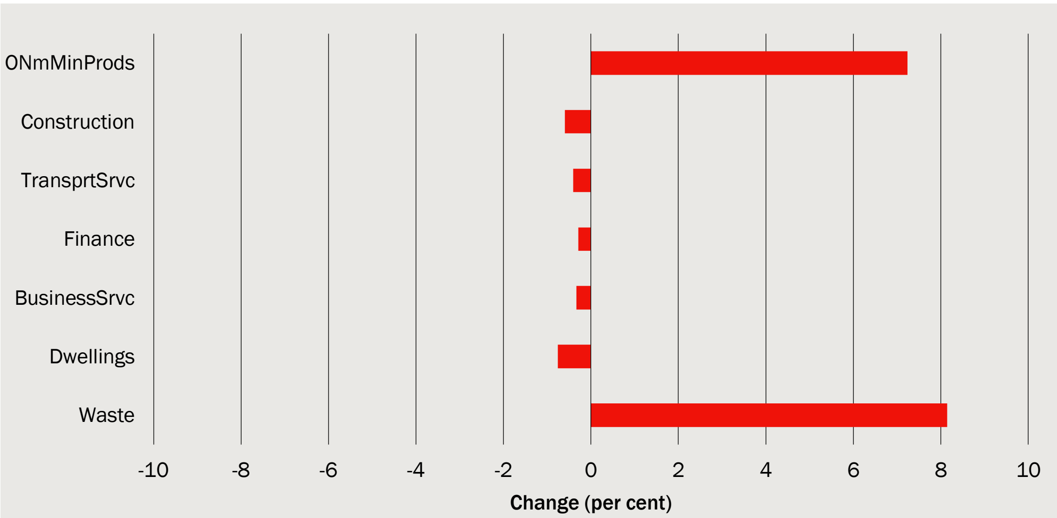
- The other non-metal minerals production sector, which includes quarried materials, expands its value added by ~7 per cent.
- The waste sector also expands, because of the large increase in waste moved to landfill, offset by the reduction in the C&D recycling, which is also part of the waste sector, however the diversion targets of NSW government are significantly impacted.
- All other sectors decline, generally in proportion to their size and use of construction. For example, dwelling services falls by over $400 Million because it is a large sector and heavily influenced by construction costs.
- The construction sector also declines, although a large part of the impact on construction is passed on to other sectors.

4.4 Impacts of closure of C&D recycling ($m in value added)



Data source: The CIE.

4.5 Impacts of closure of C&D recycling (percentage change in value added)



Data source: The CIE.

5 Social and environmental consequences and costs of reduced C&D recycling

Impacts on the construction and demolition recycling sector also have social and environmental consequences, in addition to the economic consequences set out above. If sufficient certainty around how asbestos will be required to be managed and C&D recycling halts, the impacts are enormous, simply reflecting the scale of what would otherwise have to happen. These impacts include:

- large reductions in the NSW recycling rate and in the amount of material required to be landfilled.
- increases in the amount of quarried materials
- substantial increases in movement of virgin quarried materials into Greater Sydney, with the associated GHG emissions, air pollution and other environmental impacts, congestion and safety impacts that this entails.

Changes in material flows

All three Scenarios have different impacts on the material flows around NSW and particularly Greater Sydney. These changes include how much material gets landfilled and how much virgin material is required from quarries in the regions surrounding Sydney.

The estimated magnitude of changes to material flows is set out in table 5.1.

- The EPA proposed procedure would lead to a relatively small increase in the amount of material landfilled, of 15,000 tonnes, compared to the industry scenario — this is additional material disposed of because of broader requirements for how much material is removed due to an asbestos find.
- The industry shutdown scenario has dramatically higher impacts, leading to more than 7 Million Tonnes no longer going to C&D recyclers and instead being sent directly to landfills in NSW, or potentially interstate. This leads to a requirement for 6.7 Million Tonnes more materials per annum from quarries.

5.1 Changes to material flows for each scenario

Sector	Sc1 (Shutdown)	Sc2 (EPA)	Sc3 (industry)
	Tonnes	Tonnes	Tonnes
Tonnes not directed to C&D recyclers			
Source-separated disposed waste	4 500 000	4 373	673

Sector	Sc1 (Shutdown)	Sc2 (EPA)	Sc3 (industry)
	Tonnes	Tonnes	Tonnes
Mixed disposed waste	2 850 000	13 338	2 052
Total	7 350 000	**17 711**	**2 725**
Additional requirement for virgin materials			
From loss of source-separated recyclables	4 455 000	4 344	668
From loss of mixed recyclables	2 280 000	11 856	1 824
Total C&D sector	**6 735 000**	**16 200**	**2 492**

Note: Total numbers for each sector differ as each type of material has a different recycling rate.
Source: The CIE.

A decrease in the overall recycling output and activity, and increased landfilling has social and environmental consequences across NSW.

Impact on employment and job creation

The C&D waste recycling industry has direct and indirect impacts on employment and job creation in various sectors, including waste collection, treatment and disposal, virgin material production, C&D sector, and freight transportation services. A reduction or shutdown of the C&D waste recycling industry would lead to job losses in the recycling industry and C&D sector due to less demand, while creating jobs at landfills, quarries and freight transportation services to meet increased demand.

These shifts in employment will have important short-term ramifications for people involved in the industry. However, in the medium to longer term, the impacts on employment will reflect the overall impacts across NSW driven by the change in how competitive NSW is compared to other states and territories. As shown in the previous chapter, these changes in aggregate employment can be very large in the industry shutdown scenario, and largely occur outside of the waste sector.

- **NSW employment will be maximised by having an efficient C&D recycling sector, that ensures that costs for the construction sector to dispose of waste and purchase materials are low, helping to make NSW competitive.**

Impact on virgin material requirements

According to R.W. Corkery & Co, in 2017/18, the construction sector used ~40 Million Tonnes of construction material in the Greater Sydney Region (GSR):

- 13.6 Million Tonnes of crushed rock products
- 5.6 Million Tonnes of natural sand
- 16.7 Million Tonnes of substitutes (i.e., virgin excavated natural mineral, tunnel spoil, crushed sandstone, recycled C&D waste), and

- 3.6 Million Tonnes of cement and supplementary cementitious materials.[36]

Furthermore, according to Cement, Concrete and Aggregates Australia (CCAA), in 2017, the total NSW industry delivered over 65 Million Tonnes of construction material[37] to the Greater Sydney Area (GSA). This figure was expected to increase to 72M Tonnes by 2056.[38] The CCAA figure differs from the one above as it counts total *transported* material and, therefore, "double counts" the amount of aggregates which is used in concrete production.

Sydney is in the middle of an infrastructure boom, with huge requirements for construction materials.

A reduction or shutdown of the C&D waste recycling leads to increased demand in virgin materials (table 5.1). The EPA and industry proposed procedures would not have any noticeable impact on virgin material demand. However, the industry shutdown scenario would, lead to an increase in virgin material demand of over 34 per cent. Since we assume that recovered aggregates are primarily a substitute for crushed rock products, this would lead to an increase of crushed rock product demand of over 50 per cent.

Based on our review of EPA licenses, CIE consultations, and R.W. Corkery & Co study prepared for DPIE we anticipate that quarry capacities (chart 5.2) could handle the increased demand, but at the cost of a more rapid exhaustion of primary resources, increased energy consumption, and an increased transportations task.

5.2 Annual production and approved reserves of virgin materials

	Crushed rock products	Natural Sand
	Million Tonnes	Million Tonnes
Annual production	13.6	5.9
Annual approved production limit	25.6	10.5
Total combined approved reserves	562.9	107.0

Note: Production limit might be understated as some quarries do not have a limit.

Source: R.W. Corkery & Co (2019), https://search.geoscience.nsw.gov.au/api/download/3523bfe015c97348797dae052c74f6af/Supply_and_Demand_Study_and_Appendices_-_April_2019.pdf

The time required to obtain approval for new quarries or to gain approval for expanding existing quarries may be a barrier to rapidly increasing quarried material.

Using the R.W. Corkery & Co (2019) supply and demand study, we conducted a linear demand forecast of additional virgin material (chart 5.3):

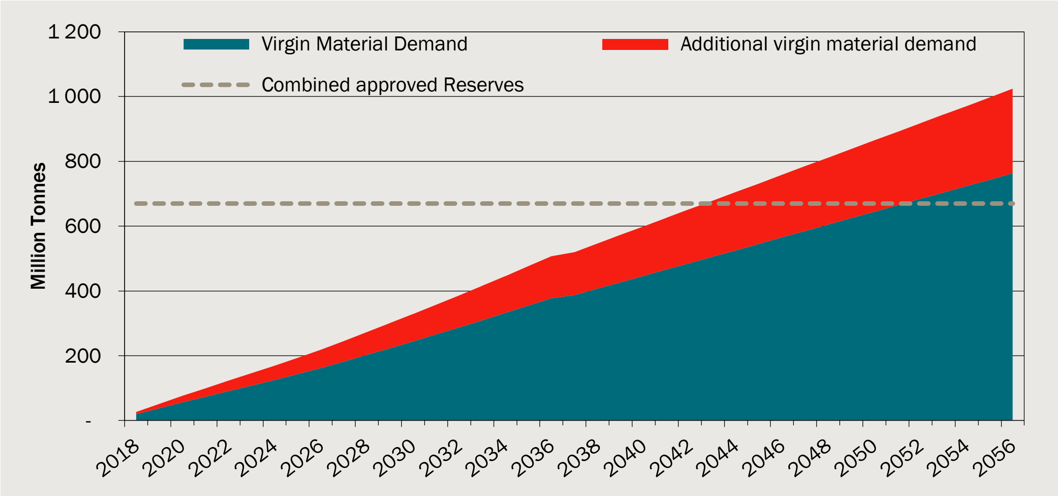
36 R.W. Corkery & Co (2019), *Supply and Demand Profile of Geological Construction Materials for the Greater Sydney Region*, https://search.geoscience.nsw.gov.au/api/download/3523bfe015c97348797dae052c74f6af/Supply_and_Demand_Study_and_Appendices_-_April_2019.pdf, p. xv

37 I.e., 40m tonnes aggregate, 23m tonnes concrete, and 2.3m tonnes cement.

38 CCAA (2018), https://www.ccaa.com.au/imis_prod/documents/CCAA_Submission_Freight_and_Ports_Plan_March_2018.pdf

- Until 2036 ~130 Million Tonnes and until 2056 ~260 Million Tonnes of additional material needs to be supplied, and
- currently approved reserves would reach their limit approximately 10 years earlier (2042 instead of 2052).[39]

5.3 Cumulative virgin material demand



Note: Original study only forecasts virgin material demand until 2036. Demand from 2037 to 2056 is a linear forecast, assuming no major demand changes. Additional virgin demand is based on the percentage recovered aggregates provide today (~35 per cent).
Data source: The CIE, R.W. Corkery & Co (2019).

Impact on the transportation task

There are multiple consequences on the transportation task of reduced recycling:

- increased transport of virgin materials from quarries outside of GSA,
- increased transport of C&D waste to landfills instead of recycling facilities, and
- decreased transport of recycled materials from recycling facilities to construction sites.

We assume that there is no significant difference in the transportation task between delivering waste from a C&D site to a recycling facility or landfill, or delivering recycled materials from a waste facility to a construction site.[40] However, there would be significantly higher transport movements to move virgin material from quarries to construction sites.

Most quarries are outside of Greater Sydney Area.[41] The main areas we expect would be used for increased quarry capacity would be Marulan and Peats Ridge, which are both

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39 Currently approved reserves might be slightly understated as some quarries do not report total approved reserves. (R.W. Corkery & Co (2019))

40 CIE analysis indicates that the largest C&D recycling facilities and landfills are located in Greater Sydney Area within a vicinity of 30km.

41 Over 63 per cent of the natural sand and 100 per cent of crushed rock products are sourced from quarries outside of GSA. (R.W. Corkery & Co (2019))

~100km from Sydney.[42] The additional transportation would be largely undertaken by road, although there are some quarries in the Marulan area who use rail transport. TfNSW figures indicate that 94 per cent of construction materials are transport by road, and that movement of construction materials equates to 13 per cent of total road tonne-kilometres carried in NSW.[43]

The impact of the scenarios on the road transportation task are shown in table 5.4.

- The EPA approach would lead to an additional 1 Million net tonne kms per year, or 2 Million tonnes increase in gross tonne kilometres, relative to there being no material lost from asbestos finds.[44] There would be 1 additional truck movement per day, and an additional 49 000 litres of fuel used per year.
- The industry shutdown scenario would have enormous transport consequences, leading to an additional 434 truck movements into Sydney per day (and the same out as empty trucks). We estimate more than 20 Million more litres of fuel would be used per year.

5.4 Impact on the transportation task

Indicator	Collapse of C&D recycling	EPA proposed approach	Industry proposed approach
	Scenario 1	Scenario 2	Scenario 3
Change in net tonne kms on road (000)	633 090	1 523	234
Gross tonne kms (000)	1 266 180	3 046	469
Full truck movements per year	158 273	381	59
Full truck movements per day	434	1	0
Vehicle kms (000 kms/year)	31 655	76	12
Fuel use from transport (000 litres/year)	20 470	49	8

Source: The CIE.

