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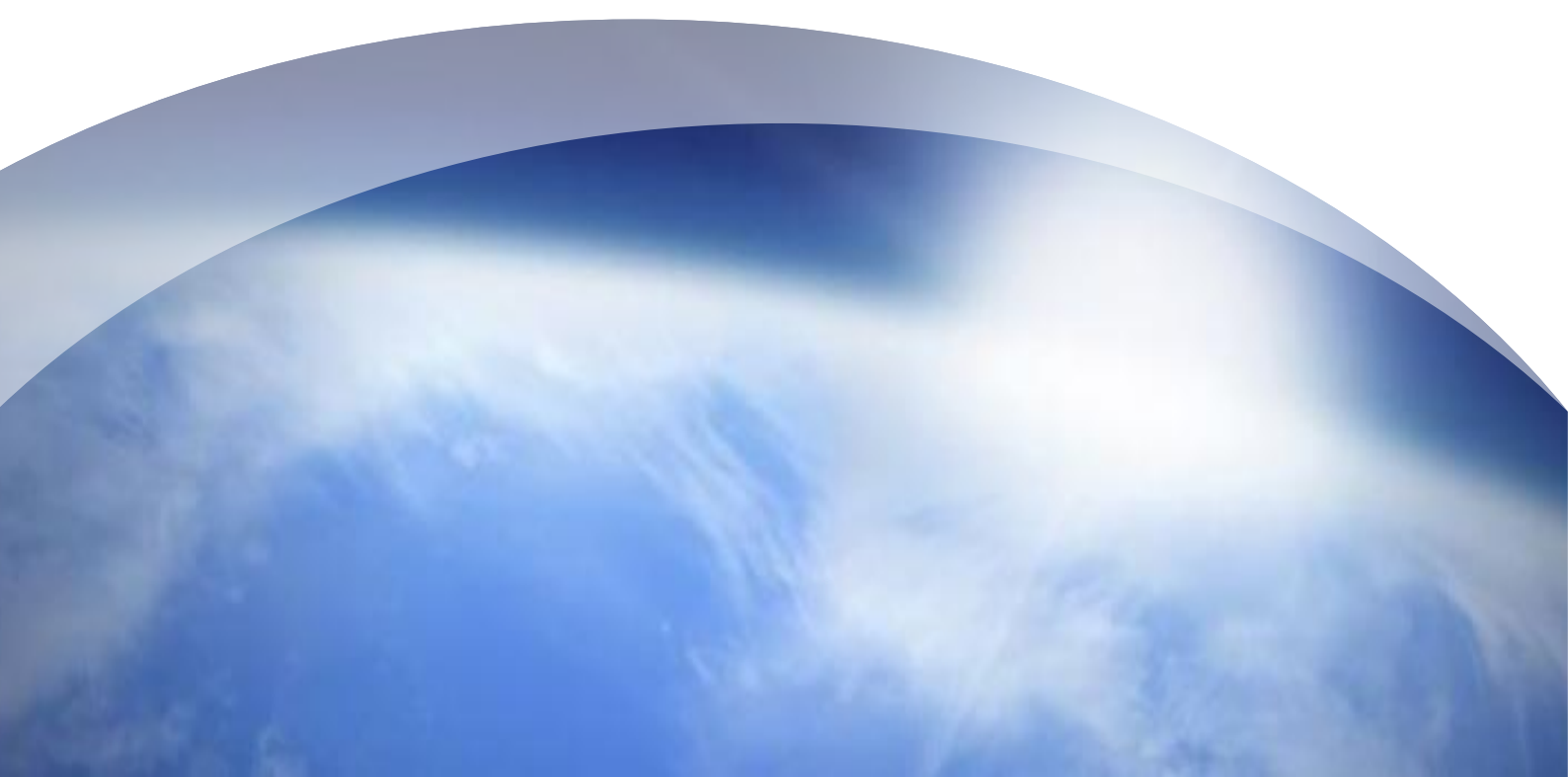
Assessment of hazardous waste infrastructure needs and capacities in Australia 2018

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Abbreviations and glossary

ABS	
ACT	Australian Capital Territory
the Act	<i>Hazardous Waste (Regulation of Exports and Imports) Act 1989</i>
AFFF	aqueous film forming foams
ANZBP	Australian & New Zealand Biosolids Partnership
ANZSIC	Australia and New Zealand Standard Industry Classification
Basel Convention	<i>The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal</i>
CAGR	compound annual growth rate
CCA	chromated copper arsenate
C&D	construction and demolition
CO ₂ -e	carbon dioxide equivalent
CPT	chemical or physical treatment
congener	are related chemical substances that are related to each other by origin, structure, or function

controlled waste	Waste that falls under the control of the NEPM. Generally equivalent to hazardous waste, although definitional differences of the latter exist across jurisdictions.
CRT	cathode ray tube
CSG	coal seam gas
DBDPE	decabromodiphenyl ethane
decaBDE	Decabromodiphenyl ether
DoEE	Department of the Environment and Energy
EOLT	end-of-life tyres
EPA	Environment Protection Authority
EPS	expanded polystyrene
expected capacity change	additional or reduced capacity changes expected at current installed infrastructure in the near future
GAC	granular activated carbon
hazardous waste	See section 1.2.1
HBCD	hexabromocyclododecane
HCB	hexachlorobenzene
HEPA	Heads of EPAs
infrastructure group	group based on the waste received and the waste management method of the infrastructure
installed infrastructure capacity	the maximum capacity that currently installed infrastructure could process on an annual basis
interstate data	data collected about hazardous waste generated in one jurisdiction and treated in another, through cross-border transport under the NEPM
intrastate data	data collected about hazardous waste generated, transported and treated within one jurisdiction
kt	kilotonnes (thousands of tonnes)
LPCL	low persistent organic pollutant concentration limit
LSLC	lead sulphate leach concentrate
MRU	mercury removal unit
Mt	Megatonnes (millions of tonnes)
NEPM	<i>National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998</i>
NSW	New South Wales
NT	Northern Territory
octaBDE	octabromodiphenyl ether
OWT	oil/water treatment
pa	per annum
PBDE	polybrominated diphenyl ethers
pentaBDE	pentabromodiphenyl ether
PCB	polychlorinated biphenyl

PFAS	per- and poly-fluoroalkyl substances, including PFOS
PFOS	perfluorooctane sulfonate
POP	persistent organic pollutants
POP-BDE	persistent organic pollutants - bromodiphenyl ethers (various forms)
PSO	Product Stewardship for Oil program
Qld	Queensland
RO	reverse osmosis
SA	South Australia
SPL	spent pot liner
Stockholm Convention	<i>Stockholm Convention on Persistent Organic Pollutants</i>
Tas	Tasmania
TBBPA	tetrabromobisphenol A
TD	thermal destruction
tpa	tonnes per annum
tracking system	jurisdiction-based hazardous waste tracking system, in place in NSW, Qld, SA, WA and Vic
tracked data	hazardous waste collected under the arrangements of a tracking system
treatment	removal, reduction or immobilisation of a hazardous characteristic to enable waste to be reused, recycled, sent to an energy from waste facility or disposed
ULAB	used lead acid batteries
Vic	Victoria
WA	Western Australia
waste	Materials or products that are unwanted or have been discarded, rejected or abandoned. Waste includes materials or products that are recycled, converted to energy, or disposed. Materials and products that are reused (for their original or another purpose without reprocessing) are not solid waste because they remain in use.
waste arisings	waste which causes demand for processing, storage, treatment or disposal infrastructure
waste code	three-digit code used by jurisdictions to describe NEPM-listed waste
waste fate	the end destination of waste, including reuse, treatment, recycling, energy recovery, and disposal
waste group	the groups of hazardous waste with similar characteristics which are used for projections of waste arising (the groups closely follow the NEPM categories)
waste management method	The waste management type provided at the site (e.g. recycling energy recovery, treatment, disposal, short-term storage or transfer, long-term storage). Some sites provide more than one waste management method.
WEEE	waste electrical and electronic equipment
XPS	Extruded Polystyrene
yr	year

At a glance

In 2016-17, 6.1 Mt of hazardous waste arose in Australia. Around 2.3 Mt of these wastes were managed by 185 specialist facilities that have an installed capacity to manage 3.1 Mt of hazardous waste. The remaining 3.8 Mt of waste arisings were managed in infrastructure such as composting facilities and landfills that receive mostly non-hazardous waste but are also licensed to receive low risk hazardous wastes (asbestos, low-level contaminated soils and/or end-of-life tyres).

Hazardous waste arisings are projected to be between 5.5 and 15.4 Mt by 2036-37 with a 'best' estimate of 8.9 Mt. The wide range reflects high levels of uncertainty in projecting the quantities of several large-scale waste streams. The high scenario, in particular, assumes:

- high range estimates of the large contaminated soil and asbestos waste streams
- releases from storages/stockpiles
- that from 2023, non-toxic salts from the coal-seam gas (CSG) industry are no longer stored onsite
- projected large-scale growth of PFAS contaminated soil and PFOS contaminated biosolids, from 2020.

Over the next few years an increase of around 1 Mt of capacity is expected to be added to Australia's management capacity across the infrastructure groups of: e-waste, lead, mercury, end-of-life tyres (EOLTs) and spent pot liner (SPL) recycling facilities; chemical or physical treatment (CPT) facilities and soil treatment facilities; persistent organic pollutant (POP) and clinical waste thermal destruction facilities; and long-term isolation facilities.

Waste industry operators raised important issues during consultation, listed below:

- falling demand for hazardous waste infrastructure risks a non-viable core infrastructure supply
- stockpiles of SPL, mercury waste and EOLTs are a significant issue and risk
- inconsistent landfill levies drive interstate disposal of hazardous wastes
- inconsistent landfill levies undermine investment in recovery or treatment of hazardous wastes
- inconsistent landfilling pre-treatment requirements create unfair market competition across different jurisdictions
- regulatory settings should support large infrastructure investment that is required
- additional infrastructure is needed to manage reverse osmosis brine wastes from the CSG industry
- asbestos disposal costs are high and access to disposal points is getting harder
- significant infrastructure for destroying POPs is coming online in 2018 in response to PFAS risks
- for PFAS contaminated waters
 - contaminant threshold requirements are needed
 - filtration media destruction requirements are inconsistent
- distances and low tonnages of hazardous waste are a major challenge in WA, in particular
- additional infrastructure is needed for recovering hazardous packaging.

The following table summarises the amount of waste sent to each infrastructure group, nationally, and when the infrastructure capacities are projected to be exceeded.

Table G1 National assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Capacity increase (kt/yr)	Est. year arisings > installed capacity		
				Best	High	Low
Recycling and energy recovery						
Hazardous waste packaging facility	15	19	0	>2037	2033	>2037
E-waste facility	4	106	12	2037	2035	>2037
Oil re-refining facility	325	526	0	>2037	2034	>2037
Lead facility	119	124	71	2023	2018	>2037
Mercury facility	0.2	CIC	CIC	>2037	>2037	>2037
Solvents/paints/organic chemicals facility	26	14	0	2018	2018	2018
Organics processing facility	600	106	0	2018	2018	2018
EOLT facility	47	100	9	>2037	>2037	>2037
SPL facility	46	CIC	CIC	>2037	2020	>2037
Energy recovery	2	CIC	CIC	>2037	>2037	>2037
Treatment						
CPT plant	395	1,129	4	>2037	>2037	>2037
Clinical waste treatment facility	23	25	0	2026	2023	>2037
Bioremediation facility	192	0	0	no inf.	no inf.	no inf.
OWT facility	187	199	0	2025	2019	>2037
Soils treatment facility	131	178	296	>2037	2018	>2037
Disposal						
Hazardous waste landfill facility	235	201	0	2018	2018	2018
Landfill facility (NEPM codes N, T)	2,875			no inf.	no inf.	no inf.
Persistent organic pollutants thermal destruction facility	5	CIC	CIC	2020	2020	2020
Clinical waste facility thermal destruction	21	33	6	>2037	>2037	>2037
Short-term storage or transfer						
Transfer facility	551	145	0	2018	2018	2018
Long-term storage						
Long-term on-site storage	0			no inf.	no inf.	no inf.
Long-term isolation facility	0	0	CIC	no inf.	no inf.	no inf.

Notes: Shaded grey infrastructure groups have coverage limitations or are excluded.

Recommendations

Recommendation 1: Qld, NT and Tas governments should consider completing feasibility studies to determine the viability of establishing additional hazardous waste packaging capacity in their jurisdiction.

Recommendation 2: NT, Tas and WA governments should consider completing feasibility studies to determine the viability of establishing e-waste recycling capacity in their jurisdiction.

Recommendation 3: The potential hazards posed by lithium ion batteries, and the best means of managing these hazards, needs further assessment. Subsequently, an assessment should be completed of the collection and processing infrastructure needs for lithium ion batteries in Australia. This recommendation was made in 2015 and is supported by a CSIRO (2018) study.

Recommendation 4: NSW, NT, Qld and Tas governments should consider completing feasibility studies to determine the viability of establishing additional oil waste capacity in their jurisdiction.

Recommendation 5: WA government should consider completing a feasibility study to determine the viability of establishing lead waste recycling capacity in their jurisdiction.

Recommendation 6: Qld, NSW, Vic and Tas governments and DoEE should continue to actively engage with aluminium smelting companies regarding current SPL stockpiles to ensure that stockpiles continue to be drawn down each year until they are removed.

Recommendation 7: DoEE and/or NSW and Qld EPAs should consult with the CSG industry to develop a strategic plan for managing its waste, in particular waste in remote areas. This recommendation was made in 2015 and remains current.

Recommendation 8: DoEE and/or Tas EPA should further investigate the supply of CPT capacity for hazardous waste in Tas. This recommendation was made in 2015 and remains current.

Recommendation 9: ACT, NSW, Qld, and Vic governments should consider completing feasibility studies to determine the viability of establishing clinical waste recycling capacity in their jurisdiction.

Recommendation 10: State regulators that are operating waste tracking systems complete ongoing auditing of waste treated through bioremediation to ensure that only appropriate hazardous waste is sent to composting operations. This may already be occurring.

Recommendation 11: NT, Qld, and SA governments should consider completing feasibility studies to determine the viability of establishing contaminated soil treatment capacity in their jurisdiction.

Recommendation 12: DoEE should work with the jurisdictions to complete a detailed assessment of the likely closure year of the identified hazardous waste landfill facility infrastructure including a risk assessment of site capacity being impacted by issues such as extreme weather events. The anticipated closure of the only hazardous waste landfill in NSW in 2030 presents a medium-term infrastructure risk that needs detailed assessment to understand where the materials currently sent to Elizabeth Drive can be sent for recovery or disposal.

Recommendation 13: DoEE should work with jurisdictions and industry to agree an approach to determine the upper limit for tonnages/concentrations that can be received at the high temperature thermal soil treatment facilities, cement kilns and clinical waste thermal destruction units that will ensure thermal destruction of PFAS, POP-BDE, HBCD and HCB wastes. This information is required to better understand how much additional dedicated POP thermal destruction capacity (from technologies such as plasma arc) may be required in future.

Recommendation 14: The process requirements and contaminant thresholds that need to be met for PFAS-impacted water clean-up should be defined. DoEE may be best placed to lead the development of a recommended process and threshold that the jurisdictions could choose to adopt. This work may already be underway.

Recommendation 15: The management requirements of PFAS-contaminated filter media should be reviewed to ensure a nationally consistent approach.

Recommendation 16: DoEE and/or Tas EPA should further investigate the need for clinical waste treatment or thermal destruction facilities in Tas.

Recommendation 17: DoEE and/or WA and Qld governments should complete a detailed assessment and consultation with industry regarding the need for and (where required) best location(s) for additional hazardous waste transfer station/temporary storage infrastructure. This recommendation was made in 2015 and remains current.

Recommendation 18: DoEE should work with state and territory governments to assess the appropriate management of reverse osmosis brine wastes from the CSG industry and determine the likelihood that offsite disposal requirements will be needed in future.

Recommendation 19: DoEE and the jurisdictions should continue to improve the consistency and completeness of tracking system data and work towards systems that enable reporting of energy recovery separately from recycling.

Summary

Introduction

The Australian Government Department of the Environment and Energy (DoEE) is responsible for administering the *Hazardous Waste (Regulation of Exports and Imports) Act 1989* (the Act), which implements Australia's international agreements on managing hazardous waste including the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* (the Basel Convention).

DoEE is also the lead agency responsible for the implementation of the current *National Waste Policy: Less Waste, More Resources*. The policy contains a commitment to assess Australia's current and future hazardous waste infrastructure capacity and needs. This is intended to provide guidance to regulators and industry on where additional investment may be needed.

In 2014, DoEE commissioned the first such assessment. The results, published in 2015, were well received by industry and government stakeholders and seen as valuable for planning Australia's current and future hazardous waste infrastructure needs.

In 2017, DoEE commissioned Blue Environment (lead consultant), Ascend Waste and Environment and Randell Environmental Consulting (the same consortium that undertook the 2015 assessment) to review and update the 2015 assessment. This revised assessment is reported here.

This report is supported by two important Microsoft Excel files:

- The ***Hazwaste infrastructure database 2018*** which details Australia's hazardous waste infrastructure capability and capacity data by site. The database has been built via an extensive industry consultation program completed during the development of the 2015 and 2018 assessments.
- The ***Hazardous waste needs vs capacity model*** which projects Australia's future quantities of hazardous waste and compares these with the currently available management infrastructure in Australia in order to identify infrastructure development needs. The projections cover the period 2018 to 2037 under best estimate, high estimate and low estimate scenarios. This model also includes data on the historical arisings (trends) of hazardous waste arisings (see the Proj. methods tab).

The revised assessment has the same three parts as the 2015 assessment:

1. prepare projections of hazardous waste arisings and fates¹ over the coming 20 years (yr)
2. consult with industry to estimate Australia's current hazardous waste infrastructure capacity, its distribution and expected future
3. identify the extent to which current infrastructure meets future needs, considering the nature and locations of particular infrastructure.

The revised assessment also contains important expansions of the scope of the infrastructure assessment, including an analysis of cement kiln infrastructure capacity to receive hazardous waste.

Each of the three project parts are discussed below.

¹ For a discussion on these terms, see Section 1.2.

Limitations and uncertainty

This assessment of projected hazardous waste infrastructure need vs capacity is affected by the limitations and levels of uncertainty in relation to:

1. the projected arisings of hazardous waste
2. the apportioning of projected waste across the different type of infrastructure
3. the assessment of the current hazardous waste infrastructure capacity.

The limitations and uncertainty of the assessment of projected need vs capacity included in this report needs to be carefully considered. See Section 4.2 for detailed analysis of uncertainty.

Projections of hazardous waste

Thirty-three hazardous waste groups were defined for use in the projections, an increase of four compared with the previous 2015 version of this report. These closely corresponded with the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998* (NEPM). Some categories were disaggregated where a component waste was of particular interest. The waste groups are listed in Table S1. The selection and formation of the waste groups is discussed in detail in Sections 1 and 2 of this report. An important aspect of the project context is the potential for new hazardous waste streams to arise due mainly to changes under the Stockholm Convention on Persistent Organic Pollutants.

Table S1: Waste groups and wastes of particular interest

	Waste group	Closest NEPM category	The aspect(s) of particular interest
1	Plating & heat treatment	A	
2	Acids	B	
3	Alkalies	C	
4	Inorganic fluorine (SPL)	D110	Significant stockpiles in Australia
5	Mercury & compounds	D120	Mercury waste
6	Lead & compounds	D220	Lead waste and waste lead acid batteries
7	Zinc compounds	D230	Large tonnages produced. Almost entirely a lead-rich zinc waste that is generated by Nyrstar in Hobart and transported to Nyrstar in Port Pirie.
8	Non-toxic salts	D300	Coal seam gas waste
9	Other inorganic chemicals	Other D	SPL waste from aluminium industry
10	Reactive chemicals	E	
11	Paints, resins, inks, organic sludges	F	
12	Organic solvents	G	
13	Pesticides	H	
14	Oils	J100 & 160	Waste is produced in particularly large quantities
15	Waste oil/water mixtures	J120	Waste is produced in particularly large quantities
16	Grease trap waste	K110	Large tonnage low hazard organic waste

	Waste group	Closest NEPM category	The aspect(s) of particular interest
17	Other putrescible/organic waste	Other K	
18	PCB	M100	
19	POP-BDEs and HBCD	M160a & b	Polybrominated diphenyl ether (PBDE) and hexabromocyclododecane (HBCD), including biosolids contaminated with these substances
20	HCB	M160c	Orica stockpile of hexachlorobenzene
21	PFOS contaminated biosolids	M270a	Biosolids contaminated with perfluorooctane sulfonate, future quantities and available infrastructure are highly uncertain
22	PFAS contaminated soils	M270b	Soils containing per- and poly-fluoroalkyl substances from use of firefighting foams
23	AFFF concentrates	M270c	Aqueous film forming foams (used for fire-fighting) containing PFAS
24	Other organic chemicals	Other M	
25	Contaminated soils	N120	Contaminated soils
26	Other contaminated biosolids	N205a	Biosolids contaminated with inorganics
27	Other industrial treatment residues	N205b	
28	Asbestos	N220	Waste asbestos
29	Other soil/sludges	Other N	
30	Clinical & pharmaceutical	R	
31	Tyres	T140	End-of-life tyres
32	Other miscellaneous	Other T	
33	Lithium ion batteries	-	Waste lithium ion batteries

Projections were built on the basis of a wide range of data (documented in Table 2 of the report). The most important input was from data reports from the states and territories. Waste tracking systems in Queensland (Qld), New South Wales (NSW), South Australia (SA), Victoria (Vic) and Western Australia (WA) require companies generating, transporting and treating or disposing hazardous waste to provide a record to government of each transaction to which they are a party. Data from these systems was collected, collated and analysed, together with other jurisdictional waste data.²

A baseline tonnage figure was established for each of 33 waste groups in each jurisdiction, typically based on the most recent datum available. Three scenarios (best, high and low estimates) of future quantities of each waste group until 2037 were developed based on considerations that varied with the waste group. Providing three scenarios reflects the highly uncertain nature of projecting future quantities of hazardous wastes. In most cases, the projections were linked to apparent trends, projected economic and population growth, and the anticipated prospects of the industries generating the waste.

² NSW, Qld, SA, Vic and WA have waste tracking systems for intrastate and interstate waste movements, whilst ACT, NT, and Tas, currently only have interstate waste tracking systems.

The best estimates of projected waste arisings for each waste group are shown in Figure S1. The overall quantity of hazardous waste is projected to rise from 6.1 Mt in 2016-17 to 8.9 Mt in 2036-37. This represents an average growth rate of 1.9% per year, larger than the projected average growth rate for population (1.4%), which is illustrated on the chart, but less than the long-term projected economic growth rate (2.8%).

The top six groups in terms of tonnes arising – in order, contaminated soils, asbestos, grease trap waste, PFAS contaminated soils, tyres and oils – represent about 70% of the total at both the start and end of the projection period. In some cases, the best estimate provides for some clearing of waste stockpiles and storages.

A few waste groups are projected to become much more significant at the end of the period than at the start. Waste lithium ion batteries are projected to grow at an average rate of 19% per year. Three other waste groups (POP-BDEs and HBCD, PFOS contaminated biosolids and PFAS contaminated soils) are recorded at zero at the start of the period but reach tens or hundreds of thousands of tonnes at the end, following the implementation of the *PFAS National Environmental Management Plan* and the assumed ratification of additions to the Stockholm Convention. All other waste streams are projected to grow at less than 3% per year on average. Five are projected to decline, three reducing by 1-2% per year on average (other inorganic chemicals, reactive chemicals, PCBs) and two disappearing entirely (HCB and AFFF concentrates).

Section 2.7 provides an account for each waste group of industry sources, considerations and factors applied in developing the projections, the arithmetical methods used, and a figure showing the projected quantities in the best, high and low estimate scenarios.

The management of hazardous waste

Data on the management of hazardous waste in 2016-17 was compiled from NSW, Qld, SA, WA and Vic tracking system data. This provided a basis for estimating the management methods for Northern Territory (NT), Australian Capital Territory (ACT) and Tasmania (Tas), for which management data was not available. The overall tonnage data by management method is presented in Figure S2. See Section 2.8 for detailed analysis of available management data.

Figure S1: Best estimate of national projections for all hazardous waste to 2037

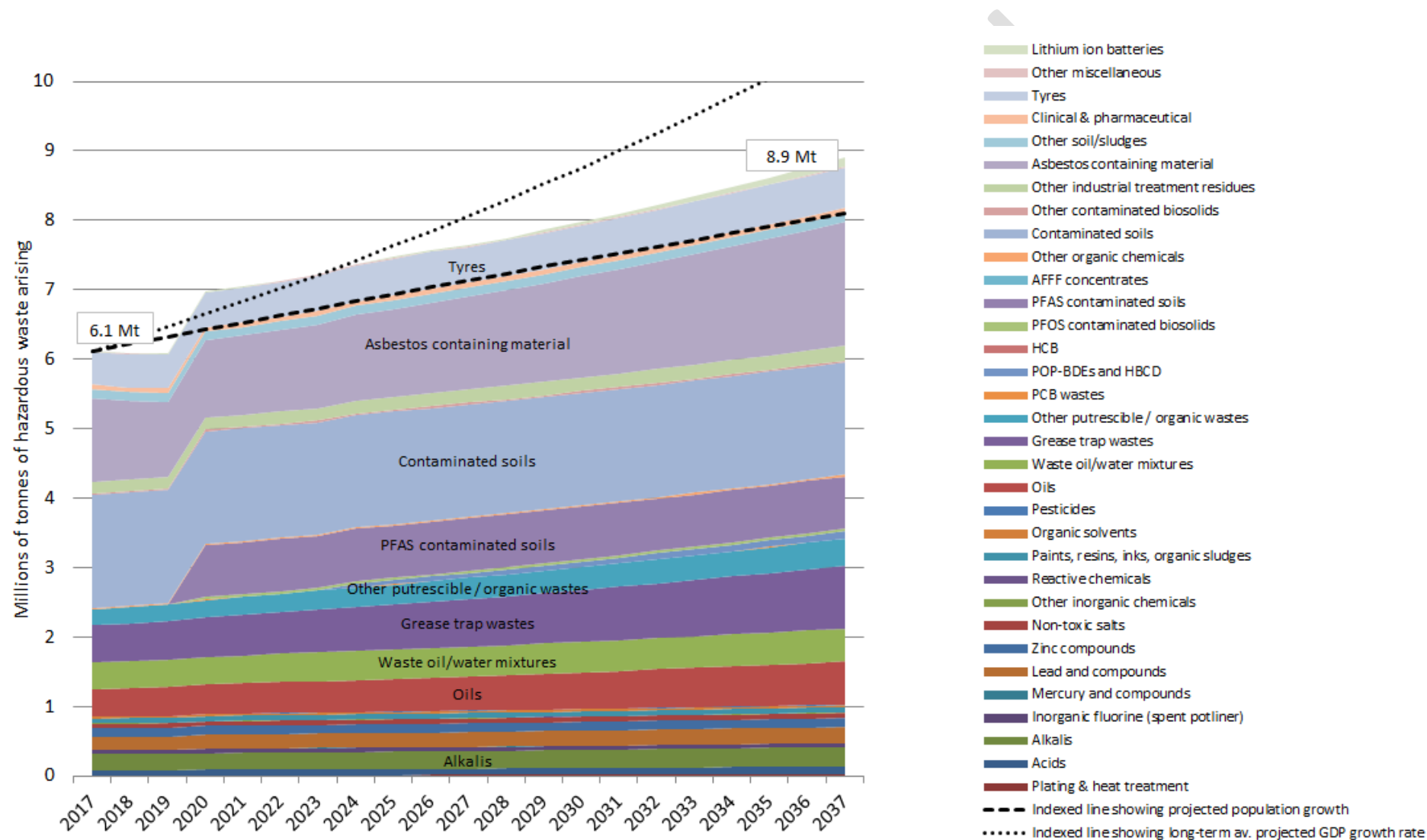
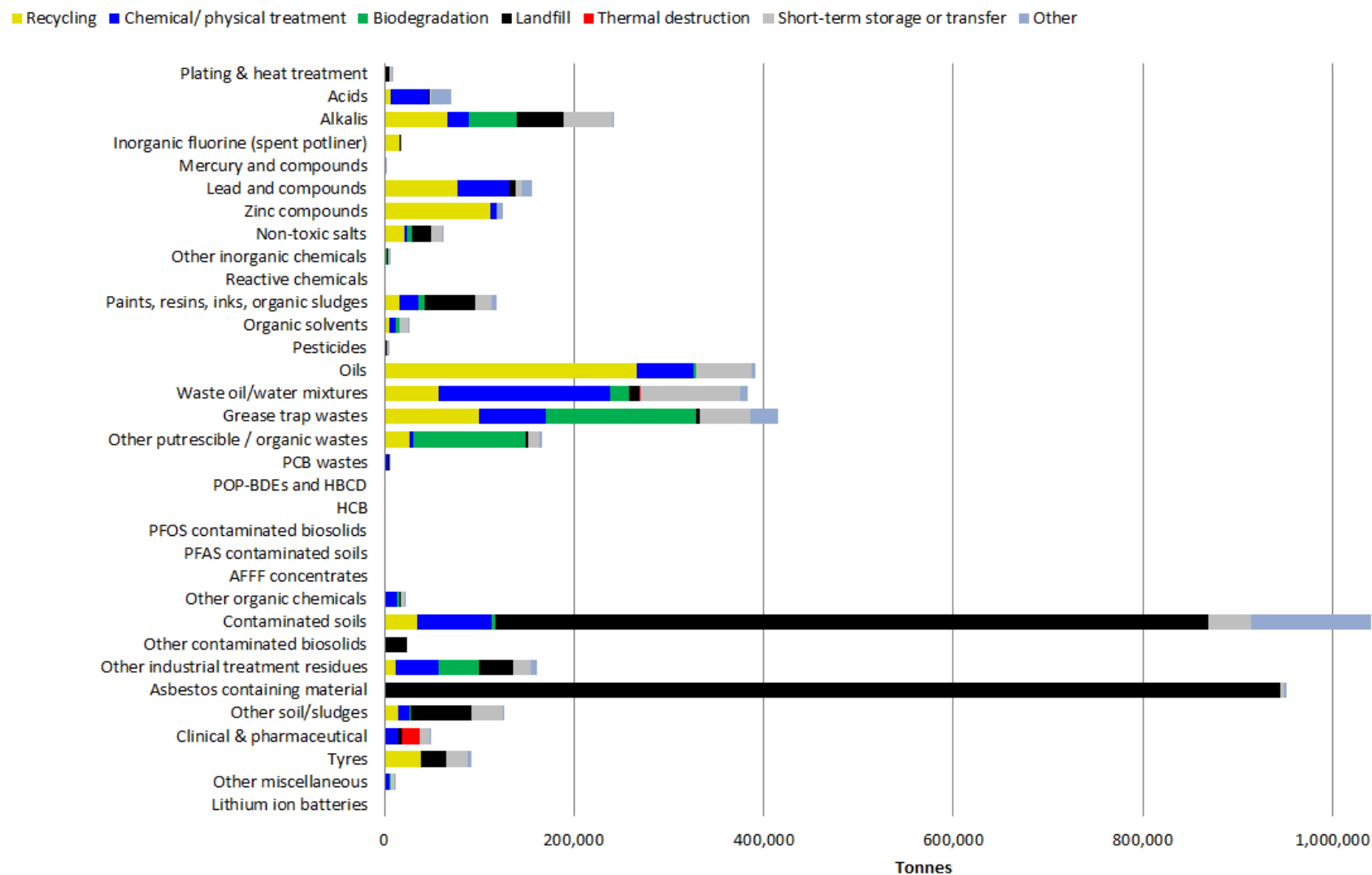


Figure S2: The management method of reported tracked hazardous waste in NSW, Qld, SA, Vic and WA, 2016-17 (tonnes)



Hazardous waste infrastructure assessment

This project involved extensive consultation with industry to update and validate the information from the original 2015 assessment and, importantly, to collate capability and capacity data for some additional infrastructure groups.

To enable the assessment of projected infrastructure need vs capacity, it was necessary to group the infrastructure included in the *Hazwaste infrastructure database 2018*. The infrastructure was grouped based on the waste received and the waste management method of the infrastructure, e.g. e-waste recycling, POP thermal destruction, clinical waste treatment and clinical waste thermal destruction.

The infrastructure groups were then used to compare waste group arisings and management to infrastructure capacity. The infrastructure groups are listed in S2 below, which is ordered following the waste hierarchy³. New infrastructure groups for the 2018 assessment are marked with an asterisk. The scope and coverage limitations for each infrastructure are also flagged below.

Table S2: Infrastructure groups description and coverage

Hazardous waste management method	Hazardous waste infrastructure group	Description and coverage
Recycling	Hazardous waste packaging facility	Facilities that recycle industrial packing that contains residual hazardous waste. Containers are typically refurbished and reused or materials are recycled.
	E-waste facility	Major e-waste physical/chemical and manual disassembly processing facilities. Facilities receive inorganic hazardous waste, such as copper, cobalt, and lead.
	Oil re-refining facility	Facilities that re-refine (recycle) waste oil. Facilities that dewater and filter waste oil are included in oil/water treatment (OWT), see below.
	Lead facility	Facilities that recycle lead. Typically, the lead is from used lead acid batteries.
	Zinc facility*	Currently this group is limited to the Nyrstar Port Pirie multi-metals recovery plant (which processes lead rich concentrates and smelting industry by-products) including waste generated by Nyrstar's zinc smelter in Hobart. Note: due to this group being limited to the Nyrstar Port Pirie facility which is treating waste mostly from Nyrstar Hobart, no needs versus capacity assessment is provided for this infrastructure group. Nyrstar Port Pirie reports unconstrained capacity to recycle all lead-rich waste from their Hobart operations.
	Mercury facility	Facilities that recycle mercury from used fluorescent light fittings and or oil and gas mining spent catalysts.
	Solvents/paints/organic chemicals facility	Facilities that recycle paints, resins, inks, organic sludges and/or organic solvents, but not for energy recovery.

³ The waste hierarchy expresses a policy preference in which recovery of waste is seen as preferable to treatment, and treatment is seen as preferable to untreated disposal.

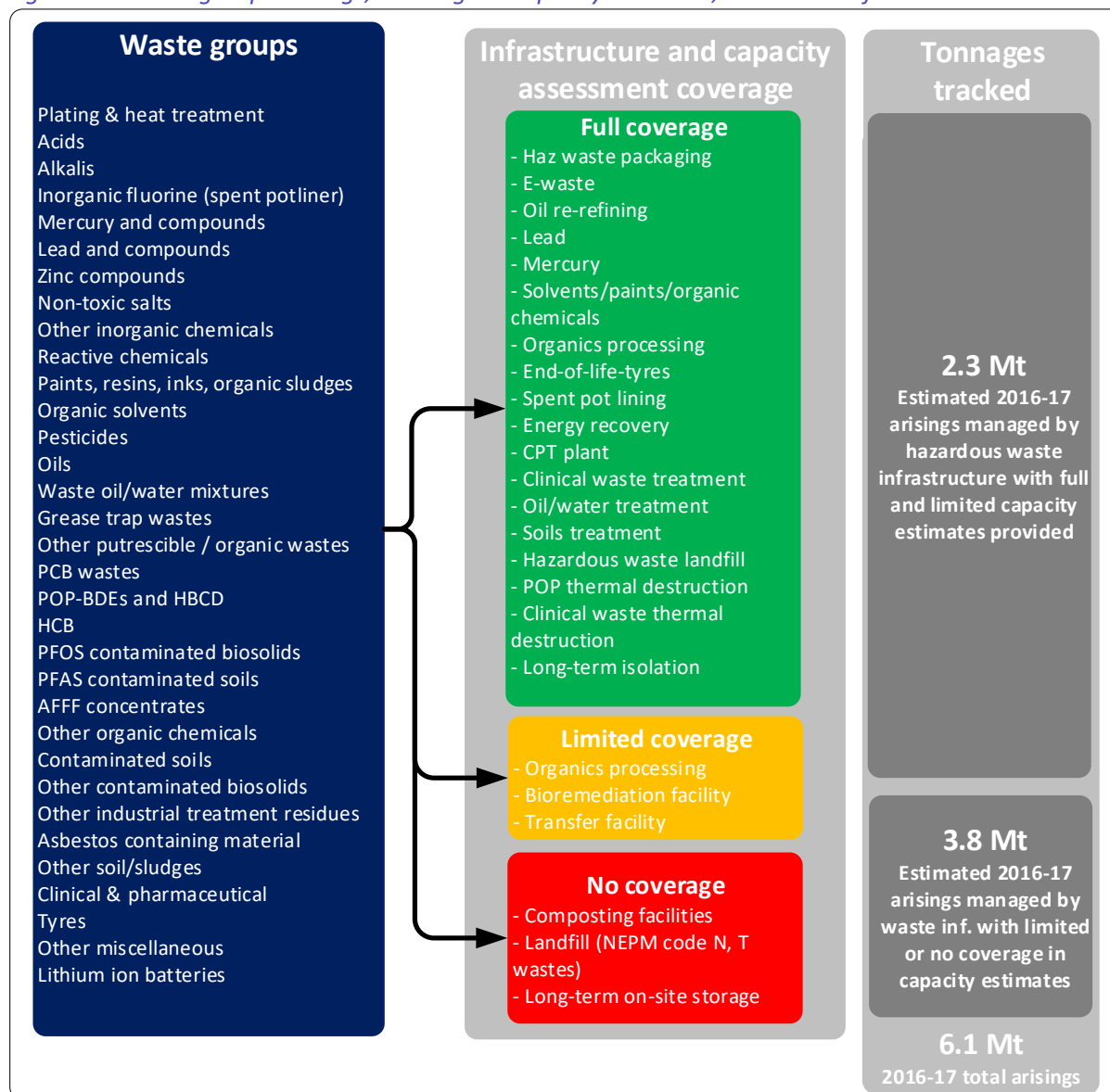
Hazardous waste management method	Hazardous waste infrastructure group	Description and coverage
	Organics processing facility	Facilities that recycle a range of low hazard organic waste such as grease trap waste, cooking oil, animal effluents, etc. Capacity data coverage limitation: composting facilities are excluded from the database. This group refers to facilities that treat grease trap waste and other similar waste.
	EOLT facility*	Facilities that recycle end-of-life-tyres (EOLT) including facilities that partially process EOLT for export and processing overseas.
	SPL facility	Facilities that recycle SPL waste from the aluminium industry.
Energy recovery	Energy recovery	Facilities that recover or use solvents, paints or other hazardous waste with calorific value for energy recovery on-site or elsewhere (e.g. a cement facility).
Treatment	Chemical or physical treatment (CPT) plant	Sophisticated facilities developed with significant capital to apply chemical and physical treatments to a broad range of waste. Often licensed to receive almost all NEPM 15 waste codes. Processes can include many chemical treatments (e.g. oxidation, reduction, precipitation, neutralisation, etc.) and physical treatments (e.g. sedimentation, filtration, adsorption, immobilisation, etc.)
	Clinical waste treatment facility	Facilities that treat clinical waste typically using an autoclave.
	Bioremediation facility*	Temporary or permanent facilities that treat hazardous waste by land-farming or bioremediation. Often does not generate a useful product for sale. Capacity data coverage limitation: composting facilities are excluded from the database. This group is intended to refer to facilities that treat hazardous waste through biodegradation that are not generating compost for sale. However, many commercial composting facilities are licenced to receive low level hazardous waste which is effectively bioremediated in the composting process and these facilities are not within the project scope.
	Oil/water treatment (OWT) facility*	Facilities that treat waste oil/water, hydrocarbons/water mixtures or emulsions. Recovered oils are then typically sent on to an oil re-refining facility
	Soils treatment facility	Facilities that treat contaminated soils. Treatment processes include biodegradation and thermal destruction of contaminants.
Disposal	Hazardous waste landfill facility	A small number of landfill facilities that are licensed to dispose of a wide range of hazardous wastes many of which can only be landfilled at these sites.
	Landfill facility (NEPM codes N, T)	Landfill facilities licensed to dispose of low-risk hazardous waste such as low-level contaminated soils, asbestos, and tyres (NEPM 15 codes N and T). These landfills also generally dispose of non-hazardous waste, which typically represents the majority of their inputs.

Hazardous waste management method	Hazardous waste infrastructure group	Description and coverage
		Capacity data for this group is excluded from database. This infrastructure group is excluded from the <i>Hazwaste infrastructure database 2018</i> . Many landfills around Australia dispose of low-level contaminated soils, asbestos and tyres. These landfills are not classified as hazardous waste landfills and are beyond the scope of this assessment.
	Persistent organic pollutants thermal destruction facility	Facilities able to destroy persistent organic compounds or pollutants (POP) by thermal destruction.
	Clinical waste facility thermal destruction	Facilities that dispose of medical waste by thermal destruction.
Short-term storage or transfer	Transfer facility	Facilities that transfer or temporarily store hazardous waste. Some of these facilities receive a wide range of waste, others only specific waste. Capacity data coverage limitation: not all transfer facilities are covered in the database and some infrastructure groups operate in part as a transfer facility.
Long-term storage	Long-term on-site storage*	Pre-approved on-site (or near site) long-term storages of hazardous waste in designated area/s. Capacity data coverage limitation: long-term on-site storage facilities are excluded from the database and the needs vs capacity assessment. The infrastructure group has been included recognising that some hazardous waste is managed in on-site infrastructure that is often for the long term.
	Long-term isolation facility*	Facilities licensed to store hazardous waste for long periods (≥ 10 years), typically until an economically viable treatment or disposal solution is developed.

Notes: * new infrastructure groups added in 2018 assessment

The scope and coverage of the infrastructure database constrains the assessment of infrastructure capacity against projected arisings. Some hazardous waste is managed in facilities that are not included in the infrastructure database, while others are sent to infrastructure with limited coverage in the database. For these wastes, a comparison of future arisings vs processing capacity using the available data may not produce an accurate result. Figure S3 illustrates which infrastructure groups are out of the capacity assessment scope or have limited coverage and the total tonnages of hazardous waste reported in 2016-17.

Figure S3: Waste groups arisings, coverage in capacity database, and extent of assessment



The capacity of each infrastructure group was compiled by jurisdiction. Data gaps were filled through estimates based on EPA licence limits and average capacity reported by survey respondents in the relevant group. Section 4.2 provides detailed analysis of the limitations and uncertainty associated with the infrastructure capacity assessment and an overall estimate of uncertainty for each infrastructure group.

The national capacity is summarised in Table S3, including the overall estimates of uncertainty for each infrastructure group capacity assessment. The difference between overall arisings (6.1 Mt) and overall capacity (2.3 Mt) is mainly attributable to the limits on the scope of the hazardous waste infrastructure database, as illustrated in Figure S3.

‘Mobile’ waste treatment technology that is moved from one site clean-up to another is included in the scope of the assessment where the technology is providing the waste treatment (onsite). Mobile equipment that is used to simply collect, concentrate, or transport hazardous wastes simply to enable treatment off-site is not included.

Table S3: National capacity estimate of hazardous waste infrastructure

Hazardous waste infrastructure	No. capacities	Current receipts (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Data quality is:		
					Good	Ok	Poor
Recycling and energy recovery							
Hazardous waste packaging facility	19	19	19	0	21%	0%	79%
E-waste facility	13	58	106	12	92%	0%	8%
Oil re-refining facility	10	387	526	0	60%	30%	10%
Lead facility	3	110	124	71	67%	33%	0%
Mercury facility	7	CIC			100%	0%	0%
Solvents/paints/organic chemicals facility	4	11	14	0	75%	0%	25%
Organics processing facility	4	99	106	0	50%	50%	0%
End-of-life tyres facility	14	83	100	9	93%	0%	0%
Spent potlining facility	4	CIC			100%	0%	0%
Energy recovery	5	CIC			60%	20%	20%
Treatment							
CPT plant	36	857	1,129	4	78%	22%	0%
Clinical waste treatment facility	9	24	25	0	33%	22%	44%
Bioremediation facility	0	0	0	0			
Oil/water treatment (OWT) facility	27	148	199	0	37%	30%	33%
Soils treatment facility	6	97	178	296	67%	33%	0%
Disposal							
Hazardous waste landfill facility	7	167	201	0	43%	0%	43%
Landfill facility (NEPM codes N, T)	Not included in assessment of arisings versus capacity						
Persistent organic pollutants thermal destruction facility	7	CIC			86%	0%	14%
Clinical waste facility thermal destruction	6	20	33	6	100%	0%	0%
Short-term storage or transfer							
Transfer facility	19	114	145	0	79%	16%	5%
Long-term storage							
Long-term on-site storage	Not included in assessment of arisings versus capacity						
Long-term isolation facility	2	0	0	CIC	100%	0%	0%
Total	202	2,336	3,092	945	67%	15%	18%

Data quality definitions	Good	Industry response received. Processing, licensed, and installed capacity data supplied during consultation
	Ok	No response. Maximum licensed processing capacity data identified in licence or published company information
	Poor	No response. Licensed processing capacity assumed to be the average of the tonnage processed by inf. with the same inf. group

Notes: Infrastructure groups that are shaded grey have coverage limitations or are excluded.

Assessment of projected need vs capacity of hazardous waste infrastructure

The assessment of need against capacity involved four main steps (refer to Section 4.1 for detail):

1. The management of 2016-17 waste arisings were expressed in proportions (percentages) and adjusted to remove anomalies.
2. For each waste group, the management methods were mapped to an infrastructure group.
3. The tonnes of each waste sent to each infrastructure group were projected for each year and scenario, assuming waste is sent to the various infrastructure groups in the same proportions as 2016-17 (i.e. the recovery rate of each waste group remains constant over the period).
4. The projected tonnages sent to each infrastructure group were compared with capacity.

The results of the comparison are shown in Table S5 on a national basis. Estimates shaded grey are considered inaccurate due mainly to the infrastructure group having limited coverage in the capacity assessment. Separate jurisdictional assessments were undertaken (see Table 52 to Table 59).

Table S5: National assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings	Installed capacity	Expected capacity change	Uncertainty of needs vs capacity assessment	Est. year arisings > installed capacity by scenario		
	(kt/yr)	(kt/yr)	(kt/yr)	low - very high	Best	High	Low
Recycling and energy recovery							
Hazardous waste packaging facility	15	19	0	High	>2037	2033	>2037
E-waste facility	4	106	12	High	2037	2035	>2037
Oil re-refining facility	325	526	0	Moderate	>2037	2034	>2037
Lead facility	119	124	71	Moderate	2023	2018	>2037
Mercury facility	0.2	CIC		Low	>2037	>2037	>2037
Solvents/paints/organic chemicals facility	26	14	0	Very high	2018	2018	2018
Organics processing facility	600	106	0	Very high	2018	2018	2018
EOLT facility	47	100	9	High	>2037	>2037	>2037
SPL facility	46	CIC		Low	>2037	2020	>2037
Energy recovery	2	CIC		Very high	>2037	>2037	>2037
Treatment							
CPT plant	395	1,129	4	Moderate	>2037	>2037	>2037
Clinical waste treatment facility	23	25	0	High	2026	2023	>2037
Bioremediation facility	192	0	0	Very high	no inf.	no inf.	no inf.
OWT facility	187	199	0	Very high	2025	2019	>2037
Soils treatment facility	131	178	296	Moderate	>2037	2018	>2037
Disposal							
Hazardous waste landfill facility	235	201	0	High	2018	2018	2018
Landfill facility (NEPM codes N, T)	2,875			n/a	no inf.	no inf.	no inf.
Persistent organic pollutants thermal destruction facility	5	CIC		Very high	2020	2020	2020
Clinical waste facility thermal destruction	21	33	6	Low	>2037	>2037	>2037
Short-term storage or transfer							
Transfer facility	551	145	0	Very high	2018	2018	2018
Long-term storage							
Long-term on-site storage	0			n/a	no inf.	no inf.	no inf.
Long-term isolation facility	0	0	CIC	n/a	no inf.	no inf.	no inf.

Notes: Shaded grey infrastructure groups have coverage limitations or are excluded.

Conclusions and recommendations

Hazardous waste arisings and management and current issues

In 2016-17, 6.1 Mt of hazardous waste arose in Australia. Around 2.3 Mt of these wastes were managed by the 185 operational sites, which have an installed capacity to manage 3.1 Mt of hazardous waste. The remaining 3.8 Mt of hazardous waste arisings were managed by other infrastructure such as composting facilities and landfills typically licenced to receive only asbestos and low-level contaminated soils.

Hazardous waste arisings are projected to increase to between 5.5 and 15.4 Mt by 2036-37 with the 'best' estimate of arisings of 8.9 Mt. In the high scenario hazardous waste quantities are projected to grow due to:

- an initial jump in quantities as contaminated soils and asbestos step from 2016-17 levels to the highest end of their range
- releases from storage/stockpiling
- the assumption that in 2023 non-toxic salts from the CSG industry are no longer stored onsite
- projected large-scale growth PFAS contaminated soil and PFOS contaminated biosolids, from 2020.

Over the next few years an increase of around 1 Mt of capacity is expected to be added to Australia's capacity across the infrastructure groups of:

- e-waste, lead, mercury, EOLT and SPL recycling facilities
- CPT and soil treatment facilities
- POP and clinical waste thermal destruction facilities
- long-term isolation facilities.

Regarding hazardous waste infrastructure sites in Australia: NSW and Vic dominate in the provision of infrastructure sites each with approximately 30% of the sites. Qld and WA follow both with around 15% of the sites. SA has 8% of the sites, followed by NT, ACT, and Tas which all have less than 5% of Australia's hazardous waste infrastructure sites.

Regarding management of 2016-17 arisings: NSW managed 34% of the waste arisings. Qld, Vic and WA follow with each managing around 20% of arisings. SA managed around 7% of arisings and NT, ACT and Tas all managed less than 2% of 2016-17 arisings.

Regarding installed hazardous waste infrastructure capacity: NSW has 32% of the waste arisings. Qld, Vic and WA follow, each having around 20% of installed capacity. SA has 6% of installed capacity and NT, ACT and Tas all have less than 1% of total installed capacity.

Industry raised many important issues during consultation which are listed below:

- Falling demand for hazardous waste infrastructure risks a non-viable core infrastructure supply
- Stockpiles of SPL, mercury waste and EOLT are a significant issue and risk
- Inconsistent landfill levies driving interstate disposal of hazardous wastes
- Inconsistent landfill levies undermining investment in recovery or treatment of hazardous wastes
- Inconsistent landfilling pre-treatment requirements create unfair advantage between jurisdictions

- Regulatory settings generally need to support large infrastructure investment that is required
- Additional CSG waste infrastructure needed
- Asbestos disposal costs are high and access to disposal points is getting harder
- Significant POP destruction infrastructure coming online in 2018 and beyond in response to PFAS waste arisings and risks
- PFAS contaminated waters: contaminant threshold requirements need
- PFAS contaminated waters: filtration media destruction requirements are inconsistent
- WA: distance and low tonnages of hazardous waste is a major challenge.

Hazardous waste packaging recycling facilities

The national assessment indicates that under the best and low scenarios over the next 20 years the installed capacity of Australia's current hazardous waste packaging recycling infrastructure will be able to recycle waste arisings. Under the high scenario, the current installed capacity would be exceeded in 2033. The infrastructure need vs capacity assessment for this group has high uncertainty due to a low response rate during 2018 consultation and the highly diffuse nature of this infrastructure group.

Contaminated hazardous waste packaging may seem like a minor issue in the hazardous waste context. This is a problematic waste stream that often has highly concentrated hazardous product residuals. The contaminated containers are voluminous, cannot be cost-effectively transported and are not able to be processed by non-hazardous waste packaging infrastructure.

Some survey respondents commented on a broader need for improved recovery options for small hazardous waste packaging and small packages of waste hazardous goods. Planned infrastructure flagged in the 2015 assessment has not proceeded and this waste stream will likely continue to be problematic and require dedicated infrastructure.

Recommendation 1: Qld, NT and Tas governments should consider completing feasibility studies to determine the viability of establishing additional hazardous waste packaging capacity in their jurisdiction.

E-waste major physical/chemical & disassembly facilities

The national assessment indicates that under the best and low scenarios over the next 20 years the current installed capacity of Australia's e-waste (major physical/chemical and manual disassembly processing) infrastructure will be able to recycle waste arisings. If e-waste arisings grow very strongly (high scenario), capacity could become constrained by 2035. However, expected increases in capacity of 12 kt/yr should provide sufficient national capacity to cater for higher growth.

The needs vs capacity assessment for this group has high uncertainty due to the waste arisings reported in tracking system data (4 kt in 2016-17) being much lower than the reported tonnages received (58 kt in 2016-17). This large difference is due to the fact that most e-waste is not transported and tracked as a hazardous waste. Considering the reporting receipts of 58 kt in 2016-17 and the current installed capacity of 106 kt/yr it is still likely that there is sufficient capacity over the projection period.

Installed capacity is concentrated in NSW, with significant capacity also in Vic and SA and some capacity in Qld and ACT. A shortfall in current capacity is apparent in NT, Tas and WA. E-waste in these jurisdictions is likely sent interstate or is sent to landfill.

For e-waste it is important to consider that the assessment assumes no change in the management methods of e-waste. Changes to product stewardship agreements or landfill bans on e-waste could significantly change current e-waste management and increase the recycling capacity required.

Recommendation 2: NT, Tas and WA governments should consider completing feasibility studies to determine the viability of establishing e-waste recycling capacity in their jurisdiction.

Lithium ion batteries infrastructure

The potential arisings of lithium ion batteries, which are not currently regulated as hazardous waste⁴, are assessed in this report due to their potential to have a significant impact on hazardous and non-hazardous waste infrastructure. Waste lithium ion batteries are projected to grow at an average rate of 19% per year (under best estimate scenario), and if not appropriately managed, represent a safety hazard due to risks of causing explosions and or fire (ABRI 2014).

While this assessment does not indicate a shortfall in the overall e-waste processing capacity in Australia, at the time of writing only one e-waste facility recycles lithium ion batteries in Australia (Envirostream Victoria). Most lithium ion batteries recovered are still likely to be exported overseas for recycling. In addition, Australia has no specific lithium ion battery collection/transfer infrastructure (lithium ion batteries that are recovered are collected with other battery types). The collection of potentially flammable lithium ion batteries without appropriate infrastructure could create a fire hazard within the collection infrastructure for other batteries.

Recommendation 3: The potential hazards posed by lithium ion batteries, and the best means of managing these hazards, needs further assessment. Subsequently, an assessment should be completed of the collection and processing infrastructure needs for lithium ion batteries in Australia. This recommendation was made in 2015 and is supported by a CSIRO (2018) study.

Oil re-refining facilities

The national assessment indicates that, under the low and best scenarios, over the next 20 years the installed capacity of Australia's current oil re-refining infrastructure will be able to recycle waste arisings. Under the high scenario, the current installed capacity would be exceeded in 2034.

The infrastructure need vs capacity assessment for this group has moderate uncertainty due to a moderate response rate during consultation and the potential under-reporting of waste oil in NSW and Vic data resulting in an under-estimate of 2016-17 arisings. In addition, some waste oils recycling may actually be sent for energy recovery, which would result in an over-estimate of waste oil re-refining demand.

The 2018 assessment for this infrastructure group is a significant improvement on the 2015 assessment due to separation of the projections of the NEPM J waste codes of J100 and J160 from J120 Waste oil/water, hydrocarbons/water mixtures or emulsions. The J120 waste arisings are now mapped to the new infrastructure group of OWT facilities. This has increased the accuracy of the assessment and resulted in a change of expected exceedance of installed capacity in 2023, in the 2015 assessment, to >2037 in this assessment.

Installed capacity is concentrated (in the following order) in WA, Qld and NSW, with some capacity also in SA and Vic. No oil re-refining capacity was identified in ACT, NT and Tas. Oil waste in these jurisdictions is likely sent interstate.

⁴ Waste lithium ion batteries are regulated as hazardous waste for international transport, but currently not for domestic transport

Jurisdictional analysis indicates that ACT, NSW, NT, Qld, Tas all either lack oil re-refining capacity or do not have capacity in the jurisdiction.⁵ Capacity in SA and WA appear to be sufficient.

Recommendation 4: NSW, NT, Qld and Tas governments should consider completing feasibility studies to determine the viability of establishing additional oil waste capacity in their jurisdiction.

Lead recycling facilities

In the best estimate scenario, lead waste arisings are projected to increase at a rate equivalent to 20-year average population growth rate (1.4%) in all jurisdictions except Tas (where lead waste is projected to follow trends in global zinc prices). On this basis, the installed lead recycling infrastructure capacity could be met by 2023.

Under the low scenario projection, of flat trend for 10 years and decline for the next 10 years due to replacement of battery technology, installed capacity is not expected to be exceeded over the next 20 years.

Under the high estimate projection, of arisings increasing at the 20-year average rate of economic growth (2.8%) for all jurisdictions except Tas, capacity would be exceeded in 2018. The high scenario also includes a 20 kt/yr release of jarosite waste from a stockpile at Nyrstar Hobart to Nyrstar in Port Pirie⁶. The Nyrstar Port Pirie site is included in the e-waste infrastructure group due to the site's defined capacity to process e-wastes such as CRT TVs and the site's unconstrained capacity to take lead waste from the Hobart zinc smelter. Nyrstar Port Pirie's lead recycling capacity is not included in the 124 kt/yr installed capacity estimate. There is also an additional 71 kt/yr of lead acid battery smelting capacity under construction that would add significant additional capacity along the east coast. As Nyrstar Port Pirie can manage all of the lead-rich waste from the Nyrstar Hobart zinc smelter and the significant additional lead acid battery processing capacity coming on-line, there is likely to be sufficient lead recycling capacity under all scenarios.

The lead recycling assessment has moderate level of uncertainty due to the:

- lack of industry response for the 2018 assessment
- lack of a clearly defined upper limit on Nyrstar Port Pirie's ability to manage all of the lead waste from Nyrstar operations, in addition to lead waste from other sectors.

Recycling capacity for lead acid batteries is almost all located in NSW, with some capacity now in Qld so lead acid batteries are transported from other jurisdictions to NSW or Qld or exported overseas under an export permit. The transport costs from WA in particular may result in significant battery stockpiling in WA.

Recommendation 5: WA government should consider completing a feasibility study to determine the viability of establishing lead waste recycling capacity in their jurisdiction.

Mercury recycling facilities

At a national level, the assessment indicates that over the next 20 years the currently installed capacity of Australia's current mercury waste recycling infrastructure will be able to recycle waste arisings.

⁵ Despite NSW and Qld both having significant capacity (as noted above) the projected waste oil sent for re-refining exceeds capacity over the projection period.

⁶ Port Pirie is understood to have unconstrained capacity to process waste from the Hobart Zinc smelting operations.

Industry reported around 10 times more receipts than was reported in the waste tracking systems, reflecting that some of the mercury waste (such as unprocessed light fittings) does not require tracking. **Text withheld to maintain commercial confidentiality**

The mercury recycling assessment has a low level of uncertainty, with excellent industry input and a clearly defined infrastructure group targeting mercury recycling as their core business.

Solvents/paints/organic chemicals recycling facilities

At a national level, the assessment indicates that the current capacity of solvents/paints/organic chemicals recycling is being exceeded. This is unlikely to be accurate due to the high level of uncertainty in the capacity assessment for this group. A number of factors need to be considered:

1. it is likely that some materials sent to energy recovery are recorded as recycled (resulting in over estimate of arisings to recycling and underestimate to energy recovery)
2. some solvent/paint recycling capacity is likely to be within the CPT infrastructure group
3. some smaller operators that recycle solvents/paint may not have not been captured in the infrastructure database.

Based on industry consultation and this assessment, a national shortage of this infrastructure over the next 20 years is considered unlikely. Solvent/paints recycling infrastructure was identified only on the east coast (NSW, Qld, Vic). ACT, NT, SA, Tas and WA had no sites identified. In these jurisdictions, solvents/paint waste is sent interstate, managed within other infrastructure groups or taken to sites not identified in the capacity database.