Environmental impacts from increased transportation

The movement of more virgin materials from quarries outside of Sydney has environmental consequences, in terms of air pollution, GHG emissions, noise pollution and water pollution. Using available guidance on fuel efficiency and the monetary value of environmental externalities, we can estimate the size of these impacts, as set out in table 5.5. We estimate that the EPA proposed approach would lead to 133 Tonnes of GHG emissions per year, compared to 20 Tonnes for the industry proposed approach. The collapse of C&D recycling would lead to an additional 55 000 Tonnes of CO2 equivalent emissions released into the atmosphere each year.

42 As virgin material quarries would be quicker exhausted, new quarries need to be exploited, increasing the transportation task.

43 TfNSW (2017), NSW Freight and Ports Plan 2018-2023

44 Net tonne kilometres is the weight of the goods being moved only. Gross tonne kilometres includes the weight of the trucks, including for return journeys which are empty. We have used a weight for a full truck of 60 tonnes and a weight for an empty truck of 20 tonnes.

5.5 GHG emissions from additional transport of materials

Indicator	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
	Tonnes per year	Tonnes per year	Tonnes per year
GHG emissions from additional transport (tonnes/year)	55 270	133	20

Source: The CIE.

The NSW guidance for transport projects also includes valuation of environmental externalities, based on tonne kilometres of road transport, and how much is in urban or rural areas.[45] Based on the expected journeys for virgin materials, we expect that 80 per cent would be rural and 20 per cent urban. The monetised environmental costs of the additional transport task is estimated at $24,000 per year for the EPA proposed approach, $4,000 for the industry proposed approach and almost $10 Million per year for the collapse of C&D recycling.

5.6 Cost of environmental externalities from transport task

Type of impact	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
	$000/year	$000/year	$000/year
Air pollution	3 696	9	1
GHG emission	3 950	10	1
Noise	831	2	0
Water pollution	1 389	3	1
Total	**9 866**	**24**	**4**

Source: The CIE.

Social impacts of additional transportation

The social impacts of additional transportation of quarried materials will include:

- damage to roads
- increasing safety incidents, and
- increased road congestion.

These have been measured and in some cases valued based on NSW Government guidance (table 5.7).[46]

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45 TfNSW Principles and Guidelines, https://www.transport.nsw.gov.au/projects/project-delivery-requirements/evaluation-and-assurance/resources.

46 TfNSW Principles and Guidelines, https://www.transport.nsw.gov.au/projects/project-delivery-requirements/evaluation-and-assurance/resources.

- Road damage and road congestion costs will be small in Scenarios 2 and 3, but over $6 Million per year and $14 Million per year for the industry collapse scenario, respectively
- Under the industry collapse scenario, there will be one additional fatality crash every four years, and over 8 additional injury crashes per year.

5.7 Social impacts from transport task

Type of impact	Collapse of C&D recycling Scenario 1	EPA proposed approach Scenario 2	Industry proposed approach Scenario 3
Road damage ($000/year)	6 116	15	2
Road congestion ($000/year)	14 207	34	5
Safety			
No of additional fatal crashes per year	0.27	0.00	0.00
Number of additional injury crashes per year	8.56	0.02	0.00

Source: The CIE.

Transport to Queensland

If NSW landfills are unable to accommodate the additional demand in Scenario 1, and some waste is shifted to Queensland then the transport impacts will be much larger. Some of this waste may be moved by rail — historically when interstate movement of waste was occurring, about half was moved by rail and half by road. Using this same split, the road transport impacts from landfilling into Queensland for Scenario 3 are shown in table 5.8. The environmental and social costs of such as movement would be very large.

5.8 Transport indicators if waste is landfilled in Queensland

Indicator	Unit	QLD transport
Net tonne kms	Million/year	3 158.7
GHG emissions	Tonnes/year	275 763
Environmental externalities	$m/year	38.3
Road damage	$m/year	30.5
Congestion	$m/year	17.7
Safety impacts		
No of additional crashes per year	No./year	1.3
Number of additional injury crashes per year	No./year	37.9

Source: The CIE.

Impact on land consumption and non-putrescible landfill capacity

In 2017, ~11 Million Tonnes of waste was disposed at landfills in NSW, of which non-putrescible waste made up 64 per cent or ~6.9M Tonnes (~3.6M C&D waste).[47] The Greater Sydney area faces decreasing remaining non-putrescible landfill capacities as some of the largest landfills are set to reach total capacity in the next 3 to 5 years.[48] While there is no reliable data on the potential total annual capacity (i.e., a combination of available land area and EPA licenses), CIE estimates over 45 Million tonnes of capacity remain. Once landfills reach their lifespan then the annual capacity could be much lower.

5.9 Greater Sydney non-putrescible landfills

Landfill	Annual capacity limit	Annual capacity	Remaining estimated capacity[a]	Estimated life
Patons Lane Landfill	licences limit	0.21	3.07	2040
Eastern Creek (Bingo)	licences limit	0.70	8.40	2033
Bankstown Kelso Landfill	no licences limit	0.20	0.20	2021
Benedicts Penrith Waste Services Landfill	no licences limit	na	na	na
Blacktown Waste Marsden Park Landfill	no licences limit	0.36	1.08	2024
Brandown C&D landfill	no licences limit	0.26	4.94	2040
Breen Kurnell Landfill	no licences limit	na	na	2030
Glenfield Waste Landfill	licences limit	0.10	na	na
Kimbriki Landfill	licences limit	0.21	3.99	2040
Kemps Creek (Suez)	no licences limit	2.20	13.10[b]	2030
Horsely Park (Veolia)	no licences limit	0.43	1.72	2025
Wanless Sydney Recycling Park	no licences limit	0.40	8.80	2043
Estimated total		**5.32**	**45.10**	

[a] Where data was not available annual capity was multiplied by remaining life span.

[b] Additional 5 Million cubic extending lifespan by 6 years.

Note: Whenever there was no annual licences limit, the annual input (where known) was used.

Source: http://www.acor.org.au/uploads/2/1/5/4/21549240/acor_-_final_report_v02__1_.pdf, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=PDA-371%2120190312T035748.017%20GMT, https://www.openbriefing.com.au/AsxDownload.aspx?pdfUrl=Report%2FComNews%2F20190501%2F02101520.pdf, https://www.suez.com.au/en-au/news/elizabeth-drive-landfill-expansion-proposal, https://www.veolia.com/anz/our-services/our-facilities/landfills/horsley-park-facility-nsw,

Additional tonnes disposed in Scenario 2 and 3 can be easily managed by the landfills, however, a shutdown of the C&D recycling would more than double the amount of non-putrescible waste that needs to be landfilled.

47 National waste database 2018

48 ACCC (2018), Statement of Issues, Bingo – proposed acquisition of Dial-a-Dump

The large increase in demand would very likely be too much for existing NSW landfills. The ability to expand capacity would be limited due to planning and approval times of up to 10 years.[49] This will in turn increase the risk of illegal dumping and interstate movement significantly, which will be discussed in the next section.

Increased landfilling has both social and environmental consequences, which are outlined in table 5.10.

5.10 Social and environmental consequences of increased landfilling

Impact	Examples
Social	▪ Decreasing life span of landfills and increase in land consumption. ▪ Less space for productive use, such as green space or living areas. ▪ Less preserved area for urban and industrial development. ▪ Decrease in land value and aesthetics ▪ Public health – Higher risk of negative externalities upon groundwater, surface-water, air, flora & fauna and landscape – Lower risk of asbestos contact for public and construction worker – Higher risk of hydrogen sulfide production at landfills caused by drywall ▪ Non-putrescible landfills are a burden for future generations ▪ Circular economy goal cannot be reached ▪ International reputation
Environment	▪ Higher risk of damage to the environment such as: – water and soil pollution, – air pollution – climate change, and – adverse effects on flora and fauna ▪ C&D waste consists of mostly clean and heterogenous materials, but can also have elements which are potentially hazardous, such as: – Concrete additives – Adhesives – Mastics / sealants – Treated timber – Paint and coatings

Source: https://ec.europa.eu/environment/waste/studies/cdw/cdw_annexes7-13.pdf, Yuan (2012) *Key indicators for assessing the effectiveness of waste management in construction projects,* Liu (2020) *Economic and Environmental Assessment of Carbon Emissions from Demolition Waste Based on LCA and LCC,* https://environmentvictoria.org.au/resource/problem-landfill/, https://cdrecycling.org/site/assets/files/1050/cdra_benefits_of_cd_recycling_final_revised_2017.pdf, CIE.

Increased risk of illegal dumping and interstate movement

In general, illegal dumping of C&D waste and asbestos takes less place compared to other illegally disposed waste types. Whereas interstate movement to Queensland was substantially and amounted to ~1m tonnes in 2017-18. However, since the introduction

49 https://wastemanagementreview.com.au/nsws-landfill-gap/

of a waste levy in Queensland this amount has decreased, however it is unclear how significantly.

While we do not except a significant increase in illegal dumping or interstate movement in Scenario 2 and Scenario 3, Scenario1 suggests a cost increase of over $1.4Billion for disposal for the demolition sector creating significantly higher incentives.

Illegal dumping

Illegal dumping is already a costly issue for local governments and is set to increase if recycling activity is shut down. While we cannot make any adequate estimates of the amount of additional illegal dumping in Scenario 1, an increase in negative environmental effects is certain.

Illegal deposits are characterised by:

- increased proliferation of pests,
- increased emissions into the air or leaching of toxic substances into the soil and/or groundwater affecting the population, and
- unstable dumps and deposits, which are dangerous for civilians and workers.[50]

Interstate movement

Interstate movement of NSW waste has increased from 0.72m in 2015-16 to 1.47m tonnes in 2017-18.[51] This represents an increase of 6 to 11 per cent of the total recycling, with most of the transported waste going to Queensland (~1MT)[52] and Victoria.

The total amount transported has now decreased significantly due to the introduction of the $80 per Tonne waste levy in Queensland in July 2019.

There will be no significant increase in interstate movement in Scenario 2 and Scenario 3 compared to past figures. However, a shutdown of the C&D recycling industry will lead to excess demand for NSW landfills, and potentially an increase in gate fees, making interstate transportation a viable economic option.

As the shutdown scenario leads to distortions in multiple sectors and states it is not possible to adequately estimate changes in interstate movement. We set out a scenario where waste is moved interstate, which highlights the enormous consequences if this occurred.

50 http://www.env.go.jp/recycle/3r/en/forum_asia/results/pdf/20091111/06.pdf

51 NSW EPA (2018), *Data quality statement - Supporting document for the NSW Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18*

52 Queensland Government (2018), *Recycling and waste in Queensland 2018*

Impact on recycling rates

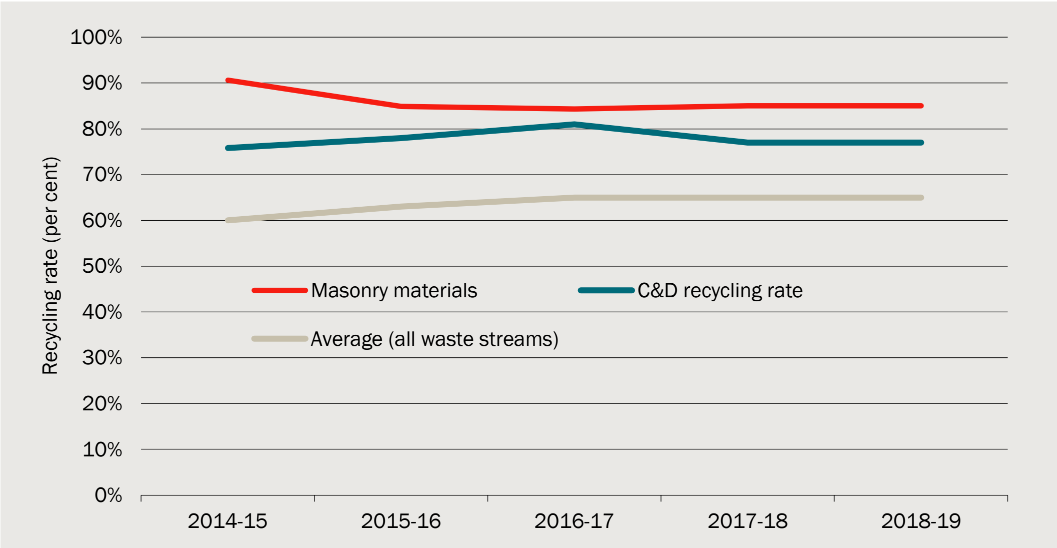
NSW EPA's 2014 to 2021 Waste Avoidance and Resource Recovery Strategy underlines the importance of increasing waste diversion from landfills along with higher recycling rates towards a circular economy. One significant key result area is the increase in recycling rates across all waste streams. The C&D recycling industry managed to achieve the results of 80 per cent in 2016-17 and remains after a decrease in 2017-18 on track.[53]

However, current regulation[54] (e.g., increase of director's liabilities) and most recent developments regarding the interpretation of asbestos contamination (Grafil case) complicate the management of C&D waste. These issues threaten the viability of the NSW C&D recycling industry as well as state and national goals for diversion and recycling rates.

In 2017-18, the C&D recycling rate was ~77 per cent, while the diversion rate of masonry material was over 85 per cent (chart 5.6).

The C&D sector generates and recycles by far the most waste. In 2017-18, 60 per cent of the total waste generated in NSW originated in the C&D sector, but the sector also makes up 70 per cent of the total recycled material, due to the highest recycling rate across all waste streams.

5.11 Selected recycling rates in NSW



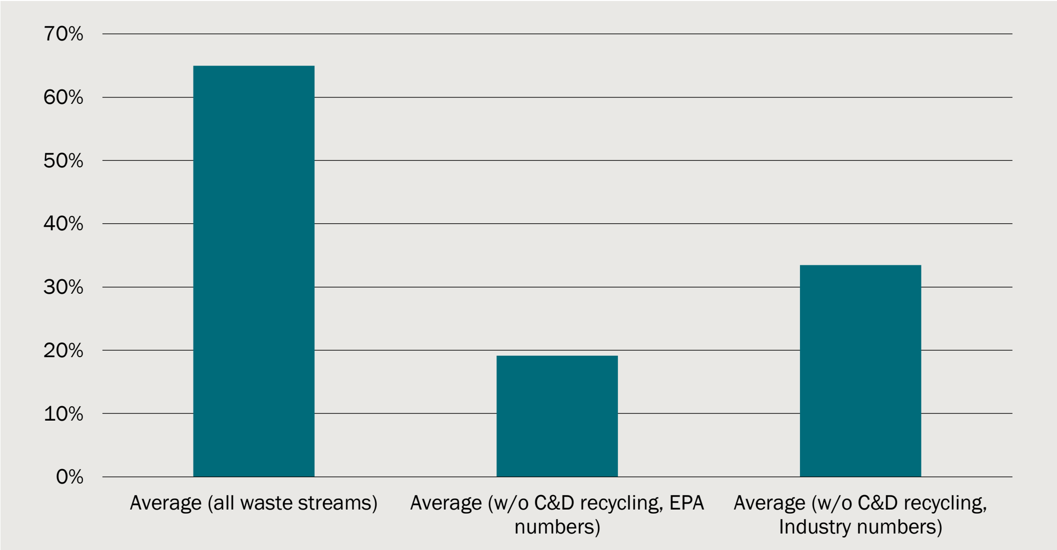
Data source: National waste database 2018 (pre 2015-16 data and masonry material recycling rate), NSW EPA progress report 2017-18 (2015-16 to 2017-18 data).

A severely reduced or shut down of recycling activity would lead to a decrease in recycling rates. In the shutdown scenario the overall recycling rate would decrease from 65 to 19 per cent (i.e., considering EPA figures of total recycled C&D volumes being stopped) or to 33 per cent considering industry figures for the specific recycling facilities examined in this study.

53 NSW EPA (2018), *Progress report 2017-18*

54 Protection of the Environment Operations Act 1997

5.12 Average NSW recycling rate with and without C&D recycling (2018-19)



Note: Differences between EPA and industry figures are due to the fact that the EPA includes VENM as recycled C&D waste.

Data source: The CIE.

A CGE modelling methodology

Increases in cost for C&D recycling, or a halt to C&D recycling, act as negative productivity shocks for the C&D recycling sector. Within the C&D recycling sector, the impacts of this would be:

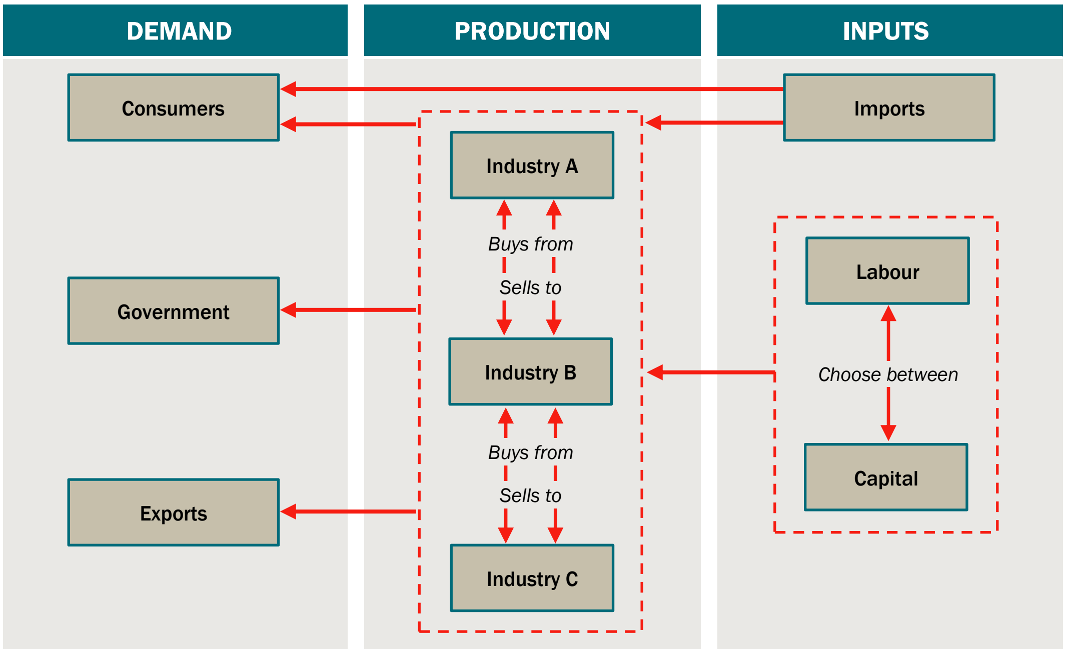
- higher prices for C&D recycling services (i.e. disposal rates)
- reduced quantity of C&D recycling.

The economywide impacts of these changes within the C&D recycling sector will reflect the interlinkages of this sector with the rest of the NSW economy. The best way to model these interlinkages is with a computable general equilibrium (CGE) model. A CGE model provides a complete view of the overall economy, covering:

- demand from consumers, government and exports
- production and linkages between producing sectors (eg construction uses quarry outputs), and
- inputs (labour and capital).

A schematic of a CGE model is shown in chart A.1.

A.1 Interactions in an economy-wide model



Data source: The CIE.

For this project, the impacts within the C&D recycling sector have been translated across the NSW economy into:

- higher costs for construction activities, both civil and building, because of higher costs for disposal of materials from demolition
- higher costs for materials, which are also generally used in civil construction, because of reduced quantities of materials supplied from recycled sources
- increased demand for virgin materials, and mining of these materials
- increased demand for landfilling

Looking even more broadly, typically a negative productivity impact within a NSW sector leads to a shift in activity away from NSW, because NSW becomes less competitive than other states. In the long term, a less productive NSW economy leads to lower wages and lower levels of investment.

The CIE has developed a CGE model with a detailed treatment of the waste sector for the Australian Government, using the National Waste Database. Some details of this are set out below. This has as a starting point the available data on the waste industry across Australia and volumes from the National Waste database.

CIE-REGIONS model is a general equilibrium model of the Australian economy. It was developed by the Centre for International Economics based on the publicly available MMRF-NRA model developed by the Centre of Policy Studies for the Productivity Commission.[55]

Some of the key aspects that make this model especially suited for this task are that it:

- uses the latest input-output table
- provides a detailed account of industry activity, investment, imports, exports, changes in prices, employment, household spending and savings and many other factors;
  - this version of the CIE-REGION model identifies 59 industries and commodities with the waste industry being separately identified (table A.2)
- includes a newly developed waste module linking waste generation to economic activities of industries, governments and households
- accounts for Australia's six states and two territories as distinct regions
  - accounts for differing economic fundamentals in the states and territories
  - state and territory results can be further disaggregated down to statistical division (SD) level
- includes specific details about the budgetary revenues and expenditures of each of the eight state and territory governments and the Australian Government (the government finances in CIE-REGIONS align as closely as practicable to the ABS government finance data)
  - specifically accounts for major taxes including land taxes, payroll taxes, stamp duties and others at the state level, as well as income taxes, tariffs, excise, the GST and other taxes at the federal level (table 3.9).

55 Productivity Commission 2006, *Potential Benefits of the National Reform Agenda*, Report to the Council of Australian Governments, available at http://www.pc.gov.au/research/commissionresearch/nationalreformagenda

  - traces out the impact of transfers between governments
- can be run in a static or dynamic mode. The dynamic version allows analysis to trace impacts over time as the economy adjusts, being particularly useful over the medium to longer terms.

The CIE has used CIE-REGIONS to analyse the impacts of a wide range of policy issues, including state tax reform, proposed reform options on accelerated depreciation, energy policy and climate change policy measures, international trade agreements, government R&D policy, local infrastructure development, and industrial development strategies, as well as projections of agriculture, mining and energy industries and greenhouse gas emissions.

A.2 CIE-REGIONS industries/commodities and margin services

Industries/commodities			
1	Livestock	31	Electricity generation – other
2	Crops	32	Electricity supply
3	Forestry	33	Gas supply
4	Fishing	34	Water supply
5	Coal	35	Construction
6	Oil	36	Wholesale trade
7	Gas	37	Retail trade
8	Iron ore	38	Mechanical repairs
9	Other metal ores	39	Accommodation and food services
10	Other mining	40	Road passenger transport
11	Food, drink and tobacco	41	Road freight transport
12	Textiles, clothing and footwear	42	Rail passenger transport
13	Wood products	43	Rail freight transport
14	Paper products	44	Pipelines
15	Printing and publishing	45	Ports
16	Petroleum products	46	Transport services
17	Chemicals	47	Water freight transport
18	Rubber and plastic products	48	Ship charter
19	Other non-metal construction materials	49	Air passenger transport
20	Cement	50	Air freight transport
21	Iron and steel	51	Communication services
22	Other metals	52	Finance
23	Metal products	53	Business services
24	Transport equipment	54	Dwellings
25	Other equipment	55	Government administration and defence
26	Other manufacturing	56	Education

Industries/commodities			
27	Electricity generation – coal	57	Health
28	Electricity generation – gas	58	Other services
29	Electricity generation – oil	59	Waste management
30	Electricity generation – hydro		

Source: CIE-REGIONS database.

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APPENDIX I

Marked-up Recovered Soils Order and Exemption

Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014

The "batch process" recovered fines order ~~2014~~ 2021

Introduction

This order, issued by the Environment Protection Authority (EPA) under clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 (Waste Regulation), imposes the requirements that must be met by suppliers of "batch process" recovered fines to which 'the "batch process" recovered fines exemption ~~2014'~~ 2021' applies. The requirements in this order apply in relation to the supply of "batch process" recovered fines for application to land for the purpose of construction or landscaping.

Commented [GS1]: As per Enrisk report dated 29 October 2021, clarity is sought as to the definition of "batch" to address current ambiguity

1. Waste to which this order applies

1.1. This order applies to "batch process" recovered fines. In this order, "batch process" recovered fines means a soil or sand substitute with a typical maximum particle size of ~~9.5~~ 6.75 mm that is derived from the batch processing of mixed construction and demolition waste including residues from the processing of skip bin waste.

Commented [GS2]: Industry proposes smaller screen size

2. Persons to whom this order applies

2.1. The requirements in this order apply, as relevant, to any person who supplies "batch process" recovered fines that have been generated, processed or recovered by the person.

2.2. This order does not apply to the supply of "batch process" recovered fines to a consumer for land application at a premises for which the consumer holds a licence under the POEO Act that authorises the carrying out of the scheduled activities on the premises under clause 39 'waste disposal (application to land)' or clause 40 'waste disposal (thermal treatment)' of Schedule 1 of the POEO Act.

3. Duration

3.1. This order commences on ~~24 November 2014~~ 1 January 2022 and is valid until revoked bythe EPA by notice published in the Government Gazette.

4. Processor requirements

The EPA imposes the following requirements on any processor who supplies "batch process” recovered fines.

Sampling requirements

4.1. On or before supplying “batch process” recovered fines, the processor must:

4.1.1. Prepare a written sampling plan which includes a description of sample preparation and storage procedures for the “batch process” recovered fines.

4.1.2. Undertake sampling and testing of the “batch process” recovered fines as required under clause 4.2 below. The sampling must be carried out in accordance with the written sampling plan and Australian Standard 1141.3.1-2012 Methods for sampling and testing aggregates – Sampling – Aggregates (or equivalent).

4.2. The processor must undertake one-off sampling by collecting 10 composite samples from every 400 tonnes (or part thereof) of the waste processed and testing each sample for the chemicals and other attributes listed in Column 1 of Table 1.

4.3. The processor must ensure that the test results for each composite sample must be validated as compliant with the maximum average concentration or other value listed in Column 2 of Table 1 and the absolute maximum concentration or other value listed in Column 3 of Table 1 prior to the supply of the “batch process” recovered fines.