Organics recycling (NEPM K code wastes) facilities

At a national level, projections indicate that under all scenarios the current capacity of organics recycling infrastructure (for NEPM K code organics) is being exceeded. This is inaccurate and is linked to the very high uncertainty of the assessment of needs vs capacity.

The majority of the 600 kt arisings in 2016-17 of NEPM K code waste is sent to composting sites that are not included in the infrastructure capacity assessment. To complete a quantitative analysis of projected arisings of NEPM K code organics against infrastructure capacity, extensive data would be required on non-hazardous waste infrastructure that accepts only a relatively small amount of low-level hazardous waste as part of much larger non-hazardous waste volumes. In addition, some smaller operators that specialise in hazardous organic waste may not be within the infrastructure database due to the diffuse nature of this infrastructure group.

Based on industry consultation and our assessment of organics recycling infrastructure (for NEPM code N) we do not believe a national shortage of this infrastructure group is likely over the next 20 years. This assessment is supported by the industry consultation results presented in Table 45. It is estimated that the sites within the scope of this infrastructure group received 99 kt of waste in 2016-17 (not 600 kt) and have an installed capacity to manage 106 kt/yr.

End-of-life-tyre recycling facilities

The national assessment of need vs capacity indicates that over the next 20 years the currently installed capacity of Australia's EOLT recycling infrastructure (100 kt/yr) will be able to recycle waste arisings (44 kt/yr in 2016-17). However, the EOLT recycling industry reported around 90 kt of EOLT received which is more than double the 44 kt waste arisings recycled in 2016-17. The difference is related to EOLT recyclers receiving EOLT and exporting them with minimal processing to international energy recovery or reuse markets (the 44 kt relates to full on-shore processing).

Whilst there is good capacity in Australia to collect and partly process tyres for export, there is a lack of well-developed on-shore markets for tyre-derived products. Around 60% of Australian EOLTs are sent to landfill, stockpiled or go to unknown fates. For Australia to increase the recovery of these lost EOLTs there will need to be strong developments in processing technology in Australia. However, these investments cannot occur without further development of offtake markets for the tyre-derived products and enforcement to ensure tyres are not sent to landfill, stockpiled, dumped or exported to low value management options.

EOLTs are the only Australian controlled waste that is exported in significant tonnages to other countries. India is the largest export market for Australian EOLTs. India may restrict EOLT imports in an effort to get local EOLT collected and recycled. This would follow recent trends such as [India banning plastic imports](#). Should India or other countries receiving large tonnages of EOLTs from Australia (e.g. Malaysia) restrict or ban this flow of EOLTs, it is likely that Australia's EOLTs processing capacity would be insufficient.

SPL recycling facilities

An estimated 46 kt of spent pot liner (SPL) arose in 2016-17 which suggests that the aluminium industry is processing all of the current SPL being generated and some of a significant stockpile of SPL. REC (2016) estimated Australia's annual SPL generation at around 30 kt/yr (based on aluminium production rates). REC (2016) estimated the stockpile of SPL to be around 700,000 tonnes, of which around 390,000 tonnes are in on-site landfills at aluminium smelters around Australia.

Under the best and low scenarios, the currently installed capacity is likely to be adequate. Under the high scenario, capacity would be exceeded, as not quite all of the stockpile would be processed in 10 years. This is consistent with the REC (2016) finding that capacity is available to treat Australian SPL stockpiles over around a 10-year period, whilst treating current arisings. REC (2016) also notes that the treatment of SPL that has been landfilled has not yet been demonstrated and may require additional or different infrastructure installation.

The uncertainty of the SPL assessment is low, due mainly to the recent and detailed study (REC 2016) of SPL processing capacity, generation and stockpiles in Australia providing the necessary data.

Recommendation 6: Qld, NSW, Vic and Tas governments and DoEE should continue to actively engage with aluminium smelting companies regarding current SPL stockpiles to ensure that stockpiles continue to be drawn down each year until they are removed.

Hazardous waste energy recovery facilities

At a national level, the assessment indicates that capacity has increased significantly since the 2015 assessment, due to the inclusion of cement kilns within the project scope and the allocation of these energy recovery tonnages to this group. The estimated arisings for this infrastructure group (2 kt) are incorrect. Industry reported **CIC** of waste currently received. The reasons for this are:

1. Some of the 26 kt of solvents/paints recycling tonnages may actually be sent to energy recovery infrastructure. Currently, the jurisdictional waste tracking systems do not support the separate reporting of tonnages sent to recycling vs energy recovery, which limits the ability to assess energy recovery infrastructure need.
2. Some of the waste that is sent for energy recovery does not require tracking in some jurisdictions, for example waste oil in NSW and EOLT in NSW, SA and Vic.

Currently Australia's energy recovery from hazardous waste relies upon cement kilns as the offtake market. Whilst current installed capacity exceeds the **CIC** estimated as received, this does not allow

for significant increases without either amendment to cement kiln licences (if technically feasible) or the development of additional energy recovery infrastructure apart from cement kilns.

Chemical and physical treatment (CPT) plant facilities

CPT plants are the archetypal hazardous waste facility, treating a range of waste types using a range of processes. Many of these operations are currently suffering from falling demand as manufacturing activity declines. Across the country, industry reported falling amounts of hazardous manufacturing waste sent for treatment. In some instances, sharp declines were reported. This issue was reported in 2015 and remains current for this 2018 assessment. Our analysis, based on waste tracking data, estimated tonnages of waste sent to CPT of 700 kt in 2015 to just 400 kt in 2018, a fall of around 43% over three years.

This project is focused on identifying where Australia's hazardous waste industry may become constrained over the next 20 years. CPT operators flagged that undersupply of waste could cause infrastructure shortages due to closure of key infrastructure that may no longer be viable as demand falls for processing of key high-volume waste.

However, the overall tonnages of hazardous waste are projected to increase from around 6 Mt currently to almost 10 Mt in 2038, so while tonnages of some waste are declining and projected to continue doing so, other hazardous waste types are projected to increase significantly. The challenge for industry and government is to plan for and implement infrastructure changes that can manage the rapidly changing composition and generating sectors/ locations of hazardous waste.

At a national level, based on the best, high and low projections of arisings, CPT infrastructure is estimated to be able to meet national demand over the next 20 years. For all three scenarios, the projections are based on varying degrees of decline in some waste groups, such as B Acids and E Reactive chemicals, and growth in other waste groups, such as D300 Non-toxic salts and C Alkalis that are projected to increase driven by oil and gas, particularly coal seam gas (CSG), industry developments.

CPT current installed capacity is projected to be sufficient under all scenarios for NSW, Qld, SA, Vic and WA. ACT, NT and Tas have no local CPT capacity. Tas in particular appears to have a shortage of CPT capacity with no CPT capacity identified and estimated arisings of 16 kt.

Recommendation 7: DoEE and/or NSW and Qld EPAs should consult with the CSG industry to develop a strategic plan for managing its waste, in particular waste in remote areas. This recommendation was made in 2015 and remains current.

Recommendation 8: DoEE and/or Tas EPA should further investigate the supply of CPT capacity for hazardous waste in Tas. This recommendation was made in 2015 and remains current.

Clinical waste treatment facilities

In the best estimate, clinical waste quantities will grow at the projected 20-year average annual growth rate of population growth (1.4% pa). At this rate, the installed capacity of clinical waste treatment could be exceeded by 2024. Based on the high projection, with growth of 2.0 to 2.1% growth based on Thornton (2014), national capacity could be exceeded in 2022. Under the low scenario where the waste arisings trend is flat, capacity is projected to meet demand over the next 20 years.

The infrastructure needs vs capacity assessment for this group has high uncertainty due to a poor response rate from industry. Despite this uncertainty, the assessment indicates that Australia's

clinical waste treatment capacity will soon become constrained and investment in additional infrastructure may be required.

NT, SA, Tas and WA all appear to have sufficient clinical waste treatment capacity. ACT, NSW, Qld, and Vic all appear to have insufficient local supply of clinical waste treatment capacity and are likely to be exporting significant quantities interstate. Based on the national assessment, interstate capacity will soon become constrained.

Recommendation 9: ACT, NSW, Qld, and Vic governments should consider completing feasibility studies to determine the viability of establishing clinical waste recycling capacity in their jurisdiction.

Bioremediation facilities

There is limited coverage of the capacity of this infrastructure group. Composting facilities are excluded from the database. This group is intended to refer to facilities that treat hazardous waste through biodegradation. Many commercial composting facilities are licenced to receive low level hazardous waste which is effectively bioremediated in the composting process and these facilities are not within the project scope.

Some 200 kt of hazardous waste were reported in tracking data as bioremediated. Most, if not all, of this material would be processed by commercial composting facilities licenced to take a range of low hazard organic waste such as grease trap. These composting facilities are not included in this database. Whilst it is worth maintaining transparency on the amount of hazardous waste being reported as bioremediated by the composting industry, it is beyond the project scope to assess the capacity of bioremediation capacity in Australia.

Recommendation 10: State regulators that are operating waste tracking systems complete ongoing auditing of waste treated through bioremediation to ensure that only appropriate hazardous waste is sent to composting operations. This may already be occurring.

Oily water treatment (OWT) facilities

This is a new infrastructure group for the 2018 assessment. Under the best estimate projection capacity would be exceeded in 2025, or as soon as 2019 under the high scenario estimate. Under the low projection, estimated capacity is not expected to be exceeded over the 20-year projection period. The reported 2016-17 arisings of 187 kt are more than the estimated receipts of around 150 kt which may be due to a lack of response from industry and the need to use averages for around a third of sites, or it could be due to the database not including all sites from this diffuse infrastructure group.

The uncertainty of the needs vs capacity assessment is very high due to the capacity assessment relying on average installed capacity for around a third of the sites and the high risk that small OWT plants are not included in the database.

Noting the above, the assessment indicates that capacity for OWT in Australia could become constrained over the next 10 years and some additional capacity may be required.

The jurisdictional assessment indicates that all jurisdictions, apart from Qld, Tas and Vic, lack OWT capacity. However, OWT facilities are typically relatively simple operations that could be established quickly and in response to market demand, and is an infrastructure group that should not require government involvement.

Contaminated soils treatment facilities

At a national level, under the best estimate projection, arisings would not exceed installed capacity over the next 20 years, but would do so under the high scenario. Under the low scenario, capacity would not be exceeded over the projection period.

Significant additional soil treatment capacity is under construction/commissioning in Vic that will add around 300 kt of additional installed capacity and provide sufficient capacity for the long-term for Vic. The significant Vic treatment capacity may also be utilised to treat soil from interstate, with appropriate approvals in place.

The uncertainty of the needs vs capacity assessment is moderate due to the highly fluctuating generation rates of contaminated soil and the difficulty that contaminated soil facilities face in securing the contaminated soil for treatment. Industry report onsite management, contamination dilution with clean soil and landfill disposal as serious threats to their investments, which reduces the certainty in infrastructure capacity investment. Importantly, these estimates assume no change to the current fate patterns of contaminated soil, which, based on the national average, is estimated to be 87% to landfill. If the treatment proportions are higher in other jurisdictions, the above assessment of no national capacity constraints would be affected.

Noting the above, the assessment indicates that there may be a need for additional soil treatment capacity in Australia if contaminated soil generation rates are high, except for Vic which has significant capacity coming online.

Installed capacity is concentrated in Vic, with some capacity also in NSW, Tas and WA. A shortfall in current capacity is apparent in NT, Qld, and SA. Contaminated soil in these jurisdictions is likely disposed to landfill.

Recommendation 11: NT, Qld, and SA governments should consider completing feasibility studies to determine the viability of establishing contaminated soil treatment capacity in their jurisdiction.

Hazardous waste landfill facilities

At a national level, for all three scenarios, the current 2016-17 arisings exceed the current installed annual capacity. The modelling assessment for this infrastructure group is incorrect. The response rate from site operators was only 50%, meaning infrastructure group averages were used, and generally the responses provided data only on waste currently received with little information on the installed capacity (i.e. how much waste the landfill can receive annually). This is understandable as, unlike other infrastructure types, landfills are usually able to cater to varying capacity demands (within reason) and a site's installed annual capacity can be difficult to define.

Perhaps more important than the above analysis are industry comments regarding the expected life (i.e. amount of airspace remaining and the number of years of operation before this capacity is consumed) of the seven landfill sites included in this infrastructure group.⁷ Landfill operators were asked how much waste could be received at the site before the site's airspace was consumed. Where the operator responded, they all responded with an estimate of the expected year of closure or simply stated that the site had more than 20 years capacity remaining.

⁷ The Mount Walton Intractable Waste facility in WA is included in the seven hazardous waste landfills. It has historically only operated on a campaign basis and Tellus Holdings are building a long-term isolation facility five km from site. The future operation of the Mount Walton Intractable waste facility is assumed unlikely following establishment of the Tellus Holdings site next-door.

Text withheld to maintain commercial confidentiality. No other sites surveyed in this category responded with a definitive response of planned closure within the new 20 years. Apart from Suez Elizabeth Drive, responses were generally vague on the expected closure year and it is recommended that more detailed investigation of the likely closure date of the landfills in this category be completed. Given the small number of sites and the extreme difficulty some jurisdictions have experienced in establishing new hazardous waste landfills, it is important to better understand the risk profile of each site in terms of its likelihood of closure due to: a lack of airspace, regulatory non-compliance, community concern and sudden airspace consumption due to extreme weather events such as cyclone or fire.

Recommendation 12: DoEE should work with the jurisdictions to complete a detailed assessment of the likely closure year of the identified hazardous waste landfill facility infrastructure including a risk assessment of site capacity being impacted by issues such as extreme weather events. **Text withheld to maintain commercial confidentiality**

Landfill facilities (NEPM code N, T)

This infrastructure group is not in the scope of hazardous waste database. As discussed in Section 3.2, a significant number of landfills are licensed to take hazardous waste NEPM codes N and T only (asbestos, EOLT, low level contaminated soil) and these facilities are not included in the infrastructure database. This is reflected in the almost 3 Mt of hazardous and controlled waste estimated to be sent to this infrastructure group, by far the largest portion of hazardous waste (almost half of the estimated 6 Mt of arisings). Based on industry consultation and our assessment of landfill infrastructure for NEPM codes N and T only, we do not believe there is likely to be a national shortage of this infrastructure group over the next 20 years.

Landfills for asbestos disposal

Unlike most waste, it is commonly accepted that the most appropriate fate for asbestos waste is landfill, where it can be safely removed from the environment for the long term. Across Australia, state and local governments are working towards a gradual rationalisation in the number of landfills in order to minimise the environmental and human health risks that landfills can create. As small regional landfills close, they are often replaced with transfer stations that consolidate waste and enable higher rates of resource recovery, reduce long term liabilities and risks, and transport bulk waste loads to a regional landfill. However, few transfer stations in Australia accept asbestos. This creates a potentially serious problem of lack of local access to disposal options for waste asbestos. Consultation suggests this is a current issue and it is likely to worsen.

POP thermal destruction facilities

At a national level, under all scenarios the current and expected future POP capacity would be greatly exceeded in 2020 when, under the best estimate scenario, arisings are projected to increase to over 400 kt and increase to 450 kt by 2037. The major increases in arisings in 2020 are mostly PFAS contaminated waste (soils, AFFF, biosolids) in 2020 and greater quantities of POP-BDEs and HBCD waste starting in 2023. Whilst this identifies a major gap in Australia's dedicated POP thermal destruction capacity, the capacity assessment uncertainty for this group is very high. POP destruction capacity could turn out to be adequate due to:

1. POP thermal destruction capacity within soils treatment facilities. By 2020, as noted above, Australia should have soil treatment facilities, that are able to receive POP, with a total installed capacity of over 300 kt. The capacity of these facilities to receive POP is not yet clear and for this assessment a conservative estimate is made of less than **CIC** of POP waste capacity within these facilities. It is possible that PFAS contaminated waste (soil and biosolids in particular) may be treated by these facilities in much larger tonnages sufficient to manage the projected arisings.

2. POP thermal destruction capacity within cement kilns. Cement kilns in Australia are currently destroying some POP including PFOS. The capacity of Australia's cement kilns to destroy POP is estimated to be **CIC**. The capacity of cement kilns to destroy additional POP tonnages is unknown and there may be additional capacity if the appropriate testing and license approvals were successfully completed.
3. POP thermal destruction capacity within clinical waste thermal destruction (TD) facilities. Daniels (Toxfree) Laverton facility is licenced to process highly contaminated PCB waste. Daniels (Toxfree) did not state the potential tonnages of POP that could be destroyed at the facility.

It may be the case that the current and planned suite of infrastructure that is able to destroy POPs can manage the projected tonnages of POP waste. This will depend on the ability of the soil treatment, cement kilns and clinical waste destruction facilities' ability to demonstrate the destruction of POP at the currently licensed limits. Future increases in POP waste may be able to be managed in the current infrastructure subject to demonstration of POP destruction and the approval of large increases in licensed capacities for POP waste.

Recommendation 13: DoEE should work with jurisdictions and industry to agree an approach to determine the upper limit for tonnages/concentrations that can be received at the high temperature thermal soil treatment facilities, cement kilns and clinical waste thermal destruction units that will ensure thermal destruction of the PFAS, POP-BDE, HBCD and HCB wastes. This information is required to better understand how much additional dedicated POP thermal destruction capacity (from technologies such as plasma arc) may be required in future.

Thermal destruction of PFAS in contaminated water

Industry commented that it urgently needs further direction from regulators regarding the process requirements and contaminant thresholds for PFAS-impacted water clean-up. There is inconsistency between the jurisdictions and reliance on existing guidelines that do not specify PFAS limits.

Recommendation 14: The process requirements and contaminant thresholds that need to be met for PFAS-impacted water clean-up should be defined. DoEE may be best placed to lead the development of a recommended process and threshold that the jurisdictions could choose to adopt. This work may already be underway.

PFAS-contaminated groundwater is being cleaned up using activated carbon filtration processes to remove PFAS. Once the filtration media's capacity to adsorb PFAS is exhausted, the contaminated material needs to be renewed. Industry commented that in Qld this material is able to be sent to landfill whereas in other jurisdictions the PFAS-contaminated material must be thermally treated to destroy PFAS. If PFAS-contaminated filtration media is being sent to landfill, rather than being thermally destroyed, it would seem to defeat the efforts in removing PFAS from the groundwater in the first place (i.e. in landfill PFAS will presumably make its way back to the environment).

Recommendation 15: The management requirements of PFAS-contaminated filter media should be reviewed to ensure a nationally consistent approach.

Clinical waste thermal destruction facilities

At a national level, based on the best, high and low projections of arisings, clinical waste thermal destruction infrastructure is estimated to meet national demand over the next 20 years.

The estimated 2016-17 arisings of 21 kt aligns with the 20 kt of waste received as reported by industry. With a currently capacity of 33 kt/yr and an expected increase of 3 kt, there appears to be sufficient clinical waste thermal destruction capacity in Australia.

The spare capacity of this infrastructure group has the potential to be impacted by the demand for POP thermal destruction where the site currently has or gains a licence for POP destruction.

There is also reasonable national coverage with facilities in all jurisdictions apart from ACT, NT and Tas. The NT is serviced by a clinical waste treatment facility (autoclave). Tas has no clinical waste facilities (treatment or thermal destruction) in the 2018 database, which indicates a gap in capacity in Tas.

Recommendation 16: DoEE and/or Tas EPA should further investigate the need for clinical waste treatment or thermal destruction facilities in Tas.

Transfer station or temporary storage facilities

Projections indicate that under all scenarios the current national transfer/temporary storage capacity of hazardous waste infrastructure is exceeded. These projections are not accurate due mainly to the capacity database having limited coverage of this group. Whilst some transfer facilities are included in this dataset, it is recognised that there are other facilities which deal with hazardous waste that are not included in the dataset, such as smaller storage facilities and transfer stations.

Transfer capacity estimates are also incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increasing the rate of load transfers).

The project team surveyed industry asking respondents to flag any major transport constraints. Very long transport distances particularly in WA were raised several times as a major barrier to treating/recovering hazardous waste. WA has four of the 19 transfer station facilities in the 2018 database. For such a large state this appears low. If not already being undertaken, further investigation of strategic locations for transfer station facilities in WA is recommended. Consultation with industry on establishing joint venture transfer stations to consolidate waste from a range of waste companies and generators should be explored for WA and potentially Qld (to reduce costs of transporting coal-seam gas waste).

Recommendation 17: DoEE and/or WA and Qld governments should complete a detailed assessment and consultation with industry regarding the need for and (where required) best location(s) for additional hazardous waste transfer station/temporary storage infrastructure. This recommendation was made in 2015 and remains current.

Long-term isolation facilities

Two long-term isolation facilities are currently under development and aim to be operational in around five years' time. Assuming that both become operational, they would provide capacity for up to **CIC** for highly intractable waste that lacks viable treatment or destruction options. This would provide good mitigation for the risks associated with having only six (operational) hazardous waste landfills in Australia, with the main NSW site due to close in **CIC**.

CSG reverse osmosis brine wastes and long-term isolation capacity: under the high projection scenario, it is assumed that, after five years new arisings of CSG reverse osmosis brine wastes will be required to be managed offsite and would be sent to long-term isolation facilities (rather than being stored onsite). Historical stockpiles are assumed to remain onsite.

This results in a very large increase, 2.5 Mt/yr, in 2023 increasing to 3.2 Mt/yr by 2037 that is projected to need long-term isolation facility capacity. This presents a shortfall of **CIC** Mt of capacity in 2023, even when the currently planned facilities are built and operating at capacity.

Recommendation 18: DoEE should work with state and territory governments to assess the appropriate management of CSG RO brine wastes and determine the likelihood that offsite disposal requirements will be needed in future.

Uncertainty in assessing need vs capacity

Future scenarios are inherently uncertain. The arisings of hazardous waste are influenced by industrial markets, development activities, social licences, government regulations and technological innovations that are all unpredictable. The infrastructure servicing this waste is changeable and difficult to characterise, and information on its activities is limited and hard to obtain. The language of the jurisdictional data (e.g. NEPM codes) differs from that of the industry, creating problems and uncertainties in matching the two. As a result of these uncertainties, the key conclusions of this analysis should be taken as indicative.

Since the 2015 assessment, significant work has been undertaken by DoEE and the jurisdictions to better understand, document and rationalise hazardous waste tracking systems and the recording of hazardous waste arisings and management methods. However, there are still challenges in compiling the data required to complete this assessment. For example, it is still not possible to determine from the tracking system data the tonnages of hazardous waste sent to energy recovery (it is hidden in the recycling tonnages).

Recommendation 19: DoEE and the jurisdictions should continue to improve the consistency and completeness of tracking system data and work towards systems that enable reporting of energy recovery separately from recycling.

1. Introduction

1.1 Project origins and scope

The Australian Government Department of the Environment and Energy (DoEE) is responsible for administering the *Hazardous Waste (Regulation of Exports and Imports) Act 1989* (the Act), which implements Australia's international agreements on managing hazardous waste including the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* (the Basel Convention).

DoEE is also the lead agency responsible for the implementation of the current *National Waste Policy: Less Waste, More Resources*. The policy contains a commitment to assess Australia's current and future hazardous waste infrastructure capacity and needs. This is intended to provide guidance to regulators and industry on where additional investment may be needed.

In 2014, DoEE commissioned the first such assessment. The results, published in 2015, were well received by industry and government stakeholders and seen as valuable for planning Australia's current and future hazardous waste infrastructure needs.

In 2017, DoEE commissioned Blue Environment (lead consultant), Ascend Waste and Environment and Randell Environmental Consulting (the same consortium that undertook the 2015 assessment) to review and update of the 2015 assessment. This revised assessment is reported here.

The revised assessment has the same three parts as the 2015 assessment:

1. prepare projections of hazardous waste arisings and fates⁸ over the coming 20 years
2. consult with industry to estimate Australia's current hazardous waste infrastructure capacity, its distribution and expected future
3. identify the extent to which current infrastructure meets future needs, considering the nature and locations of particular infrastructure.

The revised assessment also contains important expansions of the scope of the infrastructure assessment, including an analysis of cement kiln infrastructure capacity to receive hazardous wastes.

1.2 Project context and key definitions

1.2.1 Hazardous waste

Waste that, by its characteristics, poses a threat or risk to public health, safety or to the environment⁹. In national reporting this term is taken to correspond with:

- wastes that cannot be imported or exported from Australia without a permit under the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*
- wastes that any jurisdiction regulates as requiring particularly high levels of management and control, namely: regulated waste (Queensland); trackable waste (New South Wales); prescribed waste (Victoria); listed waste (South Australia and NT); or controlled waste (ACT, Tasmania and Western Australia)

⁸ For a discussion on these terms, see Section 1.2.

⁹ From AS/NZS 3831:1998 *Waste Management – Glossary of Terms*.

- additional wastes nominated as hazardous by the Australian Government¹⁰.

In addition, waste that has hazardous characteristics and has been stored on a site for more than one year should be considered hazardous waste.

NSW (along with the ACT¹¹, due to their adoption of NSW classification procedures) uses the term 'hazardous waste' in a specific regulatory sense. The NSW *Protection of the Environment Operations (Waste) Regulation 2005* and associated guidance defines 'hazardous waste' as one of six classes of waste – and it typically cannot be disposed at landfill without hazard reduction treatment such as immobilisation. 'Hazardous waste' in this strict NSW (ACT) regulatory interpretation is equivalent only to those *hazardous wastes* (in national reporting terminology) that would be categorised at the higher hazard end of the range.

1.2.2 Regulating and tracking hazardous waste in Australia

Whereas the Australian Government has responsibilities in relation to hazardous waste under the Act and the National Waste Policy, regulation of hazardous waste management is the responsibility of the states and territories. In order to ensure appropriate management of this waste, the five largest jurisdictions (NSW, Qld, SA, Vic and WA) operate systems for 'cradle to grave' tracking of the movement of each consignment of hazardous waste from point of generation to treatment or disposal. Tracking certificates include the type and quantity of waste, the dates, and the producer, transporter and details of the receiving facility. A copy is sent to the relevant environmental authority. The jurisdictions agreed to allow the use of the large data sets generated by their tracking systems in this study, under confidentiality agreements.

There is some variation in the waste that is regulated and tracked as hazardous waste between the jurisdictions. Refer to Appendix A for analysis of waste that is tracked/not tracked in NSW, Qld, SA, Vic and WA tracking systems.

1.2.3 The meaning of waste arisings

In this project, hazardous waste is said to arise when it is delivered to processing, storage, treatment or disposal infrastructure. This is distinct from 'waste generation', a term commonly used in waste reporting, in that if waste is transported to more than one site it may 'arise' more than once. The projections developed in this report are of waste arising, which is consistent with data from the jurisdictional tracking systems. It should be noted that until a waste is moved off-site, it does not arise. Waste that is created on a site and remains stored there has not arisen.

1.2.4 The potential for new hazardous wastes

An important aspect of the context for this project is the potential for new hazardous waste streams to arise. Australia is a party to the Stockholm Convention on persistent organic pollutants (POP), which aims to protect human health and the environment from the effects of these chemicals. Australia is in the process of deciding whether to ratify the chemicals added since 2009. Should it decide to do so, significant quantities of additional waste, such as POP-contaminated biosolids, might need to be managed as hazardous, some of which are not currently managed in this way. This could have major implications for the demand for hazardous waste infrastructure. The new Stockholm hazardous wastes that this project provides analysis of include:

¹⁰ For example, the Australian Government has considered waste lithium ion batteries as hazardous in assessing the adequacy of hazardous waste infrastructure. Lithium ion batteries are regulated as hazardous waste for the purposes of international movement, but not at the moment for domestic movement

¹¹ Environment ACT (2000) *ACT Environmental Standards: Assessment and Classification of Liquid & Non-liquid Wastes*, June, available from: http://www.environment.act.gov.au/_data/assets/pdf_file/0005/585500/wastestandards.pdf

- polybrominated diphenyl ethers (POP-BDE)
- hexabromocyclododecane (HBCD)
- per- and poly-fluoroalkyl substances, including PFOS

Apart from new Stockholm wastes this project also analysed potential arisings of lithium ion batteries which are not currently regulated as hazardous waste¹². Although lithium ion batteries are not regulated as hazardous waste, they are assessed in this report because of their potential to have a significant impact on hazardous waste infrastructure. Lithium ion battery use has been increasing strongly and, if not appropriately managed, represents a safety hazard due to risks of causing explosions or fire (ABRI 2014).

1.2.5 The NEPM and its waste classification systems

Hazardous waste produced in a particular jurisdiction may move to another for storage, treatment or disposal. The *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998* (NEPM) was established to ensure that hazardous waste transported between jurisdictions is properly identified, transported and otherwise handled. Among other things, the NEPM established a coding system to be used for this waste. Many of the jurisdictions' own waste classification systems have been subsequently updated to fully or mostly mirror the NEPM list. The NEPM classification system has two levels:

- the 'NEPM 75' list contained in Schedule A, List 1 of the NEPM
- the 'NEPM 15' list, which aggregates the NEPM 75 and is used for reporting purposes.

The NEPM 15 and 75 lists provide the foundation for the waste groups used in this project (see Section 2.2).

1.2.6 Grouping of waste and infrastructure applied in this project

To assess infrastructure need and capacity, grouping of both waste and infrastructure types was needed. Pre-existing classification systems provided a basis for this, but did not fully cover the project needs.

The project team defined 33 'waste groups' that are mostly consistent with the 'NEPM 15' list, but with some categories disaggregated where a component waste was of particular interest to DoEE. In developing the waste groups for analysis in the project, DoEE provided direction on the waste that was of particular interest, typically due to large or highly uncertain arisings or particular management requirements. The wastes of particular interest and the waste groups containing them are summarised in Table 1.

Similarly, infrastructure was allocated into one of 23 'infrastructure groups' based on the main wastes received and the primary function¹³. Infrastructure group examples include 'oil re-refining', 'POP thermal destruction', 'clinical waste treatment' and 'clinical waste thermal destruction'. See Table 43 for a description of the infrastructure groups.

¹² Waste lithium ion batteries are regulated as hazardous waste for international transport, but currently not for domestic transport

¹³ The 'primary function' of the infrastructure refers to the waste management that the infrastructure provides (e.g. recycling, treatment, disposal).

1.2.7 Limitations and uncertainty

This assessment of projected hazardous waste infrastructure need vs capacity is affected by the limitations and levels of uncertainty in relation to:

1. the projected arisings of hazardous waste
2. the apportioning of projected waste across the different type of infrastructure
3. the assessment of the current hazardous waste infrastructure capacity.

The limitations and uncertainty of the assessment of projected need vs capacity included in this report need to be carefully considered. See Section 4.2 for detailed analysis of uncertainty.

1.2.8 Confidentiality

The tracking system data used in this project for developing waste projections is submitted to the jurisdictions under legal commitments to protect commercial confidentiality. The jurisdictions, in turn, agreed to provide tracking system data for this project under agreements that required the project team to maintain commercial confidences. Tracking system data was analysed to examine tonnages of waste arisings by waste code, year, jurisdiction, source and fate. The risk is that some of this information could be used by companies to work out the scale of rival's operations.

The project team examined jurisdictional data by waste code to assess the extent to which waste was produced by small numbers of companies. We also reviewed the information that was already publicly available, particularly annual Basel report data. We determined that data for only one waste group – tannery & wool scouring waste – presented a confidentiality risk. Tonnage data for this group is not presented. The names of companies named on transport certificates are also avoided except where the information presented is widely known.

The information and data gathered during consultation with industry (to estimate infrastructure capacity) also contains confidential information. No company specific information from the consultation is presented in this report. Where a small number of industry providers service a part of the hazardous waste market, the capacity information has been flagged and replaced with the 'Text withheld to maintain commercial confidentiality' or simply **CIC**.

1.3 The structure of this document

Following this introduction, the report has four sections as follows:

- Section two describes the method and result of the projections of waste arisings and management
- Section three describes the consultation and estimation processes that led to the estimates of installed and expected capacity change infrastructure data, and displays these estimated capacities
- Section four compares the findings of the previous two sections.
- Section five draws conclusions from these findings.

1.4 Other project outputs

This report was submitted to DoEE together with two Microsoft Excel files:

- The *Hazwaste infrastructure database 2018* which details Australia's hazardous waste infrastructure capability and capacity data by site. The database has been built via an extensive

industry consultation program completed during the development of the 2015 and 2018 assessments.

- The *Hazardous waste needs vs capacity model* which projects Australia's future quantities of hazardous waste and compares these with the currently available management infrastructure in Australia in order to identify infrastructure development needs. The projections cover the period 2018 to 2037 under best estimate, high estimate and low estimate scenarios. This model also includes data on the historical arisings (trends) of hazardous waste arisings (see the Proj. methods tab).

The key outputs of these analyses are presented as tables and figures in this report.

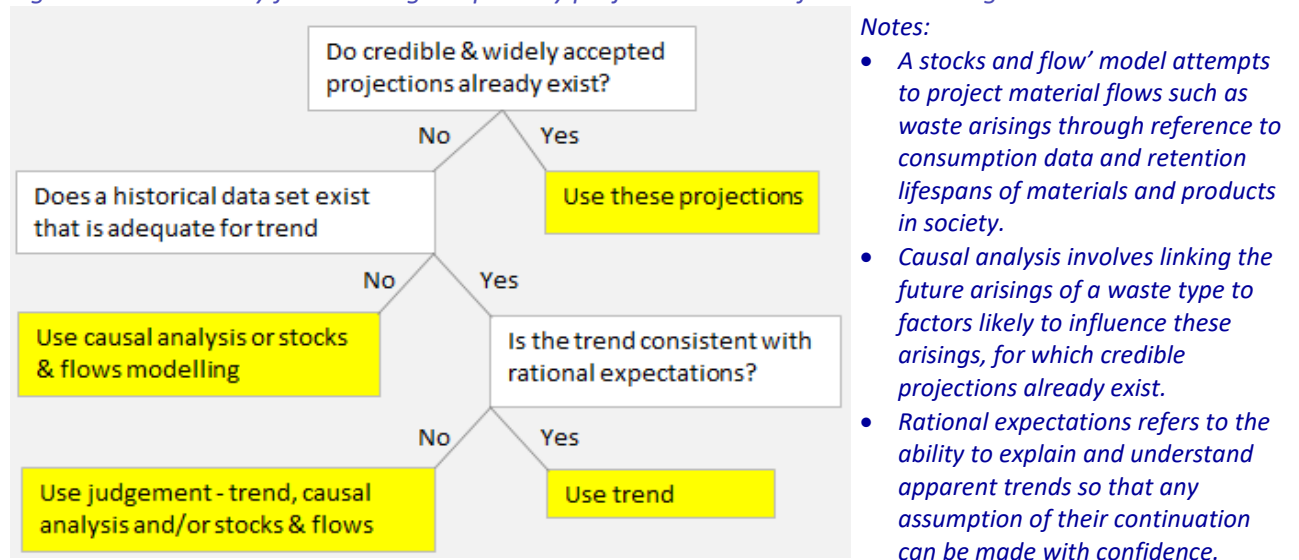
2. Projections of hazardous waste infrastructure needs

The project team developed projections of future arisings of hazardous waste that infrastructure will need to service. This section describes the methods for generating the projections and displays the results. It also presents information on the how waste is currently managed.

2.1 Overview of the approach to the projections

Wastes were classified for the purpose of the projections into ‘waste groups’ that closely correspond with the NEPM. A starting quantity of tonnes was established from which to project future quantities, typically based on 2016-17 data. An understanding of how these quantities may change over the required 20-year projection period was then developed, following the hierarchy of potential approaches illustrated in Figure 1.

Figure 1: Hierarchy for selecting the primary projection method for waste arising



2.2 Waste groups

Thirty-three waste groups were defined for use in the projections, an increase of four compared with the previous 2015 version of this report. The waste groups followed the NEPM 15 list (see Section 1.2) with some disaggregation where a component waste is of particular interest. Wastes were typically of particular interest where:

- the future quantities and available infrastructure are highly uncertain (e.g. the new Stockholm wastes POP-BDE, HBCD, HCB, PFOS contaminated materials, PFAS contaminated soil and AFFF concentrates)
- the waste has been stockpiled significantly in the past which could be due to a lack of infrastructure options, processing costs or other barriers
- there are very specific concerns relating to health or the environment (e.g. lead, mercury, asbestos)
- the waste is associated with a source industry with unusually strong growth projections (e.g. non-toxic salts, which are produced in large volumes by the coal seam gas industry)

- the waste is produced in particularly large quantities (e.g. grease trap waste, contaminated soil).

The thirty-three waste groups used in the projections are set out in Table 1. Appendix B details how each of the relevant NEPM 75 codes fall under the waste groups.

Table 1: Waste groups and components of particular interest

	Waste group	Closest NEPM category	The aspect(s) of particular interest
1	Plating & heat treatment	A	
2	Acids	B	
3	Alkalis	C	
4	Inorganic fluorine (SPL) ¹	D110	Significant stockpiles in Australia
5	Mercury & compounds	D120	Mercury waste
6	Lead & compounds	D220	Lead waste and waste lead acid batteries
7	Zinc compounds ¹	D230	Large tonnages produced. Almost entirely a lead-rich zinc waste that is generated by Nyrstar in Hobart and transported to Nyrstar in Port Pirie.
8	Non-toxic salts	D300	Coal seam gas waste
9	Other inorganic chemicals	Other D	SPL waste from aluminium industry
10	Reactive chemicals	E	
11	Paints, resins, inks, organic sludges	F	
12	Organic solvents	G	
13	Pesticides	H	
14	Oils	J100 & 160	Waste is produced in particularly large quantities
15	Waste oil/water mixtures ¹	J120	Waste is produced in particularly large quantities
16	Grease trap waste	K110	Large tonnage low hazard organic waste
17	Other putrescible/organic waste ²	Other K	
18	PCB ¹	M100	
19	POP-BDEs and HBCD ²	M160a & b	Polybrominated diphenyl ether (PBDE) and hexabromocyclododecane (HBCD), including biosolids contaminated with these substances
20	HCB	M160c	Orica stockpile of hexachlorobenzene
21	PFOS contaminated biosolids	M270a	Biosolids contaminated with perfluorooctane sulfonate, future quantities and available infrastructure are highly uncertain

	Waste group	Closest NEPM category	The aspect(s) of particular interest
22	PFAS contaminated soils ¹	M270b	Soils containing per- and poly-fluoroalkyl substances from use of firefighting foams
23	AFFF concentrates ¹	M270c	Aqueous film forming foams (used for fire-fighting) containing PFAS
24	Other organic chemicals	Other M	
25	Contaminated soils	N120	Contaminated soils
26	Other contaminated biosolids	N205a	Biosolids contaminated with inorganics
27	Other industrial treatment residues	N205b	
28	Asbestos	N220	Waste asbestos
29	Other soil/sludges	Other N	
30	Clinical & pharmaceutical	R	
31	Tyres	T140	End-of-life tyres
32	Other miscellaneous	Other T	
33	Lithium ion batteries	-	Waste lithium ion batteries

Notes on changes in the waste groups compared with the previous 2015 version of this report:

- 1 Previously formed part of a broader waste group.*
- 2 Combines wastes that previously formed a distinct waste group.*

Three waste groups were added that did not have an obvious allocation under the NEPM 15 groups:

- Food processing wastes were included because they are regulated as hazardous in some states. These were included in Other K.
- Other contaminated biosolids: Biosolids are the solid residues of sewage treatment, and are not regulated as hazardous in jurisdictional tracking systems. However, it is widely accepted that some biosolids are contaminated with heavy metals, particularly those generated in treatment plants servicing industrial areas. Contaminated soils or industrial treatment residues are regulated as hazardous, so contaminated biosolids that are understood to have a similar contaminant profile are also included as a subsection of *N205 Industrial treatment residues* (N205a Other contaminated biosolids). These are referred to here as 'other' to distinguish them from M270a PFOS contaminated biosolids. See Section 2.6 for further discussion regarding the formation of this waste group.
- Lithium ion batteries are currently not regulated as hazardous waste¹⁴. They are assessed in this report because of their potential to have a significant impact on hazardous waste infrastructure. Lithium ion battery use has been increasing strongly. If not appropriately managed, this waste represents a safety hazard due to risks of causing explosions or fire (ABRI 2014, CSIRO 2018).

¹⁴ Waste lithium ion batteries are regulated as hazardous waste for international transport, but currently not for domestic transport

2.3 Data inputs to the projections

2.3.1 Overview of data sources

The data and information sources underpinning the projections are summarised in Table 2. A list of the literature and on-line materials examined is included in the bibliography. The most important data source for this part of the project – state and territory waste data – is displayed in bold italics.

Table 2: Information and data underpinning the projections and how it was used

Information or data	Method for obtaining the info or data	Contribution to the projections
<i>State and territory waste tracking and other data</i> (see Section 2.3.2)	<i>Provided by the jurisdictions</i>	<i>Establishment of starting points</i> <i>Understanding of industry sources and management</i> <i>Understanding of trends</i>
Pre-existing waste projections (see Section 2.3.3)	Desktop research and discussions	Considered or directly reused in building the projections
Planned or recent policies or developments		Potential impacts on future hazardous waste arisings
Waste industry and regulator views and information	Consultation	Causal factors and trends
Projected long-term growth in national population & economic activity	Desktop research	Causal factors for waste arisings
Industry activity, trends, analyses and activity or employment projections (see Section 2.3.4)		
Current stores of hazardous waste that may require management	Other departmental studies	

2.3.2 State and territory data

Data from jurisdictional tracking systems was foundational in establishing starting points for each waste group and in providing an understanding of trends. Waste tracking systems in NSW, Qld, SA, Vic and WA require companies generating, transporting and treating or disposing of hazardous waste to provide a record to EPAs of each transaction to which they are a party. These systems were established to ensure that hazardous waste is appropriately managed.

‘Data dumps’ from these systems encompassing several million transactions over several years was collected, collated and analysed. Qld data was available until 2015-16 only – this was extrapolated to 2016-17 assuming increases proportional to population growth. Various other adjustments were made where the data was known to be incomplete – these will be documented in the forthcoming report *Hazardous Waste in Australia 2019*. In general, tracking system data suffers from various data quality flaws. Data on source sectors, in particular, is poorly recorded in jurisdictional data sets.

The tracking system was supplemented by collated data from the other states and territories, primarily from interstate transport (i.e. NEPM reports, see Section 1.2). Additional data from landfill reports was provided in some cases where a hazardous waste is not tracked, as shown in the table.

Table 3: Metadata for the state and territory hazardous waste data received

Jurisdiction	Date range	Waste type	Quantity	Source industry	Fate	Jurisdiction of generation apparent?	Comments
ACT	2017	✓	✓			✓	Data collated by waste type. Asbestos data from landfill reports.
NSW	2010-2017	✓	✓	✓	✓	✓	Full data dump. Asbestos, waste tyres & contaminated soil data from WasteLocate.
NT	2017	✓	✓			✓	Data collated by waste type
Qld	1999-2016	✓	✓	✓	✓	✓	Full data dump. Contaminated soil data from landfill reports.
SA	2006-2017	✓	✓	✓	✓	✓	Full data dump
Tas	2017	✓	✓			✓	Data collated by waste type
Vic	2004-2017	✓	✓		✓		Full data dump
WA	2006-2017	✓	✓		✓	✓	Full data dump. Asbestos from landfill reports.

As Table 3 shows, there was significant variability in the characteristics of the data received. A range of other challenges with the data set affected its quality and the ease of interpretation, as listed below:

- the methods used by jurisdictions to classify waste types vary
- some wastes are counted more than once in tracking system data
- the data includes potential ‘spikes’ due to periodic releases from storage
- there are definitional challenges such as whether to report on-site disposal
- data is received with varying measurement methods (mass, volume, numbers of items)
- states classify management types and source industries differently
- there are apparent differences in the way reporters classify similar wastes.

These challenges have been considered and responded to in previous DoEE projects. The [Australian Hazardous Waste Data and Reporting Standard](#) describes how they have been addressed.

Despite the challenges, the data provides a far-reaching insight into the trends in hazardous waste data arisings and the sources and management of the different waste types.

2.3.3 Pre-existing waste projections

Four useful pre-existing waste projections were identified. These are summarised in Table 4.

Table 4: Pre-existing waste projections used in building our projections

Information source	Relevant waste group	Use in projections?
BE (2016)	E-waste	Used as a proxy for POP-BDE waste (M160a), best, high and low estimates
REC (2017)	Tyres (T140)	Best estimate
REC 2018	Lithium ion batteries	Best, high and low estimates
Thornton (2014)	Clinical & pharmaceutical (R)	High estimate

2.3.4 Industry activity and employment projections and analyses

Information about particular industries was used to inform projections of some wastes that are strongly associated with particular industry types. These are summarised in Table 5.

Table 5: Industry activity projections and analyses and their use in the projections

Industry	Related wastes	Primary information source(s)
Manufacturing employment	Other inorganic chemicals, reactive chemicals, organic solvents	Department of Jobs and Small Business employment projections (Departmental website)
Mining production	Waste oil/water mixtures	Office of the Chief Economist (2018)
Oil and gas production	Mercury	Office of the Chief Economist (2018)
Meat production	Other organic/putrescible wastes	ABARES (2018)
CSG production	Alkalis, non-toxic salts	ACIL Tasman (2012), Australian Petroleum Production & Exploration Association, pers. comm. 2018
Aluminium smelting	SPL	Office of the Chief Economist (2017)
Nyrstar	Zinc	Nyrstar (2015)
Orica	HCB	Orica (2017)
Sewage treatment	Biosolids	PSD (2017)

2.4 Establishing the starting point

A starting point or baseline tonnage figure was established for each waste group in each state and territory based on the most recent data, as shown in Table 6. The most common data source was the jurisdictional data, but other sources were used in some cases as shown in the footnotes to Table 6.

Table 6: *Projection starting points for each waste group by jurisdiction (see Table 1 for full waste group descriptions)*

	ACT	NSW	NT	Qld	SA	Tas	Vic	WA
Plating & heat treatment	0	18	0	5,395	41	1	7	2,558
Acids	0	25,698	188	11,674	1,833	0	29,041	2,162
Alkalis	0	<u>5,833</u>	607	115,665	17,176	24	6,297	92,430
Inorganic fluorine	0	<u>13,019</u>	0	12,832	2	3,972	16,342	61
Mercury	2	178	19	170	60	0	99	206
Lead	0	69,613	0	20,239	55,964	40,333	8,936	1,180
Zinc	0	194	0	539	123,598	0	296	453
Non-toxic salts	0	26,132	300	19,551	556	2	1,723	14,035
Other inorg. chemicals	0	631	0	3,631	183	159	675	386
Reactive chemicals	0	81	0	53	15	7	72	48
Paints, resins etc.	20	12,716	229	15,056	5,645	12	29,290	10,000
Organic solvents	22	3,287	4	5,671	414	34	7,050	9,629
Pesticides	0	219	0	825	223	0	1,470	1,032
Oils	1,368	<u>182,497</u>	1,922	59,216	15,625	68	28,096	107,402
Oil/water mixtures	352	70,717	1,846	175,209	25,965	141	58,021	56,711
Grease trap waste	6,243	96,824	3,048	135,040	74,832	6,436	114,750	84,038
Other organic wastes	0	58,543	1,843	95,768	5,021	3,891	36,899	30,498
PCB wastes	9	1,803	0	2,282	54	1	1,456	39
POP BDEs and HBCD	0	0	0	0	0	0	0	0
HCB	0	0	0	0	0	0	0	0
PFOS contam. biosolids	0	0	0	0	0	0	0	0
PFAS contam. soils	0	0	0	0	0	0	0	0
AFFF concentrates	<u>2</u>	<u>37</u>	<u>1</u>	<u>25</u>	<u>8</u>	<u>2</u>	<u>30</u>	<u>14</u>
Other organic chemicals	5	9,227	13	8,291	652	2	764	1,133
Contaminated soils	23	348,377	8,646	567,533	227,638	6,660	452,153	5,043
Other contam. biosolids	0	311,429	31,143	342,571	124,571	31,143	482,714	140,143
Other ind. t'ment residues	5	14,550	0	84,467	26,160	0	25,799	11,394
Asbestos	5,856	675,398	5,913	148,030	11,770	15,228	118,626	39,000
Other soil/sludges	16	32,025	211	22,854	2,132	0	66,866	2,895
Clinical & pharmaceutical	206	12,768	198	19,883	9,264	30	16,326	2,763
Tyres	<u>7,244</u>	<u>136,509</u>	<u>4,507</u>	<u>88,605</u>	<u>30,553</u>	<u>9,200</u>	<u>107,635</u>	<u>49,664</u>
Other miscellaneous	49	4,219	116	1,970	522	26	1,396	310
Lithium ion batteries	65	<u>1,230</u>	<u>41</u>	<u>798</u>	<u>275</u>	<u>83</u>	<u>970</u>	<u>447</u>
Totals (tonnes x 1000)	95	2,197	42	1,796	650	204	1,208	669

Data from 2016-17 except Qld (extrapolated from 2015-16 assuming fixed generation per capita)

Code for data types:

- Normal font – 2016-17 tracking data (NSW, SA, Vic & WA data adjusted to remove multiple-counts)
- *Italics* – extrapolated from 2015-16 data (with adjustments to remove multiple-counts)
- Red font – not tracked; value assumed
- Underlined – estimated from industry data, national study or calculations
- Grey shading – adjusted to take into account unrepresentative flows in the starting point year
- Black shading – derived from other jurisdictions' data assuming identical arisings per capita.

The 2016-17 starting point for the projections summed to 6.0 Mt¹⁵.

¹⁵¹⁵ This differs from the tonnage reported in Australia's report to the Basel Convention because: the Basel report conservatively includes all biosolids; in this project some adjustments were made to make tonnages more representative (the grey shading in Table 6); and the Basel reports are by calendar year rather than financial year.

2.5 Scenarios for hazardous wastes arising

This section describes the projection scenarios and shows the collated national arisings projected under each scenario. The projections for individual waste groups are presented in Section 2.6.

There are significant uncertainties in projecting future waste arisings over a 20-year period, for example in relation to:

- factors that influence the quantities of hazardous waste generated, such as the scale of economic and population growth, the levels of activity of waste-producing industries in Australia, and whether they become more efficient in their waste generation
- the extent to which some waste will be classified as hazardous
- the extent to which current contaminated soil and waste stores will arise through release into the waste stream, whether through decisions by site owners or regulators.

Reflecting the uncertainty, projections were developed under best estimate, low estimate and high estimate scenarios. Each scenario encompasses a projection for each waste group, jurisdiction and year from 2017-18 to 2036-37. The scenarios were qualitatively defined as follows:

- best estimate – the most likely estimate of waste arisings
- high estimate – the highest, credible estimate of waste arisings
- low estimate – the lowest, credible estimate of waste arisings.

Several perspectives and considerations were applied in developing the scenarios, including, to the extent available: existing data and trends; industry sources; factors that may cause quantities to grow or diminish; and discussion with experts including those in the waste industry. The arithmetical approaches comprised one or more of the following:

- application of a percentage annual growth rate, which sometimes was projected to change over time
- addition of absolute tonnages, for example where a storage/stockpile of waste is envisaged to be released into the waste stream
- estimating a percentage margin on either side of a best estimate – for asbestos and contaminated soils, which vary unpredictably depending on particular projects and do not cumulatively increase or decrease like other waste groups.

There is pronounced uncertainty in projecting the quantities of some very large, or potentially very large, streams of hazardous waste. These include soil contaminated with PFAS and other contaminants, asbestos, PFOS contaminated biosolids and non-toxic salts from the coal seam gas industry. Because of this uncertainty, the projections span a large range – the overall tonnages projected under the high estimate in 2036-37 are about 2.8 times those in the low estimate.

2.5.1 Best estimate

The best estimate is the one considered most likely to occur. Each projection was based on different considerations but, in general, the best estimate is often linked to: projected growth rates of particular source industries; long-term projections of economic growth; apparent trends in the available data; or, in a few cases, population growth. Most waste groups are projected to grow (or occasionally shrink) at an exponential rate, adding (or losing) between 2.8% and -2% annually.

The combined best estimate for all waste groups is illustrated in Figure 2, see page 16. The quantity of hazardous waste rises from 6.1 Mt in 2016-17 to 8.9 Mt in 2036-37. This represents an average growth rate of 1.9% per year, larger than the projected average growth rate for population (1.4%), which is illustrated on the chart, but less than the long-term projected economic growth rate (2.8%).

The top six groups in terms of tonnes arising – in order, contaminated soil, asbestos, grease trap waste, PFAS contaminated soil, tyres and oils – represent about 70% of the total at both the start and end of the projection period. In some cases, the best estimate provides for some clearing of waste stockpiles and storages.

A few waste groups are projected to become much more significant at the end of the period than at the start. Waste lithium ion batteries are projected to grow at an average rate of 19% per year. Three other waste groups (POP-BDE and HBCD, PFOS contaminated biosolids and PFAS contaminated soil) are recorded at zero at the start of the period but reach tens or hundreds of thousands of tonnes at the end, following the assumed implementation of the *PFAS National Environmental Management Plan* and the ratification of additions to the Stockholm Convention.

All other waste streams are projected to grow at less than 3% per year on average. Five are projected to decline, three reducing by 1-2% per year on average (other inorganic chemicals, reactive chemicals, PCBs) and two disappearing entirely (HCB and AFFF concentrates).

2.5.2 High estimate

A highest credible estimate of waste arising was made for each waste group. The combined high estimate is illustrated in Figure 3, see page 17.

The high scenario is consistent with high economic and population growth and high rates of waste entering the waste management stream from storage. In many cases growth rates are assumed to equal projected economic growth; in others specific estimates were made based on industry growth rates or other factors. The major waste streams contaminated soils and asbestos are projected at the high end of a wide range, generating about 4.7 Mt/yr in 2036-37 rather than 3.4 Mt/yr under the best estimate. Lithium ion batteries are projected to become a major technology, producing a waste stream that grows from a current total of about 4,000 tonnes to 197,000 tonnes, an average growth rate of 22% per year.

Significantly, the high scenario assumed that in five years, non-toxic salts from coal seam gas operations are no longer allowed to be treated and disposed on-site but are taken to long-term isolation facilities offsite. These very large new arisings are estimated at 2.5 Mt in 2023 and 3.3 Mt/yr by 2036-37. See Section 4.3 for this discussion of these arisings versus infrastructure capacity.

The high scenario also assumes large-scale clearing of existing waste stockpiles and storages during the projection period, including:

- inorganic fluorine (SPL in NSW, Qld, Tas and Vic)
- mercury and compounds (NT, Qld, SA, Vic and WA)
- other inorganic chemicals (arsenic speiss waste in SA)
- pesticides (dieldrin-impregnated timber in WA)
- other contaminated biosolids (Vic)
- tyres (all jurisdictions).

Overall, in the high scenario hazardous waste quantities are projected to grow by an average of 4.6% per year, reaching 15.4 Mt by 2036-37. However, the growth is uneven due to:

- an initial jump in quantities as contaminated soils and asbestos step from 2016-17 levels to the highest end of their range
- releases from storage (as listed above)
- the assumption that in 2023 non-toxic salts from the CSG industry are no longer stored onsite
- projected large-scale growth in the new Stockholm Convention wastes, PFAS contaminated soil and PFOS contaminated biosolids, from 2020 (under this scenario, the new Stockholm wastes reach 1.5 Mt/yr by 2037).

The top six groups in terms of tonnes arising are different from the best estimate. They are, in order, contaminated soil, non-toxic salts, asbestos, PFAS contaminated soil, grease trap waste and tyres.

No waste groups are projected to decline under the high scenario.

2.5.3 Low estimate

A lowest credible estimate of waste arising was made for each group. The combined low estimate is illustrated in Figure 4, see page 18.

The low scenario is consistent with low economic and population growth, decline in the manufacturing sector and low rates of waste entering the waste management stream from storage. In many cases growth rates are assumed to equal projected population growth (less than economic growth); in others, specific estimates were made based on industry growth rates or other factors. The instances where wastes are assumed to be taken out of stockpiles and storages into the waste management system are fewer, and in smaller quantities, than in the other scenarios.

Overall, hazardous waste tonnages under the low scenario are projected to decline by an average of 0.5% per year, falling to 5.53 Mt in 2036-37. The top six waste groups amount for over 70% of the total. They are, in order, asbestos, contaminated soil, grease trap, tyres, oils and oil/water mixtures.

The major waste streams (contaminated soil and asbestos) are projected at the low end of a wide range, generating about 2.1 Mt/yr in 2036-37 rather than 3.4 Mt/yr under the best estimate. The quantities of PFAS-contaminated soil and PFOS-contaminated biosolids are much lower than in the best case. In the case of soil, this represents high levels of uncertainty; in the case of biosolids it represents lower assumed levels of contamination and higher definitional thresholds.

Strong growth is still projected for lithium ion batteries (average growth of 17% per year) and six other waste groups are projected to grow. Sixteen are projected to decline, including acids, alkalis, inorganic fluorine, lead, non-toxic salts, other inorganic chemicals, reactive chemicals, paints etc., organic solvents, waste oil/water mixtures, HCB, contaminated soil, other contaminated biosolids, other industrial treatment residues and other soil/sludges.

Figure 2: Best estimate of national projections for all hazardous waste to 2036-37

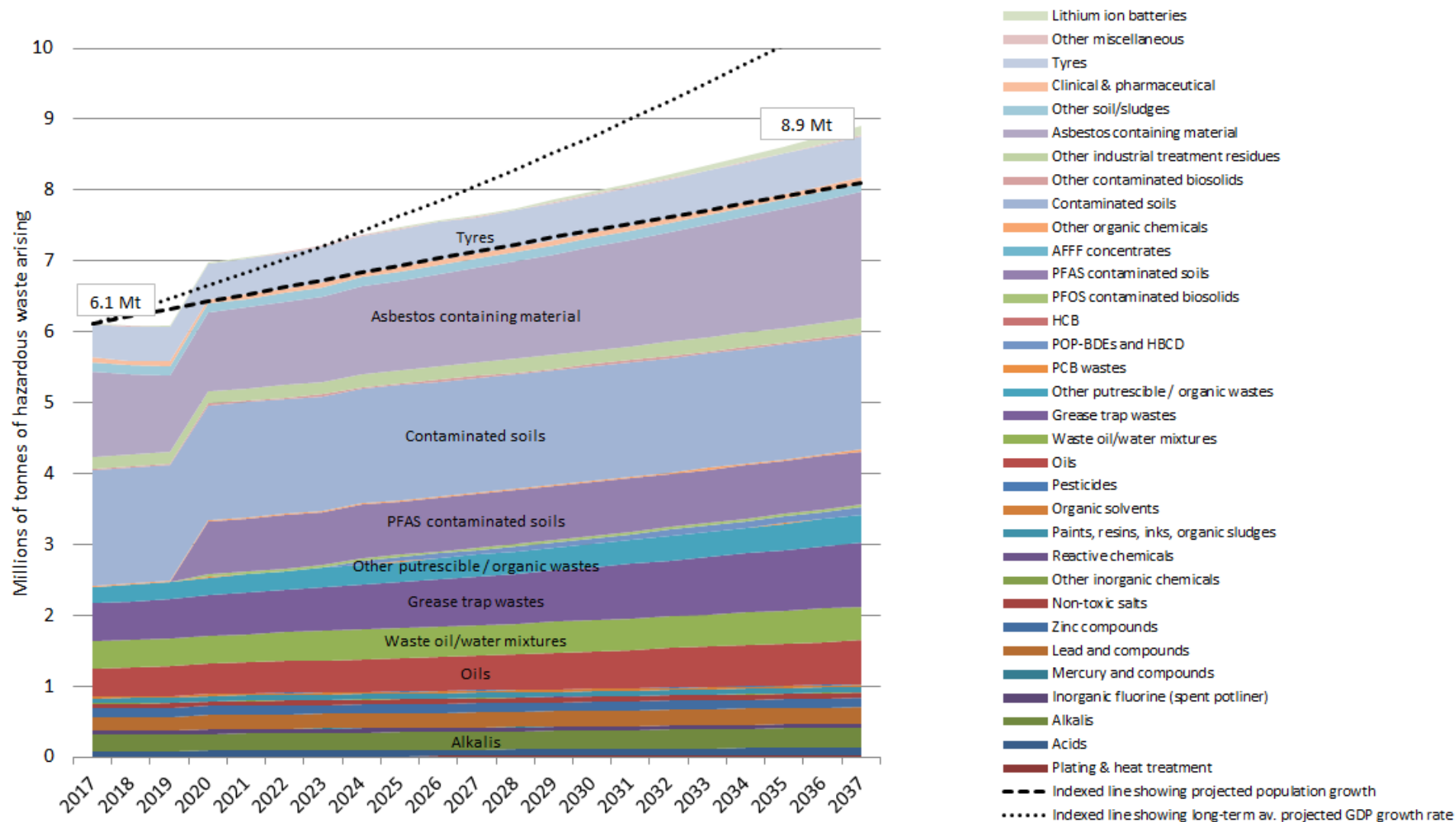


Figure 3: High estimate of national projections for all hazardous waste to 2036-37

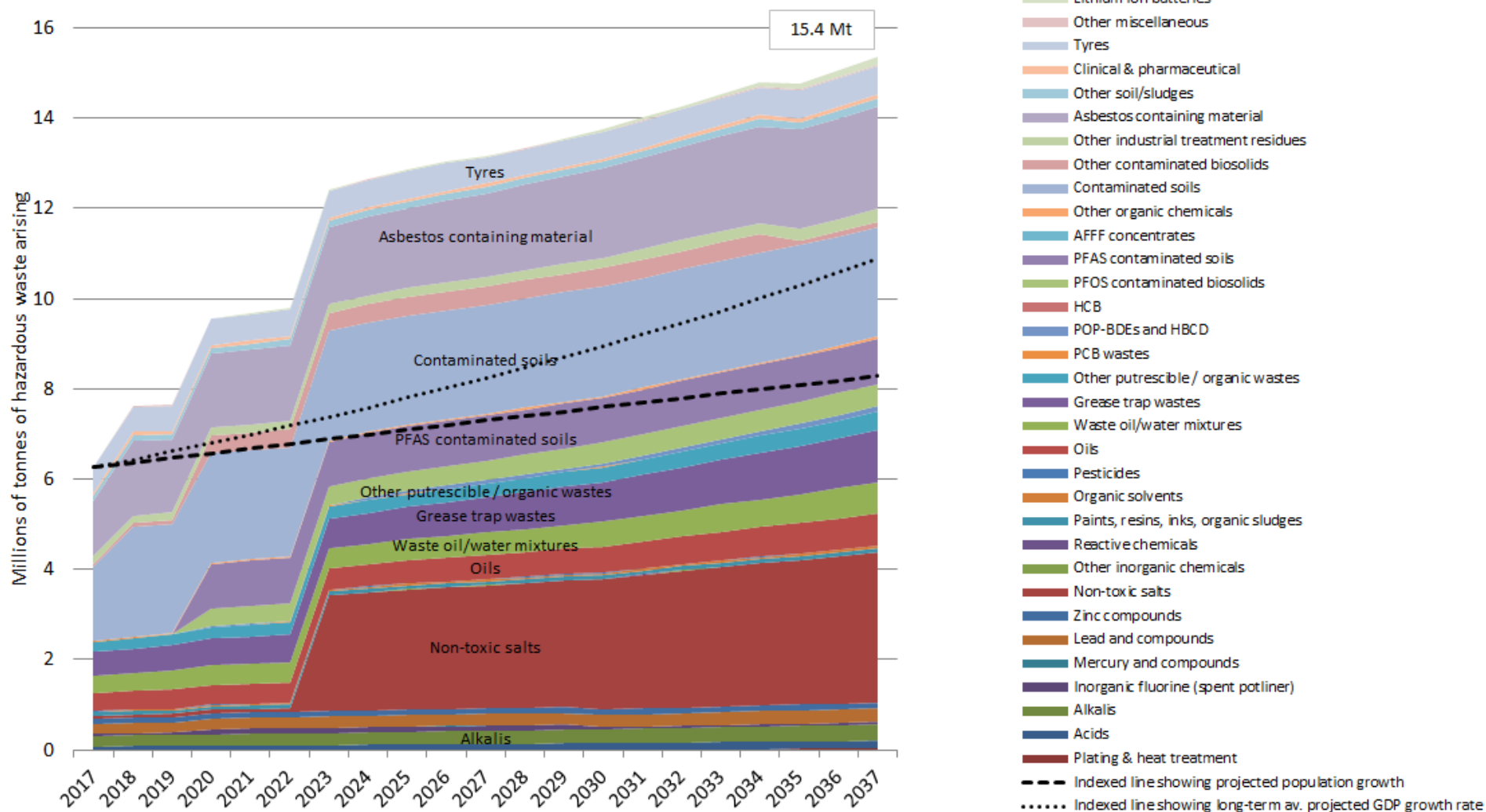
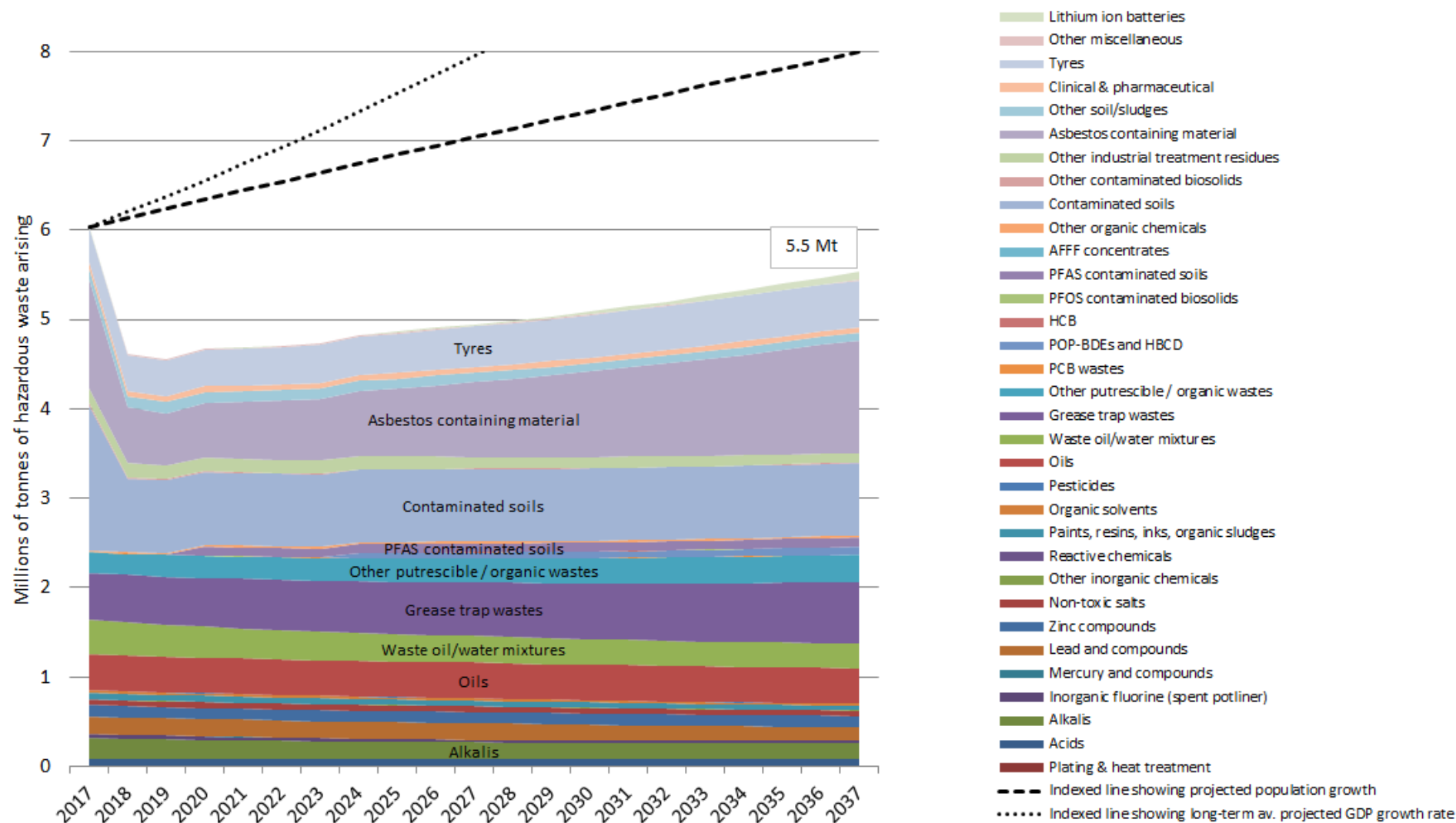


Figure 4: Low estimate of national projections for all hazardous waste to 2036-37



2.6 Comparison of the differences between these projections and those prepared in 2014-15

The assumptions underpinning the projections of hazardous waste arisings in Section 2.7 present a comprehensive review of the 2015 infrastructure assessment projections. The review of projections takes into account the significant lessons learnt in the ensuing three years working with national hazardous waste data, the market and consulting with key market operators. This has resulted in a stronger basis for waste volume projection, but also some significant changes in outcomes.

A comparison of our approach to projecting each waste group this year, compared to the 2015 assessment, is provided in Table 7. As a general rule, in a growth scenario when limited other information was available, the 2018 projections used population growth as a best case default and economic growth as a high case default, which is more conservative than the default approach in 2015.

Table 7: Significant differences in approach between 2018 and 2015 projection assumptions

Waste group		Significant changes in projection assumptions? ¹⁶	
A	Plating & heat treatment	No	Simplification of approach, limited change to projection
B	Acids	Yes	Previously assumed that aluminium smelting was the main driver – assumptions now based on steel/other metals industry as main sources. This has changed best projection from a decline (based on declining aluminium industry) to growth, based on average economic growth from major contributing states (Vic, NSW, Qld).
C	Alkalis	Yes	Waste is driven by the CSG industry in Qld and alumina refining in WA (red mud). Previously ABC (2014) was used to predict CSG industry growth, but this appears to be a simple extrapolation of CSG well numbers and has been discounted, which has led to a significant flattening in projections of this waste.
D110	Inorganic fluorine (SPL)	Yes	Waste group was not projected separately from 'Other D' in 2015, so 2018 projections are new.
D120	Mercury & compounds	Yes	2015 projections assumed major driver was fluorescent lamps, but we now believe that conventional oil & gas processing (spent catalysts) will overtake this in future, particularly following the implementation of the Minamata Convention on mercury. Starting point has been corrected to a more representative estimate. Net result is a lower starting point but inclining projection profile.
D220	Lead & compounds	Yes	While waste lead acid batteries continue to be a major source, the 2018 projections have incorporated both waste stockpile and arising considerations from zinc refining in Tas, transported to metal refining in SA for processing, which occurs in large volumes. These Tas arisings have been separately modelled to lead acid batteries. Overall, this has increased the starting point arisings but slightly flattened the growth trend.
D230	Zinc compounds	Yes	Waste group was not split out and separately modelled in 2015, so 2018 projections are new.
D300	Non-toxic salts	Yes	Waste is driven by the CSG industry in Qld and to a lesser extent dross, slag and salt cake from various metal smelting/refining. Previously ABC (2014) was used to predict CSG industry growth, but this has been discounted (see "C"). New information has

¹⁶ Comparison is between the current (2018) approach and that used in the 2015 projections. Only those assumptions that have resulted in significant changes to projections are discussed.

Waste group		Significant changes in projection assumptions? ¹⁶		
			been obtained on CSG reverse-osmosis salt waste stockpiles, which have dramatically altered the high case, and increasing this projection.	
Other D	Other inorganic chemicals	Yes	With the splitting of D110 and D230, this waste group has reduced to a much smaller volume, and is therefore a different projection to 2015.	
E	Reactive chemicals	Yes	2018 projection based on traditional manufacturing rate of decline; previously little was known of this waste given its low volume. This has resulted in the best case changing from a flat to declining trend.	
F	Paints, resins, inks, organic sludges	Yes	Flatter best projection based on lower demand due to declines in key user industries such as car manufacturing and the chemical industry, but higher starting point due to much higher recent WA arisings.	
G	Organic solvents	No	Limited change to projection	
H	Pesticides	Yes	Stockpiles of dieldrin-impregnated timber in WA now recognised in projections, causing a significant increase in the high case	
J100 & 160	Oils	Yes	Waste group was not split out (from J120) and separately modelled in 2015, so 2018 projections are new	
J120	Waste oil/water mixtures	Yes	Waste group was not split out (from J100 & J160) and separately modelled in 2015, so 2018 projections are new	
K110	Grease trap waste	No	Limited change to projection	
Other K	Other putrescible/organic wastes	No	Limited change to projection	
M100	PCB	Yes	Waste group was not split out (from ‘Other M’) and separately modelled in 2015, so 2018 projections are new.	
M160a & b	POP-BDEs and HBCD	Yes	Previously, POP were expressed as M160a-d. Since then there have been a number of developments in terms of POP, such as the establishment of a new code for PFAS wastes (M270) through the NEMP process, the listing of decaBDE on the Stockholm Convention and the restart of exports of significant volumes of Orica’s HCB stockpile. A ready-reckoner below shows the restructuring of POP wastes and the projections that have been necessary to accommodate these changes:	
			2015	2018
			M160a PFOS	M270 PFAS wastes, split up as: M270a (PFAS soils), M270b (PFOS biosolids) & M270c (AFFF concentrates)
			M160b POP-BDEs	M160a POP-BDEs ¹⁷
			M160c HBCD	M160b HBCD ¹⁷
			M160d HCB	M160c HCB
M160c	HCB	Yes	See <i>M160a & b</i> above	
M270a	PFOS contaminated biosolids	Yes	See <i>M160a & b</i> above	

¹⁷ Note that M160a and M160b have been combined in modelling to M160 a&b because their infrastructure needs are the same.

Waste group		Significant changes in projection assumptions? ¹⁶	
M270b	PFAS contaminated soil	Yes	See M160a & b above
M270c	AFFF concentrates	Yes	See M160a & b above
Other M	Other organic chemicals	Yes	New group due to splitting out of M100
N120	Contaminated soils	No	Limited change to projection
N205a	Other contaminated biosolids	Yes	New Australian & New Zealand Biosolids Partnership (ANZBP) data provides tonnages of biosolids contaminated in those contaminants jurisdictional biosolids guidelines list, and specific fates in each jurisdiction. This data was previously unavailable. In light of this data we have moved from assuming all biosolids could be contaminated (in the high case) to using ANZBP provided data. This has lowered projection volumes due to a tighter definition of the proportion of biosolids that are contaminated, and therefore likely to be hazardous waste. Also, the waste group heading has changed from 'contaminated biosolids' to 'other contaminated biosolids' to differentiate between PFAS contamination (M270b) and 'traditional pollutant' contamination (other).
N205b	Other industrial treatment residues	No	Limited change to projection, other than more conservative growth.
N220	Asbestos	No	Limited change to projection, other than the group's name change from 'asbestos' to 'Asbestos containing material'.
Other N	Other soil/sludges	Yes	Reliance on fly ash from new EfW removed from assumptions since current volumes are dominated not by fly ash but other wastes, such as N160 (encapsulated waste), N100 (drums) and N190 (filter cake).
R	Clinical & pharmaceutical	No	Limited change to projection, other than more conservative growth.
T140	Tyres	Yes	New tyres projections completed (REC 2016) and stockpiles are also included in projections.
Other T	Other miscellaneous	No	Limited change to projection.
-	Lithium ion batteries	Yes	A significant increase in AEMO projections of electric vehicle uptake results in higher projected tonnages <u>in the long term</u> . The 20-year projection actually decreases due to improved data on the average life of EV batteries which is longer than previously assumed. This results in a more delayed generation of waste batteries than previously projected.

2.7 Projections of hazardous waste arising by group

This section provides, for each waste group, an account of:

1. The waste types (at a NEPM 75 level) that are included in the waste group.
2. The analysis completed for each waste group projection including
 - the industry sectors shown to be producing the largest amounts of the waste in either Qld, SA or Vic¹⁸
 - team considerations and comments related to the development of the projection
 - the approach applied for the group, following the hierarchy set out in Figure 1.
3. The 2016-17 data and the arithmetical methods used for estimating how this quantity might change in the future under best, high and low scenarios.
4. A figure illustrating the three projection scenarios.

Projections are considered on a jurisdiction-specific basis in the assessment against infrastructure capacity in Section 4.4.

2.7.1 A Plating and heat treatment

This group includes the following.

- *A100 Waste resulting from surface treatment of metals and plastics*
- *A110 Waste from heat treatment and tempering operations containing cyanides*
- *A130 Cyanides (inorganic).*

A100, overspray and excess coating material removed in cleaning of equipment, makes up almost all of the group. Vic does not track A100 (Waste resulting from surface treatment of metals and plastics).

Summary analysis

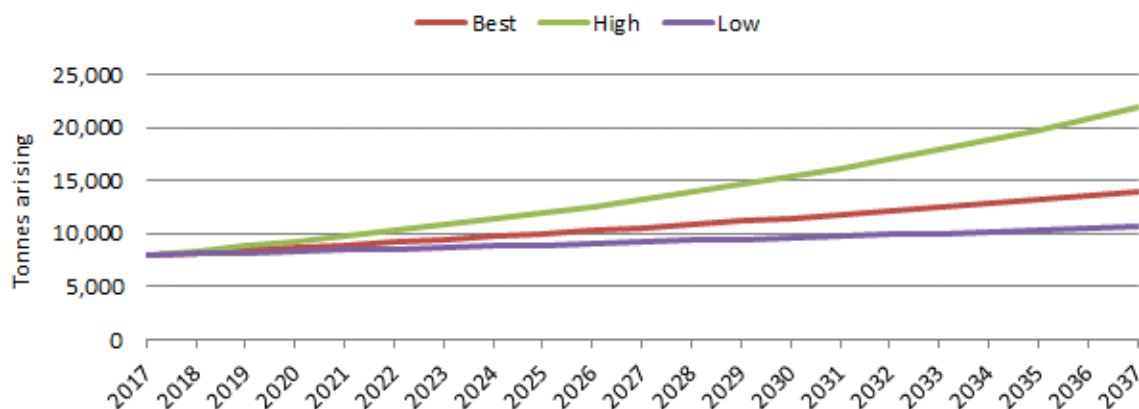
Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> • Marine fishing (abrasive cleaning/sandblasting of ships) • Mining, including coal and gold mining • Oil & gas extraction • Metal manufacturing • Metal coating and finishing 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Qld arisings dominant, WA next, others negligible</p> <p>Discernible increasing trend for last 10 years in WA and Qld (likely due to mining growth)</p>	High storage % waste in Qld & WA - could explain spikes in trends	Use judgement - trend (compound annual growth rate (CAGR) guided) and causal analysis.

Table 8: Best, high and low projected rates of change for plating & heat treatment waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	20-year average annual economic growth	2.8%	...	2.8%
High	NT, Qld, SA,	National compound annual growth rate	5.1%	...	5.1%
Low	Tas, Vic, WA	20-year average annual population growth	1.4%	...	1.4%

¹⁸ The data obtained from these three jurisdictions included ANZSIC codes, allowing this level of analysis. Other jurisdictions did not provide this data.

Figure 5: Best, high and low national projection estimates of plating & heat treatment waste to 2037



2.7.2 B Acid waste

This group includes only the single NEPM 75 code *B100 Acidic solutions or acids in solid form*. It can take a large variety of forms including, but not limited to, sulfuric acid, hydrochloric acid, nitric acid, phosphoric acid, chromic acid, hydrofluoric acid, mixed inorganic and organic acids.

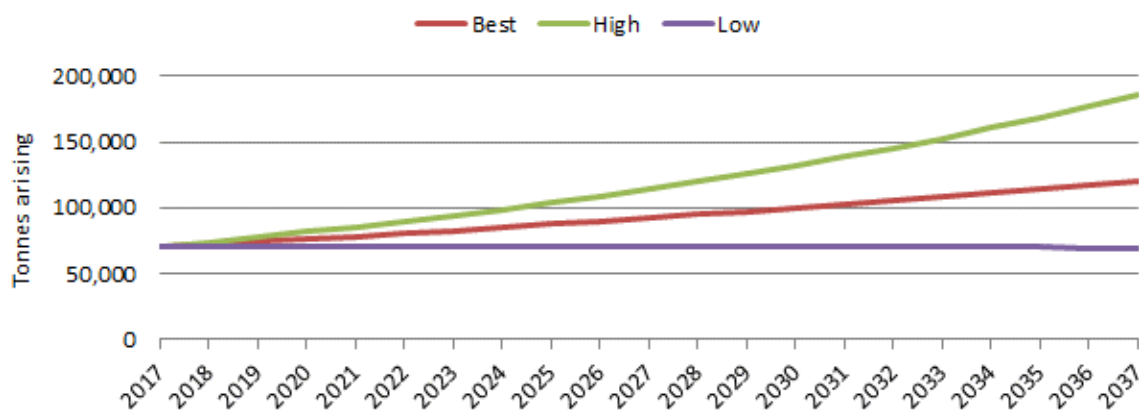
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Copper refining Petroleum refining Primary metal manufacturing Chemical product manufacturing Metal coating and finishing Coal mining 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Discernible flat to increasing trend for last 10 years in Vic, Qld, WA and SA</p>	<p>Steel & other metals are main industry drivers</p> <p>NSW arisings under-reported due to spent pickle liquor exemption (from steel manufacturing)</p> <p>Much of B100 goes to NSW - interstate tracking can also result in under-reporting</p>	Use judgement - trend (CAGR-guided) and causal analysis.

Table 9: Best, high and low projected rates of change for acid waste to 2037

	Applies to	Approach	2018	...	2037
Best	NSW, Qld, Vic, WA	20-year average economic growth	2.8%	...	2.8%
High		Average of Vic, NSW, Qld CAGR (rounded to 5%)	5.0%	...	5.0%
Low		Assume NSW flat trend is accurate and applies to all	0.0%	...	0.0%
Best	SA	SA 12-year CAGR (-1.6%)	-1.6%	...	-1.6%
High		20-year average economic growth	2.8%	...	2.8%
Low		More rapidly declining industry	-3.0%	...	-3.0%
Best	ACT, NT, Tas	Between high and low	1.4%	...	1.4%
High		20-year average economic growth	2.8%	...	2.8%
Low		Flat trend	0.0%	...	0.0%

Figure 6: Best, high and low national projection estimates of acid waste to 2037



2.7.3 C Alkali waste

This group includes only the single NEPM 75 code *C100 Basic solutions or bases in solid form*. Alkali wastes arise in significant quantities in Australia, predominantly in Qld (mostly as CSG drilling muds) and in WA (as alumina refining's red mud).

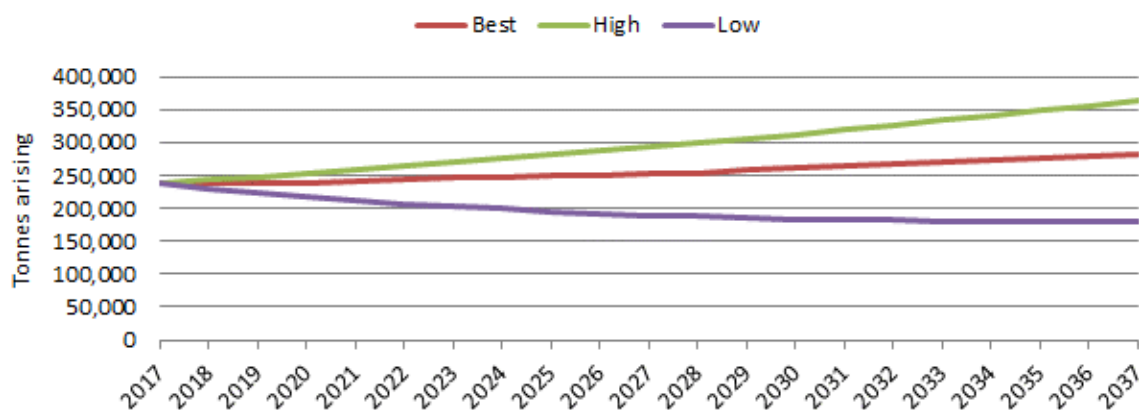
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Oil and gas extraction (including CSG) Aluminium refining Cement and lime manufacturing Metal coating and finishing 	<p>No specific pre-existing projections were identified, although ACIL Tasman (2012) projects CSG production and IBIS World project CSG revenue</p> <p>ACIL Tasman (2012) and IBIS World project CSG growth to strongly taper</p>	<p>Any onsite storages of drilling muds in evaporation ponds are not included in tracking data</p> <p>Missing Qld data post 15-16 is problematic for near-term trend confidence</p> <p>ABC (2014), which was used in the original (2015) set of projections, appears to be a simple extrapolation of CSG well numbers and has been discounted, which has led to a significant flattening in projections of this waste</p>	<p>Qld 'best' based on ACIL Tasman (2012) projections of CSG production</p> <p>All other states show flat to decreasing trend over last 5 years, Best = flat trend</p>

Table 10: Best, high and low projected rates of change for alkali waste to 2037

Applies to	Approach	2018	...	2037
Best	Based on ACIL Tasman (2012)	-0.3%	...	1.8%
High	20-year average annual economic growth	2.8%	...	2.8%
Low	20-year average annual population growth	1.4%	...	1.4%
Best	Flat trend	0.0%	...	0.0%
High	20-year average annual population growth	1.4%	...	1.4%
Low	Compound average growth rate (national excl. Qld)	-7.4%	...	-7.4%

Figure 7: Best, high and low national projection estimates of alkali waste to 2037



2.7.4 D110 Inorganic fluorine (SPL)

This group comprises the single NEPM code *D110 Inorganic fluorine compounds excluding calcium fluoride*, that was not projected in separate waste group in 2015, but presented within the broader catch-all group 'Other D – Other inorganic compounds'. This NEPM code is used in the Australian dataset virtually exclusively to describe SPL, a waste material generated from aluminium smelters, of which there are four in current operation (in Vic, NSW, Qld and Tas) and two recently closed (in Vic and NSW).

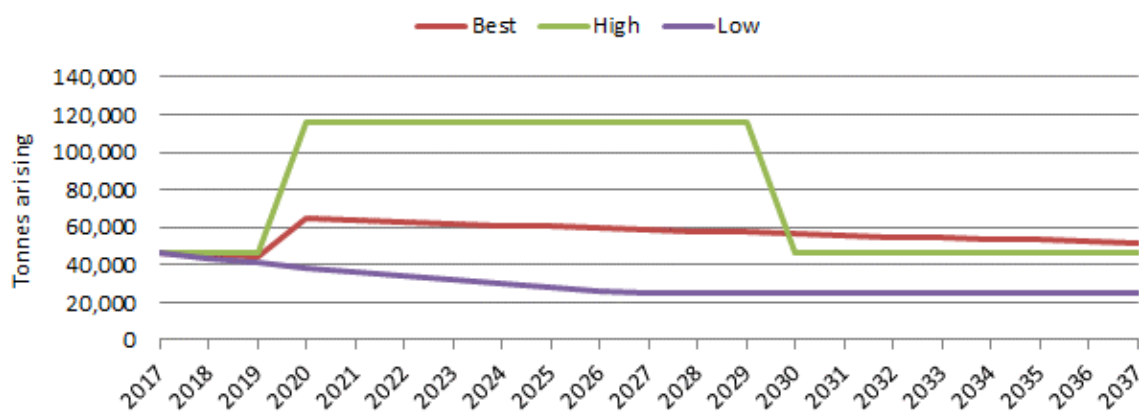
Summary analysis

Industry sources	Considerations	Comments	Approach
Aluminium smelting	<p>No specific pre-existing projections were identified, although SPL is produced proportionate to aluminium production. DISS 2017 provide historical trends and short-term future projections of aluminium production.</p> <p>Projections depend in part on regulators approach to requiring clearance of SPL onsite storages, from sheds onsite.</p>	<p>Australian aluminium industry outlook (DISS 2017) not as dire as JCP 2012 predicted (used in 2015 projections) - short-term fluctuations indicated, long-term slow decline.</p> <p>No relevant trend data; tracking data does not reflect SPL arisings due to the practice of on-site storages.</p>	<p>Informed by DISS 2017-reported for last decade & long-term commentary</p> <p>High-case additional: assume release of all onsite stored volumes to the market over 10 years</p> <p>Low-case: assume original outlook reported by JCP 2012 is correct plus zero storage releases</p>

Table 11: Best, high and low projected rates of change for Inorganic fluorine (SPL) waste to 2037

Applies to		Approach	2018	...	2027	...	2037
Arisings							
Best	NSW, Qld, Tas, Vic	Slow Al industry decline in Aust: -2%	-2.0%	...	-2.0%	...	-2.0%
High		Al production steady	0.0%	...	0.0%	...	0.0%
Low		Significant closures of local Al industry over 10 yrs	-6.0%	...	-6.0%	...	0.0%
On-site storage releases (absolute tonnes pa)							
Best	NSW	30% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	5,378	...	5,378
High		100% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	17,928	...	0
Low		No storage releases	0	...	0	...	0
Best	Qld	30% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	2,700	...	2,700
High		100% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	9,000	...	0
Low		No storage releases	0	...	0	...	0
Best	Tas	30% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	4,980	...	4,980
High		100% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	16,600	...	0
Low		No storage releases	0	...	0	...	0
Best	Vic	30% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	7,900	...	7,900
High		100% reduction in storages over 10 yrs from policy intervention (linear bleed) start in 2 yrs	0	...	26,334	...	0
Low		No storage releases	0	...	0	...	0

Figure 8: Best, high and low national projection estimates of inorganic fluorine (SPL) waste to 2037



The peculiar shape of the high estimate is due to releases of SPL from the current large stockpiles

2.7.5 D120 Mercury; mercury compounds

This group includes only the single NEPM code *D120 Mercury; mercury compounds*. While volumes are very small, this waste has been singled out due to its inherent hazard, as evidenced by the *Minamata Convention on Mercury*¹⁹.

Mercury from the oil and gas industry

In addition to the CSG industry in Qld, there has been a longer-standing 'conventional' oil and gas exploration and extraction industry presence in Australia, with large operators offshore from the north-west coast of WA.

Mercury is present in all hydrocarbon reservoirs at trace levels, and can arise most significantly as waste from mercury removal units (MRUs) in the form of spent mercury adsorbents (usually activated carbon) or contaminated hydrocarbon sludges. Other mercury wastes from the oil and gas sector include process waters, contaminated soils and contaminated worker personal protective equipment (PPE).

Apart from the obvious environmental and worker health and safety concerns about mercury, there is a specific risk that mercury entrained petroleum feedstock can damage metal components of processing plant equipment (particularly aluminium), through a form of corrosion, which can lead to catastrophic equipment failure. The latter is the likely reason for the use of MRUs over the long-term, but with the *Minamata Convention coming into force in August 2016* and Australia very close to ratification of it, historically stored or otherwise managed MRU residues will come under increased regulatory scrutiny for more environmentally sound management.

Summary analysis

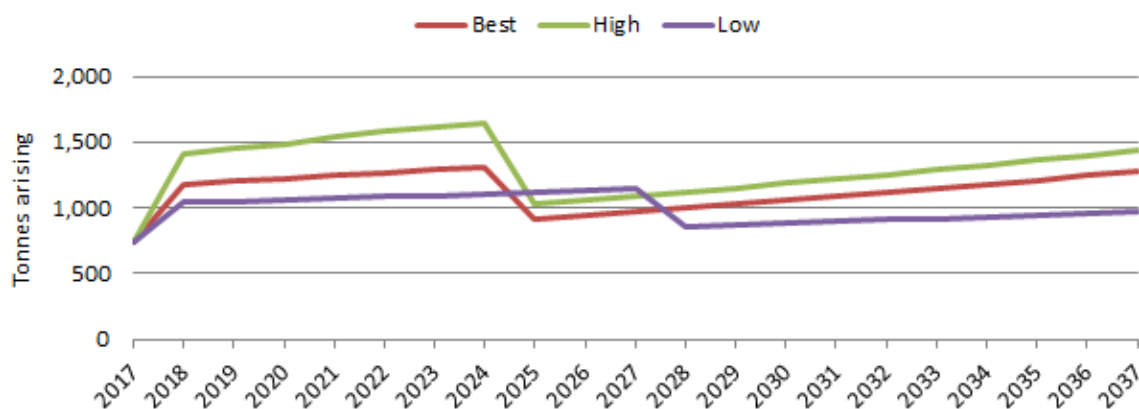
Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Oil & gas extraction Petroleum refining Mining Lighting, electricity supply, chemical manufacturing, dentistry 	<p>No specific pre-existing projections were identified.</p> <p>Trend unreliable due to contaminated soil classified as D120 in NSW (instead of N120), and a one-off stockpile clearance.</p> <p>Minamata Convention came into force in 2017.</p>	<p>2015 projections incorrectly assumed major driver was fluoro lamps.</p> <p>Oil & gas processing mercury recovery unit (MRU) spent absorbents is major source – not clear if this comes through tracking systems</p> <p>Assume large scale on-site stockpiling for Oil & gas processing mercury</p>	<p>Assume Minamata drives arisings growth but at lower rate - with reducing stockpiling behaviour.</p> <p>Assume stockpiles cleared over seven years, starting immediately, due to Minamata.</p> <p>High case - assume larger stockpile.</p>

¹⁹ <http://www.mercuryconvention.org/Convention>

Table 12: Best, high and low projected rates of change for mercury; mercury compounds waste to 2037

Applies to		Approach	2018	...	2027	...	2037
Arisings							
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Minamata drives more D120 to market, assume economic growth	2.8%	...	2.8%	...	2.8%
High		Av. projected ann. growth in oil & gas production 2018-23, then economic growth	5.3%	...	2.8%	...	2.8%
Low		20-year average annual population growth	1.4%	...	1.4%	...	1.4%
On-site storage releases (absolute tonnes pa)							
Best	NT, Qld, SA, Vic, WA	Best estimate stockpile takes seven years to clear	84	0
High		High estimate stockpile takes seven years to clear	126	0
Low		Best estimate stockpile takes 10 years to clear	59	...	59	...	0

Figure 9: Best, high and low national projection estimates of mercury, mercury compounds waste to 2037



2.7.6 D220 Lead; lead compounds

This group includes only the single NEPM code *D220 Lead; lead compounds*. The majority arising in Australia is a lead-rich by-product from zinc refining. A further significant component is from end of life (used) lead acid batteries (ULABs), while leaded glass from the e-waste recycling industry, where CRT glass contains large quantities of lead, make up most of the remainder.

Australia has the world's largest deposits of both lead and zinc and as a result, both are mined and used locally and exported²⁰.

²⁰ Geoscience Australia (2015). Zinc-Lead-Silver. Accessed April 14, 2015 from <http://www.ga.gov.au/scientific-topics/minerals/mineral-resources/aimr/zinc-lead-silver>

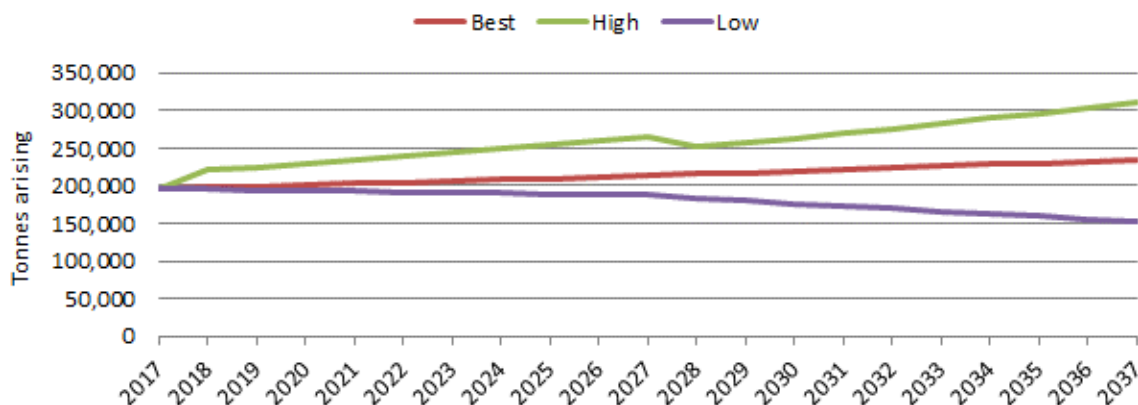
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Zinc refining Lead acid batteries e-waste recycling 	<p>Tas lead waste (going to SA) swamps all else & is likely to trend with Zn production estimates.</p> <p>Tas lead waste is likely to be arisings of lead sulphate leach concentrate (LSLC), plus stockpile releases of jarosite.</p> <p>No sufficiently credible pre-existing projections were identified, although Zn \$ forecast 2018-2030 is instructive for LSLC</p>	<p>ULABs should trend with population (car usage growth). NSW has tracking exemption for ULABs for reuse – therefore NSW tracking data under-reports</p> <p>Total jarosite stockpile was 200,000t in 2012; assume all has been processed 2012-2017 (EPA Tas 2009, TT2012)</p>	<p><u>Tas Lead projection</u>: assume only LSLC (not jarosite stockpile releases) arise going forward, at average 2012-14 reported LSLC production.</p> <p>Low case: Growth follows Nyrstar Hobart Zn production trend (Nyrstar 2017)</p> <p>Best case: Growth follows world zinc price forecast for 2018-2030 (WB 2017)</p> <p>High case: 200kt jarosite stockpile available and will be released at additional 20kt pa</p> <p><u>ULABs projection</u> (all jurisdictions):</p> <p>In line with pop growth (as surrogate for vehicle usage growth).</p> <p>China has signalled withdrawal from lead acid battery manufacture in favour of newer technologies (low case).</p>

Table 13: Best, high and low projected rates of change for lead, lead compounds waste to 2037

Applies to		Approach	2018	...	2028	...	2037
Arisings							
Best	Tas	World Bank forecast Zn price growth (2018-2030)	-1.7%	...	-1.7%	...	-1.7%
High		Flat trend	0.0%	...	0.0%	...	0.0%
Low		Nyrstar Hobart Zn production trend (Nyrstar 2017)	-2.2%	...	-2.2%	...	-2.2%
Best	ACT, NSW, NT, Qld, SA, Vic, WA	20-year average annual population growth	1.4%	...	1.4%	...	1.4%
High		20-year average annual economic growth	2.8%	...	2.8%	...	2.8%
Low		Flat trend 10 yrs, decline 10 yrs due to replacement of battery technology	0.0%	...	-2.0%	...	-2.0%
On-site storage releases (absolute tonnes pa)							
Best	Tas			
High		200 kt historical jarosite stockpile will be released at additional 20 kt pa	20,000	...	0	...	0
Low				

Figure 10: Best, high and low national projection estimates of lead, lead compounds waste to 2037



2.7.7 D230 Zinc compounds

This group comprises the single NEPM code *D230 zinc compounds*, previously not provided as its own waste group in 2015, but presented within the broader group 'Other D – Other inorganic compounds'. D230 was separated out because of the significant tonnage it has generated in recent years.

The vast majority of this waste (87%) was generated in Tas and accepted into management infrastructure in SA in 2016-17, while a further 12% is produced and managed within SA.

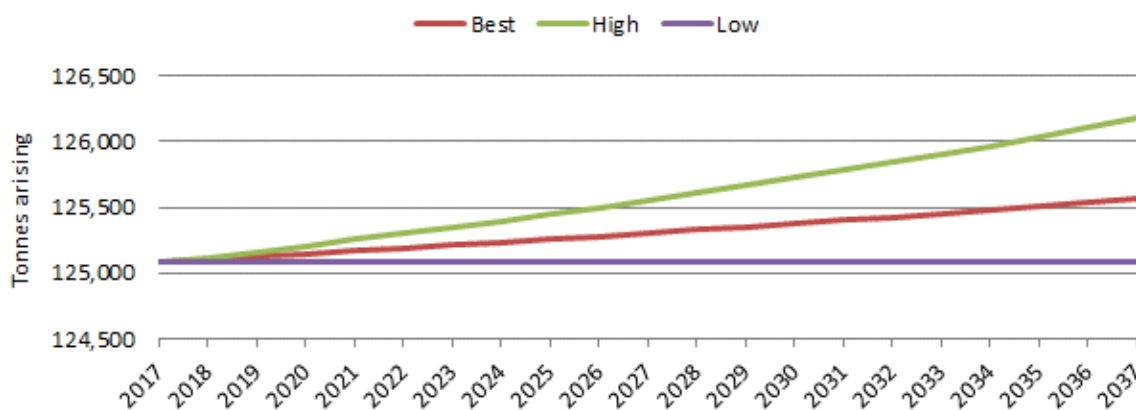
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Zn refining Iron & steel manufacturing 	<p>Zn waste from Tas appears to be <i>paragoethite</i>, a by-product of Nyrstar Hobart's zinc refining process.</p> <p>No sufficiently credible pre-existing projections were identified, but Zn \$ forecast 2018-2030 is instructive, and <i>paragoethite</i> is produced at ~29% of zinc production (Nyrstar 2015)</p>	<p><i>Paragoethite</i> is rich in Zn and is routinely sent to Nyrstar Port Pirie's lead smelter, presumably due to its relatively high lead content as well.</p>	<p><u>Tas paragoethite projection:</u></p> <p>Low case: Growth follows Nyrstar Hobart Zn production trend (Nyrstar 2017)</p> <p>Best case: Growth follows observed Nyrstar Hobart <i>paragoethite</i> trend of 29% (Nyrstar 2015)</p> <p>High case: Flat trend</p> <p><u>Other states' Zn waste:</u> Generic industry projections</p>

Table 14: Best, high and low projected rates of change for zinc compounds waste to 2037

Applies to		Approach	2018	...	2037
Best	Tas	Nyrstar Hobart paragoethite trend (2011-17)	-1.4%	...	-1.4%
High		Flat trend	0.0%	...	0.0%
Low		Nyrstar Hobart Zn production trend (Nyrstar 2017)	-2.2%	...	-2.2%
Best	ACT, NSW, NT, Qld, SA, Vic, WA	20-year average annual population growth	1.4%	...	1.4%
High		20-year average economic growth	2.8%	...	2.8%
Low		Flat trend	0.0%	...	0.0%

Figure 11: Best, high and low national projection estimates of zinc compounds waste to 2037



2.7.8 D300 Non-toxic salts

This group includes only the single NEPM code *D300 Non-toxic salts*. The main source of this waste is the CSG extraction industry's brine, waters and sludges, some of which is from reverse osmosis desalination. There is also aluminium dross/salt cake waste produced from aluminium smelting and recycling, as well as significant volumes of salt waste that presents as furnace slags from other types of metals smelting and refining, including ULAB smelting. The CSG wastes are discussed in the breakout box below.

CSG brine wastes

CSG mining occurs predominantly in Qld, in the Bowen and Surat Basins. CSG in Qld is usually liquefied to allow easier transport, such as by ship, which means it is also referred to as LNG. The CSG industry is often placed within the ANZSIC category Oil and gas extraction.

The CSG extraction process produces a range of wastes, but in volume terms there are three (all salty) wastes that are the most prevalent:

- extraction waters, otherwise known as co-produced water or CSG water
- brine solutions, sludges and salts, produced as a concentrated waste product from reverse osmosis desalination of salty extraction waters
- drilling muds (a combination waste of drilling fluids and earth materials), which arise from the drilling of a well.

Drilling muds are nominally captured in waste tracking systems as C100 alkalis (and also D300 non-toxic salts), reverse osmosis brine waste as D300 non-toxic salts and extraction waters are typically not tracked as hazardous waste.

Water is extracted as part of the CSG mining process because the gas – methane – is in the coal seam and held there at great pressure by water and other sediment layers. To release the gas, the water needs to be pumped out of this coal seam and up to the surface in a process known as dewatering. The water that is pumped out as part of the CSG mining process is very salty and contains a range of petroleum and mineral based chemical compounds, such as heavy metals and hydrocarbons.

CSG wastes are interesting as an emerging waste because, a) very large tonnages are involved, and b) salty waters, brines or solid salts are a difficult problem for the waste industry, which often relies on landfill. Water penetrating a landfill will mobilise any stored salt in the leachate stream, which creates a risk of groundwater infiltration, especially given the volumes to be managed. Consequently, landfill design is critical for this form of management to be successful. The enormous volumes also mean that treatment to reduce the salt levels, such as reverse osmosis, are expensive and energy-intensive.

Qld's *Coal Seam Gas Water (CSG) Management Policy 2012* and associated guidance that followed it effectively banned the practice of placing extraction waters in evaporation ponds or dams, in a form of indefinite storage. Since 2014, the industry has installed significant reverse osmosis desalination capacity to treat large volumes of extraction waters, which then allows various forms of reuse of desalinated water, leaving behind a salt brine or solid salt waste as a by-product.

Because of these management difficulties, large quantities of these reverse osmosis wastes are temporarily stored on site in brine ponds, awaiting a more definitive management fate. These volumes are very large, but because they do not leave the treatment site, they do not typically show up in hazardous waste tracking data.

Considering the management difficulty and tonnages, CSG waste is a current and future waste management concern and hence an area of focus for this report.

Summary analysis

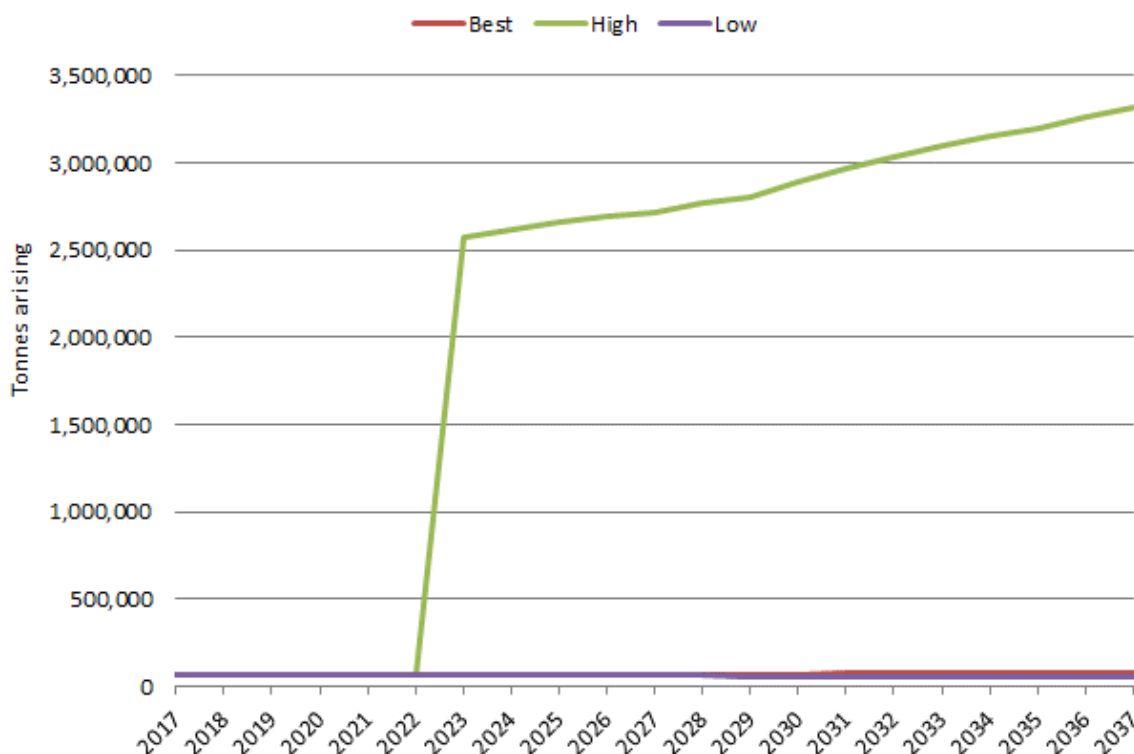
Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> CSG extraction Aluminium dross processing and aluminium recycling Other metals smelting and refining 	<p>No specific pre-existing projections were identified, although ACIL Tasman (2012) projects CSG production and IBIS World project CSG revenue.</p> <p>There has been an emergence of reverse osmosis desalination in the industry, due to regulatory phase-out of the use of evaporation ponds and requirements for water reuse. This has created many reuse opportunities for large volumes of water, but has also resulted in large RO salt/brine wastes that are typically stored on-site, creating a new waste problem.</p> <p>Consequently, a large stockpile has built up – estimated 9.5 Mt – since around 2014 when the first large-scale RO plant came online.</p> <p>A stockpile also exists of aluminium and aluminium dross recycling salt cake.</p>	<p>On-site storages in evaporation ponds are not included in tracking data.</p> <p>ABC (2014), which was used in the original (2015) set of projections, appears to be a simple extrapolation of CSG well numbers and has been discounted, which has led to a significant flattening in projections of this waste.</p> <p>Missing Qld data post 15-16 is problematic for near-term trend confidence.</p>	<p>Base <u>Qld</u> best on ACIL Tasman (2012) projections of CSG production (as per C100)</p> <p><u>NSW</u>: Mostly ULAB smelting slags - use same assumptions as for ULABs</p> <p><u>Other</u>: Assume flat for best, economic growth for high, negative for low</p>

Table 15: Best, high and low projected rates of change for non-toxic salt waste to 2037

Applies to		Approach	2018	...	2023	...	2037
Arisings							
Best	Qld	Based on ACIL Tasman (2012)	-0.3%	...	1.5%	...	1.8%
High		20-year average annual economic growth	2.8%	...	2.8%	...	2.8%
Low		20-year average annual population growth	1.4%	...	1.4%	...	1.4%
Best	NSW	20-year average population growth	1.4%		1.4%		1.4%
High		20-year average economic growth	2.8%		2.8%		2.8%
Low		Flat trend 10yrs, decline 10 yrs due to replacement of battery technology	0.0%		0.0%		-2.0%
Best	ACT, NT, SA, Vic, WA	Flat trend	0.0%	...	0.0%	...	0.0%
High		20-year average annual population growth	1.4%	...	1.4%	...	1.4%
Low		-2% annual decline	-2.0%	...	-2.0%	...	-2.0%
On-site storage releases (absolute tonnes pa)							
Best	Vic	Long-term dross stockpile remains	0	...	0	...	0
High		Dross stockpile clears in 5 years, at a linear rate, beginning in 2020	0	...	CIC	...	0
Low		Long-term dross stockpile remains	0	...	0	...	0
On-site storage releases (absolute tonnes pa)							
Best	Qld	CSG salt brines continue to be stockpiled onsite indefinitely	0	...	0	...	0
High		After 5 yrs CSG salt brines taken to long-term isolation facility. Pre-existing stockpiles remain.	0	...	2,5 Mt	...	3,2 Mt
Low		CSG salt brines continue to be stockpiled onsite indefinitely	0	...	0	...	0

The standout feature of Figure 12 overleaf is very large volumes of stockpiled CSG industry salt/brine waste as an output from reverse osmosis desalination of the waters extracted from wells. These dominate all other features of the projection graph. Under the best and low scenarios, it is assumed that CSG reverse osmosis brine wastes are permitted to remain stored onsite. Under the high scenario, it is assumed that after five years new arisings of CSG reverse osmosis brine wastes are required to be managed offsite and are sent to long-term isolation facilities. Historical stockpiles are assumed to remain onsite. This results in a very large increase (2.5 Mt) in 2023 increasing to 3.2 Mt by 2037. See section 4.3 for a discussion on arisings versus infrastructure capacity for this waste.

Figure 12: Best, high and low national projection estimates of non-toxic salt waste to 2037



2.7.9 Other D Other inorganic chemicals

This group includes waste and wastes contaminated with: metal carbonyls; inorganic sulphides; perchlorates; chlorates; arsenic²¹, cadmium²¹, beryllium²¹, antimony²¹, thallium²¹, selenium²¹ and tellurium²¹; compounds of copper, cobalt, nickel, vanadium, boron, barium (excl. barium sulphate), chromium (hexavalent & trivalent) and phosphorus (excl. mineral phosphates).

There is limited information on this group – it is a collection of low volume wastes from a variety of traditional manufacturing sources.

Summary analysis

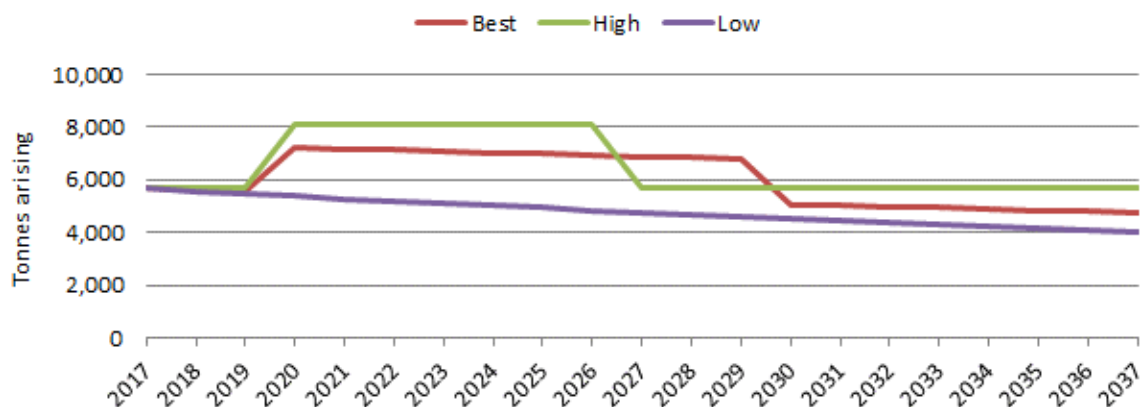
Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Fossil fuel electricity generation Motor vehicle parts manufacturing Petroleum refining Leather tanning, fur dressing and leather product manufacturing Chemical product manufacturing Metal coating and finishing Port and water transport terminal operations Professional, scientific and technical services 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Historical data set exists, not usable for discerning trends.</p>	<p>D230 (Zn) and D110 (SPL) are high volume wastes that have been split out of this group since the 2015 projections</p>	<p>Assume traditional manufacturing industry decline</p>

²¹ Also including compounds containing these elements.

Table 16: Best, high and low projected rates of change for other inorganic chemical waste to 2037

Applies to		Approach	2018	...	2020	...	2037
Arisings							
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Projected annual growth in manufacturing employment 2017-22	-0.9%	...	-0.9%	...	-0.9%
High		Flat trend - traditional industry remains competitive	0.0%	...	0.0%	...	0.0%
Low		Hazwaste from traditional manufacturing declines at double the best estimate	-1.7%	...	-1.7%	...	-1.7%
On-site storage releases (absolute tonnes pa)							
Best	Vic	Stockpile cleared in 10 years, at a linear rate, (starting 2020)	1,700	...	1,700	...	0
High		Stockpile cleared in seven years, at a linear rate, (starting 2020)	2,429	...	2,429	...	0
Low		Stockpile remains (status quo)	0	...	0	...	0

Figure 13: Best, high and low national projection estimates of other inorganic chemical waste to 2037



2.7.10 E Reactive chemicals

This waste group includes only one NEPM 75 code: *E100 Waste containing peroxides other than hydrogen peroxide*, although it shares similar strong oxidising properties to D340 Perchlorates and D350 Chlorates, which were not grouped together in this category to preserve NEPM E reporting alignment and because the contributions from D340 and D350 are similarly small.

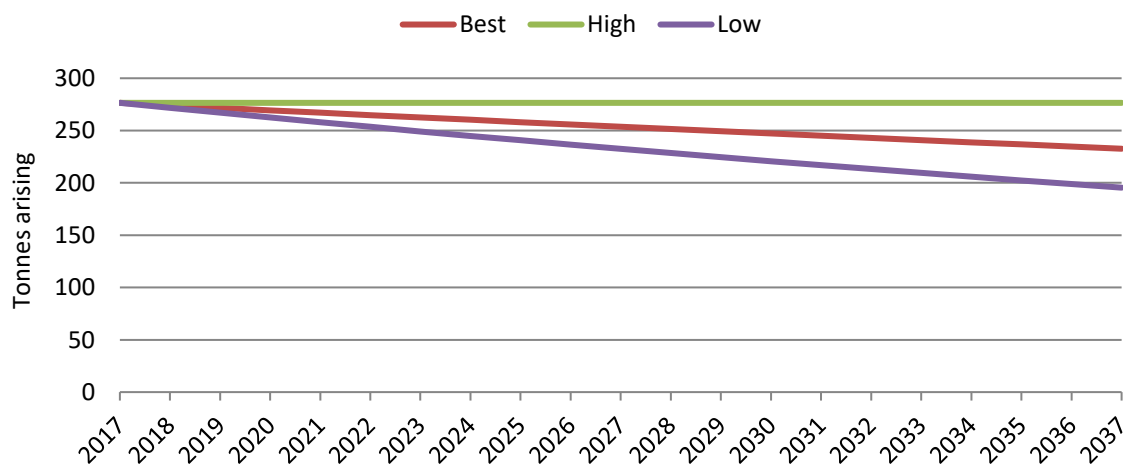
Summary analysis

Industry sources	Considerations	Approach
<ul style="list-style-type: none"> Chemical manufacturing Metal product manufacturing Water supply drainage & sewerage Oil and gas extraction Soap and other detergent manufacturing Potato, corn and other crisp manufacturing 	No sufficiently credible pre-existing projections were identified	Assume traditional manufacturing industry decline

Table 17: *Best, high and low projected rates of change for reactive chemical waste to 2037*

	Applies to	Approach	2018	...	2037
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Projected annual growth in manufacturing employment 2017-22	-0.9%	...	-0.9%
High		Flat trend - traditional industry remains competitive	0.0%	...	0.0%
Low		Hazwaste from traditional manufacturing declines at double the best estimate	-1.7%	...	-1.7%

Figure 14: *Best, high and low national projection estimates of reactive chemical waste to 2037*



2.7.11 F Paints, resins, inks, organic sludges

This group includes: *F100 Waste from the production and use of inks, dyes, pigments, paints, lacquers & varnish* and *F110 Waste from the production & use of resins, latex, plasticisers, glues and adhesives*.

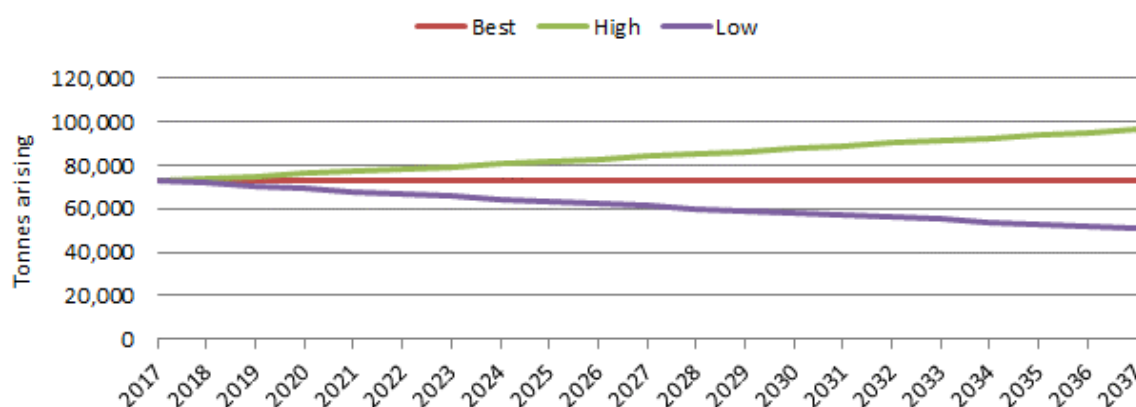
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Paint ink and resin manufacturing Chemical and chemical product manufacturing Printing Machinery and equipment manufacturing Motor vehicle manufacturing Aircraft manufacturing 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Historical data shows relatively flat trend, excluding WA 2016-17 data point</p>	<p>Main influence in trends is 2016-17 WA F100 data point - almost 10-fold increase in long-term baseline</p> <p>The data record suggests it is a release from storage</p>	<p>Exclude the apparent WA storage release</p> <p>Use population growth for the best estimate</p> <p>High = flat</p> <p>Low = CAGR</p>

Table 18: *Best, high and low projected rates of change for paints, resins, inks and organic sludge waste to 2037*

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	Flat trend	0.0%	...	0.0%
High	NT, Qld, SA,	20-year average annual population growth	1.4%	...	1.4%
Low	Tas, Vic, WA	National compound average growth rate	-1.7%	...	-1.7%

Figure 15: *Best, high and low national projection estimates of paints, resins, inks and organic sludge waste to 2037*



2.7.12 G Organic solvents

This waste group includes:

- *G100 ethers*
- *G110 organic solvents excluding halogenated solvents*
- *G150 halogenated organic solvents*
- *G160 waste from the production, formulation and use of organic solvents.*

Solvents have three principal areas of use; as cleaning agents, as a raw material or feedstock in the production and manufacture of other substances, and as a carrying and/or dispersion medium in chemical synthetic processes.