Chemical and other material requirements

4.4. The processor must not supply “batch process” recovered fines to any person if, in relation to any of the chemical and other attributes of the “batch process” recovered fines:

4.4.1. The concentration or other value of that attribute of any sample collected and tested as part of the one-off sampling of the “batch process” recovered fines exceeds the absolute maximum concentration or other value listed in Column 3 of Table 1, or

4.4.2. The average concentration or other value of that attribute from the one-off sampling of the “batch process” recovered fines (based on the arithmetic mean) exceeds the maximum average concentration orother value listed in Column 2 of Table 1.

4.5. The absolute maximum concentration or other value of that attribute in any “batch process” recovered fines supplied under this order must not exceed the absolute maximum concentration or other value listed in Column 3 of Table 1.

Commented [GS3]: As per Enrisk report October 2021, further clarity is required in relation to for example,
1. Sampling densities and sampling methods; and
2. Content and standard of Sampling Plans;
Industry is very keen to discuss and progress this with EPA.

Commented [GS4]: Industry is very keen to work with the EPA to agree a regime of independent verification of testing and sampling on an agreed three (3) or six (6) monthly basis.

Table 1

Column 1	Column 2	Column 3
Chemicals and other attributes	**Maximum average concentration for one-off characterisation** (mg/kg 'dry weight' unless otherwise specified)	**Absolute maximum concentration for one-off characterisation** (mg/kg 'dry weight' unless otherwise specified)
1. Mercury	0.5	1.5
2. Cadmium	0.5	1.5
3. Lead	100	250
4. Arsenic	20	40
5. Chromium (total)	60	150
6. Copper	70	200
7. Nickel	40	80
8. Zinc	250	600
9. Total Organic Carbon	5%	10%
10. Electrical Conductivity	2.5 dS/m	3.5 dS/m
11. pH *	7.5 - 9	7.0 - 10
12. Total Polycyclic Aromatic Hydrocarbons (PAHs)	20	80
13. Benzo(a)pyrene	1	6
14. Total Petroleum Hydrocarbons (TPHs) C_6 - C_9	80	150
15. Total Petroleum Hydrocarbons (TPHs) C_{10} - C_{36}	800	1600
16. Individual Chlorinated Hydrocarbons	Not applicable	1
17. Individual Organochlorine Pesticides	Not applicable	1
18. Individual Polychlorinated Biphenyls (PCBs)	Not applicable	1
19. Glass, metal and rigid plastics	0.1%	0.3%
20. Plastics - light flexible film	0. 05%	0. 1%
21. Proportion (by weight) retained on a 0.425 mm sieve	80%	90%
22. Proportion (by weight) retained on a 9.5 mm sieve	Not applicable	5%
23. Proportion (by weight) retained on a 26.5 mm sieve	Not applicable	0%
24 Asbestos as per Australian Standard AS 4964~~1141.3.1-2012~~	Not applicabel~~?~~	0.1g/kg~~?~~

*Note: The ranges given for pH are for the minimum and maximum acceptable pH values in the "batch process" recovered fines.

Commented [GS5]: As per industry's submission, this order should fall within an agreed system of RROs that cover intended use of materials, and as such the levels and limits should reflect this purpose and use, as well as be clear on identifying what protection they are providing given risk, and background levels.

Comparison of concentration limits in the various resource recovery orders with guidelines based on the protection of human health and ecosystems shows the limits are quite variable and are similar to or more conservative than the guidelines protective of human health and ecosystems.

Industry is very keen to discuss with EPA and independent scientific advisors.

Formatted: Left

Commented [GS6]: Proposing testing in accord with the Australian Standard

Test methods

4.6. The processor must ensure that any testing of samples required by this order is undertaken by analytical laboratories accredited by the National Association of Testing Authorities (NATA), or equivalent.

4.7. The processor must ensure that the chemicals and other attributes (listed in Column 1 of Table 1) in the "batch process" recovered fines it supplies are tested in accordance with the test methods specified below or other equivalent analytical methods. Where an equivalent analytical method is used the detection limit must be equal to or less than that nominated for the given method below.

4.7.1. Test methods for measuring the mercury concentration:

4.7.1.1. USEPA SW-846 Method 7471B Mercury in solid or semisolid waste (manual cold vapour technique), or an equivalent analytical method with a detection limit < 20% of the stated absolute maximum average concentration in Table 1, Column 3 (i.e. < 0.3 mg/kg dry weight).

4.7.1.2. Report as mg/kg dry weight.

4.7.2. Test methods for measuring chemicals 2 - 8:

4.7.2.1. Sample preparation by digestion using USEPA SW-846 Method 3051A Microwave assisted acid digestion of sediments, sludges, soils, and oils (or an equivalent analytical method).

4.7.2.2. Analysis using USEPA SW-846 Method 6010C Inductively coupled plasma - atomic emission spectrometry, or an equivalent analytical method with a detection limit < 10% of the stated absolute maximum concentration in Table 1, Column 3 (i.e. 25 mg/kg dry weight for lead).

4.7.2.3. Report as mg/kg dry weight.

4.7.3. Test methods for measuring the total organic carbon:

4.7.3.1. Method 105 (Organic Carbon) in Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or an equivalent analytical method).

4.7.3.2. Reporting as % total organic carbon.

4.7.4. Test methods for measuring the electrical conductivity and pH:

4.7.4.1. Sample preparation by mixing 1 part recovered fines with 5 parts distilled water.

4.7.4.2. Analysis using Method 103 (pH) and 104 (Electrical Conductivity) in Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or an equivalent analytical method).

4.7.4.3. Report electrical conductivity in deciSiemens per metre(dS/m).

4.7.5. Test method for measuring PAHs and benzo(a)pyrene:

4.7.5.1. Analysis using USEPA SW-846 Method 8100 Polynuclear aromatic hydrocarbons (or an equivalent analytical method).

4.7.5.2. Calculate the sum of all 16 PAHs for total PAHs.

Commented [GS7]: As per the Enrisk report 29 October 2021, greater clarity is required about the testing regime including how it is to be determined when characterisation testing is required nor does it indicate what would trigger re-characterisation after some time period.

4.7.5.3. Report total PAHs as mg/kg dry weight.
4.7.5.4. Report benzo(a)pyrene as mg/kg.

4.7.6. Test method for measuring TPHs in “batch process” recovered fines:
4.7.6.1. Method 506 (Petroleum Hydrocarbons) in Schedule B (3): Guideline on Laboratory Analysis of Potentially Contaminated Soils, National Environment Protection (Assessment of Site Contamination) Measure 1999 (or an equivalent analytical method).
4.7.6.2. Report C6 – C9 as mg/kg.
4.7.6.3. Report C10 – C 36 as mg/kg.

4.7.7. Test methods for measuring chlorinated hydrocarbons:
4.7.7.1. Analysis using USEPA SW-846 Method 8021B Aromatic and halogenated volatiles by gas chromatography using photoionization and/or electrolytic conductivity detectors (or an equivalent analytical method).
4.7.7.2. Measure the following chlorinated hydrocarbons: carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichlorothene, dichloromethane (methylene chloride), 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, vinyl chloride and hexachlorobutadiene concentrations.
4.7.7.3. Report individual listed chlorinated hydrocarbons as mg/kg.

4.7.8. Test methods for measuring organochlorine pesticides:
4.7.8.1. Analysis using USEPA SW-846 Method 8081BOrganochlorine pesticides by gas chromatography (or an equivalent analytical method).
4.7.8.2. Measure the following organochlorine pesticides: aldrin, alpha BHC, beta BHC, gamma BHC (lindane), delta BHC, chlordane, DDT, DDD, DDE, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor and endosulfan (includes endosulfan I, endosulfan II and endosulfan sulphate).
4.7.8.3. Report individual listed organochlorine pesticides as mg/kg.

4.7.9. Test methods for measuring the PCBs:
4.7.9.1. USEPA SW-846 Method 8082A Polychlorinated Biphenyls (PCBs) by gas chromatography (or an equivalent analytical method).
4.7.9.2. Measure the following PCBs: Aroclor 1016 (CAS Registry No. 12674-11-2), Aroclor 1221 (CAS Registry No. 11104-28-2), Aroclor 1232 (CAS Registry No. 11141-16-5), Aroclor 1242 (CAS Registry No. 53469-21-9), Aroclor 1248 (CAS Registry No. 12672-29-6), Aroclor 1254 (CAS Registry No. 11097-69- 1), Aroclor 1260 (CAS Registry No. 11096-82-5).
4.7.9.3. Report individual listed PCBs as mg/kg.

4.7.10. Test method for measuring 19 - 20:

4.7.10.1. NSW Roads & Traffic Authority Test Method T276 Foreign Materials Content of Recycled Crushed Concrete (or an equivalent method), using a 2.36 mm sieve.

4.7.10.2. Report as %.

4.7.11. Test method for measuring 21 -23:

4.7.11.1. NSW Roads & Traffic Authority Test Method T106 Coarse particle distribution in road construction materials (by dry sieving) and T107 Fine particle distribution in road construction materials (or an equivalent method).

4.7.11.2. Report as %.

Notification

4.8. On or before each transaction, the processor must provide the following to each person to whom the processor supplies the "batch process" recovered fines:

- a written statement of compliance certifying that all the requirements set out in this order have been met;
- a copy of the "batch process" recovered fines exemption, or a link to the EPA website where the "batch process" recovered fines exemption can be found; and
- a copy of the "batch process" recovered fines order, or a link to the EPA website where the "batch process" recovered fines order can be found.

Record keeping and reporting

4.9. The processor must keep a written record of the following for a period of six years:

- the sampling plan required to be prepared under clause 4.1.1;
- all one-off test results in relation to the "batch process" recovered fines supplied;
- the quantity of the "batch process" recovered fines supplied; and
- either the name and address of each person to whom the processor supplied the "batch process" recovered fines or the registration details of the vehicle used to transport the "batch process" recovered fines.

4.10. The processor must provide, on request, the most recent one-off sampling results for "batch process" recovered fines supplied to any consumer of the "batch process" recovered fines.

4.11. The processor must notify the EPA within seven days of becoming aware that it has not complied with any requirement in clause 4.1 to 4.7.

5. Definitions

Commented [GS8]: Asa mentioned above, a definition of "batch" required

In this order:

application or apply to land means applying to land by:

- spraying, spreading or depositing on the land; or
- ploughing, injecting or mixing into the land; or
- filling, raising, reclaiming or contouring the land.

composite sample means a sample that combines 5 discrete sub-samples of equal size into a single sample for the purpose of analysis.

consumer means a person who applies, or intends to apply, “batch process” recovered fines to land.

processor means a person who processes, mixes, blends, or otherwise incorporates “batch process” recovered fines into a material in its final form for supply to a consumer.

transaction means:

- in the case of a one-off supply, the supply of a batch, truckload or stockpile of “batch process” recovered fines that is not repeated.
- in the case where the supplier has an arrangement with the recipient for more than one supply of “batch process” recovered fines, the first supply of “batch process” recovered fines as required under the arrangement.

Manager Waste Strategy and Innovation

Environment Protection Authority

(by delegation)

Notes

The EPA may amend or revoke this order at any time. It is the responsibility of each of the processor and processor to ensure it complies with all relevant requirementsof the most current order**.** The current version of this order will be available on www.epa.nsw.gov.au

In gazetting or otherwise issuing this order, the EPA is not in any way endorsing the supply or use of this substance or guaranteeing that the substance will confer benefit.

The conditions set out in this order are designed to minimise the risk of potential harm to the environment, human health or agriculture, although neither this order northe accompanying exemption guarantee that the environment, human health oragriculture will not be harmed.

Any person or entity which supplies "batch process" recovered fines should assess whether the material is fit for the purpose the material is proposed to be used for, and whether this use may cause harm. The supplier may need to seek expert engineering or technical advice.

Regardless of any exemption or order provided by the EPA, the person who causes or permits the application of the substance to land must ensure that the action is lawful and consistent with any other legislative requirements including, if applicable, any development consent(s) for managing operations on the site(s).

The supply of "batch process" recovered fines remains subject to other relevant environmental regulations in the POEO Act and Waste Regulation. For example, a person who pollutes land (s. 142A) or water (s. 120), or causes air pollution through the emission of odours (s. 126), or does not meet the special requirements for asbestos waste (Part 7 of the Waste Regulation), regardless of this order, is guilty of an offence and subject to prosecution.

This order does not alter the requirements of any other relevant legislation that must be met in supplying this material, including for example, the need to prepare a Safety Data Sheet.

Failure to comply with the conditions of this order constitutes an offence underclause 93 of the Waste Regulation.

SUPPORTING DOCUMENT 1

Draft Guideline – Developing an Unexpected Asbestos Finds Plan

Draft Guideline - Developing an Unexpected Asbestos Finds Plan

This is a draft guideline detailing the NSW Environment Protection Authority's (EPA) requirements for site-specific Unexpected Finds Plans (UFP) for managing suspected ACM at relevant construction and demolition (C&D) waste processing facilities.

Industry acknowledges and agrees that asbestos is an area of concern for both the community and industry. The reality is that we are all exposed to low levels of asbestos in the air we breathe every day[1] and it is vital that industry and NSW EPA work together to find a common-sense approach to managing asbestos to ensure that we do not cause harm.

As such this guide deals specifically with genuine Unexpected Finds of material that is suspected to be Asbestos Containing Material (ACM)- it cannot and does not deal with finds that cannot be seen to the naked eye.

The guide also addresses friable and non-friable asbestos acknowledging that whenever friable material is identified an Occupational Hygienist must be engaged to manage the material at first instance and NSW EPA is to be immediately notified.

This guideline is therefore to be a tool to be used by licensees of C&D waste facilities to:

- act to manage genuine visible Unexpected Finds of suspected asbestos in a manner that minimises the risk of harm to human health and the environment; and
- reduce the time it would otherwise take for the EPA and the licensee to determine the appropriate steps the licensee will need to carry out to ensure suspected asbestos and/or asbestos containing material (ACM) is taken out of production and appropriately dealt with, and to enable other site operations to continue where appropriate.

This draft guideline has been prepared to ensure that licensees have clear guidance on the information that should be included in site-specific Plans

This draft guideline will be used as the basis for further discussion with stakeholders.

Where does the Guideline apply?

All C&D waste facilities are expected to have appropriately implemented the [Standards for managing construction waste in NSW] (the C&D Standards) for all waste entering their facility – that is, the tip and spread method. This guideline is to be used to guide the preparation of a site-specific Unexpected Finds Plan (UFP)to manage genuine Unexpected Finds of suspected asbestos. It will apply to all **stockpiles AFTER the tip and spread (Inspection Point 2)** and across the entire Facility. Relevant waste classifications and resource recovery orders and exemptions would continue to apply to any materials that leave the facility.

The preparation and implementation of a UFP by C&D waste facilities will be a requirement placed on all relevant C&D Waste Facility licences, as will the requirement to activate the plan

[1] enHealth in 2013 (enHealth 2013)

if visible detection of suspected ACM is found in stockpiles. The Plans do not form a part of the licence, rather they are a tool to be used by the licensee to manage the unexpected finding of suspected asbestos on site.

The contents of a Plan must be compliant with all relevant Federal and State legislation including, but not limited to, the *Work Health and Safety Regulation 2017.* It is the licensee's responsibility to ensure that the UAF Plan is consistent with any relevant requirements of SafeWork NSW.

Definitions

'Unexpected Asbestos Find' means isolated pieces of visible asbestos (including friable asbestos) found in a stockpile during visual inspections that were not identified when the requirements of the C&D Standards were carried out (that is the initial tip, spread and processing of waste). These should be found less frequently if the C&D Standards are carried out correctly.

'Asbestos Containing Material' (ACM) means asbestos containing material (eg non-friable or bonded asbestos cement products) that are solid and cannot crumbled in your hand – the asbestos has been mixed with a bonding compound such as cement

'Friable asbestos'- as defined in Work Health and Safety Act 2011, is a material containing asbestos that when dry, is in powder form or may be crushed or pulverised into powder form using your hand(https://www.safeworkaustralia.gov.au/asbestos#asbestos-a-definition)

'Relevant C&D Waste Facility' means a construction and demolition waste facility within the meaning of clause 90B of the *Protection of the Environment Operations (Waste) Regulation* 2014.

Occupational Hygienist (OH) means a person that has relevant skills, qualifications and a minimum of 5 years' experience in assessing asbestos contamination and is either:

- An Occupational Hygienist (COH) certified by the Australian Institute of Occupational Hygienists (AIOH); or
- A Licensed Asbestos Assessor (LAA); or
- A member of the Faculty of Asbestos Management (Aust/NZ) (FAMANZ),

What are the EPA's expectations when Unexpected Finds of Asbestos occur?

All UFP must include details of controls, procedures and other actions that will be implemented if an unexpected find of suspected asbestos occurs during visual inspections. This includes as a minimum:

- details of how the Plan will be activated – and who is responsible for activating the Plan
- details of person(s) responsible for carrying out controls, procedures or other actions identified in the Plan
- procedures to discontinue use of the asbestos contaminated portion of stockpile
- details of work, health and safety measures, risk controls, to be adopted, including PPE requirements
- procedure for isolating asbestos and asbestos-contaminated material and its storage prior to lawful disposal
- procedures for visual inspection of material adjacent to the asbestos find in the stockpile to determine the extent of ACM contamination and material that can be returned to production
- procedures for when an appropriately qualified occupational hygienist needs to be engaged
- details of records to be maintained which must document what was found, actions taken, asbestos and asbestos-containing material lawfully disposed of and the results of analyses
- procedures for regular training and education of staff on the requirements of the Plan.

Licensees' implementation of their UFP will not exclude the EPA taking regulatory action as appropriate under the *Protection of the Environment Operations Act*.

Information and resources relating to handling and disposal of asbestos waste is available at EPA's asbestos waste page and SafeWork NSW.

The table below sets out the minimum information to be provided in the Plan.

Steps that must be included in the Plan

Step	Guideline
Asbestos containing material (ACM) has been identified during visual inspections (Plan is activated)	• Identify location(s) and possible extent of suspected asbestos at the facility. **Note:** This step should be carried out while ensuring that processing waste stops where there is a risk of further potential contamination (as per discontinue processing Step 1).
Note: Some steps will be sequential, many may need to be carried out at the same time or at multiple stages of the process.	
Step 1 Discontinue processing	• Immediately discontinue processing any waste from the immediate area in which suspected ACM has been identified • Do not add or remove any waste to/from the immediate area in which the suspected ACM material has been identified.
Step 2 Document locations of ACM	• Include a process for documenting and recording-the location at which suspected ACM has been found or may be present as part of the process. Also include a description of the suspected ACM (e.g. bonded asbestos cement), • Include processes and procedures that ensure/require all relevant work health and safety obligations are addressed - e.g. personal protective equipment, trained personnel etc.
Step 3 Notification of relevant site personnel	• Outline the process and procedures for notifying appropriate staff and how the process and procedures will be implemented to ensure that all relevant staff are made aware that suspected asbestos has been identified and where it was found.
Step 4	The Site's Risk Controls must include but not be limited to: • Isolating affected area in which suspected ACM has been identified, in accordance with any relevant SafeWork requirements.

Step	Guideline
Implement the risk controls	• Methods to be used to isolate the suspected ACM, including for example barriers and signage. • Measures/controls to prevent the risk of release (if applicable) of asbestos fibres from the suspected ACM; including for example by use of covers/sprinklers and asbestos fibre monitoring if suspected friable asbestos has been found.
Step 5 Segregate, inspect and sample	• If the unexpected find is suspected to be **Friable asbestos** (refer to the definition), notify NSW EPA and engage an Occupational Hygienist to inspect and risk assess the area, and develop an appropriate **Friable Asbestos Management Plan**. • If the unexpected find is suspected to be **non-friable or bonded asbestos only**: (A) The affected area in which suspected ACM is identified cannot be added to or have material removed from it or be processed until the requirements of the Unexpected Finds Plan (UFP) have been implemented (B) In accordance with all applicable legislative requirements, identify and isolate a volume of $1m^3$ around each suspected ACM find. When/if this material is confirmed to be asbestos, the total volume of waste is to be automatically classified as special waste (asbestos) and sent for disposal to a waste facility that can lawfully receive asbestos waste. (C) Retain all paperwork/dockets recording the disposal of all suspected ACM waste (D) Visually inspect the area immediately adjacent to where the 1m3 was removed. (E) If no further suspected ACM is found, then resume normal site operations (F) If further suspected ACM is found, then repeat process from (A) through to (E) above for removal of a further $1m^3$ (G) This process may be repeated up to a maximum of five (5) times.

Step	Guideline
	(H) If all of the five (5) consecutive $1m^3$ portions have been determined to contain suspected ACM then appoint an Occupational Hygienist to develop an appropriate Asbestos Management Plan for the affected material. (I) If all of the five (5) consecutive samples have been positive for ACM notify the EPA's authorised officer administering the facility's licence that ACM has been identified on the premises. (J) The affected area in which the five (5) unexpected finds of ACM is identified cannot be added to or have material removed from it or be processed until the Occupational Hygienist has certified that the requirements of the Asbestos Management Plan developed by the hygienist have been complied with. A copy of this certification must be kept and made available to the EPA if requested. (K) **NOTE**: If any of the additional finds are friable asbestos then return to the first dot point above for handling a friable asbestos find
Step 6 Certify process was carried out in accordance with the Plan	• If an Asbestos Management Plan has been enacted (ie five (5) positive samples or friable asbestos detected) then the execution of the Asbestos Management Plan must be conducted or supervised by an Occupational Hygienist (OH). • Upon certification by the Hygienist that the plan has been complied with normal site operations may resume.

SUPPORTING DOCUMENT 2

Draft Guideline – Developing an Unexpected Asbestos Finds Plan

PEER REVIEW AND GAP ANALYSIS OF THE SUPPLY AND DEMAND STUDY FOR THE GREATER SYDNEY REGION

09 July 2020

MAKING COMPLEX EASY

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Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
1.0	Final	Annie Townley	Kapil Kulkarni	Kapil Kulkarni	9 July 2020

Approval for issue

Kapil Kulkarni	K Kulkarni	9 July 2020

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Contents

Tables

Figures

1 EXECUTIVE SUMMARY

1.1 Scope

The scope of this review was to conduct a peer review and gap analysis of the "Supply and Demand Study for the Greater Sydney Region (GSR)" and its supporting data (the Report), commissioned by the then Division of Resources and Geoscience in the NSW Department of Planning and Environment (DPE) (now the Mining, Exploration and Geoscience group in the Department of Regional NSW) in the 2018/2019 FY. This included a review of the conclusions made in the Report, the robustness of the source data, and methodologies used to develop the supply and demand model and provides examples of other approaches or considerations that could be made to strengthen the key findings.

1.2 Key findings and recommendations

The following are the key findings from this peer review:

1. There are several findings in the Report that are supported with data from reliable sources and with robust methodologies. These include:
    a. Demand data from 2011 to 2026 from Macromonitor that have been segmented into material type
    b. Qualitative summaries of the supply constraints of construction materials from industry consultation
    c. Transport and cost data for the supply of construction material into the GSR
2. The top-down methodology to calculate substitute materials is limited by the quality of data from industry consultations and lack of validation through additional data sources or through benchmarking. It is likely that the substitute materials proportion in the Report is overestimated based on the methodology.

    As a result, natural sand product reserves that were forecast to be depleted between 2030-2040 may be depleted earlier. This will have an immediate impact on construction projects currently in planning stages.

    Additionally, hard rock product reserves that are not forecast to be depleted until after 2036 may also be depleted earlier if the forecast substitute materials proportion is overestimated.

    This finding is explored in Section 3.2.4.
3. The Report found that there are sufficient potential resources available to meet a forecast undersupply of natural sand products reserves. However, it is unclear in the report where the potential supplies are located and calculations that support this finding are not included in the model to verify the finding.

    This finding is explored in Section 3.4.
4. Demand data from 2027 to 2036 is based on a calculation of forecast population multiplied by the average construction materials consumption rate per capita from 2011 to 2026. Further work should be undertaken to test the data's validity before it is relied upon to the same extent as forecast demand data to 2026.

    This finding is explored in Section 3.2.3.

1.3 Limitations

The following are elements beyond the scope of the Report that are likely to influence its findings:

- There is some uncertainty in the construction industry at the time of this peer review due to COVID-19, although it is highly likely that it will impact construction material demand. Some sectors such as residential building may see reduced activity as unemployment rises and interstate and international migration is limited[1]. The Government project pipeline has been reviewed to bring some projects forward, to provide economic stimulus, which may change the demand curve for infrastructure works[2][3][4].

  Macromonitor has released updated data on the forecasts for construction activity following early analysis of COVID-19 impacts[5]. This could be used to revise the Report data.

- Construction materials from outside the GSR have been excluded from the Report. Determining the extent of material imported into GSR and the cost impacts to construction projects of this would help better understand the likelihood and consequence of the risk of depleted materials in the GSR.

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[1] https://www.pm.gov.au/media/press-conference-australian-parliament-house-act-1may20

[2] https://www.pm.gov.au/media/1-billion-unlock-thousands-infrastructure-jobs-nsw

[3] https://www.infrastructure.nsw.gov.au/media/2439/nsw-treasurer-dominic-perrottet-letter-to-the-construction-and-engineering-sectors-of-nsw.pdf

[4] https://www.planning.nsw.gov.au/-/media/Files/DPE/Media-Releases/2020/April/media-release-accelerated-planning-projects-to-deliver-jobs-and-boost-the-economy-2020-04-28.pdf

[5] https://macromonitor.com.au/wp-content/uploads/2020/06/brochure_impact_of_covid19_on_australian_construction_june_2020.pdf

2 INTRODUCTION

2.1 Scope

The scope of this review was to conduct a peer review and gap analysis of the “Supply and Demand Study for the Greater Sydney Region” and its supporting data (the Report), produced for the DPE in 2018/2019 FY.