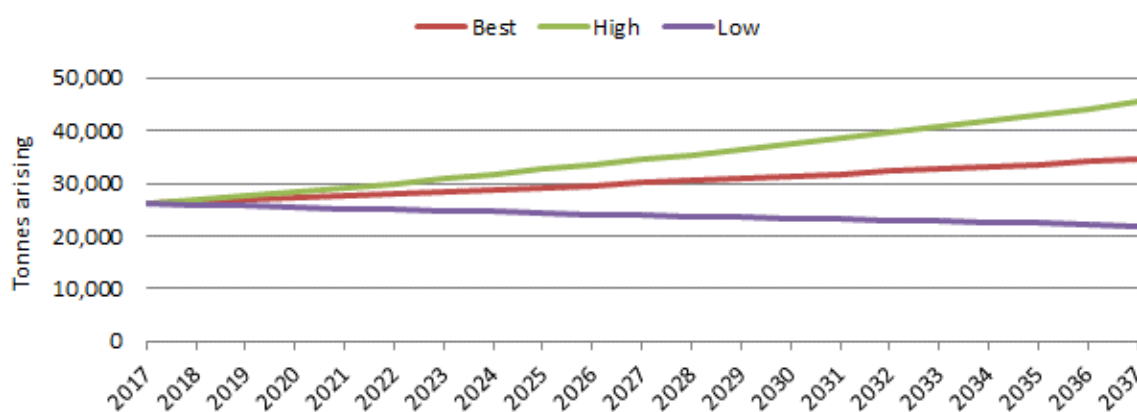
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> • Motor vehicle manufacturing • Dry cleaning • Chemical and chemical product manufacturing • Printing • Paint manufacturing 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Large rises and falls in trend data</p> <p>High storage waste across the board - can lead to storage & release spikes</p>	<p>Removing major spike years from Qld/Vic/WA appears to still show positive trend; negative for NSW</p>	<p>Use population growth for the best estimate</p> <p>High = economic growth</p> <p>Low = projected manufacturing growth</p>

Table 19: Best, high and low projected rates of change for organic solvent waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	20-year average annual population growth	1.4%	...	1.4%
High		20-year average annual economic growth	2.8%	...	2.8%
Low		Projected ann. growth in manufact. employment 2017-22	-0.9%	...	-0.9%

Figure 16: Best, high and low national projection estimates of organic solvent waste to 2037



2.7.13 H Pesticides

This group includes three potentially diverse types of waste:

- *H100 waste from the production, formulation and use of biocides & phytopharmaceuticals*
- *H110 organic phosphorous compounds*
- *H170 waste from manufacture, formulation and use of wood-preserving chemicals.*

H100 is the major pesticide heading (biocide means pesticide) although it also includes the relatively unrelated phytopharmaceuticals, which are plant-derived pharmaceutical products such as alkaloids. H110 includes waste from organic phosphorus compounds used as lubricants, plasticisers, flame retardants and, most notably, as organophosphate pesticides. H170 is different again in that it covers waste from timber preservation which in Australia has historically been dominated by chromated copper arsenate (CCA) treatment.

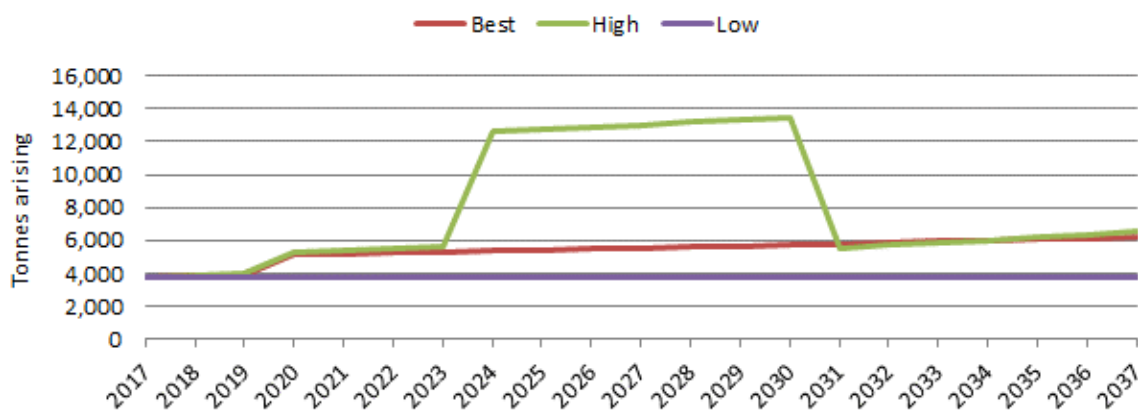
Summary analysis

Industry sources	Considerations	Comments	Approach
Services to agriculture; wood product manufacture; waste sector	<p>No sufficiently credible pre-existing projections were identified</p> <p>No historical data set exists that is adequate for discerning trends (several spikes in data)</p> <p>Dieldrin impregnated timber sleepers are stockpiled in significant volumes in WA</p>	<p>This is a high-storage waste; spikes are consistent with storage releases</p> <p>Spikes aside there is typically growth in the trends, except for NSW</p>	<p>Use causal analysis - Assume default economic growth</p> <p>Stockpile releases are considered in the 'best' case (slow release) and the 'high' case (cleared via new thermal infrastructure from 2024 onwards)</p>

Table 20: Best, high and low projected rates of change for pesticide waste to 2037

Applies to		Approach	2018	...	2024	...	2037
Arisings							
Best	ACT, NSW, NT, Qld, SA, Tas, Vic	Based on ACIL Tasman (2012)	1.4%	...	1.4%	...	1.4%
High		20-year average annual economic growth	2.8%	...	2.8%	...	2.8%
Low		20-year average annual population growth	0.0%	...	0.0%	...	0.0%
On-site storage releases (absolute tonnes pa)							
Best	WA	Stockpile slowly reduced at 2% pa, through existing infrastructure, (starting 2020)	0	...	1,200	...	1,200
High		As for best, but thermal infrastructure on-line in 2024 and clears stockpile in seven years	0	...	8,057	...	0
Low		Stockpile remains (status quo)	0	...	0	...	0

Figure 17: Best, high and low national projection estimates of pesticide waste to 2037



2.7.14 J100 & J160 Oils

This waste group includes:

- J100 waste mineral oils unfit for their original intended use; waste oil/water (predominantly)
- J160 waste tarry residues arising from refining, distillation, and any pyrolytic treatment (minor contribution).

J100 is dominated by used oil from vehicles. J160 is produced in the refining of petroleum, re-refining of lubricating oils, production of metallurgical coke or town gas by pyrolysis of coal.

Oil waste arisings are distributed across industries in jurisdictions quite similarly, with differences being more to do with jurisdictional industrial mix variations, such as the prevalence of mining in WA and Qld.

Since the 2015 report, J120 hydrocarbons/water mixtures or emulsions has been split out into its own group (see Section 2.6) due to the different management and infrastructure used for oils and oily waters.

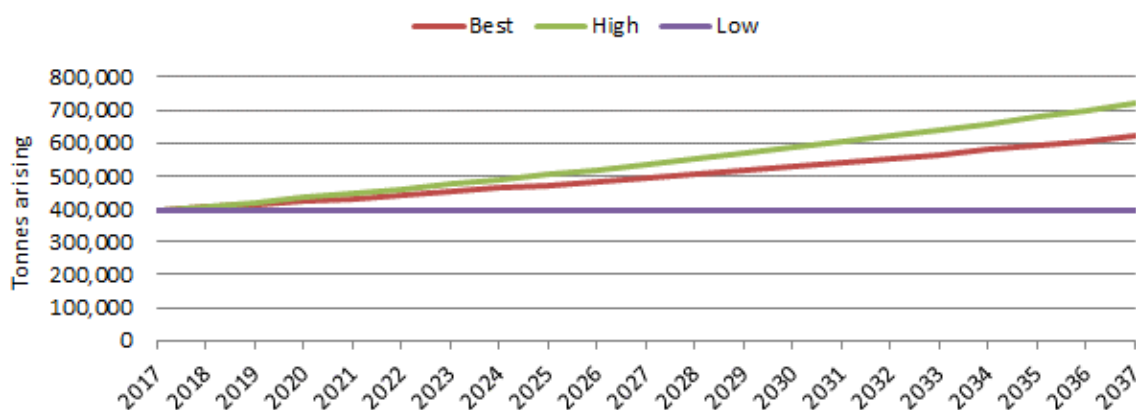
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> • Mining • Transport • Retail (vehicle servicing shops) • Waste sector 	No sufficiently credible pre-existing projections were identified	Consultation suggests mining oils are being increasingly managed on-site (poorly) - last five years	Best: Qld/WA = pop growth; other = econ growth
	NSW arisings are under-reported due to their exemption from tracking for re-refined oils	Historical tracking trends (ignoring NSW) generally show growth, also this has slowed since ~2012	High: WA/Qld = econ growth; others = Vic long-term CAGR
	PSO program (DoEE 2017) volume data used to estimate national arisings		Low: assume recent flat growth to continue

Table 21: Best, high and low projected rates of change for oil waste to 2037

	Applies to	Approach	2018	...	2037
Best	Qld, WA	20-year average annual population growth	1.4%	...	1.4%
High		20-year average annual economic growth	2.8%	...	2.8%
Low		Recent flat trend continues	0.0%	...	0.0%
Best	ACT, NSW, NT, SA, Tas, Vic	20-year average annual economic growth	2.8%	...	2.8%
High		Long-term Vic CAGR (excl. adjustment - tracking data only)	3.2%	...	3.2%
Low		Flat trend	0.0%	...	0.0%

Figure 18: Best, high and low national projection estimates of oil waste to 2037



2.7.15 J120 Waste oil/water mixtures

This waste group includes the single NEPM code *J120 hydrocarbons/water mixtures or emulsions*. J120 is typically wastewater that has been contaminated with oil, such as truck and vehicle washwater, skimmer and interceptor water, vehicle coolant water and potentially shipping bilge water.

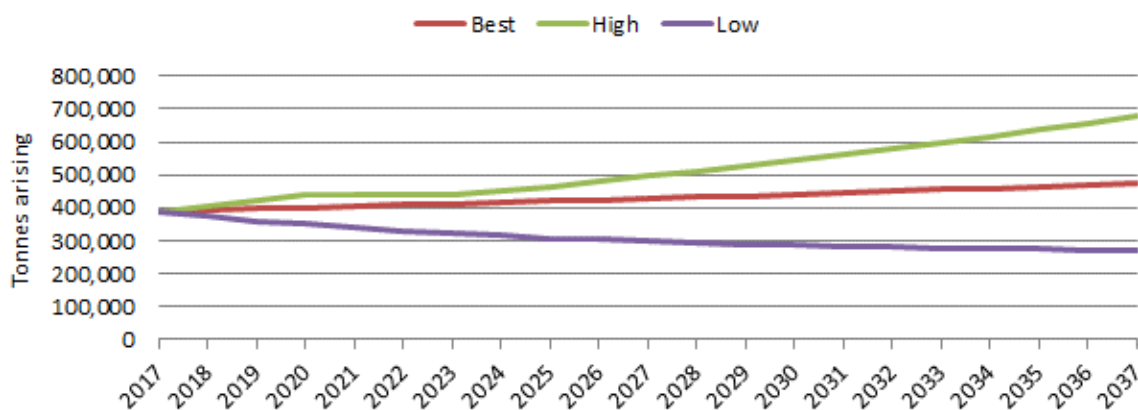
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Mining Transport Retail (vehicle servicing shops) Waste sector 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Expected to have sources much in common with J100</p>	<p>Very high storage waste nationally (30%) - practice most common in Qld</p> <p>Historical tracking trends suggest long-term flat to growth, with Qld the most notable rise until 2013-14, when volumes dropped slightly. Last five years shows Vic/NSW decline and Qld/WA relatively flat trend.</p>	<p>Best: NSW & Vic flat; others population growth</p> <p>High: Qld & WA - mining growth; NSW & Vic population growth; others economic growth.</p> <p>Low: Vic/ NSW CAGR declining rates averaged, others flat</p>

Table 22: Best, high and low projected rates of change for oily water waste to 2037

	Applies to	Approach	2018	...	2037
Best	NSW, Vic	20-year average annual population growth	0.0%	...	0.0%
High		20-year average annual economic growth	1.4%	...	1.4%
Low		Recent flat trend continues	-11.6%	...	-11.6%
Best	Qld, WA	20-year average annual economic growth	1.4%	...	1.4%
High		Long-term Vic CAGR (excl. adjustment - tracking data only)	6.0%	...	4.0%
Low		Flat trend	0.0%	...	0.0%
Best	ACT, NT, SA, Tas	20-year average annual economic growth	1.4%	...	1.4%
High		Long-term Vic CAGR (excl. adjustment - tracking data only)	2.8%	...	2.8%
Low		Flat trend	0.0%	...	0.0%

Figure 19: Best, high and low national projection estimates of oily water waste to 2037



2.7.16 K110 Grease trap waste

K110 Grease trap waste, or grease interceptor trap waste, is waste from a grease interceptor used for the capture of food, grease and solids before entry to the sewer. This waste includes any solids that are derived from the treatment of this waste. It is primarily sourced from retail food business, such as restaurants and fast food outlets. Grease trap is not tracked in NSW or SA.

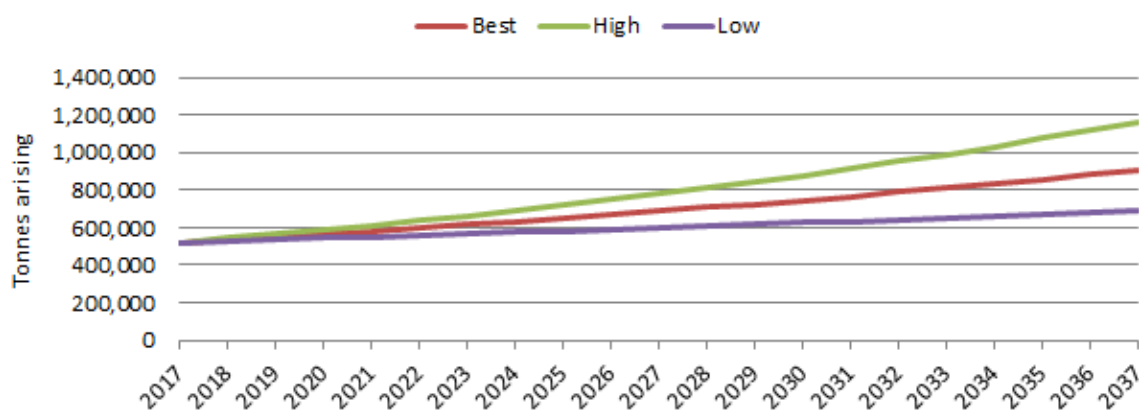
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Food product manufacturing Cafes and restaurants Supermarkets and grocery stores Waste sector (as collectors and aggregators from cafes and restaurants) 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Vic and WA trends are indicative of steady growth</p>	<p>This waste is not tracked in NSW or SA</p>	<p>Best: use economic growth as causal analysis</p> <p>High: use Vic CAGR (4.1%) growth as causal analysis</p> <p>Low: use population growth as causal analysis</p>

Table 23: Best, high and low projected rates of change for grease trap waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	20-year average annual economic growth	2.8%	...	2.8%
High	NT, Qld, SA,	Vic long-term CAGR as indicative of others	4.1%	...	4.1%
Low	Tas, Vic, WA	20-year average annual population growth	1.4%	...	1.4%

Figure 20: Best, high and low national projection estimates of grease trap waste to 2037



2.7.17 Other K Other putrescible/organic waste

This waste group represents the NEPM codes:

- *K100 Animal effluent and residues (abattoir effluent, poultry and fish processing wastes), plus the wastes unique to Qld: Liquid food processing waste and Vic/WA: Food and beverage processing wastes, including animal and vegetable oils and derivatives, all three described by their respective state tracking systems as 'K200'*
- *K140 Tannery wastes (including leather dust, ash, sludges and flours)*
- *K190 Wool scouring wastes.*

K100 Animal effluent and residues (and K200 within it) makes up the bulk of this group and includes abattoir wastes such as manure from the stockyards and the partly digested paunch or stomach content, as well as similar waste components from poultry and fish processing activities. It is notable that NSW does not track this waste group.

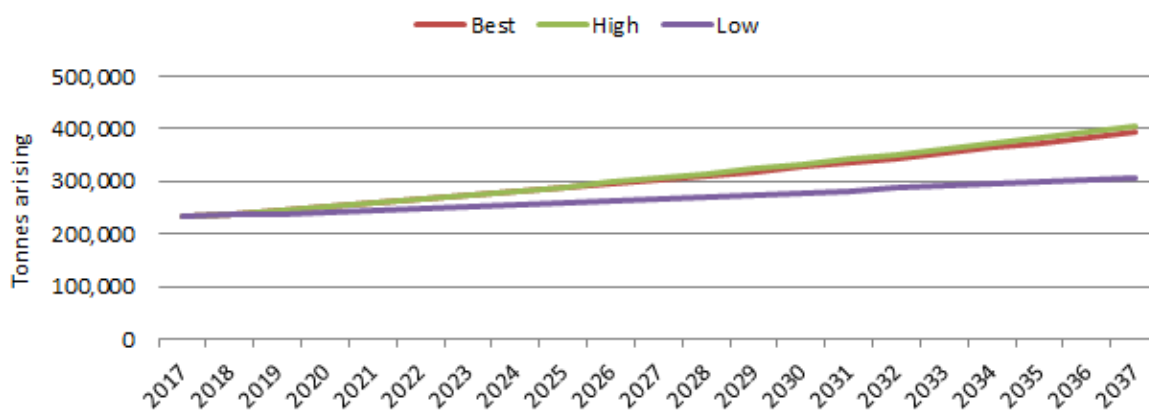
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Meat and meat product manufacturing; Food & beverage product manufacturing (meat, poultry, dairy, vegetable, fruit, beer, wine, soft drinks) Waste sector Leather & textiles manufacturing 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Vic and WA trends are indicative of flat and steady growth respectively</p>	<p>This waste is not tracked in NSW or SA</p>	<p>Best: meat production projected growth</p> <p>High: economic growth</p> <p>Low: Population growth</p>

Table 24: *Best, high and low projected rates of change for other putrescible/organic waste to 2037*

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	Av. projected ann. growth in meat production 2018-23	2.7%	...	2.7%
High	NT, Qld, SA,	20-year average annual economic growth	2.8%	...	2.8%
Low	Tas, Vic, WA	20-year average annual population growth	1.4%	...	1.4%

Figure 21: *Best, high and low national projection estimates of other putrescible/organic waste to 2037*



2.7.18 M100 PCB waste

This waste group includes the single NEPM code: *M100 waste substances and articles containing or contaminated with polychlorinated biphenyls, polychlorinated naphthalenes, polychlorinated terphenyls and/or polybrominated biphenyls.*

M100 was previously included in the broad catch-all of Other organic chemicals (Other M), but has been split out in this report as it is a specific Stockholm Convention POP with its own management requirements.

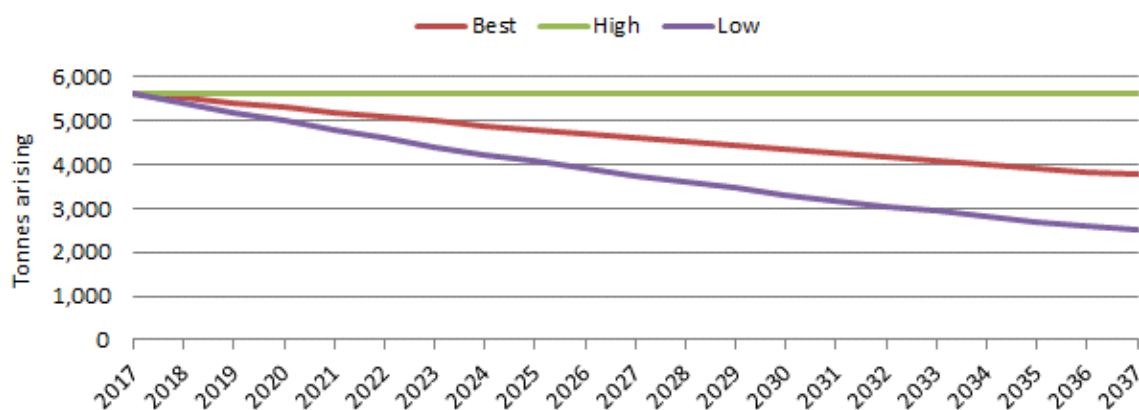
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> Electricity supply Waste sector 	<p>No sufficiently credible pre-existing projections were identified</p> <p>There is a major spike in Vic 2014-15 tracking data (due to miscoded PCB-contaminated soil). Ignoring this, NSW & WA are declining, while Vic and Qld appear to be increasing.</p>	<p>Overall national trend is relatively flat and somewhat sporadic, given the low volumes of this waste relative to other waste groups</p>	<p>Best: PCB-containing waste disappearing from waste stream</p> <p>High: Flat trend due to ongoing dismantling of aging infrastructure</p> <p>Low: PCB-containing waste disappearing from waste stream at higher rate</p>

Table 25: *Best, high and low projected rates of change for PCB waste to 2037*

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	-2% annual decline	-2.0%	...	-2.0%
High	NT, Qld, SA,	Flat	0.0%	...	0.0%
Low	Tas, Vic, WA	-4% annual decline	-4.0%	...	-4.0%

Figure 22: *Best, high and low national projection estimates of PCB waste to 2037*



2.7.19 M160a POP-BDEs

M160 Organohalogen compounds—other than substances referred to in this Table or Table 2 comprises:

- *M160a – POP-BDEs (Persistent Organic Pollutant – Brominated Diphenyl Ethers)*
- *M160b – HBCD (hexabromocyclododecane)*
- *M160c – HCB (Hexachlorobenzene).*

Each of these sub-groups is considered separately within this section. Along with PFAS waste, which is also discussed separately under *M270 Per- and poly-fluoroalkyl substances (PFAS) contaminated materials, including waste PFAS- containing products and contaminated containers*, M160a-c waste is collectively referred to as POP.

PBDEs have been used globally since the late 1970s for their flame-retarding properties and have been applied as an additive to a range of products including electrical and electronic equipment, furniture upholstery, automobile interiors, mattresses, carpet underlay and other items that are required to be flame-retardant. In May 2009 the Stockholm Convention's Conference of Parties agreed to add nine new POP to the Convention's annexes, including certain congeners contained in commercial pentabromodiphenyl ether (c-pentaBDE) and commercial octabromodiphenyl ether (c-octaBDE) and together referred to as POP-BDEs.

DecaBDE, another POP-BDE more recently added to the Stockholm Convention, also sits within M160a and is discussed in the breakout box overleaf.

Under the domestic treaty-making process, Australia must determine whether to ratify listing of the POP-BDEs after having taken into consideration the costs and benefits of the feasible technical options that it would need to implement to satisfy ratification. This decision has not yet been made.

DecaBDE, an emerging issue

While the production of commercial pentaBDE and octaBDE has long stopped, the production of decaBDE continues, as it has reduced toxicity compared to the lower brominated BDEs. Hard plastics used in electrical and electronic equipment in Australia had almost totally phased out the use of octaBDE as a flame-retardant by the year 2000. These were replaced by others like decaBDE, tetrabromobisphenol A (TBBPA) and decabromodiphenyl ethane (DBDPE).

The potential environmental impact of decaBDE has been under review over the last few years due to evidence that it can degrade in thermal processes, environmental processes and in biota to more dangerous lower brominated PBDEs, including POP-BDEs such as pentaBDE. In 2013, Norway drafted a proposal to list commercial decaBDE on the Stockholm Convention. After consideration at various stages of the Convention-listing process, decaBDE was formally listed on the Stockholm Convention at the eighth meeting of the Conference of the Parties to the Stockholm Convention held in Brussels in May 2017.

While there is likely to be a significant time-lag between this decision and an Australian regulatory response, this decision has far greater implications for the e-waste recycling industry in Australia than the listing of octaBDE, where large volumes of e-waste plastics are likely to be contaminated in high concentrations.

Summary analysis

Industry sources	Considerations	Comments	Approach
Brominated flame retardants are found in e-waste ABS plastics, furniture upholstery (polyurethane foam foams) and biosolids (downstream from industrial and domestic uses of these chemicals)	<ul style="list-style-type: none"> Australian biosolids are unlikely to exhibit POP-BDEs above 1,000 mg/kg (the Stockholm Convention's level of concern) WEEE that presents for landfill disposal (not recycling) is the major source of POP-BDEs Biggest issue is decaBDE, since it is still used for flame retardancy in manufactured EEE today (octa and penta were phased out in the late 1990s to mid-2000s) This means decaBDE will be a waste legacy issue for much longer than octa- and pentaBDE Although penta/octaBDE have not been intentionally added to WEEE since this time, some penta/octa could still be present >1000 mg/kg due to unintentional addition (contaminated recycle) 	<p>BE et al 2017 e-waste projections up to 2035 can be used in POP-BDE (from e-waste) projections. These indicate rapid e-waste growth.</p> <p>These projections are informed by good historical e-product use data.</p>	<p>Use e-waste only, since other waste streams are likely to be below 1,000mg/kg.</p> <p><u>decaBDE:</u> Assume growth directly follows national e-waste projected growth (BE et al 2017).</p> <p><u>octa- & pentaBDE:</u> Assume zero end of life (intentionally added) penta- & octaBDE items (KMH 2013) Assume some unintentional POP-BDEs will be above 1,000 due to contaminated recycle plastic (BE et al 2017) Assume Aust ratification occurs in 2020</p>

Starting point arising estimate

Penta-, octa- and decaBDE wastes are not currently represented in hazardous waste tracking data, primarily because their addition to the Stockholm Convention has not been ratified yet. Consequently, assumptions must be used to estimate a feasible starting-point tonnage that describes what might become available to the hazardous waste market once ratification occurs. These are as follows:

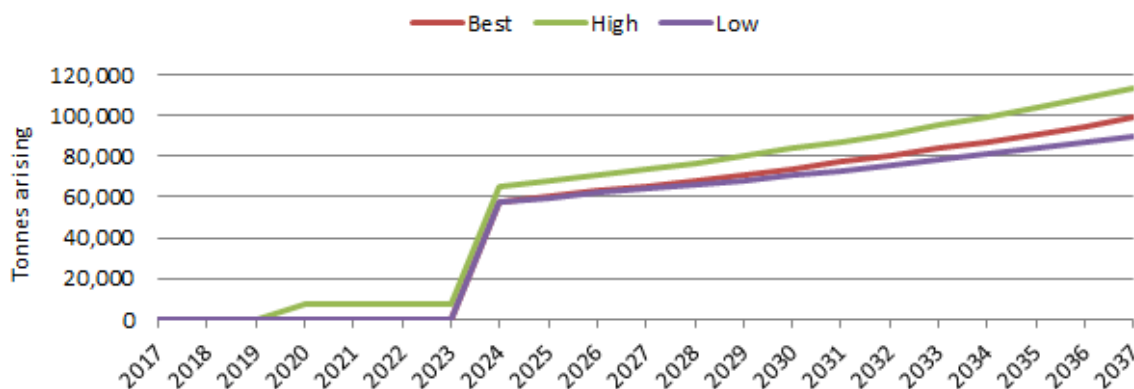
- pentaBDE = 0 tonnes arising in 2018 (KMH 2013), and remains that way throughout the projection period
- octaBDE = 131 tonnes (BE et al 2017), arising in 2020, when Australian ratification is assumed to occur
- decaBDE = 57,689 tonnes, arising in 2024, when Australian ratification is assumed to occur. DecaBDE starting point assumptions are:
 - BE (2016) (best) predicts 2024 Aust e-waste generation = 640,985 tonnes
 - DecaBDE is in widespread use - assume 30% of all e-waste plastic contains it = 192,295 tonnes
 - Assume decaBDE-containing plastic is dismantled & is 30% by weight of whole item = 57,689 tonnes
 - (30% is the average weight proportion of TVs and computers (UNEP 2012)).

Table 26: Best, high and low projected tonnes for POP-BDEs waste to 2037

Applies to		Approach	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Arisings - rate																							
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Av. projected ann. growth in e-waste 2021-35, best					4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%
High		Av. projected ann. growth in e-waste 2021-35, high					4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%
Low		Av. projected ann. growth in e-waste 2021-35, low					3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%
Arisings – absolute tonnes pa				Proportions																			
Best	ACT	Best estimate (absolute) + 50%	2%		2	2	2	2	971	1,012	1,054	1,098	1,144	1,192	1,242	1,294	1,349	1,405	1,464	1,526	1,590	1,657	
	NSW		31%		41	42	44	46	17,982	18,736	19,523	20,342	21,196	22,086	23,012	23,978	24,985	26,033	27,126	28,264	29,451	30,687	
	NT		1%		1	1	1	2	600	625	652	679	708	737	768	800	834	869	906	944	983	1,024	
	Qld		21%		27	28	29	31	11,906	12,406	12,927	13,469	14,034	14,623	15,237	15,877	16,543	17,237	17,961	18,714	19,500	20,318	
	SA		7%		9	9	10	10	3,993	4,161	4,335	4,517	4,707	4,904	5,110	5,325	5,548	5,781	6,024	6,276	6,540	6,814	
	Tas		2%		3	3	3	3	1,187	1,237	1,289	1,343	1,400	1,458	1,520	1,583	1,650	1,719	1,791	1,867	1,945	2,026	
	Vic		25%		33	34	35	37	14,360	14,963	15,591	16,245	16,927	17,637	18,378	19,149	19,952	20,790	21,662	22,572	23,519	24,506	
	WA		12%		15	16	17	18	6,836	7,123	7,422	7,733	8,058	8,396	8,749	9,116	9,498	9,897	10,312	10,745	11,196	11,666	
High	ACT				2	2	2	3	971	1,017	1,065	1,116	1,169	1,225	1,283	1,344	1,408	1,475	1,546	1,619	1,696	1,777	
	NSW				41	43	45	47	17,983	18,839	19,736	20,675	21,660	22,691	23,771	24,902	26,088	27,330	28,631	29,994	31,422	32,918	
	NT				1	1	1	2	600	629	659	690	723	757	794	831	871	912	956	1,001	1,049	1,099	
	Qld				27	28	30	31	11,907	12,474	13,068	13,690	14,341	15,024	15,739	16,489	17,273	18,096	18,957	19,860	20,805	21,795	
	SA				9	9	10	10	3,993	4,183	4,383	4,591	4,810	5,039	5,279	5,530	5,793	6,069	6,358	6,661	6,978	7,310	
	Tas				3	3	3	3	1,188	1,244	1,303	1,365	1,430	1,498	1,570	1,644	1,723	1,805	1,891	1,981	2,075	2,174	
	Vic				33	34	36	37	14,361	15,045	15,761	16,511	17,297	18,120	18,983	19,887	20,834	21,825	22,864	23,953	25,093	26,288	
	WA				15	16	17	18	6,837	7,162	7,503	7,860	8,234	8,626	9,037	9,467	9,918	10,390	10,885	11,403	11,946	12,514	
Low	ACT	Best estimate (absolute) - 50%			2	2	2	2	971	1,004	1,038	1,074	1,110	1,148	1,187	1,228	1,270	1,313	1,358	1,404	1,452	1,502	
	NSW				41	42	44	45	17,980	18,594	19,229	19,886	20,565	21,268	21,994	22,745	23,522	24,325	25,156	26,015	26,903	27,822	
	NT				1	1	1	2	600	621	642	664	687	710	734	759	785	812	840	868	898	929	
	Qld				27	28	29	30	11,905	12,312	12,732	13,167	13,617	14,082	14,563	15,060	15,574	16,106	16,656	17,225	17,813	18,422	
	SA				9	9	10	10	3,993	4,129	4,270	4,416	4,567	4,723	4,884	5,051	5,223	5,402	5,586	5,777	5,974	6,178	
	Tas				3	3	3	3	1,187	1,228	1,270	1,313	1,358	1,404	1,452	1,502	1,553	1,606	1,661	1,718	1,777	1,837	
	Vic				33	34	35	36	14,359	14,849	15,356	15,881	16,423	16,984	17,564	18,164	18,784	19,426	20,089	20,775	21,485	22,219	
	WA				15	16	17	17	6,836	7,069	7,310	7,560	7,818	8,085	8,361	8,647	8,942	9,248	9,564	9,890	10,228	10,577	

Figure 23 below charts the combined estimates for POP-BDEs (M160a) and HBCD (M160b), discussed below, on the basis that the infrastructure they could be managed by are the same. Consequently, their projections are also modelled together as M160a,b. Alternatively, M160c HCB is modelled separately on the basis that its historical management has been via export, to overseas infrastructure.

Figure 23: Best, high and low national projection estimates of POP-BDE and HBCD waste²² to 2037



2.7.20 M160b HBCD

A subset of the waste group *M160 Organohalogen compounds—other than substances referred to in this Table or Table 2*, *M160b Hexabromocyclododecane (HBCD)* is also a brominated flame retardant, but its historical application for flame retardancy in extruded and expanded polystyrene foams (used in building insulation) is quite different to the applications of the POP-BDE flame retardants.

HBCD was added to Annex B of the Stockholm Convention in May 2013 with specific exemptions and allowed uses. Under the domestic treaty-making process, Australia must determine whether to ratify listing of the HBCD after having taken into consideration the costs and benefits of the feasible technical options that it would need to implement to satisfy ratification. This decision has not yet been made.

Summary analysis

Industry sources	Considerations	Approach
End of life EPS/XPS building insulation panels/ materials from demolition or retrofitting of buildings	<ul style="list-style-type: none"> Australian biosolids are unlikely to exhibit HBCD above 1,000 mg/kg (the Stockholm Convention's level of concern) Currently presenting as part of construction and demolition (C&D) waste (not hazardous) since not under regulatory control yet No historical data set exists, although BE et al 2017 estimated theoretical annual arisings (if the waste was managed as hazardous) 	<p>High: assume 7.2 kt as calculated (BE et al 2017)</p> <p>Best: zero - assume no change in the quantity of materials requiring management</p> <p>Low: zero - assume no change in management</p> <p>Assume no growth - too many variables to predict</p> <p>Note that this means the best and low estimates are the same at zero tonnes pa in practical terms</p>

²² Combined projections for M160a and M160b

Starting point arising estimate

HBCD waste is not currently represented in hazardous waste tracking data, because the addition to the Stockholm Convention has not been ratified yet, and the fact that it arises within the C&D waste stream, and are currently managed as non-hazardous waste.

Consequently, assumptions must be used to estimate a feasible starting-point tonnage that describes what might become available to the hazardous waste market once ratification occurs. This has been done by BE et al 2017 - HBCD = 7,200 tonnes. This has been estimated to arise in 2020, when Australian ratification is assumed to occur.

Table 27: Best, high and low projected tonnes for HBCD waste to 2037*

Applies to		Approach	2020	...	2037
Arisings – absolute tonnes pa					
Best	All	No change in the quantity of materials requiring management	0	...	0
High	ACT	Absolute projections, no growth rate	121	...	121
High	NSW		2,238	...	2,238
High	NT		75	...	75
High	Qld		1,482	...	1,482
High	SA		497	...	497
High	Tas		148	...	148
High	Vic		1,787	...	1,787
High	WA		851	...	851
Low	All	No change in current management requirements	0	...	0

* Jurisdictional proportions of HBCD are distributed based on relative population, as was the case for POP-BDEs (in converting from a national estimate of 7,200 t/yr to jurisdiction-level breakdown).

Figure 23 (above) charts the combined estimates for POP-BDEs (M160a) and HBCD (M160b) on the basis that the infrastructure they could be managed by are the same. Consequently, their projections are also modelled together as M160a,b. Alternatively, M160c HCB is modelled separately on the basis that its historical management has been via export to overseas infrastructure.

2.7.21 M160c HCB

A subset of the waste group *M160 Organohalogen compounds—other than substances referred to in this Table or Table 2, M160c Hexachlorobenzene (HCB)* has been used historically as a pesticide and industrial by-product. HCB was one of the 12 POP originally listed in annexes to the Stockholm Convention in 2004, when Australia ratified its inclusion and became a party to the Convention. Its significance to hazardous waste in Australia is the single, well-documented stockpile, estimated to be 15,000 tonnes, stored at Orica's Port Botany facility in Sydney, for which a more permanent acceptable destruction or other management solution has not been found.

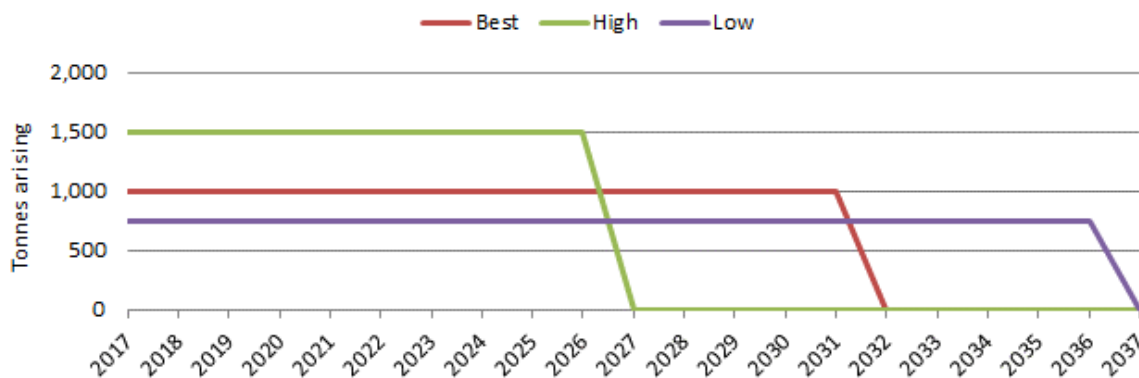
Summary analysis

Industry sources	Considerations	Approach
Sydney's Orica Port Botany stockpile is the only source of HCB waste in Australia	<ul style="list-style-type: none"> Stockpile is currently 15,000 t (ORICA 2017) This is made up of 10,300 t of concentrated waste and ~5,000 t of contaminated packaging material The concentrated waste is re-packaged periodically (ORICA 2017) This was estimated to be 10% (SIA 2008) but we will assume 5% due to new purpose-built repackaging plant (ORICA 2017) Two shipments were successfully sent to Finland and destroyed by high temperature incineration in 2017 These shipments totalled 1,635 t, and are envisaged to continue 	<p>There are no new arisings of the concentrated waste – only this stockpile is under consideration.</p> <p><u>High:</u> Assume 2017 treatment rate will become an annual rate of destruction, noting 5% re-packaging based annual stockpile growth rate. Round 1,635 t to 1,500 tpa.</p> <p><u>Best:</u> Assume 2/3 of 2017 treatment rate will become the annual rate of destruction, noting 5% re-packaging based annual stockpile growth rate. Rounding this becomes 1,000 tpa destroyed.</p> <p><u>Low:</u> Assume 1/3 of 2017 treatment rate will become the annual rate of destruction, noting 5% re-packaging based annual stockpile growth rate. Rounding this becomes 750 tpa destroyed.</p>

Table 28: Best, high and low projected tonnes for HCB waste to 2037

Applies to		Approach	2018	...	2037
Arisings – absolute tonnes pa					
Best	NSW	Conc. stockpile treated, packaging reduced. 1,000 tpa (2/3 of 2017 rate)	1,000	...	0
High	NSW	Conc. Stockpile & packaging fully treated - at 1,500 tpa (2017 rate)	1,500	...	0
Low	NSW	Conc. stockpile only treated. Destruction at 750 tpa (half of 2017 rate)	750	...	0

Figure 24: Best, high and low national projection estimates of HCB waste to 2037



2.7.22 M270a PFOS contaminated biosolids

The waste group M270 Per- and poly-fluoroalkyl substances (PFAS) contaminated materials, including waste PFAS- containing products and contaminated containers, has been split into three sub-groups for projection purposes, on the basis that each type of PFAS waste is different in how it arises and poses different management challenges:

- M270a perfluorooctanesulfonic acid or perfluorooctane sulfonate (PFOS) contaminated biosolids
- M270b per- and poly-fluoroalkyl substances (PFAS) contaminated soils
- M270c AFFF concentrates (containing PFOS).

The environmental and potential human health impacts from exposure to a group of manufactured chemicals known as PFAS are of increasing concern worldwide. The Heads of EPAs Australia and New Zealand (HEPA) and DoEE have collaborated to develop the PFAS National Environmental Management Plan (NEMP). The NEMP is designed to achieve a clear, effective coherent and nationally consistent approach to the environmental regulation of PFAS.

PFAS have been widely used for many decades in household products such as non-stick cookware, stain protection and food packaging as well as industrial and commercial applications, such as firefighting foams, mist suppressants and coatings. PFAS are persistent and highly resistant to physical, chemical and biological degradation. Consequently, they are found in humans, animals and the environment around Australia.

PFOS, the PFAS compound of most concern, was the key ingredient in Scotchguard, a fabric protector made by 3M, and numerous stain repellents and is currently used in an industrial context as a mist dispersant in surface coating and in firefighting foams. It was added to Annex B of the Stockholm Convention in May 2009. Under the domestic treaty-making process, Australia must determine whether to ratify listing of the PFOS after having taken into consideration the costs and benefits of the feasible technical options that it would need to implement to satisfy ratification. This decision has not yet been made.

M270a perfluorooctanesulfonic acid or perfluorooctane sulfonate (PFOS) contaminated biosolids is the subject of this section – the focus is more specifically on PFOS rather than the broader PFAS because the former is Stockholm-listed and the focus of more direct concern in a biosolids context.

Biosolids are a product of sewage sludge (the sludge collected from wastewater treatment) once it has undergone further treatment to reduce disease-causing pathogens and volatile organic matter, producing a stabilised product. Biosolids are typically 75-80% water in their wet state, compared to sewage sludge which is approximately 97% water. Biosolids have significant potential for beneficial reuse, which currently occurs throughout Australia.

All of the Stockholm Convention POP are potentially problematic in biosolids because of its propensity to act as a sink for pollutants that are non-polar or hydrophobic (tending to repel or fail to mix with water); in other words, these POP have a strong tendency to avoid water and adhere to organic solids in the wastewater stream. There is further complexity with PFOS because it is not non-polar *per se*; its long-chain perfluorinated structure means it can be both hydrophobic and lipophobic (tending to repel or fail to mix with oils). PFOS tends to bind to proteins (the most likely mode of adherence to biosolids) but it is also much more leachable in the environment than the other POP, due to its unusual hydrophobic/lipophobic properties.

The Stockholm Convention, and a number of individual European countries, either regulate now or are proposing to regulate PFOS specifically in biosolids, at much more stringent levels of concentration than in other materials/wastes.

PFOS, M160a-c wastes (POP-BDEs, HBCD and HCB), plus other chemicals listed on the Stockholm Convention (such as various organochlorine and organophosphorus pesticides), are collectively referred to as POP.

Summary analysis

Industry sources	Considerations	Comments	Approach
Biosolids - newly produced from wastewater treatment plants	<ul style="list-style-type: none"> Australian biosolids are unlikely to exhibit PFOS >50 mg/kg (the Stockholm Convention's level of concern), but a much lower biosolids-specific limit is likely (many overseas examples). Biosolids limit of 0.1 mg/kg applies in Germany; 0.39 (all PFAS) for biosolids in Qld (BE et al 2017) Based on limited data (Gallen et al 2016) a 0.1 mg/kg limit could mean as much as 370 kt of biosolids in Australia are contaminated PFOS-contaminated biosolids above Stockholm levels will no longer be allowed to be applied to land (post-PFOS ratification). They will require environmentally sound management. 	<p>A PFAS NEMP was agreed across Australian states and territories in 2018. It is understood that biosolids-specific issues, limits and actions will be the subject of the next iteration of the NEMP.</p> <p>The NEMP makes Stockholm POP ratification somewhat redundant, since the NEMP's existence provides the policy settings for dealing with PFAS contamination and waste issues. The new NEPM code M270, and its requirement for tracking, is proof of this.</p>	<p>Assume regulatory implementation of NEMP begins 2020</p> <p>Scenarios are based on what PFOS biosolids-specific limits may be applied in future</p> <p><u>Best</u>: Limit of 1 mg/kg results in 2% of total Australian biosolids contaminated</p> <p><u>High</u>: Limit of 0.1 mg/kg results in 25% of total Australian biosolids contaminated</p> <p><u>Low</u>: Limit of 50 mg/kg (current, non-biosolids specific limit) results in 0.1% of total Australian biosolids contaminated.</p>

Starting point arising estimate

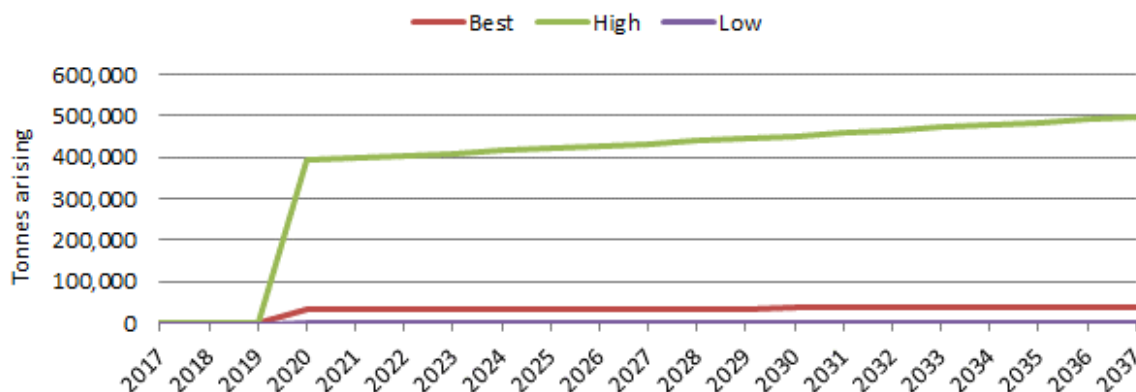
PFOS-contaminated biosolids are not represented in hazardous waste tracking data. Consequently, assumptions must be used to estimate a feasible starting-point tonnage that describes what might become available to the hazardous waste market once ratification occurs, or a subsequent revision of the NEMP instigates a lower, biosolids-specific limit. These are as follows:

- PFOS-contaminated biosolids are produced by states and territories in proportion to their population (except ACT - incinerates on-site)
- Scenarios based on potential biosolids regulatory limits of 1 mg/kg (best); 0.1 mg/kg (high) and the existing LPCL of 50 mg/kg (low). These produce the following tonnages (on a dewatered biosolids basis), beginning to arise in 2020:
 - Best = 31,143 tpa
 - High = 389,286 tpa
 - Low = 1,557 tpa.

Table 29: Best, high and low projected tonnes for PFOS contaminated biosolids waste to 2037

Applies to		Approach	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	
Arisings - rate																								
Best	All	20 yr av. annual population growth	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	
High			1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	
Low			1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Arisings – absolute tonnes pa			Proportions																					
Best	ACT	2% of Australian biosolids	-		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NSW		31%		9,957	10,097	10,240	10,385	10,531	10,680	10,831	10,984	11,139	11,296	11,456	11,617	11,781	11,948	12,117	12,288	12,461	12,637		
	NT		1%		332	337	342	347	352	357	362	367	372	377	382	388	393	399	404	410	416	422		
	Qld		21%		6,593	6,686	6,780	6,876	6,973	7,071	7,171	7,273	7,375	7,479	7,585	7,692	7,801	7,911	8,023	8,136	8,251	8,367		
	SA		7%		2,211	2,242	2,274	2,306	2,339	2,372	2,405	2,439	2,474	2,508	2,544	2,580	2,616	2,653	2,691	2,729	2,767	2,806		
	Tas		2%		658	667	676	686	695	705	715	725	736	746	756	767	778	789	800	811	823	835		
	Vic		25%		7,951	8,064	8,178	8,293	8,410	8,529	8,649	8,771	8,895	9,021	9,148	9,278	9,409	9,541	9,676	9,813	9,951	10,092		
	WA		12%		3,785	3,839	3,893	3,948	4,004	4,060	4,118	4,176	4,235	4,294	4,355	4,417	4,479	4,542	4,606	4,671	4,737	4,804		
High	ACT	25% of Australian biosolids			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NSW				124,460	126,218	128,000	129,807	131,640	133,499	135,385	137,296	139,235	141,201	143,195	145,217	147,268	149,347	151,456	153,595	155,764	157,964		
	NT				4,155	4,213	4,273	4,333	4,394	4,457	4,519	4,583	4,648	4,714	4,780	4,848	4,916	4,986	5,056	5,127	5,200	5,273		
	Qld				82,408	83,572	84,752	85,949	87,162	88,393	89,641	90,907	92,191	93,493	94,813	96,152	97,510	98,887	100,283	101,699	103,135	104,592		
	SA				27,638	28,028	28,424	28,825	29,232	29,645	30,064	30,488	30,919	31,356	31,798	32,247	32,703	33,165	33,633	34,108	34,589	35,078		
	Tas				8,219	8,335	8,453	8,572	8,693	8,816	8,940	9,067	9,195	9,325	9,456	9,590	9,725	9,863	10,002	10,143	10,286	10,432		
	Vic				99,393	100,796	102,219	103,663	105,127	106,611	108,117	109,643	111,192	112,762	114,354	115,969	117,606	119,267	120,951	122,659	124,391	126,148		
	WA				47,316	47,984	48,662	49,349	50,046	50,752	51,469	52,196	52,933	53,680	54,438	55,207	55,987	56,777	57,579	58,392	59,217	60,053		
Low	ACT	0.1% of Australian biosolids			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	NSW				498	505	512	519	527	534	542	549	557	565	573	581	589	597	606	614	623	632		
	NT				17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	21	21	21		
	Qld				330	334	339	344	349	354	359	364	369	374	379	385	390	396	401	407	413	418		
	SA				111	112	114	115	117	119	120	122	124	125	127	129	131	133	135	136	138	140		
	Tas				33	33	34	34	35	35	36	36	37	37	38	38	39	39	40	41	41	42		
	Vic				398	403	409	415	421	426	432	439	445	451	457	464	470	477	484	491	498	505		
	WA				189	192	195	197	200	203	206	209	212	215	218	221	224	227	230	234	237	240		

Figure 25: Best, high and low national projection estimates of PFOS contaminated biosolids waste to 2037



2.7.23 M270b PFAS contaminated soils

The waste group *M270 Per- and poly-fluoroalkyl substances (PFAS) contaminated materials, including waste PFAS- containing products and contaminated containers*, has been split into three sub-groups for projection purposes, on the basis that each type of PFAS waste is different in how it arises and poses different management challenges. *M270b Per- and poly-fluoroalkyl substances (PFAS) contaminated soils* is the subject of this section – the focus is more generally on PFAS rather than PFOS alone because the former is the subject of the PFAS NEMP, which triggers management actions for PFAS beyond just PFOS.

Soils contaminated in PFOS and broader PFAS chemicals are a major concern and driver of the PFAS NEMP process. Volumes are likely to be very large, due to the widespread historical use of PFOS-based firefighting foams, particularly at military, airport, major hazard facilities and other sites where firefighting training, testing and actual fire management has taken place.

PFAS contaminated soils – a large, new and current addition to the market

Aqueous film forming foams (AFFF) that contain PFOS have been widely used at sites such as airports, oil refineries, military bases, firefighting training facilities and other major hazard facilities (as defined in workplace health and safety legislation) for emergency and training purposes. Training exercises may occur on a weekly basis or even several times per week depending on the site. At sites where fire training drills occur, these are usually conducted on concrete slab training pads. Hydrocarbon-fuel (e.g. kerosene) is ignited and firefighters are then employed to extinguish the fire. The resultant exposure has led to the training ground infrastructure being contaminated by residual chemicals from the fuels used and most significantly from the fire-fighting foams.

PFOS contamination at these fire training grounds has bled into surrounding soil with run-off to surface water and seepage to groundwater causing large plumes of contamination. This contaminated soil has gained vastly increased regulatory attention in the last 2-3 years, as media reports of environmental and potential human health impacts from PFOS use have increased, starting with Oakey Army facility in Qld in 2010 and the Williamstown RAAF Base near Newcastle NSW in 2012.

Total estimates of PFOS-contaminated soil that may be present in Australia have not yet been made, or at least not on the public record. However, given the vast extent of the use of these foams, and the emerging large numbers of sites under investigation, volumes of PFAS-contaminated soil are likely to arise in large quantities over the next decade.

Summary analysis

Industry sources	Considerations	Comments	Approach
Sources are widespread, particularly from previous use of AFFF firefighting foams	<ul style="list-style-type: none"> PFAS-contaminated soil, concrete and other materials are the subject of current regulator attention, via the NEMP and subsequent state/territory actions Soil contaminated in PFAS is likely to be very high volume, given environmental values (HEPA 2018) are <<50 mg/kg Volumes are uncertain since the number of potentially affected sites is likely to be at least in the hundreds Potential volumes arising depend on levels of contamination within those soil/concrete volumes Contaminated waters would likely be remediated on-site using granular activated carbon (GAC) or similar media, creating waste GAC. 	A PFAS National Environmental Management Plan (NEMP) was agreed across Australian states and territories and the Commonwealth in 2018. Contaminated soils and their remediation/management are a major focus of the NEMP. The NEMP makes Stockholm POP ratification somewhat redundant, since the NEMP's existence provides the policy settings for dealing with PFAS contamination and waste issues. The new NEPM code M270, and its requirement for tracking, is proof of this.	<p>Assume regulatory implementation of NEMP begins 2020. Scenarios are based on arisings estimates (see Starting point arising estimate below.</p> <ul style="list-style-type: none"> A single stockpile in WA has 900,000 m³. NT report four known stockpiles of 100,000 m³, plus >100 sites of unknown scale Hundreds of defence, airports, fire-fighting facilities and major hazard facilities exist in Australia All are likely to have held AFFF stocks and many used them in training drills in previous years Standard N120 contaminated soils are reported at ~ 1.5 Mtpa nationally Assume PFAS soil arisings to be in a similar order to N120, each year, once regulatory implementation of PFAS NEMP is up and running

Starting point arising estimate

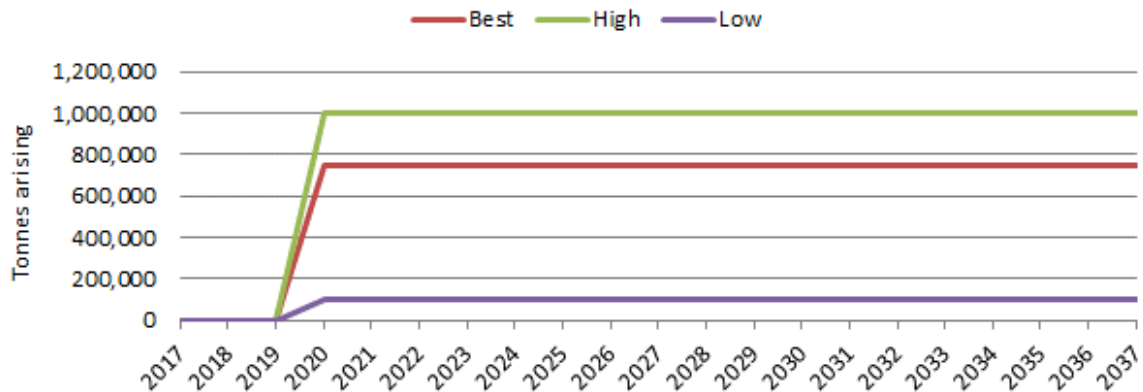
PFOS-contaminated soils are not represented in hazardous waste tracking data. Consequently, assumptions must be used to estimate a feasible starting-point tonnage that describes what might become available to the hazardous waste market once ratification occurs, or upon implementation of the NEMP. These are as follows:

- PFOS contaminated soils are produced by states and territories in proportion to their population
- Scenarios are simply an estimate of the amount of PFAS contaminated soils likely to present as a hazardous waste arising – since N120 contaminated soils arise consistently around 1.5 Mtpa, the best case is estimated to be approximately ½ of this figure; the high case 2/3 of this figure and the low case 1/10 of the high case figure
 - Best = 750,000 tpa
 - High = 1,000,000 tpa
 - Low = 100,000 tpa.
- Given the number of variables, no attempt has been made to model annual growth in these figures.

Table 30: Best, high and low projected tonnes for PFOS contaminated soils waste to 2037

Applies to	Approach	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Arisings – absolute tpa		Proportions																				
Best	ACT	1/2 of traditional contaminated soil arisings	2%		12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587	12,587
	NSW		31%		233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154	233,154
	NT		1%		7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783
	Qld		21%		154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377	154,377
	SA		7%		51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775	51,775
	Tas		2%		15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397	15,397
	Vic		25%		186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195	186,195
	WA		12%		88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638	88,638
High	ACT	2/3 of traditional contaminated soil arisings			16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783	16,783
	NSW				310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872	310,872
	NT				10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378	10,378
	Qld				205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836	205,836
	SA				69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033	69,033
	Tas				20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529	20,529
	Vic				248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259	248,259
	WA				118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184	118,184
Low	ACT	10% of high scenario			1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678
	NSW				31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087	31,087
	NT				1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038	1,038
	Qld				20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584	20,584
	SA				6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903	6,903
	Tas				2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053	2,053
	Vic				24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826	24,826
	WA				11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818

Figure 26: Best, high and low national projection estimates of PFOS contaminated soil waste to 2037



2.7.24 M270c AFFF concentrates (containing PFOS)

The waste group *M270 Per- and poly-fluoroalkyl substances (PFAS) contaminated materials, including waste PFAS- containing products and contaminated containers*, has been split into three sub-groups for projection purposes, on the basis that each type of PFAS waste is different in how it arises and poses different management challenges. *M270c AFFF concentrates (containing PFOS)* is the subject of this section.

AFFF containing very high (parts per hundred) level PFOS were used extensively in fire training and actual firefighting situations until relatively recent. Training drills conducted on concrete fire pads are routine at fire-risk sites such as defence facilities, airports, fire training facilities, fuel storage facilities and major hazard facilities. These activities are one of the major reasons for legacy PFOS contamination of the concrete pads, surrounding soil and waterways, both above and below ground. Since AFFF containing PFOS have been typically withdrawn from use there are significant quantities of the original foam concentrates still present at these sites. These are expected to arise in more significant quantities as a waste for disposal, once NEMP implementation/Stockholm ratification occurs.