The focus of the review is to:

- Complete a general review of the Report and its attachments
- Test the validity of the conclusions made in the Report by identifying supporting data within the content of the report and the methodology used to develop it
- A review of the Report’s contents against the its objectives to determine if they had been met, and to what extent
- Assess the “Approach to Study” in Appendix 2 of the Report, including the data sources, calculations and methodology used to develop the supply and demand model for the base case and forecast years, to advise on its reliability and ongoing value
- Identify whether assumptions and limitations in the Report are reasonable and/or supported by other potential alternative sources of data, and if they impact the reliability of the findings presented in the Report

This review is to be utilised as a companion document to the Report.

2.2 Report background

The Report was commissioned by the DPE in the 2018-2019 Financial Year following the release of the Greater Sydney Region Plan, the State Infrastructure Strategy 2018-2038, and Future Transport Strategy 2056. It aimed to provide government and industry with certainty regarding the availability of materials for building and infrastructure projects until 2036.

The Report included assessments of the supply and demand of extractive materials in a base case period of January 2012 to June 2018 and a forecast period of July 2018 to December 2036 to assess if there is a supply deficit of any extractive material.

3 FINDINGS OF THE PEER REVIEW AND GAP ANALYSIS

3.1 Objectives

The Report's objectives were checked against the content of the Report, with the relevant sections that meet the objectives noted.

The five objectives and the assessments are shown in the table below.

Table 1: Review of objectives

Objective	Comment
Compile an accurate profile of the current supply and demand, and supply cost profile, of construction materials within the GSR and its planned three cities.	This objective has been met albeit with the limitations detailed in this report, particularly for the demand profile after 2027 and the breakdown of substitute materials. The historical/current supply and demand profiles are presented in Section 2 (Base Case Assessment 2011-2018) of the Report, and they are disaggregated by the planned three cities. The supply cost profile is included in Section 2.12 of the Report.
Gain an understanding of the quantities, modes of transport, and rates of supply from surrounding areas (beyond the GSR) feeding these materials into the GSR.	This objective has been met. Section 2.10 details extractive materials truck movements into and throughout the GSR, with more detail in earlier sections of Section 2.
Review and assess existing and potential supply-side constraints that impact or are likely to impact upon the availability and cost-effective supply of extractive materials to meet future anticipated demand in the GSR.	This objective has been met. Existing and potential supply side constraints are reviewed and assessed in Section 2.13 and 3.6 respectively.
Estimate the future demand for extractive materials and cementitious materials needed for housing, non-residential buildings, roads, and other engineered infrastructure required within the GSR to 2036.	This objective has been met to 2026, however there is limited data supporting the future demand profiles from 2027 to 2036. This is summarised in Key Finding 17 and in more detail in Section 3 of the Report.
Identify strategically important existing and future quarries to enable the Government to protect them from competing land uses.	This objective was no longer achievable given the limitations of the data. The absence of the data limits the identification of specific existing and future quarries that may be of strategic importance into the future.

3.2 Approach to Study

3.2.1 Industry consultation

Industry consultation was undertaken to inform the estimation of the base case supply and demand data, and for qualitative data on supply constraints.

For the extractive and concrete industries, consultation, including surveys and one-on-one discussions, were more successful with smaller companies due to commercial confidentiality concerns from larger companies. The authors therefore incorporated industry feedback on the initial findings, publicly available data and Macromonitor data for demand modelling.

There was limited asphalt plant data provided by industry operators, and so Macromonitor data was used for asphalt demand.

There was limited waste industry data provided by concrete recycling facility operators.

The quality of the industry consultation data on quantities of material is limited as there were low levels of engagement across all material types. This data was relied upon for calculating substitute materials. If this was under or inaccurately reported, which is likely considering the qualifications above, it would result in a substitute material forecast that is also inaccurate.

The qualitative data from these consultations, for example on supply constraints, may be more reliable, however feedback was primarily from smaller companies and feedback may be different if larger companies had responded at the same rates.

3.2.2 Supply and demand assessments from 2011 to 2026

Supply and demand assessments to 2026 were developed based on analysis of the industry consultations as described above, NSW planning reports and documents, and data purchased from Macromonitor.

Macromonitor data combines a top down and bottom up approach that includes the commercial sector forecast investment cycle, Government forecast funding cycle, leading indicators, project lists, capital spending plans, and detailed regional activity forecasts.

Appendix 3 of the Report summarised the Macromonitor forecasting methodology. A reasonable level of detail is provided on the approach to forecasting residential building construction. However, less detail is provided on the underlying drivers of non-residential building and transport infrastructure construction. Further information on how economic activity and the need for infrastructure are used to drive demand forecasts for non-residential building and transport infrastructure construction would be beneficial.

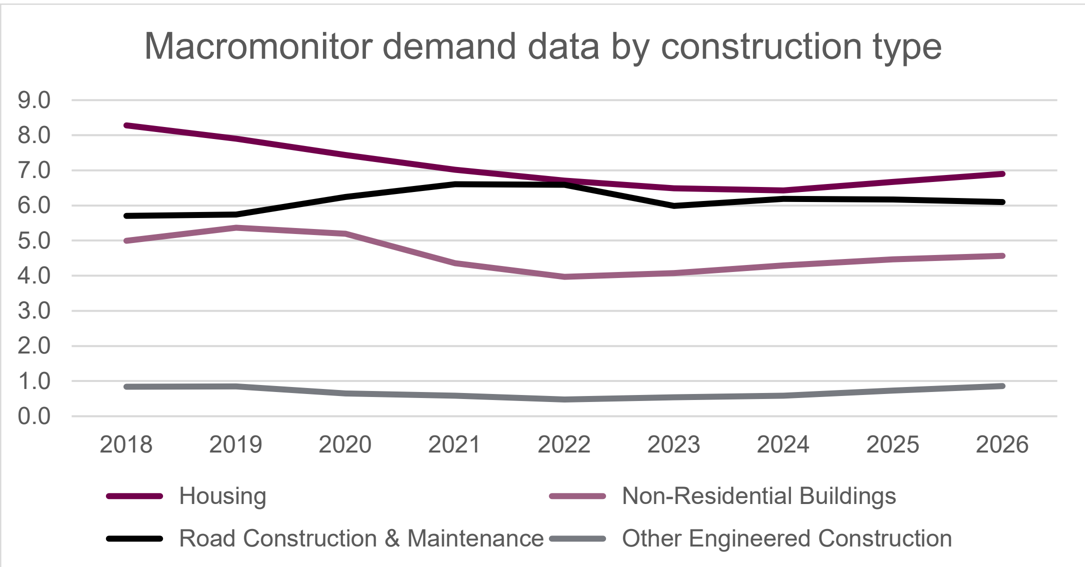
In general, Macromonitor is considered a reliable source of construction activity data for the industry.

The Macromonitor forecasts were not subject to sensitivity analysis as they were considered "best estimates" due to the perceived robustness of the methodology. Any economic forecasts, irrespective of the methodology, are subject to uncertainty. To illustrate, recent events have resulted in a very uncertain future outlook for construction, with both upside and downside risks to demand.

Macromonitor has provided a breakdown by type of construction; housing, non-residential buildings, road construction and maintenance, and other engineered construction (see Figure 1), however further review or sensitivity analysis of the following would improve the transparency and quality of the Report:

- Housing demand data shows a peak in 2018 and decline of 22 per cent to 2024 alongside a population increase of 10 per cent during that period. This decline has a significant impact on the overall construction material demand as housing demand accounts for between 36 and 42 per cent of the total demand and is the key driver to FY 2018 being noted as a “peak” in demand. Considering this, commentary on the specific assumptions or data sources behind these figures would be useful to provide confidence that FY 2018 is the demand peak, and that the housing demand is reducing at this rate.
- Non-residential buildings and other engineered construction decline from a peak in 2019 to a low in 2022 by 26 percent and 44 per cent respectively. There is significant Government investment into these sectors during this period, for example, with Sydney Metro program, the Western Sydney Airport, and increased funding to heath, education, and justice infrastructure, that may warrant further analysis into these figures or provision of the data sources used to calculate them.

Figure 1: Macromonitor data by construction type from 2018 to 2026



3.2.3 Demand assessments from 2027 to 2036

Future demand estimates from 2027 to 2036 have been calculated using a static rate of per capita consumption multiplied by population forecasts.

The per capita consumption amount used for each material type from 2027 to 2036 is the average consumption from 2011 to 2026.

The per capita consumption rates are shown in the table below.

Table 2: Per capita consumption from 2027 to 2036

Type of material	Per Capita Consumption (tpa) from 2027 to 2036
Extractive Materials	3.54
Substitute Materials (E.g. Sandstone VENM & Recycling)	3.01
Cementitious Materials (Cement, Flyash, Slag)	0.58
Total	**7.13**

This top-down calculation approach limits the reliability of the demand data from 2027:

- The per capita consumption rate chosen is based on an average, with no evidence provided on the choice of years used for the average.
- It may not provide a demand assessment that accounts for the fluctuation in the industry over time as the rate is constant and so will be limited in providing information for a specific year for planning purposes.
- Using population as the only indicator of construction activity excludes other relevant indicators such as economic growth or political priorities.

A sensitivity analysis was undertaken on the post-2027 demand data inputs of population and per capita consumption, however this analysis is not reflected in the Key Findings of the Report.

To address the above, a plausible scenario could be constructed for infrastructure and building investment and economic growth, taking into account macro trends to validate the forecast consumption per year after 2027.

3.2.4 Relationship between Extractive Materials and Substitute Construction Materials

The Report provided an estimate of the proportion of demand met using substitute materials, including:

- Virgin excavated natural material (VENM)
- Recycled construction and demolition (C&D) waste
- Industrial wastes
- Recycled asphalt

The estimates and projections are presented as 'best estimates' based on limited data being available. The Report acknowledged that the proportion of substitute materials is very high (46 per cent) according to large city standards. However, no benchmarks for typical large city proportions are provided.

The Report concluded that if the availability of substitutes reduces in the future, *"replacement roadbase and sub-base materials would need to be sourced from recycled concrete and from hard rock quarries, which would result in significant increases in costs because these materials have higher production costs and substantially higher transport costs from hard rock quarries because they are outside the GSR"*.

Overall, the following is recommended in relation to the estimates and projections of substitute materials use:

- Some benchmarks for the proportion of substitute materials normally estimated to meet the demand for construction materials in large city markets would be useful.
- The proportion of VENM could be informed and/or validated through further desktop research.
- The proportion of C&D material could be cross-checked against additional source(s).

- The conclusion relating to the availability of substitutes in the future could also acknowledge the potential for recycled municipal and commercial & industrial (C&I) sourced material to be used to supplement construction materials.

Each one of these recommendations is discussed below.

Benchmarks for typical large city proportions of substitute materials use

The statement that the proportion of substitute material use in the GSR is very high relative to large city standards could be supported with some benchmarks on typical proportions. This would provide useful context to the reader to understand how different the estimated proportion in GSR is to other large cities.

Desktop research to inform and/or validate VENM proportion

While the limited information relating to VENM use is acknowledged, further desktop research is recommended to inform and/or validate the proportion of VENM use. The Report currently estimates the amount of VENM using a top-down approach, by deducting the estimated quantity of all other supply sources from the estimated demand. As the proportion of VENM has not been estimated directly, the estimates of VENM are likely to be less accurate and reliable than other supply sources in the study.

Bottom up estimates could be made using published documents from major projects, such as spoil management plans and spoil management strategies, which would help validate the top-down estimate. A full bottom-up model of VENM sources and quantities would not be feasible as only some infrastructure projects are likely to provide any data on VENM production. However, a sample of those projects that do report VENM production could be analysed and extrapolated to the total for GSR, using an appropriate scaling factor (e.g. based on the sample percentage of total GSR project capital value).

Undertaking this exercise would provide more confidence in the top-down estimate, provided they are of a similar order of magnitude. Moreover, a bottom-up estimate would help refine and/or justify the sensitivity analysis range for substitute materials. The basis for the current sensitivity range (35-50 per cent) is not stated.

Examples of published data on major tunnelling projects active in 2018 include 5.9 million tonnes of excavated rock from the Sydney Metro City & Southwest tunnelling operations from 2018 to 2020[6], 5.8 million tonnes of excavated spoil from the Westconnex M4 East project from 2017 to 2018[7], and 6.3 million tonnes of excavated spoil from NorthConnex from 2016 to 2018[8].

A bottom-up estimate should also include assumptions on how projects manage surplus excess material, for example through redesign to reuse on their own sites, and constraints on reuse between projects, for example in aligning construction programs.

Cross-check C&D proportion with additional sources

The proportions of Construction & Demolition (C&D) waste material could be reconciled against further sources. The current estimates do not seem to reconcile with national waste data reporting by the Federal Department of Agriculture, Water and Environment (DAWE).[9]

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[6] https://www.sydneymetro.info/article/tunnelling-starts-city-metro

[7] https://www.westconnex.com.au/m4-east-construction-spoil-management-plan-december-2016

[8] https://northconnex.com.au/docs/default-source/environment-documents/construction-environment/construction-spoil-management-strategy.pdf?sfvrsn=2

[9] https://www.environment.gov.au/protection/waste-resource-recovery/national-waste-reports/national-waste-report-2018

Conclusion relating to the availability of substitutes in the future

The Report concluded that *"replacement roadbase and sub-base materials would need to be sourced from recycled concrete and from hard rock quarries"*, if the availability of currently used substitutes reduces in the future. This is an appropriate conclusion in the short term, where there are unlikely to be significant changes in the types and scales of substitute material available for use in construction applications.

However, future substitute materials could also include municipal and commercial & industrial (C&I) sourced waste material, such as waste plastics and glass. While the relative scale of these applications is currently very small and specifications limit the range of materials and material sources that can be used, these materials are likely to comprise a growing proportion of supply.

The feasibility of these materials is being trialled nationally and some applications have already been adopted, including in NSW.[10] It is acknowledged that the contribution of these materials is likely to be small relative to other sources included in the study. However, use of these materials is important for meeting circular economy policy objectives, so their potential could be acknowledged even if this potential is not necessarily estimated in quantitative terms

The Victorian Government's Recycled First Policy acknowledges the potential contribution of this source and the applications currently being considered:[11]

> *"The M80 Ring Road, Monash Freeway and South Gippsland Highway upgrades will use more than 20,000 tonnes of recycled materials, and 190 million glass bottles will be used in surfaces on the $1.8 billion Western Roads Upgrade."*

3.3 Assumptions and limitations

The Report's assumptions and limitations were assessed based on the data sources available and methodology undertaken.

The five assumptions and limitations and the assessments are shown in the table below.

Table 3: Review of assumptions and limitations

Assumption	Comment
1. Primary Data Sources	Primary data sources have been discussed in Section 3.2 Approach to Study. In general, sources are appropriate to 2026, however there is a lack of data for the demand forecast after 2027 and the substitute materials forecast. Additional data sources should be investigated for these components of the Report.
2. Relationship between Extractive Materials and Substitute Construction Materials	Further comment is provided in Section 3.2.4. This is a limitation of the Report.
3. Segmentation of Demand and Supply Data into GSR Planning Districts	The data sources have not allowed for segmentation of data into the GSR planning districts and instead segmentation is at the Three Cities level. This level of segmentation is considered reasonable.
4. Types of Quarry Products and Percentage of Supply	While there is some variation in the proportion of quarry materials in the historical data, it is minor, and maintaining the 2018 proportions into the forecast data is considered reasonable.
5. Sensitivity Analysis of Forecast Demand	Sensitivity analysis has not been undertaken on Macromonitor data. This is considered a limitation (further comment provided in Section 3.2.2).

[10] http://www.sutherlandshire.nsw.gov.au/Council/News-and-Publications/News/FIRST-NSW-ROAD-BUILT-WITH-PLASTIC-BAGS-AND-GLASS#:~:text=The%20first%20New%20South%20Wales,bottle%20equivalents%20diverted%20from%20landfill.

[11] https://www.premier.vic.gov.au/using-recycled-first-for-greener-transport-infrastructure/

3.4 Key findings

The Report's key findings were assessed based on the assumptions, methodology, and data available in the report to justify the finding. The data review of the key findings is included in Appendix A.1.1.

Several key findings were either unable to be verified from the data within the Report or they were based on underlying assumptions that lack robustness. Issues for the key findings include:

- A lack of justification on why FY 2018 is a peak of construction material demand in key finding 3 and 14, with further review in Section 3.2.2.
- Limited integrity of the methodology used for demand from 2027 to 2036 in finding 13, with further review in Section 3.2.3, finding 13.
- Limited integrity of the calculation of the substitute materials breakdown as detailed in Section 3.2.4, referred to in finding 4, 13, and 16 directly, and will also impact key finding 17 and 18.
- No specific supporting data provided on potential future resources available to supply natural sand products to meet demand in the 2030s in finding 19 and 20.

4 DATA ANALYSIS

4.1 Table data validation

Table data has been validated by checking the accuracy of formulas used, consistency with model data, and noting the data source. Key findings from the data review are:

- Significant data was unable to be verified where source data was not provided, inclusive of data collected from industry consultations and input data from Macromonitor.
- Rounding inconsistencies were evident between data in the excel model and data in the report tables.

Details of the table data validation are included in Appendix A.1.2.

4.2 Model review

The detailed model review is included in Appendix A.2. Key findings from the model review are:

- It would be beneficial for each table to state the calculation methodologies for reported proportions and sub-totals. For example, in Table A: 1 Extractive (quarry) materials (hard rock & natural sand) the material volumes are hard coded and the sub-total is derived, while Table A: 2 Substitutes for extractive materials, the values are inferred from static proportions and subtracting from the total of all extractive and substitute materials.
- The hard-coded values within the Excel model have a degree of precision with the inclusion of 12 decimal places. Using the assumption that the data is accurate, the data could supplement further exploration into forecasting construction material supply and demand in the GSR.
- Apart from hard coded values the overall layout, methods of inferring and deriving values, calculating percentage-based totals and cumulative year on year grow values is reliable and accurate within the scope of the model.

5 CONCLUSION

There are several findings in the Report that are supported with reasonable data from reliable sources:

1. Demand data from Macromonitor (2011 to 2026) segmented into material type by the three cities locations and by point of use is considered reliable. While raw data and calculations have not been provided, the data outputs have been precisely captured in the model and the data sources used in Macromonitor's methodology are reasonable.
2. Qualitative summaries of the constraints facing quarries as they continue to meet demand requirements is considered reliable from the source data of quarry operators and other industry consultations.
3. Transport and cost data for the supply of construction material into the GSR is reliable. Cost data was received from sources that are consistent with those used to develop costs for construction projects.

This peer review has highlighted sections of the Report that require additional qualification to what is provided in the Report:

1. The methodology to calculate substitute materials is a deduction of the quantity of extracted materials assessed through industry consultation from the total construction materials demand from Macromonitor for 2018 FY. The proportion of extractive to substitute materials is carried through the model from 2018 to 2036.

   Industry consultation was more successful for smaller operators and companies, with larger companies providing feedback on an operational model developed by the authors. This may have limited the accuracy of the data for extractive materials quantities where the quantity is underreported.

   There are two key issues that result from an underestimate of the demand for extractive materials:

   a. Natural sand products reserves were forecast to be between 2030-2040 but this may happen earlier than the 2030s. This issue will have immediate impacts on construction projects currently in planning in the GSR.
   b. Hard rock reserves were forecast to meet demand to at least 2036 but should be assessed further to understand how reliable this is if the demand of extractive materials increases.

   Further validation of the substitute materials forecast will provide a better understanding of these two issues. Further validation could be undertaken in the following ways:

   a. Some benchmarks for the proportion of substitute materials normally estimated to meet the demand for construction materials in large city markets would be useful.
   b. The proportion of VENM could be informed and/or validated through further desktop research.
   c. The proportion of C&D material could be cross-checked against additional source(s).
   d. The conclusion relating to the availability of substitutes in the future could also acknowledge the potential for recycled municipal and commercial & industrial (C&I) sourced material to be used to supplement construction materials.
2. Natural sand reserves are forecast to be depleted between 2030-2040, and the Report notes that there are sufficient potential resources that could be developed adjacent to or within existing quarries to meet demand. However, it is unclear in the report where the potential supplies are located and the calculations that support this finding are not included in the model to verify it.

   This, coupled with the above issue that may bring forward a gap in supply of natural sand resources, is a significant risk for future construction projects in the GSR that may increase costs and delay projects.
3. Demand data from 2027 to 2036 is based on a calculation of forecast population multiplied by the average construction materials consumption rate per capita from 2011 to 2026. This is a simplified methodology in comparison to the methodology used for data from 2011 to 2026 and should not be relied upon with the same level of confidence.

   Further work could be undertaken to test the data's validity such as the development of a plausible scenario for infrastructure and building investment and economic growth, taking into account macro trends. This may also better inform a sensitivity analysis.

A.1 Data analysis

The following table provides the key to the data assessment results in Sections A.1.1. and A.1.2.

Table 4: Data analysis key

Objective	Key
Accurate	The data matches the reference made to the model.
Accurate (to referenced table)	The data does not exist in the model however it matches the table it references in the report.
Inconsistent	The data calculation methodology is being applied inconsistently.
Unable to verify	The data referenced has not been provided as part of this review.
Inaccurate	The data does not match the reference made to the model to a significant degree.

A.1.1 Key findings data

Table 5: Review of key findings data

	Data assessment	Data source	Reasonable based on data provided and methodology used
1	Accurate	Data sourced from 1. GSR Key Inputs and Outputs Within Table 1+2+3	Reasonable.
2	Accurate	Data sourced from 1. GSR Key Inputs and Outputs Within Table C	Reasonable.
3	Accurate	Data sourced from 1. GSR Key Inputs and Outputs Within Table 1+2+3	Further investigation into this may be required to justify that FY 2018 is a peak (see Section 3.2.2).
4	Inconsistent • Natural sand rounding error	Data sourced from 1. GSR Key Inputs and Outputs Within Table A1	Further investigation into the substitute materials percentage may be required (see Section 3.2.4).
5	Accurate (to referenced table)	Data sourced from Table 2.3 within the Report	Reasonable.
6	Accurate (to referenced table)	Data sourced from Table 2.5 within the Report	Reasonable.
7	Accurate (to referenced table)	Data sourced from Table 2.9 within the Report	Reasonable.
8	Cannot validate	Reference to this key finding found in Section 2.10 of the Report Combined extractive materials truck movements	Figure seems reasonable however limited data available in the report to justify this finding.
9	Accurate (to referenced table)	Data sourced from Table 2.28 within the Report	Reasonable.

	Data assessment	Data source	Reasonable based on data provided and methodology used
10	Inaccurate • Data indicates a figure closer to 86% (finding is 80%)	Data sourced from 1. GSR Key Inputs and Outputs Within Table A1	Assumptions in this finding are reasonable; data inaccuracy is minor.
11	Unable to verify	Unable to verify	Reasonable.
12	Inconsistent • Total cementitious materials rounding error • % of total construction materials rounding error • Cement portion rounding error • Slag portion rounding error	Data sourced from 1. GSR Key Inputs and Outputs Within Table 3	Reasonable; data inaccuracy is minor.
13	Accurate	Data sourced from 1. GSR Key Inputs and Outputs Within Table A1, Table A2 and Table A3	Refer Section 3.2.4 for details on substitute material percentage. Refer Section 3.2.3 for details on forecast from 2027 to 2036.
14	Inconsistent • Total cumulative demand rounding error	Data sourced from 1. GSR Key Inputs and Outputs Within Table A1+2+3	Reasonable, however may require further justification on why 2018 is a peak for construction materials demand.
15	Accurate	Data sourced from 1. GSR Key Inputs and Outputs Within Table C	Per capita consumption is noted as lower for Sydney than Melbourne and Brisbane in 2018. Further commentary on why this may be would be useful to understand the difference.
16	Accurate	Data sourced from 1. GSR Key Inputs and Outputs Within Table A2	Recommend further work. Refer Section 3.2.4 for details on substitute material percentage.
17	Accurate	Data sourced from 2. Three Cities Within Table 1.2	Recommend further work. Refer Section 3.2.4 for details on substitute material percentage.
18	Accurate (to referenced table)	Data sourced from Table 2.4 within The Report	Reasonable.
19	Unable to verify	Unable to verify	Limited data available in the report to justify this finding.

	Data assessment	Data source	Reasonable based on data provided and methodology used
20	Unable to verify	Unable to verify	Reasonable, however limited data available in the report to justify this finding.
21	Unable to verify	Unable to verify	Reasonable, however limited data available in the report to justify this finding. In addition, a number of road projects are underway to improve freight movement in GSR that may change transport costs.
22	Unable to verify	Unable to verify	Reasonable, however limited data available in the report to justify this finding.
23	Unable to verify	Unable to verify	Reasonable, however limited data available in the report to justify this finding.