Summary analysis

Industry sources	Considerations	Comments	Approach
Sources are widespread throughout Australia at locations such as defence facilities, airports, fire training facilities, fuel storage facilities and major hazard facilities, the latter inclusive of large industrial and mining sites	<ul style="list-style-type: none"> While AFFF stocks no longer to be used are not likely to be of the same scale as PFAS contaminated soils, the key issue with this waste is that it is extremely high in PFOS – typically 2-4% as a concentrate This makes handling and management of the waste high-risk in terms of the potential for contamination to occur 	A PFAS NEMP was agreed across Australian states and territories in 2018. The NEMP makes Stockholm POP ratification somewhat redundant, since the NEMP's existence provides the policy settings for dealing with PFAS contamination and waste issues. The new NEPM code M270, and its requirement for tracking, is proof of this.	<p>Assume regulatory implementation of NEMP begins 2020. Scenarios are based on arisings estimates (see Starting point arising estimate below.</p> <ul style="list-style-type: none"> BE et al 2014 suggests 1,507 t of AFFF stocks were likely to be present at that time Since Defence have been progressively destroying AFFF stocks since this time, assume this is all of the AFFF available 2010-2013 destruction of stocks reported to be ~ -8% pa Assume this continues (best); increases due to PFAS regulator attention & the stocks are actually double what we think they are and arise at the higher rate of 8% due to regulatory pressure (high) and in the low case the stocks are lower than we think they are (1,000 t) and continue to be destroyed at 8% pa.

Starting point arising estimate

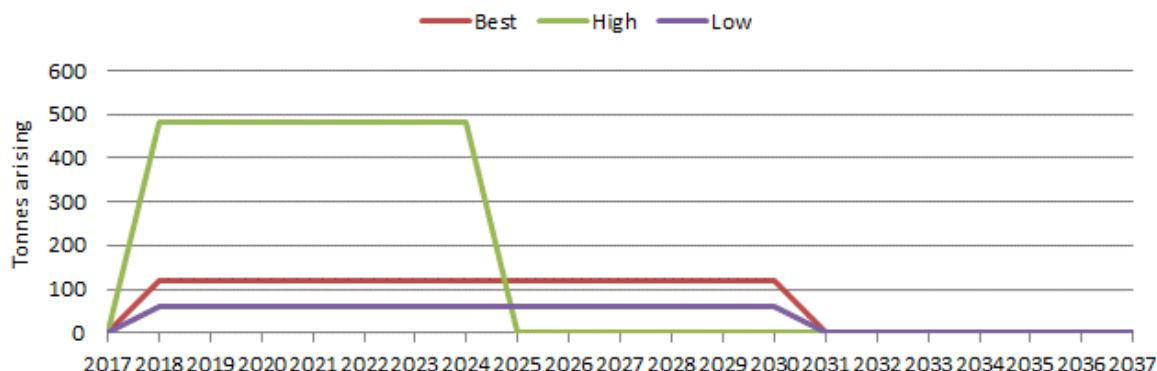
AFFF concentrates (containing PFOS) are possibly represented in tracking data, although their identification is very difficult because the M270 classification has only been adopted in 2018. Prior to this a number of NEPM codes appear to have been used, such as M160, D110 and possibly M250, and it is not easy to distinguish between what may have been AFFF concentrates and other types of waste in these categories. Consequently, assumptions must be used to estimate a feasible starting-point tonnage that describes what might become available to the hazardous waste market once ratification occurs, or upon implementation of the NEMP. These are as follows:

- AFFF concentrates (containing PFOS) arising as waste are produced by states and territories in proportion to their population
- BE et al 2014 suggests 1,507 t of AFFF were in stocks, noting that Defence data was not included in this figure
- The best scenario assumes that 1,507 t is an accurate reflection of all AFFF concentrates, including Defence, on the basis that Defence have historically taken steps ahead of other AFFF holders to progressively destroy their stocks
- The high scenario assumes that 1,507 t is not an accurate reflection of AFFF stocks, and that about as much again is present within Defence facilities
- The low scenario assumes that 1,507 t is a significant overestimate due to accelerated destruction of AFFF concentrates in the last 3-4 years, and that it is only half this figure (approximately 750 t).

Table 31: Best, high and low projected tonnes for AFFF concentrates to 2037

Applies to	Approach	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Arisings – absolute tpa	Proportions																					
Best	ACT	2%	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0
	NSW	31%	37	37	37	37	37	37	37	37	37	37	37	37	37	0	0	0	0	0	0	0
	NT	1%	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Qld	21%	25	25	25	25	25	25	25	25	25	25	25	25	25	0	0	0	0	0	0	0
	SA	7%	8	8	8	8	8	8	8	8	8	8	8	8	8	0	0	0	0	0	0	0
	Tas	2%	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0
	Vic	25%	30	30	30	30	30	30	30	30	30	30	30	30	30	0	0	0	0	0	0	0
	WA	12%	14	14	14	14	14	14	14	14	14	14	14	14	14	0	0	0	0	0	0	0
High	ACT	High: Assume rate of destruction continues at double the 2010-2013 rate (16%) and there is double the volume in stocks (starting point)	8	8	8	8	8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0
	NSW		150	150	150	150	150	150	150	0	0	0	0	0	0	0	0	0	0	0	0	0
	NT		5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0
	Qld		99	99	99	99	99	99	99	0	0	0	0	0	0	0	0	0	0	0	0	0
	SA		33	33	33	33	33	33	33	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tas		10	10	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	Vic		120	120	120	120	120	120	120	0	0	0	0	0	0	0	0	0	0	0	0	0
	WA		57	57	57	57	57	57	57	0	0	0	0	0	0	0	0	0	0	0	0	0
Low	ACT	Low: Assume rate of destruction continues at the 2010-2013 rate but the starting point is much lower due to higher destruction rates in the recent past	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	NSW		19	19	19	19	19	19	19	19	19	19	19	19	19	0	0	0	0	0	0	0
	NT		1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Qld		12	12	12	12	12	12	12	12	12	12	12	12	12	0	0	0	0	0	0	0
	SA		4	4	4	4	4	4	4	4	4	4	4	4	4	0	0	0	0	0	0	0
	Tas		1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Vic		15	15	15	15	15	15	15	15	15	15	15	15	15	0	0	0	0	0	0	0
	WA		7	7	7	7	7	7	7	7	7	7	7	7	7	0	0	0	0	0	0	0

Figure 27: Best, high and low national projection estimates of AFFF concentrates waste to 2037



2.7.25 Other M Other organic chemicals

This waste group includes the broad catch-all of the following NEPM codes:

- M150 phenols, phenol compounds including chlorophenols
- M170 & M180 polychlorinated dibenzo-furan and polychlorinated dibenzo-p-dioxin, respectively
- M210 cyanides (organic)
- M220 isocyanate compounds
- M230 triethylamine catalysts for setting foundry sands
- M250 surface active agents (surfactants) containing principally organic constituents
- M260 highly odorous organic chemicals (including mercaptans and acrylates).

Two waste codes have been split out of Other M since the 2015 edition of this report:

- M100 PCBs and M160 organohalogens, due to their own unique characteristics and regulatory interest.
- M250 surfactants as it is the dominant waste stream within Other M by volume.

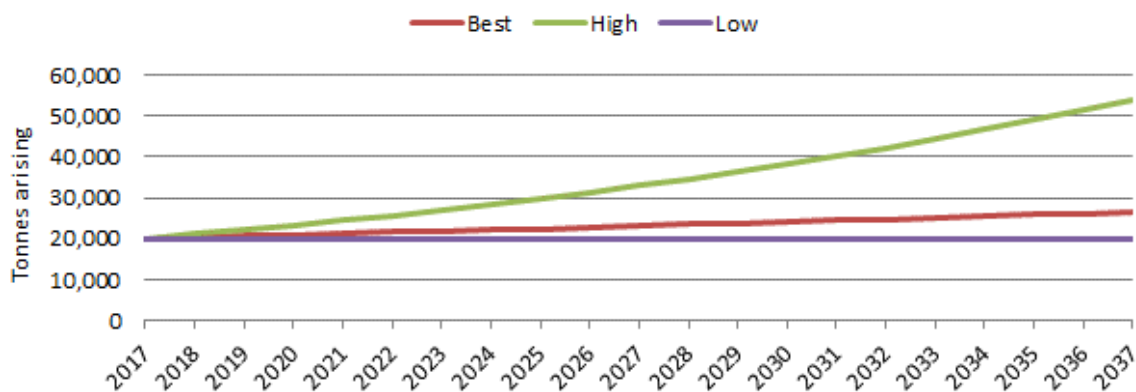
Summary analysis

Industry sources	Considerations	Approach
<ul style="list-style-type: none"> • Soap and detergent manufacturing • Chemical manufacturing • Various other manufacturing • Airline industry 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Historical data set is not adequate for clear trends to be identified – some decline in NSW, recent growth in Qld and reasonably flat for others</p>	<p>Best: CAGR (-1%) in NSW, modest growth (+1%) in others</p> <p>High: Flat in NSW, economic growth in others</p> <p>Low: More significant decline in NSW, flat in others</p>

Table 32: Best, high and low projected rates of change for other organic chemical waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	20-year average annual population growth	1.4%	...	1.4%
High	NT, Qld,	National compound annual growth rate	5.1%	...	5.1%
Low	SA, Tas, Vic, WA	Flat trend	0.0%	...	0.0%

Figure 28: Best, high and low national projection estimates of other organic chemical waste to 2037



2.7.26 N120 Contaminated soils

This group comprises *N120 Soils contaminated with a controlled waste*. NSW and Qld do not specifically track contaminated soils, but both were able to report data from landfill records. Note that projections of PFAS-contaminated soil are dealt with separately in Section 2.7.23 due to their unique and emerging management requirements compared to other forms of contaminants.

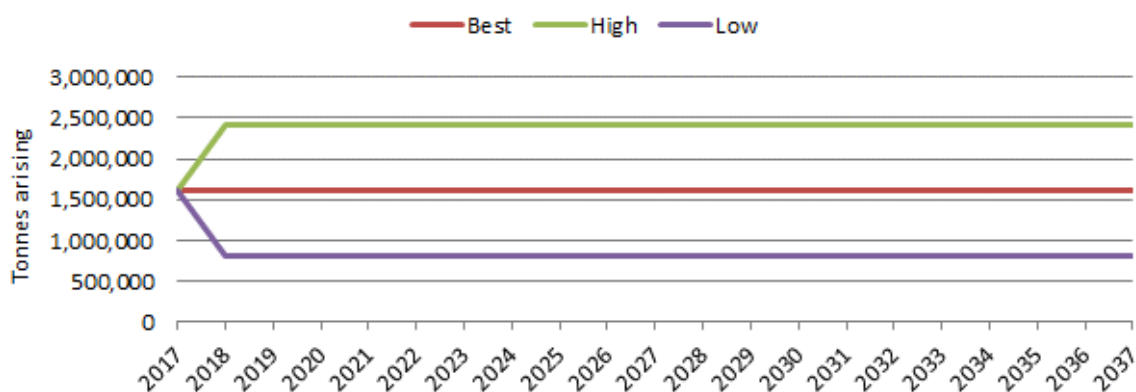
Summary analysis

Industry sources	Considerations	Comments	Approach
Construction, mining, retail trade, electricity supply	<p>No sufficiently credible pre-existing projections were identified</p> <p>Vic and SA have a relatively reliable and longstanding historical data set that is adequate for discerning trends</p>	<p>Vic and SA show a reasonably steady long-term trend</p> <p>Soils arisings tend to be sporadic from year to year, based on the extent of development projects and their contamination levels</p> <p>Historical arisings data for contaminated soils is based upon the tonnages that are managed off-site (from the generating site). Where contaminated soils are managed onsite, the tonnages are not included in tracking system data, resulting in an underestimate of contaminated soils tonnages.</p>	<p>Best: Flat</p> <p>High: Flat trend but volume is significantly higher</p> <p>Low: Flat trend but volume is significantly lower.</p> <p>This creates a wide band of projection scenarios, which reflects uncertainty and the lack of coherent trend from one year to the next</p>

Table 33: Best, high and low projected rates of change for contaminated soil waste to 2037

Applies to		Approach	2018	...	2037
Arisings - rate					
Best	ACT, NSW,	Flat trend	0.0%	...	0.0%
High	NT, Qld, SA,	As per best estimate, with adjustment below	0.0%	...	0.0%
Low	Tas, Vic, WA	As per best estimate, with adjustment below	0.0%	...	0.0%
Arisings – absolute tonnes pa					
High	ACT	Best estimate (absolute) + 50%	11	...	11
	NSW		174,188	...	174,188
	NT		4,323	...	4,323
	Qld		283,767	...	283,767
	SA		113,819	...	113,819
	Tas		3,330	...	3,330
	Vic		226,076	...	226,076
	WA		2,521	...	2,521
Low	ACT	Best estimate (absolute) - 50%	-11	...	-11
	NSW		-174,188	...	-174,188
	NT		-4,323	...	-4,323
	Qld		-283,767	...	-283,767
	SA		-113,819	...	-113,819
	Tas		-3,330	...	-3,330
	Vic		-226,076	...	-226,076
	WA		-2,521	...	-2,521

Figure 29: Best, high and low national projection estimates of contaminated soil waste to 2037



2.7.27 N205a. Other contaminated biosolids

Biosolids are a product of sewage sludge once it has undergone further treatment, producing a stabilised product. Like fly ash, biosolids have significant potential for beneficial reuse, which currently occurs throughout Australia. Suitable quality biosolids can be applied as a fertiliser to improve and maintain productive soils and stimulate plant growth.

Biosolids are not a controlled waste under the NEPM and consequently are not tracked in all jurisdictions. However, it is widely accepted that some biosolids – particularly those generated in treatment plants servicing industrial areas – are contaminated with heavy metals at levels exceeding criteria set to protect environmental and human health values. Other organic pollutants may also be present. Consequently, and conservatively, biosolids have been included in Australia’s annual hazardous waste reporting to the Basel Convention as a precaution. In the 2012 and 2013 Basel report, biosolids were included under the NEPM category *N205 Residues arising from industrial waste treatment/disposal operations*, along with other wastes that are reported to tracking systems under this category.

Biosolids guidelines exist in all jurisdictions that allow appropriate beneficial uses of biosolids matched to their inherent hazard (with respect to chemical contaminants such as heavy metals like cadmium, lead and mercury). While it is conservative to classify all biosolids as hazardous waste, it is logical that biosolids containing pollutants at concentrations exceeding the highest classification levels outlined in biosolids guidelines may be deemed to be hazardous waste: soil or other waste so contaminated would be regulated as hazardous. Consequently, the hazardous waste group contaminated biosolids was created for this project, with arisings estimates modelled from total national biosolids tonnages.

Biosolids mostly fall outside of the tracking process, although some states appear to track movements of sewage sludge (the raw state of biosolids), presumably based on issues such as odour and pathogenicity. The lack of tracking means biosolids are often missing from hazardous waste consideration; their inclusion for Basel reporting purposes is a recent development. They are not typically considered as hazardous waste, or even waste at all by some, but, like fly ash, they can contain contaminants such as heavy metals and even POP, that would make them a hazardous waste based on NSW or Vic waste contaminant classification concentrations.

While a hazard risk vs resource value tension exists for biosolids, the application of state-based biosolids guideline chemical contaminant concentration levels should ensure that beneficial reuse applications match the quality of the biosolids in a ‘fit for purpose’ way. This appears to be predominantly what occurs, although the authors were not able to obtain publicly available data to provide transparency to this evaluation process. The major exception to this was the two major Vic biosolids stockpiles (for Eastern and Western Treatment Plants), which have detailed analysis data in the public domain.

Apart from the scale of the waste stream (the largest of all reported to Basel), an emerging problem is that many biosolids guidelines applied by states and territories have varied coverage of hazardous chemicals. For example, SA and WA guidelines do not consider arsenic, mercury or lead, although these are the heavy metals within much of Vic’s historical Western Treatment Plant biosolids stockpile that exceed hazardous waste concentration thresholds.

A bigger issue is the potential presence of chemicals only relatively recently determined to be an environmental concern, such as the new Stockholm Convention listings of POP, which are known to be present in biosolids. Should these chemicals be present at levels high enough to cause concern, legislative change is foreseeable that could lead to a quite different set of biosolids management requirements in the near future. Note as detailed in Table 1, the projections for PFOS contaminated

biosolids are included with the projections for M270 (above) and to avoid double counting are not included in the projection for contaminated biosolids below.

Summary analysis

Industry sources	Considerations	Comments	Approach
Wastewater treatment	Credible projections exist (see DoE 2012b) but these are of CO ₂ -e emissions for a climate change context Expected to increase in line with population growth, assuming stability of infrastructure ACT has no biosolids – sewage sludge is incinerated on-site	PSD (2017) classifies biosolids production by contamination thresholds Contaminant grades used for this waste group are: <ul style="list-style-type: none"> grade 'unsuitable for use' or grades D or E (NSW, Qld) 	In all cases, assume all biosolids quantities grow proportionally with population Best case: PSD (2017) contaminated proportions are correct and remain constant Low case: PSD (2017) contaminated proportions are correct and decline to zero in 2038 High case: include all biosolids; Vic stockpile bleeds into infrastructure over 15 years, starting in 3 ACT is zero in all cases

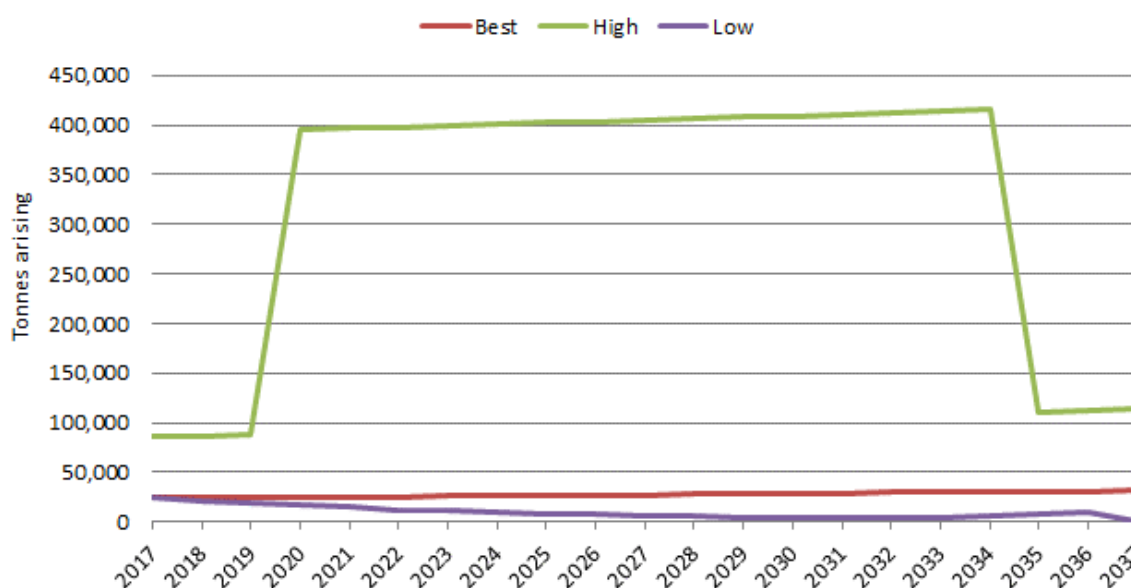
Table 34: Best, high and low projected rates of change for contaminated biosolid waste to 2037

Applies to		Approach	2018	...	2020	...	2037
Arisings - rate							
Best	ACT, NSW,	20-year average annual population growth	1.4%	...	1.4%	...	1.4%
High	NT, Qld,	20-year average annual population growth	1.4%	...	1.4%	...	1.4%
Low	SA, Tas, Vic, WA	20-year average annual population growth	1.4%	...	1.4%	...	1.4%
Arisings – absolute tonnes pa							
Best	ACT	PSD (2017) national contaminated proportion is correct for each state and territory, and remains constant.	0	...	0	...	0
	NSW		-312,466	...	-321,353	...	-407,858
	NT		-31,583	...	-32,481	...	-41,224
	Qld		-326,564	...	-335,852	...	-426,260
	SA	(Biosolids contaminated with M270 assumed to be distinct, and are therefore counted separately.)	-126,331	...	-129,924	...	-164,898
	Tas		-31,583	...	-32,481	...	-41,224
	Vic		-489,531	...	-503,454	...	-638,978
	WA		-142,122	...	-146,164	...	-185,510
High	ACT	Contaminated proportion for each jurisdiction is the highest of the PSD (2017) proportion reported as unsuitable for use or the proportion sent to landfill, stockpile, other or unspecified. (This proportions remains constant.)	0	...	0	...	0
	NSW		-303,193	...	-311,816	...	-395,754
	NT		-22,739	...	-23,386	...	-29,682
	Qld		-326,564	...	-335,852	...	-426,260
	SA		-126,331	...	-129,924	...	-164,898
	Tas	(Biosolids contaminated with M270 assumed to be distinct, and are therefore counted separately.)	-31,583	...	-32,481	...	-41,224
	Vic		-484,635	...	-498,419	...	-632,588
	WA		-102,328	...	-105,238	...	-133,567
	Vic	Vic stockpile bleeds into waste mgt infrastructure over 15 years starting in 3	0	...	306,222	...	0
Low	ACT	PSD (2017) national contaminated proportion is correct for each state and territory in 2017, and declines to zero in 2038.	0	...	0	...	0
	NSW		-313,322	...	-323,735	...	-412,244
	NT		-31,583	...	-32,481	...	-41,224

Applies to	Approach	2018	...	2020	...	2037
Qld	(Biosolids contaminated with M270 assumed to be distinct, and are therefore counted separately.)	-328,590	...	-341,735	...	-453,468
SA		-126,331	...	-129,924	...	-164,898
Tas		-31,583	...	-32,481	...	-41,224
Vic		-489,531	...	-503,454	...	-638,978
WA		-142,122	...	-146,164	...	-185,510

Growth rates given above are applied to an absolute baseline figure for each scenario.

Figure 30: Best, high and low national projection estimates of other contaminated biosolid waste to 2037



Note: the large increase in 2020 under the high scenario is a result of the assumed treatment of the Victorian contaminated biosolids stockpile over a 15-year period.

2.7.28 N205b Other industrial treatment residues

This category covers the single NEPM code *N205 Residues from industrial waste treatment/disposal operations*. For this project we rebadge this material as *N205b Other industrial treatment residues* to distinguish it from contaminated biosolids, which are not typically reported in jurisdictional tracking systems, and which we characterise as N205a. This NEPM group considers N205b, industrial treatment residues, not including any biosolids (contaminated or not contaminated).

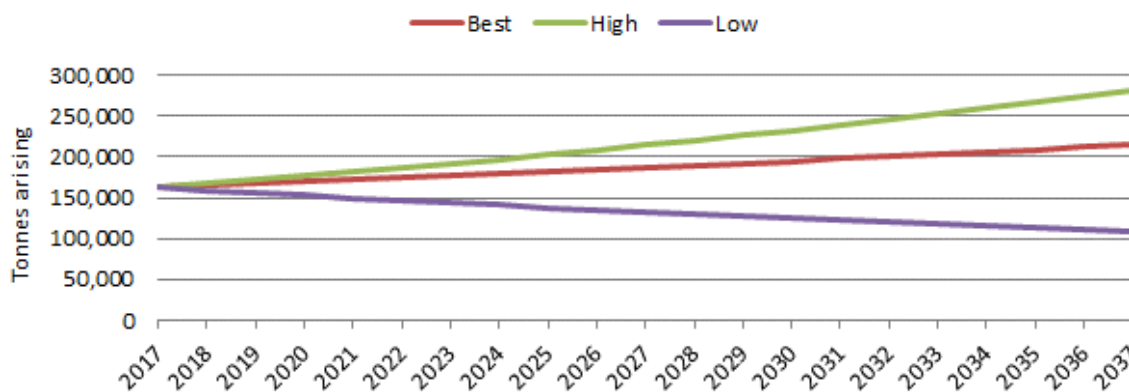
Summary analysis

Industry sources	Considerations	Approach
<ul style="list-style-type: none"> Waste treatment and disposal services Electricity supply Wastewater treatment plants 	<p>No sufficiently credible pre-existing projections were identified</p> <p>No historical data set exists that is adequate for discerning trends</p>	<p>Best: population growth</p> <p>High: economic growth</p> <p>Low: -2% annual decline</p>

Table 35: Best, high and low projected rates of change for other industrial treatment residue waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	20-year average annual population growth	1.4%	...	1.4%
High	NT, Qld, SA,	20-year average annual economic growth	2.8%	...	2.8%
Low	Tas, Vic, WA	2% annual decline	-2.0%	...	-2.0%

Figure 31: Best, high and low national projection estimates of other industrial treatment residue waste to 2037



2.7.29 N220 Asbestos

This waste group captures the single NEPM code of *N220 Asbestos*. Asbestos is the name given to a group of naturally occurring minerals found in rock formations. Asbestos-containing building products are classified as either friable (soft, crumbly) or bonded (solid, rigid, non-friable). Friable asbestos products may be as much as 100% asbestos fibres and can become airborne and inhalable very easily. Bonded products such as asbestos cement sheet (otherwise known as fibro) contain approximately 15% asbestos fibres, bonded with cement and do not normally release fibres into the air when in good condition.

Houses built before the mid-1980s are highly likely to have asbestos-containing products, between mid-1980s and 1990 likely, and after 1990 unlikely.

Asbestos is one of the largest flows of hazardous waste in Australia and poses significant health risks.

The Centre for International Economics 2017, [Headline economic value for waste and materials efficiency in Australia](#), page 30, includes analysis of the human health and economic costs of asbestos-related disease in Australia. Key findings include:

- in 2015 there were an estimated 4,152 deaths in Australia due to asbestos-related diseases, and 10,444 prevalent cases of disease
- hospital and primary healthcare costs associated with treating asbestos-related disease are an estimated \$185 million for 2015-16
- productivity losses were an estimated \$321 million in 2015-16, with 85 per cent of losses due to disease caused by occupational exposure (distributed evenly across paid and unpaid work) to asbestos
- in 2015 there were an estimated 58,754 Disability-Adjusted Life Years lost due to asbestos-related disease, excluding asbestosis (for which prevalence data was not available).

Asbestos waste includes both end-of-life asbestos-containing building materials as well as soil that has been tested to demonstrate asbestos contamination. Since the latter may involve very low asbestos fibre concentrations and very high soil volumes, this can greatly contribute to reported asbestos waste volumes. Jurisdictional tracking systems do not currently differentiate between asbestos-containing building materials and asbestos-contaminated soils. Sources of asbestos are C&D related as well as any residential, commercial or industrial buildings that are involved in removal of asbestos containing material.

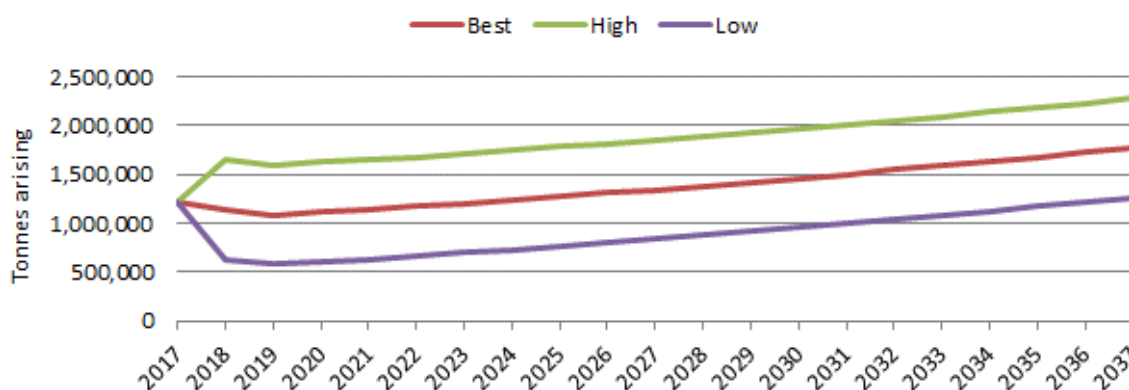
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> • C&D (including asbestos removal services) • Property development • Hospitals • Schools • Defence • Numerous sectors involved in asbestos removal from their buildings 	<p>No sufficiently credible pre-existing projections were identified</p> <p>There may be historical data set which are adequate for discerning trends</p>	<p>No evidence to suggest the supply of waste asbestos peaking or slowing</p> <p>Average 60-year lifespan of buildings suggests increasing quantities in the coming years</p> <p>NSW does not generally track asbestos</p> <p>Combined Vic, SA, Qld data between 05-06 and 12-13 is consistent with average 17% annual increase</p> <p>Estimates of >1,000 Mr Fluffy homes in ACT and NSW may need demolition (~30-60 kt)</p>	<p>Use judgement - trend and causal analysis</p> <p>Assume additional Mr Fluffy waste in the ACT over five years</p> <p>See range estimates in Belot 2014</p>

Table 36: Best, high and low projected rates of change for asbestos waste to 2037

Applies to		Approach	2018	...	2037
Arisings - rate					
Best	ACT, NSW,	20-year average annual economic growth	2.8%	...	2.8%
High	NT, Qld, SA,	As per best estimate, with adjustment below	2.8%	...	2.8%
Low	Tas, Vic, WA	As per best estimate, with adjustment below	2.8%	...	2.8%
Arisings – absolute tonnes pa					
Best	ACT	Mr Fluffy disposal estimate provided by ACT Govt	93,000	...	0
High	ACT	Best estimate + 10%	102,300	...	0
Low	ACT	Best estimate - 10%	83,700	...	0
High	NSW	Best estimate (absolute) + 50%	337,699		337,699
	NT		2,956		2,956
	Qld		74,015		74,015
	SA		5,885		5,885
	Tas		7,614		7,614
	Vic		59,313		59,313
	WA		19,500		19,500
Low	NSW	Best estimate (absolute) - 50%	-337,699	...	-337,699
	NT		-2,956	...	-2,956
	Qld		-74,015	...	-74,015
	SA		-5,885	...	-5,885
	Tas		-7,614	...	-7,614
	Vic		-59,313	...	-59,313
	WA		-19,500	...	-19,500

Figure 32: Best, high and low national projection estimates of asbestos waste to 2037



2.7.30 Other N Other soil/sludge

This waste group contains those remaining N group NEPM codes including:

- N100 containers & drums contaminated with residues of substances referred to in the NEPM 15 list
- N140 fire debris and fire wash waters
- N150 fly ash, excluding fly ash generated from Australian coal fired power stations
- N160 encapsulated, chemically-fixed, solidified or polymerised wastes referred to in the NEPM 15 list
- N190 filter cake contaminated with residues of substances referred to in the NEPM 15 list
- N230 ceramic-based fibres with physico-chemical characteristics similar to those of asbestos.

N160 is the largest contributor, as an output stream from CPT (including immobilisation), followed by N100 & N190. Other soil/sludge contains a waste of particular interest – fly ash.

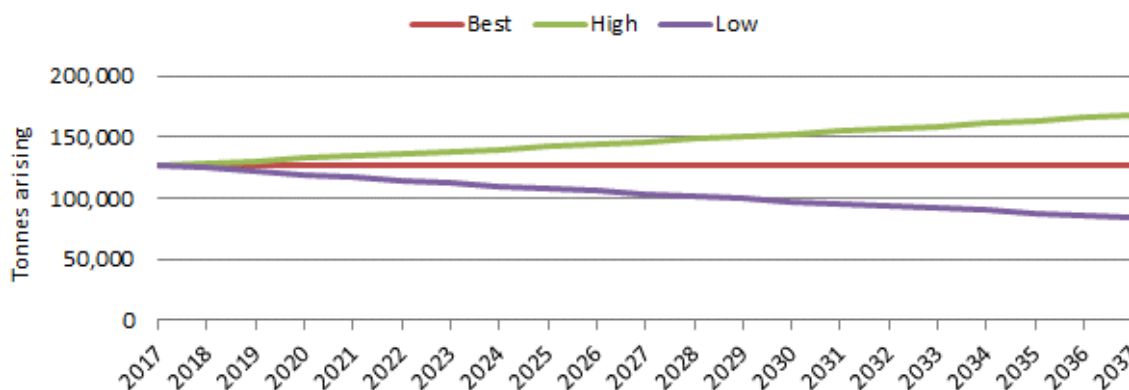
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> • Waste industry • Chemical product manufacturing • Metals manufacturing • Petroleum refining • Paper & paper product manufacturing 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Although spikes exist, Vic dataset indicates steady decline - others relatively flat over last 5-10 years</p>	<p>'Other soil/sludges' is not the ideal name but is consistent with the NEPM</p> <p>Trend supports anecdotal evidence from the waste industry that there is a decline in traditional CPT feedstock</p> <p>Energy-from-waste facilities likely to grow, initially in WA, producing 3% fly ash (Kalogirou et al. 2010)</p>	<p>Best: Flat trend overall</p> <p>High: Small growth +1%</p> <p>Low: Vic decline reflects all (declining traditional wastes into CPT). Vic CAGR (excluding start/end year spikes) = -3.1%</p>

Table 37: Best, high and low projected rates of change for other soil/sludge waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	Flat trend	0.0%	...	0.0%
High	NT, Qld, SA,	20-year average annual population growth	1.4%	...	1.4%
Low	Tas, Vic, WA	Vic decline in CPT indicative for all	-2.0%	...	-2.0%

Figure 33: Best, high and low national projection estimates of other soil/sludge waste to 2037



2.7.31 R Clinical and pharmaceutical

This waste group is made up of:

- R100 Clinical and related wastes
- R120 Waste pharmaceuticals, drugs and medicines
- R140 Waste from the production and preparation of pharmaceutical products.

Clinical and related wastes are wastes arising from medical, nursing, dental, veterinary, laboratory, pharmaceutical, podiatry, tattooing, body piercing, brothels, emergency services, blood banks, mortuary practices and other similar practices, and wastes generated in healthcare facilities or other facilities during the investigation or treatment of patients or research projects, which have the potential to cause disease, injury, or public offence, and includes sharps and non-sharps clinical waste.

Other wastes are also generated within health care settings. Waste pharmaceuticals, drugs and medicines are waste pharmaceutical products that have passed their recommended shelf life, been discarded as off-specification batches or been returned by patients or discarded. These wastes are often generated directly from pharmacies, hospitals, medical centres and hospital dispensaries.

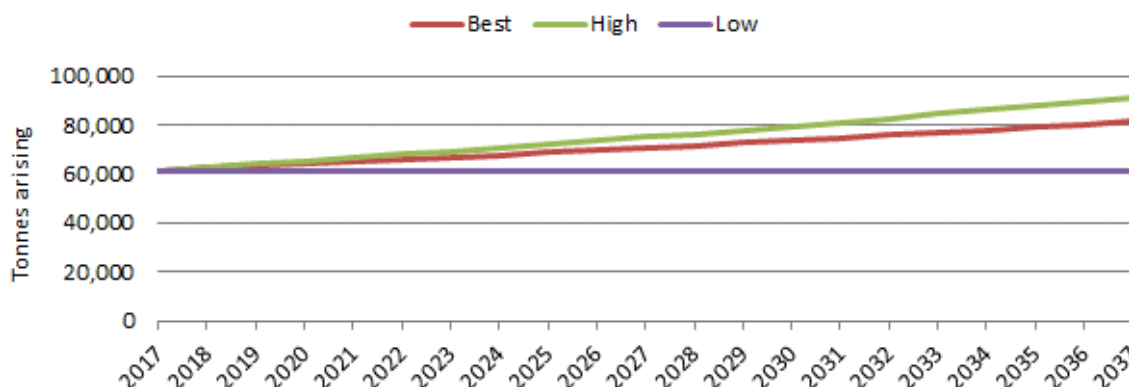
Summary analysis

Industry sources	Considerations	Comments	Approach
<ul style="list-style-type: none"> • Hospitals, health care centres and clinics • Nursing homes and aged care facilities • Dentists • Pharmacies 	<p>Credible projection exists (Thornton 2014)</p> <p>Vic, SA & WA 10+ year trends seem reasonable</p>	<p>Waste not tracked in NSW due to regulatory exemption</p> <p>There is potential to reduce hazardous waste by better separation in hospitals etc.</p>	<p>Best: Flat trend overall</p> <p>High: Thornton 2014 growth</p> <p>Low: -2% from best case, due to improved waste segregation, miniaturisation and mgt practices</p>

Table 38: Best, high and low projected rates of change for clinical and pharmaceutical waste to 2037

	Applies to	Approach	2018	...	2020
Best	ACT, NSW,	20-year average annual population growth	1.4%	...	1.4%
High	NT, Qld, SA,	Thornton 2014 growth rate (2.0 - 2.1%)	2.0%	...	2.0%
Low	Tas, Vic, WA	Flat trend	0.0%	...	0.0%

Figure 34: Best, high and low national projection estimates of clinical and pharmaceutical waste to 2037



2.7.32 T140 Tyres

This group is the sole NEPM category *T140 Tyres*. Waste tyres are used, discarded or rejected tyres that have reached the end of their useful life, i.e., when they can no longer be used for their original purpose, and are subsequently removed from a vehicle.

Tyres are only tracked in Qld and WA and the recorded arisings indicate that they are significantly under-reported in tracking data, when compared with credible recent estimates of arisings produced by REC (2016)²³. Consequently, in reporting to Basel and the 2012-13 dataset for this report, data from the Hyder report was used to estimate arisings.

Summary analysis

Industry sources	Considerations	Comments	Approach
Motor vehicle servicing industry	REC (2016a) provides credible and recent projections. No historical data set exists that is adequate for discerning trends – limited tracking data is patchy and unreliable	Only Qld & WA have historically tracked tyres, although NSW have recently begun doing so Tracking data has been replaced by more comprehensive data (Hyder 2015)	Use REC (2016a) Best + 10% Best -10%

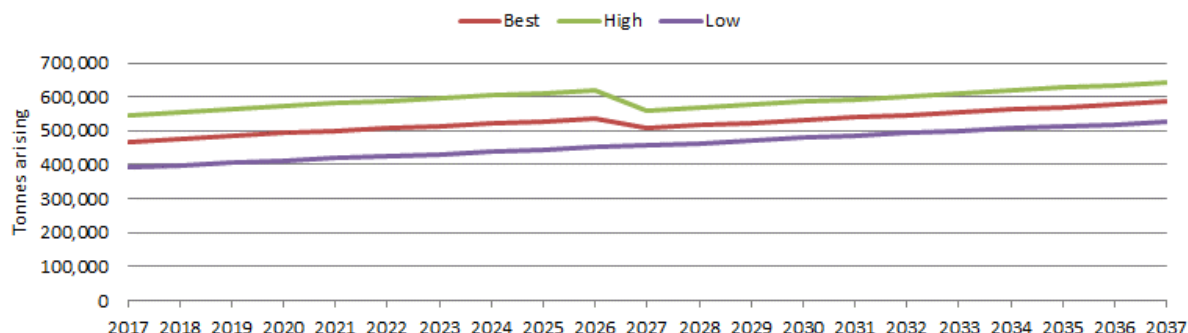
Table 39: Best, high and low projected rates of change for tyre waste to 2037

Applies to		Approach	2018	...	2037
Arisings – absolute tonnes pa					
Best	ACT	REC (2017) projections	7,398	...	10,060
	NSW		138,612	...	171,903
	NT		4,594	...	6,102
	Qld		90,581	...	125,161

²³ REC (Randell Environmental Consulting 2016) National market development strategy for used tyres, produced for Tyre Stewardship Australia and various others, available at: <https://www.accc.gov.au/system/files/public-registers/documents/AA1000409%20-%20Tyre%20Stewardship%20Australia%20Limited%20-%20Annexure%203%20-%20Appendix%20F%20-%20National%20Market%20Development%20Strategy%20for%20Used%20Tyres%20-%2005.12.17%20-%20PR.pdf>

Applies to		Approach	2018	...	2037
	SA		30,941	...	36,571
	Tas		9,278	...	10,098
	Vic		109,769	...	145,465
	WA		51,196	...	79,426
High	ACT	Best estimate (REC 2017) + 10%	8,138	...	11,066
	NSW		152,473	...	189,093
	NT		5,053	...	6,712
	Qld		99,639	...	137,677
	SA		34,035	...	40,229
	Tas		10,206	...	11,107
	Vic		120,746	...	160,011
	WA		56,316	...	87,368
Low	ACT	Best estimate (REC 2017) - 10%	6,659	...	9,054
	NSW		124,751		154,712
	NT		4,134	...	5,492
	Qld		81,523	...	112,644
	SA		27,847	...	32,914
	Tas		8,350	...	9,088
	Vic		98,792	...	130,918
	WA		46,077	...	71,483
Stockpiles – absolute tonnes pa					
Low	All	Stockpiles - no new additions and no releases	-	...	-
Best	ACT	Stockpiles - no new additions and 5% per annum cleared to recycling infrastructure from 2018 until 50% cleared	363	...	0
	NSW		10,038	...	0
	NT		550	...	0
	Qld		8,075	...	0
	SA		1,500	...	0
	Tas		1,100	...	0
	Vic		7,138	...	0
	WA		6,050	...	0
High	ACT	Stockpiles - no new additions and 10% per annum cleared to recycling infrastructure from 2018 until 100% cleared	725	...	0
	NSW		20,075	...	0
	NT		1,100	...	0
	Qld		16,150	...	0
	SA		3,000		0
	Tas		2,200	...	0
	Vic		14,275	...	0
	WA		12,100	...	0

Figure 35: Best, high and low national projection estimates of tyre waste to 2037



2.7.33 Other T Other miscellaneous

This waste group includes:

- T100 waste chemicals from research and development or teaching activities
- T120 waste from the production & use of photographic chemicals and processing materials
- T200 waste of an explosive nature not subject to other legislation.

This waste group is a collection of relatively unrelated wastes that are produced in small quantities and are made up of mostly T100, from schools, universities and other laboratory facilities such as those related to mining.

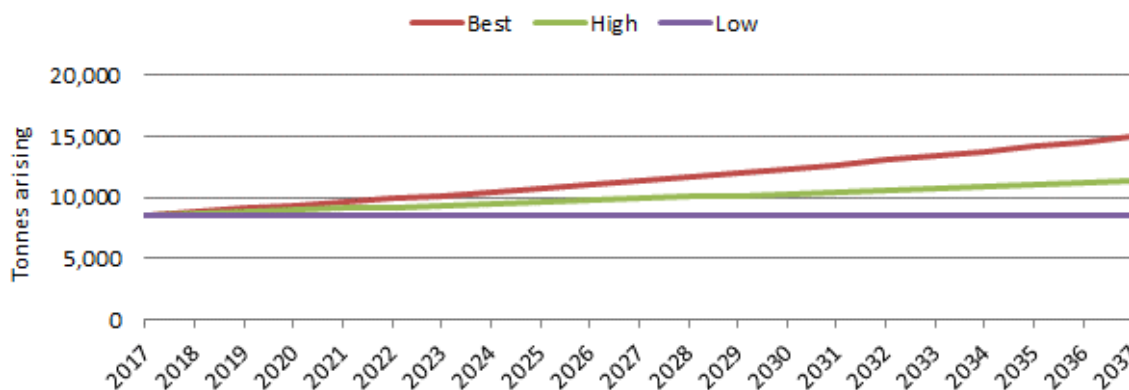
Summary analysis

Industry sources	Considerations	Approach
<ul style="list-style-type: none"> Waste sector Public administration & other education Mining Explosives manufacturing Printing Water supply, sewerage & drainage services 	<p>No sufficiently credible pre-existing projections were identified</p> <p>Vic historical data set shows a long-term decline curve, with other jurisdictions generally increasing</p>	<p>All: Use general rates of growth with flat as the low case</p>

Table 40: Best, high and low projected rates of change for other miscellaneous waste to 2037

	Applies to	Approach	2018	...	2037
Best	ACT, NSW,	20-year average annual population growth	2.8%	...	2.8%
High	NT, Qld, SA,	20-year average annual economic growth	1.4%	...	1.4%
Low	Tas, Vic, WA	Flat trend	0.0%	...	0.0%

Figure 36: Best, high and low national projection estimates of other miscellaneous waste to 2037



2.7.34 Lithium ion batteries (not regulated as hazardous waste)

Although lithium ion batteries are not regulated as hazardous waste²⁴, they are assessed in this report because of their potential to have a significant impact on hazardous waste infrastructure. Lithium ion battery use has been increasing strongly and, if not appropriately managed, represents a safety hazard due to risks of causing explosions and or fire (ABRI 2014).

Summary analysis

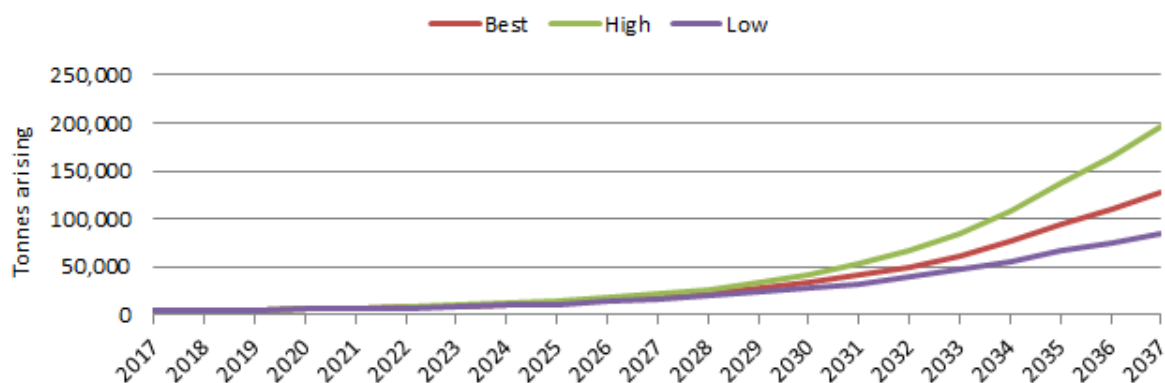
Considerations	Comments	Approach
<p>Projections for lithium ion batteries are considered for three differing sizes:</p> <ul style="list-style-type: none"> handheld batteries automotive batteries large and industrial batteries. <p>Recent projections exist: REC (2018) - lithium ion waste report for DoEE</p>	<p>Sales of rechargeable lithium ion batteries account for about 24% of all batteries by weight and 7% by unit. They have grown strongly since 2003–04, and are forecast to continue to do so as they enable new applications and replace other chemistries in existing applications (NC & SRU 2014).</p>	<p>Use REC (2018) projections</p>

²⁴ Waste lithium ion batteries are regulated as hazardous waste for international transport, but currently not for domestic transport

Table 41: Best, high and low projected rates of change for lithium ion battery waste to 2034

Applies to		Approach	2018	...	2037
Arisings – absolute tonnes pa					
Best	ACT	REC (2018) projections best estimate	65	...	2,194
	NSW		1,230	...	37,484
	NT		41	...	1,331
	Qld		798	...	27,292
	SA		275	...	7,975
	Tas		83	...	2,202
	Vic		970	...	31,719
	WA		447	...	17,319
High	ACT	REC (2018) projections high estimate	65	...	3,388
	NSW		1,230	...	57,889
	NT		41	...	2,055
	Qld		798	...	42,149
	SA		275	...	12,316
	Tas		83	...	3,400
	Vic		970	...	48,986
	WA		447	...	26,747
Low	ACT	REC (2018) projections low estimate	65	...	1,466
	NSW		1,230	...	25,054
	NT		41	...	889
	Qld		798	...	18,241
	SA		275	...	5,330
	Tas		83	...	1,472
	Vic		970	...	21,201
	WA		447	...	11,576

Figure 37: Best, high and low national projection estimates of lithium ion battery waste to 2037



2.8 Management of hazardous waste

The states with tracking systems (NSW, Qld, SA, Vic and WA) all record in their tracking data how each load of hazardous waste was managed (the management method). The management methods are classified differently across the states but DoEE has established a standard for converting to the lowest common denominator set of management data represented by NSW and SA, see BE *et al.* 2017 Appendix F.

The project team analysed jurisdictional tracking system data to determine the management methods for each waste group. The overall tonnage by management method in these jurisdictions was compiled for 2016-17 and is presented in Figure 38.

The tracking system data presented covers some waste groups partially (e.g. tyres), or not at all because the wastes are not required to be tracked (e.g. lithium ion batteries). Some wastes, such as PFAS contaminated soils, were not tracked separately in 2016-17 and therefore there is no data to report separately.

The management methods presented in Figure 38 are not always accurate or comprehensive. The reported management method required a number of adjustments for several reasons, including that:

- some smaller allocations of waste fates are apparently mistaken (e.g. a small amount of asbestos was recorded under recycling)
- the CPT infrastructure group is broad, and likely to include some waste fates apart from treatment (e.g. some recycling or biodegradation)
- similarly, some waste allocated to treatment is better considered recycling
- some allocations are very small and not material to this assessment
- exports are not accounted for.

The management method 'other' was excluded and gaps were filled through estimates. A full and transparent account of the adjustments made to the reported management methods for each waste group, for each jurisdiction, is included in the *Hazardous waste needs vs capacity model*, see 'waste mgt' tab column N.

The adjusted management methods by jurisdiction and waste group are included in Figure 39 to Figure 44. These estimates were applied in comparing future demand with infrastructure capacity, see Section 4.

Figure 38: The management method of reported tracked hazardous waste in NSW, Qld, SA, Vic and WA, 2016-17 (tonnes)

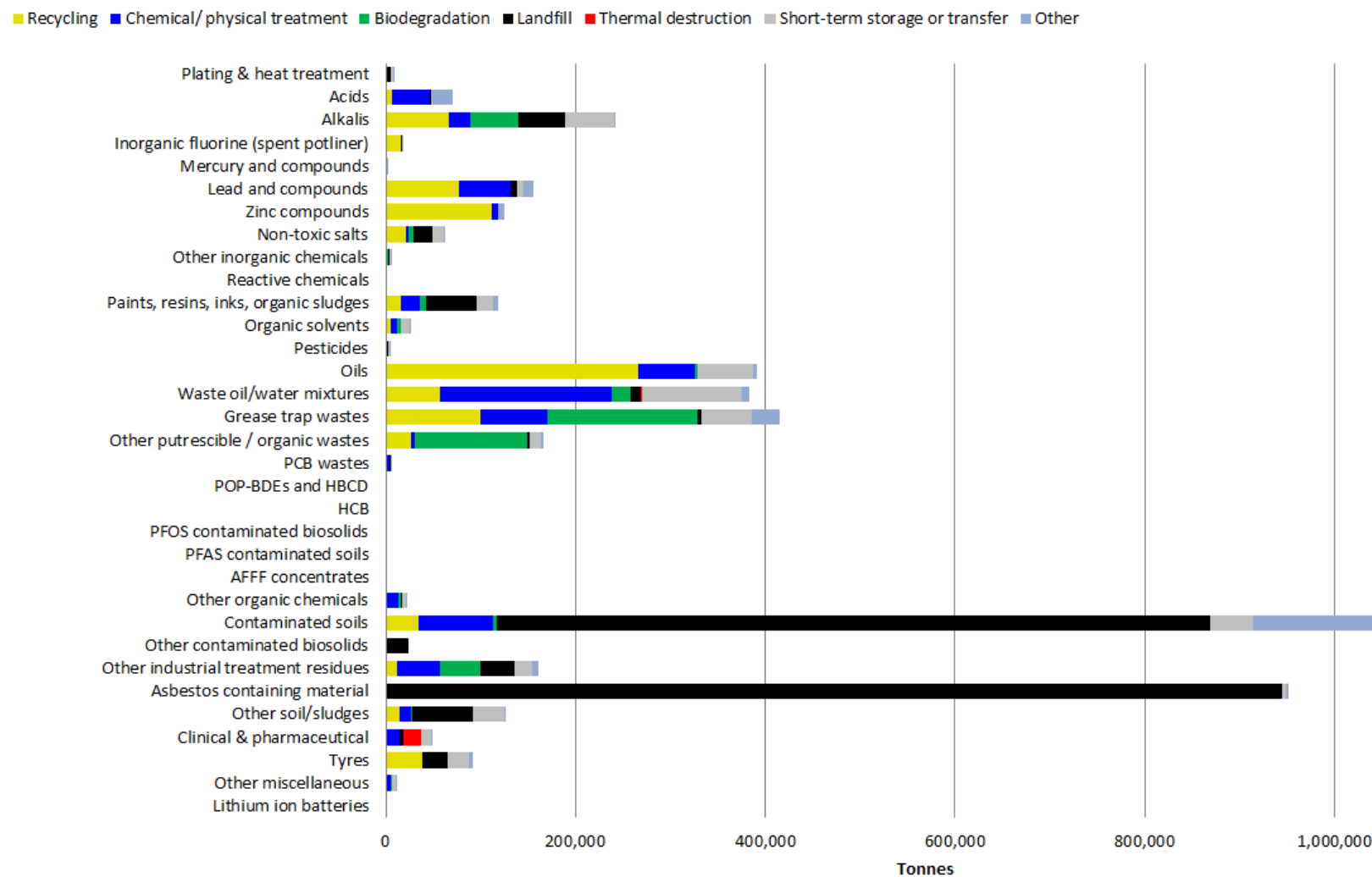


Figure 39: The assumed proportional management of each waste group in NSW, as used for comparing demand and capacity,

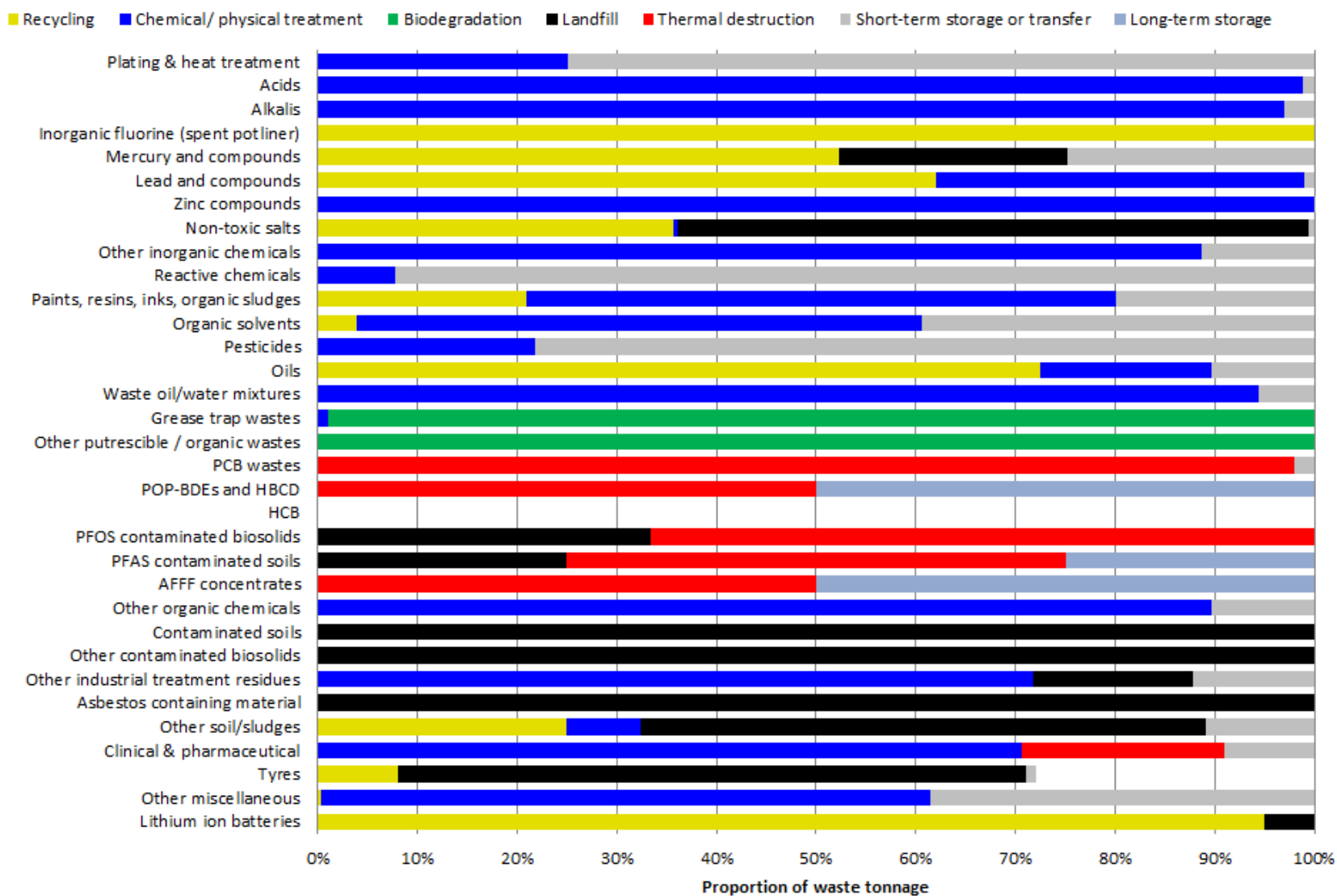


Figure 40: The assumed proportional management of each waste group in Qld, as used for comparing demand and capacity,

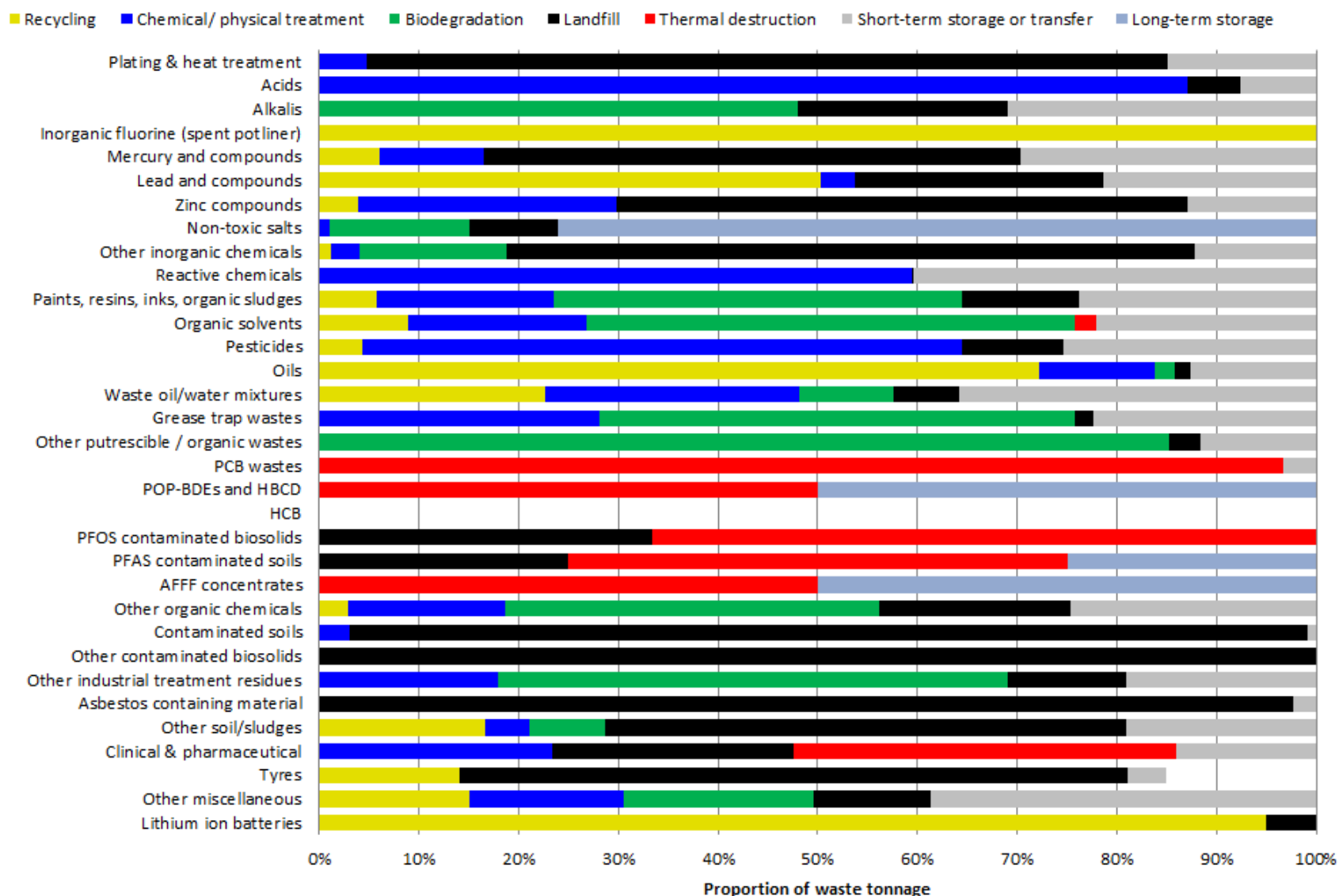


Figure 41: The assumed proportional management of each waste group in SA, as used for comparing demand and capacity,