A.1.2 Report table data validation

Table 6: Table data validation

Table no.	Table name	Accuracy check	Data source
2.1	Crushed Rock and Natural Sand Products Supplied to the Greater Sydney Region in FY 2018	Inconsistent • Natural sand rounding error • Crushed Coarse Aggregate (5mm-30mm) rounding error Total rounding error	Data sourced from 1. GSR Key Inputs & Outputs Within Table A1: 2017 – 2018
2.2	Crushed Rock Products Used in the Greater Sydney Region in FY 2018	Inconsistent • Crushed coarse aggregate (5mm-30mm) rounding error	Data sourced from 1. GSR Key Inputs & Outputs Within Table A1: 2017 – 2018
2.3	Approved Hard Rock Quarries in the Greater Sydney Region and Feeder Areas	Unable to verify	Cannot verify as no references to DPE data provided
2.4	Approved and Indicative Reserves in Hard Rock Quarries Producing Crushed Rock Products	Unable to verify	Cannot verify as no references to DPE data or interview documentation
2.5	Destinations of Crushed Rock Products	Unable to verify	Data sourced from estimations from quarry operators

Table no.	Table name	Accuracy check	Data source
2.6	Crushed Rock Road Transportation Routes and Daily Truck Loads	Unable to verify	Data sourced from estimations from quarry operators
2.7	Approved Transport Hours for Hard Rock Quarries	Unable to verify	Cannot verify as no references to DPE data provided
2.8	Natural Sand Usage by Product Type in the Greater Sydney Region – FY 2018	Unable to verify There is no drilldown to show the makeup of natural sand. Therefore, unable to validate the values	Data sourced from 1. GSR Key Inputs & Outputs Within Table A1: 2017 – 2018
2.9	Approved Natural Sand Quarries – Greater Sydney Region and Feeder Areas	Unable to verify	Cannot verify as no references to DPE data or interview documentation
2.10	Expiry Dates for Approved Quarries Producing Natural Sand Products	Unable to verify	Cannot verify as no references to DPE data provided
2.11	Annual Production and Reserves at Natural Sand Quarries	Unable to verify	Cannot verify as no references to DPE data provided
2.12	Destinations of Sand Products within the Greater Sydney Region	Unable to verify	Data sourced from estimations from quarry operators
2.13	Sand Products Transportation Routes and Daily Truck Loads	Unable to verify	Data sourced from estimations from quarry operators
2.14	Approved Hours of Transportation for Natural Sand Quarries	Unable to verify	Data sourced from estimations from quarry operators
2.15	Summary of Cementitious Materials and Origin	Unable to verify Data below should be in a table	Data sourced from consultations with industry consultants
2.16	Summary of Recycled Concrete Production	Unable to verify	Data sourced from operators of plants that recycle concrete and brick waste
2.17	Estimated Recycled Concrete Products Usage in the Greater Sydney Region – FY 2018	Unable to verify Data has poor validity due to high level of inference and estimation	Data proportions are taken from the average 2011 to 2018 proportions for substitute materials using the total quantity from Table 2.16.
2.18	Estimated Use of Substitute Construction Materials in the Greater Sydney Region – FY 2018	Unable to verify • Data has poor validity due to high level of inference and estimation	Data sourced from secondary data and consultations with industry partners (refer to Section 3.2.4 for further discussion on calculation of substitute material)
2.19	Pre-mixed Concrete Plants in the Greater Sydney Region Three Cities	Unable to verify	Data sourced from consultations with industry consultants

Table no.	Table name	Accuracy check	Data source
2.20	Raw Materials used in Concrete Production in the Greater Sydney Region – FY 2018	Inconsistent • Fine Aggregates - Natural Sand rounding error • Fine Aggregates - Manufactured Sand rounding error	Data sourced from 1. GSR Key Inputs & Outputs Within Table C: 2017 – 2018
2.21	Locations of Delivered Crushed Rock and Natural Sand Products in the Greater Sydney Region	Unable to verify	Data sourced from consultations with industry consultants
2.22	Asphalt Plants in the Greater Sydney Region Three Cities	Unable to verify	Data sourced from consultations with industry consultants
2.23	Combined Truck Loads Delivered into and within the Greater Sydney Region	Unable to verify	Data sourced from consultations with industry consultants
2.24	Per Capita Consumption of Construction Materials in the Greater Sydney Region – FY 2018	Inconsistent • Cementitious Materials (Cement, Flyash, Slag) rounding error	Data sourced from 1. GSR Key Inputs & Outputs Within table “Per Capita Consumption (tpa)
2.25	Demand for Extractive Materials by Point of Use Sector in the Greater Sydney Region – FY 20198	Inaccurate • Data source is only year-end 2018 data as there is no 2017 data present • Housing data does not match to a significant degree (Report states 8.8Mt while model states 8.3Mt). • Non-residential buildings data does not match to a significant degree (Report states 4.7Mt while model states 5.0Mt). • Road construction & maintenance data does not match to a significant degree (Report states 5.2Mt while model states 5.7Mt).	Data sourced from 2. Three Cities Within Table 1.2
2.26	Demand for Extractive Materials by Manufacturing Sector and Direct to Site – FY 2018	Unable to verify	Data indicates that is a sourced from a table which details which sector of manufacturing the extractive materials are being used in. This is not present in the Excel model
2.27	Demand for Extractive Materials by Manufacturing Sector (% by weight)	Unable to verify	Data indicates that it is a drill down for manufacturing of concrete, asphalt and for spray sealing for roads. This is not present in the Excel model

Table no.	Table name	Accuracy check	Data source
2.28	Indicative Gate Prices and Total Delivered Costs by Road to Points of Use within the Greater Sydney Region	Unable to verify	Data sourced from consultations with industry consultants
2.29	Geological Constraints upon Quarry Development and Operators	Unable to verify	Data sourced from consultations with industry consultants
2.30	Regulatory Constraints	Unable to verify	Data sourced from consultations with industry consultants
2.31	Environmental Constraints	Unable to verify	Data sourced from consultations with industry consultants
3.1	Construction Materials – Greater Sydney Region Per Capita Consumption Estimates (tpa)	Inconsistent 2011 Cementitious Materials rounding error	Data sourced from 1. GSR Inputs and Outputs Within Table C
3.2	Greater Sydney Region Extractive Materials Demand – Key inputs for Sensitivity Analysis	Accurate	Data sourced from 1. GSR Inputs and Outputs Within Table C
3.3	Greater Sydney Region Extractive Materials – Forecast Demand Profile by Point of Use (Mt)	Inconsistent • 2026 Non-Residential Buildings rounding error	Data sourced from 2. Three cities Within Table 1.2
3.4	Greater Sydney Region Extractive Materials – Forecast Demand Profile by Point of Use (% tonnes)	Accurate	Data sourced from 2. Three cities Within Table 1.2
3.5	Greater Sydney Region Extractive Materials – Demand Forecast by Product Type (Mt)	Inconsistent • Roadbase / Sub-Base (DGB/DGS) 2021 rounding error Natural Sand 2036 rounding error	Data sourced from 2. Three cites Within Table 1.1
3.6	Greater Sydney Region Extractive Materials – Demand Forecast by Product Type (% tonnes)	Accurate	Data sourced from 2. Three cites Within Table 1.1
3.7	Greater Sydney Region Extractive Materials – Baseline Cumulative Demand Forecast by Product Type – 2018 to 2036	Inconsistent Roadbase / Sub-Base (DGB/DGS) rounding error	Data sourced from 2. Three cities Within Table 1.1
3.8	Greater Sydney Region Construction Materials – Baseline Demand Forecast All Materials	Accurate	Sourced from 1. GSR Inputs and Outputs Within Table 1+2+3 Within Table B Within Table C

Table no.	Table name	Accuracy check	Data source
3.9	Greater Sydney Region Three Cities Extractive Materials – Forecast and Cumulative Forecast Demand Profile	Inconsistent • EHC 2018 Crushed Rock rounding error • CRC 2018 to 2036 Natural Sand rounding error • WPC 2018 to 2036 Natural sand rounding error	Sourced from 2. Three cities Within Table 1, Within Table 3, Within Table 4, Within Table 5
3.10	Greater Sydney Region Three Cities Extractive Materials – Baseline and Cumulative Demand Profile (% of Total Quantity)	Accurate	Sourced from 2. Three cities Within Table 2.2
3.11	Greater Sydney Region Concrete – Forecast Demand Profile by Raw Material Type	Accurate	Sourced from 1. GSR Inputs and Outputs Within Table D
3.12	Greater Sydney Region Concrete – Baseline Demand Forecast Profile by Raw Material Type (% of Total Quantity)	Inconsistent • Cement 2026 rounding error • Cement 2031 rounding error Cement 2036 rounding error	Sourced from 1. GSR Inputs and Outputs Within Table D
3.13	Greater Sydney Region Concrete – Baseline Cumulative Demand Forecast by Raw Material Type – 2018 to 2036	Accurate	Sourced from 1. GSR Inputs and Outputs Within Table D
3.14	Greater Sydney Region Extractive Materials – Forecast Demand Profile by Manufacturing Sector and Direct to Site	Unable to verify Unable to find these figures in the model	
3.15	Greater Sydney Region Extractive Materials – Forecast Demand Profile by Manufacturing Sector and Direct to Site (% of Total Quantity)	Unable to verify Percentage version of Table 3.14	
3.16	Greater Sydney Region Extractive Materials – Cumulative Forecast Demand Profile by Manufacturing Sector and Direct to Site – 2018 to 2036	Unable to verify Unable to find these figures in the model	
3.17	Greater Sydney Region Asphalt and Spray Seal – Forecast Demand /Supply Forecast Profile	Unable to verify	Data sourced from consultations with asphalt plant operators
3.18	Greater Sydney Region Construction Materials Demand Sensitivity Analysis Cumulative Forecast Demand 2018 to 2036 inclusive	Accurate	Sourced from 1. GSR Inputs and Outputs Within Table Sensitivity analysis 2027 to 2036

A.2 Excel model review

Tab 1: GSR Key inputs & outputs

Table A: Construction materials

1. Extractive (quarry) materials (hard rock & natural sand)

- Yearly figures are hard coded.

2. Substitutes for extractive materials

- Table's sub-total is built from inferred values.
  - Each year's total extractive and substitute materials is provided in row 22. The first ½ proportion of the total extractive and substitute materials is given from extractive (quarry) materials (hard rock & natural sand) which, as stated above in section 1.1.1.1, is hard coded.
  - An assumption has been made in the model that you can infer the second ½ proportion of total extractive and substitute materials by subtracting extractive (quarry) materials (hard rock and natural sand), thus the remainder would be the volume of substitutes for extractive materials.
  - This equation is referred to in the Report in Section 1.4 Assumption 4.
- The values that make up the sub total of substitutes for extractive materials are inferred as a static proportion, except for YE2018 which has hard coded values.
  - The static proportion is inferred from the table's 2018 profile % by weight applied to the year's sub-total.
- The substitutes as a % of total demand (excluding cementitious materials) is a sub-total of yearly substitutes for extractive materials out of the total extractive and substitutive materials.

3. Cementitious materials

- Yearly figures are hard coded.

1+2+3 Total construction materials

- Values are formed from total extractive and substitutive materials which is a hard-coded value and summed with the sub-total of cementitious materials.

Chart data: annual demand (base case)

- All values and derived from sub-totals of the above tables.
  - The row headers are not an exact match and is an inconsistency.

Chart data: cumulative demand 2018 to 2036 (base case)

- All values are derived from cumulative iterations of year on year growth from Chart data: annual demand (base case).
  - The row headers are not an exact match and is an inconsistent methodology.

Table B: GSR population (M)

- Values are hard coded.

Table C: Per capita consumption (tpa)

- Values are derived dividing the sub-totals of population from Table B: GSR population (M) out of Table A construction materials.
  - The row headers are not an exact match and is an inconsistent methodology.

Table D: Concrete raw materials: pre-mixed, pre-cast and mortar (Mt)

- All values are hard coded.

Sensitivity analysis 2027 to 2036

Sensitivity analysis

- See Section 3.2.4 for evaluation of sensitivity analysis.
  - The methodology for generating values in inconsistent (refer to cells C105 and C106). Cell C105 has a cell reference while C106 is a hard-coded number. This number should be referenced to T82.

Chart data: annual demand (with sensitivity)

- Table is the same as Chart data: annual demand (base case) with sensitivity applied.

Chart data: Cumulative demand 2018 to 2036 (with sensitivity)

- All values are derived from cumulative iterations of year on year growth from Chart data: annual demand (with sensitivity).

Population growth and per capita demand

- The values should be cell referenced and not hard coded.

Construction material demand (Mt)

- All values are hard coded.

Demand met from substitute sources 50%

- Cementitious materials (cement, flyash, slag) is hard-coded.
- Material values are derived from the cumulative (2018-2036) Mt of each construction material.

Demand Met from Substitute Sources 35%

- The same as demand met from substitute sources 50%.

Tab 2: Three cities

Table 1: GSR total

1.1 Crushed rock and sand (Mt) by quarry product

- Yearly figures are hard coded.

1.2 Crushed rock and sand (Mt) by point of use

- Yearly figures are hard coded.

1.3 Cementitious (Mt)

- Yearly figures are hard coded.

Three cities demand profile (% tonnes) :- High-level estimate only

2.1 FY 2018 demand profile

- All data is hard coded.

2.2 Future demand profiles

- Yearly figures are hard coded.

Table 3 EHC, Table 4 CRC, Table 5 WPC

- All data is inferred by multiplying the associated material or use-case found in Table 1: GSR total with the associated city's yearly share found in 2.2 Future demand profiles.

Tab 3: Substitutes

Table 1 Relationship between Macromonitor demand data and extractive materials (industry survey) YE Dec 2018

- Data is hard coded with source supplied.

Sandstone VENM, sandstone quarries, other surplus cut in civil works

- Data is derived from the hard-coded proportions out of the hard-coded total tonnes.

Recycled C&D waste: Concrete/brick/tile etc

- Data is derived from the hard-coded proportions out of the hard-coded total tonnes.

Other: Blast furnace / steel slag; FBA (bottom ash from coal power plants)

- Data is hard coded with source supplied.

Recycled asphalt (RAP)

- Data is hard coded with source supplied.

Total demand met by substitutes for extractive materials

- Data is derived from all other tables in this section.

Substitutes: % (by weight) by point of use - DG estimate

- Data is hard coded with source supplied.

Tab 4: Consmat worked data to FY 17

NSW DRG Consmat data - Re-worked by RWC July 2018

- Data is hard coded with source supplied.

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