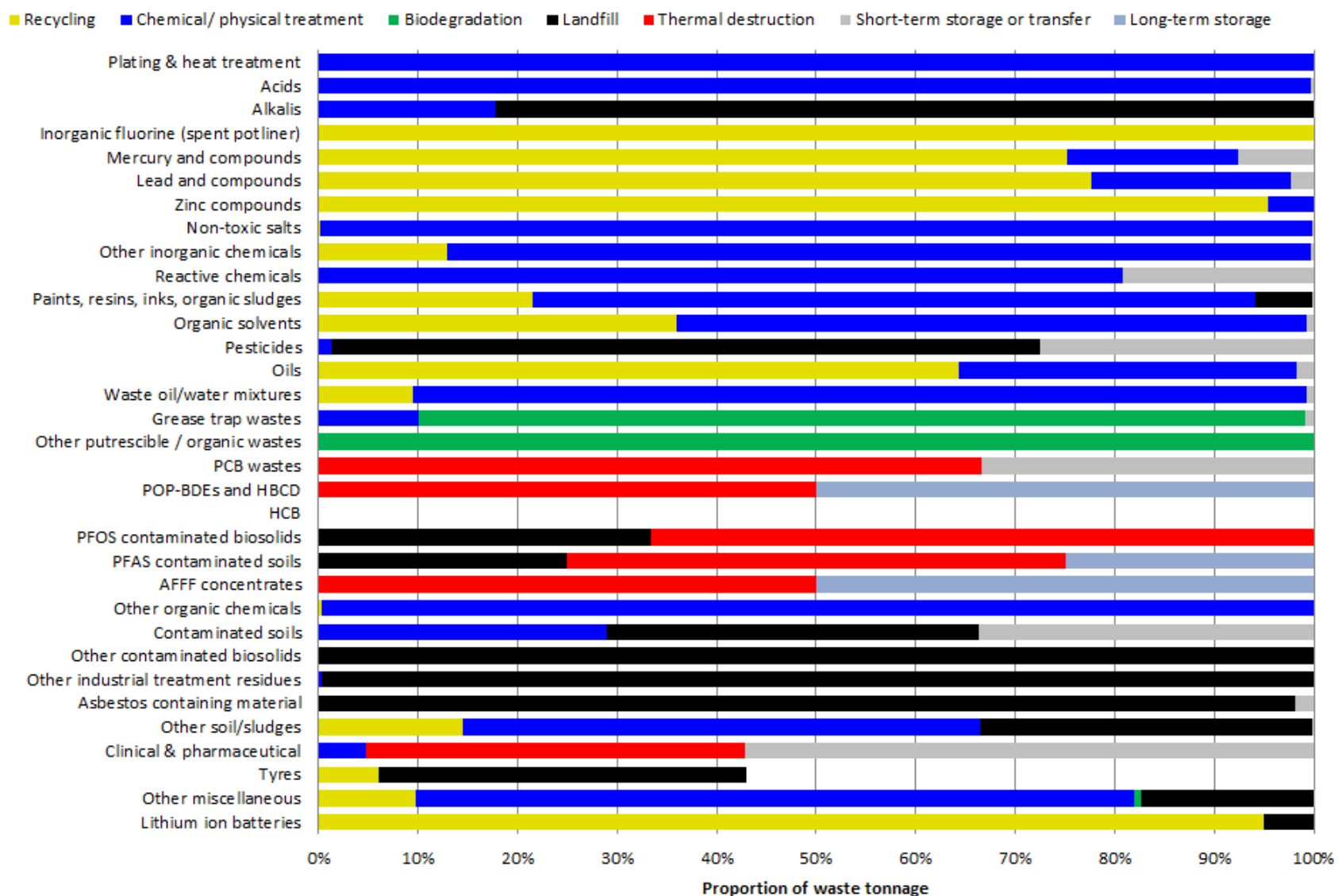


Figure 42: The assumed proportional management of each waste group in Vic, as used for comparing demand and capacity

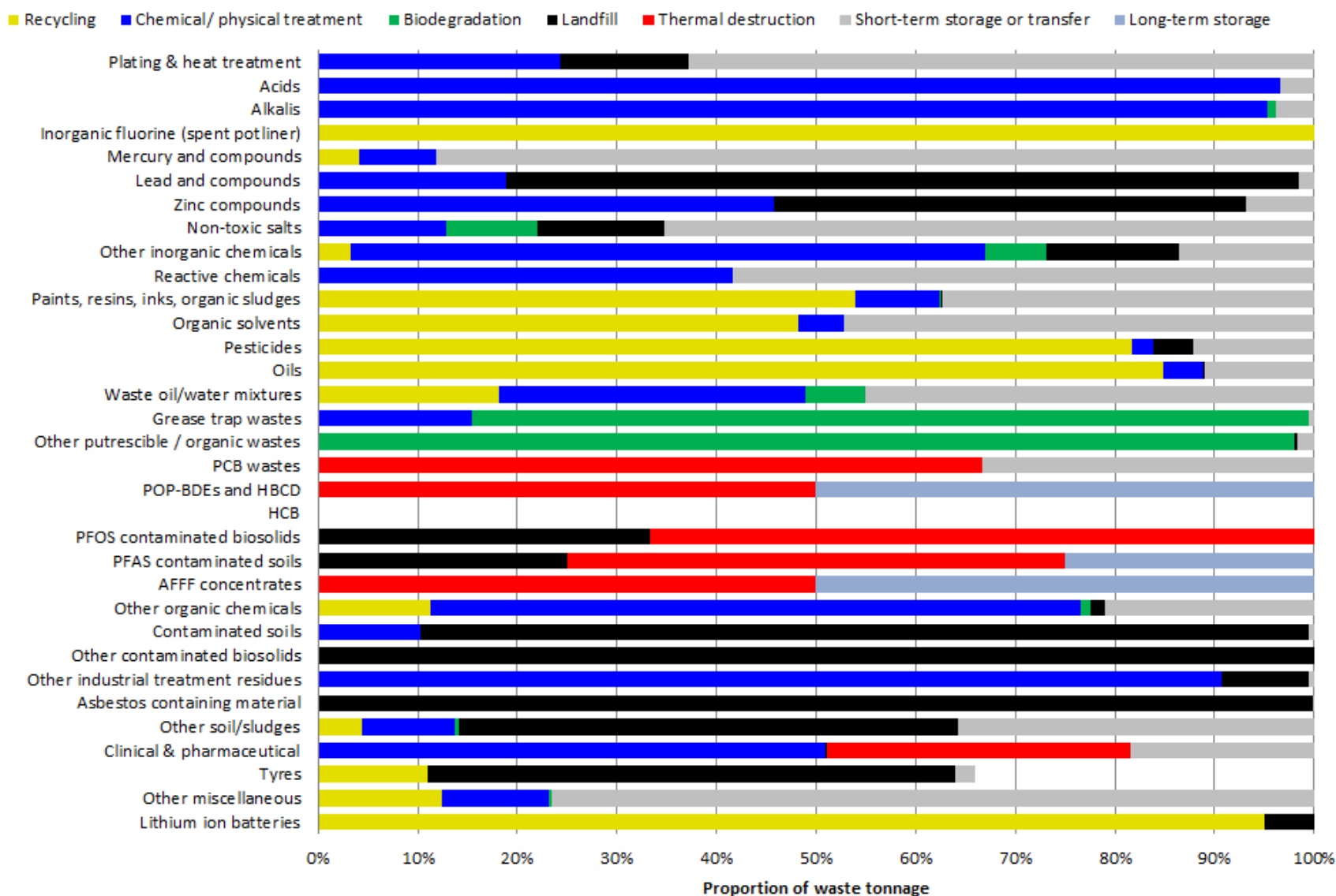


Figure 43: The assumed proportional management of each waste group in WA, as used for comparing demand and capacity

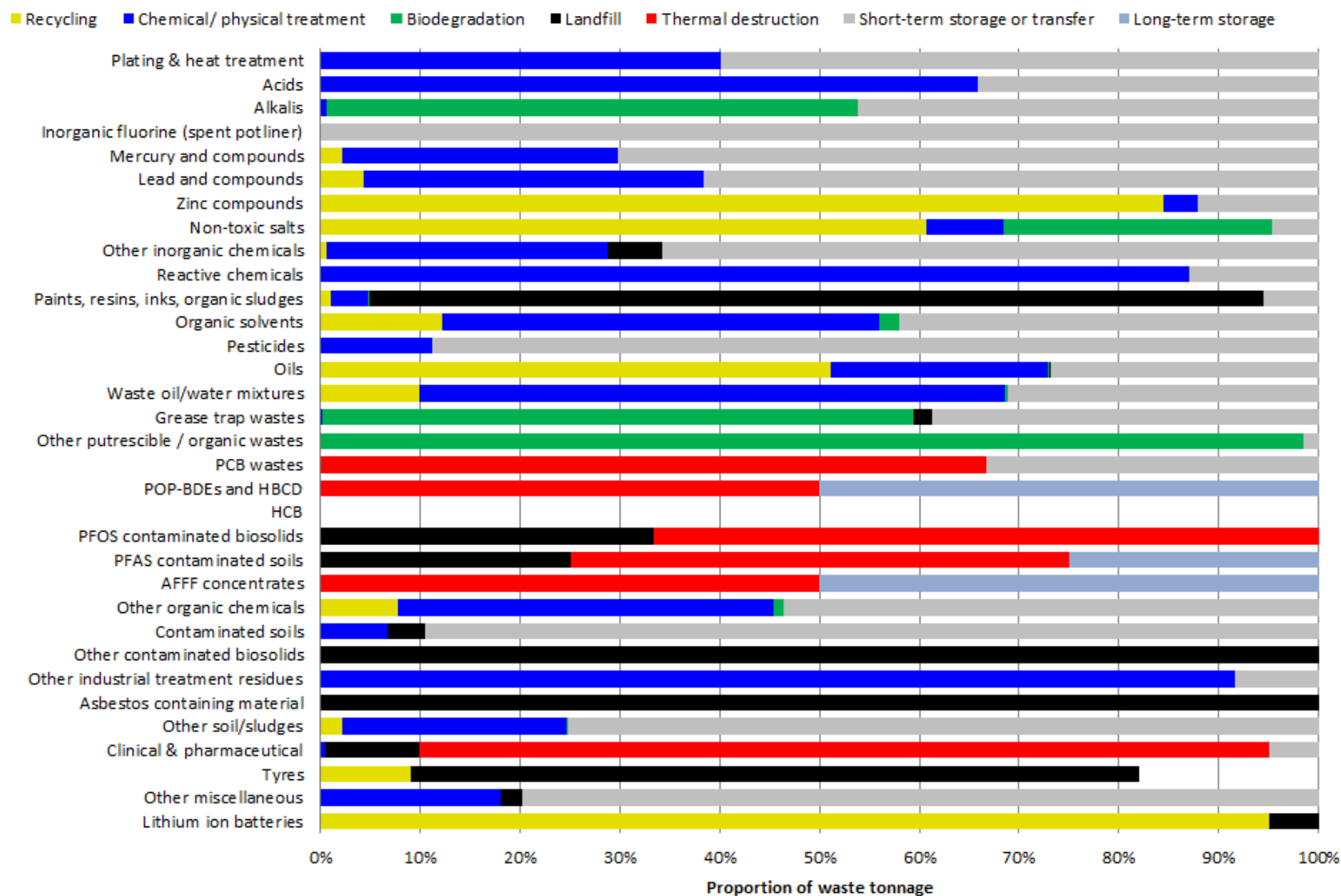
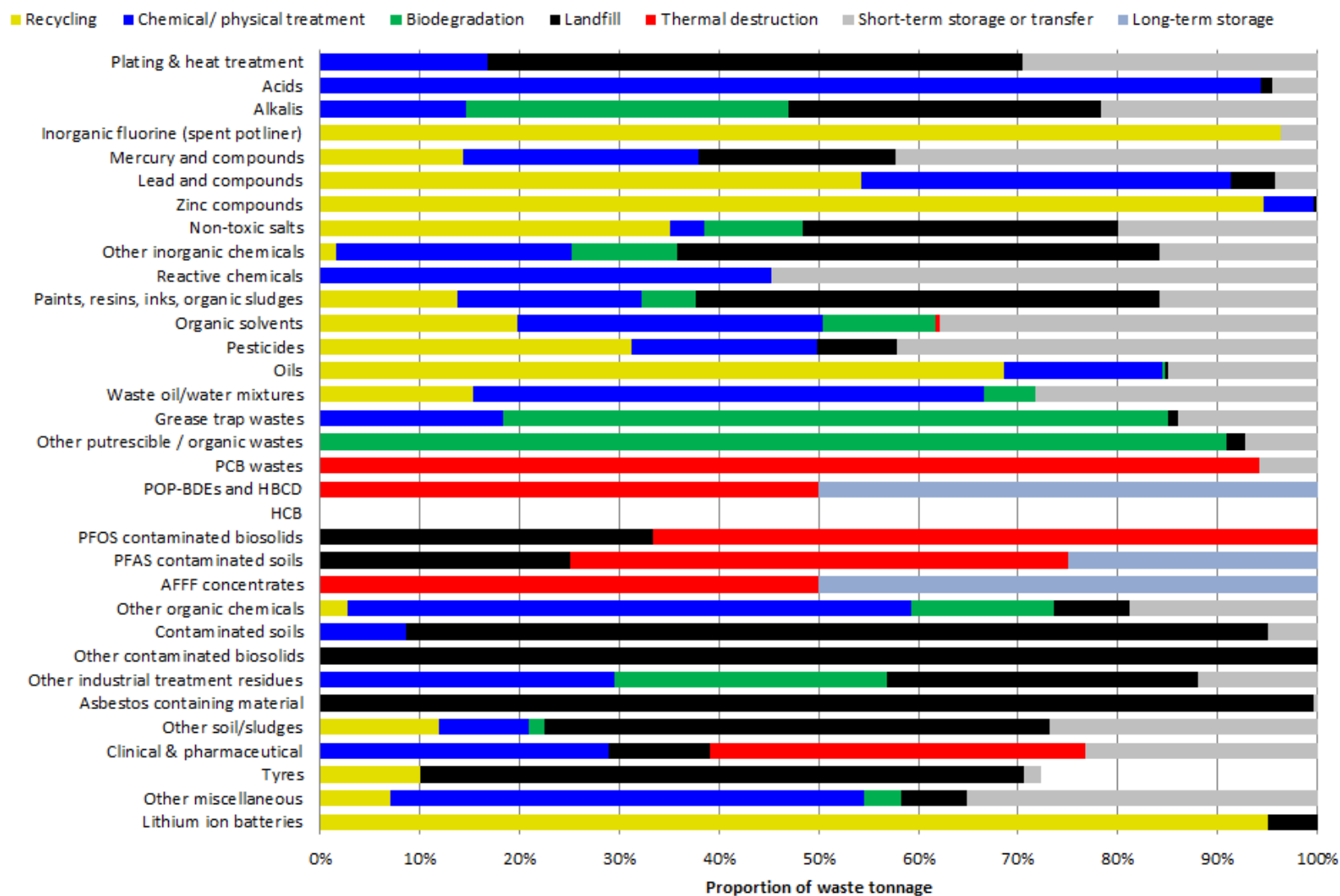


Figure 44: The assumed proportional management of each waste group generated in the ACT, NT and Tas, as used for comparing demand and capacity



3. Hazardous waste infrastructure assessment

This section reports on an assessment of the current installed²⁵ capacity of Australia's hazardous waste infrastructure which is included in the *Hazwaste infrastructure database 2018*. This was undertaken primarily through consultation with the waste industry. This section discusses the scope, method and result of the assessment. The results of the assessment are followed by a discussion of the key issues raised by industry during consultation, Section 3.6. The purpose of the assessment was to allow comparison with projected arisings, see Section 2.5.

3.1 Scope of infrastructure assessment

The 2015 infrastructure assessment scope was set by a preceding project that produced a database of hazardous waste infrastructure (Rawtec 2014)²⁶. This previous scope definition is important and is included below:

"The dataset developed for this project is focused on identifying key sites and facilities across Australia which receive, store (major facilities only), process, treat and dispose of hazardous wastes, whether these are in liquid, solid or sludge forms. It comprises commercial facilities that stand in the market to treat third party hazardous wastes. For example, a facility that generates hazardous waste and processes the hazardous waste onsite but does not process third party wastes is excluded from the dataset.

The dataset does not include sites where hazardous wastes are originally generated (such as manufacturing sites). It does not include smelters and cement kilns which may undertake processing of wastes considered hazardous. This is because smelters and cement kilns are not usually considered as hazardous waste treatment or disposal facilities. It does not include sites and facilities that manage grease trap, sewerage and industrial wash waters (e.g. composting facilities, sewerage treatment plants) or sites that dispose of asbestos and tyres (e.g. landfills), except where those sites also manage other hazardous wastes. This is because those sites are not usually considered as hazardous waste treatment or disposal facilities. Quarantine waste facilities are excluded from the scope. A number of e-waste facilities are included, focussed on major facilities that undertake physical/chemical treatment or disassembly. It is recognised that there are other facilities which deal with hazardous wastes that are not included in the dataset, such as smaller storage facilities and transfer stations. To the extent possible, multi-use facilities that also handle hazardous waste are included in the dataset. This includes landfill sites."

Rawtec (2014 p.7)

Rawtec 2014 tabulated the scope limitations as shown in the table below.

²⁵ Refers to the maximum capacity that the current installed infrastructure could process on an annual basis. For some sites, an EPA licence or planning permit amendments may be required to process the installed capacity tonnage.

²⁶ Available from: <http://www.environment.gov.au/protection/publications/hazardous-waste-infrastructure-australia>

Table 42: Limitations to the scope of the 2015 and Rawtec (2014 p.8) database of hazardous waste infrastructure in Australia

Waste item	Comments
Original points of hazardous waste generation (e.g. manufacturing facilities)	This dataset focuses on facilities or sites that treat or dispose of hazardous wastes and therefore does not include original points of generation.
Intermediate storage and transfer facilities	Some intermediate storage facilities are included in this dataset. It is recognised that there are other facilities which deal with hazardous wastes that are not included in the dataset, such as smaller storage facilities and transfer stations.
Smelters and cement kilns	Smelters and cement kilns are not considered as hazardous waste treatment facilities and therefore are not captured in this dataset; however, it is still acknowledged that they may process some hazardous wastes. ²⁷
Tyres	Tyre processing and disposal facilities were excluded from the scope.
Grease trap	Grease trap was captured where the treatment facility also treated other hazardous wastes. Grease trap to composting facilities was not included.
Sewerage and industrial wash waters	Sewerage and industrial wash water treatment facilities were excluded from the scope.
E-waste	Only major e-waste physical/chemical and manual disassembly processing facilities were included in the scope.
Quarantine wastes	Quarantine waste processing facilities were excluded from the scope, except where these facilities also treated other hazardous waste such as clinical waste.
Asbestos	Asbestos disposal facilities were excluded from the scope, except where these sites also disposed other hazardous wastes.

An important expansion was made to the 2018 assessment to include the capacity of cement kilns' hazardous waste management capacity.²⁸ Where infrastructure additional to the 2015 database was identified by the project team, it was added to the database. See Section 3.3.2 for further discussion on this infrastructure.

'Mobile' waste treatment technology that is moved from one site clean-up to another is included in the scope of the assessment where the technology is providing the waste treatment (onsite). Mobile equipment that is used to simply collect, concentrate, or transport hazardous wastes simply to enable treatment off-site is typically not included.

3.2 Infrastructure groups

To enable the assessment of projected infrastructure need vs capacity, it was necessary to group the infrastructure included in the *Hazwaste infrastructure database 2018*. The infrastructure was grouped based on the waste received and the waste management method²⁹ of the infrastructure. For example, e-waste recycling, POP thermal destruction, clinical waste treatment and clinical waste thermal destruction.

The infrastructure groups were then used to compare waste group arisings and management to infrastructure capacity. The infrastructure groups are listed in Table 43, which is ordered following

²⁷ Cement kilns were excluded from the 2015 assessment but are included in the 2018 assessment.

²⁸ Smelters (i.e. iron smelting operations) are not included in the scope expansion as it is understood these sites do not take significant amounts of hazardous wastes or provide important hazwaste management capacity.

²⁹ The waste 'management method' of the infrastructure refers to the waste management provided at the site (e.g. recycling energy recovery, treatment, disposal, short-term storage or transfer, long-term storage). Some sites provide more than one waste management method, in which case, where significant, the site has more than one entry in the database.

the waste hierarchy.³⁰ See Section 4.1 for further discussion of how the infrastructure groups were used in the assessment. New infrastructure groups for the 2018 assessment are shaded in grey.

The scope and coverage limitations for each infrastructure are also flagged in Table 43 below. The implications of the database scope and coverage limitations are discussed further in Section 4.2.

Table 43: Infrastructure groups and coverage

Hazardous waste management method	Hazardous waste infrastructure group	Description and coverage
Recycling	Hazardous waste packaging facility	Facilities that recycle industrial packing that contains residual hazardous waste. Containers are typically refurbished and reused or materials are recycled.
	E-waste facility	Major e-waste physical/chemical and manual disassembly processing facilities. Facilities receive inorganic hazardous waste, such as copper, cobalt, and lead.
	Oil re-refining facility	Facilities that re-refine (recycle) waste oil. Facilities that dewater and filter waste oil are included in oil/water treatment (OWT), see below.
	Lead facility	Facilities that recycle lead. Typically, the lead is from used lead acid batteries.
	Zinc facility*	Currently this group is limited to the Nyrstar Port Pirie multi-metals recovery plant (which processes lead rich concentrates and smelting industry by-products) including waste generated by Nyrstar's zinc smelter in Hobart. Note: due to this group being limited to the Nyrstar Port Pirie facility which is treating waste mostly from Nyrstar Hobart, no needs versus capacity assessment is provided for this infrastructure group. Nyrstar Port Pirie reports unconstrained capacity to recycle all lead-rich waste from their Hobart operations.
	Mercury facility	Facilities that recycle mercury from used fluorescent light fittings and or oil and gas mining spent catalysts.
	Solvents/paints/organic chemicals facility	Facilities that recycle paints, resins, inks, organic sludges and/or organic solvents, but not for energy recovery.
	Organics processing facility	Facilities that recycle a range of low hazard organic waste such as grease trap waste, cooking oil, animal effluents, etc. Capacity data coverage limitation: composting facilities are excluded from the database. This group refers to facilities that treat grease trap waste and other similar waste.
	EOLT facility*	Facilities that recycle end-of-life-tyres (EOLT) including facilities that partially process EOLT for export and processing overseas.
	SPL facility	Facilities that recycle SPL waste from the aluminium industry.

³⁰ The waste hierarchy expresses a policy preference in which recovery of waste is seen as preferable to treatment, and treatment is seen as preferable to untreated disposal.

Hazardous waste management method	Hazardous waste infrastructure group	Description and coverage
Energy recovery	Energy recovery	Facilities that recover or use solvents, paints or other hazardous waste with calorific value for energy recovery on-site or elsewhere (e.g. a cement facility).
Treatment	Chemical or physical treatment (CPT) plant	Sophisticated facilities developed with significant capital to apply chemical and physical treatments to a broad range of waste. Often licensed to receive almost all NEPM 15 waste codes. Processes can include many chemical treatments (e.g. oxidation, reduction, precipitation, neutralisation, etc.) and physical treatments (e.g. sedimentation, filtration, adsorption, immobilisation, etc.)
	Clinical waste treatment facility	Facilities that treat clinical waste typically using an autoclave.
	Bioremediation facility*	Temporary or permanent facilities that treat hazardous waste by land-farming or bioremediation. Often does not generate a useful product for sale. Capacity data coverage limitation: composting facilities are excluded from the database. This group is intended to refer to facilities that treat hazardous waste through biodegradation that are not generating compost for sale. However, many commercial composting facilities are licenced to receive low level hazardous waste which is effectively bioremediated in the composting process and these facilities are not within the project scope.
	Oil/water treatment (OWT) facility*	Facilities that treat waste oil/water, hydrocarbons/water mixtures or emulsions. Recovered oils are then typically sent on to an oil re-refining facility
	Soils treatment facility	Facilities that treat contaminated soils. Treatment processes include biodegradation and thermal destruction of contaminants.
Disposal	Hazardous waste landfill facility	A small number of landfill facilities that are licensed to dispose of a wide range of hazardous wastes many of which can only be landfilled at these sites.
	Landfill facility (NEPM codes N, T)	Landfill facilities licensed to dispose of low-risk hazardous waste such as low-level contaminated soils, asbestos, and tyres (NEPM 15 codes N and T). These landfills also generally dispose of non-hazardous waste, which typically represents the majority of their inputs. Capacity data for this group is excluded from database. This infrastructure group is excluded from the <i>Hazwaste infrastructure database 2018</i> . Many landfills around Australia dispose of low-level contaminated soils, asbestos and tyres. These landfills are not classified as hazardous waste landfills and are beyond the scope of this assessment.
	Persistent organic pollutants thermal destruction facility	Facilities able to destroy persistent organic compounds or pollutants (POP) by thermal destruction.
	Clinical waste facility thermal destruction	Facilities that dispose of medical waste by thermal destruction.

Hazardous waste management method	Hazardous waste infrastructure group	Description and coverage
Short-term storage or transfer	Transfer facility	Facilities that transfer or temporarily store hazardous waste. Some of these facilities receive a wide range of waste, others only specific waste. Capacity data coverage limitation: not all transfer facilities are covered in the database and some infrastructure groups operate in part as a transfer facility.
Long-term storage	Long-term on-site storage*	Pre-approved on-site (or near site) long-term storages of hazardous waste in designated area/s. Capacity data coverage limitation: long-term on-site storage facilities are excluded from the database and the needs vs capacity assessment. The infrastructure group has been included recognising that some hazardous waste is managed in on-site infrastructure that is often for the long term.
	Long-term isolation facility*	Facilities licensed to store hazardous waste for long periods (≥10 years), typically until an economically viable treatment or disposal solution is developed.

Notes: * new infrastructure groups added in 2018 assessment

3.3 Industry consultation and database updates

The 2015 infrastructure capacity assessment involved a major industry consultation program to gather details of sites that accept hazardous waste throughout Australia and contained information such as facility or site name, company name, facility address, state, treatment activities and technologies, waste types received (by NEPM 15 category) and information on current and expected future infrastructure capacities³¹.

The 2018 assessment also involved extensive consultation with industry to update and validate the information from the 2015 assessment and to collate capability and capacity data for the additional infrastructure groups that are marked in and Table 43.

Stakeholders were asked to validate and update information provided in the 2015 assessment. For each company, an extract of the 2015 database was issued for review and updating. For newly added infrastructure groups/sites, each site was provided an introduction to the project and the project objectives and requested to provide input to the 2018 assessment.

Thirty-six new sites were added to the database during the 2018 assessment to account for the expanded scope of assessment and new infrastructure groups.

A total of 27 landfill facilities (NEPM code N, T) were removed from the 2018 database. This infrastructure group is excluded from the 2018 database. Many landfills around Australia dispose of low-level contaminated soil, asbestos and tyres. These landfills are not classified as hazardous waste landfills and are beyond the scope of this assessment.

³¹ Expected future infrastructure capacity refers to infrastructure projects that are close to operational and will add additional capacity to the current installed capacity in Australia in the near future (advanced planning and construction or commissioning). It could also make reference to the planned closure of a facility that will reduce the infrastructure capacity in Australia.

In total, operators of 226 sites across Australia were consulted. Thirty-one sites/ capacities were closed or no longer taking hazardous waste. These sites remain in the 2018 database, but are noted as not operational and they do not contribute to the needs vs capacity assessment in Section 4. One-hundred and eighty-five sites are currently operational and 10 new sites are planned and expected to be operational in the near future.

A total of 234 hazardous waste management capacities were assessed across the 185 sites. Some sites provided more than one capacity (i.e. the site provided capacity for more than one infrastructure group). A total of 192 capacities were currently operational and 11 new capacities are planned and expected to be operational in near future. A total of 203 current and planned capacities were assessed across all the infrastructure groups assessed.

Table 44: Summary of numbers of sites and capacities assessed in 2018 assessment

Total <u>sites</u> assessed	Closed sites	Operational sites	Planned sites
226	31	185	10

Total <u>capacities</u> assessed	Operational capacities	Planned capacities	Closed capacities	Total current & planned capacities
234	192	11	31	203

3.3.1 The survey questions

All companies were asked to update or provide additional data for 13 questions relating to the operations and capacity of each of their sites, as listed in Table 45. Companies with several sites answered the questions several times, once for each site.

Table 45: Questions asked of industry consultation survey respondents

#	Question	Guidance notes provided
1	Briefly describe the plant, processes & equipment used at the site	
2	Estimate of average annual quantity of hazardous waste received over the last three years (tonnes by waste type)	
3	Licensed waste processing capacity for the site, in tonnes and by waste type (see note 1)	This is to help us understand if the existing infrastructure could receive additional annual tonnages if your licence allowed it
4	The installed annual capacity of the infrastructure at the site, in tonnes and by waste type	
5	Details of expected future increases or decreases in the quantities of hazardous waste you receive (see note 2)	This is to help us understand expected additional infrastructure capacity or alternatively plans to reduce the capacity of, or shut down, infrastructure. For landfill operators estimate the amount of hazardous waste you expect to receive before the site closes.
6	For treatment and processing facilities only, detail the final fate of the hazardous waste received	

#	Question	Guidance notes provided
7	Are there any major transport constraints and risks for wastes delivered to, or removed from, the site?	
8	Are you aware of any stockpiles of hazardous waste?	Stockpiles could be located on the site or on another site
9	Are you able to process any the following stockpiles of hazardous waste that are included in the attached list (Hazwaste stockpiles tab)? If so please list.	This is to help us develop projections of future hazardous waste generation and fate
10	What are your thoughts regarding future hazardous waste generation and management in Australia? This is to help us develop projections of future hazardous waste generation and fate	
11.	Would you like to bring to government attention any concerns or issues affecting the market for the hazardous wastes you deal with?	
12.	Is this database of significant hazardous waste infrastructure complete? Are you aware of any significant sites that should be included?	
13.	DoEE would like to maintain a current database of hazardous waste infrastructure. How would you prefer DoEE to engage with you to achieve this?	

3.3.2 Infrastructure assessment survey results

Individual industry responses to the survey are commercially confidential and are not included in this report, in accordance with commitments given to respondents by DoEE and the project team.

For the 2018 assessment, we updated or gathered new data for 66% of the 232 sites. In total, the *Hazwaste infrastructure database 2018* includes capacity and capability information for 87% of the sites collated from either the 2015 or 2018 assessments or from other public data sources, see Section 3.4.1.

The 2018 assessment provided updated or new data for 98% of the sites that were assessed as providing important infrastructure for a hazardous waste management in Australia. Where no response was received from a company, the infrastructure capacity was assumed to be equal to the average capacity of other sites within the same infrastructure group.

3.4 National capacity estimates of hazardous waste infrastructure

The overall national results of the hazardous waste infrastructure assessment are set out in Table 46. For each infrastructure group, the table states the number of capacities³², the amount of waste currently received³³, the installed capacity and the expected capacity change³⁴. It includes an assessment of the quality of the capacity data based on the definitions at the foot of the table.

³² This includes the 11 capacities that are still under construction or commissioning.

³³ Derived from industry consultation (not from jurisdictions' waste tracking system data).

³⁴ The expected capacity change presents: 1. additional capacity coming on-line from new sites / capacity that is under construction or commissioning, and 2. likely decreases in capacity from infrastructure closures or capacity reductions (presented as a negative value). No reductions in capacity are identified in the 2018 assessment.

Table 46: National capacity estimate of hazardous waste infrastructure

	No. capacities	Current receipts (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Data quality is:						
					Good	Ok	Poor				
Hazardous waste infrastructure											
Recycling and energy recovery											
Hazardous waste packaging facility	19	19	19	0	21%	0%	79%				
E-waste facility	13	58	106	12	92%	0%	8%				
Oil re-refining facility	10	387	526	0	60%	30%	10%				
Lead facility	3	110	124	71	67%	33%	0%				
Mercury facility	7	CIC			100%	0%	0%				
Solvents/paints/organic chemicals facility	4	11	14	0	75%	0%	25%				
Organics processing facility	4	99	106	0	50%	50%	0%				
End-of-life tyres facility	14	83	100	9	93%	0%	0%				
Spent potlining facility	4	CIC			100%	0%	0%				
Energy recovery	5	CIC			60%	20%	20%				
Treatment											
CPT plant	36	857	1,129	4	78%	22%	0%				
Clinical waste treatment facility	9	24	25	0	33%	22%	44%				
Bioremediation facility	0	0	0	0							
Oil/water treatment (OWT) facility	27	148	199	0	37%	30%	33%				
Soils treatment facility	6	97	178	296	67%	33%	0%				
Disposal											
Hazardous waste landfill facility	7	167	201	0	43%	0%	43%				
Landfill facility (NEPM codes N, T)	Not included in assessment of arisings versus capacity										
Persistent organic pollutants thermal destruction facility	7	CIC			86%	0%	14%				
Clinical waste facility thermal destruction	6	20	33	6	100%	0%	0%				
Short-term storage or transfer											
Transfer facility	19	114	145	0	79%	16%	5%				
Long-term storage											
Long-term on-site storage	Not included in assessment of arisings versus capacity										
Long-term isolation facility	2	0	0	CIC	100%	0%	0%				
Total					202	2,336	3,092	945	67%	15%	18%
Data quality definitions	Good	Industry response received. Processing, licensed, and installed capacity data supplied during consultation									
	Ok	No response. Maximum licensed processing capacity data identified in licence or published company information									
	Poor	No response. Licensed processing capacity assumed to be the average of the tonnage processed by inf. with the same inf. group									

Notes:

- Shaded grey infrastructure groups have coverage limitations or are excluded.
- Total numbers of capacities are 202, not 203 as stated in table 44, due to the exclusion of two PFAS contaminated groundwater clean-up operations. Whilst these operations are important, they provide only removal of the PFAS from the groundwater, using relatively simple activated carbon filtration technology that was not seen as 'hazardous waste infrastructure'. The important infrastructure, in this example, is that used to destroy the PFAS removed from the groundwater.

The quality assessment details for each infrastructure group the percentages of site data that were derived from industry survey responses, EPA licence data or by the infrastructure group average. In the public version of this report, data for infrastructure groups that are serviced by less than three sites or companies is removed to protect commercial confidentiality.

There are 202 operational hazardous waste capacities in Australia and 11 capacities under construction or commissioning. In 2016/17, around 2.3 Mt of waste were managed by the 185 operational sites, which have an installed capacity to manage 3.1 Mt of hazardous waste.

Over the next few years an increase of around 1 Mt of capacity is expected to be added to Australia's capacity across the infrastructure groups of:

- e-waste, lead, mercury, EOLT and SPL recycling facilities
- CPT and soil treatment facilities
- POP and clinical waste thermal destruction facilities
- long-term isolation facilities.

3.4.1 Compiling capacity estimates

The infrastructure capacity estimates were compiled primarily by summing the data provided by survey respondents by infrastructure groups. As shown in Table 46, no response was received in relation to 33% of the sites so their capacity needed estimating. For 15% of these sites, an EPA licence was publicly available containing a defined limit to the quantity of waste that could be processed annually. In those cases, that value was used as a proxy for current and installed capacity. Where this was not the case (18% of sites), current and potential capacity was assumed to equal the average of the sites that provided data for that infrastructure group.

3.4.2 Comparing total capacity and total arisings

In Section 2.4, the current arisings of hazardous waste in Australia were discussed. The best estimate of current arisings (6.1 Mt) is much higher than the approximately 2.3 Mt of waste shown above as currently received.

The difference between overall arisings and estimated capacity is mainly attributable to the limits on the scope and coverage of the infrastructure database discussed in Section 3.2. Many sites that receive hazardous waste are not included because they are not primarily hazardous waste infrastructure. In particular, many low hazard wastes such as grease trap waste, animal effluent and contaminated soil (which are generated in large volumes) are sent to sites that are not included in the database.

3.5 Jurisdictional capacity estimates of hazardous waste infrastructure

Table 47 shows the assessment of 2016-17 receipts and installed capacity broken down by jurisdiction.

To protect commercial confidentiality, in the public version of this report the infrastructure group data for tonnages of waste currently received and installed capacity have been redacted (see black cells). While there may be more than three sites included in the capacity data that is removed, the number of companies that operate these sites may be less than three. To ensure commercial confidentiality is protected, no infrastructure group capacity data is included in the public report at a jurisdictional level.

The table includes analysis of the percentage of Australia's hazardous waste infrastructure included in each jurisdiction (by the number of sites, current tonnage received and installed capacity).

The table also includes colour coding of jurisdictions that have greater than 50% of Australia's:

- total number of sites in an infrastructure group
- currently received capacity in an infrastructure group
- installed capacity in an infrastructure group.

The analysis shows the following:

- Regarding hazardous waste infrastructure sites in Australia: NSW and Vic dominate in the provision of infrastructure sites each with approximately 30% of the sites. Qld and WA follow both with around 15% of the sites. SA has 8% of the sites, followed by NT, ACT, and Tas which all have less than 5% of Australia's hazardous waste infrastructure sites.
- Regarding management of 2016-17 arisings: NSW managed 34% of the waste arisings. Qld, Vic and WA follow with each managing around 20% of arisings. SA managed around 7% of arisings and NT, ACT and Tas all managed less than 2% of 2016-17 arisings.
- Regarding installed hazardous waste infrastructure capacity: NSW has 32% of the waste arisings. Qld, Vic and WA follow, each having around 20% of installed capacity. SA has 6% of installed capacity and NT, ACT and Tas all have less than 1% of total installed capacity.

Regarding the infrastructure group capacity concentrations (locations):

- NSW has over 50% of the lead sites. NSW managed over 50% and has more than 50% of the installed capacity for lead, e-waste, SPL and energy recovery infrastructure.
- Qld managed over 50% of POP and has over 50% of POP installed capacity.
- Vic has over 50% of the sites, waste managed and installed capacity for hazardous waste packaging, and soil treatment infrastructure. Vic also managed more than 50% of mercury and organics waste.
- WA has over 50% of the sites, waste managed and installed capacity for bioremediation facilities.
- The 2018 assessment also identified three types of mobile infrastructure that is in planning stage for CPT (CIC kt capacity) and POP thermal destruction (CIC kt capacity). Note: the capacity for this mobile infrastructure is modular and scalable and defined by the site clean-up needs.

Table 47: Jurisdictional capacity estimate of hazardous waste infrastructure

	ACT			NSW			NT			Qld			SA			Tas			Vic			WA			Mobile		
Hazardous waste infrastructure groups	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Recycling and energy recovery																											
Hazardous waste packaging facility	-	-	-	4			-	-	-	1			2			-	-	-	11			1			-	-	-
E-waste facility	1			4			-	-	-	2			2			-	-	-	4			-	-	-	-	-	-
Oil re-refining facility	-	-	-	4			-	-	-	1			1			-	-	-	2			2			-	-	-
Lead facility	-	-	-	2			-	-	-	1			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury facility	-	-	-	1			-	-	-	1			1			1			1			2			-	-	-
Solvents/paints/organic chemicals facility	-	-	-	2			-	-	-	1			-	-	-	-	-	-	1			-	-	-	-	-	-
Organics processing facility	-	-	-	2			-	-	-	-	-	-	-	-	-	-	-	-	2			-	-	-	-	-	-
End-of-life tyres facility	-	-	-	4			-	-	-	1			2			1	-	-	5			1			-	-	-
Spent potlining facility	-	-	-	2			-	-	-	1			-	-	-	1			-	-	-	-	-	-	-	-	-
Energy recovery	-	-	-	2			-	-	-	1			1			-	-	-	1			-	-	-	-	-	-
Treatment																											
CPT plant	-	-	-	10			-	-	-	5			2			-	-	-	6			12			1	-	-
Clinical waste treatment facility	-	-	-	2			1			1			1			1			2			1			-	-	-
Bioremediation facility	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oil/water treatment (OWT) facility	-	-	-	9			-	-	-	6			1			2			8			1			-	-	-
Soils treatment facility	-	-	-	1			-	-	-	-	-	-	-	-	-	1			3			1			-	-	-
Disposal																											
Hazardous waste landfill facility	-	-	-	1			1			1			-	-	-	1			1			2			-	-	-
Landfill facility (NEPM codes N, T)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Persistent organic pollutants thermal destruction facility	-	-	-	-	-	-	-	-	-	2			-	-	-	-	-	-	3			-	-	-	2	-	-
Clinical waste facility thermal destruction	-	-	-	1			-	-	-	1			1			-	-	-	2			1			-	-	-
Short-term storage or transfer																											
Transfer facility	1			5			1			3			2			1			2			4			-	-	-
Long-term storage																											
Long-term on-site storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long-term isolation facility	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Total	2			56	785	944	4	37	39	29	428	559	16	160	201	9	23	24	54	428	636	29	473	684	3	-	-
Percentage of national total	1%	0%	0%	28%	34%	31%	2%	2%	1%	14%	18%	18%	8%	7%	6%	4%	1%	1%	27%	18%	21%	14%	20%	22%	1%	0%	0%

A = Number of sites (includes the 10 sites that are under construction and commissioning)

B = Quantity currently received (kt/yr) (i.e. the reported 3-year average receipts or, if unavailable, the licensed processing capacity or, if unavailable, the mean reported 3-year average receipts for the infrastructure group)

C = Installed capacity (kt/yr) (i.e. the reported installed capacity or, if unavailable, the licensed processing capacity or, if unavailable, the reported 3-year average receipts or, if unavailable, the mean reported 3-year average receipts for the infrastructure group).

	Greater than	50% of sites in Australia
	Greater than	50% of currently received capacity in Australia
	Greater than	50% of installed capacity in Australia

Notes: Shaded grey infrastructure groups have coverage limitations or are excluded

3.6 Key issues raised by industry during consultation

This section discusses the key issues raised by industry during consultation. No quotations are provided to maintain confidentiality agreements made with industry stakeholders during survey and interview.

3.6.1 Falling demand for hazardous waste infrastructure

As Australia's manufacturing sector slows, hazardous waste commonly generated by manufacturing in Australia is in decline. Across the country, industry reported falling amounts of hazardous manufacturing waste sent for treatment. In some instances, sharp declines were reported. This issue was reported in 2015 and remains current for the 2018 assessment. Our analysis, based on waste tracking data, estimated tonnages of waste sent to CPT of 700 kt in 2015 to just 400 kt in 2018, a fall of around 43% over three years.

This project is focused on identifying where Australia's hazardous waste industry may become constrained over the next 20 years. Industry flagged that undersupply of wastes could cause infrastructure shortages due to closure of key infrastructure that may no longer be viable as demand falls for processing of key high-volume wastes.

However, the overall tonnages of hazardous waste are projected to increase from around 6 Mt currently to almost 10 Mt in 2038. So, whilst tonnages of some wastes are declining, and are projected to continue doing so, other hazardous waste types are projected to increase significantly. The challenge for industry and government is to plan for and implement infrastructure changes that can manage the rapidly changing composition of hazardous waste.

3.6.2 Stockpiles of SPL, mercury waste and EOLT

This issue was raised in the 2015 assessment and remains current. REC 2016 estimated the stockpile of SPL to be around 700 kt, of which around 390 kt are landfilled on-site at aluminium smelters around Australia, with the remainder stored in sheds on-site. As the aluminium industry slows in Australia there is a risk that funding to treat/recycle these stockpiles becomes unavailable and the stockpiles become a legacy waste without funding for recovery.

Industry has commented on on-site stockpiling of mercury contaminated catalyst waste in the oil and gas industries. MRU are loaded with catalyst to draw out mercury of oil or gas stream. Each time the catalyst is spent it is reportedly stockpiled on-site in drums. MRU catalyst mercury stockpiles could be about 2% up to 10 % mercury. Recent investment in mercury recovery facilities in Australia should resolve any capacity constraints, as discussed in Section 4.

Industry and environment agencies also flagged stockpiles of tyres as a major problem. Stockpiles of EOLT create a significant environmental and human health issue if they catch fire, which is not uncommon. EPA Vic recently reported that:

*"The number of used or waste tyres generated in Victoria each year is growing; approximately six million waste passenger car tyres were unaccounted for in Victoria in 2012-13, believed to be stockpiled or illegally dumped"*³⁵

Industry commented that government needs to do more to control waste stockpiling at the sites of waste generators or waste treaters to avoid the potential liabilities of legacy waste stockpiles.

³⁵ Source: EPA website *EPA tightens regulations on tyre stockpiling* <http://www.epa.vic.gov.au/about-us/news-centre/news-and-updates/news/2015/april/15/epa-tightens-regulations-on-tyre-stockpiling> (June 2015)

3.6.3 Inconsistent landfill levies driving interstate disposal of hazardous wastes

This issue was raised in the 2015 assessment and remains current. There are large differences in the cost of landfill disposal of hazardous waste in Australia which is in large part due to landfill levy differences. In Vic the landfill levy for Category B hazardous waste is \$250/tonne and in Qld³⁶, NT and Tas the landfill levy is currently \$0/tonne. Industry commented that transport costs could be as low as \$80/tonne from Vic to Qld. If transport costs are indeed this low, landfills in Qld (charging the same gate fee³⁷ as Vic landfills) could potentially offer tipping at \$170/tonne less than tipping costs in Vic. Several industry stakeholders commented on this as a serious policy/governance issue for hazardous waste management in Australia. The legislated changes to a landfill levy in Qld will significantly improve the current situation of waste being transported for disposal in Qld, but will not remove the price incentives altogether.

3.6.4 Inconsistent landfill levies undermining investment in recovery or treatment of hazardous wastes

A related issue is the importance of landfill levies to help drive investment in hazardous waste recovery or treatment infrastructure, that often struggle to compete with the low (short term) costs of sending hazardous waste to landfills. Developments such as the ResourceCo refuse derived fuel facility in SA and NSW that provide fuel for the Adelaide Brighton and Boral cement kilns respectively are understood to not be viable in Qld or Tas, which also have cement kilns, but no landfill levy in place.

3.6.5 Inconsistent landfilling pre-treatment requirements create unfair advantage

Another more technical inconsistency that industry raised relates to jurisdictional differences in the treatment requirements for waste before it is sent to landfill. For example, a company raised concerns that in NSW they are required to immobilise (via treatment) their waste that they send to landfill, yet a competing company in Qld can send the same waste to landfill without an immobilisation. Where this occurs, it creates unfair costs to competing industries and potentially more environmental impact and legacy costs for the state without the equivalent levels of waste pre-treatment in place.

3.6.6 Regulatory settings need to support infrastructure investment

Related to the above was the issue raised of regulation supporting investment into hazardous waste recovery or treatment infrastructure. Hazardous waste infrastructure is often capital intensive and as a result relies on a regulatory framework that supports recovery/treatment more than non-hazardous waste infrastructure. In addition, hazardous waste is less consistently generated than non-hazardous waste such as household waste so investments carry a higher risk and are less secure.

In the 2015 assessment, industry raised a range of concerns that it suggested were regulatory failings (listed below). These remain current. Industry argued these can undermine investment in hazardous waste infrastructure. It is beyond the scope of this project to provide detailed analysis of these issues or to validate the accuracy of industry comments.

1. landfilling of hazardous organic waste for which recovery options exist, including the recovery of energy
2. permitting the export of hazardous waste for which there is recovery infrastructure in Australia
3. export of unprocessed waste oil without permits as 'fuel oil', contravening the Basel Convention and undermining oil recycling (which represents higher order recovery)

³⁶ The Qld levy is proposed to be increased to \$155/tonne for Category 2 regulated waste on July 1 2019.

³⁷ Gate fee: refers to the cost of tipping net of landfill levy.

4. a lack of enforcement action to prevent illegal export of hazardous waste, like the example noted above
5. a lack of auditing or enforcement of hazardous waste tracking systems administered by the jurisdictions to prevent hazardous waste being sent to inappropriate waste facilities
6. inconsistent regulation of clinical waste across Australia resulting in clinical waste being sent interstate.

3.6.7 Additional CSG waste infrastructure needed

This issue was raised in 2015 and remains current. A number of industry stakeholders commented on the need to improve infrastructure to service CSG industry waste, including brine waste and hydrocarbon impacted drilling mud. Industry commented that these wastes are likely to increase as Australia's gas export capabilities increase. One of the key challenges in treating brine waste is the large quantities and remote locations of the waste, which make transport costly. There have been reportable improvements in the levels of on-site treatment of brine waste using RO technology. This would greatly reduce the amount of brine waste requiring management, but also increase the concentrations of the waste. It is understood that this waste material is typically placed into holding lagoons on-site.

3.6.8 Asbestos disposal cost and access

A comment often made by small landfill operators in regional areas (typically local government) is the need to reduce asbestos disposal costs as it drives illegal dumping or hidden tipping of asbestos. Councils also commented on the need for asbestos collection infrastructure in remote areas where there is no landfill licensed to take asbestos. This issue was raised in 2015 and remains current.

3.6.9 Additional infrastructure for recovering packaging waste

A number of industry stakeholders commented on the need for improved recovery options for small hazardous waste packaging and small packages of waste hazardous goods. This issue was raised in 2015 and remains current.

3.6.10 Significant POP destruction infrastructure coming online

In 2015, the only capacity identified for POP destruction was the Toxfree operated plasma arc plant in Narangba, Qld. No other designated POP destruction facilities were proposed; however, additional capacity was planned within other infrastructure (soil treatment facilities, cement kilns and clinical waste thermal destruction facilities).

Since the 2015 assessment, industry has taken significant steps towards implementing this additional capacity for POP thermal destruction. Recent approvals have been granted and additional trials are underway for PFAS waste destruction at Cement Australia's cement kilns. Trials are underway for PFAS thermal destruction at RENEX and EnviroPacific soil treatment facilities in Vic. Daniels Laverton (Toxfree) also have approval to treat PCB waste. As discussed in Section 4, the upper limit of the capacity for these facilities to take POP in the future is unknown and needs further review.

RENEX and EnviroPacific have stated that they do not think their capacity will be limited beyond the overall capacity of the facility, however, this is yet to be proven.

3.6.11 PFAS contaminated waters: contaminant threshold requirements need

Industry have commented that they urgently need further direction from regulators regarding the process requirements and contaminant thresholds for PFAS impacted water clean-up. There is inconsistency between the jurisdictions and reliance on existing guidelines that do not specify PFAS limits.

Recommendation: The process requirements and contaminant thresholds that need to be met for PFAS impacted water clean-up should be defined. DoEE may be best placed to lead the development of a recommended process and threshold that the jurisdictions could choose to adopt. This work may already be underway.

3.6.12 PFAS contaminated waters: filtration media destruction requirements are inconsistent

PFAS contaminated groundwater is being cleaned-up using activated carbon filtration processes to remove PFAS. Once the filtration media's capacity to adsorb PFAS is exhausted, the contaminated material needs to be renewed. Industry commented that in Qld this material is able to be sent to landfill whereas in other jurisdictions PFAS-contaminated material must be thermally treated to destroy PFAS. If PFAS-contaminated filtration media is being sent to landfill, rather than being thermally destroyed, it would seem to defeat the efforts in removing PFAS from the groundwater in the first place (i.e. in landfill the PFAS will presumably make its way back to groundwater).

Recommendation: The management requirements of PFAS-contaminated filtration should be reviewed to ensure a nationally consistent approach.

3.6.13 WA: distance and low tonnages of hazardous waste is a major challenge

This issue was raised in 2015 and remains an issue. Jill Lethlean (Consilium Waste Consulting) provided the following comments regarding hazardous waste management in WA (reproduced with permission):

"Distance is a major issue for waste management in WA. In particular, a considerable amount of hazardous waste and hazardous waste packaging is generated a long way from the metropolitan area. Therefore, it is expensive to transport waste to the single facilities available for hazardous waste. This provides a strong incentive to find alternative disposal routes, or to stockpile the waste onsite.

The long distances to suitable disposal facilities appears to have led to some pragmatic solutions, where country landfills are permitted to accept medical/clinical waste and low level hazardous waste. The environmental standards at WA's rural landfills is highly variable. Therefore, most would not be suitable for hazardous waste disposal.

Overall, it appears that the low volume of hazardous waste generated in WA means that it has only been financially viable to have one of each of the most crucial types of hazardous waste facilities. This leaves the State vulnerable to a stockpiling crisis if one of these facilities closes. Further, the long distances to these single facilities, meaning limited access, has resulted in less than ideal practices for the management of hazardous waste. The size of the problem is not really known, as the data available on hazardous waste generation is limited.

The largest risk appears to be a shortage in Class IV landfill capacity. There is currently one Class IV landfill cell in the State, and it is located in Perth. This is not convenient when the waste is generated a long way from the metropolitan area... In the event that the cell closes, or a new one is not constructed when the current cell is full, then WA would be without its main disposal route for hazardous waste".

WA Department of Water and Environmental Regulation noted: proposals have been received for new class IV and V landfills in remote WA (Pilbara and Goldfields). These facilities, if established, will provide more options for hazardous waste management in remote WA. DWEP is also planning for future initiatives under the State's new Waste Strategy and proposed State Waste Infrastructure Plan.

4. Assessment of projected need vs capacity of hazardous waste infrastructure

Having generated projections of the arisings of hazardous waste in Section 2 and estimated infrastructure capacity in Section 3, this section of the report compares the two to identify wastes and jurisdictions where an expansion of capacity may be needed during the 20 year projection period. Before presenting the assessment of projection of need vs capacity, this section outlines the method for completing the assessment and also provides analysis of the limitations of the assessment. Section 4.2 discusses several factors that limit the completeness of the assessment and/or increase the levels of uncertainty.

4.1 Method

The assessment of need against capacity involved four main steps discussed below.

4.1.1 Step 1: determine the assumed management of waste groups

The assumed management methods of hazardous waste arisings now and over the projection period are discussed in Section 2.8 and presented in Figure 40 to Figure 44 (above).

4.1.2 Step 2: each waste group's management methods were mapped to infrastructure groups

For each waste group, the adjusted management methods were mapped to an infrastructure group (i.e. the infrastructure group most likely to receive the particular fate was selected). Examples are:

- the Plating & heat treatment waste group with a management method of CPT was mapped to CPT plant
- the Plating & heat treatment waste group with a management method of disposal was mapped to Hazardous waste landfill facility
- the Asbestos waste group with a disposal management method was mapped to the Landfill facility (NEPM codes N, T) infrastructure group.

The full mapping process is illustrated in Table 48.

4.1.3 Step 3: combine waste group projections, adjusted management method, and infrastructure group capacity

The tonnes of each waste group going to each infrastructure group were projected for each year and scenario (high, best and low). The management methods determined in Step 1 (above) are assumed to remain constant over the projection period of 20 years. It is likely that the management methods will change over the projection period and by varying amounts for different waste groups and in different jurisdictions. Changes in the management method will directly affect the capacity needs of the infrastructure groups. For example, an increase in recycling would require additional recycling capacity and reduce the demands on the disposal capacity. As discussed in Section 4.2 having limited data on the future management of waste groups limits the accuracy of the capacity assessment.

4.1.4 Step 4: assess the period when waste group projections exceed the infrastructure group capacity

The projected tonnages sent to each infrastructure group were then compared with the installed capacity of the infrastructure group to obtain an estimate of when installed capacity would be exceeded by the allocated arisings.

Table 48: Mapping of waste management method to infrastructure group

Management method	Recycling	Chemical/ physical treatment	Biodegradation	Landfill	Thermal destruction	Short-term storage or transfer	Long-term storage
Waste group							
Plating & heat treatment		CPT plant		Hazardous waste landfill facility		Transfer facility	
Acids		CPT plant		Hazardous waste landfill facility		Transfer facility	
Alkalis		CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Inorganic fluorine (SPL)	SPL facility					Transfer facility	
Mercury and compounds	Mercury facility	CPT plant		Hazardous waste landfill facility		Transfer facility	
Lead and compounds	Lead facility	CPT plant		Hazardous waste landfill facility		Transfer facility	
Zinc compounds	Zinc facility	CPT plant		Hazardous waste landfill facility		Transfer facility	
Non-toxic salts	CPT plant	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	Long-term on-site storage
Other inorganic chemicals	E-waste facility	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Reactive chemicals		CPT plant		Hazardous waste landfill facility		Transfer facility	
Paints, resins, inks, organic sludges	Solvents/paints/organic chemicals facility	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Organic solvents	Solvents/paints/organic chemicals facility	CPT plant	Bioremediation facility		POP thermal destruction facility	Transfer facility	

Management method	Recycling	Chemical/ physical treatment	Biodegradation	Landfill	Thermal destruction	Short-term storage or transfer	Long-term storage
Pesticides	Energy recovery	CPT plant		Hazardous waste landfill facility		Transfer facility	
Oils	Oil re-refining facility	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Waste oil/water mixtures	Oil re-refining facility	OWT facility	Bioremediation facility			Transfer facility	
Grease trap waste		CPT plant	Organics processing facility	Hazardous waste landfill facility		Transfer facility	
Other putrescible/ organic waste			Organics processing facility	Hazardous waste landfill facility		Transfer facility	
PCB waste					POP thermal destruction facility	Transfer facility	
POP-BDEs and HBCD					POP thermal destruction facility		Long-term isolation facility
HCB							
PFOS-contaminated biosolids				Hazardous waste landfill facility	POP thermal destruction facility		
PFAS-contaminated soils				Hazardous waste landfill facility	POP thermal destruction facility		Long-term isolation facility

Management method	Recycling	Chemical/ physical treatment	Biodegradation	Landfill	Thermal destruction	Short-term storage or transfer	Long-term storage
AFFF concentrates					POP thermal destruction facility		Long-term isolation facility
Other organic chemicals	Energy recovery	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Contaminated soil		Soils treatment facility		Landfill facility (NEPM codes N, T)		Transfer facility	
Other contaminated biosolids				Hazardous waste landfill facility			
Other industrial treatment residues		CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Asbestos containing material				Landfill facility (NEPM codes N, T)		Transfer facility	
Other soil/sludges	Hazardous waste packaging facility	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Clinical & pharmaceutical		Clinical waste treatment facility		Hazardous waste landfill facility	Clinical waste facility thermal destruction	Transfer facility	
EOLT	EOLT facility			Landfill facility (NEPM codes N, T)		Transfer facility	
Other miscellaneous	Energy recovery	CPT plant	Bioremediation facility	Hazardous waste landfill facility		Transfer facility	
Lithium ion batteries	E-waste facility			Landfill facility (NEPM codes N, T)			

4.2 Limitations and uncertainty

The assessment of projected hazardous waste infrastructure need vs capacity is affected by:

1. the levels of uncertainty of the projected arisings of hazardous waste
2. the levels of uncertainty of the assumed management methods and allocation to infrastructure (i.e. how much of each waste group's arisings will be managed by what infrastructure)
3. the limitations in coverage and levels of uncertainty of the assessment of the current hazardous waste infrastructure capacity.

These three dimensions of uncertainty are discussed below.

4.2.1 Uncertainty in projections of hazardous waste arisings

The levels of uncertainty of the projected arisings of hazardous waste are discussed in Section 2.5. The use of high, best and low scenarios reflects the levels of uncertainty and provides for a significant range in the projections.

The projected arisings (and management methods) of new hazardous waste, such as PFAS waste, are particularly uncertain as there are little or no historical arisings data to inform the baseline or trend of the projection. The range between high, best and low scenarios is greater for this waste, reflecting the increased uncertainty.

The availability and quality of the supporting jurisdictional tracking system data used to determine the baseline (starting point) for the projection are variable, see analysis in Section 2.4.

4.2.2 Uncertainty in the assumed management methods and mapping to infrastructure

Steps 1 and 2 of the assessment methods, discussed above, outline the method of determining the management methods for waste arisings and mapping the proportions to the infrastructure groups.

The assessment of the adequacy of infrastructure relies on the assumed management methods which are derived from the waste tracking data from NSW, Qld, SA, Vic and WA.

The assessment assumes the management methods for each waste group (see Figure 40 to Figure 44) and the mapping to the receiving infrastructure groups (see Table 48) remain constant over time. In reality, changing market conditions, innovation and policy efforts are likely to change these proportions and potentially the infrastructure that manages the waste.

This assessment has attempted to reduce uncertainty related to changes in the management methods of each waste group by consulting with DoEE and jurisdictional EPA (or equivalent) staff regarding likely changes in the management requirements of hazardous waste.

4.2.3 Limitations and uncertainty of the infrastructure capacity estimates

The following factors increase uncertainty in the infrastructure capacity estimates:

1. **Capacity database coverage:** Some waste groups include hazardous waste that is managed by facilities excluded from the infrastructure database. As detailed in Section 3.2, many landfills that accept low level contaminated soil, asbestos and EOLT, for example, are not included in the scope of the infrastructure database.

Some waste groups include waste that is managed by infrastructure groups with limited coverage in the infrastructure capacity database. For example, the database has limited coverage of hazardous waste organics recycling facilities and bioremediation facilities because composting facilities are excluded from the scope of database.

Incomplete coverage of an infrastructure group results in an under-estimation of the capacity of these infrastructure groups and an inaccurate estimate of the period when the capacity of these groups will be exceeded. Figure 45 illustrates which infrastructure groups are excluded from the capacity assessment or have limited coverage.

2. **Capacity data quality:** The infrastructure capacity data collated in this report is of varying accuracy. Table 46 details the proportions of what is assumed to be good, adequate or poor-quality data for each infrastructure group.
3. **Infrastructure group capacity overlap:** As discussed in Section 3.2, infrastructure was grouped based on the waste received and the waste management method³⁸ of the infrastructure. There is some overlap in the management provided by the infrastructure included in the groups. Some groups may provide capacity for more than the management method/s identified. For example, oil re-refining facilities often have a transfer and storage capacity. In these cases, the capacity of the management method may be overestimated. It follows that where the capacity of an infrastructure group is included within other groups (e.g. transfer station and temporary storage capacity is provided by many other groups) the capacity of the group is under-estimated.
4. **Diffuse infrastructure groups:** The infrastructure database may be incomplete for some infrastructure groups that are within the scope of the database due to overlooked sites. Whilst this project has added some additional sites to the database, for diffuse infrastructure groups such as waste organics or solvent recycling facilities, it is likely that some small operations have not been identified and their capacity is missing.

For each infrastructure group the limitations and uncertainties of the capacity estimates discussed above are assessed in Table 49. An overall assessment of uncertainty for capacity estimates is provided for each group (from low through to very high).

The assessment of capacity uncertainty is an important consideration when assessing the period when the waste group projections are projected to exceed the infrastructure group capacity.

³⁸ The waste management method of the infrastructure refers to the waste management provided at the site (e.g. recycling energy recovery, treatment, disposal, short-term storage or transfer, long-term storage). Some sites provide more than one waste management method, in which case, where significant, the site has more than one entry in the database.

Figure 45: Hazardous waste groups arisings, coverage in capacity database and extent of assessment

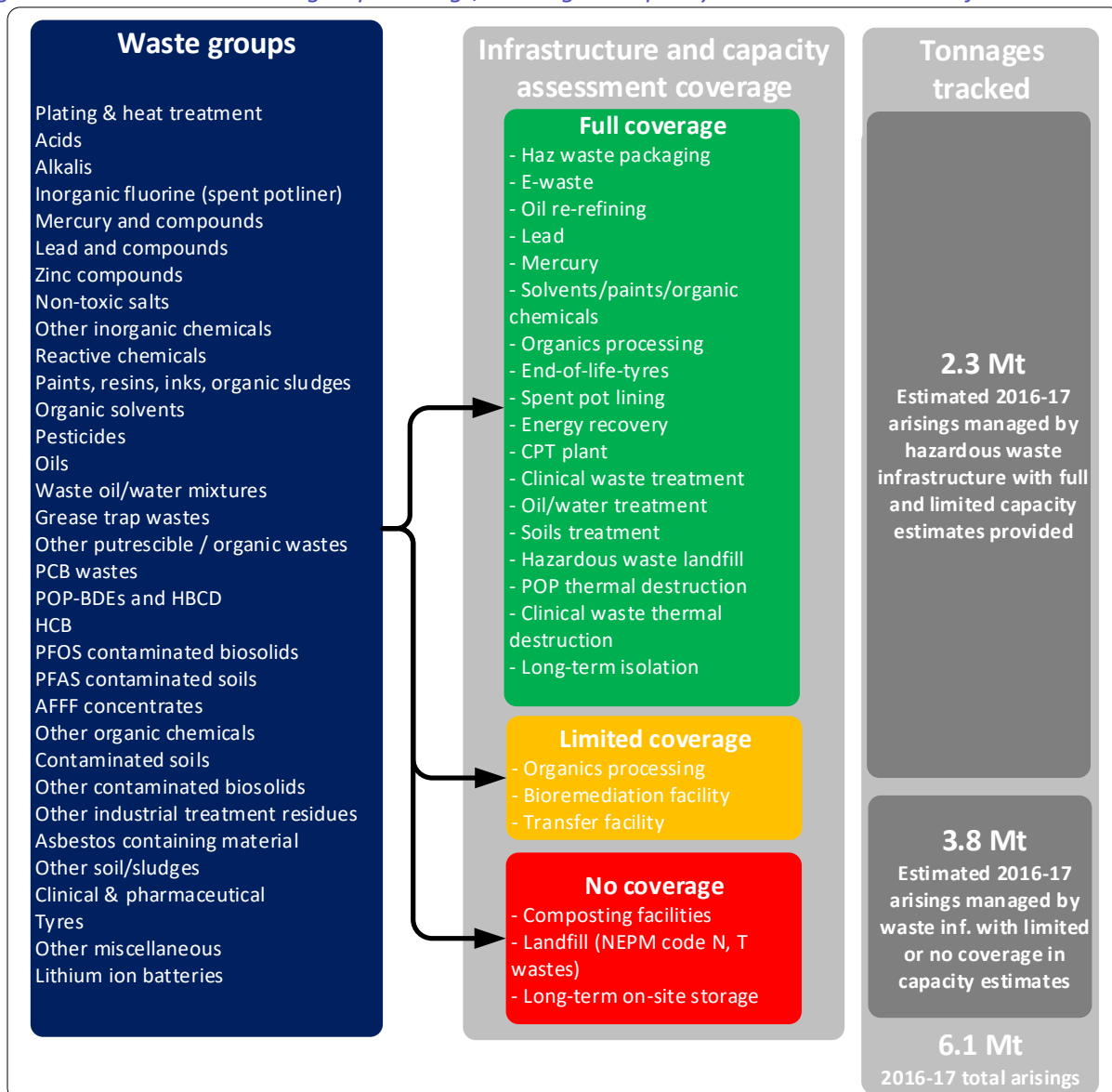


Table 49: *Infrastructure capacity estimates assessment of uncertainty*

	1. Coverage in capacity database	2. Ind. response for capacity data	3. Infrastructure grouping overlap? (Y/N)	4. Very diffuse inf. group?	Uncertainty of capacity estimate
Hazardous waste infrastructure					
Recycling and energy recovery					
Hazardous waste packaging facility	Full	21%	N	Y	High
E-waste facility	Full	92%	Y	N	Moderate
Oil re-refining facility	Full	60%	N	N	Low
Lead facility	Full	67%	N	N	Low
Mercury facility	Full	100%	N	N	Low
Solvents/paints/organic chemicals facility	Full	75%	Y	Y	Moderate
Organics processing facility	Limited	50%	Y	Y	Very high
EOLT facility	Full	93%	N	N	Low
SPL facility	Full	100%	N	N	Low
Energy recovery	Full	60%	Y	N	Moderate
Treatment					
CPT plant	Full	78%	Y	N	Moderate
Clinical waste treatment facility	Full	38%	N	N	High
Bioremediation facility	Limited	0%	Y	Y	Very high
OWT facility	Full	37%	Y	Y	High
Soils treatment facility	Full	100%	N	N	Low
Disposal					
Hazardous waste landfill facility	Full	50%	Y	N	Very high
Landfill facility (NEPM codes N, T)	None		Na	Na	Na
POP thermal destruction facility	Full	86%	N	N	Moderate
Clinical waste facility thermal destruction	Full	100%	N	N	Low
Short-term storage or transfer					
Transfer facility	Limited	79%	Y	Y	Very high
Long-term storage					
Long-term on-site storage	None		Na	Na	Na
Long-term isolation facility	Full	100%	N	N	Low

4.3 National assessment of need vs capacity by infrastructure group

A national assessment of the capacity of each infrastructure groups against hazardous waste arisings in 2016-17 and in future is given in Table 50. The table includes the following for each infrastructure group:

- the estimated arisings in 2016-17 that were managed by the infrastructure group, derived from jurisdictions waste tracking system data
- the installed capacity of the infrastructure included in the group
- the expected future change in installed infrastructure capacity from new infrastructure that is currently under construction or commissioning or alternatively from planned closures of infrastructure
- the assessment of the level of uncertainty of the capacity estimate for the group (from low to very high)
- the year in which estimated arisings exceed currently installed capacity; this value is given for all three scenarios (best, high and low estimates)
- a discussion of the assessment and any specific recommendations.

Table 50: National assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								
Hazardous waste packaging facility	15	19	0	High	>2037	2033	>2037	<p>Analysis indicates that under the best and low scenarios over the next 20 years the installed capacity of Australia's current hazardous waste packaging recycling infrastructure will be able to recycle waste arisings. Under the high scenario, the current installed capacity would be exceeded in 2033. There may be some regional limitations (see jurisdictional analysis below).</p> <p>The infrastructure need vs capacity assessment for this group has high uncertainty due to a low response rate during consultation and this infrastructure group being highly diffuse increasing the probability of capacity not being included in the capacity database.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
E-waste facility	4	106	12	High	2037	2035	>2037	<p>Analysis indicates that under the best and low scenarios over the next 20 years the current installed capacity of Australia's e-waste (major physical/chemical and manual disassembly processing) infrastructure will be able to recycle waste arisings. Under the high scenario, capacity could become constrained by 2035 if e-waste arisings grow very strongly, however, expected increases in capacity of 12 kt/yr should provide sufficient national capacity to cater for higher growth. There are some regional limitations (see jurisdictional analysis).</p> <p>The needs vs capacity assessment for this group has high uncertainty due to the waste arisings reported in tracking system data (4 kt in 2016-17) being much lower than the reported tonnages received (58 kt in 2016-17). This large difference is likely due to the fact that most e-waste is not transported and tracked as a hazardous waste. Considering the reporting receipts of 58 kt in 2016-17 and the current installed capacity of 106 kt/yr, it is still likely that there is sufficient capacity over the projection period.</p> <p>For e-waste it is important to consider that the assessment assumes no change in the management methods of e-waste. Changes to product stewardship agreements or landfill bans on e-waste could significantly change current e-waste management and increase recycling capacity required.</p>
Oil re-refining facility	325	526	0	Moderate	>2037	2034	>2037	<p>Analysis indicates that under the low and best scenarios over the next 20 years the installed capacity of Australia's current oils re-refining infrastructure will be able to recycle waste arisings. Under the high scenario, the current installed capacity would be exceeded in 2034. There may be some regional limitations (see jurisdictional analysis below).</p> <p>The infrastructure need vs capacity assessment for this group has moderate uncertainty due to a moderate response rate during consultation and the potential under-reporting of waste oil in NSW and Vic data resulting in an under-estimate of 2016-17 arisings.</p> <p>The 2018 assessment for this infrastructure group is a significant improvement on the 2015 assessment due to separating the projections of the NEPM J waste codes of J100 and J160 from J120 waste oil/water, hydrocarbons/water mixtures or emulsions. The J120 waste arisings are now mapped to the new infrastructure group of OWT facilities (see below). This has increased the accuracy of the assessment and resulted in a change of expected exceedance of installed capacity in 2023 (in the</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								2015 assessment) to >2037 in this assessment.
Lead facility	119	124	71	Moderate	2023	2018	>2037	<p>Assuming arisings increase at the 20-year average population growth rate (1.4%) for all jurisdictions, except Tas (where lead waste is projected to follow trends in global zinc prices), the installed lead recycling infrastructure capacity could be met by 2023.</p> <p>Under a low scenario, of flat trend for 10 years and decline for the next 10 years due to replacement of battery technology, installed capacity is not expected to be exceeded over the next 20 years.</p> <p>Based on the high estimate projection of arisings increasing at the 20-year average rate of economic growth (2.8%) for all jurisdictions, except Tas, capacity would be exceeded in 2018. The high scenario also includes a 20 kt/yr release of jarosite waste from a stockpile at Nyrstar Hobart's zinc smelter to Nyrstar Port Pirie (which is understood to have unconstrained capacity to process wastes from the Hobart zinc smelting operations). The Nyrstar Port Pirie site is included in the e-waste infrastructure group due to the site's defined capacity to process e-wastes such as CRT and the site's unconstrained capacity to take lead waste from Nyrstar Hobart. Nyrstar Port Pirie lead recycling capacity is not included in the 124 kt/yr current installed capacity. There is also an additional 71 kt/yr of lead acid battery smelting capacity under construction that would add significant additional capacity along the east coast. Considering the Nyrstar Port Pirie capacity to manage all of the lead-rich waste from Nyrstar Hobart and the significant additional lead acid battery processing capacity coming on-line, there is likely to be sufficient lead recycling capacity under all scenarios. There may be some regional limitations (see jurisdictional analysis).</p> <p>The lead recycling assessment has moderate level of uncertainty due to a lack of industry response for the 2018 assessment and due to there not being a clearly defined upper limit on Nyrstar Port Pirie's ability to manage all of the lead waste from Nyrstar operations in addition to lead waste from other sectors.</p>
Mercury facility	0.2	CIC	CIC	Low	>2037	>2037	>2037	<p>Analysis indicates that over the next 20 years the currently installed capacity of Australia's current mercury waste recycling infrastructure will be able to recycle waste arisings. There may be some regional limitations (see jurisdictional analysis). Industry reported around 10 times more receipts than was reported in the waste transport tracking systems, reflecting that some of the mercury waste (such as unprocessed light fittings) do not require tracking.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								<p>Text withheld to maintain commercial confidentiality</p> <p>The mercury recycling assessment has a low level of uncertainty, with excellent industry input and a clearly defined infrastructure group targeting mercury recycling as the core business.</p>
Solvents/paints/organic chemicals facility	26	14	0	Very high	2018	2018	2018	<p>Projections indicate that the current capacity of solvents/paints recycling is being exceeded. This is unlikely to be accurate due to the high level of uncertainty in the capacity assessment for this group. A number of factors need to be considered:</p> <ol style="list-style-type: none"> 1. it is likely that some materials sent to energy recovery are recorded as recycled (resulting in an over-estimate of arisings to recycling and under-estimate to energy recovery) 2. some solvent/paint recycling capacity is likely to be within the CPT infrastructure group 3. some smaller operators that recycle solvents/paint may not have not been captured in the infrastructure database. <p>Based on industry consultation and this assessment, a national shortage of this infrastructure over the next 20 years is considered unlikely. There may be some regional limitations (see jurisdictional analysis).</p>
Organics processing facility	600	106	0	Very high	2018	2018	2018	<p>Projections indicate that under all scenarios the current capacity of organics recycling infrastructure (for NEPM K code organics) is being exceeded. This is inaccurate and is linked to the very high uncertainty of the assessment of needs vs capacity. The majority of the 600 kt arisings in 2016-17 of NEPM K code wastes are sent to composting sites that are not included in the infrastructure capacity assessment. To complete a quantitative analysis of projected arisings of NEPM K code organics against infrastructure capacity, extensive data would be required on non-hazardous waste infrastructure that accepts only a relatively small amount of low-level hazardous waste as part of much larger non-hazardous waste volume. In addition, some smaller operators that specialise in hazardous organic waste may not be within the infrastructure database due to the diffuse nature of this infrastructure group.</p> <p>Based on industry consultation and our assessment of organics recycling infrastructure (for NEPM code N) we do not believe that there is likely to be a national shortage of this infrastructure group over the next 20 years. This assessment is supported by the industry consultation results presented in Table 45</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								with an estimate that the sites within the scope of this infrastructure group received 99 kt of waste in 2016-17 and have an installed capacity to manage 106 kt/yr. There may be some regional limitations (see jurisdictional analysis).
EOLT facility	44	100	9	High	>2037	>2037	>2037	<p>This is a new infrastructure group for the 2018 assessment. The assessment of need vs capacity indicates that over the next 20 years the currently installed capacity of Australia's EOLT recycling infrastructure (100 kt/yr) will be able to recycle waste arisings (44 kt/yr in 2016-17). However, the EOLT recycling industry reported around 90 kt of EOLT received which is more than double the 44 kt waste arisings recycled in 2016-17 (estimated by REC 2017). The difference is related to EOLT recyclers receiving EOLT and exporting them with minimal processing to international energy recovery or reuse markets (the 44 kt relates to full onshore processing).</p> <p>As outlined in REC 2017, whilst there is good capacity in Australia to collect and partly process tyres for export, there is a lack of well-developed on-shore markets for tyre-derived products. REC 2017 estimates that over 60% of EOLT in Australia are sent to landfill, stockpiled or go to unknown fates. To increase the recovery of these lost EOLT there will need to be strong developments in processing technology in Australia. However, these investments cannot occur without well-established offtake markets for the tyre-derived products. Whilst the lack of EOLT recycling and high rates of landfill, stockpiling and unknown management points to a lack of recycling infrastructure, the investment in this infrastructure will not happen without the development of offtake markets and strong policy and enforcement to ensure tyres are not sent to landfill, stockpiled, dumped or exported to low value management options.</p> <p>The level of uncertainty for the EOLT assessment of needs vs capacity is high due to lack of site processing information to differentiate between full on-site recycling vs minor processing and export capacity. It is also unclear how readily EOLT recyclers could scale up operations so more EOLT were recovered for processing.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
SPL facility	46	CIC	CIC	Low	>2037	2020	>2037	<p>An estimated 46 kt of SPL arose in 2016-17 which suggests that the aluminium industry is processing all of the current SPL being generated and some of a significant stockpile of SPL. REC 2016 estimates Australia's annual SPL generation at around 30 kt/yr (based on aluminium production rates). REC 2016 also provides a detailed analysis of the SPL stockpiles in Australia.</p> <p>REC 2016 estimates the stockpile of SPL to be around 700 kt, of which around 390 kt are landfilled on-site at aluminium smelters around Australia.</p> <p>For this assessment:</p> <ul style="list-style-type: none"> - the best scenario assumes a 30% reduction in storage over 10 years from policy intervention (linear bleed) start in 2 years - the high scenario assumes a 100% reduction in storage over 10 years from policy intervention (linear bleed) start in 2 years - the low scenario assumes no release from stockpiles of the projection period. <p>Under the best and low scenarios, the current installed capacity is not estimated to be exceeded. Under the high scenario capacity would be exceeded, as not quite all of the stockpile would be processed in 10 years. This is consistent with the REC 2016 findings that there is capacity to treat the SPL stockpiles in Australia over around a 10-year period, whilst treating current arisings. REC 2016 also notes that the treatment of SPL that has been landfilled has not yet been demonstrated and may require additional or different infrastructure installation.</p> <p>The uncertainty of the SPL assessment is low, due mainly to the recent and detailed study (REC 2016) of SPL processing capacity, generation and stockpiles in Australia providing the necessary data.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
Energy recovery	2	0	0	Very high	>2037	>2037	>2037	<p>This infrastructure group's capacity has increased significantly since the 2015 assessment, due to the inclusion of cement kilns within the project scope and the allocation of these energy recovery tonnages to this group. The estimated arisings for this infrastructure group (2 kt) are incorrect. Industry reported 0 of waste currently received. The reasons for this are:</p> <ul style="list-style-type: none"> - Some of the 26 kt of solvents/paints recycling may actually be sent to energy recovery infrastructure. Currently, the jurisdictional waste tracking systems do not support the separate reporting of tonnages sent to recycling vs energy recovery, which limits the ability to assess energy recovery infrastructure need. - Some of the waste that is sent for energy recovery does not require tracking in some jurisdictions, for example waste oil in NSW and EOLT in NSW, SA and Vic. <p>It is also possible that tonnages of waste suitable for energy recovery are being moved without the use of transport certificates, which would again lower the recorded tonnages within tracking system data.</p> <p>Currently Australia's energy recovery from hazardous waste relies upon cement kilns as the offtake market. Whilst current installed capacity exceeds the 83 kt estimated as received, this does not allow for significant increases without either amendment to cement kiln licences (if technically feasible) or the development of additional energy recovery infrastructure apart from cement kilns.</p> <p>The uncertainty of the energy recovery assessment is very high, due mainly to inaccurate data for energy recovery arisings, which are far too low.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
Treatment								
CPT plant	395	1,129	4	Moderate	>2037	>2037	>2037	<p>Based on the best, high and low projections of arisings, CPT infrastructure is estimated to be able to meet national demand over the next 20 years. For all three scenarios, the projections are based on varying degrees of decline in some waste groups, such as B Acids and E Reactive chemicals, and growth in other waste groups, such as D300 Non-toxic salts and C Alkalis that are projected to increase driven by oil and gas (CSG) industry developments, however, much of this waste would be more likely sent to long-term isolation (discussed below).</p> <p>Estimated arisings to CPT have decreased significantly since the 2015 assessment from around 700 kt to around 400 kt. The estimated waste received reported by industry also fell from around 1,150 kt in 2015 to 860 kt. This is partly due to the closure of around 10 CPT facilities and also reflects the declining tonnages from some industrial waste generators. This was reported as a serious concern for the waste industry in the 2015 assessment.</p> <p>The infrastructure need vs capacity assessment for CPT has moderate uncertainty due mainly to the overlapping capacity with other infrastructure groups, such as solvents/paints recycling and transfer station or temporary storage, resulting in a likely over-estimate of capacity. Offsetting this is uncertainty about the amount of CSG industry waste that will actually leave the development site and be sent to CPT facilities.</p>
Clinical waste treatment facility	23	25	0	High	2026	2023	>2037	<p>Based on the best estimate, current 20-year average annual population growth (1.4% pa) and the installed capacity of clinical waste treatment – capacity could be exceeded by 2026. Based on the high projection Thornton 2014 growth rate (2.0 - 2.1%), national capacity could be exceeded in 2023. Under the low scenario where the waste arisings trend is flat, capacity is projected to meet demand over the next 20 years.</p> <p>The infrastructure needs vs capacity assessment for this group has high uncertainty due to a poor response rate from industry. Despite this uncertainty, the assessment does indicate that Australia's clinical waste treatment capacity is soon to become constrained and investment in additional infrastructure may be required.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
Bioremediation facility	192	0	0	Very high	no inf.	no inf.	no inf.	<p>This is a new infrastructure group for the 2018 assessment. Capacity data coverage limitation: composting facilities are excluded from the database. This group is intended to refer to facilities that treat hazardous waste though biodegradation that are not generating compost for sale. However, many commercial composting facilities are licenced to receive low level hazardous waste which is effectively bioremediated in the composting process and these facilities are not within the project scope.</p> <p>Some 200 kt of hazardous waste was reported in tracking data as bioremediated. Most, if not all, of this material would be processed by commercial composting facilities licenced to take a range of low hazard organics waste such as grease trap. These composting facilities are not included in this database. Whilst it is worth maintaining transparency on the amount of hazardous waste being reported as bioremediated by the composting industry, it is beyond the project scope to assess the capacity of bioremediation capacity in Australia.</p>
Oily water treatment (OWT) facility	187	199	0	Very high	2025	2019	>2037	<p>This is a new infrastructure group for the 2018 assessment. Under the best estimate projection, capacity would be exceeded in 2025, or as soon as 2019 under the high scenario estimate. Under the low projection, estimated capacity is not expected to be exceeded over the 20-year projection period. The reported 2016-17 arisings of 187 kt are more than the estimated receipts of around 150 kt which may be due to a lack of response from industry and the need to use averages for around a third of sites or it could be due to the database not including all sites from this diffuse infrastructure group.</p> <p>The uncertainty of the needs vs capacity assessment is very high due to the capacity assessment relying on average installed capacity for around a third of the sites and the high risk that small OWT plants are not included in the database.</p> <p>Noting the above, the assessment indicates that capacity for OWT could become constrained over the next 10 years and some additional capacity may be required. There will be particular regional needs, see jurisdiction sections below.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
Soils treatment facility	131	178	296	Moderate	>2037	2018	>2037	<p>Under the best estimate projection arisings would not exceed installed capacity over the next 20 years and would currently exceed capacity under the high scenario. Under the low scenario capacity would not be exceeded over the projection period.</p> <p>Significant additional soil treatment capacity is under construction/commissioning in Vic that will add around 300 kt of additional installed capacity which will provide sufficient capacity for the long term for Vic. The significant Vic treatment capacity may also be used to treat soils from interstate, with appropriate approvals in place.</p> <p>Industry reported receiving arisings of just 97 kt of contaminated soils. The reported 2016-17 arisings of 131 kt are significantly more than this. This may be due to low level contaminated soil being received for treatment at composting facilities in some jurisdictions, which are beyond the scope of the capacity assessment, or small 'low tech' contaminated soils operations that have not been captured by the capacity assessment.</p> <p>The uncertainty of the needs vs capacity assessment is moderate due to the highly fluctuating generation rates of contaminated soils and the difficulty that contaminated soils facilities face in securing the contaminated soil for treatment. Industry report on-site management, contamination dilution with clean soils and landfill disposal as serious threats to their investments, which reduces the certainty in infrastructure capacity investments.</p> <p>Noting the above, the assessment indicates that there may be a need for additional soil treatment capacity in Australia if contaminated soils generation rates are high, except for Vic which has significant capacity coming on-line. For neighbouring jurisdictions, sending soils to Vic for treatment may be an option in future. There may be other particular regional needs, see jurisdiction sections below.</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
Disposal								
Hazardous waste landfill facility	235	201	0	High	2018	2018	2018	<p>This capacity assessment examined hazardous waste landfills’ ability to accept annual arisings of waste; this differs from the usual measure of landfill capacity, which refers to total available airspace. Landfills may be constrained in relation to the rate at which waste is accepted, for example due to limitations of specialist cells, traffic management or licence limits. These constraints are not common and are understood not to be an issue for the sites included in this group.</p> <p>For all three scenarios the current 2016-17 arisings exceed the current installed annual capacity. The modelling assessment for this infrastructure group is incorrect. The response rate from site operators was only 50%, meaning infrastructure group averages were used, and generally the responses provided data only on waste currently received with little information on the installed capacity (annual acceptance rate that is possible for the site). This is understandable as, unlike other infrastructure types, landfills are usually able to cater to varying capacity demands and a site’s installed annual capacity can be difficult to define.</p> <p>Perhaps more important than the above analysis are industry comments regarding the expected life (i.e. amount of airspace remaining and the number of years of operation before this capacity is consumed) of the seven landfill sites included in this infrastructure group.³⁹. Landfill operators were asked how much waste could be received at the site before the site’s airspace was consumed. Where the operator responded, they all responded with an estimate of the expected year of closure or simply stated that the site had more than 20 years capacity remaining. Text withheld to maintain commercial confidentiality. No other sites surveyed in this category responded with a definitive response of planned closure within the next 20 years. Apart from Suez Elizabeth Drive, responses were generally vague on the expected closure year and it is recommended that more detailed investigation of the likely closure date of the landfills in this category be completed. Given the small number of sites and the extreme difficulty some jurisdictions have experienced in establishing new hazardous waste landfills, it is important to better understand the risk profile of each site in terms of its likelihood of closure due to: a lack of airspace, regulatory non-compliance, community concern and sudden airspace consumption</p>

³⁹ The Mount Walton Intractable Waste facility in WA is included in the seven hazardous waste landfills. It has historically only operated on a campaign basis and Tellus Holdings are building a long-term isolation facility five km from site. The future operation of the Mount Walton Intractable waste facility is assumed unlikely following establishment of the Tellus Holdings site next-door.

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								<p>due to extreme weather events such as cyclone or fire.</p> <p>Recommendation: DoEE work with the jurisdictions to complete a detailed assessment of the likely closure year of the identified hazardous waste landfill facility infrastructure including a risk assessment of site capacity being impacted by issues such as extreme weather events.</p> <p>Text withheld to maintain commercial confidentiality.</p>
Landfill facility (NEPM codes N, T)	2,875	Not included in assessment of arisings versus capacity		n/a	no inf.	no inf.	no inf.	<p>This infrastructure group is not in the scope of hazardous waste database. As discussed in Section 3.2, a significant number of landfills are licensed to take hazardous waste NEPM codes N and T only (asbestos, EOLT, low level contaminated soils) and these facilities are not included in the infrastructure database. This is reflected in the almost 3 Mt of hazardous and controlled waste estimated to be sent to this infrastructure group, by far the largest portion of hazardous waste (almost half of the estimated 6 Mt of arisings). To complete a quantitative analysis of projected arisings of NEPM code N and T wastes vs licensed infrastructure capacity would require a significant expansion of the scope of the hazardous waste capacity database to cover non-hazardous waste infrastructure accepting only a relatively small amount of low level hazardous waste as part of much larger non-hazardous waste quantities.</p> <p>Landfills that accept mostly municipal waste are often also able to take low level contaminated soil and asbestos. Based on industry consultation and our assessment of landfill infrastructure for NEPM codes N and T only, we do not believe there is likely to be a national shortage of this infrastructure group over the next 20 years.</p>
POP thermal destruction facility	5	CIC	CIC	Very high	2020	2020	2020	<p>There have been significant developments in POP thermal destruction since the 2015 assessment and also the scope of the 2018 assessment includes cement kilns which are offering capacity to destroy POP. An estimated 3 kt of POP waste arose in 2016-17 and the current installed infrastructure capacity is CIC kt. Around CIC kt of the current installed capacity has only become operational in 2018 and in the past couple of years Australia's designated POP destruction capacity has been limited. An additional CIC kt of POP thermal destruction capacity is expected in the near future. It should be noted that around CIC kt of this additional capacity will be mobile and may be setup on-site for specific projects.</p> <p>However, under all scenarios the current and expected future POP capacity would be greatly exceeded in 2020 when, under the best estimate scenario, arisings are</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								<p>projected to increase to over 400 kt and increase to 450 kt by 2037. The major increases in arisings in 2020 are driven by major increases in PFAS contaminated waste (soils, AFFF, biosolids) in 2020 and by increases in POP-BDEs and HBCD waste starting in 2023. Whilst this identifies a major gap in Australia's dedicated POP thermal destruction capacity, the capacity assessment uncertainty for this group is very high. The following issues need to be considered that could provide sufficient POP destruction capacity in future:</p> <ol style="list-style-type: none"> 1. POP TD capacity within soils treatment facilities. By 2020, as noted above, Australia should have soil treatment facilities that are able to receive POP, with a total installed capacity of over 300 kt. The capacity of these facilities to receive POP is not yet clear and for this assessment a conservative estimate is made of less than 600 kt of POP waste capacity within these facilities. It is possible that PFAS contaminated waste (soil and biosolids in particular) may be treated by these facilities in much larger tonnages sufficient to manage the projected arisings. 2. POP TD capacity within cement kilns. Cement kilns in Australia are currently destroying some POP including PFOS. The capacity of Australia's cement kilns to destroy POP is estimated to be 600 kt/yr. The capacity of cement kilns to destroy additional POP tonnages is unknown and there may be additional capacity if the appropriate testing and license approvals were successful. 3. POP TD capacity within clinical waste TD facilities. Daniels (Toxfree) Laverton facility is licenced for highly contaminated PCB waste. Daniels (Toxfree) did not state the potential tonnages of POP that could be destroyed at the facility. It may be the case that the current and planned suite of infrastructure that is able to destroy POP can manage the projected tonnages of POP wastes. However, it will depend on the ability of the soil treatment, cement kilns and clinical waste destruction facilities ability to demonstrate the destruction of POP at the currently licensed limits. Future increases in POP waste may be able to be managed in the current infrastructure set subject demonstration of POP destruction and the approval of large increases in licensed capacities for POP wastes. <p>Recommendation: DoEE work with jurisdictions and industry to agree an approach to determine the upper limit for tonnages/concentrations that can be received at the high temperature thermal soil treatment facilities, cement kilns and clinical waste thermal destruction units that will ensure thermal destruction of the PFAS, BDE, HBCD, HCB wastes. This information is required to better understand how</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								much additional dedicated POP thermal destruction capacity (from technologies such as plasma arc) may be required in future.
Clinical waste facility thermal destruction	21	33	6	Low	>2037	>2037	>2037	<p>Based on the best, high and low projections of arisings, clinical waste thermal destruction infrastructure is estimated to be able to meet national demand over the next 20 years.</p> <p>The estimated 2016-17 arisings of 21 kt aligns with the 20 kt of waste received as reported by industry. With a currently capacity of 33 kt/y and an expected increase of 3 kt, there appears to be sufficient clinical waste thermal destruction capacity in Australia. There may be local regional needs, see each jurisdiction's section below.</p> <p>The spare capacity of this infrastructure group has the potential to be impacted by the demand for POP thermal destruction where the site is currently or gains a licence for POP destruction (see discussion under POP facilities).</p> <p>The infrastructure needs vs capacity assessment for this group has low uncertainty due to a full response rate from industry a well-defined and industry group with good coverage in the capacity database.</p>
Short-term storage or transfer								
Transfer facility	551	145	0	Very high	2018	2018	2018	<p>Projections indicate that under all scenarios the current national transfer/temporary storage capacity of hazardous waste infrastructure is exceeded. These projections are not accurate due mainly to the capacity database having limited coverage of this group. Whilst some transfer facilities are included in this dataset it is recognised that there are other facilities which deal with hazardous waste that are not included in the dataset, such as smaller storage facilities and transfer stations. This infrastructure group is also not the focus of this project.</p> <p>We surveyed industry asking them to flag any major transport constraints. Very long transport distances particularly in WA were raised several times as a major barrier to treating/recovering hazardous waste. WA has 4 of the 19 transfer station facilities in the 2018 database. For such a large state this appears low. If not already being undertaken, further investigation of strategic locations for transfer station facilities in WA is recommended. Consultation with industry on establishing joint venture transfer stations to consolidate waste from a range of waste companies and generators should be explored for WA and potentially Qld (to reduce costs of CSG wastes transport).</p>

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								Recommendation: DoEE and/or WA and Qld governments complete a detailed assessment and consultation with industry regarding the need for and (where required) best location(s) for additional hazardous waste transfer station/temporary storage infrastructure. ⁴⁰
Long-term storage								
Long-term on-site storage	Not included in assessment of arisings versus capacity			n/a	no inf.	no inf.	no inf.	This is a new infrastructure group for 2018. Long-term on-site storage facilities are excluded from the database and the needs versus capacity assessment. The infrastructure group has been included recognising that some hazardous wastes are managed in on-site infrastructure that is often for the long term (e.g. CSG RO brine wastes). No tonnages are currently mapped to this infrastructure group because the waste disposed in these sites does not leave the site and is not recorded in hazardous waste tracking data and therefore is not recorded as a waste arising in the assessment database. Data for waste stored in these storages is only available by direct consultation with industry and/or state regulators.
Long-term isolation facility	0	0	CIC	n/a	no inf.	no inf.	no inf.	<p>This is a new infrastructure group for 2018. Two long-term isolation facilities are currently under development and aim to be operational in around five years' time. Assuming that both of these facilities become operational, they would provide capacity for up to CIC kt/yr for highly intractable wastes that do not have viable treatment or destruction options. This would provide good risk mitigation for the risks associated with having only six (operating) hazardous waste landfills in Australia, with the main NSW site due to close in CIC.</p> <p>CSG reverse osmosis brine wastes and long-term isolation capacity: under the high projection scenario, it is assumed that, after five years new arisings of CSG reverse osmosis brine wastes will be required to be managed offsite and would be sent to long-term isolation facilities (rather than being stored onsite). Historical stockpiles are assumed to remain onsite.</p> <p>This results in a very large increase, 2.5 Mt/yr, in 2023 increasing to 3.2 Mt/yr by 2037 that is projected to need long-term isolation facility capacity. This presents a shortfall of CIC Mt of capacity in 2023, even when the currently planned facilities are built and operating at capacity.</p> <p>The projected needs versus capacity assessment does not identify the year of</p>

⁴⁰ WA DWER noted: State's new Waste Strategy and proposed State Waste Infrastructure Plan aim to reduce risks from long transport distances.

Infrastructure group	16-17 arisings (kt/yr)	Installed capacity (kt/yr)	Expected capacity change (kt/yr)	Uncertainty of assessment low - very high	Est. year arisings > installed capacity			Assessment discussion and recommendations
					Best	High	Low	
								<p>exceedance (2023 under a high scenario for D300) because the CIC kt/yr capacity is not yet operational.</p> <p>Recommendation: DoEE should work with state and territory governments to assess the appropriate management of CSG RO brine wastes and determine the likelihood of offsite disposal.</p>

Notes

1. Analysis assumes that the current national average proportions of fate (i.e. how much is recovered, disposed) remain static. This limits the quantitative analysis for wastes that are currently disposed but could be recovered in higher proportion in future. Consultation with government stakeholders about expected changes in regulation has been completed as well as discussing likely future trends with industry during consultation.
2. Landfill installed capacity refers to the potential tonnages that the site can landfill in a year. It does not refer to the amount of waste the site can receive before closure. Where the installed capacity is exceeded, it indicates that the landfill would need to increase capabilities to dispose more waste each year. This may require amendment to the site's EPA licence.

4.4 Jurisdictional assessment of need versus capacity

An assessment of installed capacity in each jurisdiction against estimated wastes arising is included in the sections below in Table 52 to Table 59. Each of these tables includes the following for each infrastructure group:

- the installed capacity of the infrastructure included in the group
- the estimated 2016-17 arisings assumed to be managed by each infrastructure group
- the year in which estimated waste arisings exceed installed capacity under best, high and low estimates
- a discussion.

For the jurisdictional assessments, the data is presented in tonnes (not kt) due to the small tonnages for some waste streams at a jurisdictional level. This means that for some larger tonnage waste streams, data is presented at four or five significant figures rather than the two or three significant figures that is more appropriate given high levels of uncertainty.

In the public version of this report, the data for infrastructure groups that are serviced by less than three sites have been removed to protect commercial confidentialities. At a jurisdictional level, this has required the redaction of a significant amount of data.

4.4.1 Limitation: using the national average of management method for ACT, NT and Tas

The management methods for the 2016-17 waste arisings in ACT, NT and Tas have been estimated using the average of the management methods from the combined weighted average of NSW, Qld, Vic, SA and WA (the national average). Figure 44 shows the national average for management methods by waste group.

In reality, waste in the ACT, NT and Tas may be managed differently to the states included in the national average. This issue is discussed further in the jurisdictional sections that follow.

4.4.2 Assessment of NEPM data for net interstate movements of hazardous wastes

The NEPM data is published in the [National Environment Protection Council Annual Report](#). The NEPM data illustrates which jurisdictions are importing and exporting which types of wastes, which is important as it has a direct impact on the need for infrastructure capacity in a jurisdiction. Figure 46 and Table 51 show the NEPM data for the 2016-17 period for each jurisdiction, illustrating firstly the total imports and exports, then the net imports/exports by NEPM 15 waste code. The NEPM 2016-17 data for each jurisdiction is discussed in each of the jurisdictions' tables that follow.

Figure 46: NEPM 2016-17 total imports and exports by jurisdiction

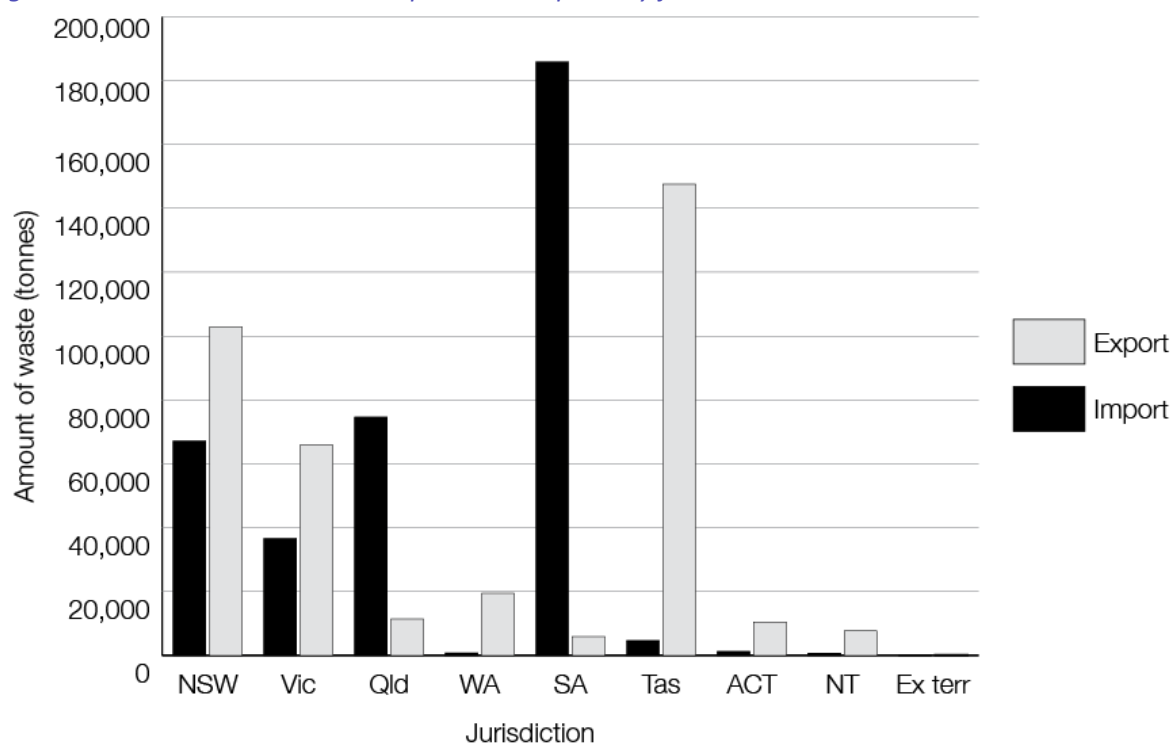


Table 51: NEPM 2016-17 net imports/exports by jurisdiction and NEPM 15 code

Code	Description	Net imports/exports (tonnes) (negative values are net imports)							
		NSW	Vic	Qld	WA	SA	Tas	ACT	NT
A	Plating & heat treatment	-2	-1	1	-16	1	1	0	16
B	Acids	-19,970	19,920	38	26	-229	23	0	186
C	Alkalis	46	137	-198	7	-725	11	1	720
D	Inorganic chemicals	-10,666	19,963	4,264	16,943	-173,455	142,848	51	1,050
E	Reactive chemicals	102	-5	-106	0	-1	0	0	0
F	Paints, resins, inks organic sludges	1,941	-1,439	774	300	-1,931	-97	23	159
G	Organic solvents	6,918	-1,243	-6,213	326	150	47	21	0
H	Pesticides	252	-685	254	447	-30	0	0	0
J	Oils	21,783	-215	-25,461	855	-1,819	109	2,554	2,159
K	Putrescible/organic waste	-3,350	352	-3,631	-344	74	-92	6,537	356
L	Industrial washwater	5,484	-980	-4,505	0	42	0	0	0
M	Organic chemicals	30,624	-156	-30,623	-26	135	54	118	87
N	Soil/sludge	2,665	-3,720	106	61	-363	307	-495	129
R	Clinical & pharmaceutical	379	-1,730	420	63	-1,754	51	118	2,021
T	Misc.	-585	124	0	23	-26	17	229	32
TOTAL (t)		35,623	29,322	-70,722	18,664	-179,930	143,278	9,159	6,915
Net tonnage waste imported									
Net tonnage exported									

Table 52: ACT assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery							<p>This assessment is based on the national average (NSW, Vic, Qld, WA and SA) of waste management methods. This reduces the accuracy and may result in arisings being mapped to infrastructure that does not exist in this jurisdiction.</p> <p>Recycling and energy recovery</p> <ul style="list-style-type: none">- Hazwaste packaging, oils re-refining, solvents, organics, EOLT wastes are all sent interstate for recycling.- E-waste infrastructure capacity is likely to be sufficient under all scenarios. <p>Treatment</p> <ul style="list-style-type: none">- All waste treatment appears to be occurring interstate (the Daniels ACT medical waste autoclave facility is no longer operational). <p>Disposal (landfill and thermal destruction)</p> <ul style="list-style-type: none">- All hazardous waste apart from NEPM codes N and T (asbestos, tyres and low level contaminated soils) are likely sent interstate for disposal. <p>Short-term storage or transfer</p> <ul style="list-style-type: none">- ACT appears to have sufficient transfer station capacity to meet projected need over the next 20 years. <p>NEPM 2016-17 data indicates that the bulk of the estimated 10 kt of waste arisings in 2016-17, net of what is managed at landfill facilities (NEPM code N,T i.e.</p>	
Hazardous waste packaging facility	2	CIC	n/a	no inf.	no inf.	no inf.		
E-waste facility	62		Good	>2037	2037	>2037		
Oil re-refining facility	993		n/a	no inf.	no inf.	no inf.		
Lead facility	0		n/a	no inf.	no inf.	no inf.		
Mercury facility	0		n/a	no inf.	no inf.	no inf.		
Solvents/paints/organic chemicals facility	7		n/a	no inf.	no inf.	no inf.		
Organics processing facility	4,166		n/a	no inf.	no inf.	no inf.		
EOLT facility	764		n/a	no inf.	no inf.	no inf.		
SPL facility	0		n/a	no inf.	no inf.	no inf.		
Energy recovery	4		n/a	no inf.	no inf.	no inf.		
Treatment								
CPT plant	1,403	CIC	n/a	no inf.	no inf.	no inf.		
Clinical waste treatment facility	60		n/a	no inf.	no inf.	no inf.		
Bioremediation facility	31		n/a	no inf.	no inf.	no inf.		
OWT facility	180		n/a	no inf.	no inf.	no inf.		
Soils treatment facility	2		n/a	no inf.	no inf.	no inf.		
Disposal								
Hazardous waste landfill facility	104	CIC	n/a	no inf.	no inf.	no inf.		
Landfill facility (NEPM codes N, T)	211,629		n/a	no inf.	no inf.	no inf.		
Persistent organic pollutants thermal destruction facility	8		n/a	no inf.	no inf.	no inf.		
Clinical waste facility thermal destruction	78		n/a	no inf.	no inf.	no inf.		

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Short-term storage or transfer								asbestos, tyres, low level contaminated soils) is exported to other jurisdictions for management.
Transfer facility	2,220	CIC		Good	>2037	2032	>2037	
Long-term storage								
Long-term on-site storage	0	CIC		n/a	no inf.	no inf.	no inf.	'Mr Fluffy' Asbestos waste: As per the 2015 assessment, landfill facility (NEPM code N, T) capacity is not included in the capacity database. Asbestos is assumed to be 100% sent to this infrastructure group. Discussions with ACT NoWaste and EPA staff indicate that there will be sufficient landfill capacity available to dispose of asbestos wastes (including from Mr Fluffy houses) due to the expansion of the current landfill and establishment of an additional landfill.
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	10,084							
NEPM 12-13 net imp./exp. (kt)	9,159	(export)						

Table 53: NSW assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								<p>Recycling and energy recovery</p> <p>- NSW recycling and energy recovery infrastructure capacity is projected to be sufficient for all infrastructure groups apart from hazwaste packaging, oil re-refining and organics processing.</p> <p>- Organics processing capacity assessment has limited coverage as composting facilities are excluded and may not be accurate.</p> <p>- Hazardous waste packaging facilities capacity assessment is poor due to a poor industry response rate. There are four facilities across NSW, that are likely to have sufficient capacity for this waste stream.</p> <p>- Oil (re-refining) capacity may be constrained in NSW resulting in waste oil being exported interstate (Qld) for processing.</p> <p>Treatment</p> <p>- CPT plant capacity is likely to be sufficient and this includes CSG mining industry waste growing very strongly and some volumes being sent off-site to CPT plants.</p> <p>- Clinical waste treatment capacities could be constrained and these wastes are likely being sent interstate. NEPM 2016-17 data for clinical waste confirms net exports from NSW to other jurisdictions.</p> <p>- Contaminated soils treatment arisings are reported as zero, which is due to NSW not tracking contaminated soils. If NSW soils treatment capacity was to become constrained the soils may be sent to Vic for treatment (approval required).</p> <p>- NSW OWT capacity could be constrained currently, however, the capacity estimate for this group is poor due to poor industry response and a diffuse infrastructure group</p>
Hazardous waste packaging facility	7,982	CIC	CIC	Poor	2018	2018	2018	
E-waste facility	1,168			Good	>2037	>2037	>2037	
Oil re-refining facility	132,239			Good	2018	2018	2018	
Lead facility	43,160			Good	>2037	>2037	>2037	
Mercury facility	93			Good	>2037	>2037	>2037	
Solvents/paints/organic chemicals facility	2,800			Good	>2037	>2037	>2037	
Organics processing facility	154,398			Good	2018	2018	2018	
EOLT facility	11,724			Good	>2037	>2037	>2037	
SPL facility	13,019			Good	>2037	>2037	>2037	
Energy recovery	16			Good	>2037	>2037	>2037	
Treatment								
CPT plant	123,201	CIC	CIC	Good	>2037	>2037	>2037	
Clinical waste treatment facility	9,024			Poor	2018	2018	2018	
Bioremediation facility	0			n/a	no inf.	no inf.	no inf.	
OWT facility	66,792			Poor	2018	2018	2018	
Soils treatment facility	0			Good	>2037	>2037	>2037	
Disposal								
Hazardous waste landfill facility	40,400	CIC	CIC	Good	2020	2018	>2037	
Landfill facility (NEPM codes N, T)	1,116,161			n/a	no inf.	no inf.	no inf.	
Persistent organic pollutants thermal destruction facility	1,767			n/a	no inf.	no inf.	no inf.	
Clinical waste facility thermal destruction	2,595			Good	>2037	>2037	>2037	
Short-term storage or transfer								
Transfer facility	38,745	CIC	CIC	Good	2018	2018	2018	

Infrastructure group	16-17 arising (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arising > capacity			Assessment discussion and recommendations
					Best	High	Low	
Long-term storage								that may be missing sites and capacity. Disposal (landfill and thermal destruction) - Hazwaste landfill could have insufficient annual landfill disposal capacity currently or by 2020 which could require a licence amendment or changes in site management to take more tonnages per year. Text withheld to maintain commercial confidentiality. - POP (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - NSW clinical waste thermal destruction capacity is projected to provide sufficient capacity over the next 20 years. Transfer station or temporary storage - NSW transfer capacity may already be exceeded, however, capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increasing the rate of loads transferred). NEPM 2016-17 data showed that NSW had net exports of 36 kt of hazardous wastes (organics chemicals, pesticides, oils, soils and clinical wastes) to other jurisdictions.
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	649,123							
NEPM 12-13 net imp./exp. (kt)	35,623	(export)						

Table 54: NT assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								
Hazardous waste packaging facility	25	CIC	CIC	n/a	no inf.	no inf.	no inf.	This assessment is based on the national average (NSW, Vic, Qld, WA and SA) of waste management methods. This reduces accuracy and may result in arisings being mapped to infrastructure that does not exist in this jurisdiction. Recycling and energy recovery - All recycling and energy recovery occurs interstate or at sites not covered or missing from the hazwaste infrastructure database. Treatment - All hazardous waste requiring treatment appears to be sent interstate for treatment, apart from clinical waste. - Clinical waste treatment infrastructure capacity is likely to be sufficient under all scenarios. Disposal (landfill and thermal destruction) - Hazwaste landfill has sufficient annual disposal capacity over the projection period. Note, this does not mean that the landfill has over 20 years life remaining, see note 2. - POP (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - Clinical waste is sent interstate for destruction where required. Transfer station or temporary storage - Capacity is likely to be sufficient under all scenarios. The long-term isolation facility that is planned for NT would provide a significant amount of additional capacity for NT
E-waste facility	39			n/a	no inf.	no inf.	no inf.	
Oil re-refining facility	1,603			n/a	no inf.	no inf.	no inf.	
Lead facility	0			n/a	no inf.	no inf.	no inf.	
Mercury facility	3			n/a	no inf.	no inf.	no inf.	
Solvents/paints/organic chemicals facility	32			n/a	no inf.	no inf.	no inf.	
Organics processing facility	3,708			n/a	no inf.	no inf.	no inf.	
EOLT facility	508			n/a	no inf.	no inf.	no inf.	
SPL facility	0			n/a	no inf.	no inf.	no inf.	
Energy recovery	8			n/a	no inf.	no inf.	no inf.	
Treatment								
CPT plant	1,269	CIC	CIC	n/a	no inf.	no inf.	no inf.	Disposal (landfill and thermal destruction) - Hazwaste landfill has sufficient annual disposal capacity over the projection period. Note, this does not mean that the landfill has over 20 years life remaining, see note 2. - POP (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - Clinical waste is sent interstate for destruction where required.
Clinical waste treatment facility	57			Good	>2037	>2037	>2037	
Bioremediation facility	352			n/a	no inf.	no inf.	no inf.	
OWT facility	944			n/a	no inf.	no inf.	no inf.	
Soils treatment facility	738			n/a	no inf.	no inf.	no inf.	
Disposal								
Hazardous waste landfill facility	601	CIC	CIC	Poor	>2037	>2037	>2037	Transfer station or temporary storage - Capacity is likely to be sufficient under all scenarios.
Landfill facility (NEPM codes N, T)	16,436			n/a	no inf.	no inf.	no inf.	
Persistent organic pollutants thermal destruction facility	0			n/a	no inf.	no inf.	no inf.	
Clinical waste facility thermal destruction	75			n/a	no inf.	no inf.	no inf.	
Short-term storage or transfer								
Transfer facility	2,296	CIC	CIC	Good	>2037	>2037	>2037	

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Long-term storage								and would also likely result in some hazardous waste being imported to NT in future. NEPM 2016-17 data indicates that around 7 kt (of the estimated 12 kt of arisings in 2018, net of landfill NEPM N,T wastes) is exported to other jurisdictions and NT imports no hazardous waste. This suggests that some of the remaining 5 kt of estimated waste arisings are managed by sites not covered/missing from the hazwaste infrastructure database or are sent to landfill in NT.
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	12,257							
NEPM 12-13 net imp./exp. (kt)	6,915	(export)						

Table 55 Qld assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								
Hazardous waste packaging facility	3,799	CIC	CIC	Good	2018	2018	2018	<p>Recycling and energy recovery</p> <p>- Hazwaste packaging infrastructure capacity appears constrained in Qld currently.</p> <p>- E-waste capacity is likely to be sufficient assuming no change in recovery rate until around 2030.</p> <p>- Oil re-refining capacity could be constrained locally by 2025 or by 2031 under the best estimate projection. However, if oil arisings do not increase the current capacity should be sufficient over the next 20 years.</p> <p>- Organics recycling infrastructure for Qld is missing from hazwaste capacity database. Qld has significant arisings of NEPM K code wastes and was a net importer of NEPM K code wastes in 2016-17. The missing infrastructure capacity is likely to be composting facilities, which are out of scope of this assessment.</p> <p>- Qld's annual SPL processing capacity could be exceeded under the high scenario (all SPL current arisings and stockpiles processed over 10 years), projections show it would take more like 15 years to process the Qld stockpile of SPL whilst processing current arisings.</p>
E-waste facility	799			Good	2031	2030	2033	
Oil re-refining facility	82,445			Good	2031	2025	>2037	
Lead facility	10,169			Good	>2037	>2037	>2037	
Mercury facility	10			Good	>2037	>2037	>2037	
Solvents/paints/organic chemicals facility	1,370			Poor	>2037	>2037	>2037	
Organics processing facility	146,022			n/a	no inf.	no inf.	no inf.	
EOLT facility	13,535			Good	>2037	2025	>2037	
SPL facility	12,832			Good	>2037	2020	>2037	
Energy recovery	572			Good	>2037	>2037	>2037	
Treatment								
CPT plant	78,358	CIC	CIC	Good	>2037	>2037	>2037	<p>Treatment</p> <p>- Clinical waste treatment capacity appears limited in Qld under all scenarios. NEPM data shows Qld exports clinical wastes.</p> <p>- Dedicated soils treatment capacity in Qld now appears to be a capacity constraint under all scenarios. Toxfree Narangba site capacity has been dedicated to POP destruction and OWT. NEPM data shows Qld as a net exporter of soils. With limited soils treatment capacity in NSW and none in NT,</p>
Clinical waste treatment facility	4,639			Poor	2018	2018	2018	
Bioremediation facility	133,977			n/a	no inf.	no inf.	no inf.	
OWT facility	44,702			Good	>2037	2032	>2037	
Soils treatment facility	17,021			n/a	no inf.	no inf.	no inf.	
Disposal								
Hazardous waste landfill facility	96,393	CIC	CIC	Poor	2018	2018	2018	
Landfill facility (NEPM codes N, T)	754,462			n/a	no inf.	no inf.	no inf.	
Persistent organic pollutants thermal destruction facility	2,329			Good	2020	2020	2020	
Clinical waste facility thermal destruction	7,619			Good	2036	2030	>2037	
Short-term storage or transfer								
Transfer facility	197,990	CIC	CIC	Good	2018	2018	2018	

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Long-term storage								<p>additional soil treatment capacity in Qld may be required, unless the wastes are to be transported to Vic for treatment.</p> <p>- Around 130 kt of hazardous waste in Qld was sent to biodegradation facilities, which are understood to be mostly commercial composting facilities (capacity assessment beyond scope).</p> <p>Disposal (landfill and thermal destruction)</p> <p>- Hazwaste landfill capacity in Qld may be insufficient to manage annual disposal tonnages currently and into the future which could require a licence amendment or changes in site management to take more tonnages per year.</p> <p>- POP TD capacity could be constrained by 2020 under all scenarios, servicing Qld's POP wastes, alone.</p> <p>Transfer station or temporary storage</p> <p>- Qld's transfer capacity may already be exceeded; however, capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increasing the rate of loads transferred).</p> <p>Long-term isolation capacity:</p> <p>Under the high projection scenario, CSG reverse osmosis brine wastes will be required to be managed offsite at long-term isolation. This results in a very large increase and a shortfall of 2.0 Mt of capacity in 2023, even when the currently planned facilities are built in NT and WA.</p> <p>NEPM 2016-17 data showed a net import of 70 kt of hazwaste into Qld. Major imports were organic chemicals, oils, organic solvents, industrial wash waters and organics.</p>
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	854,581							
NEPM 12-13 net imp./exp. (kt)	-70,722	(import)						

Table 56 SA assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								Recycling and energy recovery - Hazwaste packaging, oil re-refining, e-waste, mercury, EOLI recycling capacity is likely to be sufficient over the projection period. - Lead acid batteries, solvent wastes are likely being sent interstate for recycling. It is unclear if Nyrstar lead smelter is able to process lead acid batteries currently. - SPL would not be generated in SA (this is likely inorganic fluorine waste from another source, not SPL). - Solvents/paints infrastructure capacity may be missing from the database or capacity is provided by SA's CPT or energy recovery facilities. NEPM 2016-17 data indicates SA is a net importer of solvents/paints wastes. - Organics processing infrastructure capacity is incomplete as it excludes composting facilities.
Hazardous waste packaging facility	309	CIC	CIC	Poor	>2037	>2037	>2037	
E-waste facility	285			Good	>2037	>2037	>2037	
Oil re-refining facility	12,534			Poor	>2037	>2037	>2037	
Lead facility	43,439			n/a	no inf.	no inf.	no inf.	
Mercury facility	45			Good	>2037	>2037	>2037	
Solvents/paints/organic chemicals facility	1,366			n/a	no inf.	no inf.	no inf.	
Organics processing facility	71,659			n/a	no inf.	no inf.	no inf.	
EOLT facility	1,923			Good	>2037	>2037	>2037	
SPL facility	2			n/a	no inf.	no inf.	no inf.	
Energy recovery	54			Good	>2037	>2037	>2037	
Treatment								Treatment - CPT, clinical waste and OWT capacity appear to be sufficient to manage arisings over the projection period. - Soil treatment facility capacity in SA appears to be insufficient currently and into the future and additional soil treatment capacity may be required, unless the soils are to be transported to sites in Vic (approval required).
CPT plant	42,045	CIC	CIC	Good	>2037	>2037	>2037	
Clinical waste treatment facility	436			Good	>2037	>2037	>2037	
Bioremediation facility	5			n/a	no inf.	no inf.	no inf.	
OWT facility	23,291			Good	2018	2018	2018	
Soils treatment facility	65,956			n/a	no inf.	no inf.	no inf.	
Disposal								Disposal (landfill and thermal destruction) - No Hazwaste landfill fac. capacity was included in the capacity database for SA. The landfills listed were only listed as receiving NEPM code N wastes. It is not clear which SA landfills would receive the 42 kt of waste this assessment has mapped to hazardous waste landfills.
Hazardous waste landfill facility	41,499	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Landfill facility (NEPM codes N, T)	108,500			n/a	no inf.	no inf.	no inf.	
Persistent organic pollutants thermal destruction facility	36			n/a	no inf.	no inf.	no inf.	
Clinical waste facility thermal destruction	3,538			Good	2018	2018	2018	
Short-term storage or transfer								
Transfer facility	84,631	CIC	CIC	Good	2018	2018	2018	

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Long-term storage								<p>- Clinical TD capacity appears to be currently constrained. In 2015, industry commented that there was spare capacity for clinical waste thermal destruction in SA. The listed installed capacity of CIC tpa may be too low as it appears SA is destroying around 3.5 kt of clinical waste currently.</p> <p>- POP (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required.</p> <p>Transfer station or temporary storage</p> <p>- SA's transfer capacity may already be exceeded, however, capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increasing the rate of loads transferred).</p> <p>NEPM 2016-17 showed a net import of around 180 kt of hazwaste into SA. The main imports were NEPM D Inorganic chemicals (175 kt) which is mostly a lead rich zinc waste from the Nyrstar Zinc smelter in Hobart being sent to Nyrstar Port Pirie.</p>
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	393,054							
NEPM 12-13 net imp./exp. (kt)	-179,930	(import)						

Table 57 Tas assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations	
					Best	High	Low		
Recycling and energy recovery									
Hazardous waste packaging facility	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	<p>This assessment is based on the national average (NSW, Vic, Qld, WA and SA) of waste management methods. This reduces the accuracy and may result in arisings being mapped to infrastructure that does not exist in this jurisdiction.</p> <p>Recycling and energy recovery</p> <p>- Hazardous waste recycling and energy recovery occurs interstate for all waste streams except mercury, EOLT and SPL and there appears to be sufficient capacity for these waste streams. Organics are also likely to be processed locally, however this capacity is not captured by the database. NEPM 2016-17 data indicates organics are not exported interstate for recovery.</p> <p>Treatment</p> <p>- CPT plant waste capacity could be constrained currently. This is based on the national average of the percentage of arisings sent to CPT for treatment. However, with no CPT capacity identified and estimated arisings of 16 kt there appears to be a lack of CPT capacity in Tas.</p> <p>- All hazardous waste except for oil/water mixtures are sent to the mainland for treatment. The OWT capacity is sufficient.</p> <p>Disposal (landfill and thermal destruction)</p> <p>- Hazwaste landfill could be constrained currently or by 2020, under the best estimate projection, for annual disposal capacity, which could require a licence amendment or changes in site management to take more tonnages per year.</p> <p>- POP (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required.</p> <p>- Clinical waste likely to be sent interstate for thermal</p>	
E-waste facility	81			n/a	no inf.	no inf.	no inf.		
Oil re-refining facility	68			n/a	no inf.	no inf.	no inf.		
Lead facility	21,865			n/a	no inf.	no inf.	no inf.		
Mercury facility	0			Good	>2037	>2037	>2037		
Solvents/paints/organic chemicals facility	8			n/a	no inf.	no inf.	no inf.		
Organics processing facility	7,830			n/a	no inf.	no inf.	no inf.		
EOLT facility	1,034			n/a	no inf.	no inf.	no inf.		
SPL facility	3,826			Good	2020	2020	>2037		
Energy recovery	2			n/a	no inf.	no inf.	no inf.		
Treatment									
CPT plant	16,247	CIC	CIC	n/a	no inf.	no inf.	no inf.		
Clinical waste treatment facility	9			Good	>2037	>2037	>2037		
Bioremediation facility	38			n/a	no inf.	no inf.	no inf.		
OWT facility	72			Poor	>2037	>2037	>2037		
Soils treatment facility	568			Good	>2037	>2037	>2037		
Disposal									
Hazardous waste landfill facility	2,032	CIC	CIC	Good	2020	2018	>2037		
Landfill facility (NEPM codes N, T)	27,171			n/a	no inf.	no inf.	no inf.		
Persistent organic pollutants thermal destruction facility	1			n/a	no inf.	no inf.	no inf.		
Clinical waste facility thermal destruction	11			n/a	no inf.	no inf.	no inf.		
Short-term storage or transfer									
Transfer facility	3,691	CIC	CIC	Good	2018	2018	2018		

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Long-term storage								destruction where required. Transfer station or temporary storage - Tas's transfer capacity may already be exceeded, however, capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increases the rate of loads transfers). NEPM 2016-17 showed a net export of 143 kt of hazwaste from Tas. This is mostly NEPM code D wastes which are lead-rich zinc wastes from the Nyrstar zinc smelter in Hobart that is shipped to Nyrstar Port Pirie for recovery in the lead smelter.
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	57,385							
NEPM 12-13 net imp./exp. (kt)	143,278	(export)						

Table 58 Vic assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								Recycling and energy recovery - Hazwaste packaging, e-waste, mercury, EOLT, energy recovery infrastructure is likely to have sufficient capacity. - Due to a significant change in the reported capacity of oil re-refining capacity in Vic, capacity could be constrained under all scenarios and significant tonnages of oil may need to be recovered interstate without infrastructure upgrades. - Lead wastes are likely to be sent interstate to SA or NSW for recycling. - Solvent/paints/organic chemicals capacity could be constrained. However, a number of factors need to be considered: 1. It is likely that some materials sent to energy recovery are recorded as recycled (resulting in over-estimate of arisings to recycling and under-estimate to energy recovery), 2. Some solvent/paint recycling capacity is likely to be within the CPT infrastructure group, 3. Some smaller operators that recycle solvents/paint may not have not been captured in the infrastructure database. - Organics infrastructure capacity could be constrained currently, however, capacity data has limited coverage in the database. Text withheld to maintain commercial confidentiality. Treatment - CPT plant, OWT and soil treatment capacity is likely to be sufficient. - Clinical waste treatment capacity could be constrained by 2024 or 2022 if clinical waste grows strongly. Disposal (landfill and thermal destruction) - Hazwaste landfill could be constrained by 2020, under the
Hazardous waste packaging facility	2,958	CIC	CIC	Ok	>2037	>2037	>2037	
E-waste facility	943			Good	2036	2034	>2037	
Oil re-refining facility	34,375			Good	2018	2018	2018	
Lead facility	0			n/a	no inf.	no inf.	no inf.	
Mercury facility	4			Good	>2037	>2037	>2037	
Solvents/paints/organic chemicals facility	19,181			Good	2018	2018	2018	
Organics processing facility	132,590			Ok	2018	2018	2018	
EOLT facility	12,625			Good	>2037	>2037	>2037	
SPL facility	16,342			n/a	no inf.	no inf.	no inf.	
Energy recovery	1,461			Good	>2037	>2037	>2037	
Treatment								
CPT plant	88,542	CIC	CIC	Good	>2037	2035	>2037	
Clinical waste treatment facility	8,322			Good	2024	2022	>2037	
Bioremediation facility	4,078			n/a	no inf.	no inf.	no inf.	
OWT facility	17,826			Good	>2037	>2037	>2037	
Soils treatment facility	46,148			Good	>2037	>2037	>2037	
Disposal								
Hazardous waste landfill facility	43,557	CIC	CIC	Good	2020	2020	>2037	
Landfill facility (NEPM codes N, T)	582,811			n/a	no inf.	no inf.	no inf.	
Persistent organic pollutants thermal destruction facility	972			Good	2020	2020	2020	
Clinical waste facility thermal destruction	4,983			Good	>2037	>2037	>2037	
Short-term storage or transfer								
Transfer facility	81,453	CIC	CIC	Good	2018	2018	2018	

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Long-term storage								best estimate projection, for annual disposal capacity, which could require a licence amendment or changes in site management to take more tonnages per year. - POP (PFOS, BDEs, HBCD, HCB) capacity is projected to be sufficient until 2020, when large tonnages of PFAS contaminated waste are projected to exceed the current permitted capacity in Vic. There may be additional and sufficient capacity within Vic's soils treatment, clinical thermal destruction and cement kiln infrastructure (via Geocycle) (subject to demonstration of POP destruction and licence amendments). - Clinical waste TD capacity should be sufficient for projection period. Transfer station or temporary storage - Vic's transfer capacity may already be exceeded, however, capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increases the rate of loads transfers). NEPM 2016-17 showed a net export of 29 kt. Main exports included NEPM group acids and inorganic chemicals (lead from lead acid batteries sent to NSW for processing). Main imports included paints, solvents, soils and clinical wastes.
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	516,360							
NEPM 12-13 net imp./exp. (kt)	29,322	(export)						

Table 59 WA assessment of projected arisings vs infrastructure capacity

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Recycling and energy recovery								Recycling and energy recovery - Hazwaste packaging, mercury, oil refining capacities are likely to be sufficient under all scenarios. - E-waste, solvents/paints/organic chemicals, lead waste are likely sent interstate for recycling. The 2015 assessment included a proposal for a new lead processing facility for WA that has not developed, which has changed the findings. Treatment - CPT plant, clinical waste and soil treatment capacity should be sufficient across projection period. It's worth noting WA's main soils facility uses bioremediation techniques to treat soil (not a high temperature thermal treatment process), so much of the bioremediation tonnages may be sent to the WA soil treatment facility. - WA's OWT capacity appears to be constrained currently and additional capacity may be required.
Hazardous waste packaging facility	60	CIC	CIC	Poor	>2037	>2037	>2037	
E-waste facility	427			n/a	no inf.	no inf.	no inf.	
Oil re-refining facility	60,503			Good	>2037	>2037	>2037	
Lead facility	51			n/a	no inf.	no inf.	no inf.	
Mercury facility	4			Good	>2037	>2037	>2037	
Solvents/paints/organic chemicals facility	1,274			n/a	no inf.	no inf.	no inf.	
Organics processing facility	79,880			n/a	no inf.	no inf.	no inf.	
EOLT facility	5,014			Good	2020	2018	2029	
SPL facility	0			n/a	no inf.	no inf.	no inf.	
Energy recovery	87			n/a	no inf.	no inf.	no inf.	
Treatment								Disposal (landfill and thermal destruction) - Hazwaste landfill annual disposal capacity could be constrained currently if waste disposal rates are high which could require a licence amendment or changes in site management to take more tonnages per year. The expected CIC tonnes of capacity at the long-term isolation facility will also provide additional capacity. ⁴¹ - POP (PFOS, BDEs, HBCD, HCB) will be sent interstate for
CPT plant	44,431	CIC	CIC	Good	>2037	>2037	>2037	
Clinical waste treatment facility	11			Poor	>2037	>2037	>2037	
Bioremediation facility	53,523			n/a	no inf.	no inf.	no inf.	
OWT facility	33,317			Good	2018	2018	2018	
Soils treatment facility	336			Good	>2037	>2037	>2037	
Disposal								
Hazardous waste landfill facility	10,902	CIC	CIC	Poor	2020	2018	>2037	
Landfill facility (NEPM codes N, T)	79,885			n/a	no inf.	no inf.	no inf.	
Persistent organic pollutants thermal destruction facility	27			n/a	no inf.	no inf.	no inf.	

⁴¹ WA Department of Water and Environmental Regulation noted: Intractable Waste Disposal Facility (IWDF) at Mount Walton is currently the only Class V landfill in WA. The WA Minister for Environment approved Tellus Holdings Limited's proposal for the Sandy Ridge Facility through Part IV of the Environmental Protection Act 1986 on 27 June 2018. The proposal subsequently received Commonwealth approval through the Environment Protection and Biodiversity Act 1999 on 7 January 2019. The Sandy Ridge Facility is for a dual open cut kaolin clay mine and a near-surface geological waste repository accepting Class IV and Class V waste, approximately 75 kilometres (km) north east of Koolyanobbing and 5.5 km west of the Mount Walton IWDF. The

Infrastructure group	16-17 arisings (t/yr)	Installed capacity (t/yr)	Expected capacity change (t/yr)	Capacity data quality Good, ok, poor	Est. year arisings > capacity			Assessment discussion and recommendations
					Best	High	Low	
Clinical waste facility thermal destruction	2,353			Good	>2037	2035	>2037	<p>thermal destruction where required. - Clinical waste TD capacity should be sufficient over projection period.</p> <p>Transfer station or temporary storage - WA's transfer capacity may already be exceeded; however, capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increasing the rate of loads transferred).</p> <p>NEPM 2016-17 showed a net export of 19 kt with the main export being NEPM code D Inorganic chemicals which is likely to be lead acid batteries.</p>
Short-term storage or transfer								
Transfer facility	140,543	CIC	CIC	Good	2018	2018	2018	
Long-term storage								
Long-term on-site storage	0	CIC	CIC	n/a	no inf.	no inf.	no inf.	
Long-term isolation facility	0			n/a	no inf.	no inf.	no inf.	
Total net Landfill fac. (NEPM code N, T)	432,744							
NEPM 12-13 net imp./exp. (kt)	18,664	(export)						

Red Hill Waste Management Facility is a Class III and IV landfill, located in the Perth metropolitan area. The Class IV waste cells have been decommissioned, and this facility is not accepting any additional Class IV waste at this stage (but this is due to change). The Department of Water and Environmental Regulation (WA) is also aware that there may be two potential Class IV waste facilities proposed in WA in the near future.

5. Conclusions and recommendations

5.1 Hazardous waste arisings and management and current issues

In 2016-17, 6.1 Mt of hazardous waste arose in Australia. Around 2.3 Mt of these wastes were managed by 185 specialist facilities that have an installed capacity to manage 3.1 Mt of hazardous waste. The remaining 3.8 Mt of waste arisings were managed in infrastructure such as composting facilities and landfills that receive mostly non-hazardous waste but are also licensed to receive low risk hazardous wastes (asbestos, low-level contaminated soils and/or end-of-life tyres).

Hazardous waste arisings are projected to be between 5.5 and 15.4 Mt by 2036-37 with a 'best' estimate of 8.9 Mt. The wide range reflects high levels of uncertainty in projecting the quantities of several large-scale waste streams. The high scenario, in particular, assumes:

- high range estimates of the large contaminated soil and asbestos waste streams
- releases from storages/stockpiles
- that from 2023, non-toxic salts from the CSG industry are no longer stored onsite
- projected large-scale growth PFAS contaminated soil and PFOS contaminated biosolids, from 2020.

Over the next few years an increase of around 1 Mt of capacity is expected to be added to Australia's capacity across the infrastructure groups of:

- e-waste, lead, mercury, EOLT and SPL recycling facilities
- CPT and soil treatment facilities
- POP and clinical waste thermal destruction facilities
- long-term isolation facilities.

NSW and Vic dominate Australia's provision of hazardous waste infrastructure, each hosting approximately 30% of the sites. Qld and WA follow both with around 15% of the sites. SA has 8% of the sites, followed by NT, ACT, and Tas which all have less than 5% of Australia's hazardous waste infrastructure sites.

In relation to the installed capacity of this infrastructure, NSW has 32%, followed by Qld, Vic and WA, which each have about 20%. SA has 6% of installed capacity and NT, ACT and Tas each have less than 1%.

NSW managed 34% of the 2016-17 waste arisings. Qld, Vic and WA each managed about 20%. SA managed around 7% of arisings and NT, ACT and Tas all managed less than 2%.

Waste industry operators raised important issues during consultation, listed below:

- falling demand for hazardous waste infrastructure risks a non-viable core infrastructure supply
- stockpiles of SPL, mercury waste and EOLTs are a significant issue and risk
- inconsistent landfill levies drive interstate disposal of hazardous wastes
- inconsistent landfill levies undermine investment in recovery or treatment of hazardous wastes
- inconsistent landfilling pre-treatment requirements create unfair market competition across different jurisdictions
- regulatory settings should support large infrastructure investment that is required

- additional infrastructure is needed to manage reverse osmosis brine wastes from the CSG industry
- asbestos disposal costs are high and access to disposal points is getting harder
- significant infrastructure for destroying POPs is coming online in 2018 in response to PFAS risks
- for PFAS contaminated waters
 - contaminant threshold requirements are needed
 - filtration media destruction requirements are inconsistent
- distances and low tonnages of hazardous waste are a major challenge in WA, in particular
- additional infrastructure is needed for recovering hazardous packaging.

5.2 Hazardous waste packaging recycling facilities

The national assessment indicates that under the best and low scenarios over the next 20 years the installed capacity of Australia's current hazardous waste packaging recycling infrastructure will be able to recycle waste arisings. Under the high scenario, the current installed capacity would be exceeded in 2033. The infrastructure need vs capacity assessment for this group has high uncertainty due to a low response rate during 2018 consultation and the highly diffuse nature of this infrastructure group.

Contaminated hazardous waste packaging may seem like a minor issue in the hazardous waste context. This is a problematic waste stream that often has highly concentrated hazardous product residuals. The contaminated containers are voluminous, cannot be cost-effectively transported and are not able to be processed by non-hazardous waste packaging infrastructure.

Some survey respondents commented on a broader need for improved recovery options for small hazardous waste packaging and small packages of waste hazardous goods. Planned infrastructure flagged in the 2015 assessment has not proceeded and this waste stream will likely continue to be problematic and require dedicated infrastructure.

Recommendation 1: Qld, NT and Tas governments should consider completing feasibility studies to determine the viability of establishing additional hazardous waste packaging capacity in their jurisdiction.

5.3 E-waste major physical/chemical & disassembly facilities

The national assessment indicates that under the best and low scenarios over the next 20 years the current installed capacity of Australia's e-waste (major physical/chemical and manual disassembly processing) infrastructure will be able to recycle waste arisings. If e-waste arisings grow very strongly (high scenario), capacity could become constrained by 2035. However, expected increases in capacity of 12 kt/yr should provide sufficient national capacity to cater for higher growth.

The needs vs capacity assessment for this group has high uncertainty due to the waste arisings reported in tracking system data (4 kt in 2016-17) being much lower than the reported tonnages received (58 kt in 2016-17). This large difference is due to the fact that most e-waste is not transported and tracked as a hazardous waste. Considering the reporting receipts of 58 kt in 2016-17 and the current installed capacity of 106 kt/yr it is still likely that there is sufficient capacity over the projection period.

Installed capacity is concentrated in NSW, with significant capacity also in Vic and SA and some capacity in Qld and ACT. A shortfall in current capacity is apparent in NT, Tas and WA. E-waste in these jurisdictions is likely sent interstate or is sent to landfill.

For e-waste it is important to consider that the assessment assumes no change in the management methods of e-waste. Changes to product stewardship agreements or landfill bans on e-waste could significantly change current e-waste management and increase the recycling capacity required.

Recommendation 2: NT, Tas and WA governments should consider completing feasibility studies to determine the viability of establishing e-waste recycling capacity in their jurisdiction.

5.3.1 Lithium ion batteries infrastructure

The potential arisings of lithium ion batteries, which are not currently regulated as hazardous waste⁴², are assessed in this report due to their potential to have a significant impact on hazardous and non-hazardous waste infrastructure. Waste lithium ion batteries are projected to grow at an average rate of 19% per year (under best estimate scenario), and if not appropriately managed, represent a safety hazard due to risks of causing explosions and or fire (ABRI 2014).

While this assessment does not indicate a shortfall in the overall e-waste processing capacity in Australia, at the time of writing only one e-waste facility recycles lithium ion batteries in Australia (Envirostream Victoria). Most lithium ion batteries recovered are still likely to be exported overseas for recycling. In addition, Australia has no specific lithium ion battery collection/transfer infrastructure (lithium ion batteries that are recovered are collected with other battery types). The collection of potentially flammable lithium ion batteries without appropriate infrastructure could create a fire hazard within the collection infrastructure for other batteries.

Recommendation 3: The potential hazards posed by lithium ion batteries, and the best means of managing these hazards, needs further assessment. Subsequently, an assessment should be completed of the collection and processing infrastructure needs for lithium ion batteries in Australia. This recommendation was made in 2015 and is supported by a CSIRO (2018) study.

5.4 Oil re-refining facilities

The national assessment indicates that, under the low and best scenarios, over the next 20 years the installed capacity of Australia's current oil re-refining infrastructure will be able to recycle waste arisings. Under the high scenario, the current installed capacity would be exceeded in 2034.

The infrastructure need vs capacity assessment for this group has moderate uncertainty due to a moderate response rate during consultation and the potential under-reporting of waste oil in NSW and Vic data resulting in an under-estimate of 2016-17 arisings. In addition, some waste oils recycling may actually be sent for energy recovery, which would result in an over-estimate of waste oil re-refining demand.

The 2018 assessment for this infrastructure group is a significant improvement on the 2015 assessment due to separation of the projections of the NEPM J waste codes of J100 and J160 from J120 Waste oil/water, hydrocarbons/water mixtures or emulsions. The J120 waste arisings are now mapped to the new infrastructure group of OWT facilities. This has increased the accuracy of the

⁴² Waste lithium ion batteries are regulated as hazardous waste for international transport, but currently not for domestic transport

assessment and resulted in a change of expected exceedance of installed capacity in 2023, in the 2015 assessment, to >2037 in this assessment.

Installed capacity is concentrated (in the following order) in WA, Qld and NSW, with some capacity also in SA and Vic. No oil re-refining capacity was identified in ACT, NT and Tas. Oil waste in these jurisdictions is likely sent interstate.

Jurisdictional analysis indicates that ACT, NSW, NT, Qld, Tas all either lack oil re-refining capacity or do not have capacity in the jurisdiction.⁴³ Capacity in SA and WA appear to be sufficient.

Recommendation 4: NSW, NT, Qld and Tas governments should consider completing feasibility studies to determine the viability of establishing additional oil waste capacity in their jurisdiction.

5.5 Lead recycling facilities

In the best estimate scenario, lead waste arisings are projected to increase at a rate equivalent to 20-year average population growth rate (1.4%) in all jurisdictions except Tas (where lead waste is projected to follow trends in global zinc prices). On this basis, the installed lead recycling infrastructure capacity could be met by 2023.

Under the low scenario projection, of flat trend for 10 years and decline for the next 10 years due to replacement of battery technology, installed capacity is not expected to be exceeded over the next 20 years.

Under the high estimate projection, of arisings increasing at the 20-year average rate of economic growth (2.8%) for all jurisdictions except Tas, capacity would be exceeded in 2018. The high scenario also includes a 20 kt/yr release of jarosite waste from a stockpile at Nyrstar Hobart to Nyrstar in Port Pirie⁴⁴. The Nyrstar Port Pirie site is included in the e-waste infrastructure group due to the site's defined capacity to process e-wastes such as CRT TVs and the site's unconstrained capacity to take lead waste from the Hobart zinc smelter. Nyrstar Port Pirie's lead recycling capacity is not included in the 124 kt/yr installed capacity estimate. There is also an additional 71 kt/yr of lead acid battery smelting capacity under construction that would add significant additional capacity along the east coast. As Nyrstar Port Pirie can manage all of the lead-rich waste from the Nyrstar Hobart zinc smelter and the significant additional lead acid battery processing capacity coming on-line, there is likely to be sufficient lead recycling capacity under all scenarios.

The lead recycling assessment has moderate level of uncertainty due to the:

- lack of industry response for the 2018 assessment
- lack of a clearly defined upper limit on Nyrstar Port Pirie's ability to manage all of the lead waste from Nyrstar operations, in addition to lead waste from other sectors.

Recycling capacity for lead acid batteries is almost all located in NSW, with some capacity now in Qld so lead acid batteries are transported from other jurisdictions to NSW or Qld or exported overseas under an export permit. The transport costs from WA in particular may result in significant battery stockpiling in WA.

⁴³ Despite NSW and Qld both having significant capacity (as noted above) the projected waste oil sent for re-refining exceeds capacity over the projection period.

⁴⁴ Port Pirie is understood to have unconstrained capacity to process waste from the Hobart Zinc smelting operations.

Recommendation 5: WA government should consider completing a feasibility study to determine the viability of establishing lead waste recycling capacity in their jurisdiction.

5.6 Mercury recycling facilities

At a national level, the assessment indicates that over the next 20 years the currently installed capacity of Australia's current mercury waste recycling infrastructure will be able to recycle waste arisings.

Industry reported around 10 times more receipts than was reported in the waste tracking systems, reflecting that some of the mercury waste (such as unprocessed light fittings) does not require tracking. **Text withheld to maintain commercial confidentiality**.

The mercury recycling assessment has a low level of uncertainty, with excellent industry input and a clearly defined infrastructure group targeting mercury recycling as their core business.

5.7 Solvents/paints/organic chemicals recycling facilities

At a national level, the assessment indicates that the current capacity of solvents/paints/organic chemicals recycling is being exceeded. This is unlikely to be accurate due to the high level of uncertainty in the capacity assessment for this group. A number of factors need to be considered:

1. it is likely that some materials sent to energy recovery are recorded as recycled (resulting in over estimate of arisings to recycling and underestimate to energy recovery)
2. some solvent/paint recycling capacity is likely to be within the CPT infrastructure group
3. some smaller operators that recycle solvents/paint may not have not been captured in the infrastructure database.

Based on industry consultation and this assessment, a national shortage of this infrastructure over the next 20 years is considered unlikely. Solvent/paints recycling infrastructure was identified only on the east coast (NSW, Qld, Vic). ACT, NT, SA, Tas and WA had no sites identified. In these jurisdictions, solvents/paint waste is sent interstate, managed within other infrastructure groups or taken to sites not identified in the capacity database.

5.8 Organics recycling (NEPM K code wastes) facilities

At a national level, projections indicate that under all scenarios the current capacity of organics recycling infrastructure (for NEPM K code organics) is being exceeded. This is inaccurate and is linked to the very high uncertainty of the assessment of needs vs capacity.

The majority of the 600 kt arisings in 2016-17 of NEPM K code waste is sent to composting sites that are not included in the infrastructure capacity assessment. To complete a quantitative analysis of projected arisings of NEPM K code organics against infrastructure capacity, extensive data would be required on non-hazardous waste infrastructure that accepts only a relatively small amount of low-level hazardous waste as part of much larger non-hazardous waste volumes. In addition, some smaller operators that specialise in hazardous organic waste may not be within the infrastructure database due to the diffuse nature of this infrastructure group.

Based on industry consultation and our assessment of organics recycling infrastructure (for NEPM code N) we do not believe a national shortage of this infrastructure group is likely over the next 20

years. This assessment is supported by the industry consultation results presented in Table 45. It is estimated that the sites within the scope of this infrastructure group received 99 kt of waste in 2016-17 (not 600 kt) and have an installed capacity to manage 106 kt/yr.

5.9 End-of-life-tyre recycling facilities

The national assessment of need vs capacity indicates that over the next 20 years the currently installed capacity of Australia's EOLT recycling infrastructure (100 kt/yr) will be able to recycle waste arisings (44 kt/yr in 2016-17). However, the EOLT recycling industry reported around 90 kt of EOLT received which is more than double the 44 kt waste arisings recycled in 2016-17. The difference is related to EOLT recyclers receiving EOLT and exporting them with minimal processing to international energy recovery or reuse markets (the 44 kt relates to full on-shore processing).

Whilst there is good capacity in Australia to collect and partly process tyres for export, there is a lack of well-developed on-shore markets for tyre-derived products. Around 60% of Australian EOLTs are sent to landfill, stockpiled or go to unknown fates. For Australia to increase the recovery of these lost EOLTs there will need to be strong developments in processing technology in Australia. However, these investments cannot occur without further development of offtake markets for the tyre-derived products and enforcement to ensure tyres are not sent to landfill, stockpiled, dumped or exported to low value management options.

EOLTs are the only Australian controlled waste that is exported in significant tonnages to other countries. India is the largest export market for Australian EOLTs. India may restrict EOLT imports in an effort to get local EOLT collected and recycled. This would follow recent trends such as [India banning plastic imports](#). Should India or other countries receiving large tonnages of EOLTs from Australia (e.g. Malaysia) restrict or ban this flow of EOLTs, it is likely that Australia's EOLTs processing capacity would be insufficient.

5.10 SPL recycling facilities

An estimated 46 kt of spent pot liner (SPL) arose in 2016-17 which suggests that the aluminium industry is processing all of the current SPL being generated and some of a significant stockpile of SPL. REC (2016) estimated Australia's annual SPL generation at around 30 kt/yr (based on aluminium production rates). REC (2016) estimated the stockpile of SPL to be around 700,000 tonnes, of which around 390,000 tonnes are in on-site landfills at aluminium smelters around Australia.

Under the best and low scenarios, the currently installed capacity is likely to be adequate. Under the high scenario, capacity would be exceeded, as not quite all of the stockpile would be processed in 10 years. This is consistent with the REC (2016) finding that capacity is available to treat Australian SPL stockpiles over around a 10-year period, whilst treating current arisings. REC (2016) also notes that the treatment of SPL that has been landfilled has not yet been demonstrated and may require additional or different infrastructure installation.

The uncertainty of the SPL assessment is low, due mainly to the recent and detailed study (REC 2016) of SPL processing capacity, generation and stockpiles in Australia providing the necessary data.

Recommendation 6: Qld, NSW, Vic and Tas governments and DoEE should continue to actively engage with aluminium smelting companies regarding current SPL stockpiles to ensure that stockpiles continue to be drawn down each year until they are removed.

5.11 Hazardous waste energy recovery facilities

At a national level, the assessment indicates that capacity has increased significantly since the 2015 assessment, due to the inclusion of cement kilns within the project scope and the allocation of these energy recovery tonnages to this group. The estimated arisings for this infrastructure group (2 kt) are incorrect. Industry reported **CIC** kt of waste currently received. The reasons for this are:

1. Some of the 26 kt of solvents/paints recycling tonnages may actually be sent to energy recovery infrastructure. Currently, the jurisdictional waste tracking systems do not support the separate reporting of tonnages sent to recycling vs energy recovery, which limits the ability to assess energy recovery infrastructure need.
2. Some of the waste that is sent for energy recovery does not require tracking in some jurisdictions, for example waste oil in NSW and EOLT in NSW, SA and Vic.

Currently Australia's energy recovery from hazardous waste relies upon cement kilns as the offtake market. Whilst current installed capacity exceeds the **CIC** kt estimated as received, this does not allow for significant increases without either amendment to cement kiln licences (if technically feasible) or the development of additional energy recovery infrastructure apart from cement kilns.

5.12 Chemical and physical treatment (CPT) plant facilities

CPT plants are the archetypal hazardous waste facility, treating a range of waste types using a range of processes. Many of these operations are currently suffering from falling demand as manufacturing activity declines. Across the country, industry reported falling amounts of hazardous manufacturing waste sent for treatment. In some instances, sharp declines were reported. This issue was reported in 2015 and remains current for this 2018 assessment. Our analysis, based on waste tracking data, estimated tonnages of waste sent to CPT of 700 kt in 2015 to just 400 kt in 2018, a fall of around 43% over three years.

This project is focused on identifying where Australia's hazardous waste industry may become constrained over the next 20 years. CPT operators flagged that undersupply of waste could cause infrastructure shortages due to closure of key infrastructure that may no longer be viable as demand falls for processing of key high-volume waste.

However, the overall tonnages of hazardous waste are projected to increase from around 6 Mt currently to almost 10 Mt in 2038, so while tonnages of some waste are declining and projected to continue doing so, other hazardous waste types are projected to increase significantly. The challenge for industry and government is to plan for and implement infrastructure changes that can manage the rapidly changing composition and generating sectors/ locations of hazardous waste.

At a national level, based on the best, high and low projections of arisings, CPT infrastructure is estimated to be able to meet national demand over the next 20 years. For all three scenarios, the projections are based on varying degrees of decline in some waste groups, such as B Acids and E Reactive chemicals, and growth in other waste groups, such as D300 Non-toxic salts and C Alkalis that are projected to increase driven by oil and gas, particularly coal seam gas (CSG), industry developments.

CPT current installed capacity is projected to be sufficient under all scenarios for NSW, Qld, SA, Vic and WA. ACT, NT and Tas have no local CPT capacity. Tas in particular appears to have a shortage of CPT capacity with no CPT capacity identified and estimated arisings of 16 kt.

Recommendation 7: DoEE and/or NSW and Qld EPAs should consult with the CSG industry to develop a strategic plan for managing its waste, in particular waste in remote areas. This recommendation was made in 2015 and remains current.

Recommendation 8: DoEE and/or Tas EPA should further investigate the supply of CPT capacity for hazardous waste in Tas. This recommendation was made in 2015 and remains current.

5.13 Clinical waste treatment facilities

In the best estimate, clinical waste quantities will grow at the projected 20-year average annual growth rate of population growth (1.4% pa). At this rate, the installed capacity of clinical waste treatment could be exceeded by 2024. Based on the high projection, with growth of 2.0 to 2.1% growth based on Thornton (2014), national capacity could be exceeded in 2022. Under the low scenario where the waste arisings trend is flat, capacity is projected to meet demand over the next 20 years.

The infrastructure needs vs capacity assessment for this group has high uncertainty due to a poor response rate from industry. Despite this uncertainty, the assessment indicates that Australia's clinical waste treatment capacity will soon become constrained and investment in additional infrastructure may be required.

NT, SA, Tas and WA all appear to have sufficient clinical waste treatment capacity. ACT, NSW, Qld, and Vic all appear to have insufficient local supply of clinical waste treatment capacity and are likely to be exporting significant quantities interstate. Based on the national assessment, interstate capacity will soon become constrained.

Recommendation 9: ACT, NSW, Qld, and Vic governments should consider completing feasibility studies to determine the viability of establishing clinical waste recycling capacity in their jurisdiction.

5.14 Bioremediation facilities

There is limited coverage of the capacity of this infrastructure group. Composting facilities are excluded from the database. This group is intended to refer to facilities that treat hazardous waste through biodegradation. Many commercial composting facilities are licenced to receive low level hazardous waste which is effectively bioremediated in the composting process and these facilities are not within the project scope.

Some 200 kt of hazardous waste were reported in tracking data as bioremediated. Most, if not all, of this material would be processed by commercial composting facilities licenced to take a range of low hazard organic waste such as grease trap. These composting facilities are not included in this database. Whilst it is worth maintaining transparency on the amount of hazardous waste being reported as bioremediated by the composting industry, it is beyond the project scope to assess the capacity of bioremediation capacity in Australia.

Recommendation 10: State regulators that are operating waste tracking systems complete ongoing auditing of waste treated through bioremediation to ensure that only appropriate hazardous waste is sent to composting operations. This may already be occurring.

5.15 Oily water treatment (OWT) facilities

This is a new infrastructure group for the 2018 assessment. Under the best estimate projection capacity would be exceeded in 2025, or as soon as 2019 under the high scenario estimate. Under the low projection, estimated capacity is not expected to be exceeded over the 20-year projection period. The reported 2016-17 arisings of 187 kt are more than the estimated receipts of around 150 kt which may be due to a lack of response from industry and the need to use averages for around a third of sites, or it could be due to the database not including all sites from this diffuse infrastructure group.

The uncertainty of the needs vs capacity assessment is very high due to the capacity assessment relying on average installed capacity for around a third of the sites and the high risk that small OWT plants are not included in the database.

Noting the above, the assessment indicates that capacity for OWT in Australia could become constrained over the next 10 years and some additional capacity may be required.

The jurisdictional assessment indicates that all jurisdictions, apart from Qld, Tas and Vic, lack OWT capacity. However, OWT facilities are typically relatively simple operations that could be established quickly and in response to market demand, and is an infrastructure group that should not require government involvement.

5.16 Contaminated soils treatment facilities

At a national level, under the best estimate projection, arisings would not exceed installed capacity over the next 20 years, but would do so under the high scenario. Under the low scenario, capacity would not be exceeded over the projection period.

Significant additional soil treatment capacity is under construction/commissioning in Vic that will add around 300 kt of additional installed capacity and provide sufficient capacity for the long-term for Vic. The significant Vic treatment capacity may also be utilised to treat soil from interstate, with appropriate approvals in place.

The uncertainty of the needs vs capacity assessment is moderate due to the highly fluctuating generation rates of contaminated soil and the difficulty that contaminated soil facilities face in securing the contaminated soil for treatment. Industry report onsite management, contamination dilution with clean soil and landfill disposal as serious threats to their investments, which reduces the certainty in infrastructure capacity investment. Importantly, these estimates assume no change to the current fate patterns of contaminated soil, which, based on the national average, is estimated to be 87% to landfill. If the treatment proportions are higher in other jurisdictions, the above assessment of no national capacity constraints would be affected.

Noting the above, the assessment indicates that there may be a need for additional soil treatment capacity in Australia if contaminated soil generation rates are high, except for Vic which has significant capacity coming online.

Installed capacity is concentrated in Vic, with some capacity also in NSW, Tas and WA. A shortfall in current capacity is apparent in NT, Qld, and SA. Contaminated soil in these jurisdictions is likely disposed to landfill.

Recommendation 11: NT, Qld, and SA governments should consider completing feasibility studies to determine the viability of establishing contaminated soil treatment capacity in their jurisdiction.

5.17 Hazardous waste landfill facilities

At a national level, for all three scenarios, the current 2016-17 arisings exceed the current installed annual capacity. The modelling assessment for this infrastructure group is incorrect. The response rate from site operators was only 50%, meaning infrastructure group averages were used, and generally the responses provided data only on waste currently received with little information on the installed capacity (i.e. how much waste the landfill can receive annually). This is understandable as, unlike other infrastructure types, landfills are usually able to cater to varying capacity demands (within reason) and a site's installed annual capacity can be difficult to define.

Perhaps more important than the above analysis are industry comments regarding the expected life (i.e. amount of airspace remaining and the number of years of operation before this capacity is consumed) of the seven landfill sites included in this infrastructure group.⁴⁵ Landfill operators were asked how much waste could be received at the site before the site's airspace was consumed. Where the operator responded, they all responded with an estimate of the expected year of closure or simply stated that the site had more than 20 years capacity remaining.

Text withheld to maintain commercial confidentiality. No other sites surveyed in this category responded with a definitive response of planned closure within the new 20 years. Apart from Suez Elizabeth Drive, responses were generally vague on the expected closure year and it is recommended that more detailed investigation of the likely closure date of the landfills in this category be completed. Given the small number of sites and the extreme difficulty some jurisdictions have experienced in establishing new hazardous waste landfills, it is important to better understand the risk profile of each site in terms of its likelihood of closure due to: a lack of airspace, regulatory non-compliance, community concern and sudden airspace consumption due to extreme weather events such as cyclone or fire.

Recommendation 12: DoEE should work with the jurisdictions to complete a detailed assessment of the likely closure year of the identified hazardous waste landfill facility infrastructure including a risk assessment of site capacity being impacted by issues such as extreme weather events.

Text withheld to maintain commercial confidentiality.

5.17.1 Landfill facilities (NEPM code N, T)

This infrastructure group is not in the scope of hazardous waste database. As discussed in Section 3.2, a significant number of landfills are licensed to take hazardous waste NEPM codes N and T only (asbestos, EOLT, low level contaminated soil) and these facilities are not included in the infrastructure database. This is reflected in the almost 3 Mt of hazardous and controlled waste estimated to be sent to this infrastructure group, by far the largest portion of hazardous waste (almost half of the estimated 6 Mt of arisings). Based on industry consultation and our assessment of landfill infrastructure for NEPM codes N and T only, we do not believe there is likely to be a national shortage of this infrastructure group over the next 20 years.

⁴⁵ The Mount Walton Intractable Waste facility in WA is included in the seven hazardous waste landfills. It has historically only operated on a campaign basis and Tellus Holdings are building a long-term isolation facility five km from site. The future operation of the Mount Walton Intractable waste facility is assumed unlikely following establishment of the Tellus Holdings site next-door.

5.17.2 Landfills for asbestos disposal

Unlike most waste, it is commonly accepted that the most appropriate fate for asbestos waste is landfill, where it can be safely removed from the environment for the long term. Across Australia, state and local governments are working towards a gradual rationalisation in the number of landfills in order to minimise the environmental and human health risks that landfills can create. As small regional landfills close, they are often replaced with transfer stations that consolidate waste and enable higher rates of resource recovery, reduce long term liabilities and risks, and transport bulk waste loads to a regional landfill. However, few transfer stations in Australia accept asbestos. This creates a potentially serious problem of lack of local access to disposal options for waste asbestos. Consultation suggests this is a current issue and it is likely to worsen.

5.18 POP thermal destruction facilities

At a national level, under all scenarios the current and expected future POP capacity would be greatly exceeded in 2020 when, under the best estimate scenario, arisings are projected to increase to over 400 kt and increase to 450 kt by 2037. The major increases in arisings in 2020 are mostly PFAS contaminated waste (soils, AFFF, biosolids) in 2020 and greater quantities of POP-BDEs and HBCD waste starting in 2023. Whilst this identifies a major gap in Australia's dedicated POP thermal destruction capacity, the capacity assessment uncertainty for this group is very high. POP destruction capacity could turn out to be adequate due to:

1. POP thermal destruction capacity within soils treatment facilities. By 2020, as noted above, Australia should have soil treatment facilities, that are able to receive POP, with a total installed capacity of over 300 kt. The capacity of these facilities to receive POP is not yet clear and for this assessment a conservative estimate is made of less than **CIC** of POP waste capacity within these facilities. It is possible that PFAS contaminated waste (soil and biosolids in particular) may be treated by these facilities in much larger tonnages sufficient to manage the projected arisings.
2. POP thermal destruction capacity within cement kilns. Cement kilns in Australia are currently destroying some POP including PFOS. The capacity of Australia's cement kilns to destroy POP is estimated to be **CIC**. The capacity of cement kilns to destroy additional POP tonnages is unknown and there may be additional capacity if the appropriate testing and license approvals were successfully completed.
3. POP thermal destruction capacity within clinical waste thermal destruction (TD) facilities. Daniels (Toxfree) Laverton facility is licenced to process highly contaminated PCB waste. Daniels (Toxfree) did not state the potential tonnages of POP that could be destroyed at the facility.

It may be the case that the current and planned suite of infrastructure that is able to destroy POPs can manage the projected tonnages of POP waste. This will depend on the ability of the soil treatment, cement kilns and clinical waste destruction facilities' ability to demonstrate the destruction of POP at the currently licensed limits. Future increases in POP waste may be able to be managed in the current infrastructure subject to demonstration of POP destruction and the approval of large increases in licensed capacities for POP waste.

Recommendation 13: DoEE should work with jurisdictions and industry to agree an approach to determine the upper limit for tonnages/concentrations that can be received at the high temperature thermal soil treatment facilities, cement kilns and clinical waste thermal destruction units that will ensure thermal destruction of the PFAS, POP-BDE, HBCD and HCB wastes. This information is required to better understand how much additional dedicated POP thermal destruction capacity (from technologies such as plasma arc) may be required in future.

5.18.1 Thermal destruction of PFAS in contaminated water

Industry commented that it urgently needs further direction from regulators regarding the process requirements and contaminant thresholds for PFAS-impacted water clean-up. There is inconsistency between the jurisdictions and reliance on existing guidelines that do not specify PFAS limits.

Recommendation 14: The process requirements and contaminant thresholds that need to be met for PFAS-impacted water clean-up should be defined. DoEE may be best placed to lead the development of a recommended process and threshold that the jurisdictions could choose to adopt. This work may already be underway.

PFAS-contaminated groundwater is being cleaned up using activated carbon filtration processes to remove PFAS. Once the filtration media's capacity to adsorb PFAS is exhausted, the contaminated material needs to be renewed. Industry commented that in Qld this material is able to be sent to landfill whereas in other jurisdictions the PFAS-contaminated material must be thermally treated to destroy PFAS. If PFAS-contaminated filtration media is being sent to landfill, rather than being thermally destroyed, it would seem to defeat the efforts in removing PFAS from the groundwater in the first place (i.e. in landfill PFAS will presumably make its way back to the environment).

Recommendation 15: The management requirements of PFAS-contaminated filter media should be reviewed to ensure a nationally consistent approach.

5.19 Clinical waste thermal destruction facilities

At a national level, based on the best, high and low projections of arisings, clinical waste thermal destruction infrastructure is estimated to meet national demand over the next 20 years.

The estimated 2016-17 arisings of 21 kt aligns with the 20 kt of waste received as reported by industry. With a currently capacity of 33 kt/yr and an expected increase of 3 kt, there appears to be sufficient clinical waste thermal destruction capacity in Australia.

The spare capacity of this infrastructure group has the potential to be impacted by the demand for POP thermal destruction where the site currently has or gains a licence for POP destruction.

There is also reasonable national coverage with facilities in all jurisdictions apart from ACT, NT and Tas. The NT is serviced by a clinical waste treatment facility (autoclave). Tas has no clinical waste facilities (treatment or thermal destruction) in the 2018 database, which indicates a gap in capacity in Tas.

Recommendation 16: DoEE and/or Tas EPA should further investigate the need for clinical waste treatment or thermal destruction facilities in Tas.

5.20 Transfer station or temporary storage facilities

Projections indicate that under all scenarios the current national transfer/temporary storage capacity of hazardous waste infrastructure is exceeded. These projections are not accurate due mainly to the capacity database having limited coverage of this group. Whilst some transfer facilities are included in this dataset, it is recognised that there are other facilities which deal with hazardous waste that are not included in the dataset, such as smaller storage facilities and transfer stations.

Transfer capacity estimates are also incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. The capacity of transfer infrastructure is also not fixed (i.e. capacity can be scaled up and down by simply increasing the rate of load transfers).

The project team surveyed industry asking respondents to flag any major transport constraints. Very long transport distances particularly in WA were raised several times as a major barrier to treating/recovering hazardous waste. WA has four of the 19 transfer station facilities in the 2018 database. For such a large state this appears low. If not already being undertaken, further investigation of strategic locations for transfer station facilities in WA is recommended. Consultation with industry on establishing joint venture transfer stations to consolidate waste from a range of waste companies and generators should be explored for WA and potentially Qld (to reduce costs of transporting coal-seam gas waste).

Recommendation 17: DoEE and/or WA and Qld governments should complete a detailed assessment and consultation with industry regarding the need for and (where required) best location(s) for additional hazardous waste transfer station/temporary storage infrastructure. This recommendation was made in 2015 and remains current.

5.21 Long-term isolation facilities

Long-term isolation facilities

Two long-term isolation facilities are currently under development and aim to be operational in around five years' time. Assuming that both become operational, they would provide capacity for up to **CIC** for highly intractable waste that lacks viable treatment or destruction options. This would provide good mitigation for the risks associated with having only six (operational) hazardous waste landfills in Australia, with the main NSW site due to close in **CIC**.

CSG reverse osmosis brine wastes and long-term isolation capacity: under the high projection scenario, it is assumed that, after five years new arisings of CSG reverse osmosis brine wastes will be required to be managed offsite and would be sent to long-term isolation facilities (rather than being stored onsite). Historical stockpiles are assumed to remain onsite.

This results in a very large increase, 2.5 Mt/yr, in 2023 increasing to 3.2 Mt/yr by 2037 that is projected to need long-term isolation facility capacity. This presents a shortfall of **CIC** Mt of capacity in 2023, even when the currently planned facilities are built and operating at capacity.

Recommendation 18: DoEE should work with state and territory governments to assess the appropriate management of CSG RO brine wastes and determine the likelihood that offsite disposal requirements will be needed in future.

5.22 Uncertainty in assessing need vs capacity

Future scenarios are inherently uncertain. The arisings of hazardous waste are influenced by industrial markets, development activities, social licences, government regulations and technological innovations that are all unpredictable. The infrastructure servicing this waste is changeable and difficult to characterise, and information on its activities is limited and hard to obtain. The language of the jurisdictional data (e.g. NEPM codes) differs from that of the industry, creating problems and uncertainties in matching the two. As a result of these uncertainties, the key conclusions of this analysis should be taken as indicative.

Since the 2015 assessment, significant work has been undertaken by DoEE and the jurisdictions to better understand, document and rationalise hazardous waste tracking systems and the recording of hazardous waste arisings and management methods. However, there are still challenges in compiling the data required to complete this assessment. For example, it is still not possible to determine from the tracking system data the tonnages of hazardous waste sent to energy recovery (it is hidden in the recycling tonnages).

Recommendation 19: DoEE and the jurisdictions should continue to improve the consistency and completeness of tracking system data and work towards systems that enable reporting of energy recovery separately from recycling.

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Appendix A Wastes that are tracked in tracking systems

The following diagram shows wastes that are not tracked in intra-state tracking systems by states that run such systems. Emerging wastes such as Li-ion batteries are not yet tracked by any jurisdiction.

Status of waste tracking by jurisdiction tracking system

Not tracked
Not fully tracked

15 code & description	75 code and description (NEPM Schedule A, List 1)	NSW	Qld	SA	Vic	WA
A Plating and heat treatment	A100 Waste resulting from surface treatment of metals & plastics					
	A110 Waste from heat treatment & tempering operations containing cyanides					
	A130 Cyanides (inorganic)					
B Acids	B100 Acidic solutions or acids in solid form					
C Alkalis	C100 Basic solutions or bases in solid form					
D Inorganic chemicals	D100 Metal carbonyls					
	D110 Inorganic fluorine compounds excluding calcium fluoride					
	D120 Mercury; mercury compounds					
	D130 Arsenic; arsenic compounds					
	D140 Chromium compounds (hexavalent & trivalent)					
	D150 Cadmium; cadmium compounds					
	D160 Beryllium; beryllium compounds					
	D170 Antimony; antimony compounds					
	D180 Thallium; thallium compounds					
	D190 Copper compounds					
	D200 Cobalt compounds					
	D210 Nickel compounds					
	D220 Lead; lead compounds					
	D230 Zinc compounds					
	D240 Selenium; selenium compounds					
	D250 Tellurium; tellurium compounds					
	D270 Vanadium compounds					
	D290 Barium compounds (excluding barium sulphate)					
	D300 Non-toxic salts					
	D310 Boron compounds					
	D330 Inorganic sulfides					
	D340 Perchlorates					
	D350 Chlorates					
	D360 Phosphorus compounds excluding mineral phosphates					
E Reactive chemicals	E100 Waste containing peroxides other than hydrogen peroxide					
F Paints, resins, inks, organic sludges	F100 Waste from production, formulation & use of inks, dyes, pigments, paints, lacquers & varnish					
	F110 Waste from the production, formulation & use of resins, latex, plasticisers, glues & adhesives					
G Organic solvents	G100 Ethers					
	G110 Organic solvents excluding halogenated solvents					
	G150 Halogenated organic solvents					
	G160 Waste from the production, formulation & use of organic solvents					
H Pesticides	H100 Waste from the production, formulation & use of biocides & phytopharmaceuticals					
	H110 Organic phosphorous compounds					
	H170 Waste from manufacture, formulation & use of wood-preserving chemicals					
J Oils	J100 Waste mineral oils unfit for their original intended use					
	J120 Waste oil/water, hydrocarbons/water mixtures or emulsions					
	J160 Waste tarry residues arising from refining, distillation, & any pyrolytic treatment					
K Putrescible/ organic waste	K100 Animal effluent & residues (abattoir effluent, poultry & fish processing wastes)					
	K110 Grease trap waste					
	K140 Tannery wastes (incl. leather dust, ash, sludges & flours)					
	K190 Wool scouring wastes					
M Organic chemicals	M100 Waste substances & articles containing or contaminated with polychlorinated biphenyls, polychlorinated biphenyls					
	M150 Phenols, phenol compounds including chlorophenols					
	M160 Organo halogen compounds—other than substances referred to in this Table or Table 2					
	M170 Polychlorinated dibenzo-furan (any congener)					
	M180 Polychlorinated dibenzo-p-dioxin (any congener)					
	M210 Cyanides (organic)					
	M220 Isocyanate compounds					
	M230 Triethylamine catalysts for setting foundry sands					
	M250 Surface active agents (surfactants), containing principally organic constituents & which may contain					
	M260 Highly odorous organic chemicals (including mercaptans & acrylates)					
N Soil/ sludge	N100 Containers & drums that are contaminated with residues of substances referred to in this list					
	N120 Soils contaminated with a controlled waste					
	N140 Fire debris & fire wash waters					
	N150 Fly ash, excluding fly ash generated from Australian coal fired power stations					
	N160 Encapsulated, chemically-fixed, solidified or polymerised wastes referred to in this list					
	N190 Filter cake contaminated with residues of substances referred to in this list					
	N205 Residues from industrial waste treatment/disposal operations					
	N220 Asbestos					
	N230 Ceramic-based fibres with physico-chemical characteristics similar to those of asbestos					
	R100 Clinical & related wastes					
R Clinical and pharmaceutical	R120 Waste pharmaceuticals, drugs & medicines					
	R140 Waste from the production & preparation of pharmaceutical products					
T Miscellaneous	T100 Waste chemical substances arising from research & development or teaching activities, including t					
	T120 Waste from the production, formulation & use of photographic chemicals & processing materials					
	T140 Tyres					
	T200 Waste of an explosive nature not subject to other legislation					

Appendix B NEPM 75 codes links to waste groups

NEPM code	NEPM waste description	Waste group	Waste group description
A100	Waste resulting from surface treatment of metals and plastics	A	Plating & heat treatment
A110	Waste from heat treatment and tempering operations containing cyanides	A	
A130	Cyanides (inorganic)	A	
B100	Acidic solutions or acids in solid form	B	Acids
C100	Basic solutions or bases in solid form	C	Alkalis
D100	Metal carbonyls	Other D	Other inorganic chemicals
D110	Inorganic fluorine compounds excluding calcium fluoride	D110	Inorganic fluorine (SPL)
D120	Mercury; mercury compounds	D120	Mercury and compounds
D130	Arsenic; arsenic compounds	Other D	Other inorganic chemicals
D140	Chromium compounds (hexavalent and trivalent)	Other D	
D150	Cadmium; cadmium compounds	Other D	
D160	Beryllium; beryllium compounds	Other D	
D170	Antimony; antimony compounds	Other D	
D180	Thallium; thallium compounds	Other D	
D190	Copper compounds	Other D	
D200	Cobalt compounds	Other D	
D210	Nickel compounds	Other D	
D220	Lead; lead compounds	D220	Lead and compounds
D230	Zinc compounds	D230	Zinc compounds
D240	Selenium; selenium compounds	Other D	Other inorganic chemicals
D250	Tellurium; tellurium compounds	Other D	
D270	Vanadium compounds	Other D	
D290	Barium compounds (excluding barium sulphate)	Other D	Non-toxic salts
D300	Non-toxic salts	D300	
D310	Boron compounds	Other D	Other inorganic chemicals
D330	Inorganic sulfides	Other D	
D340	Perchlorates	Other D	
D350	Chlorates	Other D	
D360	Phosphorus compounds excluding mineral phosphates	Other D	
E100	Waste containing peroxides other than hydrogen peroxide	E	Reactive chemicals
F100	Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers and varnish	F	Paints, resins, inks, organic sludges
F110	Waste from the production, formulation and use of resins, latex, plasticisers, glues and adhesives	F	
G100	Ethers	G	Organic solvents
G110	Organic solvents excluding halogenated solvents	G	
G150	Halogenated organic solvents	G	
G160	Waste from the production, formulation and use of organic solvents	G	
H100	Waste from the production, formulation and use of biocides and phytopharmaceuticals	H	Pesticides
H110	Organic phosphorous compounds	H	
H170	Waste from manufacture, formulation and use of wood-preserving chemicals	H	

NEPM code	NEPM waste description	Waste group	Waste group description
J100	Waste mineral oils unfit for their original intended use	J100 & J160	Oils
J120	Waste oil/water, hydrocarbons/water mixtures or emulsions	J120	Waste oil/water mixtures
J160	Waste tarry residues arising from refining, distillation, and any pyrolytic treatment	J100 & J160	Oils
K100	Animal effluent and residues (abattoir effluent, poultry and fish processing wastes)	Other K	Other putrescible / organic wastes
K110	Grease trap waste	K110	Grease trap wastes
K140	Tannery wastes (including leather dust, ash, sludges and flours)	Other K	Other putrescible / organic wastes
K190	Wool scouring wastes	Other K	Other putrescible / organic wastes
M100	Waste substances and articles containing or contaminated with polychlorinated biphenyls, polychlorinated naphthalenes, polychlorinated terphenyls and/or polybrominated biphenyls	M100	PCB wastes
M150	Phenols, phenol compounds including chlorophenols	Other M	Other organic chemicals
M160	Organo halogen compounds—other than substances referred to in this Table or Table 2	M160a&b	POP BDEs and HBCD
		M160c	HCB
M170	Polychlorinated dibenzo-furan (any congener)	Other M	Other organic chemicals
M180	Polychlorinated dibenzo-p-dioxin (any congener)	Other M	
M210	Cyanides (organic)	Other M	
M220	Isocyanate compounds	Other M	
M230	Triethylamine catalysts for setting foundry sands	Other M	
M250	Surface active agents (surfactants), containing principally organic constituents and which may contain metals and inorganic materials	Other M	
M260	Highly odorous organic chemicals (including mercaptans and acrylates)	Other M	
			PFOS contaminated biosolids
M270	PFAS contaminated materials	M270a	PFAS contaminated biosolids
		M270b	PFAS contaminated soils
		M270c	AFFF concentrates
N100	Containers and drums that are contaminated with residues of substances referred to in this list	Other N	Other soil/sludges
N120	Soils contaminated with a controlled waste	N120	Contaminated soils
N140	Fire debris and fire wash waters	Other N	Other soil/sludges
N150	Fly ash, excluding fly ash generated from Australian coal fired power stations	Other N	
N160	Encapsulated, chemically-fixed, solidified or polymerised wastes referred to in this list	Other N	
N190	Filter cake contaminated with residues of substances referred to in this list	Other N	

NEPM code	NEPM waste description	Waste group	Waste group description
N205	Residues from industrial waste treatment/disposal operations	N205a	Other contaminated biosolids
		N205b	Other industrial treatment residues
N220	Asbestos		Asbestos containing material
		N220	
N230	Ceramic-based fibres with physico-chemical characteristics similar to those of asbestos	Other N	Other soil/sludges
R100	Clinical and related wastes	R	Clinical & pharmaceutical
R120	Waste pharmaceuticals, drugs and medicines	R	
R140	Waste from the production and preparation of pharmaceutical products	R	
T100	Waste chemical substances arising from research and development or teaching activities, including those which are not identified and/or are new and whose effects on human health and/or the environment are not known	Other T	Other miscellaneous
T120	Waste from the production, formulation and use of photographic chemicals and processing materials	Other T	
T140	Tyres	T140	Tyres
T200	Waste of an explosive nature not subject to other legislation	Other T	Other miscellaneous